The Great Grid Upgrade

Sea Link

Preliminary Environmental Information Report

Volume: 1

Part 4 Offshore Scheme

Chapter 3 Benthic Ecology

Version A

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4.3 Benthic Ecology

4.3.1 Introduction

4.3.1.1 This chapter of the Preliminary Environmental Information Report (PEIR) presents information about the preliminary environmental assessment of the likely significant effects on benthic ecology identified to date, that could result from the Proposed Project (as described in **Volume 1, Part 1, Chapter 4, Description of the Proposed Project**).

4.3.1.2 This chapter describes the methodology used, the datasets that have informed the preliminary assessment, baseline conditions, mitigation measures and the preliminary residual significant effects on benthic ecology that could result from the Proposed Project.

4.3.1.3 The draft Order Limits, which illustrate the boundary of the Proposed Project, are illustrated on **Figure 1.1.1 Draft Order Limits** and the Offshore Scheme Boundary is illustrated on **Figure 1.1.4 Offshore Scheme Boundary**.

4.3.1.4 This chapter should be read in conjunction with:

- **Volume 1, Part 1, Chapter 3, Main Alternatives Considered;**
- **Volume 1, Part 1, Chapter 4, Description of the Proposed Project;**
- **Volume 1, Part 1, Chapter 5, PEIR Approach and Methodology;**
- **Volume 1, Part 1, Chapter 6, Scoping Opinion and EIA Consultation;**
- **Volume 1, Part 4, Chapter 1, Evolution of the Offshore Scheme;**
- **Volume 1, Part 4, Chapter 2, Physical Environment;**
- **Volume 1, Part 4, Chapter 4, Fish and Shellfish;**
- **Volume 1, Part 4, Chapter 6, Ornithology;**
- **Volume 1, Part 5, Chapter 3, Habitat Regulations Screening Report;** and
- **Volume 1, Part 5, Chapter 4, Marine Conservation Zone Assessment.**

4.3.1.5 This chapter is supported by the following figures:

- **Volume 3, Figure 4.3.1 Benthic Ecology Study Area and Designated Sites;**
- **Volume 3, Figure 4.3.2 Subtidal habitat complexes within the Offshore Scheme;**
- **Volume 3, Figure 4.3.3 Subtidal Annex I habitats within the Offshore Scheme;** and
- **Volume 3, Figure 4.3.4 Habitats present at, and location of, trenchless solution entry/exit entry/exit pits.**

4.3.1.6 This chapter is supported by the following appendices:

- **Volume 2, Appendix 1.4.A, Outline Code of Construction Practice;**
- **Volume 2, Appendix 1.4.F, Outline Schedule of Environmental Commitments and Mitigation Measures;**

- **Volume 2, Appendix 4.3.A Benthic Characterisation Report;** and
- **Volume 2, Appendix 4.8.B Electromagnetic Deviation Study.**

4.3.2 Regulatory and Planning Context

4.3.2.1 This section sets out the legislation and planning policy that is relevant to the preliminary benthic ecology assessment. A full review of compliance with relevant national and local planning policy will be provided within the Planning Statement that will be submitted as part of the application for Development Consent.

4.3.2.2 Policy generally seeks to minimise effects on benthic ecology from development and to avoid significant adverse effects. This applies particularly where project activities have the potential to interfere with protection and conservation initiatives for local populations, and species/habitats of conservation importance.

Legislation

Marine and Coastal Access Act 2009

4.3.2.3 The Marine and Coastal Access Act 2009 (Ref 3.1) is the legal mechanism to help ensure clean, healthy, safe, and productive and biologically diverse oceans and seas.

The Conservation of Habitats and Species Regulations 2017 (amended 2019)

4.3.2.4 The Conservation of Habitats and Species Regulations 2017 (Ref 3.2) (amended 2019[1]) transposes the Habitats Directive (92/43/EEC) and implements provisions from the Birds Directive (2009/147/EC), into UK legislation. These regulations cover the requirements to protect sites that are internationally important for threatened habitats and species out to the 12 nautical mile (NM) limit.

The Conservation of Offshore Marine Habitats and Species Regulations 2017

4.3.2.5 The Conservation of Offshore Marine Habitats and Species Regulations 2017 (Ref 3.3) covers the requirements to protect sites that are internationally important for marine habitats and species within the UK Offshore Marine Area (beyond the 12 NM limit).

The Wildlife and Countryside Act 1981

4.3.2.6 The Wildlife and Countryside Act 1981 (Ref 3.4) (as amended) includes provisions relating to nature conservation, including marine habitats and species.

The Marine Strategy Regulations 2010

4.3.2.7 The Marine Strategy Regulations 2010 (Ref 3.5) transposes the Marine Strategy Framework Directive (2008/56/EC) into UK legislation as retained law from the European Union.

