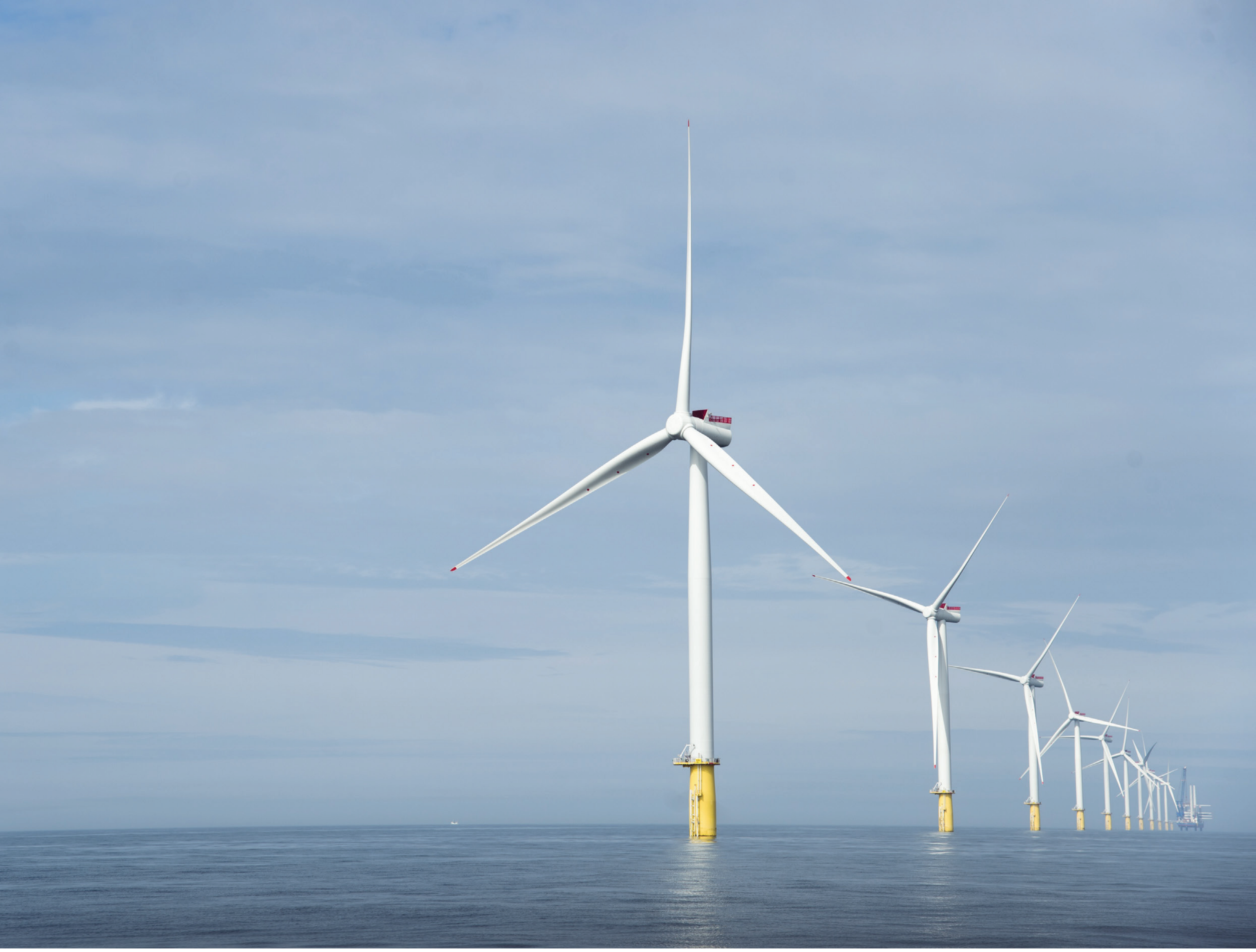

Sheringham Shoal and Dudgeon Offshore Wind Farm Extension Projects

Environmental Statement

Volume 1

Chapter 8 - Benthic Ecology

August 2022
Document Reference: 6.1.8
APFP Regulation: 5(2)(a)

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<tr><td colspan="3">Title:
Sheringham Shoal and Dudgeon Offshore Wind Farm Extension Projects Environmental Statement
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<tr><td colspan="3">PINS document no.:
6.1.8</td></tr>
<tr><td colspan="3">Document no.:
C282-RH-Z-GA-00028</td></tr>
<tr><td>Date:</td><td colspan="2">Classification</td></tr>
<tr><td>August 2022</td><td colspan="2">Final</td></tr>
<tr><td colspan="2">Prepared by:</td><td rowspan="2"></td></tr>
<tr><td colspan="2">Royal HaskoningDHV</td></tr>
<tr><td colspan="2">Approved by:</td><td>Date:</td></tr>
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Glossary of Acronyms

AoO	Advice on Operations
BAP	Biodiversity Action Plan
BEIS	Department for Business, Energy and Industrial Strategy
BGS	British Geological Survey
BSL	Below Sea Level
BTO	British Trust for Ornithology
BWN	International Convention for the Control and Management of Ships' Ballast Water and Sediments
CIA	Cumulative Impact Assessment
CIEEM	Chartered Institute of Ecology and Environmental Management
CSCB	Cromer Shoal Chalk Beds
CSIMP	Cable Specification, Installation and Monitoring Plan
CSQC	Canadian Sediment Quality Guidelines
DBT	Dibutyltin
DCO	Development Consent Order
DDV	Drop-Down Video
DEP	Dudgeon Offshore Wind Farm Extension Project
DML	Deemed Marine Licence
EAC	Environmental Quality Standards
EEA	European Economic Area
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EIFCA	Eastern Inshore Fisheries Conservation Authority
EMF	Electro-Magnetic Field
EPP	Evidence Plan Process
EQS	Environmental Quality Standard
ER-Ls	Effects Range Lows
ES	Environmental Statement
ETG	Expert Topic Group
EU	European Union
EUNIS	European Nature Information System
FEPA	Food and Environment Protection Act

FERA	Food and Environment Research Agency
FOCI	Feature of Conservation Interest
GBS	Gravity Base Structure
HDD	Horizontal Directional Drilling
ICBS	Interim Cable Burial Study
IEEM	Institute of Ecology and Environmental Management
INNS	Invasive Non-Native Species
IPC	Infrastructure Planning Commission
IPMP	In-Principle Monitoring Plan
JNCC	Joint Nature Conservation Committee
MarESA	Marine Evidence based Sensitivity Assessment
MarLIN	Marine Life Information Network
MARPOL	International Convention for the Prevention of Pollution from Ships
MBT	Monobutyltin
MCZ	Marine Conservation Zone
MCZA	Marine Conservation Zone Assessment
MMO	Marine Management Organisation
MPA	Marine Protected Area
MPS	Marine Policy Statement
MW	Megawatts
NBN	National Biodiversity Network
NE	Natural England
NNDC	North Norfolk Coast District Council
NPL	National Physical Laboratory
NPS	National Policy Statement
NSIP	Nationally Significant Infrastructure Project
OfTO	Offshore Transmission Owner
OSP	Offshore Substation Platform
OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantic
OWF	Offshore Wind Farm
PAH	Polycyclic Aromatic Hydrocarbons
PEIR	Preliminary Environmental Information Report

PEL	Probable Effect Level
PEMP	Project Environmental Management Plan
PLGR	Pre-lay grapnel run
PSD	Particle Size Distribution
RIAA	Report to Inform Appropriate Assessment
SAC	Special Area of Conservation
SEP	Sheringham Shoal Offshore Wind Farm Extension Project
SMP	Shoreline Management Plan
SMRU	Sea Mammal Research Unit
SNCB	Statutory Nature Conservation Body
SPA	Special Protection Area
SSC	Suspended Sediment Concentrations
TBT	Tributyltin
TEL	Threshold Effect Level
THC	Total hydrocarbons
TNT	Trinitrotoluene
TWT	The Wildlife Trusts
UK	United Kingdom
UNCLOS	The United Nations Convention on the Law of the Sea
UXO	Unexploded Ordnance
WCS	Worst Case Scenario

Glossary of Terms

Dudgeon Offshore Wind Farm Extension Project (DEP)	The Dudgeon Offshore Wind Farm Extension onshore and offshore sites including all onshore and offshore infrastructure.
DEP offshore site	The Dudgeon Offshore Wind Farm Extension consisting of the DEP wind farm site, interlink cable corridors and offshore export cable corridor (up to mean high water springs).
DEP onshore site	The Dudgeon Offshore Wind Farm Extension onshore area consisting of the DEP onshore substation site, onshore cable corridor, construction compounds, temporary working areas and onshore landfall area.
DEP North array area	The wind farm site area of the DEP offshore site located to the north of the existing Dudgeon Offshore Wind Farm
DEP South array area	The wind farm site area of the DEP offshore site located to the south of the existing Dudgeon Offshore Wind Farm
DEP wind farm site	The offshore area of DEP within which wind turbines, infield cables and offshore substation platform/s will be located and the adjacent Offshore Temporary Works Area. This is also the collective term for the DEP North and South array areas.
European site	Sites designated for nature conservation under the Habitats Directive and Birds Directive. This includes candidate Special Areas of Conservation, Sites of Community Importance, Special Areas of Conservation, potential Special Protection Areas, Special Protection Areas, Ramsar sites, proposed Ramsar sites and sites compensating for damage to a European site and is defined in regulation 8 of the Conservation of Habitats and Species Regulations 2017, although some of the sites listed here are afforded equivalent policy protection under the National Planning Policy Framework (2021) (paragraph 176) and joint Defra/Welsh Government/Natural England/NRW Guidance (February 2021).
Evidence Plan Process (EPP)	A voluntary consultation process with specialist stakeholders to agree the approach, and

	information to support, the EIA and HRA for certain topics.
Expert Topic Group (ETG)	A forum for targeted engagement with regulators and interested stakeholders through the EPP.
Grid option	Mechanism by which SEP and DEP will connect to the existing electricity network. This may either be an integrated grid option providing transmission infrastructure which serves both of the wind farms, or a separated grid option, which allows SEP and DEP to transmit electricity entirely separately.
Horizontal directional drilling (HDD)	Trenchless technique used to install cables – in this case referring to the installation of the export cables at the landfall.
Horizontal directional drilling (HDD) zones	The areas within the onshore cable route which would house HDD entry or exit points.
Infield cables	Cables which link the wind turbine generators to the offshore substation platform(s).
Interlink cables	Cables linking two separate project areas. This can be cables linking: 1) DEP South array area and DEP North array area 2) DEP South array area and SEP 3) DEP North array area and SEP 1 is relevant if DEP is constructed in isolation or first in a phased development. 2 and 3 are relevant where both SEP and DEP are built.
Interlink cable corridor	This is the area which will contain the interlink cables between offshore substation platform/s and the adjacent Offshore Temporary Works Area.
Integrated Grid Option	Transmission infrastructure which serves both extension projects.
Jointing bays	Underground structures constructed at regular intervals along the onshore cable route to join sections of cable and facilitate installation of the cables into the buried ducts.

Landfall	The point at the coastline at which the offshore export cables are brought onshore, connecting to the onshore cables at the transition joint bay above mean high water.
Offshore cable corridors	This is the area which will contain the offshore export cables or interlink cables, including the adjacent Offshore Temporary Works Area.
Offshore export cable corridor	This is the area which will contain the offshore export cables between offshore substation platform/s and landfall, including the adjacent Offshore Temporary Works Area.
Offshore export cables	The cables which would bring electricity from the offshore substation platform(s) to the landfall. 220 – 230kV.
Offshore scoping area	An area presented at Scoping stage that encompassed all planned offshore infrastructure, including landfall options at both Weybourne and Bacton, allowing sufficient room for receptor identification and environmental surveys. This has been refined following further site selection and consultation for the PEIR and ES.
Offshore substation platform (OSP)	A fixed structure located within the wind farm site/s, containing electrical equipment to aggregate the power from the wind turbine generators and convert it into a more suitable form for export to shore.
Offshore Temporary Works Area	An Offshore Temporary Works Area within the offshore Order Limits in which vessels are permitted to carry out activities during construction, operation and decommissioning encompassing a 200m buffer around the wind farm sites and a 750m buffer around the offshore cable corridors. No permanent infrastructure would be installed within the Offshore Temporary Works Area.
Onshore cable corridor	The area between the landfall and the onshore substation sites, within which the onshore cable circuits will be installed along with other temporary works for construction.
Onshore export cables	The cables which would bring electricity from the landfall to the onshore substation. 220 – 230kV.

Onshore Substation	Compound containing electrical equipment to enable connection to the National Grid.
Order Limits	The area subject to the application for development consent, including all permanent and temporary works for SEP and DEP.
PEIR boundary	The area subject to survey and preliminary impact assessment to inform the PEIR.
Separated Grid Option	Transmission infrastructure which allows each project to transmit electricity entirely separately.
Sheringham Shoal Offshore Wind Farm Extension Project (SEP)	The Sheringham Shoal Offshore Wind Farm Extension onshore and offshore sites including all onshore and offshore infrastructure.
SEP offshore site	Sheringham Shoal Offshore Wind Farm Extension consisting of the SEP wind farm site and offshore export cable corridor (up to mean high water springs).
SEP onshore site	The Sheringham Shoal Wind Farm Extension onshore area consisting of the SEP onshore substation site, onshore cable corridor, construction compounds, temporary working areas and onshore landfall area.
SEP wind farm site	The offshore area of SEP within which wind turbines, infield cables and offshore substation platform/s will be located and the adjacent Offshore Temporary Works Area.
Study area	Area where potential impacts from the project could occur, as defined for each individual Environmental Impact Assessment (EIA) topic.
The Applicant	Equinor New Energy Limited

8 BENTHIC ECOLOGY

8.1 Introduction

1. This chapter of the Environmental Statement (ES) considers the potential impacts of the proposed Sheringham Shoal Offshore Wind Farm Extension Project (SEP) and Dudgeon Offshore Wind Farm Extension Project (DEP) on benthic ecology. The chapter provides an overview of the existing environment for the proposed offshore sites, followed by an assessment of the potential impacts and associated mitigation for the construction, operation and decommissioning phases of SEP and DEP.

2. This chapter has been written by Royal HaskoningDHV, with the assessment undertaken with specific reference to the relevant legislation and guidance, of which the primary source are the National Policy Statements (NPS). Details of these and the methodology used for the Environmental Impact Assessment (EIA) and Cumulative Impact Assessment (CIA) are presented in **Section 8.4**.

3. The assessment should be read in conjunction with the following linked chapters and supporting documents:
   - **Chapter 6 Marine Geology, Oceanography and Physical Processes**;
   - **Chapter 7 Marine Water and Sediment Quality**;
   - **Chapter 9 Fish and Shellfish Ecology**;
   - **Chapter 10 Marine Mammal Ecology**;
   - **Chapter 11 Offshore Ornithology**; And
   - **Stage 1 Cromer Shoal Chalk Beds (CSCB) Marine Conservation Zone Assessment (MCZA)** (document reference 5.6).

4. Additional information to support the benthic ecology assessment includes:
   - **Appendix 8.1 DEP Benthic Characterisation Report**;
   - **Appendix 8.2 SEP Benthic Characterisation Report**;
   - **Appendix 8.3 DEP Benthic Habitat Report**;
   - **Appendix 8.4 SEP Benthic Habitat Report**;
   - **Appendix 8.5 SEP and DEP Habitat Mapping**; and
   - **Appendix 8.6 Benthic Ecology Sensitivity MarESA**.

8.2 Consultation

5. Consultation with regard to benthic ecology has been undertaken in line with the general process described in **Chapter 5 EIA Methodology** and the **Consultation Report** (document reference 5.1). The key elements to date have included scoping, the ongoing Evidence Plan Process (EPP) via the Seabed Expert Topic Group (ETG) and the Preliminary Environmental Information Report (PEIR).

6. The feedback received throughout this process has been considered in preparing the ES. **Table 8-1** provides a summary of the consultation responses received to date relevant to this topic and details of how these have been addressed .

7. Details of consultation relating to the MCZA has been included in the **Stage 1 CSCB MCZA** (document reference 5.6) and has not been repeated here.

8. The consultation process is described further in **Chapter 5 EIA Methodology**. Full details of the consultation process are presented in the **Consultation Report** (document reference 5.1), which has been submitted as part of the DCO application.

Table 8-1: Consultation Responses

Consultee	Date / Document	Comment Received	Project Response
Scoping Opinion and ETG Meetings			
Habitat Loss			
Planning Inspectorate	Scoping Opinion, 19/11/19	The Scoping Report proposes to assess permanent habitat loss during operation and decommissioning only. A number of construction activities have the potential to result in a degree of habitat loss during construction. The Inspectorate considers that 'temporary habitat loss' should be scoped in for all phases of the Proposed Development as any interaction with the sea bed may cause loss of habitat for some species. This should include as assessment of likely significant effects from cable protection. The consultation responses from the MMO and NE support this position. The Inspectorate therefore does not agree that construction phase effects can be scoped out of the assessment.	Temporary habitat loss/disturbance is assessed during construction in (**Section 8.6.2.1**) operation (**Section 8.6.3.1**) and decommissioning (**Section 8.6.4**). Potential long term habitat loss due to external cable protection installation is assessed during operation in **Section 8.6.3.3**; and potential permanent habitat loss is assessed in **Section 8.6.3.2** for any infrastructure proposed to be decommissioned *in situ*. The assessment is based on the worst-case area of sea bed that may be affected for each project (in isolation and if SEP and DEP are both built).
Planning Inspectorate	Scoping Opinion, 19/11/19	The ES should assess the significant effects associated with temporary habitat loss which could arise from construction activities that extend beyond the permanent footprint of the infrastructure, for example from construction vessels' extendible legs and anchors.	
Planning Inspectorate	Scoping Opinion, 19/11/19	The ES should assess any likely significant effects resulting from the loss of habitat due to scour, scour protection and altered sedimentary processes.	
MMO	Scoping Opinion, 19/11/19	The potential impact of 'Permanent habitat loss' has been scoped in under the operation phase of the development in Table 2-8. While there is a recognition that the exact nature and design of turbine foundation remains unknown, all available types result in a degree of habitat loss during the construction phase. The MMO recommend including reference to the maximum area of sea bed that may be affected (e.g. a total of 61 turbine with gravity base	

Consultee	Date / Document	Comment Received	Project Response
		foundations), in relation to the SEP and DEP area for lease, to help justify the scoping decision.	
Sediment deposition			
Natural England	Sea bed Expert Topic Group 03/02/2021	How will the project ensure that sea bed sediments moved as a result of the works will be deposited in an environment of a similar nature and will avoid sensitive habitats etc. It is recommended that this is considered as part of the assessment. Consideration of sediment deposition on as part of benthic ecology assessment is required.	Embedded mitigation for the project (**Section 8.3.2**) states that any sediment removed from the Cromer Shoal Chalk Beds Marine Conservation zone (CSCB MCZ) will be deposited within the MCZ in areas similar to the habitat removed. **Section 8.6.2.2** (construction), **Section 8.6.3.4** (operation) and Section 8.6.4 (decommissioning) assesses impacts of sediment deposition on benthic ecology.
Contaminated sediments			
Planning Inspectorate	Scoping Opinion, 19/11/19	Table 2-8 of the Scoping Report proposes to scope out re-mobilisation of contaminated sediments during operation, however there is no text within the chapter to support this approach. For the reasons given above in Table 4.2 of this Opinion, and as the Scoping Report scopes in this matter for effects to fish and shellfish, the Inspectorate does not consider it has sufficient information to scope this matter out. Any likely significant effects should be assessed within the ES.	Impacts on benthic ecology receptors from re-mobilisation of contaminated sediments are assessed in **Section 8.6.2.3**, in relation to construction. This explains that due to there being no contaminated sediments above levels of concern within SEP and DEP offshore sites there is no pathway for effect to benthic receptors. Therefore, there is no impact for all scenarios and the impact is not considered further in relation to operation or decommissioning due to there being no pathway for impact on benthic receptors.
Underwater noise			
Planning Inspectorate	Scoping Opinion, 19/11/19	The Scoping Report proposes to scope out underwater noise and vibration during the operational phase. This is on the basis that monitoring studies of operational turbines (North Hoyle, Scroby Sands, Kentish Flats and Barrow wind farms) have shown noise levels from wind farms to be only	Impacts to benthic ecology due to underwater noise and vibration during the operational phase have been assessed in **Section 8.6.3.6.**

Consultee	Date / Document	Comment Received	Project Response
		marginally above ambient noise levels and there is no evidence to suggest that this low level of noise and vibration has a significant effect on benthic ecology. The Inspectorate is concerned that the evidence presented within the Scoping Report to support the proposed scope of works may not be comparable to conditions likely to prevail for the SEP and DEP. The Inspectorate is also aware of current evidence gaps supporting the proposed approach in relation to vibration. The consultation responses from the MMO and NE both point to concerns in this regard. The Inspectorate considers that an assessment of the likely significant effects associated with these matters should be included in the ES. The Applicant is encouraged to make effort to agree the extent of any such assessment with relevant statutory consultation bodies including the MMO and NE.	
Natural England	Scoping Opinion, 19/11/19	Underwater noise: Please be advised that the EIA will need to clearly demonstrate that data from previous R1 and 2 OWF remains fit for purpose for the larger turbines and electrical systems now used across industry. This has not been presented here in order for us to agree to it being scoped out.	Impacts to benthic ecology due to underwater noise and vibration during the operational phase has been assessed in **Section 8.6.3.6**.
Planning Inspectorate	Scoping Opinion, 19/11/19	The Inspectorate welcomes the intent to assess effects from underwater noise and vibration during the construction and decommissioning phases. The Applicant should make effort to agree the methodology with the relevant consultation bodies and it should be clearly explained within the ES. The baseline environment should be established and potential noise and vibration impacts assessed against this baseline. The criteria/thresholds used to determine the likely significance of effect should be clearly explained and justified, based on scientific publications, where available.	The baseline for benthic ecology is presented in **Section 8.5**. The methodology for the impact assessment is presented in **Section 8.4.3**.
Invasive Non-Native Species (INNS)			

Consultee	Date / Document	Comment Received	Project Response
Planning Inspectorate	Scoping Opinion, 19/11/19	The Scoping Report states that the introduction of artificial hard substrates and the use of vessels during construction could encourage the influx of invasive species, the effect of which will be assessed during operation. The Inspectorate considers the effects of invasive species should be assessed throughout the lifetime of the Proposed Development. The ES should identify and assess any likely significant effects associated with the potential introduction and spread of INNS, including the colonisation of hard substrates, in the marine environment from offshore works. Any measures to prevent or reduce these effects should be described in the ES.	INNS is assessed in the construction phase (**Section 8.6.2.5**) and in the operational phase (**Section 8.6.3.7**).
Marine Management Organisation (MMO)	Scoping Opinion, 19/11/19	The potential impact of 'Invasive species' has been scoped out of the construction phase of the development. The MMO recommend that further justification is included, e.g., mitigation measures for vessels/platforms involved in the construction of the SEP and DEP to ensure they are free from non-native species	
Cable Protection			
Natural England	Scoping Opinion, 19/11/19	Cable protection: Please be advised that a joint position paper between the MMO and Natural England is currently being drafted in relation to the place of cable protection. This position will clearly define the parameters for what is considered a construction impact, maintenance over the life time of the project, additional O&M placement and decommissioning. Currently the impacts from the use of cable protection are considered to be construction/installation and should be assessed as such recognising that this phase can last several years. In addition it is Natural England advice that cable protection is a permanent/long lasting impact not just during the lifetime of the project, but also beyond as there is currently no evidence to support the successful removal.	Temporary habitat loss/disturbance is assessed during construction (**Section 8.6.2.1**), operation (**Section 8.6.3.1**) and decommissioning (**Section 8.6.4**). Long term habitat loss is assessed in **Section 8.6.3.2**, and permanent habitat loss in **Section 8.6.3.2** for any cable protection not removed.

Consultee	Date / Document	Comment Received	Project Response
		Especially within designated sites where remove is likely to further impact on the interest feature of the site.	
Natural England	ETG1, 30/10/2019	In principle Natural England is not against a 'no cable protection solution' but stated that they would be concerned of the risk of the Offshore Transmission Owner (OfTO) requiring burial post-consent and subsequent risk to the designated site conservation objectives. NE would also be concerned about later exposure of buried cable requiring protection post-consent.	Noted. Cables will be buried where possible, minimising the requirement for external cable protection measures and thus minimising habitat loss impacts to benthic ecology receptors.
Habitat Creation			
Planning Inspectorate	Scoping Opinion, 19/11/19	The Inspectorate agrees that effects are unlikely to be significant during construction and that this matter can therefore be scoped out. However, any likely significant effects to colonisers of artificial substrates from decommissioning activities should be assessed.	The assessment of permanent habitat loss is assessed during decommissioning as a worst-case scenario due to the fact that the artificial structures, where benthic receptors have the potential to colonise, may remain *in situ*, therefore in the worst-case scenario that is assessed the colonisers will also remain *in situ*, therefore this impact has not been assessed. If the artificial structures are removed then an assessment of impacts to colonisers will be undertaken at the point of decommissioning, as stated in **Section 8.6.4.**
Planning Inspectorate	Scoping Opinion, 19/11/19	The Scoping Report states that there may be beneficial impacts such as habitat creation during operation. Any increase and/or change in biodiversity and species abundance as a result of the Proposed Development may not necessarily be beneficial if it is not representative of sea bed/designated site features. This should be taken into account in the Applicant's assessment.	Habitat creation during operation as a result of colonisation of foundations and cable protection is assessed in **Section 8.6.3.5**. The impacts of change in habitat and associated biodiversity and species abundance as a result of the addition of the new artificial hard substrate are assessed in **Section 8.6.3.3** (for long term habitat loss) and **Section 8.6.3.2** (for permanent habitat loss).
Natural England	Scoping Opinion, 19/11/19	Habitat Creation: Please be advised that any increase and/or change in biodiversity and species abundance as a result of	

Consultee	Date / Document	Comment Received	Project Response
		the OWF and associated infrastructure may not be beneficial as not representative of sea bed/designated site features.	
Designated sites and species			
Planning Inspectorate	Scoping Opinion, 19/11/19	The Scoping Report identifies the potential for *S. spinulosa* reef to be present in the application site. The ES should assess any impacts occurring during construction and also any potential impacts occurring during maintenance activities on reef that may colonise the cables during the operational phase.	Project surveys did not record any Annex I biogenic reefs. Biogenic reef that develops on artificial substrate such as external cable protection is not considered Annex I habitat as it would not naturally occur at the location. Impacts on *S. spinulosa* reef that may develop on the sea bed in the vicinity of buried cables are assessed for operation (**Section 8.6.3**).
MMO	Scoping Opinion, 19/11/19	The data sources presented in Table 2-9 are relevant and the characterisation surveys proposed in Table 2-10 are suitable. However, if the cable route is re-routed to avoid the MCZ, further data will need to be obtained as the area to the west of the MCZ is data poor.	N/A. The cable corridor has not been re-routed to avoid the MCZ.
Natural England	Scoping Opinion, 19/11/19	For designated site features please determine sensitivity using conservation advice packages and advice on operations.	Conservation advice packages and advice on operations were used to determine sensitivity of designated site features, presented in the baseline in **Appendix 8.6**.
Natural England	Sea bed ETG2, 02/06/2020	Subtidal chalk feature does not have to be at the surface to be a feature of the site and therefore Natural England disagrees the chalk feature was only identified near the shore and extends further and covers most of the area – this position is considered necessary so as to be consistent with advice given to fisheries. Natural England stated that the assessment needs to make a distinction between outcropping and subcropping chalk features.	The distribution of outcropping subtidal chalk is described in **Section 8.5**. Further information is available in the **Stage 1 CSCB MCZA** (document reference 5.6).
Cumulative Impact Assessment			

Consultee	Date / Document	Comment Received	Project Response
The Planning Inspectorate	Scoping Opinion, 19/11/19	The cumulative effects assessment should assess impacts on fisheries management areas that could potentially interact with the Proposed Development and where significant effects are likely to occur.	Cumulative impacts are assessed in **Section 8.7** which includes consideration of impacts from fisheries management.
MMO	Scoping Opinion, 19/11/19	For the cumulative impact assessment, and especially for the nearshore zone (landfall), the MMO advises that the local Shoreline Management Plan should be included in the considerations of impacts, especially as the minimum expected operational life of the projects will be 30 years and that a full list of nearby developments/schemes should be provided and considered.	Cumulative impacts are assessed in **Section 8.7** and include consideration of the relevant shoreline management plan. The SEP and DEP export cable corridor landfall is located within Policy Unit 6.01 of the Kelling Hard to Lowestoft Ness Shoreline Management Plan (SMP) (AECOM, 2010). The policy in this area is to allow natural processes to take place, i.e. allow coastal retreat through a policy of no active intervention on the open coast. HDD at landfall will avoid direct impact on the coastline. Erosion would continue as a natural phenomenon driven by waves and subaerial processes, which would not be affected by SEP and DEP.
Natural England	Scoping Opinion, 19/11/19	Please be advised that fisheries management areas will need to be considered as a plan or project.	Cumulative impacts are assessed in **Section 8.7** which includes consideration of impacts from fisheries management.
Benthic survey			
MMO	Scoping Opinion, 19/11/19	The precise benthic survey design to aid site characterisation currently remains unknown. However, the approach presented in the scoping report states that habitat maps will be made following interpretation of geophysical data. The MMO recommend that acoustic data are first interpreted and used to inform the placement of sampling stations for ground truthing, using the methods proposed (sediment samples and sea bed imagery), before any habitat maps are created to ensure a more accurate assessment.	The benthic survey design, including the locations of sampling stations, has been informed by a review of geophysical acoustic data. The results of the benthic sampling survey were then used to classify acoustic data to produce habitat maps as described in **Appendix 8.5 SEP and DEP Habitat Mapping**.

Consultee	Date / Document	Comment Received	Project Response
MMO	Scoping Opinion, 19/11/19	Furthermore, it is recommended that the location of suitable reference areas is considered at this stage to aid with future monitoring requirements (for both extension projects and the current Dudgeon and Sheringham OWFs).	A subset of the benthic survey stations were grab sampled in triplicate so that statistically robust assessment can be made by future monitoring surveys.
Natural England	Scoping Opinion, 19/11/19	Please be advised that Natural England advises against undertaking benthic surveys during the winter months in this location due to prevailing weather conditions and ability to collect satisfactory data sets. Case example is the Sheringham Shoal pre- construction benthic survey. In addition, the use of sub-bottom profilers along the Bacton export cable route should be avoided in the winter months due to potential impacts to marine mammals within the Southern North Sea SAC. Natural England notes that no geotechnical investigations are included. We advise that as a minimum there would need to be some geotechnical investigations done pre- application to understand the feasibility of cable installation within the MCZ (see also comments on paragraph 204). These would need to be licenced through the MMO and would need to follow after the benthic surveys to demonstrate that there would be a significant impact to the features from the geotechnical surveys themselves. We would therefore expect a Preliminary Trenching Assessment (as done by Hornsea P3) or A cable installation assessment (Vanguard) to be provided as part of the project application.	The project geophysical surveys (using a sub-bottom profiler) were completed between September and December 2019 (offshore cable corridors, including the Bacton corridor) and between March and May 2020 (wind farm sites and interlink cable corridors) and therefore avoided the winter months. The project benthic surveys were completed in August 2020 and therefore avoided the winter months. No pre-application geotechnical surveys are planned. Existing geotechnical information, particularly evidence obtained from installing the nearby Dudgeon Offshore Wind Farm (OWF) export cable, has been used to inform an **Outline CSCB MCZ Cable Specification, Installation and Monitoring Plan (CSIMP)** (document reference 9.7) submitted with the DCO application.
Cefas	ETG3, 03/02/2021	Cefas noted that mixed and coarse sediment areas usually overlap with each other, this type of habitat with the addition of muddier sediments could provide habitat for different species.	A mosaic of similar subtidal course and mixed sediments was identified by project surveys with the distinction between them based on variations in the low proportion of fine sediment, that were sufficient to influence the macrofaunal communities present (**Section 8.5.5.1.3**).

Consultee	Date / Document	Comment Received	Project Response
Interactions with other chapters			
MMO	Scoping Opinion, 19/11/19	It is clearly stated in the text that "The Marine Geology, Oceanography and Physical Processes assessment is likely to have key inter-relationships with Marine Water and Sediment Quality, Benthic and Intertidal Ecology and Fish and Shellfish Ecology and these will be considered where relevant throughout the EIA process" (Chapter 2.1.2), but there is no further information provided on how this assessment will be done. As the combination of activities within the development project could lead to significant impacts, further explanation should be given accordingly.	Impact interactions are considered in **Section 8.10**, which includes interactions between marine geology, oceanography and physical processes and benthic ecology.
Scoping Report			
MMO	Scoping Opinion, 19/11/19	Section 2.3 'Benthic Ecology', (line 256, page 69) incorrectly summarises the Dudgeon OWF post-construction monitoring report. The MMO recommend that the sentence "The overall conclusion of the Dudgeon post-construction monitoring is that there are no significant differences in the benthic communities due to the construction of the wind farm." is removed from the scoping report. Prior advice on the Dudgeon OWF post-construction monitoring report has highlighted significant differences between the pre- and post-construction benthic assemblage.	A summary of the Dudgeon OWF (DOW) post-construction monitoring report is provided in **Section 8.4.2**.
MMO	Scoping Opinion, 19/11/19	Not all protected features presented in the designation order of the Cromer Shoal Chalk Beds MCZ are included in the scoping report (line 265, page 70). Please amend the report accordingly.	All features of the CSCB MCZ are presented in the baseline in **Section 8.5.5.1**.
Transboundary			
Planning Inspectorate	Scoping Opinion, 19/11/19	The Scoping Report states that effects on Benthic and Intertidal Ecology are likely to be restricted to the Proposed Development boundary and the immediate surrounding area.	

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		Having regard to the location of the Proposed Development (a minimum of 100km from any international territory boundary), the nature of potential impacts to benthic and intertidal ecology, the Inspectorate considers that transboundary impacts are unlikely to result in significant effects and therefore can be scoped out of the ES.	Transboundary impacts to benthic ecology have been scoped out. Justification for this is provided in **Section 8.8**.
MMO	Scoping Opinion, 19/11/19	Regarding transboundary impacts, the applicant suggests that they are unlikely to occur or if they do, it's unlikely that they will be significant. No information is provided on how they have reached this conclusion. The text should be revised accordingly, and this conclusion should be further explained and better justified.	
EMF			
Planning Inspectorate	Scoping Opinion, 19/11/19	The Scoping Report proposes to scope out the assessment of effects from EMF on benthic species as any impacts are likely to be highly localised and impacts from EMFs are strongly attenuated decreasing as an inverse square of distance from the cable. The Scoping Report references studies which show EMFs do not impact benthic species and habitats. The Inspectorate considers that the evidence presented by in the Scoping Report is sufficient to demonstrate no likely significant effects in this regard and this matter can be scoped out of the ES	EMF has been scoped out in agreement with advice from Natural England and the MMO, as per the scoping response.
MMO	Scoping Opinion, 19/11/19	Potential impacts from Electromagnetic Fields (EMF) on benthic invertebrates have also been scoped out with the justification that there is a lack of evidence to suggest impact. The MMO agree with this justification. Note that while Bochert & Zettler (2006) did conclude that the distributions of the brown shrimp Crangon, common starfish *Asterias rubens* and polychaete worm Hediste diversicolor do not change when exposed to EMF, the experimental conditions were much	

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		lower salinity (10 psu) than is typically found in the North Sea (~35 psu).	
Natural England	Scoping Opinion, 19/11/19	EMF should not be completely scoped out of the EIA, but Natural England agrees that it can be for benthic ecology.	
Natural England, MMO, Cefas, TWT.	Seabed ETG Agreement Log	Agreement that the baseline should describe all subtidal and intertidal habitats and species with potential to be impacted by the projects with a focus on the MCZ and any other particularly sensitive receptors identified.	The baseline describes all subtidal habitats and species with the potential to be impacted by the project in **Section 8.5**. Intertidal habitats have been scoped out of the assessment due to there being no pathway for impact to intertidal habitats due to the use of HDD to approximately 1,000m offshore in the subtidal (**Table 8-3**). This was agreed at the sea bed ETG4 meeting on the 16th of August 2021 with Natural England and the MMO (see below).
Cefas	Seabed ETG 4, 16/08/2021	Requested that contingency be added to the volumes. Just in case you need extra volumes in case you need to bury deeper than expected or profiles are different. Or sandwave fields, which can be variable. Please consider the range of sediment disposal volumes.	Contingency for sediment disposal has been incorporated during selection of the worst-case design parameters which have fed into the worst-case scenario calculation (**Table 8-2**).
Section 42 Responses			
North Norfolk Coast District Council	PEIR Response June 2021	NNDC would defer to the advice of Natural England and the Marine Management Organisation and other experts in respect of matters within this Chapter of the PEIR.	Noted.
Worst-Case Scenario (WCS)			
Natural England	PEIR Response June 2021	Project Definition: The SEP and DEP together options result in confusion in defining the integrated and separated grid options, with the option for sequential or simultaneous build. Further, DEP is split into two areas, DEPN and DEPS, with resulting variation in interlink / export cable corridor options.	Further information has been provided in **Chapter 4 Project Description** and **Table 8-2** to clearly describe the differences between the different options and the reasons for the selection of the WCS.

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Natural England	PEIR Response June 2021	WCS: The WCS for SEP and DEP together includes options for separated or integrated options, built sequentially or simultaneously. The WCS interchanges between these options and for clarity, the WCS for each 'together' option would be better presented as a separate column in the relevant table of impacts. This would help in the event that one of the options becomes an obvious choice for development.	The construction programme for SEP and DEP (built sequentially or concurrently) is not referenced in the WCS table (**Table 8-2**) as it does not have a bearing on the worst-case project parameters. However, where relevant, it is considered in the impact assessment in **Section 8.6** as it does have a bearing on the magnitude of impacts. Where relevant, within each impact assessment it is stated whether it is a sequential or concurrent construction programme depending on which is considered to be the worst-case for the impact in question. In relation to the grid options when SEP and DEP are both built, the worst-case scenario table (**Table 8-2**) has been differentiated by the number of OSPs required (i.e. one or two) as this determines the worst-case footprints and volumes that are assessed. The worst-case scenario for each project component for SEP and DEP has been specified in the table to show what has been assessed as a worst-case in **Section 8.6**.
Natural England	PEIR Response June 2021	Section 10.3.2.1 As comments on Chapter 5 Project Description, the WCS for SEP and DEP together includes options for separate or integrated options, built sequentially or simultaneously. The WCS interchanges between these options and for clarity, the WCS for each of these options would be better presented as a separate column.	
TWT	PEIR Response June 2021	It is important that the worst-case scenarios are assessed. TWT is happy to discuss and consider realistic worst-case scenarios as long as this is the limit to be included in the DCO.	
Natural England	PEIR Response June 2021	Natural England position on WCS: Natural England does not agree with all WCS presented in this chapter mainly due to lack of clarity or apparent miscalculations.	The WCS have been updated in **Table 8-2**. Further information has been provided in **Chapter 4 Project Description.**
Natural England	PEIR Response June 2021	Assessment conclusion: until greater clarity is presented on the impacts it is difficult for NE to agree with the conclusions.	
Natural England	PEIR Response June 2021	10.3.2.1 / Table 10-2 Construction Impact 1: DEP in isolation is cited as 267km–the length of cables from the breakdown in this column (62km + 135km +66km) totals 263km.	Noted, this has been amended in **Table 8-2**.