[1] Amended in response to the UK's exit from the European Union (EU), making the Habitats (92/43/EEC) and Wild Birds (2009/147/EC) Directives, operable from 1 January 2021, and creating a UK natural site network in place of the EU Natura 2000 ecological network.

The Water Environment (Water Framework Directive (England and Wales)) Regulations 2017

4.3.2.8 The Water Environment (Water Framework Directive (England and Wales)) Regulations 2017 (Ref 3.6) transposes the EU Water Framework Directive (2000/60/EC) into UK legislation as retained law from the European Union.

Section 41 of the Natural Environment and Rural Communities (NERC) Act 2006

4.3.2.9 Section 41 of the NERC Act 2006 (Ref 3.7) imposes a requirement on the Secretary of State to publish a list species of principal importance for the purpose of conservation of biodiversity.

Environment Act 2021

4.3.2.10 The Environment Act 2021[2] sets clear statutory targets for the recovery of the natural world in four priority areas: air quality, biodiversity, water and waste, and includes the introduction of Biodiversity Net Gain (BNG).

National Policy

National Policy Statements

4.3.2.11 National Policy Statements (NPS) set out the primary policy tests against which the application for a Development Consent Order (DCO) for the Proposed Project would be considered. A review of the NPS was announced in the 2020 Energy white paper: Powering our net zero future. This review was to ensure the NPSs were brought up to date to reflect the policies set out in the white paper. The below information reflects these updates currently under consultation. Table 4.3.1, Table 4.3.2: NPS EN-3 requirements relevant to benthic ecology

NPS EN-3 section	Where this is covered in the PEIR
3.8.118…*"Applicants should consult at an early stage of pre-application with relevant statutory consultees, as appropriate, on the assessment methodologies, baseline data collection, and potential avoidance, mitigation and compensation options should be undertaken".*	Consultation with the statutory consultees, including the Marine Management Organisation and Natural England, was undertaken during the scoping stage and is ongoing. Relevant comments are provided in section 4.3.3
3.8.163…"*The applicant should demonstrate compliance with mitigation measures identified by The Crown Estate in any plan-level HRA produced as part of its leasing round".*	Relevant mitigation measures identified at this stage are provided in section 4.3.8. Impacts to biodiversity are considered in section 4.3.9 and the HRA Screening

[2] The Act has been enshrined into law; however, it is not anticipated to come into full effect until the end of 2023 (2025 for NSIPs).

NPS EN-3 section	Where this is covered in the PEIR
	Report (**Volume 1, Part 5, Chapter 3**).
3.8.166…" Applicant assessment of the effects on the subtidal environment should include: loss of habitat due to foundation type including associated seabed preparation, predicted scour, scour protection and altered sedimentary processes, e.g. sandwave/boulder/UXO clearance; environmental appraisal of inter-array and export cable routes and installation/maintenance methods, including predicted loss of habitat due to predicted scour and scour/cable protection and sandwave/boulder/UXO clearance; habitat disturbance from construction and maintenance/repair vessels' extendable legs and anchors; increased suspended sediment loads during construction and from maintenance/repairs; predicted rates at which the subtidal zone might recover from temporary effects; potential impacts from EMF on benthic fauna; protected sites; and potential for invasive/non-native species introduction	A preliminary impact assessment of all relevant impact pathways can be found in section 4.3.9. A full assessment will be included in the Environmental Statement.

4.3.2.12 Table 4.3.3 and Table 4.3.3 below provide details of the elements of NPS (EN-1) Overarching National Policy Statement for Energy (Ref 3.8), NPS for Renewable Energy Infrastructure (EN-3) (Ref 3.9) and NPS for Electricity Networks Infrastructure (EN-5) (Ref 3.10) that are relevant to this chapter, and how and where they are covered in the PEIR or will be covered within the Environmental Statement (ES).

Table 4.3.1: NPS EN-1 requirements relevant to benthic ecology (Update for consultation 2023).

NPS EN-1 section	Where this is covered in the PEIR
4.4.7 "... *Applicants are encouraged to approach the marine licensing regulator (MMO in England and Natural Resources Wales in Wales) in pre-application, to ensure that they are aware of any needs for additional marine licences alongside their DCO application".*	Consultation with the MMO was undertaken during the scoping stage and is ongoing. Relevant comments are provided in section 4.3.3.
4.4.8…"*Applicants for a development consent order must take account of any relevant Marine Plans and are expected to complete a Marine Plan assessment as part of their project development, using this information to support an application for development consent*"	Relevant Marine Plans are identified in Table 4.3.5 and considered in section 4.5.8 Preliminary Assessment of Effects.

NPS EN-1 section	Where this is covered in the PEIR
4.4.9…"*Applicants are encouraged to refer to Marine Plans at an early stage, such as in preapplication, to inform project planning, for example to avoid less favourable locations as a result of other uses or environmental constraints*".	Relevant Marine Plans are identified in Table 4.3.5 and considered in section 4.3.9 Preliminary Assessment of Effects. Further detail on the routing is considered in **Volume 1, Part 1, Chapter 1.3, Maine Alternatives Considered** and **Part 4, Chapter 1, Evolution of the Project.**
5.4.17 (part)"... *Where the development is subject to EIA the applicant should ensure that the ES clearly sets out any effects on internationally, nationally, and locally designated sites of ecological or geological conservation importance (including those outside England), on protected species and on habitats and other species identified as being of principal importance for the conservation of biodiversity, including irreplaceable habitats".*	Details of designated sites and protected species, and other habitats and species of principal importance are provided in section 4.3.7 and a preliminary impact assessment can be found in section 4.3.9. Full assessment will be included in the Environmental Statement. An assessment of impacts on designated sites is available in the HRA Screening Report **(Volume 1, Part 5, Chapter 3)**.
5.4.19 *"… The applicant should show how the project has taken advantage of opportunities to conserve and enhance biodiversity and geological conservation interests".*	The project will adopt a range of measures to conserve and enhance biodiversity as detailed in Section 4.3.8.
5.3.18 *"… The applicant should include appropriate mitigation measures as an integral part of the proposed development".*	Relevant mitigation measures identified at this stage are provided in section 4.3.8.

Table 4.3.2: NPS EN-3 requirements relevant to benthic ecology

NPS EN-3 section	Where this is covered in the PEIR
3.8.118…*"Applicants should consult at an early stage of pre-application with relevant statutory consultees, as appropriate, on the assessment methodologies, baseline data collection, and potential avoidance, mitigation and compensation options should be undertaken".*	Consultation with the statutory consultees, including the Marine Management Organisation and Natural England, was undertaken during the scoping stage and is ongoing. Relevant comments are provided in section 4.3.3
3.8.163…"*The applicant should demonstrate compliance with mitigation measures identified by*	Relevant mitigation measures identified at this stage are provided in section

NPS EN-3 section	Where this is covered in the PEIR
The Crown Estate in any plan-level HRA produced as part of its leasing round".	4.3.8. Impacts to biodiversity are considered in section 4.3.9 and the HRA Screening Report (**Volume 1, Part 5, Chapter 3**).
3.8.166…" Applicant assessment of the effects on the subtidal environment should include: loss of habitat due to foundation type including associated seabed preparation, predicted scour, scour protection and altered sedimentary processes, e.g. sandwave/boulder/UXO clearance; environmental appraisal of inter-array and export cable routes and installation/maintenance methods, including predicted loss of habitat due to predicted scour and scour/cable protection and sandwave/boulder/UXO clearance; habitat disturbance from construction and maintenance/repair vessels' extendable legs and anchors; increased suspended sediment loads during construction and from maintenance/repairs; predicted rates at which the subtidal zone might recover from temporary effects; potential impacts from EMF on benthic fauna; protected sites; and potential for invasive/non-native species introduction	A preliminary impact assessment of all relevant impact pathways can be found in section 4.3.9. A full assessment will be included in the Environmental Statement.

Table 4.3.3: NPS EN-5 requirements relevant to benthic ecology (Update for consultation 2023).

NPS EN-5 section	Where this is covered in the PEIR
2.2.10 "...*As well as having duties under Section 9 of the Electricity Act 1989, (in relation to developing and maintaining an economical and efficient network), applicants must take into account Schedule 9 to the Electricity Act 1989, which places a duty on all transmission and distribution licence holders, in formulating proposals for new electricity networks infrastructure, to "have regard to the desirability of preserving natural beauty, of conserving flora, fauna and geological or physiographical features of special interest … and …do what [they] reasonably can to mitigate any effect which the proposals would have on the natural beauty of the countryside or on any such flora, fauna, features, sites, buildings or objects".*	The project undertook a detailed routeing and siting study (**Volume 1, Part 1, Chapter 3, Main Alternatives Considered**) which considered a wide range of environmental factors including flora and fauna of special interest. Relevant mitigation measures identified at this stage are provided in section 4.3.8
2.13.15 *"…The sensitivities of many coastal locations and of the marine environment as well as*	Landfall design is summarised in **Volume 1,**

NPS EN-5 section	Where this is covered in the PEIR
the potential environmental, community and other impacts in neighbouring onshore areas must be considered in the identification onshore connection points."	**Part 1 Chapter 4: Description of the Proposed Project**. Other mitigation relevant to benthic ecology is provided in section 4.3.8
2.14.2..."*In the assessments of their designs, applicants should demonstrate how environmental, community and other impacts have been considered and how adverse impacts have followed the mitigation hierarchy i.e. avoidance, reduction and mitigation of adverse impacts through good design; and how enhancements to the environment post construction will be achieved including demonstrating consideration of how proposals can contribute towards biodiversity net gain (as set out in Section 4.5 of EN-1 and the Environment Act 2021), as well as wider environmental improvements in line with the Environmental Improvement Plan and environmental targets (paragraph 4.2.29 of EN-1). In addition, all applicants are encouraged to demonstrate how the construction planning for the proposals has been coordinated with that for other similar projects in the area on a similar timeline*".	Mitigation, embedded measures, and control and management measure to minimise environmental impacts to benthic ecology are discussed in section 4.3.8. Cumulative effects are assessed in **Volume 1, Part 4, Chapter 12: Inter-Project Cumulative Effects.**