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Natural England	PEIR Response June 2021	10.3.2.1 / Table 10-2 The calculations summarised within this table require acceptance that the calculations are correct. Details of the parameters or calculations should be included for transparency. Whilst most can be cross checked, not all are possible. It would also be helpful to cross reference to the appropriate paragraph/table within Chapter 5 or to provide expanded detail.	Further information has been provided in **Chapter 4 Project Description** and **Table 8-2**.
Natural England	PEIR Response June 2021	10.3.3.1 / Table 10-3 Sediment disposal. We welcome the intention for sediment disposal to return material within the MCZ at or close to the source, to ensure that it remains within the site. Further, we welcome the intention that sediment will be deposited within an area of similar sediment type, site to ensure any sensitive habitats are avoided. Natural England would welcome the opportunity to be consulted on the location of any such disposal site as part of the pre-application process	Offshore disposal of sediment will take place within tens of meters of the source, either near the sea bed or at the sea surface. Further information has been provided in the **Disposal Site Characterisation Report** (document reference 9.13) which has been submitted with the DCO application.
TWT	PEIR Response June 2021	Rock bags: TWT would like to see evidence to support the use of rock bags as the cable protection method which will a) cause minimal habitat loss and b) can be confidently decommissioned. TWT cannot agree with the conclusion of the assessment in paragraph 250 until further information is provided.	If external cable protection is required in the CSCB MCZ, the Applicant is proposing to install removable external cable protection systems (e.g. rock bags) within the CSCB MCZ and has committed to removal, if required, at decommissioning (see **Table 8-4** and the **Stage 1 CSCB MCZA** (document reference 5.6)). This ensures no permanent habitat loss within the MCZ. Further information is provided in the **Outline CSCB MCZ CSIMP** (document reference 9.7) and associated appendices. **Appendix 3 Decommissioning Feasibility Study** (document reference 9.7.3) of the **Outline CSCB MCZ CSIMP** describes the decommissioning feasibility of the

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			removable external cable protection systems anticipated to be installed within the MCZ.
TWT	PEIR Response June 2021	TWT is pleased that HDD will be implements to avoid impacts to chalk features. Is Equinor confident that HDD can extend approximately 1000m offshore? And will this avoid all nearshore chalk features?	The Applicant is confident that HDD can extend to approximately 1,000m from shore and that this will ensure avoidance of the nearshore outcropping chalk feature shown on **Figure 8.6 (sheet 3).** Geophysical surveys indicate that the nearshore outcropping chalk feature extends approximately 480m at its minimum extent and 890m at its maximum extent from Mean Low Water Springs (MLWS) and therefore the feature will be avoided through HDD. Further information on cable installation in the nearshore area is provided within the **Outline CSCB MCZ CSIMP** (document reference 9.7) and further detail on the proposed landfall installation methodology is provided in **Appendix 3.2 Cable Landfall Concept Study** of **Chapter 3 Site Selection and Assessment of Alternatives.**
TWT	PEIR Response June 2021	Construction scenario: TWT welcome that Sheringham and Dudgeon will share a cable corridor. However, habitats will encounter repeated disturbance if projects are constructed separately. To reduce this impact, what extra commitments could Equinor make?	The Applicant's intention is to build both projects concurrently however flexibility is required within the consent in case this approach is not feasible (as set out in **Chapter 4 Project Description**). From an offshore/benthic ecology perspective, the impacts from cable installation, accounting for a sequential construction, are anticipated to be temporary, minor, and not significant. Therefore, no additional measures to those already included in the

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			assessment (**Sections 8.6.2.1** and **8.6.2.2**) are required.
Survey			
Natural England	PEIR Response June 2021	Baseline characterisation: The survey methodology is appropriate	Noted.
Natural England	PEIR Response June 2021	Data Gap: In areas where sample attempts failed due to the coarse nature of the sediment, sediment samples for chemical analysis were not acquired.	Where sampling failed in coarse sediment locations, a second attempt was made, the majority of which also failed due to the nature of the sediments. As part of consultation on survey design, stakeholders advised that repeat sampling should be kept to a minimum to reduce impacts on habitats, particularly in the MCZ. It is considered the current sampling is adequate in this respect, especially given that any contaminants do not persist in coarse sediments and that reasonable endeavours were made to obtain samples in these locations. Sampling was agreed in advance during earlier ETG meetings and the MMO have confirmed the number and sites are appropriate in response to the PEIR. Therefore, no further sampling has been undertaken to inform the DCO application. Further information has been provided in Section 8.5.2.
Natural England	PEIR Response June 2021	Section 10.4.2.2: The sampling strategy could be summarised here. For example, the rationale for station selection by the Applicant being based on review of geophysical data ensuring representative coverage of the variation in potential habitat types. Consideration was also given to existing sample data, particularly where sensitive habitats were identified, from	Further information on the survey strategy has been provided in **Section 8.4.2.2** and within **Appendix 8.1** and **Appendix 8.2**, including references to previous survey data which informed the sampling strategy. Notes have been added in **Appendix 8.1** and **Appendix 8.2** to stations D_12 to D_14 and SS_13

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		Marine Recorder (JNCC), National Biodiversity Network (NBN) and Eastern IFCA. This information does not translate through to Appendix 10.1 and 10.2 other than a broad description in Table 2.1 (without the source). Rather than describing agreement with Natural England and the MMO, the methodology for survey strategy should be described and summarised within these paragraphs for the benefit of other interested parties and for clarity moving forward. Also, were all samples successfully required? If not, why was this? From comparison of Figure 10.1 we know that D-04, CC-04 or SS-18 chemistry were not acquired due to coarse nature of the sediment – this is explained later in Section 10.5.2 (paragraph 64).	to SS_17, SS_20, SS_22 and EC_06 to detail the origins of the previous *S. spinulosa* records that were used to select sample locations. The relevant references have been added to the reference list. Further information on why contaminant samples were not collected at three stations has been provided in **Section 8.5.2**. In addition, **Figure 8.1** has been updated to only show locations where samples were collected.
Natural England	PEIR Response June 2021	Appendix 10.1 and 10.2 | Section 2 / Table 2 The table states that a chemistry sample was acquired at EC-07 – the sample was in fact acquired at EC-05 – according to the logs and the results.	The tables are correct. Table 2-1 in **Appendix 8.1** and **Appendix 8.2** shows the planned survey locations and Table 4.2 shows the completed survey locations. Text has been added to section 4.1.3 in **Appendix 8.1** and section 4.1.2 in **Appendix 8.2** to detail the move of the sampling location from EC_07 to EC_05 to a more suitable sediment type
Natural England	PEIR Response June 2021	Appendix 10.1 and 10.2 | Table 2.1 The rationale for sediment sampling column suggests the location of several of the stations e.g. D10, D-11 and D-12 were chosen where previous samples included existing records of Sabellaria spinulosa. Further detail on the source of the existing records should be added.	Further information has been provided in **Appendix 8.1** and **Appendix 8.2** in relation to the previous survey data which was used to determine the sampling strategy. Notes have been added to stations D_12 to D_14 and SS_13 to SS_17, SS_20, SS_22 and EC_06 to detail the origins of the previous *S. spinulosa* records. The relevant references have been added to the reference list.
Baseline characterisation			
Natural England	PEIR Response June 2021	Section 10.5.2 PEL description. Please amend Probably to Probable as to read Probable Effects Level (PEL). The meaning of	The reference to PEL and a description of both PEL and TEL have been provided in **Section 8.5.2**.

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		concentrations within this range is missing – 'the possible effect range within which adverse effects occasionally occur'. In addition to the quoted range for uncontaminated sediments from Neff, 1997, the regional context for elevated As concentrations recorded off the northeast coast of Norfolk as explored by Whalley et al should be acknowledged. Within this paper, Whalley et al suggest: "the source may be derived from oil and gas drilling which have arsenic-rich marine shales to the surface, and therefore concentrations are not considered atypical from expected for the region".	Reference to Whalley *et al*., 1999 has also been included in **Section 8.5.2**.
Natural England	PEIR Response June 2021	Section 10.5.4 | Table 10-14 Adding the station names to SEP and DEP (N/S), as with the export cable corridor would enable an understanding of the proportion of the stations where these habitats/biotopes occur. Within the 'Recorded in DEP column? ' for A5.611, please state the survey type as well as/instead of the reference (Fugro2020a and 2020b) – benthic or habitat report, and within the export cable corridor please state the transect/station(s) where A5.611 Sabellaria spinulosa on stable circalittoral mixed sediment occurs along with A5.431.Also, within the' Recorded in SEP? column', amend description of within group A to be consistent with the other habitats by naming/describing the stations where 'Possible A5.611 identified in all SEP project areas with A5.431'.	**Table 8-14** has been amended with the station names that were identified for each biotope.
Natural England	PEIR Response June 2021	Section 10.6.3.1.1 It should also be added to this paragraph, the statement from Section 10.6.2.1 that "Like the Dudgeon OWF post-construction survey, year one and two post construction surveys of the Sheringham Shoal OWF site showed likely recovery within two years in most areas (Fugro, 2013; 2014). However, the offshore export cable trenches in coarse sediment areas still represented a disturbed benthic habitat by the time of the second post-construction monitoring survey."	The information relating to the Sheringham Shoal OWF (SOW) and (DOW) monitoring surveys is described in **Section 8.6.2.1.** Section 4.3.1.1 of the **Outline CSCB MCZ CSIMP** (document reference 9.7) describes why slower recovery of the export cable trenches occurred for SOW. The SEP and DEP export cable corridor runs parallel to the DOW export cable corridor. The

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			Applicant will make reasonable endeavours to use a similar export cable installation methodology to that project. Post-construction surveys did not show any exposed export cables, nor visibility of the trenched route on the sea bed for the DOW (see Section 4.3.1.2 of the **Outline CSCB MCZ CSIMP**). Therefore, a full recovery for SEP and DEP is anticipated in less than four years. **Section 8.6.3.1.1** includes a cross reference to **Section 8.6.2.1** which has been updated to provide further detail.
MMO	PEIR Response June 2021	The MMO agree that the habitats and biotopes identified as potential receptors in Section 10.5.4 are appropriate as well as the potential impacts of pressures associated with the proposed works as assessed in Section 10.6.	Noted.
Magnitude, sensitivity and value			
Natural England	PEIR Response June 2021	Identified impacts: Marine Evidence Based Sensitivity Assessment (MarESA) sensitivities guidance followed	Noted.
Natural England	PEIR Response June 2021	Section 10.4.3.1.2 Paragraph 44. Value. Natural England disagree with the differentiation of protected habitats. Habitats protected under national law broadly afford the same protected status as those under international law, and MCZ and UK Priority habitats for example should be included as being of 'high' value. This would be consistent with Chapter 6 EIA methodology Paragraph 47, Table 6-2 of the assessment, where nationally important protected sites are listed as high value.	The value of national designations has been increased to high in **Table 8-9**, including the CSCB MCZ.
Natural England	PEIR Response	Section 10.4.3.1.2	

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	June 2021	Value. Natural England disagrees with the differentiation of protected habitats. Habitats protected under national law afford broadly the same protected status as those under international law and for example MCZ and UK Priority habitats should be included as being of 'high' value. This would be consistent with Chapter 6 EIA methodology Paragraph 47, Table 6-2 of the assessment, where nationally important protected sites are listed as high value. The source of the assigned definitions within this table should be included if there is justification.	
Natural England	PEIR Response June 2021	Section 10.6.2.1.4 Based on comments to paragraph 44, consideration should be given to the value of the habitats within the MCZ being modified to 'high' given the nationally protected status of the site.	
TWT	PEIR Response June 2021	TWT does not agree with the value levels. SACs and MCZs both form part of the Marine Protected Areas (MPA) network, and therefore should be treated the same. If not, substandard assessment and management will be applied to MCZs thus placing the MPA network at risk. Both SACs and MCZs should be valued as high.	
Natural England	PEIR Response June 2021	Section 10.6.3.3.1 Natural England disagrees with the sensitivity value adjustment within the MCZ as the habitat is of National Importance. Natural England advises the value is adjusted to be 'high' as listed in Chapter 6 paragraph 47 Table 6.2	The value of national designations has been increased to high as shown in **Table 8-9**, including the CSCB MCZ. This has been referenced in **Section 8.6.3.3.1**.
Natural England	PEIR Response June 2021	Section 10.6.3.3.1 Within the MCZ, if the sensitivity is amended to 'high' the impact of significance would be 'moderate adverse'. As such mitigation options to avoid cable protection where possible, should be outlined.	As above, the value of national designations has been increased to high as shown in **Table 8-9**, including the CSCB MCZ. This has been referenced in **Section 8.6.3.3.1**. Mitigation measures (**Table 8-4**) have been incorporated into the impact assessment

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			where applicable, following the mitigation hierarchy of avoid, minimise, mitigate.
Natural England	PEIR Response June 2021	Section 10.4.3.1.3 The definitions used here for Magnitude (Table 10-10) are listed in Chapter 6 EIA methodology para 53 Table 6-4 as the 'Impact significance definitions. Conversely, the impact significance definitions in Table 10-12 of this chapter are not listed as such in the Chapter 6 EIA. The impact significance includes consideration of 'value' in the description and the expanded definitions should be explained.	The example criteria for Impact Significance provided within **Chapter 5 EIA Methodology** of the PEIR should have been assigned to Magnitude of Effect and therefore Chapter 5 has been amended. Receptor specific amendments have been made to the EIA methodology and associated definitions in each chapter where relevant. Value has already been incorporated into the impact significance definitions provided in **Table 8-12**.
Natural England	PEIR Response June 2021	Section 10.6.2.1 Construction impact 1: Suggest stating the MarESA pressure type in this paragraph that is considered an operational long term or permanent and covered in Section 10.6.3.2, namely "Physical change (to another substratum type)."	Physical change (to another substratum type) is considered to be a long term or permanent pressure however construction impact 1 is temporary habitat loss/ disturbance therefore it is considered that the pressures listed in construction Impact 1 (**Section 8.6.2.1**) are the appropriate pressures from MarESA and no changes have been made.
Natural England	PEIR Response June 2021	Section 10.6.2.1.4 Natural England disagrees with the magnitude of effect within the MCZ as negligible, given the protected status of the site. Further given the value of habitats within the MCZ Natural England would consider the Impact Significance to be at least minor adverse at least.	Magnitude of effect relates to (for example) the area/proportion of the receptor impacted and the duration of the impact, rather than the protected status or value of a receptor. The latter is accounted for in the sensitivity assessment. The sensitivity of habitats that may be impacted is assessed as medium based on consideration of both value and sensitivity from MarESA. However, it should be noted that the assessment conclusion for this impact and receptor is already minor adverse (**Section 8.6.2.1.5**).

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Natural England	PEIR Response	Section 10.6.3.1.2 See above comments to paragraphs 156 and 158. Further, given the value of habitats within the MCZ, Natural England would consider the Impact Significance to be moderate adverse at least.	Consideration of the high value of the MCZ has been undertaken for the impact assessment in **Section 8.6.2.1.5**. Justification for a medium sensitivity of habitats and biotopes is provided in **Section 8.6.2.1.5** and is considered appropriate for this impact. Therefore, based on the medium sensitivity and negligible magnitude of temporary habitat loss/physical disturbance, the impact is assessed as minor adverse.
Natural England	PEIR Response June 2021	Section 10.6.2.5.1 Add high sensitivity for A5.451 Polychaete-rich deep Venus community in offshore mixed sediments	The biotope A5.451 has not been added to **Section 8.6.2.5.2** since this biotope was not recorded within the DEP wind farm site or the offshore export cable corridor. However, this biotope was recorded in the SEP wind farm site and is assessed as being of high sensitivity to INNS (**Section 8.6.2.5.3**). **Table 8-14** provides a summary of the biotopes identified and their locations.
Natural England	PEIR Response June 2021	Section 10.6.3.1.1 Natural England disagrees with the statement that S. spinulosa reef is unlikely to form naturally within the project area. The presence of circalittoral mixed sediments coupled with the observed presence of patches of Sabellaria sp, means there is the potential that reef could be present within the survey area or emerge in the future and this should be considered during all phases of the project. Given the nationally protected status as a UK BAP priority habitat, the evaluation of the value of this habitat should be reconsidered	Baseline surveys for SOW, DOW, SEP and DEP (which included ground-truthing drop-down video surveys) and the pre- and post-construction monitoring surveys for SOW and DOW, found no UK BAP priority habitat / Annex I habitat *S. spinulosa* reef. Based on this, the Applicant considers that it is unlikely that UK BAP priority habitat / Annex I *S. spinulosa* reef is present within either of the sites. Reference to *S. spinulosa* reef being unlikely to form naturally within the area has been updated (**Section 8.6.3.1.1**) to make it clear that this relates to UK BAP priority habitat / Annex I *S. spinulosa* reef only.

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			The locations of potential future UK BAP priority habitat / Annex I *S. spinulosa* reef are unknown, however it is anticipated that if it was to form that it would be identified during pre- or post-construction monitoring surveys and could be subsequently avoided, as required. The value of UK BAP / Annex I habitats has been increased to high (**Table 8-9**).
Natural England	PEIR Response June 2021	Section 10.6.3.2 Impact 2 Permanent Habitat Loss: Natural England disagrees with the change of the sensitivity to medium for all the biotopes within Table 10-20. Most notably for the UK BAP protected habitats A4.231 Piddocks with a sparse associated fauna in sublittoral very soft chalk or clay and A5.611 S. spinulosa on stable circalittoral mixed sediment the sensitivity should remain high'.	The MarESA pressure that represents permanent habitat loss is 'physical change (to another sediment type), which is described as removal of a biotope permanently. Evidence has been provided in **Section 8.6.3.2** showing that the biotopes are present elsewhere in the southern North Sea and are not limited to the footprint of the permanent habitat loss. Therefore, MarESA pressure of biotope removal is not entirely representative of the impact, given the biotope is not entirely removed. The sensitivity of biotopes from this MarESA pressure has therefore been reduced from high to medium in acknowledgement of the biotope still being present in some locations. However, taking into account the particular sensitivity and value of the Annex I / UK BAP priority habitat *S. spinulosa* reefs that can be associated with biotope A5.611 and the UK BAP priority habitat 'peat and clay exposures with piddocks' which can be associated with biotope A4.231, these designated habitats will remain as high sensitivity for this MarESA pressure.

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			Baseline surveys for SOW, DOW, SEP and DEP (which included ground-truthing drop-down video surveys) and the pre- and post-construction monitoring surveys for SOW and DOW, found no Annex I / UK BAP priority habitat *S. spinulosa* reef. Based on this, the Applicant considers that it is unlikely that Annex I / UK BAP priority habitat *S. spinulosa* reef is present within any of the sites.
MMO	PEIR Response June 2021	The MMO do not currently agree with the reduction of receptor sensitivity from 'high' to 'medium' relating to permanent and long-term habitat loss during the operational phase (Section 10.6.3.2 and 10.6.3.3). It is reasoned that because the relevant biotopes are known to be present across the wider area in the southern North Sea, the sensitivity can be considered 'medium' rather than 'high'. This may be a reasonable decision, it does not appear that this procedure has been applied to other assessments (e.g. sensitivity to temporary physical disturbance during construction; Section 10.6.2.1.3). The MMO would appreciate further clarification on this point. The assessment should also refer to the evidence that shows that the relevant biotopes are present across the wider Southern North Sea area.	Evidence has been provided in **Section 8.6.3.2** showing that the biotopes are present elsewhere in the southern North Sea and are not limited to the footprint of the permanent habitat loss. This approach has not been applied to other sensitivity assessments as it is only relevant to the MarESA pressure that represents permanent habitat loss 'physical change (to another sediment type)'. The MarESA pressure describes a removal of a biotope permanently. However, as evidence has been provided showing these biotopes are present in other areas of the southern North Sea including in the vicinity of SEP and DEP, the biotope will not be entirely removed in this case. Therefore, the MarESA pressure of biotope removal is not entirely representative of the impact, given the biotope is not entirely removed. The sensitivity of biotopes from this MarESA pressure has therefore been reduced from high to medium in acknowledgement of the biotope still being present in some locations.

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MMO	PEIR Response June 2021	The applicant has considered that the impact magnitude for temporary physical disturbance during the construction phase as 'negligible' (Section 10.6.2.1), however, as around 2.5 kilometres squared (km2) of sea bed would be disturbed (Table 10-2). The MMO consider a higher impact magnitude (e.g. 'low') would be more appropriate in this instance. It is noted that the criteria used to define the different levels of impact magnitude in the PEIR are not quantitative (Table 10-10), with 'negligible' implied when the impact occurs "over a small area of the receptor", which is open to subjectivity. The Applicant should confirm that a 'negligible' impact magnitude is consistent with the conclusions made for other developments that have had similar footprints of temporary physical disturbance.	The estimated area of temporary habitat loss/ physical disturbance has been increased from $2.5km^2$ to $7.83km^2$, primarily due to the estimated width of disturbance from cable installation being increased from 3m to 15m on a precautionary, worst-case basis. A review of other offshore wind farm developments has been undertaken and it is considered that low impact magnitude is appropriate for this scale of temporary habitat loss / physical disturbance. **Section 8.6.2.1** has been updated to reflect this.
EIFCA	PEIR Response June 2021	EIFCA would welcome further dialogue to better understand the basis to the following statement - "132. As described in Section 10.3.3, there will be no direct impacts on the intertidal zone as a result of the use of HDD to approximately 1,000m from the coastline. Additionally, the assessment provided in Chapter 8 Marine Geology, Oceanography and Physical Processes concludes that there will be no significant indirect impacts on the nearshore environment. Therefore, no impacts are predicted on the intertidal zone and it is not considered further in this chapter." Please be aware that the "EIFCA Restricted area 35 (closed to bottom towed gear)" you refer to on page 108 is not yet "Active" it has been agreed by our Authority however it has not been signed off by the Secretary of State. (We do have an active restricted area 35 in the 2018 version of this byelaw however it does not coincide with this project.	Intertidal habitats have been scoped out of the assessment due to there being no pathway for impact to intertidal habitats due to the use of HDD to approximately 1,000m offshore in the subtidal (**Table 8-3**). This was agreed at the sea bed ETG4 meeting on the 16th of August 2021 with Natural England and the MMO and EIFCA deferred to Natural England on this point. Further information has been included on embedded mitigation in **Table 8-3** in relation to why there will be no impacts in the intertidal zone. The reference to Restricted area 35 in **Table 8-23** has been updated to show it is not yet active.
TWT	PEIR Response June 2021	Impacts during construction - sandwave levelling: TWT would like to know if sandwave levelling occurred during the installation of the existing Sheringham and Dudgeon	No sand wave levelling was undertaken at SOW and DOW. During DOW infield cable installation, a trench was jetted through a small sand wave however no

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		Offshore Wind Farms and see evidence of recovery from this activity. We cannot agree with the assessment conclusions until further information has been provided.	dredging / levelling of sand waves was undertaken. Post construction monitoring was carried out throughout the arrays and export cables. Discussion of the monitoring that was undertaken is included in the assessment of this impact (**Section 8.6.2.1**). Race Bank offshore wind farm conducted monitoring of sand waves where crests were reduced in elevation. The monitoring showed greater than 75% recovery of all sand waves monitored. More information is available in **Section 8.6.2.1.2**. Monitoring of sand wave recovery following their clearance, if required, is included in the **Offshore In-Principle Monitoring Plan (IPMP)** (document reference 9.5).
Annex I / UK BAP priority habitat			
Natural England	PEIR Response June 2021	Data analysis: Although the habitat assessment is summarised within Appendix 10.1 and 10.2, it was not included as a separate appendix to Chapter 10.-Appendix 10.1 and Appendix 10.2 suggests chalk reef assessment was not undertaken due to lack of a defined method. Paragraph 106 of Chapter 10 and Appendix 10.1 and 10.2, Section 4.5.2.1.1 suggests two stations/transects (within the export cable corridor (EC_03 and EC-24) showed areas of low resemblance to stony reef. However as neither of these two stations were defined as Annex 1, stony reef, the biotope is not mapped or taken further for assessment within this chapter. Further, these two stations are situated within the Cromer Shoal Chalk Beds (CSCB) MCZ.	The habitat reports have been included as **Appendix 8.3** and **Appendix 8.4**, which includes the stony reef assessment in Appendix B.5. The Measures of 'Reefiness' for stony reef habitat used in **Appendix 8.3** and **Appendix 8.4** are taken from Irving (2009) and Golding (2020). The stony reef assessment in **Appendix 8.3** and **Appendix 8.4** determined that stations EC_03 and EC_24 did not constitute areas of Annex I habitat. Further information has been included in **Section 8.5.4.4** in relation to stony reef.
Natural England	PEIR Response	Section 10.5.4.4	

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	June 2021	No further detail is provided in the Benthic Report Appendix 10.1 and 10.2 for the criteria/methodology for assigning bedrock (chalk) and stony reef (reference is given to the habitat reports which were not included as an Appendix to this chapter) and as stated in this paragraph, there is no defined criteria for chalk reef habitat	
Natural England	PEIR Response June 2021	Section 10.5.4.4 Please provide distance from shore, to characterise the location of EC-03 and EC-24 and to clarify this location is within the MCZ, but outside the 1km intertidal area where cables are proposed to be installed using HDD. No symbology is assigned in the figures to denote the low reef habitat at these stations. Appendix 10.1 and 10.2 appendices summarises these two stations as coarse sediment and mixed sediment, respectively. Therefore, although mentioned here, potential stony reef habitat is not taken forward within this chapter for assessment of significance of impact. The focus remains on the area of geogenic chalk reef associated with the findings at EC-26.	Distances to shore have been provided in **Section 8.5.4.4**. The stony reef assessment in **Appendix 8.3** and **Appendix 8.4** determined station EC_03 and EC_24 did not constitute areas of Annex I habitat. Further information on the stony reef assessment is included in **Section 8.5.4.4**.
Natural England	PEIR Response June 2021	Assessment: The significance of the presence of Sabellaria reef habitat within the development area is not appropriately considered, with respect to its protected status as a UKBAP priority habitat under Section 40 and 41 of the NERC Act, 2006. Chapter 10 paragraphs 104 to 106 consider geogenic (bedrock and stony) reef. While outcropping chalk at Transect EC-26 is taken forward for consideration within this chapter, the low resemblance stony reef / coarse sediment observed along Transect EC-03 and EC-24 is not	*S. spinulosa* reef No Annex I / UK BAP priority habitat *S. spinulosa* reef habitat was identified within the SEP and DEP offshore sites during the SEP and DEP benthic characterisation surveys. Where *S. spinulosa* was found it was at low densities (<1%) therefore it did not warrant a full assessment, as these densities fall under 'Not a reef' category. JNCC guidelines for determining *S. spinulosa* reef (Gubbay, 2007) and UK BAP priority habitat description (Maddock, 2008) were both used when analysing *S. spinulosa* for reef potential. The crusts were also considered ephemeral. Further information has been provided in **Section 8.5.4.4** and **Table 8-15** has been updated.
Natural England	PEIR Response June 2021	Section 10.5.4.1 A5.6 Bullet point. Although the A5.6 Sublittoral biogenic reef was not classified as Annex 1 habitat, the presence of Sabellaria suggests the suitability for this habitat to occur within the export cable corridor. Sabellaria spinulosa reef of all	

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		quality is protected under Section 40 and 41 of the Natural Environmental and Rural Communities (NERC) Act 2006.	Although the biotope A5.611 *Sabellaria spinulosa* on stable circalittoral mixed sediment was assigned, this was based on best fit to the faunal assemblage and sediment type rather than any reef characteristics (Fugro pers comms., 2021). Further information on the analysis of *S. spinulosa* and the assignment of the A5.611 biotope is available in **Appendix 8.3** and **Appendix 8.4**. The Applicant has committed to avoiding Annex I / UK BAP priority habitat *S. spinulosa* reef (**Table 8-4**) where required, as informed by pre-construction survey. Stony reef The stony reef assessment in **Appendix 8.3** and **Appendix 8.4** determined station EC_03 and EC_24 did not constitute as areas of Annex I habitat. Further information has been included in **Section 8.5.4.4** in relation to stony reef.
Natural England	PEIR Response June 2021	Section 10.6.2.1.2 Construction Impact 1: Consideration to the A5.611 Sabellaria spinulosa on stable circalittoral mixed sediment habitat should be given. Although not classified as Annex 1, regardless of quality, Sabellaria sp. reef is a UKBAP priority habitat, protected under Section 40 and 41 of the NERC, 2006 Act. This habitat will require consideration for micro-siting during construction to avoid, mitigate and reduce any damage or loss to any emergent reef	
Natural England	PEIR Response June 2021	Section 10.5.4.4 Table 10-15 Designation / status column-Sabellaria spinulosa reef is a UKBAP habitat protected under Section 40 and 41 of the Natural Environmental and Rural Communities (NERC) Act 2006.	
Natural England	PEIR Response June 2021	Section 10.5.4 The co-location of Sublittoral biogenic reef A5.6(11) with A5.431 along the export cable corridor should also be described within this paragraph.	Biotope A5.6 has not been included in **Section 8.5.4.1** as this biotope was not identified in the DEP characterisation report (**Appendix 8.1**). Therefore, no change has been made to **Section 8.5.4.1.** Further analysis of the export cable corridor during the SEP analysis allowed for further refinement of the EUNIS classification resulting in the co-location of the sublittoral biogenic reef A5.611 with A5.431. Biotopes were identified using the multivariate analysis of the infaunal dataset, in conjunction with the physical and biological characteristics of each

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			multivariate group. However, as the DEP multivariate analysis (**Appendix 8.3**) included different stations to the SEP multivariate analysis (**Appendix 8.4**), the biotopes identified using the multivariate analysis are different. Further information has been provided in **Section 8.5.3** and **Section 8.5.4**. In relation to the co-location of A5.611 with A5.431, this has been included in the list of biotopes identified in the SEP offshore site (**Section 8.5.4.2**)
Natural England	PEIR Response June 2021	Section 10.6.2.1 Summarise the detail of habitat A4.231 (Piddocks with a sparse associated fauna in sublittoral very soft chalk or clay), including its location and spatial extent to explain overall conclusion of the impact of significance. Given the nationally protected significance for Sabellaria reef habitat, the overall evaluation of significance may require re-assessment for the WCS.	Further information has been provided in the impact significance summary for construction impact 1 temporary habitat loss/physical disturbance (**Section 8.6.2.1.2**, **Section 8.6.2.1.3**, and **Section 8.6.2.1.4**). The Applicant has committed to avoiding Annex 1 / UK BAP priority habitat *S. spinulosa* reef and UK BAP priority habitat 'peat and clay exposures with piddocks' (**Table 8-4**) where required, therefore no temporary habitat loss/physical disturbance to these habitats is expected.
CIA			
Natural England	PEIR Response June 2021	CEA: Natural England doesn't support 5km as an acceptable distance for benthic CEA.	A radius of 10km around the SEP and DEP project boundary has been used to identify the plans, projects and activities to be included in the CIA (**Section 8.7.2**). A radius of 10km also follows the approach used in the **Stage 1 CSCB MCZA** (document reference 5.6) and the **Report to Inform Appropriate Assessment (RIAA)** (document reference 5.4) areas of search for the associated screening exercises.

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Natural England	PEIR Response June 2021	Section 10.7.3.2 Cumulative Impact 2: long term habitat loss. How is the Applicant assured the cumulative effect of SEP and DEP will not be above the threshold for which the conservation objectives of the CSCB MCZ will be hindered? Natural England disagree with the conclusion that cumulative habitat loss is ‘minor adverse’ with consideration of the conservation objectives of the Cromer Shoal MCZ.	For information on the conservation objectives of the CSCB MCZ see the **Stage 1 CSCB MCZA** (document reference 5.6).
MMO	PEIR Response June 2021	The Applicant has concluded that there is no potential for cumulative impacts relating to invasive non-native species (INNS) because biosecurity measures will be used to prevent their introduction (Table 20-21). While the MMO agree with this conclusion, it is important to note that cumulative impacts may occur due to the installed marine infrastructure acting as ‘stepping stones’ for the spread of INNS that are either currently in the region or may be introduced in the future. The MMO note that this possible ‘stepping stone’ effect has been acknowledged by the Applicant when considering the potential impacts of the proposed development alone (Section 10.6.3.7), but the MMO suggest this process is likely to be most relevant when considering the interconnectedness of the proposed development with other artificial marine structures in the region. Benthic invertebrate larvae can disperse over distances of tens to over a hundred kilometres (Álvarez-Noriega,2020),which is therefore the scale at which potential cumulative impacts relating to the spread of INNS should be considered.	Noted. The potential impact of INNS has been considered in the CIA in **Section 8.7** in relation to the potential for SEP and DEP sea bed infrastructure to act as a stepping stone for INNS during the operational phase. Construction phase impacts from INNS have been screened out of the CIA.
Transboundary			
MMO	PEIR Response June 2021	Transboundary impacts are addressed in Section 10.8. Such impacts are screened out for benthic ecology receptors because of their localised nature. MMO largely agree with this conclusion but as noted above in paragraph 7.10 there is a	The ‘stepping stone’ potential for INNS during the operational phase of SEP and DEP has been considered in transboundary impacts in **Section 8.8**.

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		potential for the spread of INNS by using marine infrastructure as stepping stones, giving the potential for this to occur over a much broader spatial scale than the other pressures associated with the proposed development. The MMO recommend that this possibility should be considered when determining whether there is potential for transboundary impacts in Section 10.8.	
Decommissioning			
Natural England	PEIR Response June 2021	Section 10.3.2.1 | Table 10-2 Decommissioning: We question the Applicant's outline plan to decommission scour protection, crossing and cable protection outside the Cromer Shoal Chalk Beds MCZ and possibly offshore cables *in situ*. Decommissioning should aim to remove surface laid infrastructure to avoid irreversible (permanent) habitat loss, thus returning the sea bed habitat to its pre-developed baseline status. We recognise there is merit in decommissioning buried infrastructure such as cables *in situ* to avoid further habitat disturbance; however in highly dynamic environments, such as the Southern North Sea, it is possible that cables may become free spanning in the future and require removal, or if left in -situ require further protection resulting in disturbance and loss of habitat. Natural England advices that cable protection options that have the most likelihood of being removed should be taken forward within Cromer Shoal MCZ. Natural England welcome that a decommissioning plan will be produced.	A Decommissioning Programme will be produced at the pre-construction stage with an anticipated commitment to decommission *in situ* any buried scour protection and cables, as removing them is generally accepted to be likely to cause more disturbance. However, the Decommissioning Programme would ensure there is reasonable flexibility in the options available, with the final decision being based on the available information and guidance at the time of decommissioning. However, for the purposes of the assessment, decommissioning through removal of buried infrastructure is likely to be the worst-case scenario. Impacts of removal of infrastructure are considered to be comparable to construction phase impacts. The Applicant has committed to removing external cable protection within the MCZ (see **Table 8-4** and the **Outline CSCB MCZ CSIMP** (document reference 9.7).
Natural England	PEIR Response June 2021	Section 10.6.4 Decommissioning. Natural England consider scour and cable protection should be removed during decommissioning if above the sea bed thus avoiding permanent habitat loss. While it is recognised that decommissioning buried infrastructure '*in situ'* such as cables avoids further temporary	

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		impacts, it is possible that in the future cables may free span from the surface and require further protection. This likelihood in areas of mobile sandy sediment should be considered decommissioning plan.	
TWT	PEIR Response June 2021	Although TWT appreciate that decommissioning is subject to a separate planning application, we would like to see a commitment within the DCO from Equinor to decommission as much infrastructure as possible to ensure the recovery of the marine environment. A huge amount of infrastructure at sea is expected over the next 30 years to meet net zero, and therefore every effort should be made to decommission infrastructure in order to make 'head room' for this scale of development. It is a requirement under the Energy Act, UNCLOS and OSPAR to decommission offshore infrastructure.	
Natural England	PEIR Response June 2021	Section 10.6.3.2 Impact 2: Permanent Habitat Loss. Natural England consider there are opportunities to reduce the permanent loss of habitat to long term, through commitment to remove surface infrastructure such as for cable protection.	
Mitigation			
Natural England	PEIR Response June 2021	Section 10.3.3.1 Foundations -Please expand to include details of the embedded mitigation for micro-siting.	Micro-siting will be used where possible to minimise the requirements for sea bed preparation prior to foundation installation. Further information on micro-siting has been provided in **Table 8-4**.
Natural England	PEIR Response June 2021	Section 10.3.3.2 Natural England welcomes the additional mitigation measures within the CSCB MCZ, namely the commitment to minimise external cable protection. Can it be explained here how this certainty can be achieved?	The **Outline CSCB MCZ CSIMP** (document reference 9.7) and the Interim Cable Burial Study (**Appendix 1** of the **Outline CSCB MCZ CSIMP** (document reference 9.7.1)) provides further detail on these matters.

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Natural England	PEIR Response June 2021	Section 10.6.2.1.2 Impact 1 - Given the high sensitivity of the Habitat A4.231 and the fact that it is a UKBAP priority habitat, Natural England suggest that the Applicant details how there will be no direct impacts from construction - due to its location within the array and/or micro-siting and thus avoiding around this habitat for any construction and O&M works.	Habitat A4.231 'piddocks with a sparse associated fauna in sublittoral very soft chalk or clay' has only been confirmed at one location in the southwest corner of the SEP wind farm site. Pre-construction surveys will be undertaken to identify any potential Annex I / UK BAP priority habitat *S. spinulosa* reefs or UK BAP priority habitat 'peat and clay exposures with piddocks' which, if required, will be avoided during detailed design. This commitment has been included in **Table 8-4**.
Natural England	PEIR Response June 2021	Section 10.6.2.2.2 Impact 2: As above, clarification of certainty, of avoiding the biotope A4.231 Piddocks with a sparse associated fauna in sublittoral very soft chalk or clay within a plan should be stated here rather than 'likely' as stated in this paragraph	
Natural England	PEIR Response June 2021	Section 10.6.2.5.1 Natural England welcome the proposed measures to minimise the introduction of Invasive Non-Native Species.	Noted.
Natural England	PEIR Response June 2021	Section 10.6.3.3.1 Impact 3: Long term Habitat Loss. Natural England welcomes the commitment to the use of removable rock bags as cable protection, thus minimising permanent habitat loss within the MCZ. However, every effort should be made to minimise cable protection within the MCZ.	Noted. The commitment to reduce the use of external cable protection as much as possible and to use removable external protection systems within the MCZ is included in **Table 8-4**. Also see the **Outline CSCB MCZ CSIMP**.
MMO	PEIR Response June 2021	The MMO note that additional mitigation measures have been summarised in Tables 10-3 and 10-4. It is stated that the cable corridor will be routed to avoid as many known sensitive benthic habitats as possible and that turbine foundations will be micro-sited to minimise the requirements for sea bed preparation prior to foundation installation (Table 10-3). However, it is unclear whether pre-construction surveys will be used to inform the positioning of infrastructure and avoid sensitive benthic features (e.g., Sabellaria reef). The MMO would like to see further information from the Applicant to provide clarification on their plans relating to pre-construction surveys and micro-siting. The MMO would expect sensitive	Pre-construction surveys will be undertaken to identify any benthic habitats of particular importance (including Annex I habitats). The pre-construction survey methodology would be agreed with the MMO in consultation with Natural England. The survey design would be based on best practice at the time and is anticipated to consist of a mixture of geophysical, drop-down video (DDV) and grab surveys (as applicable) to ensure a comprehensive ground-truthing of the proposed final wind turbine locations and cable route design.

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		benthic features to be avoided wherever possible and for monitoring to be carried out if any infrastructure is installed within the vicinity of sensitive benthic features.	Initial geophysical surveys will be reviewed with DDV ground-truthing surveys to confirm presence as appropriate. This shall then be used to inform detailed layout design in the design plan and will inform the mitigation scheme requirements. If potentially sensitive benthic features are identified, the results of the survey will be discussed at that time with the MMO and Natural England to agree whether the features constitute Annex I / UK BAP priority habitat features and whether they are required to be avoided through micro-siting. Further information has been provided in **Table 8-4**. Also see the **Outline CSCB MCZ CSIMP** (document reference 9.7) and its **Appendix 3 Interim Cable Burial Study (ICBS)** (document reference 9.7.1) for more information regarding cable installation through the MCZ. Anticipated benthic monitoring requirements are described in the **Offshore IPMP** (document reference 9.5).
MMO	PEIR Response June 2021	The MMO note that the Applicant has considered offsetting some potential impacts by creating an artificial reef with juvenile lobsters outside the MCZ. Should this approach be taken, the Applicant will need to provide detailed plans of how this will be constructed.	The Applicant has removed this option from **Appendix 1 In-Principle Measures of Equivalent Environmental Benefit (MEEB) Plan** (document reference 5.7.1) of the **Marine and Coastal Access Act (MCAA) Derogation: Provision of Evidence** (document reference 5.7) following feedback from stakeholders.
TWT	PEIR Response June 2021	Could Equinor commit to micro-siting around areas of soft chalk or clay to avoid impacts?	There was only one area of potential soft clay recorded (EC_26) however this is inshore of the HDD exit point and would therefore not require micro-siting.