National Planning Policy Framework

4.3.2.13 The National Planning Policy Framework (NPPF) (Ref 3.11) has the potential to be considered important and relevant to the Secretary of State (SoS) consideration of the Proposed Project. Biodiversity is stated as one of the factors contributing to the core objectives of sustainable economic development. Table 4.3.4 below provides details of the elements of the NPPF that are relevant to this chapter, and how and where they are covered in the PEIR or will be covered within the ES.

Table 4.3.4: NPPF requirements relevant to benthic ecology

NPPF section	Where this is covered in the PEIR
Paragraph 174 "*Planning policies and decisions should contribute to and enhance the natural and local environment by [inter alia] … protecting and enhancing valued landscapes, sites of biodiversity or geological value and soils (in a manner commensurate with their statutory status or identified quality in the development plan); … [and] recognising the intrinsic character and beauty of*	Statutory protected sites and their associated features of interest which will be impacted by project activities are considered in section 4.3.9. Relevant designated sites have been further subjected to an HRA

NPPF section	Where this is covered in the PEIR
the countryside, and the wider benefits from natural capital and ecosystem services; … [and] minimising impacts on and providing net gains for biodiversity; …[and] preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability".	Screening Report (**Volume 1, Part 5, Chapter 3**). Any requirements for biodiversity net gain will be considered within the ES.
Paragraph 175 *"Plans should: distinguish between the hierarchy of international, national and locally designated sites; allocate land with the least environmental or amenity value, where consistent with other policies in this Framework; take a strategic approach to maintaining and enhancing networks of habitats and green infrastructure; and plan for the enhancement of natural capital at a catchment or landscape scale across local authority boundaries*".	Locally, nationally, and internationally designated sites have all been considered where relevant for benthic ecology receptors. Details for relevant designated sites is provided in section 4.3.7 and undergo an HRA Screening Report (**Volume 1, Part 5, Chapter 3**).
Paragraph 179 *"To protect and enhance biodiversity and geodiversity, plans should: Identify, map and safeguard components of local wildlife-rich habitats and wider ecological networks, including the hierarchy of international, national and locally designated sites of importance for biodiversity; wildlife corridors and stepping stones that connect them; and areas identified by national and local partnerships for habitat management, enhancement, restoration or creation; [and] promote the conservation, restoration and enhancement of priority habitats, ecological networks and the protection and recovery of priority species; and identify and pursue opportunities for securing measurable net gains for biodiversity."*	Impacts to biodiversity are considered in section 4.3.9. and the HRA Screening Report (**Volume 1, Part 5, Chapter 3**).
Paragraph 180 *"When determining planning applications, local planning authorities should apply the following principles: if significant harm to biodiversity resulting from a development cannot be avoided (through locating on an alternative site with less harmful impacts), adequately mitigated, or, as a last resort, compensated for, then planning permission should be refused; [and] development on land within or outside a Site of Special Scientific Interest, and which is likely to have an adverse effect on it (either individually or in combination with other developments), should not normally be permitted. The only exception is where the benefits of the development in the location proposed clearly*	Impacts to biodiversity are considered in section 4.3.9. and the HRA Screening Report (**Volume 1, Part 5, Chapter 3**). Consideration has been given to relevant designated sites and species in the project design. Details for relevant designated sites is provided in section 4.3.7

NPPF section	Where this is covered in the PEIR
outweigh both its likely impact on the features of the site that make it of special scientific interest, and any broader impacts on the national network of Sites of Special Scientific Interest; [and] development whose primary objective is to conserve or enhance biodiversity should be supported; while opportunities to improve biodiversity in and around developments should be integrated as part of their design, especially where this can secure measurable net gains for biodiversity or enhance public access to nature where this is appropriate."	
Paragraph 181 *"The following should be given the same protection as habitats sites: possible Special Areas of Conservation; [and] listed or proposed Ramsar sites; [and] sites identified, or required, as compensatory measures for adverse effects on habitats sites, potential Special Protection Areas, possible Special Areas of Conservation, and listed or proposed Ramsar sites."*	No possible/proposed sites have been identified in addition to existing designations. Should any be proposed prior to the completion of the ES, they would be included in ES and HRA Screening Report (**Volume 1, Part 5, Chapter 3**). A full list of sites designated for the protection of marine mammals is provided in section 4.3.7.