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			The **Stage 1 CSCB MCZA** (document reference 5.6) describes that, within the offshore export cable route, in areas of mobile sand, there is potential for temporary exposure and reburial of underlying geological units, including chalk, however due to their transient nature, micro-siting is unlikely to be appropriate in these cases. However, as set out in the **Outline CSCB MCZ CSIMP** (document reference 9.7), micro-siting will be used within the offshore export cable corridor to avoid areas that are likely to be challenging to cable burial. See above and **Table 8-4** regarding mitigation to avoid UK BAP priority habitat 'peat and clay exposures with piddocks'.
Cables			
Natural England	PEIR Response June 2021	Section 10.3.3.1 Cables – Natural England welcomes the intention to bury cables where possible, thereby minimising the requirement for cable protection. We would also welcome options for a joint cable system which would reduce the impacts.	Noted. The **Outline CSCB MCZ CSIMP** (document reference 9.7) and its **Appendix 1 Interim Cable Burial Study** (document reference 9.7.1) provides further detail on offshore export cable installation within the MCZ. Post-consent the number of Offshore Substation Platforms (OSPs) and offshore export cables (and the nature of their design) will be decided during detailed design considerations. Detail on the requirement for flexibility in design and construction scenarios is provided in the **Scenarios Statement** (document reference 9.28).
Natural England	PEIR Response June 2021	Section 10.6.2.1.2 Natural England welcomes the intention to commit to avoiding the creation of persistent trenches particularly in coarse	Noted. The **Outline CSCB MCZ CSIMP** (document reference 9.7) and its **Appendix 1 Interim Cable Burial Study** (document reference 9.7.1) provides

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		areas, thus reducing the recovery time for habitats disturbed during construction. Further explanation on the technique or plan to ensure this, should be provided or cross referenced here.	further detail on offshore export cable installation within the MCZ.
Figures			
Natural England	PEIR Response June 2021	Section 10.5.4 The EUNIS habitats are presented in Figure 10.5 (not 10.4 as stated).	Noted. The Figure references have been updated in **Section 8.5.4**.
Natural England	PEIR Response June 2021	Section 10.5.4.2 How many stations does the coarse and mixed habitats apply to? Was there any notable spatial distribution?	The habitats found at each station is provided in **Table 8-14** and in **Figures 8.6** and **Figure 8.7**.
Natural England	PEIR Response June 2021	Section 10.5.4.2 Again, further description of the frequency / spatial distribution station names for the A5.611 habitat would be useful here.	
Natural England	PEIR Response June 2021	Section 10.5.5.3 Reference should be to Figure 10.7. The SPA is not presented within this figure and should be added.	**Figure 8.8** has been updated to include The Wash and North Norfolk Coast Special Protection Area (SPA).
Natural England	PEIR Response June 2021	Figure 10.7 Add the Greater Wash SPA as referenced within Chapter 10, Section 10.5.5.3, paragraph 122.	
Natural England	PEIR Response June 2021	All figures Please add the outline boundary of the MCZ to all figures. It would be helpful to visualise the location of this site in relation to the data presented.	Figures have been updated to include the boundary of the MCZ where applicable.
Natural England	PEIR Response June 2021	All figures In the legend, the symbols should be denoted to state the habitat was determined from grab sampling (circle) and video (triangle).The habitats from polygons should be denoted to say they are extrapolated from survey data. All habitats are classified from EUNIS/MNCR and this description should be at the top of the legend.	Figures have been updated.

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Natural England	PEIR Response June 2021	Figure 10.1 No chemistry sample was acquired at EC-07. The logs and results of the benthic characterisation report indicate a chemistry sample was taken at EC-05. The map should be amended to show where samples were successful as otherwise this is mis-leading to the information available in Chapter 10, paragraph 32. For example, no chemistry samples were acquired at D-04, CC-04 or SS-18.	**Figure 8.1** has been updated to shows stations where chemical samples failed.
Natural England	PEIR Response June 2021	Figure 10.5 The EUSeaMap symbols below (taken from Appendix 10.3) are omitted from the legend.	The symbology for areas interpreted using EUSeaMap has been added to the legend on **Figure 8.6**.
Natural England	PEIR Response June 2021	Appendix 10.1 | Figure 4.8 The y axis should be labelled as the 'Composition of Individuals (%)'	The figure in **Appendix 8.1** has been updated.

8.3 Scope

8.3.1 Study Area

9. The study area for benthic ecology has been determined by the extent of the potential effects on benthic receptors. Direct effects will occur within the offshore footprint of SEP and DEP infrastructure and construction, maintenance and decommissioning activities. These direct impacts will be entirely within the SEP wind farm site, DEP North and DEP South array areas and offshore cable corridors. Indirect impacts may extend beyond the ES boundary, determined by the extent of potential changes to marine physical processes and sediment redeposition, as described in **Chapter 6 Marine Geology, Oceanography and Physical Processes**.

8.3.2 Realistic Worst-Case Scenario

8.3.2.1 General Approach

10. The final design of SEP and DEP will be confirmed through detailed engineering design studies that will be undertaken post-consent to enable the commencement of construction. In order to provide a precautionary but robust impact assessment at this stage of the development process, realistic worst-case scenarios have been defined in terms of the potential effects that may arise. This approach to EIA, referred to as the Rochdale Envelope, is common practice for developments of this nature, as set out in Planning Inspectorate Advice Note Nine: Rochdale Envelope (v3, 2018). The Rochdale Envelope for a project outlines the realistic worst-case scenario for each individual impact, so that it can be safely assumed that all lesser options will have less impact. Further details are provided in **Chapter 5 EIA Methodology**.

11. The realistic worst-case scenarios for the benthic ecology assessment are summarised in **Table 8-2**. These are based on the project parameters described in **Chapter 4 Project Description**, which provides further details regarding specific activities and their durations.

12. In addition to the design parameters set out in **Table 8-2**, consideration is also given to:

- How SEP and DEP will be built out as described in **Section 8.3.2.2** to **Section 8.3.2.4** below. This accounts for the fact that whilst SEP and DEP are the subject of one DCO application, it is possible that only one Project could be built out (i.e. build SEP or DEP in isolation) or that both of the Projects could be developed. If both are developed, construction may be undertaken either concurrently or sequentially.
- A number of further development options which either depend on pre-investment or anticipatory investment, or that relate to the final design of the wind farms.
- Whether one OSP or two OSPs are required.
- The design option of whether to use all of the DEP North and DEP South array areas, or whether to use the DEP North array area only.

13. In order to ensure that a robust assessment has been undertaken, all development scenarios and options have been considered to ensure the realistic worst-case scenario for each topic has been assessed. Further details are provided in **Chapter 4 Project Description**.

14. In relation to the different OSP scenarios where both SEP and DEP are built (i.e. where there are one or two OSPs), each scenario has been presented, however only the overall realistic worst-case for each impact has been assessed in **Section 8.6**. The worst-case parameter for each activity / footprint in the SEP and DEP one or two OSP scenario has been denoted with an asterisk and underlined in **Table 8-2**. In addition, cells have been shaded grey to indicate which scenario represents the worst-case in relation to each of the impacts assessed.

8.3.2.2 Construction Scenarios

15. In the event that both SEP and DEP are built, the following principles set out the framework for how SEP and DEP may be constructed:

- SEP and DEP may be constructed at the same time, or at different times;
- If built at the same time both SEP and DEP could be constructed in four years;
- If built at different times, either Project could be built first;
- If built at different times, each Project would require a four year period of construction;
- If built at different times, the offset between the start of construction of the first Project, and the start of construction of the second Project may vary from two to four years;
- Taking the above into account, the total maximum period during which construction could take place is eight years for both Projects; and
- The earliest construction start date is 2025.

16. The impact assessment for benthic ecology considers the following development scenarios in determining the worst-case scenario for each topic:

- Build SEP or build DEP in isolation – one OSP only; and
- Build SEP and DEP concurrently or sequentially – with either two OSPs, one for SEP and one for DEP, or with one OSP only to serve both SEP and DEP

17. For each of these scenarios it has been considered whether the build out of the DEP North and DEP South array areas, or the build out of the DEP North array area only, represents the worst-case for that topic. Any differences between SEP and DEP, or differences that could result from the manner in which the first and the second projects are built (concurrent or sequential and the length of any gap) are identified and discussed where relevant in the impact assessment section of this chapter (**Section 8.6**). For each potential impact, where necessary, only the worst-case construction scenario for two Projects is presented, i.e. either concurrent or sequential. The justification for what constitutes the worst-case is provided, where necessary, in **Section 8.6**.

8.3.2.3 Operation Scenarios

18. Operation scenarios are described in detail in **Chapter 4 Project Description**. Where necessary, the assessment considers the following three scenarios:

- Only SEP in operation;
- Only DEP in operation; and
- The two Projects operating at the same time, with a gap of two to four years between each Project commencing operation.

19. The operational lifetime of each Project is expected to be 40 years.

8.3.2.4 Decommissioning Scenarios

20. Decommissioning scenarios are described in detail in **Chapter 4 Project Description**. Decommissioning arrangements will be agreed through the submission of a Decommissioning Programme prior to construction, however for the purpose of this assessment it is assumed that decommissioning of SEP and DEP could be conducted separately, or at the same time.

Table 8-2: Realistic Worst-Case Scenarios

Impact	DEP in Isolation	SEP in Isolation	SEP and DEP		Notes and Rationale
			Two OSPs (one in SEP wind farm site and one in DEP North array area)	One OSP (located in SEP wind farm site)	
Construction					
Impact 1: Temporary habitat loss / physical disturbance	**Offshore cables**: Up to **263km**: • One HVAC export cable up to **62km** in length • **135km** of infield cables (DEP North array area: 90km; DEP South array area: 45km) • Up to 3 parallel interlink cables between DEP South array area and OSP in DEP North array area: up to **66km** in length (combined) • Burial depth: 0.5 to 1.5m (excluding burial in sand waves up to 20m; and up to 1.0m for the export cables. • Cable installation maximum width of disturbance: 15m Maximum area disturbed: **3.95km²** (Export cable 0.93km², Infield cables 2.025km², Interlink cables 0.99km²)	**Offshore cables:** Up to **130km**: • One HVAC export cable up to **40km** in length • **90km** of infield cables • No interlink cables • Burial depth: Same as DEP in isolation • Cable installation maximum width of disturbance: Same as DEP in isolation Maximum area disturbed: **1.95km²** (Export cable 0.60km², Infield cables 1.35km²)	**Offshore cables**: Up to **393km**: • 2 HVAC export cables up to **102km** in length • Up to **225km** of infield cables (DEP North array area: 90km; DEP South array area 45km; SEP 90km) • Up to 3 interlink cables from DEP South array area to the OSP in DEP North array area **66km** total length • Burial depth: Same as SEP or DEP in isolation • Cable installation maximum width of disturbance: Same as SEP or DEP in isolation Maximum area disturbed: **5.90km²** (Export cable: 1.53km², infield 3.38km², interlink cables 0.99km²)	**Offshore cables**: Up to **448km**: • 2 HVAC export cables from SEP up to **80km** in length • Up to **225km** of infield cables (DEP North array area: 90km; DEP South array area 45km [1]; SEP 90km) • Up to 7 interlink cables from DEP North array area (up to 5) and DEP South array area (up to 3) to OSP in SEP, up to **143km*** total length [2] • Burial depth: Same as SEP or DEP in isolation • Cable installation maximum width of disturbance: Same as SEP or DEP in isolation Maximum area disturbed: **6.72km²*** (Export cable: 1.20km², infield 3.37km², interlink cables 2.15km²)	The temporary disturbance relates to sea bed preparation and cable installation and is based on a 15m maximum cable installation disturbance width.
	Sea bed preparation • Sand wave clearance: **0.93km²** • Worst-case is for GBS foundations: **0.073km²** (for up to 24 18MW wind turbines) • Route clearance: • Pre-lay grapnel run (PLGR): included in cable installation width area	**Sea bed preparation** • Sand wave clearance: **0km²** • Worst-case is for GBS foundations: **0.057km²** (for up to 19 18MW wind turbines) • Route clearance: • PLGR: included in cable installation width area	**Sea bed preparation** • Sand wave clearance: **0.93km²*** • Worst-case is for GBS foundations: **0.13km²** (for up to 43 18MW wind turbines) • Route clearance: • PLGR: included in cable installation width area.	**Sea bed preparation** • Sand wave clearance [3]: **0.76km²** • Worst-case is for GBS foundations: **0.13km²** (for up to 43 18MW wind turbines) • Route clearance: • PLGR: included in cable installation width area	The maximum area of sea bed preparation disturbance from a single 18MW GBS foundation = 3,019m². Sea bed preparation disturbance from a 15MW GBS foundation = 1,735m² and therefore despite there being a higher number of 15MW foundations (30 for DEP and 23 for SEP) the worst-case is associated with the 18MW GBS foundation of which there could be up to 24 for DEP and 19 for SEP.

[1] Build out of DEP North and South array areas is worst-case scenario for infield cable disturbance

[2] While a scenario where only the DEP North array area is built out would require a greater length of interlink cables (154km compared to 143km), overall, the worst-case area subject to temporary habitat loss / disturbance would be a scenario where both DEP North and South array areas are built out

[3] Greater area of sand wave clearance required for a one OSP scenario where both the DEP North and South array areas are developed compared to when only the DEP North array area is developed (0.76km² versus 0.64km²) means the former is the worst-case.

Impact	DEP in Isolation	SEP in Isolation	SEP and DEP		Notes and Rationale
			Two OSPs (one in SEP wind farm site and one in DEP North array area)	One OSP (located in SEP wind farm site)	
	• Boulder clearance (up to 20): **785m^2** **Total = 1km^2**	• Boulder clearance (up to 30): **1,178m^2** **Total = 0.057km^2**	• Boulder clearance (up to 50): **1,963.5m^2** **Total = 1.06km^2***	• Boulder clearance (up to 50): **1,963.5m^2** **Total = 0.89km^2**	Sand wave clearance (pre-sweeping) is confined to the DEP North and South array areas, the northern portion of the interlink cable route between the DEP North array area and SEP wind farm site and the interlink cable route between the DEP North and DEP South array areas (see **Figure 4.9** of **Chapter 4 Project Description**). Therefore, no sand wave clearance is required in the SEP wind farm site. The WCS is based on a two OSP scenario and is estimated based on analysis of existing geophysical data to determine where sand wave clearance is likely to be required. The width of sea bed disturbance along the PLGR is estimated to be up to 3m, which would be encompassed by the 15m cable installation disturbance width accounted for in the row above. Calculations assume boulders of 5m diameter and an equivalent disturbance footprint at the origin boulder location and at the location to which it is moved.
	Vessels *Jack up vessels* • Up to two jack-up deployments at each turbine/OSP (**30 15MW turbines + one OSP = 74,400m^2**) *Anchoring* (**Total = 76,080m^2**) • Turbines (30) and OSP (1) installation vessel anchoring (up to 12 lines per location) = **22,320m^2**	**Vessels** *Jack up vessels* • Up to two jack-up deployments at each turbine/OSP (**23 15MW turbines + one OSP: 57,600m^2**) *Anchoring* (**Total = 34,080m^2**) • Turbines (23) and OSP (1) installation vessel anchoring (up to 12 lines per location) = **17,280m^2**	**Vessels** *Jack up vessels* • Up to two jack-up deployments at each turbine/OSP (**53 15MW turbines + two OSPs: 132,000m^2**) Anchoring (Total = **110,160m^2**) • Turbines (53) and OSP (2) installation vessel anchoring: (up to 12 lines per location) **39,600m^2**.	**Vessels** *Jack up vessels* • Up to two jack-up deployments at each turbine/OSP. (**53 15MW turbines + one OSP: 129,600m^2**) Anchoring[4] (Total = **137,160m^2**) • Turbines (53) and OSP (1) installation vessel anchoring: (up to 12 lines per location) **38,880m^2**.	Worst-case scenario is a jack-up barge with six legs per barge (200m^2 per leg) equating to a total footprint of 1,200m^2 per installation. Individual anchor footprint = 30m^2. Up to two anchor deployments required at each location.

[4] The greater overall length of interlink cables in a scenario where both the DEP North and South array areas are developed results in a greater area of disturbance from vessel anchoring compared to a DEP North array area only scenario and therefore this represents the worst-case for sea bed disturbance footprints from vessels

Impact	DEP in Isolation	SEP in Isolation	SEP and DEP		Notes and Rationale
			Two OSPs (one in SEP wind farm site and one in DEP North array area)	One OSP (located in SEP wind farm site)	
	• Export cable installation vessel anchoring (seven lines) (62km) = **26,040m²** • Interlink cable installation vessel anchoring (seven moorings) = **27,720m²** **Total** sea bed disturbance footprint from vessels for DEP in isolation = **0.150km²**	• Export cable installation vessel anchoring (seven lines) (40km) = **16,800m²** **Total** sea bed disturbance footprint from vessels for SEP in isolation = **0.092km²)**	• Export cable installation vessel anchoring (seven lines) (62km + 40km) = **42,840m²** • Interlink cable installation vessel anchoring (seven moorings) = **27,720m²** **Total** sea bed disturbance footprint from vessels = **0.242km²**	• Export cable installation vessel anchoring (seven lines) (40km + 40km) = **33,600m²** • Interlink cable installation vessel anchoring (seven moorings) = **64,680m²*** **Total** sea bed disturbance footprint from vessels = **0.267km²***	
	HDD Exit Point • Initial trench (600m²) • Transition zone (50m²) • Jack-up footprint (128m²) • Deposited material on sea bed (200m²) **Total = 978m²**	**HDD Exit Point** • Initial trench (600m²) • Transition zone (50m²) • Jack-up footprint (128m²) • Deposited material on sea bed (200m²) **Total = 978m²**	**HDD Exit Point** • Initial trench (600m²) • Transition zone (100m²) • Jack-up footprint (256m²) • Deposited material on sea bed (400m²) **Total = 1,356m²***		HDD beneath the intertidal zone with offshore exit point approximately 1,000m offshore. For SEP and SEP scenario, the initial trench assumes both export cables are within the same initial trench, meaning the area of disturbance is the same as SEP or DEP in isolation scenarios. However, for the transition zone it assumes two trenches and therefore the area of disturbance is double the SEP or DEP in isolation scenarios. Jack-up footprints for SEP and DEP include total jack-up leg footprints and jack-up movements required. Disturbance from the HDD exit point activities are within the CSCB MCZ, therefore the footprint of temporary habitat loss/disturbance within the MCZ has been provided (below).
	Total disturbance footprint for DEP Worst-case scenario total temporary disturbance footprint for DEP in isolation = **5.12km²** **Disturbance in the MCZ** Worst-case scenario total temporary disturbance footprint for DEP in isolation in the CSCB MCZ due to cable installation = **0.17km²**	**Total disturbance footprint for SEP** Worst-case scenario total temporary disturbance footprint for SEP in isolation = **2.12km²** **Disturbance in the MCZ** Worst-case scenario total temporary disturbance footprint for SEP in isolation in the CSCB MCZ due to cable installation = **0.17km²**	**Total disturbance footprint for SEP and DEP** = **7.20km²** **Disturbance in the MCZ** Worst-case scenario total temporary disturbance footprint for SEP and DEP in the CSCB MCZ due to cable installation = **0.33km²**	**Total disturbance footprint for SEP and DEP** = **7.87km²*** **Disturbance in the MCZ** Worst-case scenario total temporary disturbance footprint for SEP and DEP in the CSCB MCZ due to cable installation = **0.33km²**	Long term habitat loss in the Cromer Shoal Chalk Beds MCZ is assessed under operational impacts. Temporary disturbance within MCZ includes: • Area of disturbance from jetting within MCZ • Boulder clearance in offshore export cable corridor • Total jack-up footprint • Temporary moorings anchor footprint within the MCZ • Sea bed footprint of deposited material

Impact	DEP in Isolation	SEP in Isolation	SEP and DEP: Two OSPs (one in SEP wind farm site and one in DEP North array area)	SEP and DEP: One OSP (located in SEP wind farm site)	Notes and Rationale
					• Initial exit point trench area of disturbance • Further transition zone area of disturbance
Impact 2: Temporary increases in suspended sediment concentrations (SSC) and deposition	The worst-case scenario for this potential impact on benthic ecology receptors is provided in the below row. The worst-case scenarios for Impact 2 are also set out in **Chapter 6 Marine Geology, Oceanography and Physical Processes** (**Table 6-2**). The following impacts are relevant to the worst-case for benthic ecology: • Impact 1 (a and b): Changes in suspended sediment concentrations due to sea bed preparation and drill arisings for wind turbine and OSP foundation installation; • Impact 2 (a and b): Changes in sea bed level due to sea bed preparation and drill arisings for wind turbine and OSP foundation installation; • Impact 3: Changes in suspended sediment concentrations due to export cable installation; • Impact 4: Change in sea bed level due to deposition from the suspended sediment plume during export cable installation within the offshore cable corridor; • Impact 5: Changes in suspended sediment concentrations due to offshore cables installation (infield and interlink cables), and • Impact 6: Changes in sea bed level due to offshore cable installation (infield and interlink cables).				The worst-case scenario represents the greatest potential for increased SSC across the study area as a result of changes to physical processes which could result in impacts on benthic ecology receptors. The worst-case scenario for increased SSC during the construction period is associated with sea bed preparation for 19 18MW (SEP) and 24 18MW (DEP) GBS foundations, drilling for OSPs, jetting for export cable installation, and mechanical cutting for infield and interlink cable installation.
	Sea bed preparation for 24 18MW GBS foundations = 407,150m^3 Drill arisings at one OSP = 425m^3 **Displaced sediment during export cable trenching** • Export cable = 31,000m^3 • HDD exit point = 650m^3 (600m^3 initial exit point trench and 50m^3 further transition zone) • Sand wave levelling = 144,200m^3 **Displaced sediment during infield and interlink cable trenching** • Infield = 151,875m^3 • Interlink = 74,250m^3 • Sand wave levelling = 232,200m^3	**Sea bed preparation** for 19 18MW GBS foundations = 322,327m^3 Drill arisings at one OSP = 425m^3 **Displaced sediment during export cable trenching** • Export cable = 20,000m^3 • HDD exit point = 650m^3 (600m^3 initial exit point trench and 50m^3 further transition zone) • Sand wave levelling = 0m^3 **Displaced sediment during infield and interlink cable trenching** Infield = 101,250m^3 Interlink = 0m^3 Sand wave levelling = 0m^3	**Sea bed preparation** for 43 18MW GBS foundations = 729,477m^3 Drill arisings at two OSP = 850m^3 **Displaced sediment during export cable trenching** • Export cable = 51,000m^3 • HDD exit point = 700m^3 (600m^3 initial exit point trench and 100m^3 further transition zone) • Sand wave levelling = 144,200m^3 **Displaced sediment during infield and interlink cable trenching** • Infield = 253,125m^3 • Interlink = 74,250 m^3 • Sand wave levelling = 232,200m^3	**Sea bed preparation** for 43 18MW GBS foundations = 729,477m^3 Drill arisings at one OSP = 425m^3 **Displaced sediment during export cable trenching** • Export cable = 40,000m^3 • HDD exit point = 700m^3 (600m^3 initial exit point trench and 100m^3 further transition zone) • Sand wave levelling = 0m^3 **Displaced sediment during infield and interlink cable trenching** • Infield = 253,125m^3 • Interlink = 160,875m^3*	As above For the HDD exit pit, if SEP and DEP are both built it is assumed that both export cables are within the same initial trench meaning the volume of disturbance is the same as SEP or DEP in isolation scenarios. However, for the transition zone it assumes two trenches and therefore the area of disturbance is double the SEP or DEP in isolation scenarios.

<table>
<tr><th rowspan="2">Impact</th><th rowspan="2">DEP in Isolation</th><th rowspan="2">SEP in Isolation</th><th colspan="2">SEP and DEP</th><th rowspan="2">Notes and Rationale</th></tr>
<tr><th>Two OSPs (one in SEP wind farm site and one in DEP North array area)</th><th>One OSP (located in SEP wind farm site)</th></tr>
<tr><td></td><td>Total increases in SSC
• Worst-case scenario for total temporary increases in SSC for DEP in isolation= 1,041,750m^3

Total increases in SSC in the MCZ
• Worst-case scenario for total temporary increases in SSC for DEP in isolation in the CSCB MCZ due to export cable installation= 6,148.33m^3</td><td>Total increases in SSC
• Worst-case scenario for total temporary increases in SSC for SEP in isolation= 444,652m^3

Total increases in SSC in the MCZ
• Worst-case scenario for total temporary increases in SSC for SEP in isolation in the CSCB MCZ due to export cable installation = 6,148.33m^3.</td><td>Total increases in SSC
• Worst-case scenario for total temporary increases in SSC for SEP and DEP = 1,485,802m^3

Total increases in SSC in the MCZ
• Worst-case scenario for total temporary increases in SSC for SEP and DEP in the CSCB MCZ due to export cable installation = 11,696.65m^3</td><td>• Sand wave levelling[5] = 360,200m^3* (216,000m^3 infield and 144,200m^3 interlink)

Total increases in SSC
Worst-case scenario for total temporary increases in SSC for SEP and DEP = 1,544,802m^3*

Total increases in SSC in the MCZ
• Worst-case scenario for total temporary increases in SSC for SEP and DEP in the CSCB MCZ due to export cable installation = 11,696.65m^3</td><td></td></tr>
<tr><td>Impact 3: Re-mobilisation of contaminated sediments</td><td colspan="4">The worst-case scenarios for Impact 3 are set out in Chapter 7 Marine Water and Sediment Quality (Table 7-3). The following impacts are relevant to the worst-case scenario for benthic ecology:

Construction Impact 5: Deterioration in water quality due to the release of contaminated sediment</td><td></td></tr>
<tr><td>Impact 4: Underwater noise and vibration</td><td colspan="4">The worst-case scenarios for Impact 4 are set out in Chapter 10 Marine Mammal Ecology. They are underwater noise and vibration from UXO (Unexploded Ordnance) clearance and from piling. Noise levels from these sources are summarised in the marine mammals chapter in Table 10-21 (UXO) and Table 10-31 (piling). Underwater noise will be generated by other construction activities including sea bed preparations, cable installation and rock placement, and from vessels.

UXO
Various possible types and sizes of UXO. Worst-case identified by SOW and DOW:
2,000lb German air dropped bomb (Trinitrotoluene (TNT) equivalent of 525kg)
Possible number of UXO unknown.
Piling
Maximum hammer energy for monopiles
• Up to 5,000kJ for 15 MW wind turbines
• Up to 5,500kJ for 18+MW wind turbines

Maximum hammer energy for pin-piles: up to 3,000kJ
Further details, including piling durations are set out in Chapter 10 Marine Mammal Ecology.</td><td>UXO clearance generates highest impulsive noise levels.

Hammer piled foundations generate underwater noise at multiple locations over a larger area for a longer duration.</td></tr>
<tr><td>Impact 5: Invasive Non-Native Species (INNS)</td><td>Construction vessels
• Maximum number of construction vessels: 16</td><td>Construction vessels
• Maximum number of construction vessels: 16</td><td colspan="2">Construction vessels
• Maximum number of construction vessels: 25</td><td>Impacts from INNS may occur during and after the operation phase if INNS introduced by SEP and DEP activities establish on project infrastructure and in the surrounding marine environment. The risk of introducing INNS during construction is primarily related to vessel activities should</td></tr>
</table>

[5] Greater volume of sand wave clearance required for a one OSP scenario where both the DEP North and South array areas are developed compared to when only the DEP North array area is developed (360,200m^2 versus 315,900m^2) means the former is the worst-case.

Impact	DEP in Isolation	SEP in Isolation	SEP and DEP		Notes and Rationale
			Two OSPs (one in SEP wind farm site and one in DEP North array area)	One OSP (located in SEP wind farm site)	
					vessels come from other marine bioregions.
Operation					
Impact 1: Temporary habitat loss / physical disturbance	• Up to 10 jack-up deployments per year. Legs footprint up to **12,000m^2** per year • Cable repair, replacement and reburial footprint: **1,743m^2** per year **Total Disturbance** Worst-case scenario total temporary disturbance footprint for DEP in isolation per year = **13,743m^2** Approximate total temporary disturbance footprint for operational lifetime (40 years) = **0.55km^2**	• Up to 10 jack-up deployments per year. Legs footprint up to **12,000m^2** per year • Cable repair, replacement and reburial footprint: **1,170m^2** per year **Total Disturbance** Worst-case scenario total temporary disturbance footprint for SEP in isolation per year = **13,170m^2** Approximate total temporary disturbance footprint for operational lifetime (40 years) = **0.53km^2**	• Up to 20 jack-up deployments per year. Legs footprint up to **24,000m^2** per year • Cable repair, replacement and reburial footprint: **4,473m^2** per year. **Total Disturbance** Realistic worst-case scenario total temporary disturbance footprint SEP and DEP per year = **28,473m^2** Approximate total temporary disturbance footprint for operational lifetime (40 years) = **1.14km^2**	• Up to 20 jack-up deployments per year. Legs footprint up to **24,000m^2** per year • Cable repair, replacement and reburial footprint: **4,704m^2*** per year. **Total Disturbance** Realistic worst-case scenario total temporary disturbance footprint SEP and DEP per year = **28,704m^2*** Approximate total temporary disturbance footprint for operational lifetime (40 years) = **1.148km^2***	Assuming a jack-up vessel with a sea bed footprint of 1,200m^2 (up to four legs, each with a footprint of up to 300m^2). Disturbance is shown on average per year, however maintenance could vary across years during the operational stage and therefore an approximate total disturbance is shown for the operational life time, which is expected to be 40 years.
Impact 2: Permanent habitat loss	**Wind turbine foundations:** Maximum footprint of 24 GBS foundations (18MW) including foundation scour protection: **0.61km^2** Substation foundations: Maximum footprint of OSP foundations including scour protection (with jackets): **4,761m^2 (0.0048km^2)**	**Wind turbine foundations:** Maximum footprint of 19 GBS foundations (18MW) including foundation scour protection: **0.48km^2** Substation foundations: Maximum footprint of OSP foundations including scour protection (with jackets): **4,761m^2 (0.0048km^2)**	**Wind turbine foundations:** Maximum footprint of 43 18MW GBS foundations including foundation scour protection: **1.09km^2** Substation foundations: Maximum footprint of OSP foundations including scour protection (with jackets) (2 OSPs): **9,522m^2 (0.0095km^2)***	**Wind turbine foundations:** Maximum footprint of 43 18MW GBS foundations including foundation scour protection: **1.09km^2** Substation foundations: Maximum footprint of OSP foundations including scour protection (with jackets) (one OSP): **4,761m^2 (0.0048km^2)**	Infrastructure that may not be removed during decommissioning. Individual GBS footprints including scour protection are 14,313.8m^2 and 25,446.9m^2 for a 15MW and 18MW wind turbine respectively and therefore the worst-case across the windfarm sites is associated with the 18MW wind turbines. For reference, the DEP wind farm site covers an area of 114.75km^2. The SEP wind farm site covers an area of 97.0km^2.
	Subsea cable surface protection: • **Export cables** up to **0.5km** (including 100m in the MCZ) of cable protection **6m wide** = 3,000m^2. For this impact worst-case = **2,400m^2** to account for 600m^2 in the MCZ which is assessed in the below impact • **Interlink cables** up to **1.5km** of cable protection 6m wide = **9,000m^2**	**Subsea cable surface protection:** • **Export cables** up to **0.5km** (including 100m in the MCZ) of cable protection **6m wide** = 3,000m^2. For this impact worst-case = **2,400m^2** to account for 600m^2 in the MCZ which is assessed in the below impact	**Subsea cable surface protection:** • Same as for a DEP in isolation scenario **Crossings** Up to **21 crossings** (over-trawlable) • Export cables: 8 crossings = 16,800m^2 • Infield cables: 7 crossings = 14,700m^2	Same as for a 2 OSP scenario.	Footprint of cable protection does not include export cable protection in the MCZ as this is covered in long term habitat loss (Impact 3) below. Cable protection for crossings will be up to 21m wide and 100m long and consist of either concrete mattressing or rock dumping.

Impact	DEP in Isolation	SEP in Isolation	SEP and DEP: Two OSPs (one in SEP wind farm site and one in DEP North array area)	SEP and DEP: One OSP (located in SEP wind farm site)	Notes and Rationale
	• **Infield cables** up to **1km** of cable protection 4m wide = **4,000m²** Total = **15,400m² (0.0154km²)** **Crossings** Up to **17 crossings** (over-trawlable), each crossing has a 2,100m² footprint (21m width x 100m length) • Export cable: 4 crossings = 8,400m² • Infield cables: 7 crossings = 14,700m² • Interlink cables: 6 crossings = 12,600m² Total crossings protection = **35,700m²** **Total** maximum footprint of cable protection (export, interlink and infield) and cable crossing protection = **0.051km²**	• **Infield cables** up to **1km** of cable protection 4m wide = **4,000m²** **Crossings** • Export cable: 4 crossings = 8,400m² • **No interlink or infield cable crossing** protection material is required for a SEP in isolation scenario. **Total** maximum footprint of cable protection (export, interlink and infield) and cable crossing protection = **0.015km²**	• Interlink cables: 6 crossings = 12,600m² Total crossings protection = **44,100m² (0.0441km²)** **Total** maximum footprint of cable protection (export, interlink and infield) and cable crossing protection = **0.06km²**		**SEP and DEP worst-case crossing locations** • Infield cables: up to seven crossings (three in the DEP North array area at Durango-Waveney pipeline, up to four in the DEP South array area) • Interlink cables, up to six crossings (three cables from the DEP South array area crossing two Dudgeon export cables) • Export cable, up to four crossings (two at Dudgeon export cables, two for Hornsea Three export cables). One disused subsea cable crosses the export cable, but no crossing required.
	Total permanent habitat loss: 0.67km²	**Total permanent habitat loss: 0.50km²**	**Total permanent habitat loss: 1.159km²***	**Total permanent habitat loss: 1.155km²**	
Impact 3: Long term habitat loss (in Cromer Shoal Chalk Beds MCZ)	Cable protection (900m²): • HDD exit transition zone (100m x 3m): **300m²** • External cable protection (100m x 6m): **600m²**	Cable protection (900m²): • HDD exit transition zone (100m x 3m): **300m²** • External cable protection (100m x 6m): **600m²**	Cable protection (1,800m²): • HDD exit transition zone (2 cables): **600m²** • External cable protection (2 cables): **1,200m²**		External cable protection systems (designed to be removable on decommissioning (see **Appendix 3 Decommissioning Feasibility Study** (document reference 9.7.3) of the **Outline CSCB MCZ CSIMP** (document reference 9.7)) may be placed in the HDD exit transition zone and as cable protection for export cable. The impact assessment is based on removal during decommissioning.
Impact 4: Temporary increases SSC and deposition	See Operation Impact 1: Temporary habitat loss / disturbance. Temporary increases in SSC will result from periodic jack-up vessel deployment, and cable repair, replacement and reburial activities.				The volume of sediment that could be suspended has not been calculated but will be a much smaller proportion compared with the quantity generated by construction and decommissioning activities.

Impact	DEP in Isolation	SEP in Isolation	SEP and DEP		Notes and Rationale
			Two OSPs (one in SEP wind farm site and one in DEP North array area)	One OSP (located in SEP wind farm site)	
Impact 5: Colonisation of foundations and cable protection	See impacts 2 and 3.				
Impact 6: Underwater noise and vibration	The worst-case scenarios for Impact 6 are set out in **Chapter 10 Marine Mammal Ecology** (**Table 10-3**). The following impacts are relevant to the worst-case scenario for benthic ecology: • Underwater noise from operational turbines • Underwater noise from maintenance activities • Underwater noise from vessels				
Impact 7: INNS	**Construction vessels** Maximum number of construction vessels on site at any one time: **16** **O&M vessels** • Maximum number of O&M vessels on site at any one time: **7** See also impacts 2, 3 and 6 for infrastructure that may be colonised.	**Construction vessels** Maximum number of construction vessels on site at any one time: **16** **O&M vessels** • Maximum number of O&M vessels on site at any one time: **7** See also impacts 2, 3 and 6 for infrastructure that may be colonised.	**Construction vessels** Maximum number of construction vessels on site at any one time: **16** **O&M vessels** • Maximum number of O&M vessels on site at any one time: **9** See also impacts 2, 3 and 6 for infrastructure that may be colonised.		For the purposes of this assessment, the risks of introduction and spread of INNS are assessed for the operational phase when INNS may become established. However, measures to minimise the risk of introduction apply to all project phases. Impacts from INNS may occur during and after the construction phase if INNS introduced by SEP and DEP activities establish on project infrastructure and in the surrounding marine environment. The risk of introducing INNS during construction is primarily related to vessel activities should vessels come from other marine bioregions.
Decommissioning					
Impact 1: Temporary habitat loss / physical disturbance Impact 2: Permanent habitat loss Impact 3: Temporary increases in SSC and deposition Impact 4: Re-mobilisation of contaminated sediments	No final decision has yet been made regarding the final decommissioning policy for the offshore project infrastructure. It is also recognised that legislation and industry best practice change over time. However, the following infrastructure is likely be removed, reused or recycled where practicable: • Turbines including monopile, steel jacket and GBS foundations; • OSPs including topsides and steel jacket foundations; • Offshore cables may be removed or left *in situ* depending on available information at the time of decommissioning; and • Cable protection in the Cromer Shoal Chalk Beds MCZ. The following infrastructure is likely to be decommissioned *in situ* depending on available information at the time of decommissioning: • Scour protection; • Offshore cables may be removed or left *in situ*; and • Crossings and cable protection outside the Cromer Shoal Chalk Beds MCZ. The detail and scope of the decommissioning works will be determined by the relevant legislation and guidance at the time of decommissioning and will be agreed with the regulator. For the purposes of the worst-case scenario, it is anticipated that the impacts will be no greater than those identified for the construction phase.				Decommissioning arrangements will be detailed in a Decommissioning Programme, which will be drawn up and agreed with the Department for Business, Energy and Industrial Strategy (BEIS) prior to construction.

Impact	DEP in Isolation	SEP in Isolation	SEP and DEP		Notes and Rationale
			Two OSPs (one in SEP wind farm site and one in DEP North array area)	One OSP (located in SEP wind farm site)	
Impact 5: Underwater noise and vibration					
Impact 6: INNS					
Impact 7: Potential impacts on sites of marine conservation importance					

8.3.3 Summary of Mitigation

8.3.3.1 Mitigation Embedded in the Design

21. This section outlines the embedded mitigation relevant to the benthic ecology assessment, which has been incorporated into the design of the projects (**Table 8-3**). Where other mitigation measures are proposed, these are detailed in the impact assessment (**Section 8.6**).

Table 8-3: Embedded Mitigation Measures

Parameter	Mitigation Measures Embedded into the Design of SEP and DEP
General	
Site selection	Careful site selection of the SEP and DEP wind farm sites and offshore cable corridors has been carried out to avoid designated sites as far as possible. It has not been possible to avoid the CSCB MCZ (as detailed in **Chapter 3 Site Selection and Assessment of Alternatives**), however use of appropriate cable installation methodologies can help to ensure that impacts from cable installation are short term and reversible. The offshore cable corridor takes the shortest, most direct route possible from the SEP and DEP wind farm sites to landfall, whilst avoiding as many known sensitive benthic habitats as possible therefore reducing impacts to benthic ecology. Additionally, the offshore cable corridor has been sited to avoid cable crossings where possible and there are no cable crossings in the MCZ.
Turbines	Larger turbines have been selected that will reduce the number of turbines (and foundations) required whilst maintaining generating capacity, and therefore reduce impacts to benthic ecology.
Landfall	HDD will be used to install the export cables at the landfall, with the HDD exit point located approximately 1,000m offshore. Therefore, there will be no direct impacts on the intertidal zone due to cable installation or the landfall, as they will not be within the intertidal zone.
Foundations	The selection of appropriate foundation designs and sizes at each wind turbine location will be made following pre-construction surveys within the offshore sites.
	For piled foundation types, such as monopiles and jackets with pin piles, pile-driving will be used in preference to drilling where it is practicable to do so (i.e. where ground conditions allow). This would minimise the quantity of sub-surface sediment released into the water column from the installation process.
	Micro-siting will be used where possible to minimise the requirements for sea bed preparation prior to foundation installation.
Cables	The Applicant will make reasonable endeavors to bury offshore cables, minimising the requirement for external cable protection measures and thus minimising habitat loss impacts on benthic ecology receptors. The minimum amount of pre-sweeping (sand wave levelling) that is required to assist with the cable installation process will be undertaken and only in relation to the interlink cables and wind farm sites.
Cable protection	The allowance for external cable protection within the CSCB MCZ boundary has been minimised as far as possible.
Sediment disposal	All sea bed material arising from the CSCB MCZ during cable installation (namely at the HDD exit point) would be placed back within the MCZ at or close to the source, using an approach to be agreed with the MMO in consultation with the relevant Statutory Nature Conservation Bodies (SNCB). Sediment would not be disposed of

Parameter	Mitigation Measures Embedded into the Design of SEP and DEP
	in or nearby known sensitive benthic habitats and where possible will be redeposited within areas of similar sediment type.
Invasive Non-Native Species	Use of best practice measures including appropriate vessel maintenance following International Convention for the Prevention of Pollution from Ships (MARPOL) Guidance will be used to minimise the potential for the spread of INNS.

8.3.3.2 Other Mitigation Measures

22. In addition to the embedded mitigation measures as outlined above, the Applicant has also committed to the following mitigation measures summarised in **Table 8-4**.