National Planning Practice Guidance

4.3.2.14 This PEIR Chapter has also followed National Planning Practice Guidance for the Natural Environment (Department for Levelling Up, Housing and Communities, and Ministry of Housing, Communities and Local Government, 2016), which describes how biodiversity and ecosystems should be taken into account, for the purpose of conserving biodiversity. The PEIR Chapter follows guidance on evidence required, such as location of designated sites and the distribution and consideration of protected and priority species. In addition, guidance has been followed applying policy to avoid, mitigate or compensate for significant harm to biodiversity, to ensure that project impacts do not cause adverse effects to fish and shellfish.

Marine Planning Policy

4.3.2.15 The following marine plans are relevant to benthic ecology and have informed the assessment of preliminary effects in this chapter:

- The UK Marine Policy Statement (MPS), which was adopted in 2011 and provides the policy framework for the preparation of marine plans and establishes how decisions affecting the marine area should be made (Ref 3.12);
- East Inshore and East Offshore Marine Plan (Ref 3.13); and

- South East Inshore Marine Plan (Ref 3.14).

Table 4.3.5: Marine Planning Policies relevant to benthic ecology

Marine Plan	Where this is covered in the PEIR
The UK MPS ensures that marine resources are used in a sustainable way by ensuring biodiversity is protected and conserved by using the precautionary principle and relying on sound evidence.	In line with policy objectives in the MPS, this PEIR Chapter has taken into consideration measures that can be taken to avoid biodiversity loss. Where possible, consideration has been given to conserving and avoiding harm to benthic ecology through routeing, mitigation, and consideration of reasonable alternatives. Potential adverse effects to designated sites and protected features have been avoided where possible. Details of protected sites and species designations are provided in section 4.3.7, with an assessment of potential impacts in section 4.3.9. Relevant mitigation is detailed in section 4.3.8
East Inshore and East Offshore Marine Plan ensures biodiversity is protected and conserved between Flamborough Head and Felixstowe.	Routeing of the Offshore Scheme has been selected to avoid sensitive habitats. An ecosystems-based approach has been adopted and cumulative impacts have been considered to ensure that effects from project activities do not adversely impact benthic ecology.
South East Inshore Marine Plan ensures biodiversity is protected and conserved between Felixstowe and Dover.	

Local Planning Policy

4.3.2.16 The intertidal area of the Offshore Scheme lies within the jurisdiction of Suffolk County Council, East Suffolk Council, Suffolk Coastal Local Plan, Kent County Council and within the boundary of Thanet District Council Local Plan and Dover District Local Plan. However, as both landfalls will be achieved using trenchless techniques, there are no activities occurring at the surface in the intertidal area.

4.3.3 Scoping Opinion and Consultation

Scoping

4.3.3.1 A Scoping Report (Ref 3.15) for the Proposed Project was issued to the Planning Inspectorate (PINS) on 24 October 2022 and a Scoping Opinion (Ref 3.16) was adopted by PINS on behalf of the SoS on 1 December 2022. Table 4.3.6 sets out the points raised in the Scoping Opinion and how these have been addressed in this PEIR or will be addressed within the ES. The Scoping Opinion takes account of responses from prescribed consultees as appropriate.

Table 4.3.6: Comments raised in the Scoping Opinion

ID	Inspectorate's comments	Response
5.2.1	[*Changes to marine water quality during cable installation and cable lay from the use of HDD drilling fluids (construction)].* The Applicant proposes to scope this matter out on the basis that the control and management measure LVS05 of the outline CoCP would be implemented meaning only inert (non-toxic), biodegradable drilling fluid will be used and disposed of at a licenced disposal site. The Inspectorate agrees that this matter can be scoped out on the basis that the mitigation measures proposed within the outline CoCP should be sufficient to address the likely impacts and avoid a likely significant effect. The ES should include details of the mitigation and explain how its delivery is assured with reference to relevant documents.	Changes to marine water quality during cable installation and cable lay from the use of drilling fluids has been scoped out and has not been assessed further. Relevant mitigation measures identified at this stage are provided in Section 4.3.8 Full details will be provided in the ES
5.2.2	[*Changes to marine water quality from accidental leaks and spills from vessels, including loss of fuel oils (construction, maintenance and decommissioning*)]. The Applicant proposes to scope this matter out on the basis that the control and management measures referred to within the outline CoCP create limited potential for accidental spills to occur and should an accidental spill or leak occur, it would be small in extent and subject to immediate control measures, dilution and rapid dispersal within the marine environment. The Inspectorate agrees that this matter can be scoped out on the basis that the mitigation measures proposed within the outline CoCP should be sufficient to address the likely impacts and avoid a likely significant effect. The ES should include details of the mitigation and explain how its delivery is assured with reference to relevant documents.	Changes to marine water quality from accidental leaks and spills from vessels, including loss of fuel oils has been scoped out and has not been assessed further. Relevant mitigation measures identified at this stage are provided in section 4.3.8
5.2.3	[*Introduction and spread of invasive non-native species (INNS) via vessel hull or ballast water (construction, maintenance and decommissioning*)]. The Applicant proposes to scope this matter out on the basis that the control and management measures referred to within	Introduction and spread of INNS via vessel hull or ballast water has been scoped out and has not been assessed further. Relevant mitigation measures identified at this

ID	Inspectorate's comments	Response
	the outline CoCP make the introduction of INNS through ship hulls and ballast water unlikely. The Inspectorate agrees that this matter can be scoped out on the basis that the mitigation measures proposed within the outline CoCP such as the Biosecurity Plan should be sufficient to address the likely impacts and avoid a likely significant effect. The ES should include details of the mitigation and explain how its delivery is assured with reference to relevant documents.	stage are provided in section 4.3.8
5.2.4	[*Underwater sound impacts on marine invertebrates (intertidal and subtidal ecology) (construction, maintenance and decommissioning)].* The Applicant proposes to scope this matter out on the basis that the type and duration of underwater sound that will be generated by the Proposed Development will not have any significant effects on benthic invertebrates or benthic communities. In the absence of confirmed construction, details the Inspectorate considers that this matter should be scoped in for further assessment.	Underwater sound impacts on marine invertebrates has been scoped in for further assessment in section 4.3.9
5.2.5	[*EMF emissions (operation)].* The Applicant proposes to scope this matter out on the basis that significant effects from EMF are unlikely to occur due to the depth of cable burial and the limited sensitivity of benthic species. In the absence of an estimation of EMFs arising from cables the Inspectorate considers that this matter should be scoped in for further assessment.	EMF emissions has been scoped in for further assessment in section 4.3.9
5.2.6	[*Methodology for bringing cables onshore*]. It is not clear what method will be used to bring the cables onshore from the subtidal to intertidal area. The Applicants attention is drawn to the advice from the EA (see Appendix 2 of this Opinion) which advises that for all potential methods for bringing cables onshore, potential disturbances to benthic ecology are scoped in. The Inspectorate agrees that this level of detail will support the assessment and the understanding of likely significant effects associated.	The cables will be installed between the marine environment and onshore via trenchless solution. Thus, there will be no activities, and hence no impacts, in the intertidal environment and any disturbance to intertidal benthic ecology receptors has been scoped out. For completeness a brief description of the intertidal area has been provided in section 4.3.7.

ID	Inspectorate's comments	Response
5.2.7	[*Subtidal benthic habitats*]. The Inspectorate notes that the Scoping Report does not refer to benthic habitats surveyed within or adjacent to Marine Conservation Zones (MCZs). The ES should clearly identify protected features within or adjacent to designated sites such as Goodwin Sands MCZ and Kentish Knock East MCZ.	Subtidal benthic habitats within or adjacent to designated sites, including Goodwin Sands MCZ and Kentish Knock East MCZ, have been identified within section 4.3.7 The MCZ Assessment is provided in **Volume 1, Part 5, Chapter 4**.

Consultation and Project Engagement

4.3.3.2 Necessary statutory consultees relevant to benthic ecology include Natural England and the MMO. Beyond statutory consultation, no additional stakeholder consultation has been identified.

4.3.3.3 On 12th May 2023, a meeting was held with the MMO, Cefas, and Natural England in order to demonstrate the progress which had been made with respect to benthic ecology matters since the Scoping Opinion was received. During this meeting, the consultees were presented with further information about the Proposed Project and the approach to the PEIR and ES benthic assessments.

4.3.4 Approach and Methodology

4.3.4.1 **Volume 1, Part 1, Chapter 5, PEIR Approach and Methodology** sets out the overarching approach that has been used in developing the preliminary environmental information. This section describes the technical methods used to determine the baseline conditions, sensitivity of the receptors and magnitude of effects and sets out the significance criteria that have been used for the preliminary benthic ecology assessment.

Guidance specific to the benthic ecology assessment

4.3.4.2 The preliminary benthic ecology assessment has been carried out in accordance with the following good practice guidance documents:

- Chartered Institute for Ecology and Environmental Management (CIEEM) Guidelines for Ecological Impact Assessment in Britain and Ireland – Terrestrial, Freshwater, Coastal and Marine (Ref 3.17);
- The Convention for the Protection of the Marine Environment of the North-East Atlantic, or OSPAR Convention (the Convention for the Protection of the Marine Environment of the North-East Atlantic), produced the OSPAR List of Threatened and/or Declining Species and Habitats, considered to be of conservation concern within the north-east Atlantic (Ref 3.18);
- Assessment of the environmental impacts of cables (Ref 3.19), which assesses the environmental impacts of sea cables in terms of their relevance for the area covered by the Convention;

- Natural England and JNCC 2022 guidance ‘Nature conservation considerations and environmental best practice for subsea cables for English Inshore and UK offshore waters.’ (Ref 3.20)
- Refining the criteria for defining areas with a 'low resemblance' to Annex I stony reef (Ref 3.21) which supports habitat classification;
- Defining and managing *Sabellaria spinulosa* reefs (Ref 3.22); and
- The identification of the main characteristics of Annex I stony reef habitats under the Habitats Directive (Ref 3.23).