Table 8-4: Additional Mitigation Measures

Parameter	Additional Mitigation Measures
Cable protection	All external cable protection systems used within the CSCB MCZ will be designed to be removable (i.e. no loose rock) with a commitment to remove it, at decommissioning if it is deemed to be required at that time. This is secured in Schedule 2, Requirement 8, part 1 of the **Draft DCO** (document reference 3.1).
Pre-construction surveys and micro-siting	As secured through the DMLs in the **Draft DCO** (document reference 3.1), pre-construction surveys will be undertaken to determine if potential Annex I / UK BAP Priority Habitat *S. spinulosa* reef[6] and UK BAP priority habitat 'peat and clay exposures with piddocks' are present within the proposed wind turbine locations or offshore cable routes. The pre-construction survey methodology would be agreed with the MMO in consultation with Natural England. The survey design would be based on best practice at the time and is anticipated to consist of a mixture of geophysical, drop-down video (DDV) and grab surveys (as applicable) to ensure a comprehensive ground-truthing of the proposed final wind turbine locations and cable route design. Initial geophysical surveys will be reviewed with DDV ground-truthing surveys to confirm presence as appropriate. This shall then be used to inform detailed layout design in the design plan and will inform the mitigation scheme requirements. If potentially sensitive benthic features are identified, the results of the survey will be discussed at that time with the MMO and Natural England to agree whether the features constitute Annex I / UK BAP priority habitat features and whether they are required to be avoided through micro-siting.

[6] Note any Annex I *S. spinulosa* reef identified would not be associated with an SAC for which *S. spinulosa* reef is a qualifying feature since the SEP and DEP offshore sites do not overlap with any SACs.

8.4 Impact Assessment Methodology

8.4.1 Policy, Legislation and Guidance

8.4.1.1 National Policy Statements

23. The assessment of potential impacts upon benthic ecology has been made with specific reference to the relevant NPS. These are the principal decision making documents for Nationally Significant Infrastructure Projects (NSIPs). The NPS for Renewable Energy Infrastructure (EN-3) (DECC, 2011) is the NPS of most relevance to the benthic ecology assessment.

24. The specific assessment requirements for benthic ecology, as detailed in the NPS, are summarised in **Table 8-5** together with an indication of the section of the ES chapter where each is addressed.

25. It is noted that the NPS for Renewable Energy Infrastructure (EN-3) is in the process of being revised. A draft version was published for consultation in September 2021 (Department for Business Energy and Industrial Strategy (BEIS), 2021). A review of this draft version has been undertaken in the context of this ES chapter.

26. **Table 8-5** includes a section for the draft version of NPS (EN-3) in which relevant additional NPS requirements not presented within the current NPS (EN-3) have been included. A reference to the particular requirement's location within the draft NPS and to where within this ES chapter or wider ES it has been addressed has also been provided.

Table 8-5: NPS Assessment Requirements

NPS Requirement	NPS Reference	Section Reference
NPS for Renewable Energy Infrastructure (EN-3)		
Applicants are expected to have regard to guidance issued in respect of Food and Environment Protection Agency (FEPA) (now Marine Licence) requirements.	Paragraph 2.6.83	Other relevant guidance, including Marine Licensing, are outlined below (**Section 8.4.1.2**).
Where necessary, assessment of the effects on the subtidal environment should include: • loss of habitat due to foundation type including associated seabed preparation, predicted scour, scour protection and altered sedimentary processes; • environmental appraisal of inter-array and cable routes and installation methods; • habitat disturbance from construction vessels' extendible legs and anchors; • increased suspended sediment loads during construction; and • predicted rates at which the subtidal zone might recover from temporary effects.	Paragraph 2.6.113	An assessment of effects on the subtidal environment is set out in **Section 8.6**, this includes: Temporary loss of habitat / disturbance from sea bed preparation for wind turbine foundations, installation of offshore cables and disturbance from construction vessels are assessed in **Section 8.6.2.1**. Potential impacts from increases in suspended sediment are assessed in **Section 8.6.2.2**.

NPS Requirement	NPS Reference	Section Reference
		The resilience or ability of a receptor to recover has been considered when defining the sensitivity of receptor in the impact assessment **Section 8.6** (also see impact assessment methodology in **Section 8.4.3**).
Construction and decommissioning methods should be designed appropriately to minimise effects on subtidal habitats, taking into account other constraints. Mitigation measures which the IPC should expect the applicants to have considered may include: • surveying and micrositing of the export cable route to avoid adverse effects on sensitive habitat and biogenic reefs; • burying cables at a sufficient depth, taking into account other constraints, to allow the seabed to recover to its natural state; and • the use of anti-fouling paint might be minimised on subtidal surfaces, to encourage species colonisation on the structures.	Paragraph 2.6.119	Mitigation measures are set out in **Section 8.3.3.** Pre-construction surveys will be undertaken to identify any potential Annex I or UKBAP priority habitats and the results discussed with the MMO and Natural England. The Applicant will make reasonable endeavours to bury offshore cables, minimising the requirement for external cable protection measures and thus minimising habitat loss impacts on benthic ecology receptors. The minimum amount of pre-sweeping (sand wave levelling) that is required to assist with the cable installation process will be undertaken and only in relation to the interlink cables and wind farm sites.
Draft NPS for Renewable Energy Infrastructure (EN-3) (BEIS, 2021)		
Assessment of the effects on the subtidal environment should include: • environmental appraisal of inter-array and export cable routes and installation/maintenance methods, including predicted loss of habitat due to predicted scour and scour protection • habitat disturbance from construction and maintenance/repair vessels' extendible legs and anchors • increased suspended sediment loads during construction and from maintenance/repairs • potential impacts from EMF on benthic fauna • impacts on protected sites (e.g. HRA sites and MCZs)	Paragraph 2.30.2	An assessment of effects on the subtidal environment is set out in **Section 8.6** which includes an assessment of potential impacts during maintenance activities. EMF impacts on benthic invertebrates was scoped out of the assessment (see **Table 8-1**). The CSCB MCZ is included as a sensitive receptor within this chapter and therefore potential impacts on protected sites have been considered.

NPS Requirement	NPS Reference	Section Reference
Construction, maintenance and decommissioning methods should be designed appropriately to minimise effects on subtidal habitats, taking into account other constraints. Review of up-to-date research should be undertaken and all potential mitigation options presented. Mitigation measures which the Secretary of State should expect the applicants to have considered may include: • surveying and micrositing or re-routing of the export and inter-array cables to avoid adverse effects on sensitive habitats, biogenic reefs or protected species	Paragraph 20.30.3	Mitigation measures are set out in **Section 8.3.3.** Pre-construction surveys will be undertaken to identify any potential Annex I or UKBAP priority habitats and the results discussed with the MMO and Natural England. The Applicant will make reasonable endeavours to bury offshore cables, minimising the requirement for external cable protection measures and thus minimising habitat loss impacts on benthic ecology receptors. **Table 8-4** includes provision for pre-construction survey and micro-siting, if required.
Where cumulative impacts on subtidal habitats are predicted as a result of multiple cable routes, applicants for various schemes are encouraged to work together to ensure that the number of cables crossing the subtidal zone is minimised and installation/ decommissioning phases are coordinated to ensure that disturbance is reasonably minimised	2.30.4	Potential cumulative impacts are assessed in **Section 8.7**. The site selection process described in **Chapter 3 Site Selection and Assessment of Alternatives** sought to minimise the number of cable crossings. There are no cable crossings within the MCZ.

8.4.1.2 Other

27. The Marine Policy Statement (MPS) (HM Government, 2011); discussed further in **Chapter 2 Policy and Legislative Context**) provides a high-level approach to marine planning and general principles for decision making that contribute to the NPS objectives. It also sets out the framework for environmental, social and economic considerations that need to be taken into account in marine planning. The high-level objective 'Living within environmental limits' covers points relevant to benthic ecology, and requires that:

- Biodiversity is protected, conserved and where appropriate recovered and loss has been halted;
- Healthy marine and coastal habitats occur across their natural range and are able to support strong, biodiverse biological communities and the functioning of healthy, resilient and adaptable marine ecosystems; and
- Our oceans support viable populations of representative, rare, vulnerable, and valued species.

28. England currently has nine marine plans; those relevant to SEP and DEP are the East Inshore and The East Offshore Marine Plans (HM Government, 2014). These

contain the two objectives stated below, which are of relevance to benthic ecology, as they cover policies and commitments on the wider ecosystem set out in the MPS:

- Objective 6: 'To have a healthy, resilient and adaptable marine ecosystem in the East Marine Plan areas'; and
- Objective 7: 'To protect, conserve and, where appropriate, recover biodiversity that is in or dependent upon the East marine plan areas'.

29. Other guidance on the requirements for wind farm studies are provided in the documents listed below:

- Cefas (2004) Offshore Wind Farms: Guidance Note for Environmental Impact Assessment in Respect of FEPA and CPA requirements: Version 2;
- Cefas (2010) Strategic Review of Offshore Wind Farm Monitoring Data Associated with FEPA licence conditions, with input from the Food and Environment Research Agency (FERA) and the Sea Mammal Research Unit (SMRU);
- Marine Management Organisation (MMO) (2014) Review of Post-Consent Offshore Wind Farm Monitoring Data Associated with Licence Conditions, with input from the British Trust for Ornithology (BTO), National Physical Laboratory (NPL) and the SMRU;
- Defra (2005) Nature Conservation Guidance on Offshore Windfarm Development. A guidance note on the implications of the EC Wild Birds and Habitats Directives for developers undertaking offshore windfarm developments. Version R1.9. 13.
- Natural England (2021) Natural England's Approach to Offshore Wind. Natural England Technical Information Note TIN181
- Peritus International Ltd (2022) Scour and Cable Protection Decommissioning Study. NECR403. Natural England.

30. The principal guidance documents used to inform the baseline characterisation and the assessment of impacts are as follows:

- Cefas (2012) Guidelines for data acquisition to support marine environmental assessments of offshore renewable energy projects;
- Wyn & Brazier (2001); Joint Nature Conservation Committee (JNCC) Marine Monitoring Handbook;
- Ware and Kenny (2011) Guidance for the Conduct of Benthic Studies at Marine Aggregate Extraction Sites;
- Institute of Ecology and Environmental Management (IEEM) (2010) Guidelines for Ecological Impact Assessment in Britain and Ireland – Marine and Coastal;
- Chartered Institute of Ecology and Environmental Management (CIEEM) (2016) Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater and Coastal, 2nd Edition; and

- The British Standards Institution (2015) Environmental impact assessment for offshore renewable energy projects – Guide. PD 6900:2015.

31. Further detail is provided in **Chapter 2 Policy and Legislative Context**.

8.4.2 Data and Information Sources

8.4.2.1 Project geophysical surveys

32. Site specific geophysical surveys (using a multibeam echosounder, side scan sonar and sub-bottom profiler) were undertaken prior to the benthic characterisation surveys, to inform the design of the benthic site characterisation surveys and to feed into the habitat mapping process. The surveys were undertaken in accordance with Ware and Kenny (2011) guidelines and agreed in advance with stakeholders including the MMO, Cefas and Natural England as required. The surveys undertaken were:

- Geophysical survey of the offshore export cable corridor options, September to December 2019 (Gardline, 2020a); and
- Geophysical survey of the SEP and DEP wind farm sites and interlink cable corridors, March to May 2020 (Gardline, 2020b).

8.4.2.2 Project benthic characterisation survey

33. In order to provide site specific and up to date information on which to base the impact assessment, a benthic site characterisation survey was conducted split into separate reports for SEP and DEP. The site characterisation reports and habitat reports are available in **Appendix 8.1 DEP Benthic Characterisation Report** (Fugro, 2020a), **Appendix 8.2 SEP Benthic Characterisation Report** (Fugro, 2020b) **Appendix 8.3 DEP Benthic Habitat Report** (Fugro, 2020c) and **Appendix 8.4 SEP Benthic Habitat Report** (Fugro, 2020e).

34. The aims of the benthic characterisation survey were to assess the benthic communities and potentially sensitive habitats, such as Annex I habitats. The offshore export cable corridor passes through the CSCB MCZ and, as such, emphasis was placed on the identification of designated features such as any subtidal chalk habitats. The survey station locations are representative of the full range of potential habitats and acoustic ground types in the area of interest.

35. The benthic characterisation survey was conducted in August 2020 and covered the SEP and DEP wind farm sites and the offshore cable corridors (excluding the temporary works areas and the narrow interlink cable corridor between the DEP North and South array areas – see **Figure 8.1**). The 'DEP offshore survey area' covered the DEP wind farm site, interlink and offshore export cable corridors (**Appendix 8.1**) and 'SEP offshore survey area' covered the SEP wind farm site and the SEP offshore export cable corridor (**Appendix 8.1**). The survey areas and locations of survey stations are shown in **Figure 8.1**.

36. The survey included 26 survey stations within the DEP wind farm site (with a 'D' prefix), 26 stations within the SEP wind farm site (with an 'SS' prefix), 19 stations in the two DEP interlink cable corridors (with a 'CC' prefix), and 25 stations in the export cable corridor between the SEP wind farm site and landfall (with an 'EC'

prefix). The sampling consisted of drop down video and still photography at all stations, and grab sampling for macrofaunal and Particle Size Distribution (PSD) analysis at the majority of stations, some with triplicate grabs. At a subset of stations additional sediment grabs were taken for chemical analysis to determine levels of sediment contamination. The distribution of this sampling is illustrated in **Figure 8.1**.

37. The number of stations of each type of sampling method in the project areas were:

- Drop down video: All stations
- Grab samples:
  - 21 of the 26 stations within DEP wind farm site ('D' stations);
  - 17 of the 26 stations within SEP wind farm site ('SS' stations);
  - 19 of the 19 stations within the two interlink cable corridors ('CC' stations); and
  - 18 of the 25 stations within the offshore export cable corridor ('EC' stations).
- Grab for chemical samples:
  - 2 stations within DEP wind farm sites;
  - 1 station within SEP wind farm site;
  - 1 station within the interlink cable corridors; and
  - 3 stations within the SEP and DEP offshore export cable corridor.

38. The design of the survey was based on an analysis of multibeam echosounder (MBES) and side scan sonar (SSS) data derived from geophysical surveys of the offshore export cable corridor (September – November 2019) and the extension wind farm sites and interlink corridors (April – May 2020). The sea bed has been classified based on depth, rugosity (derived from bathymetry data) and SSS return strength. The methodology for the benthic characterisation survey and subsequent data analysis was agreed with Natural England and the MMO. Further details of the surveys are available in **Appendix 8.1 DEP Benthic Characterisation Report** and **Appendix 8.2 SEP Benthic Characterisation Report**.

8.4.2.3 Benthic habitat mapping

39. Benthic habitat maps have been produced for the project area by combining the geophysical data sets and benthic sample data (grab and drop down video imagery) using geostatistical processing and spatial statistical analysis. A technical report summarising the benthic habitat mapping method and results is provided in **Appendix 8.5 SEP and DEP Habitat Mapping** (Envision, 2021).

8.4.2.4 Other available sources

40. The data sources that have been used to inform the assessment are listed in **Table 8-6**.

Table 8-6: Other Available Data and Information Sources

Data set	Spatial coverage	Year	Notes
DOW ES (including 2009 pre-construction survey)	Dudgeon project area including the wind farm site and offshore export cable corridor.	2009	The report covers the Dudgeon project area which is in close proximity to the DEP wind farm sites, DEP South array area to SEP wind farm site interlink cable corridor and offshore export cable corridor between the SEP wind farm site and landfall.
SOW ES	Sheringham Shoal project area including the wind farm site and offshore export cable corridor.	2006	The report covers the Sheringham Shoal project area which is in close proximity to the SEP wind farm site and offshore export cable corridor close to landfall.
DOW post-construction survey (MMT, 2019)	Dudgeon wind farm site (including outside the boundary) and export cable corridor section within the CSCB MCZ.	2018	Recent survey data in close proximity to the SEP and DEP offshore sites, allowing comparison with the pre-construction baseline survey and an assessment of benthic recovery.
Sheringham Shoal Post Construction Monitoring Benthic Survey (Fugro, 2013)	Sheringham Shoal wind farm site and offshore export cable corridor, plus reference sites including inside the SEP with farm site and in close proximity to the SEP and DEP export cable corridor.	2012	Survey data in close proximity to, and within, the SEP and DEP offshore sites, allowing comparison with the pre-construction baseline survey and an assessment of benthic recovery.
SOW Second Post-Construction Benthic Monitoring Survey (Marine Ecological Surveys, 2014)	Sheringham Shoal wind farm site and offshore export cable corridor, plus reference sites including inside the SEP with farm site and in close proximity to the SEP and DEP export cable corridor.	2014	Survey data in close proximity to, and within, the SEP and DEP offshore sites, allowing comparison with the pre-construction baseline survey and an assessment of benthic recovery.
SOW Export Cable Route Post - Construction Benthic Monitoring Survey (Fugro, 2020d)	Sheringham Shoal offshore export cable corridor within the CSCB MCZ.	2020	Recent survey data in close proximity to the SEP and DEP offshore export cable corridor. Ten video transects across the offshore export cable route within the MCZ. Photographic data was analysed and compared with pre-construction survey data.
Marine Life Information Network (MarLIN) Marine evidence and	UK waters	Various	The MarLIN 'evidence base' remains the largest review yet undertaken on the effects of human activities and natural events on

Data set	Spatial coverage	Year	Notes
sensitivity assessment (MarESA)			marine species and habitats, and includes evidence-based sensitivity assessments that have been used in the impact assessment.

8.4.3 Impact Assessment Methodology

41. **Chapter 5 EIA Methodology** provides a summary of the general impact assessment methodology applied to SEP and DEP. The following sections confirm the methodology used to assess the potential impacts on benthic ecology.

42. A matrix approach has been used to assess impacts following best practice, EIA guidance and the approach outlined in the SEP and DEP Scoping Report (Royal HaskoningDHV, 2019). An explanation of how this is applied within the benthic ecology assessment is set out below.

43. The data sources summarised in **Section 8.4.2** were used to characterise the existing environment, the description of which is presented in **Section 8.5.** Each impact, which has been identified using expert judgement and through the Scoping Process, is then assessed in terms of its significance using the methods described below.

8.4.3.1 Definitions

8.4.3.1.1 Sensitivity

44. The assessment identifies receptors for which there is a pathway for effect, and the sensitivity of those receptors to each effect. The definitions of sensitivity are based on MarLIN's Marine Evidence based Sensitivity Assessment (MarESA) (Tyler-Walters *et al*., 2018) which determines sensitivity based on resistance (tolerance) and resilience (recoverability) which are defined as:

- **Resistance:** the likelihood of damage (termed intolerance or resistance) due to a pressure; and
- **Resilience:** the rate of (or time taken for) recovery (termed recoverability, or resilience) once the pressure has abated or been removed.

45. The MarESA assessment of sensitivity is guided by the presence of key structural or functional species/assemblages and/or those that characterize the biotope groups. Physical and chemical characteristics are also considered where they structure the community. MarESA has been used in order to determine sensitivity of specific biotopes and dominant macrofauna recorded during the site-specific benthic characterisation surveys. The sensitivity of biotopes taken from MarESA is provided in **Appendix 8.6**.

Table 8-7: Resistance and Resilience Scale Definitions

Level	Description
Resistance (Tolerance)	
None	Key functional, structural, characterising species severely decline and/or physicochemical parameters are also affected e.g. removal of habitats causing a

Level	Description
	change in habitats type. A severe decline/reduction relates to the loss of 75% of the extent, density or abundance of the selected species or habitat component e.g. loss of 75% substratum (where this can be sensibly applied).
Low	Significant mortality of key and characterising species with some effects on the physicochemical character of habitat. A significant decline/reduction relates to the loss of 25-75% of the extent, density, or abundance of the selected species or habitat component e.g. loss of 25-75% of the substratum.
Medium	Some mortality of species (can be significant where these are not keystone structural/functional and characterising species) without change to habitats relates to the loss <25% of the species or habitat component.
High	No significant effects on the physicochemical character of habitat and no effect on population viability of key/characterising species but may affect feeding, respiration and reproduction rates.
Resilience (Recovery)	
Very Low	Negligible or prolonged recovery possible; at least 25 years to recover structure and function.
Low	Full recovery within 10-25 years.
Medium	Full recovery within 2-10 years.
High	Full recovery within 2 years.

46. MarESA uses a matrix approach using both recovery and resilience to determine sensitivity. The sensitivity matrix used in this assessment, based on MarESA, is presented in **Table 8-8**.

Table 8-8: Sensitivity Matrix

		Resistance			
		None	Low	Medium	High
Resilience	Very Low	High	High	Medium	Low
	Low	High	High	Medium	Low
	Medium	Medium	Medium	Medium	Low
	High	Medium	Low	Low	Negligible

47. MarESA sensitivities are not available at the habitat level (European Nature Information System (EUNIS)[7] level 3). However, the confidence in the data at the habitat level is higher than at the biotope level (EUNIS level 5). Therefore, where sensitivity at the habitat level is assessed, it is based on the worst-case sensitivity of biotopes identified within the habitat.

[7] The European Nature Information System (EUNIS) habitat classification is a comprehensive pan-European system for habitat identification. More information is available at: [redacted]

48. It is important to note that where local evidence is available about habitat tolerance and recovery, for example from post construction benthic monitoring surveys at the SOW and DOW, sensitivities are modified accordingly.

8.4.3.1.2 Value

49. In addition, the 'value' of the receptor forms an important element within the assessment, for instance if the receptor is a protected species or habitat. It is important to understand that high value and high sensitivity are not necessarily linked within a particular impact. A receptor could be of high value (e.g. Annex I habitat) but have a low or negligible physical/ecological sensitivity to an effect. Similarly, low value does not equate to low sensitivity and is judged on a receptor by receptor basis. The value will be considered, where relevant, as a modifier for the sensitivity assigned to the receptor, based on expert judgement.

Table 8-9: Definitions of Value Levels for Benthic Ecology

Value	Definition
High	Habitats (and species) protected under international law (e.g. Annex I habitats within a Special Area of Conservation (SAC) boundary). Habitats protected under national law (e.g. Annex I habitats within an MCZ boundary; UK BAP priority habitats and species).
Medium	Regional UK BAP priority species and habitats. Habitats or species that provide prey items for other species of conservation value. Species/habitat that may be rare or threatened internationally.
Low	Locally important or nationally rare habitats and species.
Negligible	Habitats and species which are not protected under conservation legislation and are not considered to be particularly important or rare.

8.4.3.1.3 Magnitude of Effect

50. The definitions of magnitude for the purpose of the benthic ecology assessment are provided in **Table 8-10**.

Table 8-10: Definition of Magnitude

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 (throughout project duration) change, over a minority of the receptor, and / or limited but discernible alteration to key characteristics or features of the particular receptors character or distinctiveness.
Negligible	Discernible, temporary (for part of the project duration) change, or barely discernible change for any length of time, over a small area of the receptor, and/or slight alteration to key characteristics or features of the particular receptors character or distinctiveness.

8.4.3.2 Impact Significance

51. In basic terms, the potential significance of an impact is a function of the sensitivity of the receptor and the magnitude of the effect (see **Chapter 5 EIA Methodology** for further details). The determination of significance is guided by the use of an impact significance matrix, as shown in **Table 8-11**. Definitions of each level of significance are provided in **Table 8-12**.

52. Potential impacts identified within the assessment as major or moderate are regarded as significant in terms of the EIA regulations. Appropriate mitigation has been identified, where possible, in consultation with the regulatory authorities and relevant stakeholders. The aim of mitigation measures is to avoid or reduce the overall impact in order to determine a residual impact upon a given receptor.

Table 8-11: Impact Significance Matrix

		Adverse Magnitude				Beneficial Magnitude			
		High	Medium	Low	Negligible	Negligible	Low	Medium	High
Sensitivity	High	*Major*	*Major*	*Moderate*	*Minor*	*Minor*	*Moderate*	*Major*	*Major*
	Medium	*Major*	*Moderate*	*Minor*	*Minor*	*Minor*	*Minor*	*Moderate*	*Major*
	Low	*Moderate*	*Minor*	*Minor*	*Negligible*	*Negligible*	*Minor*	*Minor*	*Moderate*
	Negligible	*Minor*	*Negligible*	*Negligible*	*Negligible*	*Negligible*	*Negligible*	*Negligible*	*Minor*

Table 8-12: Definition of Impact Significance

Significance	Definition
Major	Very large or large change in receptor condition, both adverse or beneficial, which are likely to be important considerations at a regional or district level because they contribute to achieving national, regional or local objectives, or could result in exceedance of statutory objectives and / or breaches of legislation.
Moderate	Intermediate change in receptor condition, which are likely to be important considerations at a local level.
Minor	Small change in receptor condition, which may be raised as local issues but are unlikely to be important in the decision-making process.
Negligible	No discernible change in receptor condition.
No change	No impact, therefore, no change in receptor condition.

8.4.4 Cumulative Impact Assessment Methodology

53. The CIA (**Section 8.7**) considers other plans, projects and activities that may impact cumulatively with SEP and DEP. As part of this process, the assessment considers which of the residual impacts assessed have the potential to contribute to a cumulative impact, the data and information available to inform the cumulative

assessment and the resulting confidence in any assessment that is undertaken. **Chapter 5 EIA Methodology** provides further details of the general framework and approach to the CIA.

54. For benthic ecology, these activities include other OWFs, subsea cables and pipelines, oil and gas exploration and extraction, and fisheries management areas. As a general rule, other activities are only screened into the CIA where there is a spatial and/or temporal overlap in effects such that a cumulative impact would be possible, or where impacts are on a defined receptor group (such as within the boundaries of a designated site).

8.4.5 Transboundary Impact Assessment Methodology

55. The transboundary assessment (**Section 8.8**) considers the potential for transboundary effects to occur on benthic ecology receptors as a result of SEP and DEP; either those that might arise within the Exclusive Economic Zone (EEZ) of European Economic Area (EEA) states or arising on the interests of EEA states. **Chapter 5 EIA Methodology** provides further details of the general framework and approach to the assessment of transboundary effects.

8.4.6 Assumptions and Limitations

56. A large amount of data has been collected by the site-specific surveys, in addition to that available from the neighbouring SOW and DOW. Datasets for the latter projects include those from the characterisation (EIA), pre-construction and post-construction stages of development (e.g. DOW, 2009; Scira, 2006; Scira, 2014, Fugro, 2013, 2015, 2020c; MMT, 2019; Marine Ecological Surveys, 2014). As a result, the benthic ecology of the project areas has been thoroughly characterised and there is a high degree of confidence in the data for the purpose of informing the impact assessment.

57. With regard to the habitat maps (EUNIS level 3) and biotope maps (EUNIS 5), the confidence is provided in **Appendix 8.5** however, in summary, the Level 2-3 habitat maps have a high confidence, and the accuracy assessment supports this. Mapping extents of benthic communities at higher EUNIS levels may decrease the accuracy but this is often due to the potential for ‘confusion’ between biotopes which occupy similar habitats e.g. Sublittoral sands (A5.2) mapped as Infralittoral sands (A5.23). However, this is a known characteristic of the habitat mapping process and is not considered to materially affect the overall confidence in it for the purpose of informing the assessment. See **Appendix 8.5** for further details.

8.5 Existing Environment

58. The environmental baseline, including descriptions of sediment type, infauna and epifauna, is presented for the SEP and DEP wind farm sites and the offshore cable corridors. A description of protected areas and important species in the vicinity of the project is also provided. Analysis of the various benthic ecology data sets is provided in **Appendices 8.1 to 8.5**.

8.5.1 Sediment Characterisation

59. Particle size analysis has been completed for all stations where grab samples were taken. Stations were then classified according to Folk (1954) and the British

Geological Survey (BGS) modified Folk classification (Long, 2006) based on the proportion of gravel, sand and mud (fines). **Figure 8.2** shows the sediment fractional composition recorded at each survey station and the BGS modified Folk classification for each sample. Multivariate analysis of sediments was also undertaken.

60. Further information about the sediments recorded is available in **Appendix 8.1** and **Appendix 8.2**.

8.5.1.1 DEP offshore survey area

61. Sand was the dominant fraction of the sediment at the majority of stations ranging from 36.81% (EC_24) to 100% (D_19) with a mean of 73.47%. The gravel content ranged from 0.00% (D_19) to 60.33% (EC_24) with a mean of 23.89%. The proportion of fine sediments was generally low across the survey area ranging from being absent (0.00%) at 22 stations to 22.13% (EC_16) with a mean of 2.65%.

62. Based on the proportions of gravel, sand and mud, five sediment classes have been identified across the DEP survey areas based on the BGS modified Folk classification. The most common sediment type is sandy gravel ‘sG’ (25 stations), followed by sand ‘S’ (20 stations), gravelly sand ‘gS’ (9 stations), muddy sandy gravel ‘msG’ (3 stations) and 1 station classed as gravelly muddy sand ‘gmS’.

63. The geographical distribution of these different sediment types did not appear to have any distinct spatial pattern, however, the stations with the higher sand proportion were primarily within the DEP wind farm site, particularly in the DEP North array area where the majority of stations were classed as sand (S). The stations with a higher gravel proportion were primarily along the offshore cable corridors (CC and EC stations) where most stations were classed as sandy gravel (sG) or gravelly sand (gS) (**Figure 8.2**).

64. The multivariate analysis of sediments identified five groups (A to E) differentiated by the proportion of medium sand and coarse sand, and also whether a secondary element was present in the sediments, as either coarse pebble, medium pebble and fine pebble. Epifauna associated with these sediment groups are described in **Section 8.5.3.1.2**.

8.5.1.2 SEP offshore survey area

65. Sand was the dominant fraction of the sediment at the majority of stations ranging from 34.19% (SS_26) to 99.98% (EC_19), with a mean of 60.48%. The gravel content was generally higher than in the DEP wind farm sites, present at all stations and ranging from 0.02% in the export cable corridor (EC_19) to 60.51% (SS_08) in the SEP wind farm site, with a mean of 36.17%. The proportion of fine sediments was generally low across the survey area. Eight of the stations were devoid of fines and across the SEP offshore survey area fines content ranged from 0.00% to 22.13% (EC_16) with a mean of 3.35%.

66. Four sediment classes based on the BGS modified Folk classification have been identified across the SEP survey areas. The most common sediment type is sandy gravel ‘sG’ (22 stations), followed by muddy sandy gravel ‘msG’ (7 stations), sand ‘S’ (4 stations), gravelly sand ‘gS’ (1 station), and 1 station classed as gravelly muddy sand ‘gmS’.

67. The geographical distribution of these different sediment types did not appear to have any distinct spatial pattern, however, sandy gravel was present along the majority of the offshore export cable corridor, including within the CSCB MCZ, and much of the SEP wind farm site. Sand areas are present along the offshore export cable corridor in the nearshore area (EC_15 and EC_19) and around the Sheringham Shoal sandbank feature (EC_08, EC_09). Although the proportion of fine sediments was generally low, higher proportions were present at EC_16 and in the western part of the SEP wind farm site, resulting in the classification of these stations as ‘mixed sediments’ (msG and gmS) (**Figure 8.2**).

68. The multivariate analysis of sediments identified four groups (A to D) differentiated primarily by the proportion of medium sand, then coarse sand, and coarse pebble. Epifauna associated with these sediment groups are described in **Section 8.5.3.2.2**.

8.5.2 Sediment Chemistry

69. To inform the baseline for sediment quality, seven grab samples were taken for chemical analysis during benthic surveys of the SEP and DEP offshore survey areas (**Appendix 8.1** and **Appendix 8.2**). Sample locations are shown in **Figure 8.1**. Ten samples were originally planned, however, at three sites, sampling was unsuccessful because of repeated failure of the grab to take a sample due to rocks in the grab jaws and insufficient sediment recovered.

70. Analysis was undertaken for the following contaminants:

- Heavy metals (arsenic, mercury, cadmium, chromium, copper, lead, nickel and zinc);
- Polycyclic Aromatic Hydrocarbons (PAHs);
- Organotins (Monobutyltin (MBT), Dibutyltin (DBT) and Tributyltin (TBT)); and
- Total hydrocarbons (THC).

71. The context of the contaminants found within sediments is established through the use of recognised guidelines and action levels, in this case Cefas Action Levels have been applied because they provide good coverage of contaminants, across a broad range of contaminant types (MMO, 2018). These levels are used to indicate general contaminant levels in the sediments. If, overall, levels do not generally exceed the lower threshold values of these guideline standards, then contamination levels are not considered to be of significant concern and are low risk in terms of potential impacts on the marine environment. This approach is recommended by the Environment Agency in their WFD compliance assessment guidance ‘Clearing the Waters for All’, for example (Environment Agency, 2017). Whilst the sediment sampling was not undertaken by an MMO accredited lab (required for licensing procedures), the Cefas Action Levels can be applied to the data where contaminants correlate with those in the MMO’s list for the purposes of informing EIA and WFD compliance assessments, as these assessments do not have the same accreditation requirements.

72. The comparison of the sediment quality data against Cefas Action Levels has been undertaken within **Chapter 7 Marine Sediment and Water Quality**, **Section 7.5.4** and is not repeated here. However, the comparison showed that no samples exceed

the lower Cefas Action Level 1 and therefore sediment contamination levels are low. Six samples had levels of arsenic marginally exceeding Canadian Sediment Quality Guidelines for the Protection of Aquatic Life (CSQC) TEL (7.24mg/kg) concentrations, ranging from 8.73 to 14.3mg/kg. However, these are well below the CSQC arsenic PEL (41.6mg/kg). TEL, the lower level, represents a concentration below which adverse biological effects are expected to occur only rarely (in some sensitive species for example). The higher level, the PEL, defines a concentration above which adverse effects may be expected in a wider range of organisms.

73. Regional information is available in relation to arsenic concentrations. Specifically, Whalley *et al*., (1999) analysed archived samples from historical surveys and combined the data with results for the Dogger Bank OWF, to examine the distribution of total arsenic in sediments from the western North Sea and Humber Estuary. This identified a range of concentrations falling between 14 to 70mg/kg. Historically, the Humber has been subjected to a large point discharge of arsenic from industrial sources and samples collected during various North Sea surveys have identified numerous areas with high raw arsenic concentrations, particularly off north Yorkshire and the Humber Estuary. The arsenic concentrations within sediments in the SEP and DEP offshore sites (range between 5 and 15mg/kg) are considerably below those reported by Whalley *et al*. (1999) and therefore do not represent excessive levels for the region.

74. Furthermore, Whalley *et al*., (1999) state that uncontaminated nearshore marine and estuarine sediments contain from about 5 to about 15mg/kg dry weight total arsenic found primarily in the form of arsenate which is less toxic than in its inorganic forms (Neff, 1997). Therefore, sediment arsenic concentrations are well below any likely biological effects concentrations and are within the range of uncontaminated marine sediment concentrations.

75. Following consultation through the Sea bed ETG, sediments were analysed for organotin contamination because of a link between these compounds and the disruption of the reproductive capabilities of a number of gastropod mollusc species. All recorded organotin (TBT) concentrations were below the levels expected to affect the reproductive capability of sensitive gastropod species (Fugro, 2020a, 2020b).

76. **Figure 8.1** shows the sediment samples within the SEP and DEP offshore sites. One predefined sediment sample station along the export cable failed (EC_07) so another station was sampled for chemistry instead (EC_05), Additionally, one chemistry sample failed in SEP at SS_18 and in DEP at D_04. Three sampling stations along the export cable corridor were only sampled once due to unsuccessful second attempts. The unsuccessful chemistry samples were due to the coarse nature of the sediments. As part of consultation on survey design, stakeholders stressed that repeat sampling should be kept to a minimum to reduce impacts in the MCZ, therefore no further sampling attempts within the MCZ were made.

77. It is considered the sampling undertaken is adequate despite the failed sampling attempts given that any contaminants do not persist in coarse sediment areas and that reasonable endeavours were made to obtain samples in these locations. Sampling was agreed in advance during earlier ETG meetings and the MMO have

confirmed the number and sites are appropriate in response to the PEIR. Sampling at OWFs is to confirm the generally accepted principle that offshore sediments are unlikely to be significantly contaminated and the samples collected here are in line with previous projects to date.

8.5.3 Macrofaunal Communities

78. The species identified during the project benthic characterisation surveys were either infauna (living within the sediment) and epifauna (living on the surface of the sea bed). Epifauna comprised sessile solitary species such as sea anemones, and colonial organisms such as bryozoans. The infauna was assessed for species diversity, abundance and distribution. The sessile colonial epifauna was assessed for taxa composition and distribution and the solitary epifauna was assessed for species diversity, abundance and distribution.

79. Multivariate statistical analysis has been conducted on the survey data to identify statistically significant macrofaunal communities and this showed that the spatial pattern of infaunal distribution was influenced by the sediment type. It should be noted that multivariate statistical analysis to identify macrofaunal groups was undertaken separately for the SEP and DEP survey areas, and therefore they are not comparable between survey areas (i.e. 'DEP Group A' is not the same as 'SEP Group A'). The geographical distribution of infaunal groups identified is shown on **Figure 8.4** (DEP) and **Figure 8.5** (SEP). More information on macrofaunal communities recorded during the benthic characterisation surveys are provided in **Appendix 8.1** and **Appendix 8.2**.

80. Due to the multivariate analysis being undertaken separately for the SEP and DEP survey areas, multivariate statistical analysis of the offshore export cable corridor has been undertaken twice, once for the DEP offshore survey area, which analysed the DEP wind farm site, the interlink cable corridors and offshore export cable corridor (**Appendix 8.1**), and for the SEP offshore survey area which analysed the SEP wind farm site and offshore export cable corridor (**Appendix 8.2)**. Therefore, the description of the results of the analysis of the offshore export cable corridor is different depending on which wind farm site it was analysed in conjunction with. However, the faunal groups identified within the separate multivariate analysis exercises were broadly similar for both projects.

8.5.3.1 DEP Offshore Survey Area / DEP Offshore Site

81. The benthic communities recorded across the DEP offshore site are considered to be typical of sandy and gravelly sediments within the southern North Sea (Heip and Craeymeersch, 1995; Rees *et al*., 2007).

82. The survey recorded 272 benthic taxa following rationalisation of the dataset, of which 122 (44.9%) were annelids, 87 (32.0%) were arthropods, 47 (17.3%) were molluscs, 7 (2.6%) were echinoderms, 9 (3.3%) were other phyla (cnidarians, nemerteans, phoronids, platyhelminthes and sipunculids).

8.5.3.1.1 Infauna

83. Five different faunal communities were grouped statistically, described below, distinguished by having different dominant taxa as well as the absence of other key

taxa within other groups. The variations in communities were driven by the different sediment types observed.

- **Group A** comprised 2 samples in the offshore export cable corridor. Defining infaunal taxa are the polychaetes *Lanice conchilega*, *Sabellaria spinulosa*, *Spiophanes bombyx* agg., which all show preference for medium to coarse sands which they use to build their protective tubes. The sea snail *Rissoa parva* was the second most abundant infaunal species in Group A.
- **Group B** comprised 26 samples distributed across the survey area in mixed sediment habitat comprising sandy gravel with a variable mud content. Defining taxa include the slipper limpet *Crepidula fornicata*, the crab *Pisidia longicornis* and the squat lobster *Galathea intermedia*, which have preference for gravelly sediments where they can either attach (in the case of *C. fornicata*) or take shelter. *S. spinulosa* was present although not in sufficient numbers to constitute reef. More information on determination of *S. spinulosa* reef is provided in **Section 8.5.4** below.
- **Group C** comprised 4 samples, all located in the interlink cable corridors with sediments comprising poorly sorted gravelly sand with no mud content. The most abundant taxa were the bivalve *Goodallia triangularis*, and the polychaetes *SphaerosInyllis bulbosa*, *Glycera lapidum, Schistomeringos neglecta*.
- **Group D** comprised two samples, one in the offshore export cable corridor (EC_11) and one in the interlink corridor between the DEP South array area and the SEP wind farm site (CC_06). Defining taxa were the sipunculid worm *Nephasoma minutum* and the polychaetes *Leiochone*, *S. spinulosa*, *Spio goniocephala,* and *Lanice conchilega*, which are considered typical of sandy gravel/gravelly sand sediments.
- **Group E** comprised 19 samples, primarily located in the DEP wind farm sites but also in the offshore export cable corridor. Defining species were the polychaete *Ophelia borealis* and the amphipod *Bathyporeia elegans* which show preference for sandy sediments. The shrimp-like crustacean *Gastrosaccus spinifer* was the second most abundant species in Group E.

8.5.3.1.2 Epifauna

84. As epifauna rely on a hard surface for epilithic attachment, the characteristic epifauna within each sediment group deduced from the multivariate analysis are described.

85. A total of 11 taxa of solitary epifauna were identified across three phyla; cnidarians, arthropods and tunicates. The barnacle *Balanus crenatus* was the dominant species, being abundant across all groups.

86. A total of 81 colonial epifaunal taxa were identified across 7 phyletic groups, of which 43 (54.4%) were bryozoans, 18 (22.8%) were cnidarians, 8 (10.1%) were tunicates, 6 (7.6%) were porifera, 2 (2.5%) were entoproctas, and 1 (1.3%) of each annelids and ciliophoras. Bryozoans were the most abundant taxa across all of the groups,

including *Conopeum reticulum* and also Alcyonidiidae, *Bicellariella ciliata* and *Flustra foliacea*. The cnidarian Sertulariidae and the ciliophoran Folliculinidae were also abundant.

87. As with the infaunal communities, statistical analysis showed epifaunal communities are being driven by the proportion and type of sand present, as well as whether any coarse material such as gravel or pebbles was present.

8.5.3.2 SEP Offshore Survey Area / SEP Offshore Site

88. The results of the macrofauna analysis across the SEP offshore site are indicative of a dynamic area subject to a degree of physical disturbance with subsequent reworking of the sediments which prevents the establishment of permanent biotic communities. The presence of fines contributes to a degree of sediment compactness which allows the establishment of molluscs, which generally occur in more compacted sediment, while the presence of coarse sediment provides suitable substrate for the attachment of epifauna.

8.5.3.2.1 Infauna

89. The survey recorded 238 taxa represented by 6,053 individuals following rationalisation of the dataset, of which 44.6% were annelids, 31.3% were arthropods, 20.0% were molluscs and 1.5% were echinoderms. Other phyla comprised 2.6% of the taxa composition and included platyhelminthes, nemerteans, sipunculids, phoronids and Enteropneusta.

90. Different faunal communities were grouped statistically, described below, distinguished by having different dominant taxa as well as the absence of other key taxa within other groups. Four groups, A, B, C and D, and two single stations, EC_09 and EC_11, were identified through the multivariate analysis.

- **Group A** comprised 13 stations across the SEP wind farm site and offshore export cable corridor, plus two stations (EC_17 and EC_23) with a lower degree of similarity. Characterising taxa included the slipper limpet *C. fornicata*, the polychaetes *S. spinulosa* and *Polycirrus*, the brittlestar *Amphipholis squamata*, and the squat lobster *Galathea intermedia*. Group A was subdivided in to three distinct sub-groups (A1, A2 and A3). Differences between the sub-groups were related largely to species abundance.
- **Group B** comprised two stations (EC_07 and EC_14) from the offshore export cable corridor. Of the characterising taxa, *L. conchilega* was present at the highest mean abundance (10 individuals) and other characterising taxa included the sea snail *R. parva*, the polychaetes *S. spinulosa* along with *S. bombyx*, sea spiders such as *Anoplodactylus petiolatus* and *Achelia echinata*, and amphipods, such as *Bathyporeia guilliamsoniana* and *Abludomelita obtusata*.
- **Group C** comprised four stations from the SEP wind farm site characterised by the bivalve *G. triangularis*, the slipper limpet *C. fornicata* and the polychaetes *G. lapidum*, *Polycirrus* and *Spio symphyta*.

- **Group D** comprised three stations characterised by a low number of taxa and individuals, represented by the amphipod *B. elegans* and *Urothoe brevicornis* and the polychaetes *O. borealis, Nephtys cirrosa, Travisia forbesii* and *S. bombyx*.

8.5.3.2.2 Epifauna

91. The characteristic epifauna within each sediment group deduced from the multivariate analysis are described below.

92. A total of 11 taxa of solitary epifauna were identified comprising sea anemones of the order Actiniaria, the barnacles *B. crenatus* and *Verruca stroemia*, and tunicates. Stations SS_08, EC_08, EC_09, EC_11, EC_15 and EC_19, were devoid of solitary epifauna.

93. Seventy-six colonial epifaunal taxa were identified including bryozoans, notably *F. foliacea*, *Escharella immersa*, *C. reticulum* and *B. ciliate*; cnidarians, notably *Cliona*; and hydroids, notably *Hydrallmania falcata*, *Calycella syringa*, *Nemertesia antennina* and *Nemertesia ramosa*.

94. The epifauna recorded was typical of those reported for the shallower sediment areas of the southern North Sea (Callaway *et al*., 2002; Jennings *et al*., 1999) indicative of a dynamic area subject to a degree of physical disturbance with subsequent reworking of the sediments which prevents the establishment of permanent biotic communities (Fugro, 2020b).

8.5.4 Sea bed Habitats and Biotopes

95. The sea bed video and still image data collected at stations across the SEP and DEP offshore survey areas were used in conjunction with the particle size data and multivariate analysis of the infaunal data to classify stations in terms of habitats and biotopes in line with the hierarchical EUNIS habitat classification (EUNIS, 2019). An example of the classification hierarchy is provided in **Table 8-13**.

Table 8-13: EUNIS (2019) Biotope Classification Hierarchy Example

Level	Example Classification Name	Example Classification Code
1. Environment	Marine Habitats	A
2. Broad habitat types	Sublittoral sediments	A5
3. Main habitats	Sublittoral sand	A5.2
4. Biotope complexes	Infralittoral fine sand	A5.23
5. Biotopes	*Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand	A5.233

96. **Table 8-14** summarises the habitats and biotopes identified in the SEP and DEP offshore survey areas. Confidence in the classifications at the biotope level is generally lower than further up the EUNIS hierarchy. Further information on the classification of biotopes is available in **Appendix 8.1** and **Appendix 8.2**.

97. As mentioned in **Section 8.5.3**, the biotopes identified within the offshore export cable corridor are different depending on which site is being considered (SEP or

DEP) as the biotopes are assigned using the multivariate analysis which was conducted separately for SEP and DEP.

98. Benthic habitat maps have been produced using geophysical data sets along with the benthic sample data to interpret the distribution of habitats and biotopes in between survey stations. A summary report of habitat mapping process, completed by Envision (2021) using geostatistical processing and spatial statistical analysis, in provided in **Appendix 8.5 SEP and DEP Habitat Mapping**. The spatial distribution of the EUNIS Level 3 main habitats identified (equivalent to Marine Habitat Classification for Britain and Ireland 'habitat complexes') are presented in **Figure 8.6** and distribution of the EUNIS Level 5 biotopes identified are presented in **Figure 8.7**.

Table 8-14: Summary of Habitats and Biotopes Identified in the SEP and DEP Offshore Survey Areas

Broad Habitat Level 2	Habitat Level 3	Biotope Complex Level 4	Biotope Level 5	Recorded in SEP?	Recorded in DEP?
A3 Infralittoral rock and other hard substrata	-	-	-	Yes. Export cable corridor (station EC_26).	Yes. Export cable corridor (station EC_26).
A4 Circalittoral rock and other hard substrata	A4.1 Atlantic and Mediterranean high energy circalittoral rock	A4.13 Mixed faunal turf communities on circalittoral rock	A4.134 *Flustra foliacea* and colonial ascidians on tide-swept moderately wave-exposed circalittoral rock	A4.134 recorded across the survey area on larger pebbles, cobbles and boulders in coarse and mixed sediment areas. An epibiotic overlay of infaunal biotopes.	No. However, likely to be present in the export cable corridor near EC_26.
	A4.2 Atlantic and Mediterranean moderate energy circalittoral rock	A4.23 Communities on soft circalittoral rock	A4.231 Piddocks with a sparse associated fauna in sublittoral very soft chalk or clay	A4.231 observed at one location within the transect at SS21 (western corner of SEP wind farm site). Piddocks could not be confirmed.	No
A5 Sublittoral sediment	A5.1 Sublittoral coarse sediment	A5.13 Infralittoral coarse sediment	Possible A5.133 *Moerella* spp. with venerid bivalves in infralittoral gravelly sand	A5.13 in the offshore export cable corridor. (EC_07, EC_14, EC_09, EC_11). A5.133 not identified.	A5.13 in DEP interlink and offshore export cable corridors (CC_06, EC_07, EC_09, EC_11, EC_14). Possible A5.133 in interlink corridors (CC_03, CC_05, CC_12, CC_15)
	A5.2 Sublittoral sand	A5.23 Infralittoral fine sand	Possible A5.233 *Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand	A5.233 in offshore export cable corridor (EC_08, EC_15, EC_19).	A5.23, and possibly A5.233 in all DEP project areas. (D_06, D_08, D_09, D_15, D_16, D_17, D_19, D_20, D_22, D_23, D_25, CC_16, CC_17, CC_18, CC_19,

Broad Habitat Level 2	Habitat Level 3	Biotope Complex Level 4	Biotope Level 5	Recorded in SEP?	Recorded in DEP?
					EC_08, EC_09, EC_15, EC_19).
	A5.4 Sublittoral mixed sediment	A5.43 Infralittoral mixed sediment	A5.431 *Crepidula fornicata* with ascidians and anemones on infralittoral coarse mixed sediment (?)	A5.43, and possibly A5.431 identified in all SEP project areas. (SS_03, SS_07, SS_09, SS_10, SS_11, SS_1, EC_10, EC_12, EC_16, SS_18, SS_19, SS_21, SS_23, SS_25, EC_05, EC_17, EC_23).	A5.43, and possibly A5.431 identified in all DEP project areas. (D_01, D_03, D_04, D_05, D_07, D_10, D_11, D_18, D_21, D_26, CC_01, CC_02, CC_04, CC_07, CC_08, CC_09, CC_10, CC_11, CC_13, CC_14, EC_05, EC_10, EC_12, EC_16, EC_17, EC_23).
		A5.44 Circalittoral mixed sediments	-	Identified in all SEP project areas.	Identified in all DEP project areas.
		A5.45 Deep circalittoral mixed sediments	A5.451 Polychaete-rich deep Venus community in offshore mixed sediments	Impoverished version or a transition of the biotope A5.451 identified in the SEP wind farm site. (SS_02, SS_05, SS_06, SS_08)	No
	A5.6 Sublittoral biogenic reefs	A5.61 Sublittoral polychaete worm reefs on sediment	A5.611 *Sabellaria spinulosa* on stable circalittoral mixed sediment	Possible A5.611 identified in all SEP project areas. (SS_03, SS_07, SS_09, SS_10, SS_11, SS_1, EC_10, EC_12, EC_16, SS_18, SS_19, SS_21, SS_23, SS_25, EC_05, EC_17, EC_23). No Annex I habitat identified.	Not identified in the DEP offshore site benthic characterisation survey (Fugro, 2020a). However, the SEP benthic characterisation survey (Fugro, 2020b) confirms a mosaic of this biotope with A5.431 in the offshore export cable corridor.

8.5.4.1 DEP offshore survey area

99. The following habitats and biotopes were recorded across the DEP survey area (including the wind farm sites, interlink and offshore export cable corridors):

- A3 Infralittoral rock and other hard substrata (A4 Circalittoral rock also likely to be present in the export cable corridor near landfall)
- A5 Sublittoral sediment
- A5.1 Sublittoral coarse sediment
- A5.13 Infralittoral coarse sediment
- A5.133 *Moerella* spp. with venerid bivalves in infralittoral gravelly sand
- A5.2 Sublittoral sand
- A5.23 Infralittoral fine sand
- A5.233 *Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand
- A5.4 Sublittoral mixed sediments
- A5.43 Infralittoral mixed sediments
- A5.431 *Crepidula fornicata* with ascidians and anemones on infralittoral coarse mixed sediment

100. The majority of stations (26) were classified as the biotope complex 'Infralittoral mixed sediment' (A5.43) and included stations across the DEP North and South array areas, the interlink and offshore export cable corridors. Sediments primarily comprised sandy gravels with a variable mud content. The macrofaunal and epifaunal assemblages present at these stations were typical of mixed sediments with low to moderate levels of exposure to tide and wave action. The infaunal community showed similarities to the biotope '*Crepidula fornicata* with ascidians and anemones on infralittoral coarse mixed sediment' (A5.431), which was therefore thought possible to be present at these stations. This biotope was also identified within the DOW site (MMT, 2019).

101. Nineteen stations, distributed across the DEP North and South array areas, the interlink and offshore export cable corridors, were classified as 'Infralittoral fine sand' (A5.23) due to the high sand and low gravel/mud content and faunal assemblages being typical of clean sands with moderate exposure to wave or tidal action. The infaunal community showed similarities to the biotope '*Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand' (A5.233), which was therefore thought possible to occur at these stations. This biotope was identified throughout the DOW site where the sea bed comprised sand (MMT, 2019).

102. Eight stations were classified as biotope complex 'Infralittoral coarse sediment' (A5.13) due to the sediments comprising sandy gravels/gravelly sands with low mud content. These included three stations in the EC survey area and five in the CC survey area. These stations included samples that were grouped, based on their infaunal assemblages, into groups A, C and D. The macrofaunal and epifaunal assemblages present at these stations were typical of moderately exposed coarse sediments. The infaunal community identified in samples within group C showed

similarities to the biotope '*Moerella* spp. with venerid bivalves in infralittoral gravelly sand' (A5.133) and was therefore thought possible to be present at those stations.

103. The distribution of the biotopes identified did not show any distinct pattern in distribution. This is likely to be due to the heterogeneity of the sediments across the survey area, evident on the side scan sonar data. Sand waves and megaripples were both interpreted as present across the survey area, which typically result in the sand crests comprise mobile sediment environments and tend to have low diversity, and the troughs contain more stable gravelly sediments, due to less sediment movements (Koop *et al*., 2019), allowing an accumulation of organic material and therefore support more diverse infaunal and epifaunal communities.

104. Infralittoral rock (A3) and other hard substrata was recorded amongst sandy gravel in the export cable corridor near landfall at station EC_26 in water depths ranging from 2.8m to 5.5m below sea level (BSL). Circalittoral rock (A4) also likely to be present in this area. Exposed chalk areas were colonised by red and brown seaweed, starfish (*Asterias rubens*), and anemones (*Sagartia* sp., Sagartiidae and *Urticina* sp.) (Fugro, 2020e).

8.5.4.2 SEP offshore survey area

105. The following habitats and biotopes were recorded across the SEP offshore survey area (including the wind farm site and offshore export cable corridor):

- A3 Infralittoral rock and other hard substrata
- A4 Circalittoral rock and other hard substrata
- A4.1 Atlantic and Mediterranean high energy circalittoral rock
- A4.13 Mixed faunal turf communities on circalittoral rock
- A4.134 *Flustra foliacea* and colonial ascidians on tide-swept moderately wave-exposed circalittoral rock
- A4.2 Atlantic and Mediterranean moderate energy circalittoral rock
- A4.23 Communities on soft circalittoral rock
- A4.231 Piddocks with a sparse associated fauna in sublittoral very soft chalk or clay
- A5 Sublittoral sediment
- A5.1 Sublittoral coarse sediment
- A5.13 Infralittoral coarse sediment
- A5.2 Sublittoral sand
- A5.23 Infralittoral fine sand
- A5.233 *Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand
- A5.4 Sublittoral mixed sediments
- A5.45 Deep circalittoral mixed sediments
- A5.451 Polychaete-rich deep Venus community in offshore mixed sediments (Impoverished or a transition biotope)

- A5.43 Infralittoral mixed sediments
- A5.431 *Crepidula fornicata* with ascidians and anemones on infralittoral coarse mixed sediment
- A5.6 Sublittoral biogenic reef
- A5.61 Sublittoral polychaete worm reefs on sediment
- A5.611 *Sabellaria spinulosa* on stable circalittoral mixed sediment

106. Coarse and mixed habitats were recorded across most of the SEP survey area with associated benthic communities influenced strongly by sediment type. Three stations in the SEP wind farm site and five stations along the offshore export cable corridor featured rippled sand with shell fragments and little or no epifauna recorded, indicative of sediment disturbance associated with waves and tides.

107. A combination of the biotopes '*Crepidula fornicata* with ascidians and anemones on infralittoral coarse mixed sediment' (A5.431) and '*Sabellaria spinulosa* on stable circalittoral mixed sediment' (A5.611), was assigned to most stations that featured coarse mixed sediments, high diversity and a numerical dominance of *C. fornicata* and *S. spinulosa*.

108. The biotope 'Polychaete-rich deep Venus community in offshore mixed sediments' (A5.451) was assigned to four stations in the SEP wind farm site characterised by coarse sediment with negligible percentage of fines, and an infaunal community dominated by *G. triangularis* and polychaetes.

109. The biotope '*Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand' (A5.233) was assigned to three stations along the offshore export cable corridor, characterised by rippled sand with reduced diversity, compared to other stations, and dominated by *N. cirrosa* and *B. elegans.* This biotope has also been recorded by surveys at SOW (Fugro, 2013).

110. The biotope complex 'Infralittoral coarse sediment' (A5.13) was assigned at four stations in the offshore export cable corridor. These stations were found to represent transitional areas, between heterogeneous mixed and homogeneous sandy sediments, with video images indicating accumulation of coarse sediment in the troughs of sand waves, in line with the literature of the North Sea describing wave environment (Koop *et al*., 2019).

111. The biotope '*Flustra foliacea* and colonial ascidians on tide-swept exposed circalittoral mixed substrata' (A4.1343) occurred as an epibiotic overlay of sedimentary communities across the entire survey area, where coarse sediment suitable for the attachment of large epibiotic taxa occurred.

112. As described under the DEP offshore survey area, infralittoral rock (A3) and other hard substrata was recorded in the export cable corridor near landfall (Fugro, 2020e). Circalittoral rock (A4) also likely to be present in this area.

8.5.4.3 Offshore Export Cable Corridor within the CSCB MCZ

113. It is useful to specify the benthic habitats and biotopes identified within the CSCB MCZ for the assessment of impacts on marine ecology receptors represented within the MCZ designated features. Based on Fugro (2020b) these are:

- A3 Infralittoral rock and other hard substrata
- A4 Circalittoral rock and other hard substrata
- A5 Sublittoral sediment
- A5.1 Sublittoral coarse sediment
- A5.13 Infralittoral coarse sediment
- A5.2 Sublittoral sand
- A5.23 Infralittoral fine sand
- A5.233 *Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand
- A5.4 Sublittoral mixed sediments
- A5.43 Infralittoral mixed sediments
- A5.431 *Crepidula fornicata* with ascidians and anemones on infralittoral coarse mixed sediment
- A5.6 Sublittoral biogenic reef
- A5.61 Sublittoral polychaete worm reefs on sediment
- A5.611 *Sabellaria spinulosa* on stable circalittoral mixed sediment

8.5.4.4 Sensitive species / habitats

114. Benthic habitats and associated species which could occur within the SEP or DEP offshore survey areas are described in **Table 8-15**.

Table 8-15: Summary of Sensitive Habitats/Species Potentially Present in SEP or DEP Offshore Survey Area

Listed Feature		Relationship*	Related Feature	
Description	**Designation/ Status**		**Description**	**Designation/ Status**
Geogenic reef	Habitats Directive Annex I habitat; habitat Features of Conservation Interest (FOCI)	May occur	Bedrock reef	Annex I habitat; Subtidal chalk
	Annex I habitat	May occur	Stony reef	Annex I habitat
Subtidal sands and gravels	Priority habitat; habitat FOCI	Contains	Offshore subtidal sands and gravel	UK BAP priority habitat; MPA search feature
	Annex I habitat	May occur	Sandbanks which are slightly covered	Annex I habitat

Listed Feature		Relationship*	Related Feature	
Description	Designation/ Status		Description	Designation/ Status
			by sea water all the time	
Peat and clay exposures with piddocks	Priority habitat	Contains	Peat and clay exposures with piddocks	UK BAP priority habitat
Subtidal chalk	Priority habitat; habitat FOCI	May occur	Subtidal chalk	UK BAP priority habitat
	Annex I habitat	May occur	Reefs	Annex I habitat
S. spinulosa reef	OSPAR threatened and/or declining habitat; UK BAP priority habitat; habitat FOCI	Not recorded	Reefs	Annex I habitat UK BAP priority habitat

Notes
FOCI = Feature of Conservation Interest
UK BAP = United Kingdom Biodiversity Action Plan
OSPAR = Oslo and Paris Commission
MPA = Marine Protected Area
* = Summarises the relationship between different protected habitat designations. For example, where Annex I geogenic reef occurs, bedrock reef may occur, in this case from subtidal clay. Similarly, the priority habitat 'Subtidal sands and gravels' contains the UK BAP priority habitat and MPA Search feature 'Offshore subtidal sands and gravels' (JNCC, 2018).

8.5.4.4.1 Geogenic and Biogenic Reef

115. A geophysical survey of the offshore export cable corridor (Gardline, 2020a) identified an area of high reflectivity close to landfall, identified as outcropping chalk. Video transect EC_26 targeted this feature and the imagery confirmed hard compacted substrate (soft rock, likely chalk) emerging from the surrounding sediment. This is potential bedrock reef, however, due to the lack of defined assessment criteria for this habitat, it is not possible to confirm whether this falls within the Annex I 'Reefs' definition, so an area of 'Potential reef' was assigned (Fugro, 2020c, 2020e).

116. Station EC_26 was located within the CSCB MCZ, and therefore the chalk has been characterised by Natural England Marine Characterisation Project (Natural England, 2020) which includes lithological composition, hydrodynamics, extent of chalk within the MCZ and geographic context.

117. Three characteristics of this feature can be further refined. In relation to structural complexity, the feature was recorded as low-lying chalk outcrops. In relation to zonation, the depth at which the chalk was recorded was approximately 3m below sea surface level. Additionally, in relation to community composition, the biotope present at the observed area of chalk was A3 'Infralittoral rock and other hard substrata'. This biotope is listed as having been recorded within the CSCB MCZ (Natural England, 2020).

118. To qualify as a 'Stony reef' there should be a minimum elevation of 64mm above the sea bed, a coverage of at least 10% cobbles and boulders and a minimum area extent of 25m^2. The measures of 'Reefiness' for stony reef habitat are taken from Irving (2009) and Golding (2020). At stations in the SEP and DEP wind farm sites and interlink cable corridors sea bed was classed as 'not a reef' at all transects due to the elevation of cobble, percentage of cobble and boulder coverage; and epifaunal species composition less than 80%. Therefore, coarse sediments within these survey areas do not fulfil the definition of Annex I habitat (Fugro, 2020c, 2020e).

119. Along the offshore export cable corridor, the majority of the transects were classed as 'not a reef', except for transects EC_03 and EC_24, which were classed as 'Low reef'. EC_03 and EC_24 were located within close proximity to each other, 2.9km and 4.6km offshore respectively. Both stations are located towards the nearshore end of the offshore export cable corridor within the CSCB MCZ, and offshore of the HDD exit point. Transects EC_03 and EC_24 were classed as 'Low reef' due to the higher percentage of cobble coverage (10% to 40%) and elevation observed. As the two stations were categorised as 'Low reef' they do not constitute Annex I reef (Irving, 2009 and Golding, 2020).

120. Areas where *S. spinulosa* were recorded were analysed in detail for potential classification as a biogenic reef. Video and geophysical data were reviewed according to JNCC's guidelines (Gubbay, 2007), and using the UK Biodiversity Action Plan Priority Habitat Descriptions description of *S. spinulosa* reef (Maddock, 2008). Analysis of the *S. spinulosa* present within the SEP and DEP offshore survey area concluded that it did not constitute Annex I / UK BAP priority habitat *S. spinulosa* reef. Further information on the analysis of *S. spinulosa* is available in the Habitat Reports in **Appendix 8.3** and **Appendix 8.4**.

8.5.4.4.2 Subtidal Chalk

121. Sample planning selected stations within suspected areas of chalk/rock but only one station (EC_26) was successfully sampled, meaning mapping and confidence in the distribution of the habitat "A3 / A4 –Subtidal rock" is relatively low. As described above, transect EC_26 had areas of outcropping chalk bedrock that had the potential to form the UK BAP priority habitat 'Subtidal chalk' (UK BAP, 2008a). This may represent part of the CSCB MCZ designated subtidal chalk feature (**Section 8.5.5.1**). The area of chalk within the EC_26 transect was not rich in species and was characterised by red algae (Rhodophyta), starfish and anemones. The lack of species diversity was expected due to the 'hostility' of the environment in which the subtidal chalk habitats occur (UK BAP, 2008a).

8.5.4.4.3 Subtidal Sands and Gravels

122. Most of the SEP and DEP surveys area were classified within three EUNIS habitats, 'Sublittoral coarse sediment' (A5.1), 'Sublittoral sand' (A5.2) and 'Sublittoral mixed sediments' (A5.4). 'Sublittoral coarse sediment' and 'Sublittoral sand', and the biotope complexes identified under them (A5.13 Infralittoral coarse sediment, A5.23 Infralittoral fine sand) are categorised within the broad habitat of 'subtidal sands and gravels' defined by UK BAP (UK BAP, 2008b). Although, offshore subtidal sands

and gravels are identified as a priority habitat and thought to be of conservation importance, this habitat is widespread within UK waters.

8.5.4.4.4 Peat and Clay Exposures

123. A section of transect SS_21A in the SEP wind farm site represented the biotope A4.231 'Piddocks with a sparse associated fauna in sublittoral very soft chalk or clay', which is classed as an illustrative biotope of the UK BAP priority habitat 'peat and clay exposures with piddocks', which are known to occur on the south and east coasts of England (UK BAP, 2008c). Although piddocks could not be confirmed to have been responsible for the burrows present along SS_21A, the definition of the UK BAP priority habitat also encompasses occurrences of peat and clay exposures with no evidence of either past or present piddock activity, but which have the potential for this community to develop on the basis of environmental conditions and presence of similar beds locally (UK BAP, 2008c). Peat and clay exposures have been reported within the nearby Cromer Shoals Chalk Beds MCZ.

8.5.4.4.5 Other Potentially Sensitive Habitats and Species

124. Gardline (2020a, 2020b) highlighted features with potential to be *S. spinulosa* reefs in the SEP and DEP offshore survey areas. Specimens of *S. spinulosa* were present within grab samples and camera transects within the SEP and DEP wind farm sites, DEP interlink cable corridors and the offshore export cable corridor. *S. spinulosa* reefs are classified as a UK BAP priority habitat, an OSPAR threatened and/or declining habitat and a Habitats Directive Annex I habitat. However, the specimens found were either in the forms of single tubes, veneer, or very small clumps and therefore did not constitute Annex I reef habitat as defined in Gubbay (2007).

125. No other Annex I habitats or Annex II species, OSPAR threatened and/or declining species and habitats or UK Biodiversity Action Plan priority habitats and species (OSPAR, 2008; JNCC & Defra, 2012) were observed within the survey area.

8.5.5 Designated Sites

126. The following section provides a brief summary of the designated sites and associated interest features with the potential to be affected by SEP and DEP. **Section 8.6.1** describes the approach taken to the consideration of potential impacts on designated sites in this chapter.

8.5.5.1 Cromer Shoal Chalk Beds MCZ

127. The SEP and DEP offshore export cable corridor passes through the CSCB MCZ, as shown in **Figure 8.8** The CSCB MCZ begins 200m offshore of the North Norfolk Coast and extends 10km out to sea, covering a total area of 321km^2 (DEFRA, 2016).

128. The site is designated for the following features:

- Marine Habitat FOCI:
  - Subtidal chalk
  - Peat and clay exposures
- Broadscale Marine Habitat features
  - Moderate energy infralittoral rock

  - High energy infralittoral rock
  - Moderate energy circalittoral rock
  - High energy circalittoral rock
  - Subtidal coarse sediment
  - Subtidal mixed sediments
  - Subtidal sand
- Subtidal geological feature:
  - North Norfolk Coast

129. Sea bed habitats representative of all three broadscale marine sediment habitat features have been recorded in the export cable corridor within the MCZ, as well as an area of infralittoral rock.

8.5.5.1.1 Subtidal rock

130. A single video transect (EC_26) was completed in an area close to landfall identified as outcropping rock by geophysical surveys. Locations on the transect were classified to EUNIS level 2 only, as infralittoral rock (A3), although it is likely that these are part of the subtidal chalk FOCI MCZ feature and also moderate or high energy infralittoral rock. It should be noted that the mapped habitat of "A3 Infralittoral rock" is also likely to include circalittoral rock (A4) (Envision, 2021) and therefore the moderate energy circalittoral rock (MCZ) feature (**Figure 8.6**).

8.5.5.1.2 Subtidal sand

131. Areas of sublittoral sand (A5.2) have been identified close to landfall offshore of an area of infralittoral (and possibly also circalittoral rock) and near the seaward boundary of the MCZ, associated with the Sheringham Shoal sandbank feature. These coincide with areas of the subtidal sand feature previously mapped within the MCZ (Defra, 2016.

8.5.5.1.3 Subtidal coarse and subtidal mixed sediments

132. The remainder of the offshore export cable corridor in the MCZ is a mixture of subtidal coarse sediment (A5.1) and subtidal mixed sediment (A5.4) habitats. There is generally a low percentage of fine material with a mean fraction of 1.7% for grab samples in the MCZ, and therefore all stations not classified as sand (S) are sandy gravel (sG) based on the BGS modified Folk classification (**Figure 8.2**).

133. However, there are some mismatches between biological communities and physical habitats recorded in the benthic sample data on which the habitats maps are based. This suggests there is sufficient fine material in some areas to support species associated with mixed sediment habitats. As such, some stations have been modified from subtidal coarse sediment habitat (A5.1) to subtidal mixed sediment (A5.4) habitat based on their biological community. Biological groupings often do not adhere to exact sediment classes and the two habitats could be considered to be variations of each other (Envision, 2021). Indeed Fugro (2020a,b) suggested the biological communities present to be uncertain and that the appropriate habitat at

the next level up in the EUNIS hierarchy has be assigned to relevant samples. In summary, it is difficult to delineate subtidal coarse and subtidal mixed sediment habitats in the offshore export cable corridor due to their similarity, with mixed sediment areas being close the coarse sediment areas with a relatively low percentage of fines, but sufficient fine material to influence benthic communities.

8.5.5.2 Greater Wash SPA

134. The SEP and DEP offshore export cable corridor passes through the Greater Wash SPA as shown in **Figure 8.8**. The Greater Wash SPA stretches between the counties of Yorkshire to Suffolk over an area of 3,536km^2. The site is primarily designated for the protection of seabirds including breeding terns and non-breeding red-throated diver and little gull. Further information on the designated features of the SPA is provided in **Chapter 11 Offshore Ornithology**.

135. The supporting features of the Greater Wash SPA include marine habitats and species which will overlap with the proposed offshore export cable corridors. The supporting features which could be present in the SEP and DEP offshore export cable corridor including the following:

- Subtidal sandbanks;
- Biogenic reef including *Sabellaria* reefs and mussel beds; and
- Coarse sediments, with occasional areas of sand, mud and mixed sediments.

8.5.5.3 The Wash and North Norfolk Coast SAC

136. The Wash and North Norfolk Coast SAC covers an area of 1,077km^2 within The Wash Estuary and along the Norfolk Coast (**Figure 8.8**). Through the site selection process an offshore export cable route through the Wash and North Norfolk Coast SAC was avoided to prevent direct impacts on its designated features.

137. At the closest point, the boundary of the SEP and DEP offshore export cable corridor is 1.26km east of the SAC at its closest point near landfall. The Wash and North Norfolk Coast SAC is designated for the following features:

- Sandbanks which are slightly covered by sea water all the time
- Mudflats and sandflats not covered by seawater at low tide
- Reefs
- Large shallow inlets and bays
- Salicornia and other annuals colonising mud and sand
- Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*)
- Mediterranean and thermo-Atlantic halophilous scrubs (*Sarcocornetea fruticosi*)
- Coastal lagoons
- Harbour seal (*Phoca vitulina*)
- Otter (*Lutra lutra*)

138. Of the designated marine features, sandbanks which are slightly covered by sea water all the time may be located near the eastern boundary of the SAC in closest proximity to the offshore export cable corridor (Natural England, 2017).

8.5.5.4 Inner Dowsing, Race Bank and North Ridge SAC

139. The Inner Dowsing, Race Bank and North Ridge SAC covers an area of 845km^2 and is located off the south Lincolnshire coast (**Figure 8.8**). At the closest point, the boundary of the SEP wind farm site is approximately 2.2km east of the SAC (and the DEP North array area is approximately 10.3km to the east).

140. The Inner Dowsing, Race Bank and North Ridge SAC is designated for the following features:

- Sandbanks which are slightly covered by sea water all the time; and
- Reefs.

8.5.6 Climate Change and Natural Trends

141. The baseline conditions for benthic ecology are considered to be relatively stable within SEP and DEP and the wider area, with multiple data sets covering several years exhibiting similar patterns, including SOW and DOW post-construction monitoring.

142. The existing environment within SEP and DEP is influenced by the physical processes which exist within the southern North Sea, including waves and tidal currents driving changes in sediment transport and then sea bed morphology (see **Chapter 6 Marine Geology, Oceanography and Physical Processes**). Long term established patterns may be affected by climate change driven sea-level rise, however this will have a reduced impact offshore compared to along the coastline. Warming sea temperatures and ocean acidification are likely to result in changes to the composition and geographical distribution of benthic communities, with a general northerly shift in the latitudinal ranges of many species.

143. Anthropogenic pressures that currently exist across the study area such as commercial fishing, particularly using bottom towed gear, have the potential to influence future change in the existing benthic environment (**Chapter 12 Commercial Fisheries**). Fisheries management measures have the potential to reduce fishing effort in the certain areas, therefore reducing fishing related pressures on benthic ecology; but may also displace fishing effort and potentially increase impacts in other areas. The cumulative impacts of other plans and projects, including fisheries management measures, are assessed in **Section 8.7**.

8.6 Potential Impacts

144. As described in **Section 8.4.3.1.1**, the sensitivity of benthic receptors is based on the MarESA method which describes the sensitivity of biotopes in relation to different MarESA pressures. These sensitivities are modified, where appropriate, by local evidence, for example from post construction benthic monitoring surveys at the SOW and DOW, or if habitats or biotopes are of conservation value as described in **Section 8.4.3.1.2**.

145. MarESA sensitivity is only available at the biotope level. However, confidence in the classification of biotopes present across the SEP and DEP offshore survey areas is lower than classification at the habitat level (EUNIS Level 3). Therefore, where sensitivity at the habitat level is assessed it is based on the worst-case sensitivity of biotopes identified within the habitat. The sensitivity of relevant habitats and

biotopes is summarised throughout this section. Further information presenting the resistance and resilience assessments determining biotope sensitivity is presented in **Appendix 8.6**.

146. As described in **Section 8.3.2**, there will be no direct impacts on the intertidal zone as a result of the use of HDD to approximately 1,000m from the coastline. Additionally, the assessment provided in **Chapter 6 Marine Geology, Oceanography and Physical Processes** concludes that there will be no significant indirect impacts on the nearshore environment. Therefore, no impacts are predicted on the intertidal zone and it is not considered further in this chapter.

8.6.1 Consideration of Potential Impacts on Designated Sites

147. As described in **Section 8.5.5**, the export cable corridor passes through the CSCB MCZ and Greater Wash SPA (**Figure 8.8**). SEP and DEP are also in proximity to The Wash and North Norfolk Coast SAC and the Inner Dowsing, Race Bank and North Ridge SAC. The following summarises the approach taken to the consideration of potential impacts on these designated sites in this chapter:

- Impacts on the CSCB MCZ are assessed in the **Stage 1 CSCB MCZA** (document reference 5.6). However, for context and to provide a link between the EIA and the MCZA, where relevant an assessment is also provided in EIA terms in this chapter.
- Impacts on the supporting features of the Greater Wash SPA are not assessed explicitly in this chapter, although the benthic ecology impact assessment provides context to the assessments presented in **Chapter 11 Offshore Ornithology** and the **RIAA** (document reference 5.4).
- Impacts on The Wash and North Norfolk Coast SAC and the Inner Dowsing, Race Bank and North Ridge SAC are assessed in the **RIAA** (document reference 5.4). However, for context and to provide a link between the EIA and the HRA, where relevant an assessment is also provided in EIA terms in this chapter.

8.6.2 Potential Impacts during Construction

8.6.2.1 Impact 1: Temporary habitat loss / physical disturbance

148. Temporary habitat loss and physical disturbance will occur during the construction phase as a result of sea bed preparation for the installation of cables and foundations, cable installation, placement of anchors during wind turbine and cable installation, and jack-up vessel operations. Some activities will result in disturbance of surface sediments, and some will result in habitat loss (removal of substratum).

149. Where disturbed sediments (e.g. preparation areas for foundations) are subsequently covered with infrastructure, habitat loss is long term or permanent, therefore this has been assessed as an operational impact in **Section 8.6.3.2** and is not considered further here.

8.6.2.1.1 Sensitivity

150. The sensitivity of the biotopes identified in the SEP and DEP offshore sites has been assessed in relation to MarESA pressures relevant to construction phase temporary habitat loss / physical disturbance. These are:

- Habitat structure changes – removal of substratum (extraction)
- Abrasion/disturbance of the surface of the substratum or sea bed
- Penetration or disturbance of the substratum subsurface

151. The sensitivity of identified habitats and biotopes to temporary habitat loss / physical disturbance pressures are summarised **Table 8-16** below. Further information describing the resistance and resilience of these habitats and biotopes, used to determine sensitivity, is provided in **Appendix 8.6**.

152. It should be noted that the SEP and DEP surveys only identified the broad habitat A3 Infralittoral rock and other hard substrata in the offshore export cable corridor close to landfall, but although the bedrock was identified as chalk no biotope was assigned. Natural England's Advice on Operations for the CSCB MCZ references 'A4.232 *Polydora* sp. tubes on moderately exposed sublittoral soft rock' as the relevant biotope for the Subtidal chalk feature and therefore this has been used for the sensitivity assessment. However, it should be noted that the degree of certainty in this assessment is relatively low.

Table 8-16: Habitat and biotope Sensitivity to Temporary Habitat Loss / Disturbance Pressures

Habitat and Biotope	Presence of biotope in the SEP and DEP offshore sites	MarESA sensitivity		
		Removal of substratum	Abrasion / disturbance	Substratum penetration / disturbance
A3/4 Infralittoral / Circalittoral rock and other hard substrata	-	High		
A4.232 *Polydora* sp. tubes on moderately exposed sublittoral soft rock	Not recorded in DEP or SEP however it has been used as a proxy for A3/A4	High	Medium	Medium
A4.1 Atlantic and Mediterranean high energy circalittoral rock	-	Low		
A4.134 *F. foliacea* and colonial ascidians on tide-swept moderately wave-exposed circalittoral rock	recorded across the SEP survey area on larger pebbles, cobbles and boulders in coarse and mixed sediment areas. An epibiotic overlay of infaunal biotopes. Not recorded in DEP, however likely to be	Not relevant	Low	Not relevant

Habitat and Biotope	Presence of biotope in the SEP and DEP offshore sites	MarESA sensitivity		
		Removal of substratum	Abrasion / disturbance	Substratum penetration / disturbance
	present in the export cable corridor.			
A4.2 Atlantic and Mediterranean moderate energy circalittoral rock	-	High		
A4.231 Piddocks with a sparse associated fauna in sublittoral very soft chalk or clay	observed at one location within the transect at SS21 (western corner of SEP wind farm site). Piddocks could not be confirmed. Not recorded in DEP.	High	Medium	High
A5.1 Sublittoral coarse sediment	-	Medium		
A5.133 ‘*Moerella* spp. with venerid bivalves in infralittoral gravelly sand’	Possible A5.133 in the interlink corridor. A5.13 recorded in the offshore export cable corridor.	Medium	Low	Low
A5.2 Sublittoral sand	-	High		
A5.233 *Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand	Possible A5.233 recorded in all DEP project areas, and recorded in the SEP offshore export cable corridor.	Medium	Low	Low
A5.4 Sublittoral mixed sediments	-	Medium		
A5.431 *Crepidula fornicata* with ascidians and anemones on infralittoral coarse mixed sediment	Possible A5.431 identified across SEP and DEP.	Medium	Low	Low
A5.451 Polychaete-rich deep Venus community in offshore mixed sediments	Impoverished version or a transition of the biotope A5.451 identified in the SEP offshore survey area. Not identified in the DEP offshore survey area	Medium	Low	Low
A5.6 Sublittoral biogenic reefs	-	Medium		

Habitat and Biotope	Presence of biotope in the SEP and DEP offshore sites	MarESA sensitivity		
		Removal of substratum	Abrasion / disturbance	Substratum penetration / disturbance
A5.611 *S. spinulosa* on stable circalittoral mixed sediment	Possible A5.611 identified in all SEP project areas. Not identified in the DEP benthic characterisation survey (Fugro, 2020a). However, the SEP benthic characterisation survey (Fugro, 2020b) confirms a mosaic of this biotope with A5.431 in the offshore export cable corridor.	Medium	Medium	Medium

8.6.2.1.2 DEP in Isolation

8.6.2.1.2.1 Sensitivity

153. The habitat map (**Figure 8.6**) indicates that the majority of the DEP wind farm site is comprised of sublittoral coarse sediment (A5.1); sublittoral sand (A5.2); and sublittoral mixed sediment (A5.4) habitats. Biotopes identified with a higher degree of uncertainty were A5.133 *Moerella* spp. with venerid bivalves in infralittoral gravelly sand, A5.233 *Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand, and A5.431 *Crepidula fornicata* with ascidians and anemones on infralittoral coarse mixed sediment (**Figure 8.7**, **Section 8.5.4.1**). The biotope assigned to A3 Infralittoral rock and other hard substrata has high sensitivity to removal of substratum (extraction) and habitat structure changes. However, there will be no direct impacts on this nearshore feature due to the use of HDD which will ‘pop-out’ offshore in an area identified by the project characterisations surveys as sand (refer to the **Stage 1 CSCB MCZA** (document reference 5.6) and **Outline CSCB MCZ CSIMP** (document reference 9.7) for further details).