4.3.4.3 In the absence of Environmental Quality Standards for in situ sediments in the UK, the following guidance has been used to inform a ‘Weight of Evidence’ (WoE) approach to assess whether benthic ecology is at risk from concentrations of toxic contaminants:

- Centre for Environment, Fisheries and Aquaculture Science (Cefas) Chemical Action Levels (Ref 3.24). These values are used in conjunction with a range of other assessment methods to make management decisions regarding the fate of dredged material. The action levels are not ‘pass/fail’ criteria but triggers for further assessment. In general, contaminant levels in dredged material below Action Level 1 are of no concern and are unlikely to influence the licensing decision. However, dredged material with contaminant levels above Action Level 2 is generally considered unsuitable for sea disposal. Dredged material with contaminant levels between Action Levels 1 and 2 requires further consideration and testing before a decision can be made. Action Levels are therefore used as a guide in assessments of sediment contamination in non-dredging activities;
- Canadian Sediment Quality Guidelines (Ref 3.25) applied to contaminants where no other regional threshold value is available. Canadian Sediment Quality Guidelines for the Protection of Aquatic Life. The Canadian Sediment Quality Guidelines were developed by the Canadian Council of Ministers of the Environment (CCME) as broadly protective tools to support the functioning of healthy aquatic ecosystems;
- UK Offshore Operators Association (UKOOA) sediment quality guidelines for the UK North Sea (Ref 3.26); and
- OSPAR background concentrations and background assessment concentrations and effect range low (ERL) and effect range median (ERM) concentrations for contaminants (Ref 3.27).

Baseline Data Gathering and Forecasting Methods

4.3.4.4 The benthic ecology baseline conditions have been established by undertaking a combination of desktop review of published information, collection of project-specific survey data, and consultation with relevant organisations. The baseline provides a robust and up-to-date characterisation of the benthic environment within the Study Area.

Desk Study

4.3.4.5 A significant amount of publicly available data exist for benthic ecology in the Study Area. A large proportion of this information has been produced for current and historical offshore developments, such as offshore wind farms and subsea cable projects, which have required statutory or non-statutory Environmental Impact Assessments (EIA).

4.3.4.6 Where relevant, this information has been used to inform the benthic ecology baseline characterisation for the Offshore Scheme. In addition, a range of other data sources have been used to inform the baseline description and appraisal including:

- Kent Habitat Survey Partnership (Ref 3.28);
- European Marine Observation Data Network (EMODnet) Seabed Habitats Project data for broad-scale habitat maps of the Study Area (Ref 3.29);
- European Union Nature Identification System (EUNIS) for classifying benthic habitats (Ref 3.30);
- Defra Future Coast Project (Ref 3.31);
- Marine Data Exchange Offshore Wind Environmental Evidence Register (OWEER) (Ref 3.32);
- Marine Life Information Network for habitat and species sensitivity assessments, where available (Ref 3.33);
- Cefas OneBenthic Portal (Ref 3.34);
- MAGIC maps for designated and protected sites (Ref 3.35);
- Designated sites condition assessments as available;
- Academic papers and online reports as available for the Study Area; and
- Relevant Environmental Statements.

Field Survey

4.3.4.7 A dedicated subtidal benthic survey was commissioned to characterise benthic ecological conditions and map the distribution and extent of marine benthic habitats in the Offshore Scheme. Detailed information related to the benthic surveys undertaken is provided in **Appendix 4.3A**, with a summary of the methods provided below and a baseline within section 4.3.7.

4.3.4.8 Surveys were carried out between 08 September and 06 October 2021. The two key objectives of the surveys were to:

- Collect video/stills footage and grab samples from pre-defined stations positioned along the Offshore Scheme, in order to characterise seabed sediments and associated benthic communities within this area.
- Collect additional video/stills at proposed ground truthing stations along the Proposed Project route, particularly where features of interest were observed (e.g., mottled seabed indicative of possible reef habitats etc.) to allow for high confidence mapping of any habitats of conservation importance.

4.3.4.9 Sample sites were selected by reviewing remote sensing data provided by side scan sonar (SSS) and multi beam echo sounder (MBES) from a preliminary geophysical survey. The number and location of sample sites were determined based on depth variation, sediment, and habitat changes to provide benthic data for all habitat types interpreted across the survey route. As a result, the sampling effort was mainly concentrated in areas of heterogeneous and varying seabed. This resulted in the selection of 37 subtidal sampling stations positioned to reflect the diversity of habitats identified in the geophysical survey data.