154. The sensitivity of DEP biotopes to these pressures ranges from low to medium according to MarESA, with the highest sensitivity being to penetration or removal of substratum (extraction) and disturbance of the substratum subsurface (both medium sensitivity). A post-construction survey of DOW was completed in August and September 2018, less than one year after the wind farm became operational. It identified A5.233 *Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand, and A5.431 *Crepidula fornicata* with ascidians and anemones on infralittoral coarse mixed sediment and showed no significant differences between the pre-construction and post-construction surveys (MMT, 2019). This suggests that recovery of these biotopes is possible within two years and supports the MarESA sensitivity assessments which are based on high resilience / recovery. Therefore, as a worst-case scenario an overall sensitivity of medium has been determined in relation to temporary habitat loss / disturbance.

155. Additionally, monitoring at Race Bank Offshore Wind Farm where crests of sand waves were reduced in elevation was undertaken pre (2015/16) during (2017) and post (2018) sand wave levelling (Orsted 2018). The monitoring was to assess the level of disturbance and the rate of natural recovery (restoration) of sea bed morphology. The monitoring used multibeam echosounder and nine areas were chosen. The results of the monitoring showed that along most of the sand waves surveyed the sea bed had completely or nearly completely recovered to pre-construction levels (greater than 75% recovery of sand waves in all areas). Meaning the assessment of medium sensitivity in relation to temporary habitat loss / disturbance is considered appropriate.

156. Taking into account the sensitivity to this pressure and value of the Annex I / UK BAP priority habitat *S. spinulosa* reef that can be associated with biotope A5.611 and the UK BAP priority habitat 'peat and clay exposures with piddocks' that can be associated with biotope A4.231, these designated habitats have been determined to have a high sensitivity for this MarESA pressure. However, for clarity, it should be noted that no Annex I or UK BAP priority habitat *S. spinulosa reefs* or UK BAP priority habitat 'peat and clay exposures with piddocks' have been identified from any of the site specific surveys to date and the biotopes themselves are not considered to be of high sensitivity as the biotopes do not always contain Annex I or UK BAP priority habitat. Nonetheless, they have been considered in the assessment as a precautionary measure given the assignment of the aforementioned biotopes which indicates that these Annex I / UK BAP priority habitats could potentially be present. This would be confirmed through detailed pre-construction surveys, the results of which would be consulted on with the MMO and Natural England. The biotopes themselves (A4.231 and A5.611) are assigned a medium sensitivity.

8.6.2.1.2.2 Magnitude of Effect

157. Activities associated with the offshore construction works of DEP in isolation will result in direct temporary loss / disturbance to subtidal habitats. Relevant construction activities are:

- Sea bed preparation for the installation of cables and foundations (sand wave clearance, levelling and PLGR)
- Burial of offshore cables (including export, infield and interlink cables)
- Vessel moorings (jack-up, anchor placements)

158. The disturbance would be temporary and intermittent over a construction period of up to two years. The disturbance footprints are summarised in **Table 8-2**. The area of disturbance is considered to be small in the context of the extent of these benthic habitats present across the wider southern North Sea. A temporary (for part of the project duration) change, over a small area of the receptor is anticipated and, therefore, the magnitude of this effect is considered to be low.

8.6.2.1.2.3 Impact Significance

159. Based on the worst-case medium sensitivity of habitats and biotopes and the low magnitude of temporary habitat loss / physical disturbance during the DEP construction phase, the impact is assessed as **minor adverse** significance.

160. Based on a sensitivity of high for potential Annex I / UK BAP priority habitat *S. spinulosa* reefs and the UK BAP priority habitat 'peat and clay exposures with piddocks' and a low impact magnitude in relation to temporary habitat loss / physical disturbance, the impact significance is assessed as **moderate adverse**. However, as detailed in **Table 8-4**, if these habitats are identified during pre-construction surveys, they will be avoided, if required, through micro-siting. Taking into account the proposed mitigation measures, the residual impact is assessed as **no impact**.

8.6.2.1.3 SEP in Isolation

8.6.2.1.3.1 Sensitivity

161. The habitat map (**Figure 8.7**) indicates that the majority of the SEP offshore site is comprised of sublittoral coarse sediment (A5.1) and sublittoral mixed sediment (A5.4) with some areas of sublittoral sand (A5.2). Biotopes identified, with a higher degree of uncertainty, were A4.134 *Flustra foliacea* and colonial ascidians on tide-swept moderately wave-exposed circalittoral rock, A5.431 *Crepidula fornicata* with ascidians and anemones on infralittoral coarse mixed sediment, A5.611 *Sabellaria spinulosa* on stable circalittoral mixed sediment, and an impoverished or transition version of A5.451 Polychaete-rich deep Venus community in offshore mixed sediments. In sand areas A5.233 *Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand was identified (**Figure 8.7**, **Section 8.5.4.2)**. Sublittoral coarse sediment habitat was not classified to the biotope level.

162. As discussed above, the biotope assigned to A3 Infralittoral rock and other hard substrata has high sensitivity to removal of substratum (extraction) and habitat structure changes but there will be no direct impacts on this nearshore feature due to the use of HDD on approach to the landfall.

163. A single record of the biotope A4.231 'piddocks with a sparse associated fauna in sublittoral very soft chalk or clay' was identified at station SS_21 in the western area of the SEP wind farm site. This UK BAP priority habitat has also been recorded outside the offshore survey area in the vicinity of the Sheringham Shoal offshore export cable (Fugro, 2020e) and in the CSCB MCZ.

164. The sensitivity of SEP biotopes to the pressures described in **Section 8.6.2.1.2.2**ranges from low to medium for all biotopes except A4.231 which has high sensitivity to removal and/or penetration of the substratum. Like the DOW post-construction survey, year one and two post construction surveys of the SOW site showed likely recovery within two years in most areas (Fugro, 2013; 2014). However, the offshore export cable trenches in coarse sediment areas still represented a disturbed benthic habitat by the time of the second post-construction monitoring survey. By the time of a third post-construction benthic survey of the export cable in the CSCB MCZ in August 2020, epifaunal community structure had recovered such that it was not significantly different to unimpacted areas (Fugro, 2020d). Recovery of benthic communities in localised areas impacted by SOW

export cable installation took longer than recovery of benthic communities impacted by DOW export cable installation (up to 10 years compared to up to 2 years). It is understood that this was due to the cable trenching technique used by SOW, which left a trench that persisted in coarse sediment areas. Section 4.3.1.1 of the **Outline CSCB MCZ CSIMP** (document reference 9.7) describes why slower recovery of the export cable trenches occurred for the SOW. The SEP and DEP export cable corridor runs parallel to the DOW export cable corridor and will undertake a similar export cable installation methodology to that project. Post-construction surveys did not show any exposed export cables, nor visibility of the trenched route on the sea bed for DOW (see section 4.3.1.2 of the **Outline CSCB MCZ CSIMP**). Therefore, a full recovery of benthic habitats and communities for SEP and DEP is anticipated within two years of construction.

165. A4.231 Piddocks with a sparse associated fauna in sublittoral very soft chalk or clay is not widespread in the SEP project area and it is likely that there will be no direct impacts on it from construction. Possible A5.611 was identified in all SEP project areas. Taking into account the sensitivity to temporary habitat loss / physical disturbance and value of the UK BAP priority habitat 'peat and clay exposures with piddocks' which can be associated with biotope A4.231 and the Annex I / UK BAP priority habitat *S. spinulosa* reefs that can be associated with biotope A5.611, these designated habitats will remain as high sensitivity for this MarESA pressure. However, as there are no Annex I / BAP priority habitats present, the biotopes themselves (A4.231 and A5.611) are assigned a medium sensitivity.

8.6.2.1.3.2 Magnitude of Effect

166. Activities associated with the offshore construction works of SEP in isolation will result in direct temporary loss/disturbance to subtidal habitats. Relevant construction activities are:

- Sea bed preparation for the installation of foundations (levelling, PLGR)
- Burial of offshore cables (including export and infield cables)
- Vessel moorings (jack-up, anchor placements)

167. The disturbance would be temporary and intermittent over a construction period of up to two years. The disturbance footprints are summarised in **Table 8-2**. The area of disturbance is considered to be small in the context of the extent of these benthic habitats present across the wider southern North Sea. A temporary (for part of the project duration) change, over a small area of the receptor is anticipated and, therefore, the magnitude of this effect is considered to be low.

8.6.2.1.3.3 Impact Significance

168. Based on the worst-case medium sensitivity and low magnitude of temporary habitat loss/physical disturbance during the SEP construction phase, the impact is assessed as **minor adverse** significance.

169. As stated in **Section 8.6.2.1.2,** based on a sensitivity of high for Annex I / UK BAP priority habitat *S. spinulosa* reefs and the UK BAP priority habitat 'peat and clay exposures with piddocks' and a low impact magnitude in relation to temporary habitat loss / physical disturbance, the impact significance is assessed as **moderate**

adverse. However, as detailed in **Table 8-4**, if these habitats are identified during pre-construction surveys, they will be avoided, if required, through micro-siting. Taking into account the proposed mitigation measures the residual impact is assessed as **no impact**.

8.6.2.1.4 SEP and DEP

8.6.2.1.4.1 Sensitivity

170. The worst-case sensitivity assessment for SEP and DEP remains the same as the sensitivity presented for SEP in isolation (high), based on the assessment of the most sensitive receptor.

8.6.2.1.4.2 Magnitude of Effect

171. Activities associated with the offshore construction works of SEP and DEP will result in direct temporary loss/disturbance to subtidal habitats. Relevant construction activities are:

- Sea bed preparation for the installation of cables and foundations (sand wave clearance, levelling, PLGR)
- Burial of offshore cables (including export, infield, interlink cables)
- Vessel moorings (jack-up, anchor placements)

172. The disturbance would be temporary and intermittent over a construction period of two years if the projects are constructed concurrently. If constructed sequentially, offshore construction works would require up to two years per Project (excluding pre-construction activities such as surveys), with a gap of up to four years between the start of construction of each Project. The total footprint of disturbance is summarised in **Table 8-2** and would be greater than for each project in isolation. However, the area of disturbance is still small in the context of the extent of these benthic habitats present across the wider southern North Sea. A temporary (for part of the project duration) change, over a small area of the receptor is anticipated and, therefore, the magnitude of this effect is considered to be low.

8.6.2.1.4.3 Impact Significance

173. The worst-case sensitivity assessment for SEP and DEP remains the same as the sensitivity presented for SEP in isolation (medium), based on the most sensitive receptor. Additionally, the magnitude of the impact of temporary habitat loss/physical disturbance for SEP and DEP remains low. Therefore, the impact of temporary habitat loss/physical disturbance is assessed as **minor adverse** significance.

174. As stated in **Section 8.6.2.1.2,** based on a sensitivity of high for potential Annex I / UK BAP priority habitat *S. spinulosa* reefs and the UK BAP priority habitat 'peat and clay exposures with piddocks' and a low impact magnitude in relation to temporary habitat loss / physical disturbance, the impact significance is assessed as **moderate adverse**. However, as detailed in **Table 8-4**, if these habitats are identified during pre-construction surveys, they will be avoided, if required, through micro-siting. Taking into account the proposed mitigation measures the residual impact is assessed as **no impact**.

8.6.2.1.5 *Cromer Shoal Chalk Beds MCZ*

8.6.2.1.5.1 Sensitivity

175. Based on the habitats and biotopes recorded in the CSCB MCZ (**Section 8.5.4.3**), sensitivity to temporary habitat loss / physical disturbance ranges from low to high. However, there will be no direct impacts on the outcropping chalk (A3 / IR (**Figure 8.6**)) feature due to the use of HDD on approach to the landfall, and therefore the assigned biotope (A4.232 *Polydora* sp. tubes on moderately exposed sublittoral soft rock) which has high sensitivity to this impact will not be affected. Therefore, the worst-case sensitivity is medium. The value of the habitats is high as they are within the CSCB MCZ which is a national designation (**Table 8-9**). However, following a review of the MarESA sensitivity it is considered that a sensitivity classification of medium is still applicable despite the value of the habitats because they are found outside of the MCZ in this area of the southern North Sea (see **Table 8-21**). Consideration of the potential impacts on the MCZ as a whole, and its contribution to the ecologically coherent network of Marine Protected Areas, is considered within the **Stage 1 CSCB MCZA** (document reference 5.6).

8.6.2.1.5.2 Magnitude of Effect

176. The maximum area of sea bed within the MCZ that could be disturbed by cable installation activities, HDD exit point trenching and deposition, and jack-up footprint would be 0.167km^2 each for SEP or DEP in isolation, and up to 0.33km^2 for SEP and DEP (all OSP scenarios) (**Table 8-2**). This is approximately 0.05% and 0.1% of the MCZ area respectively.

177. The magnitude of effect from temporary habitat loss/physical disturbance is considered to be negligible.

8.6.2.1.5.3 Impact Significance

178. Based on the worst-case medium sensitivity of habitats and biotopes and the negligible magnitude of temporary habitat loss/physical disturbance during the DEP and/or SEP construction phase, the impact on the CSCB MCZ is assessed as minor adverse significance.

179. However, as detailed in **Table 8-4**, if Annex I / UK BAP priority habitat *S. spinulosa* reef and UK BAP priority habitat ‘peat and clay exposures with piddocks’ are identified during pre-construction surveys, they will be avoided, if required, through micro-siting. Therefore, taking into account the proposed mitigation measures the residual impact is assessed as **no impact.**

8.6.2.2 Impact 2: Temporary increases in SSC and deposition

180. Increases in SSC within the water column and subsequent deposition onto the sea bed may occur as a result of sea bed preparation for the installation of foundations and cables and through sediment disturbed due to installation of offshore infrastructure, including foundations and cables. Activities such as sea bed disturbances from jack-up vessels and placement of cable protection are not expected to increase suspended sediment concentrations to the extent to which there would be a discernible impact to benthic ecology receptors. **Chapter 6 Marine**

Geology, Oceanography and Physical Processes provides details of changes to SSC and subsequent sediment deposition.

181. Increased suspended sediments have the potential to affect benthic ecology receptors by blocking feeding apparatus as well as by smothering sessile species upon redeposition.

8.6.2.2.1.1 Sensitivity

182. The sensitivity of the biotopes identified in the SEP and DEP offshore sites has been assessed in relation to MarESA pressures relevant to construction phase increased SSC and deposition. The relevant pressures are:

- Smothering and siltation rate changes
- Changes in suspended solids (water clarity)

183. The sensitivity of identified habitats and biotopes to increased SSC and deposition pressures are summarised in **Table 8-17** below (see also **Figure 8.7**). Further information describing the resistance and resilience of these habitats and biotopes, used to determine sensitivity, is provided in **Appendix 8.6**. As stated in **Section 8.6.2.1**, biotope A4.232 has been used as the relevant biotope for the sensitivity assessment of the nearshore infralittoral / circalittoral rock feature.

184. **Chapter 6 Marine Geology, Oceanography and Physical Processes** states that during foundation installation, drill arisings deposited on the sea bed would be deposited near to the point of release up to thicknesses of approximately 3cm over a sea bed area local to each foundation (within 200 metres). Therefore, the MarESA pressure 'Smothering and siltation rate changes (light)' has been used for the sensitivity assessment because 'Light' deposition is defined as "of up to 5cm of fine material added to the habitat in a single, discrete event", as opposed to 'Heavy' deposition "of up to 30cm of fine material added to the habitat in a single discrete event".

Table 8-17: Habitat and Biotope Sensitivity to Increased SSC And Deposition Pressures

Habitat and Biotope	Presence of biotope in the SEP and DEP offshore sites	MarESA sensitivity	
		Smothering and siltation rate changes (light)	Changes in suspended solids (water clarity)
A3/4 Infralittoral / Circalittoral rock and other hard substrata	-	Low	
A4.232 Polydora sp. tubes on moderately exposed sublittoral soft rock	Not recorded in SEP or DEP however it has been used as a proxy for A3/A4	Not sensitive	Low
A4.1 Atlantic and Mediterranean high energy circalittoral rock	-	Low	

Habitat and Biotope	Presence of biotope in the SEP and DEP offshore sites	MarESA sensitivity	
		Smothering and siltation rate changes (light)	Changes in suspended solids (water clarity)
A4.134 F. foliacea and colonial ascidians on tide-swept moderately wave-exposed circalittoral rock	Recorded across the SEP survey area on larger pebbles, cobbles and boulders in coarse and mixed sediment areas. An epibiotic overlay of infaunal biotopes. Not recorded in DEP, however likely to be present in the export cable corridor.	Not sensitive	Low
A4.2 Atlantic and Mediterranean moderate energy circalittoral rock	-	Medium	
A4.231 Piddocks with a sparse associated fauna in sublittoral very soft chalk or clay	Observed at one location within the transect at SS_21 (western corner of SEP wind farm site). Piddocks could not be confirmed. Not recorded in DEP.	Medium	Not sensitive
A5.1 Sublittoral coarse sediment	-	Low	
A5.133 'Moerella spp. with venerid bivalves in infralittoral gravelly sand'	Possible A5.133 in the interlink corridor. A5.13 recorded in the offshore export cable corridor.	Low	Low
A5.2 Sublittoral sand	-	Low	
A5.233 Nephtys cirrosa and Bathyporeia spp. in infralittoral sand	Possible A5.233 recorded in all DEP project areas, and recorded in the SEP offshore export cable corridor.	Low	Not sensitive
A5.4 Sublittoral mixed sediments	-	Low	
A5.431 Crepidula fornicata with ascidians and anemones on infralittoral coarse mixed sediment	Possible A5.431 identified across SEP and DEP.	Not sensitive	Low

Habitat and Biotope	Presence of biotope in the SEP and DEP offshore sites	MarESA sensitivity	
		Smothering and siltation rate changes (light)	Changes in suspended solids (water clarity)
A5.451 Polychaete-rich deep Venus community in offshore mixed sediments	Impoverished version or a transition of the biotope A5.451 identified in the SEP offshore survey area. Not identified in the DEP offshore survey area	Low	Low
A5.6 Sublittoral biogenic reefs	-	Not sensitive	
A5.611 *S. spinulosa* on stable circalittoral mixed sediment	Possible A5.611 identified in all SEP project areas. Not identified in the DEP benthic characterisation survey (Fugro, 2020a). However, the SEP benthic characterisation survey (Fugro, 2020b) confirms a mosaic of this biotope with A5.431 in the offshore export cable corridor.	Not sensitive	Not sensitive

8.6.2.2.2 DEP in Isolation

8.6.2.2.2.1 Sensitivity

185. As stated in **Section 8.6.2.1.2**, the habitats present across the majority of the DEP offshore survey area are sublittoral coarse sediment (A5.1); sublittoral sand (A5.2); and sublittoral mixed sediment (A5.4) (**Figure 8.6**).

186. A review of the sensitivities of the biotopes associated with the habitats present across the DEP offshore site in relation to the pressures of increased SSC and deposition indicates that all biotopes are either not sensitive or have a low sensitivity to these pressures (**Table 8-16**). Therefore, a worst-case scenario of low sensitivity has been determined in relation to increased SSC and deposition.

8.6.2.2.2.2 Magnitude of Effect

187. Activities associated with the offshore construction works of DEP in isolation will result in temporary increases in SSC and subsequent deposition of suspended sediment. Relevant construction activities are:

- Sea bed preparation;
- Wind turbine foundation installation;

- OSP foundation installation;
- Export cable installation, and
- Interlink and infield cable installation.

188. **Chapter 6 Marine Geology, Oceanography and Physical Processes** describes the expected movement of sediment suspended during DEP construction phase, which has been summarised below. Due to the predominance of medium and coarse grained sand across the DEP wind farm site most disturbed sediment would fall rapidly (minutes or tens of minutes) to the sea bed as a highly turbid dynamic plume immediately upon its discharge (within a few tens of metres along the axis of tidal flow).

189. Some of the finer sand fraction from this release and the very small proportion of mud that is present are likely to stay in suspension for longer and form a passive plume which would become advected by tidal currents. Due to the sediment sizes present, this is likely to exist as a measurable but modest concentration plume (tens of mg/l) for around half a tidal cycle (up to six hours). Sediment would eventually settle to the sea bed in proximity to its release (within a few hundred metres up to around a kilometre along the axis of tidal flow) within a short period of time (hours to days). Whilst lower suspended sediment concentrations would extend further from the dredged area, along the axis of predominant tidal flows, the magnitudes would be indistinguishable from background levels.

190. In relation to the export cable installation activities the sand and gravel-sized sediment (which represents most of the disturbed sediment) would settle out of suspension rapidly to the bed within 20m of the export cable corridor. Fine sand will most likely remain in the bottom 1-2m of the water column, and with settling velocities of around 10mm/s, this will ensure the fine sand settles within half an hour or less or become part of the ambient near bed transport (Soulsby, 1997), with no sand being transported further than 100m of the cable.

191. Mud-sized material (which represents only a very small proportion of the disturbed sediment) would be advected a greater distance and persist in the water column for hours to days. Chalk dispersion could extend for around 10km to the west and less to the east, with SSCs dropping to less than 1mg/l within a single flood or ebb excursion

192. Drill arisings during the installation of piled foundations for wind turbines would disturb subsurface sediments which could give rise to increases in SSCs. The coarser sediment sand / gravel would be deposited near to the point of release up to thicknesses of approximately 3cm over a sea bed area local to each foundation (within 200m). For the most part, the deposited sediment layer across the wider sea bed area would be very thin, and based on a worst-case scenario of 5% of monopile foundations requiring drilling, would be confined to a maximum of two foundations in DEP.

193. Overall, increases in SSC are expected to be localised at the point of discharge and short-term. Fine suspended sediment may then be transported by tidal currents, however due to the small quantities of fine-sediment released it is likely to be widely and rapidly dispersed. In most cases the elevation of suspended sediment is

expected to be lower than concentrations that would develop in the water column during storm conditions. Deposition of sediment is expected to be localised to the point of disturbance, with deposits of up to approximately 3cm.

194. Given the localised and short-term increases in SSC around the point of discharge, and negligible changes in sea bed level expected due to deposition, the magnitude of effect is considered to be negligible.

8.6.2.2.2.3 Impact Significance

195. Based on a worst-case low sensitivity of habitats and biotopes and the negligible magnitude of temporary increases in SSC and deposition during the DEP construction phase, the impact is assessed as **negligible adverse** significance.

8.6.2.2.3 SEP in Isolation

8.6.2.2.3.1 Sensitivity

196. As stated in **Section 8.6.2.1.3** the majority of the SEP offshore site is comprised of sublittoral coarse sediment (A5.1) and sublittoral mixed sediment (A5.4) with some areas of sublittoral sand (A5.2) (**Figure 8.6**).

197. A review of the sensitivities of the biotopes associated with the habitats present in the SEP offshore site in relation to the pressures of increased SSC and deposition indicates that most biotopes are either not sensitive or have a low sensitivity to these pressures (**Table 8-16**), except for one biotope A4.231 Piddocks with a sparse associated fauna in sublittoral very soft chalk or clay, which has a sensitivity of medium. This biotope is not widespread in the SEP project area and it is likely that construction activities will be a sufficient distance from this receptor such that the pathway for an effect is limited. However, as a worst-case scenario a sensitivity of medium has been determined in relation to temporary increases in SSC and deposition.

8.6.2.2.3.2 Magnitude of Effect

198. The activities causing increases in SSC and subsequent deposition during the construction of SEP are the same as presented for DEP in isolation (**Section 8.6.2.2.2**) except for the interlink cable installation which would not be required in the SEP in isolation scenario.

199. The fate of suspended sediment during the SEP construction phase has been determined in **Chapter 6 Marine Geology, Oceanography and Physical Processes**. Due to the sediment composition across the SEP offshore site being similar to DEP, suspended sediment is expected to disperse and settle in a similar way to that described for DEP.

200. In summary, increases in SSC are expected to be localised at the point of discharge and short-term. Fine suspended sediment may then be transported by tidal currents, however due to the small quantities of fine-sediment released it is likely to be widely and rapidly dispersed. In most cases, the elevation of suspended sediment is expected to be lower than the concentrations that would develop in the water column during storm conditions. Deposition of sediment is expected to be localised to the point of disturbance, with deposits of up to approximately 3cm.

201. Given the localised and short-term increases in SSC around the point of discharge, and negligible changes in sea bed level is expected due to deposition, the magnitude of effect is considered to be negligible.

8.6.2.2.3.3 Impact Significance

202. Based on the worst-case medium sensitivity of one habitat (A4.231) and the negligible magnitude of temporary increases SSC and deposition during the SEP construction phase, the impact is assessed as **minor adverse** significance.

8.6.2.2.4 SEP and DEP

8.6.2.2.4.1 Sensitivity

203. The worst-case sensitivity assessment for SEP and DEP remains the same as the sensitivity presented for SEP in isolation (medium), based on the assessment of the most sensitive receptor.

8.6.2.2.4.2 Magnitude of Effect

204. Although the area over which SSC and deposition effects would occur will be greater for SEP and DEP in comparison to the SEP or DEP in isolation, the increases in SSC are still expected to cause localised and short-term increases in SSC around the point of discharge, with negligible changes in sea bed level expected due to deposition. The magnitude is not expected to be larger if SEP and DEP are constructed concurrently because the plumes would not overlap as the tidal currents would drive the plumes in similar directions at both sites with a significant distance between SEP and DEP (the plumes would be parallel to each other). The impact magnitude is therefore considered to remain as negligible.

8.6.2.2.4.3 Impact Significance

205. The worst-case sensitivity assessment for SEP and DEP remains the same as the sensitivity presented for SEP in isolation (medium) based on the most sensitive receptor. Additionally, the magnitude of the impact of increased SSC and deposition for SEP and DEP remains negligible. Therefore, the impact of increased SSC and deposition during the construction phase for SEP and DEP is assessed as **minor adverse** significance.

8.6.2.2.5 Cromer Shoal Chalk Beds MCZ

8.6.2.2.5.1 Sensitivity

206. Based on the habitats and biotopes recorded in the CSCB MCZ (**Section 8.5.4.3**) sensitivity to increased SSC and deposition ranges from not sensitive to low. The sensitivity of MCZ habitats can be modified based on their value (**Section 8.4.3.1.2**), and because they are component biotopes of MCZ designated features the worst-case sensitivity is increased to medium.

8.6.2.2.5.2 Magnitude of Effect

207. The magnitude of effect from increases in SSC and deposition remains negligible.

8.6.2.2.5.3 *Impact Significance*

208. Based on the worst-case medium sensitivity of habitats and biotopes and the negligible magnitude of increased SSC and deposition during the DEP and/or SEP construction phase, the impact on the CSCB MCZ is assessed as **minor adverse** significance.

8.6.2.2.6 *Inner Dowsing, Race Bank and North Ridge SAC*

209. The Inner Dowsing, Race Bank and North Ridge SAC is located approximately 2.2km west of the SEP wind farm site boundary. A full assessment of potential impacts on the designated features of the SAC is provided in the **RIAA** (document reference 5.4) which is summarised below in the context of EIA.

8.6.2.2.6.1 *Sensitivity*

210. Using Natural England's advice on operations for the Inner Dowsing, Race Bank and North Ridge SAC in relation to the relevant pressure of smothering and siltation rate changes (Light) all biotopes associated with the Annex I sandbanks have either a low sensitivity or are not sensitive, except for the following two biotopes which have medium sensitivity:

- A5.432 *Sabella pavonina* with sponges and anemones on infralittoral mixed sediment; and
- A5.445 *Ophiothrix fragilis* and/or *Ophiocomina nigra* brittlestar beds on sublittoral mixed sediment.

211. These biotopes have not been confirmed within the extent of the effect, however, taking a precautionary approach the worst-case sensitivity is medium. The sensitivity of habitats can be modified based on their value (**Section 8.4.3.1.2**), and because there may be an impact on Annex I habitats within a SAC boundary the worst-case sensitivity is increased to high.

8.6.2.2.6.2 *Magnitude of Effect*

212. The potential for increases in SSC is considered greatest during the construction phase. **Chapter 6 Marine Geology, Oceanography and Physical Processes** assessed the potential increased SSC and deposition from construction sources such as foundation installation.

213. Mobilised sediment may be transported by wave and tidal action in suspension in the water column. Conceptual evidence-based assessment suggests that, due to the predominance of medium and coarse grained sand across the SEP and DEP offshore sites, sediment disturbed at the sea bed would remain close to the bed and settle back to the bed rapidly. Most of the sediment released at the water surface (e.g. from a dredger vessel) would fall rapidly to the sea bed within a few tens of metres along the axis of tidal flow. Some of the finer sand fraction from this release and the very small proportion of mud that is present are likely to stay in suspension for longer and form a passive plume which would become advected by tidal currents. Due to the sediment sizes present, this is likely to exist as a measurable but modest concentration plume (tens of mg/l) for around half a tidal cycle (up to six hours). Sediment would settle to the sea bed within a few hundred metres up to around a

kilometre from the release location along the axis of tidal flow within a short period of time (hours). Whilst lower suspended sediment concentrations would extend further from the dredged area, along the axis of predominant tidal flows and potentially as far as the Inner Dowsing, Race Bank and North Ridge SAC (which is within the zone of tidal influence from the western boundary of the SEP wind farm site), the magnitudes would be indistinguishable from background levels. Deposited sediment would be to a maximum thickness of less than 0.1mm within the SAC and is also likely to be indistinguishable from background levels.

214. Based on the assessment provided in **Chapter 6 Marine Geology, Oceanography and Physical Processes**, the effect of temporary increases in SSC and deposition on the Inner Dowsing, Race Bank and North Ridge SAC is expected to be negligible.

8.6.2.2.6.3 Impact Significance

215. Based on the worst-case high sensitivity of habitats and biotopes and the negligible magnitude of increased SSC and deposition during the SEP construction phase, the impact on the Inner Dowsing, Race Bank and North Ridge SAC is assessed as **minor adverse** significance. No impact is anticipated from the construction of DEP.

8.6.2.3 Impact 3: Re-mobilisation of contaminated sediments

8.6.2.3.1 SEP or DEP in Isolation and SEP and DEP

8.6.2.3.1.1 Sensitivity

216. The MarESA pressure benchmark for 'Pollution and other chemical changes' is set at 'compliance with all Annual Average Environmental Quality Standards (EQS), conformance with PELs, and OSPAR Environmental Assessment Criteria (EACs) or Effects Range Lows (ER-Ls')' and that compliance with 'all relevant environmental protection' is likely to result in no effects on the features (Tyler-Walters *et al*., 2018). Given contaminant levels are within environmental protection standards (i.e. no exceedance of Action Level 1), marine species and habitats are not considered to be sensitive to changes that remain within these standards.

8.6.2.3.1.2 Magnitude of Effect

217. As described in **Section 8.5.2**, data collected during the benthic characterisation surveys was analysed for contaminants. **Chapter 7 Marine Water and Sediment Quality** has conducted a comparison of levels of sediment contamination against recognised sediment quality guidelines. Sediment contamination levels in the surveyed area are not considered to be of significant concern and are low risk in terms of potential impacts on the marine environment. Specifically, the organotin concentrations recorded were low and insufficient to affect the reproductive capability of sensitive gastropod species.

218. Therefore, it is considered there is a low magnitude of effect in relation to re-mobilisation of contaminated sediments.

8.6.2.3.1.3 Impact Significance

219. Due to there being no contaminated sediments above levels of concern within the SEP and DEP offshore sites there is no pathway for effect on benthic receptors. Therefore, the potential impact is considered to be of **minor adverse** significance

for all scenarios. This impact is not considered further in the operational phase and decommissioning phase due to there being no pathway for impact on benthic receptors.

8.6.2.4 Impact 4: Underwater noise and vibration

8.6.2.4.1 SEP or DEP in Isolation and SEP and DEP

220. Underwater noise and vibration from UXO clearance, pile driving for the installation of some foundation types, and other construction activities including sea bed preparation, cable installation and rock placement, and from vessels (as described in **Chapter 4 Project Description**) have potential to impact on benthic ecology receptors.

8.6.2.4.1.1 Sensitivity

221. Noise sources other than piling and UXO clearance are unlikely to have a significant effect on benthic ecology as the benthos in this area is likely to be habituated to ambient noise such as that created by shipping.

222. The sensitivity of the biotopes identified in the SEP and DEP offshore sites has been assessed in relation to MarESA pressures relevant to construction phase underwater noise and are summarised in **Table 8-18** below.

Table 8-18: Habitat and Biotope Sensitivity to Underwater Noise Pressures

Habitats and Biotopes	Presence of biotope in the SEP and DEP offshore sites	Underwater noise changes
A3/4 Infralittoral / Circalittoral rock and other hard substrata	-	Not sensitive
A4.232 *Polydora* sp. tubes on moderately exposed sublittoral soft rock	Not recorded in SEP or DEP however it has been used as a proxy for A3/A4	Not sensitive
A4.1 Atlantic and Mediterranean high energy circalittoral rock	-	Not sensitive
A4.134 *F. foliacea* and colonial ascidians on tide-swept moderately wave-exposed circalittoral rock	Recorded across the SEP survey area on larger pebbles, cobbles and boulders in coarse and mixed sediment areas. An epibiotic overlay of infaunal biotopes. Not recorded in DEP, however likely to be present in the offshore export cable corridor.	Not sensitive
A4.2 Atlantic and Mediterranean moderate energy circalittoral rock	-	Not relevant
A4.231 Piddocks with a sparse associated fauna in sublittoral very soft chalk or clay	Observed at one location within the transect at SS_21 (western corner of SEP wind farm site). Piddocks could not be confirmed. Not recorded in DEP.	Not relevant
A5.1 Sublittoral coarse sediment	-	Not relevant

Habitats and Biotopes	Presence of biotope in the SEP and DEP offshore sites	Underwater noise changes
A5.133 '*Moerella* spp. with venerid bivalves in infralittoral gravelly sand'	Possible A5.133 in the interlink corridor. A5.13 recorded in the offshore export cable corridor.	Not relevant
A5.2 Sublittoral sand		Not relevant
A5.233 *Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand	Possible A5.233 throughout the DEP offshore site, and recorded in the SEP offshore export cable corridor.	Not relevant
A5.4 Sublittoral mixed sediments	-	Not relevant
A5.431 *Crepidula fornicata* with ascidians and anemones on infralittoral coarse mixed sediment	Possible A5.431 identified across SEP and DEP.	Not relevant
A5.451 Polychaete-rich deep Venus community in offshore mixed sediments	Impoverished version or a transition of the biotope A5.451 identified in the SEP offshore survey area. Not identified in the DEP offshore survey area	Not relevant
A5.6 Sublittoral biogenic reefs	-	Not relevant
A5.611 *S. spinulosa* on stable circalittoral mixed sediment	Possible A5.611 identified in all SEP project areas. Not identified in the DEP benthic characterisation survey (Fugro, 2020a). However, the SEP benthic characterisation survey (Fugro, 2020b) confirms a mosaic of this biotope with A5.431 in the offshore export cable corridor.	Not relevant

223. The sensitivity of benthic species to noise and vibration is poorly understood, however studies have shown that some species are able to detect sound. Horridge (1966) found the hair-fan organ of the common lobster *Homarus gammarus* to act as an underwater vibration receptor. Lovell *et al*. (2005) showed that the common prawn *Palaemon serratus* is capable of hearing sounds within a range of 100 to 3,000Hz, and the brown shrimp *Crangon crangon*, which was recorded in abundance near the SEP and DEP offshore sites, has shown behavioural changes at frequencies around 170Hz (Heinisch and Weise, 1987).

224. During seismic surveys, polychaetes have been observed to retreat into the bottom of their burrows or retract their palps, and bivalve species withdrew their siphons (Richardson *et al*., 1995). Furthermore, the air-filled cavities within certain invertebrate species may alter the transmission of sound waves through their bodies, which could potentially cause physiological damage.

225. Evidence suggests that some benthic species perceive and react to noise, however the MarESA sensitivity assessment for the biotopes recorded within the SEP and DEP offshore survey areas is that they are either 'not sensitive' or that noise impacts are 'not relevant' (**Table 8-18**). 'Not relevant' is recorded where the evidence suggests that there is no direct interaction between the pressure and the habitat

(biotope) or species. Therefore, the sensitivity of benthic biotopes and species to underwater noise and vibration is considered to be negligible.

8.6.2.4.1.2 Magnitude of Effect

226. Underwater noise from the worst-case sources (described in **Table 8-2**) may result in a discernible, temporary (for part of the construction phase) change, or over a small area of the receptor. Therefore, the magnitude of this effect is considered to be negligible.

8.6.2.4.1.3 Impact Significance

227. Based on the worst-case negligible sensitivity of habitats and biotopes and the negligible magnitude of effects of underwater noise on benthic ecology receptors during the construction phase, the impact is assessed as **negligible adverse** significance. Although the duration and spatial extent of noise effects would be greater for SEP and DEP, the magnitude is still assessed as negligible and therefore the impact remains negligible.

8.6.2.5 Impact 5: Invasive Non-Native Species (INNS)

228. Potential INNS impacts are a growing consideration for other proposed offshore developments including aquaculture, tidal and wave energy projects as well as the increasing number of mobile deep water drilling rigs and proposed floating production, storage and offloading facilities. The primary pathway for the potential introduction of INNS is from the use of vessels and infrastructure that has originated from outwith the North Sea and Northeast Atlantic region, particularly from regions that are ecologically distinct from the southern North Sea. Ship ballast water appears to be the largest single vector for INNS, and bio-fouling communities on ships are also a contributor (Glasby *et al*. 2007).

229. This pathway for introduction of INNS will be greatest during the construction phase and is assessed here. The impacts from colonisation and establishment of INNS following introduction has been considered as an operational impact (**Section 8.6.3.7**), including the potential introduction of species non-native to otherwise soft substrate habitats (**Section 8.6.3.5**).

8.6.2.5.1.1 Sensitivity

230. The sensitivity of the biotopes identified in the SEP and DEP offshore sites has been assessed in relation to MarESA pressure ‘introduction or spread of INNS’.

231. The sensitivity of identified habitats and biotopes to INNS pressures are summarised **Table 8-19** below. Further information describing the resistance and resilience of these habitats and biotopes, used to determine sensitivity, is provided in **Appendix 8.6**.

Table 8-19: Habitat and Biotope Sensitivity to INNS

Habitat and Biotope	Presence of biotope in the SEP and DEP offshore sites	MarESA sensitivity
		Introduction or spread of INNS
A3/4 Infralittoral / Circalittoral rock and other hard substrata	-	Not Relevant
A4.232 *Polydora* sp. tubes on moderately exposed sublittoral soft rock	Not recorded in SEP or DEP however it has been used as a proxy for A3/A4	Not Relevant
A4.1 Atlantic and Mediterranean high energy circalittoral rock	-	Not sensitive
A4.134 *F. foliacea* and colonial ascidians on tide-swept moderately wave-exposed circalittoral rock	Recorded across the SEP survey area on larger pebbles, cobbles and boulders in coarse and mixed sediment areas. An epibiotic overlay of infaunal biotopes. Not recorded in DEP, however likely to be present in the offshore export cable corridor.	Not sensitive
A4.2 Atlantic and Mediterranean moderate energy circalittoral rock	-	Not sensitive
A4.231 Piddocks with a sparse associated fauna in sublittoral very soft chalk or clay	Observed at one location within the transect at SS_21 (western corner of SEP wind farm site). Piddocks could not be confirmed. Not recorded in DEP.	Not sensitive
A5.1 Sublittoral coarse sediment	-	High
A5.133 '*Moerella* spp. with venerid bivalves in infralittoral gravelly sand'	Possible A5.133 in the interlink corridor. A5.13 recorded in the offshore export cable corridor.	High
A5.2 Sublittoral sand	-	Not sensitive
A5.233 *Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand	Possible A5.233 recorded in all DEP project areas, and recorded in the SEP offshore export cable corridor.	Not sensitive
A5.4 Sublittoral mixed sediments	-	High
A5.431 *Crepidula fornicata* with ascidians and anemones on infralittoral coarse mixed sediment	Possible A5.431 identified across SEP and DEP.	Not relevant
A5.451 Polychaete-rich deep Venus community in offshore mixed sediments	Impoverished version or a transition of the biotope A5.451 identified in the SEP offshore	High

Habitat and Biotope	Presence of biotope in the SEP and DEP offshore sites	MarESA sensitivity
		Introduction or spread of INNS
	survey area. Not identified in the DEP offshore survey area	
A5.6 Sublittoral biogenic reefs	-	Not sensitive
A5.611 *S. spinulosa* on stable circalittoral mixed sediment	Possible A5.611 identified in all SEP project areas. Not identified in the DEP benthic characterisation survey (Fugro, 2020a). However, the SEP benthic characterisation survey (Fugro, 2020b) confirms a mosaic of this biotope with A5.431 in the offshore export cable corridor.	Not sensitive

8.6.2.5.2 DEP in Isolation

8.6.2.5.2.1 Sensitivity

232. The sensitivity of DEP biotopes to INNS is either not sensitive or high according to MarESA, with the highest sensitivity biotopes being A5.133 '*Moerella* spp. with venerid bivalves in infralittoral gravelly sand'.

8.6.2.5.2.2 Magnitude of Effect

233. The risk of spreading INNS will be mitigated by employing biosecurity measures in accordance with the following relevant regulations and guidance:

- International Convention for the Prevention of Pollution from Ships (MARPOL). The MARPOL sets out appropriate vessel maintenance;
- The Environmental Damage (Prevention and Remediation) (England) Regulations 2015, which set out a polluter pays principle where the operators who cause a risk of significant damage or cause significant damage to land, water or biodiversity will have the responsibility to prevent damage occurring, or if the damage does occur will have the duty to reinstate the environment to the original condition; and
- The International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM Convention), which provide global regulations to control the transfer of potentially invasive species.

234. These commitments would be secured in the Project Environmental Management Plan (PEMP) (in accordance with the **Outline PEMP** (document reference 9.10) submitted with the DCO application) which will be agreed prior to the start of construction.

235. With mitigations in place, it is not expected INNS will be introduced, therefore the magnitude of effect is assessed as negligible.

8.6.2.5.2.3 *Impact Significance*

236. Based on the worst-case high sensitivity of habitats and biotopes and the negligible magnitude of effect during the DEP construction phase, the impact is assessed as **minor adverse** significance.

8.6.2.5.3 *SEP in Isolation*

8.6.2.5.3.1 *Sensitivity*

237. The sensitivity of SEP biotopes to INNS is either not sensitive or high according to MarESA, with the highest sensitivity biotopes being A5.133 '*Moerella* spp. with venerid bivalves in infralittoral gravelly sand' and A5.451 Polychaete-rich deep Venus community in offshore mixed sediments, although the latter is an impoverished version of the biotope and therefore its sensitivity is likely to be lower.

8.6.2.5.3.2 *Magnitude of Effect*

238. The risk of spreading INNS will be mitigated by application of the same regulations and guidance as described for DEP above and commitments would be secured in the PEMP which will be agreed prior to the start of construction. Therefore, with mitigations in place it is not expected INNS will be introduced, therefore the magnitude of effect is assessed as negligible.

8.6.2.5.3.3 *Impact Significance*

239. Based on the worst-case high sensitivity of habitats and biotopes and the negligible magnitude of effect during the SEP construction phase, the impact is assessed as **minor adverse** significance.

8.6.2.5.4 *SEP and DEP*

8.6.2.5.4.1 *Sensitivity*

240. The worst-case sensitivity assessment for SEP and DEP remains the same as the sensitivity presented for SEP or DEP in isolation (high), based on the assessment of the most sensitive receptors.

8.6.2.5.4.2 *Magnitude of Effect*

241. Although the number of vessels on site during construction will be greater if SEP and DEP and both developed, either concurrently or sequentially, with mitigation measures in place the magnitude of effect is assessed as the same as for SEP or DEP in isolation, negligible.

8.6.2.5.4.3 *Impact Significance*

242. Based on the worst-case high sensitivity of habitats and biotopes and the negligible magnitude of effect during SEP and DEP construction, the impact is assessed as **minor adverse** significance.

8.6.3 Potential Impacts during Operation

8.6.3.1 Impact 1: Temporary habitat loss / physical disturbance

8.6.3.1.1 SEP and DEP – All Scenarios

243. Temporary habitat loss / physical disturbance will occur during the operational phase of SEP and DEP including cable repairs and reburial, and turbine repairs, potentially requiring deployment of jack-up vessels or vessel anchors. The area disturbed would be extremely small in comparison to during construction (**Table 8-2**). For this impact it is considered that there is no clear difference in the assessment outcomes between the different development scenarios. As such a single assessment is provided that applies to all scenarios.

8.6.3.1.1.1 Sensitivity

244. The sensitivity of the biotopes identified in the SEP and DEP offshore sites has been assessed in relation to MarESA pressures relevant to construction phase temporary habitat loss / physical disturbance, set out in **Table 8-16.**

245. As described in **Section 8.6.2.1**, post-construction monitoring surveys of the SOW and DOW have been undertaken. The results of the surveys suggest that recovery of biotopes is likely within two years, which supports the MarESA sensitivity assessments which are based on high resilience / recovery.

246. A worst-case medium sensitivity was determined for biotopes within the DEP offshore site, and a worst-case high sensitivity for the biotopes in the SEP offshore site. The Scoping Response (The Planning Inspectorate, 2019) requested that potential impacts occurring during maintenance activities on *S. spinulosa* reef that may colonise the cables during the operational phase be assessed (**Table 8-1**). 'A5.611 *S. spinulosa* on stable circalittoral mixed sediment' has been recorded in the SEP and DEP offshore sites but not as reef that qualifies as Annex I habitat. The introduction of stable artificial substrate in the form of external cable protection and turbine foundations may encourage reef formation but would not be considered Annex I habitat as it would not naturally occur at the location. The sensitivity of 'A5.611 *S. spinulosa* on stable circalittoral mixed sediment' to temporary habitat loss and physical disturbance pressures is medium and this is the case for all biotopes relevant to *S. spinulosa* reefs (based on Advice on Operations (AoO) advice on The Wash and North Norfolk Coast SAC 'Subtidal biogenic reefs: Sabellaria spp' feature). As such impacts on *S. spinulosa* reef that may colonise the cables during the operational phase are covered by the general assessment.

8.6.3.1.1.2 Magnitude of Effect

247. The impact will be intermittent, highly localised and temporary. The area of disturbance is considered to be very small in the context of the extent of these benthic habitats present across the wider southern North Sea, and a fraction or the area affected during the construction phase. A discernible, temporary (for part of the project duration) change, over a small area of the receptor is anticipated and, therefore, the magnitude of this effect is considered to be negligible.

8.6.3.1.1.3 Impact Significance

248. Based on the worst-case medium sensitivity of habitats and biotopes and the negligible magnitude of temporary habitat loss/physical disturbance during the SEP and DEP operation phase, the impact is assessed as **minor adverse** significance for SEP or DEP in isolation and SEP and DEP.

8.6.3.1.2 Cromer Shoal Chalk Beds MCZ

249. The magnitude of temporary habitat loss / physical disturbance in the CSCB MCZ during the operation phase will be smaller than during construction. The assessment of significance is consistent with the construction phase assessment (**Section 8.6.2.1**). Based on the worst-case medium sensitivity of habitats and biotopes and the negligible magnitude of temporary habitat loss/physical disturbance, the impact on the CSCB MCZ is assessed as **minor adverse** significance.

8.6.3.2 Impact 2: Permanent habitat loss

250. Habitat loss will occur during the lifetime of SEP and DEP as a result of structures, scour and external cable protection installed on the sea bed. It is currently unknown which structures will be removed or remain *in situ* at the point of decommissioning. Removal of accessible installed components such as the wind turbine components and foundations (above the sea bed level) is expected, however, there is a potential for some structures to be left *in situ* such as external cable protection or scour protection.

251. A Decommissioning Programme will be agreed with the relevant authorities at the point of decommissioning. Therefore, it is currently unknown if habitat loss during the operational phase will be lasting/long term or permanent. As a precautionary approach, habitat loss has been considered as permanent with the exception of where the Applicant has made a commitment to removal on decommissioning, such as within the CSCB MCZ, which is addressed by Impact 3 below and described in **Table 8-4**.

8.6.3.2.1.1 Sensitivity

252. The sensitivity of the biotopes identified in the SEP and DEP offshore sites has been assessed in relation to MarESA pressures relevant to permanent habitat loss (MarESA pressure ‘Physical change to another sea bed type’).

253. It is possible that artificial hard substratum installed in rock habitat areas will be colonised by the same benthic community present before installation, and therefore there would be no long term or permanent loss. However, artificial hard substratum may also differ in character from natural hard substratum, so that replacement of natural surfaces with artificial hard substratum may lead to changes in the biotope through changes in species composition, richness and diversity.

254. The sensitivity of identified habitats and biotopes to habitat loss is summarised in **Table 8-20** below. Further information describing the resistance and resilience of these habitats and biotopes, used to determine sensitivity, is provided in **Appendix 8.6**.

Table 8-20: Habitat and Biotope Sensitivity to Habitat Loss Pressures

Habitat and Biotope	Presence of biotope in the SEP and DEP offshore sites	MarESA sensitivity
		Physical change to another sea bed type
A3/4 Infralittoral / Circalittoral rock and other hard substrata	-	High
A4.232 Polydora sp. tubes on moderately exposed sublittoral soft rock	Not recorded in SEP or DEP however it has been used as a proxy for A3/A4	High
A4.1 Atlantic and Mediterranean high energy circalittoral rock	-	High
A4.134 F. foliacea and colonial ascidians on tide-swept moderately wave-exposed circalittoral rock	Recorded across the SEP survey area on larger pebbles, cobbles and boulders in coarse and mixed sediment areas. An epibiotic overlay of infaunal biotopes. Not recorded in DEP, however likely to be present in the offshore export cable corridor.	High
A4.2 Atlantic and Mediterranean moderate energy circalittoral rock	-	High
A4.231 Piddocks with a sparse associated fauna in sublittoral very soft chalk or clay	Observed at one location within the transect at SS_21 (western corner of the SEP wind farm site). Piddocks could not be confirmed. Not recorded in DEP.	High
A5.1 Sublittoral coarse sediment	-	High
A5.133 'Moerella spp. with venerid bivalves in infralittoral gravelly sand'	Possible A5.133 in the interlink corridor. A5.13 recorded in the offshore export cable corridor.	High
A5.2 Sublittoral sand		High
A5.233 Nephtys cirrosa and Bathyporeia spp. in infralittoral sand	Possible A5.233 recorded in all DEP project areas, and recorded in the SEP offshore export cable corridor.	High
A5.4 Sublittoral mixed sediments	-	High
A5.431 Crepidula fornicata with ascidians and anemones on infralittoral coarse mixed sediment	Possible A5.431 identified across SEP and DEP.	High
A5.451 Polychaete-rich deep Venus community in offshore mixed sediments	Impoverished version or a transition of the biotope A5.451 identified in the SEP offshore survey area. Not identified in the DEP offshore survey area	High
A5.6 Sublittoral biogenic reefs	-	High

Habitat and Biotope	Presence of biotope in the SEP and DEP offshore sites	MarESA sensitivity
		Physical change to another sea bed type
A5.611 *S. spinulosa* on stable circalittoral mixed sediment	Possible A5.611 identified in all SEP project areas. Not identified in the DEP benthic characterisation survey (Fugro, 2020a). However, the SEP benthic characterisation survey (Fugro, 2020b) confirms a mosaic of this biotope with A5.431 in the offshore export cable corridor.	High

255. By definition, the sensitivity of benthic ecology receptors to permanent habitat loss is high. Therefore, in the context of an individual biotope in a spatially distinct area where the biotope is present, the sensitivity is high. However, in the context of the wider community level impacts for these biotopes which are known to be present across the wider area in the southern North Sea, the sensitivity is considered to be medium as the biotope will not be completely removed. Evidence of the presence of these biotopes in this region of the southern North Sea is provided in **Table 8-21** below.

256. Taking into account the sensitivity to this pressure and value of Annex I / UK BAP priority habitat *S. spinulosa* reefs that can be associated with biotope A5.611 and the UK BAP priority habitat 'peat and clay exposures with piddocks' which can be associated with biotope A4.231, these designated habitats will remain as high sensitivity for this MarESA pressure.

Table 8-21: Presence of Biotopes Recorded During the SEP and DEP Benthic Characterisation Survey in Other Locations in the Southern North Sea

Biotope	Records of biotope in the Southern North Sea	Reference
A4.232 *Polydora* sp. tubes on moderately exposed sublittoral soft rock	This biotope is associated with the chalk feature within the CSCB MCZ therefore it is expected that it will be present throughout the MCZ.	Natural England's advice on operations for CSCB MCZ. (Natural England, 2021).
A4.134 *F. foliacea* and colonial ascidians on tide-swept moderately wave-exposed circalittoral rock	This biotope was recorded across the entire survey area on larger pebbles, cobbles and boulders and where coarse and mixed sediments occurred, as an epibiotic overlay of infaunal biotopes. The development will not result in loss of all coarse and mixed sediments therefore this biotope will not be entirely removed due to the areas of permanent habitat loss.	**Appendix 8.1** and **Appendix 8.2**.
A4.231 Piddocks with a sparse associated fauna in sublittoral very soft chalk or clay	This biotope was recorded at only one station (SS_21) however, no piddocks were confirmed, however the clay appeared to have been bored by bivalves. Peat and clay exposures have been recorded inshore of SEP as part of the CSCB MCZ site designation survey. The value of 'peat and clay exposures with piddocks' as a UK BAP priority habitat, and its limited capacity for recoverability is	**Appendix 8.2**. Cefas Cromer Shoal Chalk Beds rMCZ underwater imagery survey (Cefas, 2014).

Biotope	Records of biotope in the Southern North Sea	Reference
	noted and therefore the sensitivity is considered to be high. However, the Applicant has committed to pre-construction surveys (see **Table 8-4**) to identify any potential areas of UK BAP priority 'peat and clay exposures with piddocks' and, if required, micro-site around them. Therefore, there will be no permanent loss of this UK BAP habitat.	EA MCZ verification survey (EA, 2013).
A5.133 'Moerella spp. with venerid bivalves in infralittoral gravelly sand'	This biotope was recorded during the Hornsea Project Three benthic survey in the centre of the former Hornsea Zone and the shallower water of the nearshore section of the Hornsea Project Three offshore cable corridor.	Hornsea Project Three, Environmental Statement Volume 5, Annex 2.1 Benthic Ecology Technical Report (Orsted, 2018).
A5.233 *Nephtys cirrosa* and Bathyporeia spp. in infralittoral sand	This biotope was recorded during the Hornsea Project Three benthic survey in the central part of the former Hornsea Zone, the central part of the Hornsea Project Three array area and six discrete areas along the Hornsea Project Three offshore cable corridor. This biotope was identified throughout the DOW site where the sea bed comprised sand, and within the SOW site.	Hornsea Project Three, Environmental Statement Volume 5, Annex 2.1 Benthic Ecology Technical Report (Orsted, 2018). Dudgeon OWF - Environmental Post Construction Survey (MMT, 2019). Sheringham Shoal Post Construction Monitoring Benthic Survey (Fugro, 2013).
A5.431 *Crepidula fornicata* with ascidians and anemones on infralittoral coarse mixed sediment	Found throughout the SEP and DEP offshore sites at the following stations: SS_03, SS_07, SS_09, SS_10, SS_11, SS_01, SS_18, SS_19, SS_21, SS_23: SS_25; EC_05, EC_10, EC_12; EC_16, EC_17, EC_23, D_01, D_03, D_04, D_05, D_07, D_10, D_11, D_18, D_21, D_26, CC_01, CC_02, CC_04, CC_07, CC_08, CC_09, CC_10, CC_11, CC_13, CC_14, This biotope was also identified in the DOW site.	**Appendix 8.1** and **Appendix 8.2**. Dudgeon OWF - Environmental Post Construction Survey (MMT, 2019).
A5.451 Polychaete-rich deep Venus community in offshore mixed sediments	This biotope was distributed extensively throughout the Hornsea Project Three array area, particularly to the south and northeast. It was also found in the southwest and the central section of the former Hornsea Zone and along much of the Hornsea Project Three offshore cable corridor within approximately 40 km from the shore.	Hornsea Project Three, Environmental Statement Volume 5, Annex 2.1 Benthic Ecology Technical Report (Orsted, 2018).

Biotope	Records of biotope in the Southern North Sea	Reference
A5.611 *S. spinulosa* on stable circalittoral mixed sediment	This biotope was recorded in the Hornsea Project Three offshore wind farm site but predominantly along the offshore cable corridor and particularly in the nearshore. The sensitivity and value of Annex I / UK BAP priority habitat *S. spinulosa* reef is noted and therefore the sensitivity is determined as high. However, the Applicant has committed, if required, to micro-site around any identified Annex I / UK BAP priority habitat *S. spinulosa* reefs (**Table 8-4**). Therefore, there will be no permanent loss of this designated habitat.	Hornsea Project Three, Environmental Statement Volume 5, Annex 2.1 Benthic Ecology Technical Report (Orsted, 2018).

8.6.3.2.2 *DEP in Isolation*

8.6.3.2.2.1 *Magnitude of Effect*

257. The worst-case DEP footprint of permanent infrastructure (which may not be decommissioned) includes scour protection for up to 24 turbines (18MW) with GBS foundations and one OSP with piled jacket foundations and scour protection, unburied cable protection and cable crossings. The maximum area of permanent habitat loss 0.67km^2 (**Table 8-2**). Permanent habitat loss represents 0.65% of the total sea bed area within the DEP wind farm site (excluding offshore temporary works area). Some of this habitat loss would occur along the offshore cable corridors, however areas for the interlink and export cables corridors cannot be accurately defined as they differ depending on the project development scenario, although the proportion of total habitat loss would be smaller across the entire DEP offshore site.

258. Although the effect is permanent, it is over a small proportion of the total benthic ecology resource due to the presence of comparable habitats identified throughout the SEP and DEP offshore survey area, and the wider region, as demonstrated by survey data from SOW, DOW and Hornsea Project Three OWF (RPS, 2018). Therefore, the magnitude of this effect is considered to be low.

8.6.3.2.2.2 *Impact Significance*

259. Based on the worst-case medium sensitivity of biotopes and a low impact magnitude in relation to permanent habitat loss during and potentially after the operational phase, the impact significance is assessed as **minor adverse**.

260. Based on a sensitivity of high for Annex I / UK BAP priority habitat *S. spinulosa* reefs and the UK BAP priority habitat ‘peat and clay exposures with piddocks’ and a low impact magnitude in relation to permanent habitat loss during and potentially after the operational phase, the impact significance is assessed as **moderate adverse**. However, as detailed in **Table 8-4**, if these habitats are identified during pre-construction surveys, they will be avoided, if required, through micro-siting. Taking into account the proposed mitigation measures the residual impact is assessed as **no impact**.

8.6.3.2.3 SEP in Isolation

8.6.3.2.3.1 Magnitude of Effect

261. The worst-case SEP footprint of permanent infrastructure (which may not be decommissioned) includes scour protection for up to 19 turbines (18MW) with GBS foundations and one OSP with piled jacket foundations and scour protection, unburied cable protection and cable crossings. The maximum area of permanent habitat loss 0.50km^2 (**Table 8-2**). Permanent habitat loss represents 0.54% of the total sea bed area within the SEP wind farm site (excluding offshore temporary works area). Some of this habitat loss would occur along the offshore cable corridor however areas for the export cable cannot be accurately defined, although the proportion of total habitat loss would be smaller across the entire SEP offshore site.

262. As for DEP in isolation, although the effect is permanent, it is over a small proportion of the total benthic ecology resource due to the presence of comparable habitats identified throughout the SEP and DEP offshore survey area, and the wider region, as demonstrated by survey data from SOW, DOW and Hornsea Project Three OWF (RPS, 2018). Therefore, the magnitude of this effect is considered low.

8.6.3.2.3.2 Impact Significance

263. Based on the worst-case medium sensitivity of biotopes and a low impact magnitude in relation to permanent habitat loss during and potentially after the operational phase, the impact significance is assessed as **minor adverse**.

264. Based on a sensitivity of high for Annex I / UK BAP priority habitat *S. spinulosa* reefs and the UK BAP priority habitat ‘peat and clay exposures with piddocks’ and a low impact magnitude in relation to permanent habitat loss during and potentially after the operational phase, the impact significance is assessed as **moderate adverse**. However, as detailed in **Table 8-4**, if these habitats are identified during pre-construction surveys, they will be avoided, if required, through micro-siting. Taking into account the proposed mitigation measures, the residual impact is assessed as **no impact**.

8.6.3.2.4 SEP and DEP

8.6.3.2.4.1 Magnitude of Effect

265. The worst-case footprint of permanent SEP and DEP infrastructure includes scour protection for up to 43 turbines (18MW) with GBS foundations, two OSPs withpiled jacket foundations and scour protection, unburied cable protection and cable crossings. The maximum area of permanent habitat loss equals 1.159km^2 (**Table 8-2**). Permanent habitat loss represents 0.59% of the total sea bed area within the SEP and DEP wind farm sites (excluding offshore temporary works area). Some of this habitat loss would occur along the offshore cable corridors, however areas for the interlink and export cable corridors cannot be accurately defined as they differ depending on the project development scenario, although the proportion of total habitat loss would be smaller across the entire SEP and DEP offshore sites.

266. As for SEP or DEP in isolation, although the effect is permanent, it is over a small proportion of the total benthic ecology resource due to the presence of comparable habitats identified throughout the SEP and DEP offshore survey area, and the wider

region, as demonstrated by survey data from SOW, DOW and Hornsea Project Three OWF (RPS, 2018). Therefore, the magnitude of this effect is considered low.

8.6.3.2.4.2 Impact Significance

267. Based on the worst-case scenario of medium sensitivity of biotopes and a low impact magnitude in relation to permanent habitat loss during and potentially after the operational phase of SEP and DEP, the impact significance is assessed as **minor adverse**.

268. Based on a sensitivity of high for Annex I / UK BAP priority habitat *S. spinulosa* reefs and the UK BAP priority habitat 'peat and clay exposures with piddocks' and a low impact magnitude in relation to permanent habitat loss during and potentially after the operational phase, the impact significance is assessed as **moderate adverse**. However, as detailed in **Table 8-4**, if these habitats are identified during pre-construction surveys, they will be avoided, if required, through micro-siting. Taking into account the proposed mitigation measures, the residual impact is assessed as **no impact**.

8.6.3.3 Impact 3: Long term habitat loss

8.6.3.3.1 Cromer Shoal Chalk Beds MCZ

269. As described in **Table 8-2,** external rock bags may be used for cable protection inside the CSCB MCZ, at the offshore export cable HDD exit transition zone and as external cable protection, where necessary, for unburied cables along the offshore export cable route through the MCZ. Rock bags are designed to be removable, and the Applicant has committed to remove offshore export cable protection material within the MCZ at the decommissioning stage (if it is deemed to be required at that time) to avoid permanent impact to MCZ benthic habitats (see **Table 8-4**).

8.6.3.3.1.1 Sensitivity

270. The sensitivity of identified habitats and biotopes to habitat loss is summarised in **Section 8.6.3.2** and **Table 8-20** above. Further information describing the resistance and resilience of these habitats and biotopes, used to determine sensitivity, is provided in **Appendix 8.6**.

271. Artificial hard substratum installed in rock habitat areas may be colonised by the same, or a similar benthic community to that present before installation, thereby reducing the impact. However, the offshore export cable corridor within the CSCB MCZ and in the areas where external cable protection may be installed comprises primarily subtidal sediment habitats. Infralittoral and circalittoral rock and other hard substrata are restricted to the area landward of the HDD exit location with the exception of occasional sublittoral rock biotopes on larger cobbles and boulders in predominantly sediment areas.

272. The sensitivity of habitats and biotopes recorded in the offshore export cable corridor to habitat loss is high. In the context of an individual biotope in a spatially distinct area where the biotope is present the sensitivity is high. However, in the context of the wider community level impacts for these biotopes which are known to be present across the wider area in the southern North Sea, the sensitivity is

considered to be medium. The sensitivity of MCZ habitats can be modified based on their value (**Section 8.4.3.1.2**), but the worst-case sensitivity remains medium.

273. The value of these habitats is considered high as they are within the CSCB MCZ which is a national designation. However, following a review of the MarESA sensitivity it is considered the sensitivity of medium is still applicable despite the value of the habitats, due to their presence outside the MCZ within this region of the southern North Sea (**Table 8-21**). This is with the exception of the Annex I / UK BAP priority habitat *S. spinulosa* reefs and the UK BAP priority habitat 'peat and clay exposures with piddocks' which will remain as high sensitivity for this MarESA pressure.

8.6.3.3.1.2 Magnitude of Effect

274. The worst-case footprint of SEP and DEP cable protection in the MCZ, and therefore the maximum area of long term habitat loss, is 900m^2 for SEP or DEP in isolation or 1,800m^2 for SEP and DEP (**Table 8-2**). The worst-case habitat loss of 1,800m^2 represents 0.0006% of the CSCB MCZ area.

275. If the cable protection in the MCZ were to be decommissioned *in situ* habitat loss would be permanent and the magnitude of effect would be assessed as medium. However, with the commitment to remove this infrastructure at decommissioning (see **Table 8-4**) it is expected that habitat loss will last for the duration of the SEP and/or DEP operational phase (40 years).

276. Therefore, the impact will be temporary (throughout the project duration), but over a minority of the receptor, and the magnitude is assessed as low.

8.6.3.3.1.3 Impact Significance

277. Based on the worst-case medium sensitivity of receptors and a low impact magnitude in relation to long term habitat loss during the operational phase of SEP or DEP in isolation, or SEP and DEP, the impact significance is assessed as **minor adverse**.

278. Based on a sensitivity of high for Annex I / UK BAP priority habitat *S. spinulosa* reefs and the UK BAP priority habitat 'peat and clay exposures with piddocks' and a low impact magnitude in relation to permanent habitat loss during and potentially after the operational phase, the impact significance is assessed as **moderate adverse**. However, as detailed in **Table 8-4**, if these habitats are identified during pre-construction surveys, they will be avoided, if required, through micro-siting. Taking into account the proposed mitigation measures the residual impact is assessed as **no impact**.

8.6.3.4 Impact 4: Temporary increases in SSC and deposition

279. Increases in SSC within the water column, and subsequent deposition onto the sea bed may occur as a result of operation and maintenance activities that require the use of jack-up vessels, as well as cable repair, replacement and reburial activities.

8.6.3.4.1 SEP and DEP – All Scenarios

280. For this impact it is considered that there is no clear difference in the assessment outcomes between the different development scenarios. As such a single assessment is provided that applies to all scenarios.

8.6.3.4.1.1 Sensitivity

281. The sensitivity of the biotopes identified in the SEP and DEP offshore sites has been assessed in relation to MarESA pressures relevant to operational phase temporary increases in SSC and deposition, which has been set out in **Table 8-17**.

282. A worst-case scenario of low sensitivity was determined for biotopes within the DEP offshore site, and a worst-case scenario of medium sensitivity for the biotopes in the SEP offshore site (**Section 8.6.2.2**).

8.6.3.4.1.2 Magnitude of Effect

283. As outlined in **Table 8-2**, operation phase maintenance is likely to require periodic jack-up vessel deployments and cable repair, replacement and reburial activities. Increased SSCs due to jack-up vessels are expected to be very small. Cable repair, replacement and reburial will mobilise larger volumes of sediment, but these will be small in magnitude relative to cable installation during construction. Increases in SSC and deposition as a result of operation phase activities are expected to cause localised and short-term increases in SSC at the point of discharge. Released sediment may then be transported by tidal currents in suspension in the water column. As described in **Section 8.6.2.2**, localised and short-term increases in SSC around the point of discharge are expected with negligible changes in sea bed level due to deposition, and the impact magnitude is considered to be negligible.

8.6.3.4.1.3 Impact Significance

284. The worst-case sensitivity assessment for SEP and DEP is medium based on the most sensitive receptor in the SEP wind farm site (DEP sensitivity is likely to be low). The magnitude of the effect is negligible. Therefore, the impact of increased SSC and deposition during the operational phase of SEP or DEP in isolation, or SEP and DEP, is assessed as **minor adverse** significance.

8.6.3.5 Impact 5: Colonisation of foundations and cable protection

285. The SEP and DEP benthic characterisation survey (**Appendix 8.1** and **8.2**) and habitat mapping study (**Appendix 8.3** and **8.4**) show that most of the sea bed within the ES boundary consists of subtidal soft sediments (**Figure 8.5** and **Figure 8.6**). Therefore, introduction of hard substrate will have a direct effect on benthic ecology by facilitating the establishment of species uncharacteristic of soft sediment habitats.

286. Studies of operational wind farms in the North Sea have found that widespread colonisation of sub-sea surfaces occurs. For example, boulders and mattresses used as cable protection have been found to add habitat complexity and increase heterogeneity of the environment in and around offshore wind farms (Lindeboom *et al*., 2011; Goriup, 2017).

287. Lindeboom *et al*. (2011) demonstrated that at the Egmond aan Zee Offshore Windfarm in Dutch waters, new hard substrate led to the establishment of new faunal communities and new species. During surveys, 33 species were found to have colonised the monopiles and 17 species on the scour protection after two years of monitoring (Lindeboom *et al*. 2011).

288. A study of the FINO 1 Research platform located in the immediate vicinity of the Alpha Ventus, a German Offshore Wind Farm in the North Sea also reported findings of epifaunal communities colonising offshore foundations (Krone *et al*., 2013). *Mytilus edulis* was found to dominate the communities that colonised the offshore foundations. Additionally, the shells of the *M. edulis* were found to provide additional hard substrate for epifauna to colonise (Krone *et al*., 2013).

8.6.3.5.1.1 Sensitivity

289. The most relevant MarESA pressure in relation to the presence of new artificial structures is ‘physical change to another sea bed type’. However, this impact has been assessed in relation to permanent habitat loss, indicating a medium sensitivity due to the limited proportion of the benthic receptors impacted.

290. Although the relevant pressure is the same, the impact itself is different to habitat loss. The presence of hard substrate will increase the structural complexity of the substrata, providing refuge and niche habitats as well as increasing feeding opportunities for a range of larger and more mobile species. The species potentially introduced through artificial reef structures created by the turbine foundations may have indirect and adverse effects through increased predation on, or competition with, neighbouring subtidal sediment species.

291. As any newly introduced substrate would be a change from the existing environment (if not from sandy to hard then from natural to artificial) the impact on any ecological receptors cannot be considered beneficial in ecological terms.

292. Therefore, due to the presence of artificial hard substrate in an area of predominantly sediment habitats, species that colonise the artificial hard substrate would represent a change in biodiversity in the area. However, the change will be limited to the artificial structures themselves, therefore in the context of the wider community level impacts for the biotopes present across the wider area where the same habitats and species are known to be present, the sensitivity is considered to be medium.

8.6.3.5.2 DEP in isolation

8.6.3.5.2.1 Magnitude of Effect

293. The footprint of DEP artificial hard substrate which has a potential to be colonised by benthic fauna has been provided within operation Impact 2: Permanent habitat loss in **Section 8.6.3.2.2** and **Table 8-2**. The habitat area available for colonisation on three dimensional structures will be larger than this footprint.

294. The change of habitat from a sedimentary substrate to hard substrate will result in potential increases in the diversity and biomass of the marine community in the area. However, there is likely to be only a small interaction between the remaining available sea bed and the introduced hard substrate and any interactions would be

highly localised. Relative to the extent of benthic communities in the project area and the wider southern North Sea, which are predominantly associated with sediment habitats, the magnitude of this effect is considered to be low.

8.6.3.5.2.2 Impact Significance

295. The sensitivity assessment for DEP is medium and the magnitude of the effect is low. Therefore, the impact of colonisation of foundations and cable protection during the operational phase of DEP in isolation is assessed as **minor adverse** significance.

8.6.3.5.3 SEP in Isolation

8.6.3.5.3.1 Magnitude of Effect

296. The footprint of SEP artificial hard substrate which has a potential to be colonised by benthic fauna has been provided within operation Impact 2: Permanent habitat loss in **Section 8.6.3.2.3** and **Table 8-2**. The habitat area available for colonisation on three dimensional structures will be larger than this footprint.

297. As for DEP in isolation, relative to the extent of benthic communities in the project area and the wider southern North Sea, which are predominantly associated with sediment habitats, the magnitude of this effect is considered to be low.

8.6.3.5.3.2 Impact Significance

298. The sensitivity assessment for SEP is medium and the magnitude of the effect is low. Therefore, the impact of colonisation of foundations and cable protection during the operational phase of SEP in isolation is assessed as **minor adverse** significance.

8.6.3.5.4 SEP and DEP

8.6.3.5.4.1 Magnitude of Effect

299. The worst-case footprint of SEP and DEP artificial hard substrate which has a potential to be colonised by benthic fauna has been provided within operation Impact 2: Permanent habitat loss in **Section 8.6.3.2.4** and **Table 8-2**. The habitat area available for colonisation on three dimensional structures will be larger than this footprint.

300. As for SEP or DEP in isolation, relative to the extent of benthic communities in the projects area and the wider southern North Sea, which are predominantly associated with sediment habitats, the magnitude of this effect is still considered to be low.

8.6.3.5.4.2 Impact Significance

301. The sensitivity assessment for SEP and DEP is medium, and the magnitude of the effect is low. Therefore, the impact of colonisation of foundations and cable protection during the operational phase of SEP and DEP is assessed as **minor adverse** significance.

8.6.3.5.5 Cromer Shoal Chalk Beds MCZ

302. Cable protection in the CSCB MCZ will be colonised by a different benthic community to the primarily soft sediment communities present prior to installation. As for the wider SEP and DEP offshore sites, the sensitivity is considered to be medium. The sensitivity of MCZ habitats can be modified based on their value (**Section 8.4.3.1.2**), but the worst-case sensitivity remains medium.

303. The maximum footprint of external cable protection is summarised in **Table 8-2** under operation Impact: Long term habitat loss. The magnitude of effect is still considered to be low given the extent of benthic communities in the projects area, the MCZ and the wider southern North Sea.

304. Based on the worst-case medium sensitivity of habitats and biotopes and the low magnitude of effect, the impact on the CSCB MCZ is assessed as **minor adverse** significance.

8.6.3.6 Impact 6: Underwater noise and vibration

305. Underwater noise and vibration as a result of operation and maintenance activities are largely associated with operational wind turbines, vessel activities and maintenance including cable repair, replacement and reburial (**Table 8-2**).

8.6.3.6.1 SEP and DEP – All Scenarios

306. For this impact it is considered that there is no clear difference in the assessment outcomes between the different development scenarios. As such a single assessment is provided that applies to all scenarios

8.6.3.6.1.1 Sensitivity

307. As described in **Section 8.6.2.4**, evidence suggests that some benthic species perceive and react to noise, however the MarESA sensitivity assessment for the biotopes recorded within the SEP and DEP offshore survey areas is that they are either ‘not sensitive’ or that noise impacts are ‘not relevant’ (**Table 8-18**). ‘Not relevant’ is recorded where the evidence suggests that there is no direct interaction between the pressure and the habitat (biotope) or species. Therefore, the sensitivity of benthic biotopes and species to underwater noise and vibration is considered to be negligible.

8.6.3.6.1.2 Magnitude of Effect

308. As described in **Section 8.6.2.4** operational activities such as vessel activity are unlikely to have a significant effect on benthic ecology as the benthos in this area is likely to be habituated to ambient noise such as that created by shipping. Additionally, the magnitude of noise and vibration effect during construction piling and UXO clearance is much greater than from operation phase sources, therefore it is considered any operational noise and vibration impacts will be negligible.

8.6.3.6.1.3 Impact Significance

309. The sensitivity of benthic ecology receptors identified in the SEP and DEP offshore sites to underwater noise and vibration is negligible, and the magnitude of the effect is negligible. Therefore, the impact of underwater noise and vibration during the

operational phase of SEP or DEP in isolation, or SEP and DEP, is assessed as **negligible adverse** significance.

8.6.3.7 Impact 7: Invasive Non Native Species

310. Artificial hard substrates introduced by SEP and DEP including foundations, scour and cable protection could act as potential 'stepping stones' or vectors for INNS, as well as supporting species non-native to otherwise soft substrate habitats (the latter considered under operation Impact 5).

311. The primary pathway for the potential introduction of INNS is from the use of vessels and infrastructure that have originated from outwith the North Sea and Northeast Atlantic region, particularly from regions that are ecologically distinct from the southern North Sea, as discussed in **Section 8.6.2.5** for construction. Construction phase mitigation measures will be applied to vessel activities and the introduction of materials throughout the operational phase of the Projects.

312. The vector capability of introduced artificial hard substrate would be most pronounced during the operational lifetime of SEP and DEP when the likelihood of INNS establishing and extending their range would be greatest. Depending on the species, there is potential for secondary ecological changes to occur where there is competition between the non-native species and the native community. This is evidenced by the presence of the slipper limpet *C. fornicata* in SEP and DEP benthic surveys, a characterising species in the biotope A5.431 *Crepidula fornicata* with ascidians and anemones on infralittoral coarse mixed sediment, identified in the SEP and DEP wind farm sites. The slipper limpet was accidentally introduced with Pacific oyster, imported for shellfish aquaculture, and has since colonised extensive areas of the North Sea.

8.6.3.7.1 SEP and DEP – All Scenarios

313. For this impact it is considered that there is no clear difference in the assessment outcomes between the different development scenarios. As such a single assessment is provided that applies to all scenarios.

8.6.3.7.1.1 Sensitivity

314. As discussed in **Section 8.6.2.5** the sensitivity of SEP and DEP biotopes to INNS is either not sensitive or high according to MarESA, with the highest sensitivity biotopes being A5.133 '*Moerella* spp. with venerid bivalves in infralittoral gravelly sand' and A5.451 Polychaete-rich deep Venus community in offshore mixed sediments, although the latter is an impoverished version of the biotope and therefore its sensitivity is likely to be lower.

8.6.3.7.1.2 Magnitude of Effect

315. As discussed in construction **Section 8.6.2.5**, the risk of spreading INNS will be mitigated by application of regulations and guidance secured in the PEMP which will be agreed prior to the start of construction. Therefore, with mitigations in place it is not expected INNS will be introduced, or become established and spread.

316. Through the application of the mitigation measures secured through the PEMP, it is not expected that INNS will be introduced, and the risk of introduction to the southern

North Sea is not considered to be significantly increased as a result of SEP and DEP. The magnitude of effect is therefore considered to be negligible.

8.6.3.7.1.3 Impact Significance

317. Based on the worst-case scenario of high sensitivity of habitats and biotopes and a negligible magnitude of effect, the impact of the introduction of INNS has been assessed as **minor adverse** significance.

8.6.3.7.2 Cromer Shoal Chalk Beds MCZ

318. The sensitivity of biotopes identified in the SEP and DEP offshore benthic survey area is summarised in **Table 8-19**. Of the biotopes recorded in the offshore export cable corridor inside the CSCB MCZ, sensitivity to INNS ranges for 'not sensitive' or 'not relevant'. However, due to the lack of information about sensitivity to INNS, a precautionary approach has been taken and a sensitivity of low has been assigned.

319. With adherence to the biosecurity measures outlined in **Section 8.6.2.5** it is not expected that INNS will be introduced by SEP and / or DEP or have the ability to become established or spread. therefore, the magnitude of effect is considered to be negligible. However, given the potential sensitivity of benthic receptors to INNS impacts, the impact significance has been assessed as **minor adverse**.

8.6.4 Potential Impacts during Decommissioning

320. The scope of the decommissioning works would most likely involve removal of the accessible installed components. This is outlined in **Chapter 4 Project Description** and the detail would be agreed with the relevant authorities at the time of decommissioning. Offshore, this is likely to include removal of all the wind turbine components, part of the foundations (those above sea bed level), removal of some or all of the infield cables, interlink cables, and export cables. Scour and cable protection would likely be left *in situ,* other than in the MCZ where cable protection will be removed.

321. During the decommissioning phase, there is potential for wind turbine foundation and cable removal activities to cause effects that would be comparable to those identified for the construction phase (construction phase impacts 1, 2, 3, 4, and 5) and the operational phase (operational phase impacts 1, 4, and 6). These impacts are:

- Temporary habitat loss / physical disturbance
- Temporary increases in SSC and deposition
- Re-mobilisation of contaminated sediments
- Underwater noise and vibration
- Invasive Non Native Species

322. Permanent habitat loss as a result of infrastructure decommissioned *in situ* is assessed and as operational impact (**Section 8.6.3.2**) because the impact begins from the beginning of the operation phase when wind farm infrastructure in in place. The same is true for colonisation of foundations and cable protection (**Section 8.6.3.5)**.

323. The magnitude of decommissioning effects will be comparable to or less than those identified for the construction and operational phases. Accordingly, given the construction and operational phase assessments concluded no significant residual impacts (i.e. **minor adverse** impact or lower) for benthic ecology receptors, it is anticipated that the same would be valid for the decommissioning phase regardless of the final decommissioning methodologies. The magnitude of effects will be the same for SEP or DEP in isolation and for SEP and DEP.

324. The significance of impacts on other related receptors is addressed within relevant chapters of this ES (**Chapter 6 Marine Geology, Oceanography and Physical Processes**, **Chapter 7 Marine Water and Sediment Quality**, **Chapter 9 Fish and Shellfish Ecology**, **Chapter 10 Marine Mammal Ecology** and **Chapter 11 Offshore Ornithology**).

8.7 Cumulative Impacts

8.7.1 Identification of Potential Cumulative Impacts

325. The first step in the cumulative assessment is the identification of which residual impacts have the potential for a cumulative impact with other plans, projects and activities (described as 'impact screening'). This information is set out in **Table 8-22** below, together with a consideration of the confidence in the data that is available to inform a detailed assessment and the associated rationale. Only potential impacts assessed in **Section 8.6** as negligible or above are included in the CIA (i.e. those assessed as 'no impact' are not taken forward as there is no potential for them to contribute to a cumulative impact).

Table 8-22: Potential Cumulative Impacts (Impact Screening)

Impact	Potential for Cumulative Impact	Data Confidence	Rationale
Construction			
Impact 1: Temporary habitat loss / physical disturbance	No	High	Impacts occur at discrete locations for a time-limited duration and are local in nature with a negligible impact magnitude. This applies to SEP or DEP in isolation, and SEP and DEP.
Impact 2: Temporary increases in SSC and deposition	No	High	Increases in SSC are expected to be localised at the point of discharge and short-term. The small quantities of fine-sediment present may be transported up to approximately 1km, however it will be widely and rapidly dispersed. In most cases the elevation of SSC is expected to be lower than concentrations that would develop in the water column during storm conditions.
Impact 4: Underwater noise and vibration	No	High	The sensitivity of benthic ecology receptors to underwater noise and vibration is considered to be negligible and underwater noise effects will be localised, with the highest magnitude noise sources being short term and intermittent.

Impact	Potential for Cumulative Impact	Data Confidence	Rationale
Impact 5: INNS	No	High	Biosecurity measures will be used to prevent the introduction of INNS. The risk of introduction to the southern North Sea is not considered to be significantly increased as a result of SEP and DEP.
Operation			
Impact 1: Temporary habitat loss / physical disturbance	No	High	Impacts occur at discrete locations for a time-limited duration and are local in nature with a low impact magnitude. This applies to SEP or DEP in isolation, and SEP and DEP.
Impact 2: Permanent habitat loss	Yes	High	Additive habitat loss across the region. Other developments in the region have the potential to have cumulative habitat loss impacts.
Impact 3: Long term habitat loss	Yes	High	Additive temporary but long term habitat loss across the region, including on the protected features of designated sites e.g. CSCB MCZ. Although habitat loss in the MCZ will not be permanent, there will be a cumulative impact over the operational phase of SEP and DEP.
Impact 4: Temporary increases in SSC and deposition	No	High	Impacts occur at discrete locations for a time-limited duration and are local in nature with a negligible impact magnitude. This applies to SEP or DEP in isolation, and SEP and DEP.
Impact 5: Colonisation of foundations and cable protection	No	High	The effects of recolonisation would be highly localised on the introduced structures and therefore there is no potential cumulative impact. Embedded mitigation is proposed for SEP and DEP to avoid the spread of INNS and it is expected that other projects would follow best practice.
Impact 6: Underwater noise and vibration	No	High	The sensitivity of benthic ecology receptors to underwater noise and vibration is considered to be negligible and underwater noise effects will be localised and of negligible magnitude.
Impact 7: INNS	No	Low	Artificial hard substrates on the sea bed such as foundations, scour protection and cable protection have the potential to act as 'stepping stones' enabling the spread of INNS. Although SEP and DEP will result in additional artificial hard substrates on the sea bed, it is not considered it will result in a cumulative effect of enabling further transmission of INNS. Prior to the construction of SEP and DEP there is already an interconnectedness of the artificial hard structures surrounding SEP and DEP. For example, SOW and DOW are directly adjacent to SEP and DEP, Triton Knoll and Race Bank OWFs are

Impact	Potential for Cumulative Impact	Data Confidence	Rationale
			approximately 10km away and Norfolk Vanguard and Scroby Sands OWFs are approximately 60km away. Given benthic invertebrate larvae can disperse over distances of tens to over a hundred kilometres (Álvarez-Noriega, 2020) the addition of artificial hard substrates at SEP and DEP will not materially increase the stepping stone potential of INNS due to all of the surrounding hard substrates already present on the sea bed. The potential for a stepping stone effect of INNS from the existing hard structures already occurs and no material increase in stepping stone potential will occur with the presence of SEP and DEP. Therefore, any cumulative impact would be negligible and therefore this is not considered further within the cumulative assessment.
Decommissioning			
Impact 1: Temporary habitat loss / physical disturbance	No	High	Impacts occur at discrete locations for a time-limited duration and are local in nature with a negligible impact magnitude. This applies to SEP or DEP in isolation, and SEP and DEP.
Impact 2: Temporary increases in SSC and deposition	No	High	
Impact 4: Underwater noise and vibration	No	High	The sensitivity of benthic ecology receptors to underwater noise and vibration is considered to be negligible and underwater noise effects will be localised, with the highest magnitude noise sources being short term and intermittent.
Impact 5: INNS	No	High	Biosecurity measures will be used to prevent the introduction of INNS. The risk of introduction to the southern North Sea is not considered to be significantly increased as a result of SEP and DEP.

8.7.2 Other Plans, Projects and Activities

326. The second step in the cumulative assessment is the identification of the other plans, projects and activities that may result in cumulative impacts for inclusion in the CIA (described as 'project screening'). This information is set out in **Table 8-23** below, together with a consideration of the relevant details of each, including current status (e.g. under construction), planned construction period, closest distance to SEP and DEP, status of available data and rationale for including or excluding from the assessment.

327. The project screening has been informed by the development of a CIA Project List which forms an exhaustive list of plans, projects and activities in a very large study

area relevant to SEP and DEP. The list has been appraised, based on the confidence in being able to undertake an assessment from the information and data available, enabling individual plans, projects and activities to be screened in or out.

328. The only impact to be screened into the CIA is permanent/long term habitat loss which is a direct impact limited to the spatial footprint of the SEP and DEP infrastructure. Other projects with potential to have cumulative habitat loss impacts within the boundary of the CSCB MCZ have been included.

329. In order to identify which plans, projects and activities to include in the CIA a radius of 10km around the SEP and DEP project boundaries has been used. A radius of 10km also follows the approach used in the **Stage 1 CSCB MCZA** (document reference 5.6) and the **RIAA** (document reference 5.4) screening exercises.

Table 8-23: Planned Projects Within 10km of SEP or DEP

Project	Status	Construction Period	Closest Distance from the Project (km)	Confidence in Data	Included in the CIA (Y/N)	Rationale
DOW	Operational	N/A	0 (cable corridor) 0 (array area)	High	N	SOW and DOW are operational. Impacts from operation and maintenance activities are considered to be non-significant for both projects, as shown in the environmental assessments accompanying the marine licence applications for operational and maintenance (O&M) activities: • Sheringham O&M generation (MLA/2020/00095) • Sheringham O&M Transmission (MLA/2020/00096) • Dudgeon O&M generation (MLA/2018/00511 • Dudgeon O&M Transmission (MLA/2019/00049) Indirect impacts to SEP and DEP are considered to be small scale and localised, meaning there is no pathway for interaction with SOW and DOW.
SOW	Operational	N/A	0 (cable corridor) 0 (array area)	High	N	
EIFCA Byelaw 12 Inshore trawling restriction and Byelaw	Active	N/A	0 (cable corridor) 9 (array area)	High	N	The restrictions on the use of bottom towed gear have the potential to be beneficial to benthic ecology receptors with potential to be impacted by SEP and DEP. Therefore, there is no potential for cumulative adverse impacts. It should be noted that Restricted

Project	Status	Construction Period	Closest Distance from the Project (km)	Confidence in Data	Included in the CIA (Y/N)	Rationale
15 Towed gear restriction for bivalve molluscs						area 35 is still not active however this would not change the conclusion of no cumulative impacts.
EIFCA Restricted area 35 (closed to bottom towed gear)	Active	N/A	0 (cable corridor) 6 (array area)	High	N	
Weybourne Beck outfall to Walcott coastal frontage – Maintenance works	Active	Unknown (open licence until 3rd July 2028)	0 (cable corridor) 15 (array area)	High	N	Maintenance works and project impacts will not interact because the nearest marine components of the projects are the HDD exit pits located approximately 1km offshore.
Hornsea Project Three OWF	Consented	2023-2031 (offshore export cable construction 2026-2027, possibly also 2030-2031)	0 (cable corridor) 83 (array area)	High	Y	The potential for cumulative impacts are in relation to the Hornsea Project Three offshore export cables only, as the OWF area is 80km away at its closest point.
Blythe Hub Development	Installed	Approved in 2020 (subject to subsequent	1 (array area) (4 cable corridor)	High	N	First gas is expected in 2022, therefore the project will be operational before SEP and DEP construction begins in 2025 at the

Project	Status	Construction Period	Closest Distance from the Project (km)	Confidence in Data	Included in the CIA (Y/N)	Rationale
		permit applications) and first gas is expected in 2022.				earliest. Given all impacts were considered not significant and are local in nature it is considered there is no impact pathway for interaction between the two projects.
Sheringham lifeboat station – maintenance works	Active	Unknown (open licence until 31st May 2027)	2 (cable corridor) 15 (array area)	High	N	Maintenance works and project impacts will not interact because the nearest marine components of the projects are the HDD exit pits located approximately 1km offshore.
Race Bank Offshore Wind Farm	Active	Operational	9 (array area) 15 (cable corridor)	High	N	The Applicant and Race Bank OWF concluded non-significant impacts due to long term and permanent habitat loss. As detailed in **Table 8-4**, if potentially sensitive benthic habitats are identified during pre-construction surveys, they will be avoided, if required, through micro-siting. Race Bank OWF committed to micro siting around cobble reefs and *S. spinulosa* reef dominant habitats. Given both projects have committed to avoid sensitive habitats there is not expected to be a cumulative impact due to permanent or long term habitat loss.
Race Bank Offshore Wind Farm Operation and	Active	Marine licence (L/2018/00214) granted. Valid 24th October	9 (array area) 15 (cable corridor)	High	N	Operational and maintenance activities will not cause long term or permanent habitat loss therefore there is no potential for cumulative impacts with SEP or DEP.

Project	Status	Construction Period	Closest Distance from the Project (km)	Confidence in Data	Included in the CIA (Y/N)	Rationale
Maintenance for non-cable activities - Generator assets		2018-31st May 2043.				
Sustainable Seaweed Ltd Seaweed Farm	Application on hold	N/A	1.5 (array area) 8 (cable corridor)	Low	N	Not defined in sufficient detail within the public domain to enable a meaningful assessment.

8.7.3 Assessment of Cumulative Impacts

8.7.3.1 Cumulative Impact 1: Permanent habitat loss

330. As discussed in **Section 8.6.3.2**, the sensitivity of benthic habitats and biotopes to habitat loss is considered to be medium. The Hornsea Project Three OWF will result in a permanent loss of approximately 3.6km^2 of habitat (RPS, 2018). SEP and DEP will result in a permanent loss of up to 0.87km^2 of sea bed habitat. Although the cumulative area of permanent habitat loss is considerably larger than for SEP or DEP in isolation or SEP and DEP, given the small scale of habitat loss in the context of the extent of impacted habitats in the wider southern North Sea the magnitude of the cumulative effect remains low. Therefore, the impact of cumulative habitat loss is assessed as minor adverse significance.

8.7.3.2 Cumulative Impact 2: Long term habitat loss

331. As discussed in **Section 8.6.3.3** the sensitivity of benthic habitats and biotopes to habitat loss is considered to be medium. The Hornsea Project Three offshore export cables will, like the SEP and DEP offshore export cables, route through the CSCB MCZ. Construction of Hornsea Project Three will result in up to 2,940m^2 of cable protection in the CSCB MCZ within an area identified as part of the designated Subtidal Sand broadscale feature. This equates to approximately 0.016% of the extent of this MCZ feature and 0.0009% of the total MCZ area (RPS, 2020). The developer, Orsted, has committed to remove this cable protection at the decommissioning stage at the end of the operational life of the project (approximately 35 years). Similarly, and as discussed in **Section 8.6.3.3**, the Applicant has committed to remove SEP and DEP cable protection in the CSCB MCZ, totalling up to 1,800m^2. The locations of cable protection are not known at this time so the MCZ designated habitat features and the percentage of their estimated extent that will be lost is not known. However, as a worst-case up to 0.0006% of the total MCZ area could be impacted by long term habitat loss as a result of SEP and DEP.

332. Together, cumulative long term habitat loss from Hornsea Project Three and SEP and DEP represents less than 0.0015% of the MCZ. Although, with the addition of Hornsea Project Three impacts, the cumulative area of long term habitat loss is larger than for SEP or DEP in isolation or SEP and DEP, given the small scale of habitat loss in the context of the extent of impacted habitats in the CSCB MCZ and the wider southern North Sea, the magnitude of the cumulative effect remains low.

333. Therefore, the impact of cumulative habitat loss is assessed as **minor adverse** significance. An assessment of potential impacts on the CSCB MCZ with an assessment of implications for achieving the site's conservation objectives is included in the SEP and DEP **Stage 1 CSCB MCZA Report** (document reference 5.6).

8.8 Transboundary Impacts

334. Transboundary impacts for benthic ecology have been scoped out of the assessment in line with the recommendation of the Planning Inspectorate in the Scoping Opinion (Planning Inspectorate, 2019) with the exception of the

transmission potential for INNS during the operational phase following the advice from the MMO on the PEIR (**Table 8-1**, **Section 8.2**).

335. Transboundary impacts have largely been scoped out because potential impacts on benthic ecology are localised in nature, being restricted to the project boundaries and immediate surrounding area (see **Section 8.6**). SEP and DEP are a minimum of 187km from any international territory boundary.

336. The risk of spreading INNS e.g. in vessel ballast water or as biofouling on the hulls of vessels will be mitigated by employing biosecurity measures in accordance with the following relevant regulations and guidance:

- International Convention for the Prevention of Pollution from Ships (MARPOL). The MARPOL sets out appropriate vessel maintenance;
- The Environmental Damage (Prevention and Remediation) (England) Regulations 2015, which set out a polluter pays principle where the operators who cause a risk of significant damage or cause significant damage to land, water or biodiversity will have the responsibility to prevent damage occurring, or if the damage does occur will have the duty to reinstate the environment to the original condition; and
- The International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM Convention), which provide global regulations to control the transfer of potentially invasive species.

337. These commitments would be secured in the Project Environmental Management Plan (PEMP) (in accordance with the **Outline PEMP** (document reference 9.10) submitted with the DCO application) which will be agreed prior to the start of construction. Therefore, no detectable transboundary impacts from the spread of INNS from vessels operating at SEP and DEP are expected.

338. With regards to the potential for SEP and DEP introduced artificial hard substrates acting as ‘stepping stones’ enabling the spread of INNS, it is known INNS can spread tens to over a hundred kilometres away (Álvarez-Noriega, 2020), however given SEP and DEP are a minimum of 187km away from any international territory boundary it is not expected any INNS from SEP and DEP specifically would pass over a territorial boundary and any potential impact occurring from this would be so small as to be undetectable when considered against natural variation.

339. There is the consideration of the stepping stone potential from SEP and DEP to other artificial structures which could then lead to a transboundary impact. However, as stated in **Section 8.7.1**, given SEP and DEP are surrounded by nearby artificial hard substrates such as from SOW and DOW, Triton Knoll, Race Bank, Norfolk Vanguard and Scroby Sands OWFs, the potential for transboundary impacts from the spread of INNS between artificial hard substrates is already present and the addition of more artificial hard substrate will not materially increase that spreading potential. Therefore, no detectable transboundary impacts from the spread of INNS from SEP and DEP introduced artificial hard substrates are expected.

8.9 Inter-relationships

340. **Table 8-24** describes the inter-relationships between impacts discussed in this chapter and those discussed in other chapters. All of the identified inter-relationships have been considered in the relevant chapters, as indicated below.

Table 8-24: Benthic Ecology Inter-Relationships

Topic and description	Related chapter	Where addressed in this chapter	Rationale
Construction			
Fish and Shellfish – edible crabs, prey resources, nursery and spawning ground	**Chapter 9 Fish and Shellfish Ecology**	This chapter informs **Chapter 8 Benthic Ecology**	The benthic environment represents a habitat for many fish and shellfish species. Additionally, a number of benthic species are prey for fish and shellfish. Therefore, impacts on benthic ecology can lead to in-direct impacts on fish and shellfish.
Suspended sediments and deposition	**Chapter 6 Marine Geology, Oceanography and Physical Processes**	Impacts as a result of suspended sediments and deposition are assessed in **Section 8.6.2.2**	Changes in suspended sediment concentrations due to SEP and DEP are assessed in **Chapter 6 Marine Geology, Oceanography and Physical Processes**. Changes in suspended sediment concentrations and associated sediment deposition could have potential impacts on benthic habitats and species.
Re-mobilisation of contaminated sediments	**Chapter 7 Marine Water and Sediment Quality**	Re-mobilisation of contaminated sediments during construction is assessed in **Section 8.6.2.3**	**Chapter 7 Marine Water and Sediment Quality** provides an assessment of the potential for contaminants to be present in the study area. Re-mobilisation of contaminated sediments and associated deposition could have potential impacts on benthic habitats and species
Operation			
Fish and Shellfish – edible crabs, prey resources, nursery and spawning ground	**Chapter 9 Fish and Shellfish Ecology**	This chapter informs **Chapter 8 Benthic Ecology**	The benthic environment represents a habitat for many fish and shellfish species. Additionally, a number of benthic species are prey for fish and shellfish. Therefore, impacts on benthic ecology can lead to in-direct impacts on fish and shellfish.
Suspended sediments and	**Chapter 6 Marine Geology,**	Impacts as a result of suspended sediments	Changes in suspended sediment concentrations due

Topic and description	Related chapter	Where addressed in this chapter	Rationale
deposition	Oceanography and Physical Processes	and deposition are assessed in Section 8.6.3.3	to SEP and DEP are assessed in Chapter 6 Marine Geology, Oceanography and Physical Processes. Changes in suspended sediment concentrations and associated sediment deposition could have potential impacts on benthic habitats and species.
Decommissioning			
Fish and Shellfish – edible crabs, prey resources, nursery and spawning ground	Chapter 9 Fish and Shellfish Ecology	This chapter informs Chapter 10 Benthic Ecology	The benthic environment represents a habitat for many fish and shellfish species. Additionally, a number of benthic species are prey for fish and shellfish. Therefore, impacts on benthic ecology can lead to in-direct impacts on fish and shellfish.
Suspended sediments and deposition	Chapter 6 Marine Geology, Oceanography and Physical Processes	Impacts as a result of suspended sediments and deposition are assessed in Section 8.6.2.2	Changes in suspended sediment concentrations due to SEP and DEP assessed in Chapter 6 Marine Geology, Oceanography and Physical Processes. Changes in suspended sediment concentrations and associated sediment deposition could have potential impacts on benthic habitats and species.

8.10 Interactions

341. The impacts identified and assessed in this chapter have the potential to interact with each other. The areas of potential interaction between impacts are presented in **Table 8-25**. This provides a screening tool for the identification of which impacts have the potential to interact, accounting for the assessment outcomes presented in **Section 8.6**. **Table 8-26** then provides an assessment for each receptor (or receptor group) as related to these impact/s.

342. The impacts are first assessed relative to each development phase ('phase assessment', i.e. construction, operation or decommissioning) to see if (for example) multiple construction impacts affecting the same receptor could increase the level of impact upon that receptor. Following this, a 'lifetime assessment' is undertaken which considers the potential for impacts to affect receptors across all development phases.

343. None of the potential interactions identified with respect to benthic ecology are expected to result in a synergistic or greater impact than those assessed in **Section 8.6**.

Table 8-25: Interactions Between Impacts

Potential Interaction between Impacts					
Construction					
	Impact 1: Temporary habitat loss / physical disturbance	Impact 2: Temporary increases in SSC and deposition	Impact 3: Re-mobilisation of contaminated sediments	Impact 4: Underwater noise and vibration	Impact 5: INNS
Impact 1: Temporary habitat loss / physical disturbance	-	Yes	No	No	No
Impact 2: Temporary increases in SSC and deposition	Yes	-	No	No	No
Impact 3: Re-mobilisation of contaminated sediments	No	No	-	No	No
Impact 4: Underwater noise and vibration	No	No	No	-	No
Impact 5: Invasive non-	No	No	No	No	-

Potential Interaction between Impacts							
native species							
Operation							
	Impact 1: Temporary habitat loss / physical disturbance	Impact 2: Permanent habitat loss	Impact 3: Long term habitat loss	Impact 4: Temporary increases in SSC and deposition	Impact 5: Colonisation of foundations and cable protection	Impact 6: Underwater noise and vibration	Impact 7: INNS
Impact 1: Temporary habitat loss / physical disturbance	-	Yes	Yes	No	Yes	No	Yes
Impact 2: Permanent habitat loss	Yes	-	Yes	No	Yes	No	Yes
Impact 3: Long term habitat loss	Yes	Yes	-	No	No	No	Yes
Impact 4: Temporary increases in SSC and deposition	No	No	No	-	No	No	No
Impact 5: Colonisation of foundations and cable protection	Yes	Yes	No	No	-	No	Yes

Potential Interaction between Impacts							
Impact 6: Underwater noise and vibration	No	No	No	No	No	-	No
Impact 7: INNS	Yes	Yes	Yes	No	Yes	No	-
Decommissioning							
The magnitude of decommissioning effects will be comparable to or less than those identified for the construction and operational phases.							

Table 8-26: Interaction Between Impacts – Phase and Lifetime Assessment

	Highest significance level				
Receptor	**Construction**	**Operation**	**Decommissioning**	**Phase assessment**	**Lifetime assessment**
Benthic habitats and biotopes	Minor adverse	Minor adverse	Minor adverse	No greater than individually assessed impacts: • Permanent and long term habitat loss during operation increase the potential for interactions with other impacts assessed for that phase. • However, all potential impacts are non-significant (minor adverse or less) and localised in nature, being restricted to the project boundaries and immediate surrounding area. The majority of impacts are also temporary in nature. Together, these factors limit the potential for different impacts to interact within each phase. • As a result, none of the potential interactions identified with respect to benthic ecology are expected to result in a synergistic or greater impact than those already assessed.	No greater than individually assessed impacts: • As with the phase assessment, all potential impacts are non-significant and localised in nature, limiting the potential for different impacts to interact across the different phases. • Impacts from construction and decommissioning are temporary in nature, limiting their potential to result in a synergistic or greater impact with those considered in other phases.

8.11 Potential Monitoring Requirements

344. Monitoring requirements are described in the **Offshore IPMP** (document reference 9.5) submitted alongside the DCO application and further developed and agreed with stakeholders prior to construction based on the **Offshore IPMP** and taking account of the final detailed design of the Projects.

345. As described in this chapter, a large amount of geophysical and benthic ecology monitoring information is available from the existing SOW and DOW, much of which will be highly relevant to SEP and DEP given their close proximity and the similarity of the developments. The Applicant intends to focus any further monitoring requirements on addressing any remaining areas of uncertainty and on those features of greatest sensitivity (e.g. the MCZ and any identified sensitive benthic habitats) which is reflected in the **Offshore IPMP**.

8.12 Assessment Summary

346. This chapter has provided a characterisation of the existing environment for benthic ecology based on both existing data and extensive site specific survey data.

347. Sea bed sediments across the SEP and DEP offshore sites are dominated by sands and gravels, with the corresponding benthic communities recorded considered to be typical of sandy and gravelly sediments within the southern North Sea. Benthic habitat maps produced using the site specific geophysical and benthic sample data show a range of EUNIS Level 3 sublittoral habitats and their associated biotopes including coarse sediment, sand, mixed sediment and biogenic reefs. No Annex I reef (biogenic or geogenic) was identified by the surveys, with the possible exception of the nearshore area of outcropping chalk, however this area will be completely avoided through the use of long HDD from the landfall which will exit in an area identified as sand within the benthic characterisation surveys.

348. The assessment has established that there will be some minor adverse residual impacts during the construction, operation and decommissioning phases of SEP and DEP. Impacts are generally localised in nature, being restricted to the project boundaries and immediate surrounding area.

349. A summary of the impact assessment for benthic ecology is provided in **Table 8-27**. It should be noted that all impact magnitudes and significance conclusions are the same when SEP or DEP are built in isolation or when both SEP and DEP are both built.

Table 8-27: Summary of Potential Impacts Benthic Ecology

Potential impact	Receptor	Sensitivity	Magnitude	Pre-mitigation impact	Mitigation measures proposed	Residual impact	Cumulative Residual Impact
Construction							
Impact 1: Temporary habitat loss / physical disturbance	Benthic habitats and species within the benthic ecology study area.	Medium	Low	Minor adverse impact	N/A	Minor adverse impact	Minor adverse impact
	Annex I and UK BAP priority habitats with the potential to be present in the benthic ecology study area.	High	Low	Moderate adverse impact	Micro-siting around Annex I and UK BAP priority habitats (**Table 8-4**)	No impact	No impact
Impact 2: Temporary increases in SSC and deposition	Benthic habitats and species within the benthic ecology study area.	Medium	Negligible	Minor adverse impact	N/A	Minor adverse impact	Minor adverse impact
Impact 3: Re-mobilisation of contaminated sediments	Benthic habitats and species within the benthic ecology study area.	N/A	N/A	No impact	N/A	No impact	No impact
Impact 4: Underwater noise and vibration	Benthic habitats and species within the benthic ecology study area.	Negligible	Negligible	Negligible adverse impact	N/A	Negligible adverse impact	Negligible adverse impact
Impact 5: INNS	Benthic habitats and species within the benthic ecology study area.	High	Negligible	Minor adverse impact	Employment of biosecurity measures in accordance	Minor adverse impact	Minor adverse impact

Potential impact	Receptor	Sensitivity	Magnitude	Pre-mitigation impact	Mitigation measures proposed	Residual impact	Cumulative Residual Impact
					with relevant regulations and guidance such as MARPOL and BWM convention		
Operation							
Impact 1: Temporary habitat loss / physical disturbance	Benthic habitats and species within the benthic ecology study area.	High	Negligible	Minor adverse impact	N/A	Minor adverse impact	Minor adverse impact
Impact 2: Permanent habitat loss	Benthic habitats and species within the benthic ecology study area.	Medium	Low	Minor adverse impact	N/A	Minor adverse impact	Minor adverse impact
	Annex I and UK BAP priority habitats with the potential to be present in the benthic ecology study area.	High	Low	Moderate adverse impact	Micro-siting around Annex I and UK BAP priority habitats (**Table 8-4**)	No impact	No impact
Impact 3: Long term habitat loss	Benthic habitats and species within the benthic ecology study area.	Medium	Low	Minor adverse impact	N/A	Minor adverse impact	Minor adverse impact

Potential impact	Receptor	Sensitivity	Magnitude	Pre-mitigation impact	Mitigation measures proposed	Residual impact	Cumulative Residual Impact
	Annex I and UK BAP priority habitats with the potential to be present in the benthic ecology study area.	High	Low	Moderate adverse impact	Micro-siting around Annex I and UK BAP priority habitats (**Table 8-4**)	No impact	No impact
Impact 4: Temporary increases in SSC and deposition	Benthic habitats and species within the benthic ecology study area.	Low	Negligible	Negligible	N/A	Negligible	Negligible
Impact 5: Colonisation of foundations and cable protection	Benthic habitats and species within the benthic ecology study area.	Medium	Low	Minor adverse impact	N/A	Minor adverse impact	Minor adverse impact
Impact 6: Underwater noise and vibration	Benthic habitats and species within the benthic ecology study area.	Negligible	Negligible	Negligible adverse impact	N/A	Minor adverse impact	Minor adverse impact
Impact 7: INNS	Benthic habitats and species within the benthic ecology study area.	High	Negligible	Minor adverse impact	Employment of biosecurity measures in accordance with relevant regulations and guidance such as MARPOL	Minor adverse impact	Minor adverse impact

Potential impact	Receptor	Sensitivity	Magnitude	Pre-mitigation impact	Mitigation measures proposed	Residual impact	Cumulative Residual Impact
					and BWM convention		
Decommissioning							
Impact 1: Temporary habitat loss / physical disturbance	Benthic habitats and species within the benthic ecology study area.	High	Negligible	Minor adverse impact	N/A	Minor adverse impact	Minor adverse impact
	Annex I and UK BAP priority habitats with the potential to be present in the benthic ecology study area.	High	Low	Moderate adverse impact	Micro-siting around Annex I and UK BAP priority habitats (**Table 8-4**)	No impact	No impact
Impact 2: Permanent habitat loss	Benthic habitats and species within the benthic ecology study area.	Medium	Low	Minor adverse impact	N/A	Minor adverse impact	Minor adverse impact
	Annex I and UK BAP priority habitats with the potential to be present in the benthic ecology study area.	High	Low	Moderate adverse impact	Micro-siting around Annex I and UK BAP priority habitats (**Table 8-4**)	No impact	No impact
Impact 3: Temporary increases in SSC and deposition	Benthic habitats and species within the benthic ecology study area.	Medium	Negligible	Negligible	N/A	Negligible	Negligible

Potential impact	Receptor	Sensitivity	Magnitude	Pre-mitigation impact	Mitigation measures proposed	Residual impact	Cumulative Residual Impact
Impact 4: Colonisation of foundations and cable protection	Benthic habitats and species within the benthic ecology study area.	Medium	Low	Minor adverse impact	N/A	Minor adverse impact	Minor adverse impact
Impact 5: Underwater noise and vibration	Benthic habitats and species within the benthic ecology study area.	Negligible	Negligible	Negligible adverse impact	N/A	Minor adverse impact	Minor adverse impact
Impact 6: INNS	Benthic habitats and species within the benthic ecology study area.	High	Negligible	Minor adverse impact	Employment of biosecurity measures in accordance with relevant regulations and guidance such as MARPOL and BWM convention	Minor adverse impact	Minor adverse impact

8.13 References

The British Standards Institution (2015) Environmental impact assessment for offshore renewable energy projects – Guide. PD 6900:2015.
Callaway, R., Alsvåg J., De Boois, I., Cotter, J., Ford, A., Hinz, H., Jennings, S., Kröncke, I., Lancaster, J., Piet, G., Prince, P. & Ehrich, S. (2002). Diversity and Community Structure of Epibenthic Invertebrates and Fish in the North Sea. ICES Journal of Marine Science, 59,1199-1214.
Cefas (2004) Offshore Wind Farms: Guidance Note for Environmental Impact Assessment in Respect of FEPA and CPA requirements: Version 2
Cefas (2010) Strategic Review of Offshore Wind Farm Monitoring Data Associated with FEPA licence conditions, with input from the Food and Environment Research Agency (FERA) and the Sea Mammal Research Unit (SMRU)
Cefas (2012) Guidelines for data acquisition to support marine environmental assessments of offshore renewable energy projects.
Chartered Institute of Ecology and Environmental Management (CIEEM) (2016) Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater and Coastal, 2nd Edition.
BEIS (2021) Draft National Policy Statement for Renewable Energy Infrastructure (EN-3) Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1015236/en-3-draft-for-consultation.pdf
Department for Environment, Food and Rural Affairs (Defra) (2009) UK Offshore Energy Strategic Environmental Assessment. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/194348/OES_A3h_Other_Users.pdf
Defra (2005) Nature Conservation Guidance on Offshore Windfarm Development. A guidance note on the implications of the EC Wild Birds and Habitats Directives for developers undertaking offshore windfarm developments. Version R1.9. 13.
Defra (2015) Cromer Shoal Chalk Beds rMCZ Post-survey Site Report. Contract Reference: MB0120. Report Number: 34. Version 5. September 2015.
Defra (2016) Cromer Shoal Chalk Beds MCZ Feature Map.
Department of Energy and Climate Change (DECC) (2011) National Policy Statement for Renewable Energy Infrastructure (EN-3). Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/37048/1940-nps-renewable-energy-en3.pdf
Dudgeon Offshore Wind Limited (2009) Dudgeon Offshore Wind Farm Environmental Statement
ENVISION (2021). Benthic Habitat Mapping for Dudgeon and Sheringham Extension Projects - Geophysical Data Interpretation & Habitat Mapping.

European Nature Information Service [EUNIS]. (2019). The European Nature Information Service. [redacted]
Folk, R. L. (1954). The distinction between grain size and mineral composition in sedimentary-rock nomenclature. The Journal of Geology, 62(4), 344-359. [redacted]
Fugro (2013) Sheringham Shoal Post Construction Monitoring Benthic Survey.
Fugro (2014) Sheringham Shoal Post Construction Monitoring Benthic Survey.
Fugro (2015) Dudgeon Offshore Wind Farm Development Pre- Construction Baseline Ecology Study.
Fugro (2020a). Dudgeon Extension Benthic Characterisation Report. Dudgeon Extension Project. Volume 4 Benthic Characterisation Report. Survey Period: 10 to 19 August 2020. 200270-R-00403. 23 December 2020.
Fugro (2020b). Sheringham Shoal Extension Benthic Characterisation Report Sheringham Extension Project. Volume 5 Benthic Characterisation Report. Survey Period: 10 to 19 August 2020. 200270-R-00502. 23 December 2020.
Fugro (2020c). Dudgeon Extension Habitat Report. Dudgeon Extension Project. Volume 3 Habitat Assessment Report. Survey Period: 10 to 19 August 2020. 00270 R 00302. 23 October 2020.
Fugro (2020d). Sheringham Shoal Post-construction Benthic Survey - Sheringham Shoal Offshore Wind Farm Export Cable Route. Post-construction Monitoring Report. Survey Period: 18 to 19 August 2020. 200270.1-R-00201. 13 November 2020. Draft
Fugro (2020e). Sheringham Shoal Extension Habitat Report. Sheringham Extension Project. Volume 2 Habitat Assessment Report. Survey Period: 10 to 19 August 2020. 200270 R 00202. 23 October 2020.
Gardline (2020a). UK Extension Sea bed and UHRS Survey: Sheringham Shoal and Cable Routes Wind Farm Survey: Geophysical Survey (September to December 2019).
Gardline (2020b). UK Extension Sea bed and UHRS Survey: Dudgeon and Sheringham Shoal Wind Farm Survey (March to May 2020)
Glasby TM, Connell SD, Holloway MG, Hewitt CL. 2007. Nonindigenous biota on artificial structures: could habitat creation facilitate biological invasions? Mar Biol 151:887–895.
Goriup, P. D. (2017) Management of Marine Protected Areas: A Network Perspective, Chicheser: Wiley Blackwell.
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.

Heinisch P., and Wiese. K. (1987). Sensitivity to Movement and Vibration of Water in the North Sea Shrimp Crangon crangon: Journal of Crustacean Biology Vol. 7, No. 3 pp. 401-413 Published by: The Crustacean Society.
Heip C.,& Craeymeersch J.A. (1995). Benthic community structures in the North Sea. Helgoländer Meeresuntersuchungen, 49, 313-328.
HM Government (2014). East Inshore and East Offshore Marine Plans. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/312496/east-plan.pdf
Horridge, G.A (1966). Some recently discovered underwater vibration receptors in invertebrates. In H.Barnes (ed.). Some contemporary studies in marine science, George Allen and Unwin Ltd. London
Institute of Ecology and Environmental Management (IEEM) (2010) Guidelines for Ecological Impact Assessment in Britain and Ireland – Marine and Coastal
Irving, R. (2009). The identification of the main characteristics of stony reef habitats under the Habitats Directive. Summary report of an inter-agency workshop. JNCC, Volume 432
Jennings, S., Lancaster, J., Woolmer, A.,& Cotter, J. (1999). Distribution, diversity and abundance of epibenthic fauna in the North Sea. Journal of the Marine Biological Association of the UK, 79,385-399
Joint Nature Conservation Committee [JNCC] and Department for Environment, Food and Rural Affairs [Defra] (on behalf of the Four Countries' Biodiversity Group). (2012). UK Post-2010 Biodiversity Framework. July 2012. http://jncc.defra.gov.uk/page-6189.
Koop, L., Amiri-Simkooei, A., J van der Reijden, K., O'Flynn, S., Snellen, M. & G Simons, D. (2019). Seafloor classification in a sand wave environment on the Dutch continental shelf using multibeam echosounder backscatter data. Geosciences, 9(3), 42.
Krone, R., Gutow, L., Joschko, T.J. and Schroder, A. (2013) Epifauna dynamics at an offshore foundation –Implications of future wind power farming in the North Sea. Marine Environmental Research, 85, 1-12.
Lindeboom, H., Kouwenhoven, H., Bergman, M., Bouma, S., Brasseur, S., Daan, R., Fijn, R., de Haan, D., Dirksen, S., van Hal, R., Hille Ris Lambers, R., ter Hofstede, R., Krijgsveld, K., 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).
Long, D. (2006). BGS Detailed explanation of sea bed sediment modified Folk classification. MESH (Mapping European Sea bed Habitats).
Lovell J.M, Findlaya M.M, Moateb R M and Yanc H.Y (2005). The hearing abilities of the prawn Palaemon serratus. Comparative Biochemistry and Physiology, Part A 140 89 – 100.
Marine Ecological Surveys (2014). Sheringham Shoal Offshore Wind Farm Second Post-Construction Benthic Monitoring Survey.

MMO (2014) Review of Post-Consent Offshore Wind Farm Monitoring Data Associated with Licence Conditions, with input from the British Trust for Ornithology (BTO), National Physical Laboratory (NPL) and the SMRU.
MMO (2018). Marine Licensing: sediment analysis and sample plans. Guidance. Available online at: https://www.gov.uk/guidance/marine-licensing-sediment-analysis-and-sample-plans###Suitability%20of%20material
MMT (2019). Dudgeon OWF - Environmental Post Construction Survey Report (ST18692). August – September 2018. 102952-EQU-MMT-SUR-REP-ENVIRON VOLUME IV OF IV
Natural England (2017) Conservation Advice for Marine Protected Areas: The Wash and North Norfolk Coast SAC. Natural England Designated Sites website. Last updated: 15th September 2017. Available at: [redacted]
Neff, J. (1997) Ecotoxicology of arsenic in the marine environment. A review. Environmental Toxicology and Chemistry 16, 917-927
Orsted (2020). Hornsea Project Three Offshore Wind Farm. Response to the Secretary of State's Consultation. Appendix 5 - Updated MCZ Assessment. Environmental Statement: Volume 5, Annex 2.3 – Marine Conservation Zone Assessment. PINS Document Reference: A6.5.2.3 - Updated February 2020
OSPAR (2008). OSPAR List of threatened and/or declining species and habitats. Reference Number: 2008-06 [redacted]
Peritus International Ltd. 2022. Scour and Cable Protection Decommissioning Study. NECR403. Natural England.
The Planning Inspectorate (2019). Scoping Opinion: Proposed Dudgeon and Sheringham Shoal Offshore Wind Farm Extensions. Planning Inspectorate Reference EN010109. Available at: https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010109/EN010109-000006-EQNR_Scoping%20Opinion%202017%20EIA%20Regs.pdf
The Planning Inspectorate (2018). Planning Inspectorate Advice Note Nine: Rochdale Envelope.
Rees, H.L., Eggleton, J.D., Rachor, E.,& Vanden Berghe, E. (2007). Structure and Dynamics of the North Sea benthos. ICES Cooperative Research Report no. 288, 258pp.
Richardson, W. J., Greene, C. R., and Malme, C.I (1995). Marine Mammals and Noise, Academic Press.
RPS (2018) Hornsea Project Three Environmental Statement.

Scira Offshore Energy Ltd. (2006) Sheringham Shoal Offshore Wind Farm Environmental Statement
Scira Offshore Energy Ltd (2014) Sheringham Shoal Offshore Wind Farm. Second post-construction benthic monitoring survey. Marine Ecological Surveys Ltd. November 2014.
Soulsby, R.L. (1997). Dynamics of Marine Sands. Thomas Telford
The Crown Estate (2019) Record of the Habitats Regulations Assessment Undertaken under Regulation 63 of The Conservation of Habitats and Species Regulations 2017 and Regulation 28 of The Conservation of Offshore Marine Habitats and Species Regulations 2017. 2017 Offshore Wind Extensions Plan. Dated 28 August 2019
Tyler-Walters, H., Tillin, H.M., d'Avack, E.A.S., Perry, F. & Stamp, T. (2018). Marine Evidence-based Sensitivity Assessment (MarESA) – A Guide. Marine Life Information Network (MarLIN). Marine Biological Association of the United Kingdom, Plymouth, 91 pp
United Kingdom Biodiversity Action Plan [UK BAP] (2008a). Priority Habitat Descriptions. http://data.jncc.gov.uk/data/0a9b6b43-4827-44a4-ab06-0f94d5ad6b93/UKBAP-BAPHabitats-53-SubtidalChalk.pdf
United Kingdom Biodiversity Action Plan [UK BAP] (2008b). Priority Habitat Descriptions.http://jncc.defra.gov.uk/pdf/UKBAP_BAPHabitats-54-SubtidalSandsGravels.pdf
United Kingdom Biodiversity Action Plan [UK BAP](2008b). Priority Habitat Descriptions.http://jncc.defra.gov.uk/pdf/UKBAP_BAPHabitats-41-PeatClayExpo.pdf
Ware and Kenny (2011) Guidance for the Conduct of Benthic Studies at Marine Aggregate Extraction Sites.
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.
Wyn & Brazier (2001); Joint Nature Conservation Committee (JNCC) Marine Monitoring Handbook.