4.3.4.10 Grab sampling was carried out at each of the survey stations for quantitative macrobenthic, particle size analysis (PSA), and sediment chemical analysis. The primary grab sampler utilized was a dual Van Veen (2 x 0.1 m^2) and the secondary grab sampler was a Hamon grab (0.1 m^2).

4.3.4.11 In areas with hard bottom substrates or sensitive areas that could not be sampled with grab samplers, grab sampling was not attempted and an extended drop-down video (DDV) transect was performed to identify epifauna and habitat transitions. The survey line was planned over the area of interest, and still images were collected along the entire DDV transect. Five DDV transects were performed in total.

4.3.4.12 To connect the epifaunal to the faunal assemblage, and to minimise impacts to sensitive seabed habitats and features, five minutes of continuous video were acquired by the DDV system and a minimum of five still images were collected along each video transect preceding any grab sampling. Where sensitive habitats were observed, grab samples were not taken.

4.3.4.13 Habitat, PSA and macrofaunal data obtained from the surveys were used to classify the sampled areas in accordance with the EUNIS classification system. Habitats were subsequently assessed in terms of their ecological and conservation importance, drawing from current marine legislation.

Assessment Criteria

2.1.1.1 Several factors have been considered when assessing the impacts on benthic ecology resulting from the Offshore Scheme including sensitivity of the receptors, magnitude of the impact, and the overall significance of effects. Factors relating to magnitude include the scale and duration of the impact and sensitivity includes whether the damage caused by the impact is reversible or not.

2.1.1.2 The following section outlines the approach and criteria for assessment of potential impact pathways as set out in **Volume 1, Part 1, Chapter 5, PEIR Approach and Methodology**. The methodologies for assessing sensitivity, magnitude and significance for benthic ecology are described in more detail below.

2.1.1.3 The approach taken to determining the significance of effect in this preliminary assessment is to only to state whether effects are likely or unlikely to be significant, rather than assigning significance levels.

Sensitivity

4.3.4.14 When defining sensitivity, reference has been made to the criteria levels set out in **Volume 1, Part 1, Chapter 5 PEIR Approach and Methodology.** To determine sensitivity of the receptor, the vulnerability of the receptor to the specific impact and its ability to recover and adapt were also considered. Vulnerability differs between different benthic ecology receptors and the ability to recover also differs between species and habitats, with some more likely to recover over a shorter timeframe. For example, mobile sands are naturally subject to high levels of physical disturbance from water movement (from waves and/or tides), often have low diversity communities, and so are tolerant of mechanical disturbance, recovering rapidly after the activity stops.

4.3.4.15 The importance, or value, of the receptor on an international, national and local scale has also been considered in assessing sensitivity.

Magnitude

4.3.4.16 The magnitude of an impact that could affect benthic ecology is influenced by several key factors, including the scale of the change (and how much the receptor is likely to be affected which could range from individuals and species to whole communities), the spatial extent over which the impact is likely to occur, and the duration and frequency of the impact.

4.3.4.17 Habitats vary and can range from being highly dynamic low diversity to stable communities supporting a wide range of infauna and epifauna. Many benthic species are slow-moving or sessile organisms, and thus avoidance of the impact may not be possible, so the effect from a single activity will vary. When defining the magnitude of the impact, criteria detailed in **Volume 1, Part 1, Chapter 5 PEIR Approach and Methodology** has been followed: large, medium, small, and negligible.

Significance of effects

4.3.4.18 As set out in **Volume 1, Part 1, Chapter 5, PEIR Approach and Methodology** the general approach taken to determining the significance of effect in this preliminary assessment is only to state whether effects are likely or unlikely to be significant, rather than assigning significance levels.

4.3.4.19 To determine whether an effect is significant or not, the nature and anticipated timeframe of the impact has been considered, in addition to the likely sensitivity of affected receptors. The magnitude and spatial extent of the impact have also been considered.

4.3.4.20 The criteria for assessing effects and residual significance are presented in **Volume 1, Part 1, Chapter 5,** and are referred to in the assessment. However, in the absence of quantitative thresholds for ecology, assessments are undertaken based on available evidence, professional judgment, and knowledge from previous projects, rather than adopting a purely matrix-based approach (CIEEM, 2018). In addition, a precautionary approach has been taken with the reasonable worst-case scenario assessed for each impact, in order to account for uncertainty or lack of baseline survey data in the assessment.

Assumptions and Limitations

4.3.4.21 In terms of the field survey, although the sampling design and collection process for the survey data analysed provided robust data on the benthic communities, interpreting these data by classifying and grading biotopes has three main limitations:

- It can be difficult to interpolate data collected from discrete sample locations to cover the whole Study Area and to define the precise extent of each biotope, even with site specific geophysical data;
- Benthic communities generally show a transition from one biotope to another and therefore, boundaries of where one biotope ends and the next begins cannot be defined with absolute precision; and
- The classification of the community data into biotopes is not always straightforward, as some communities do not readily fit the available descriptions in the biotope classification system and the classification for subtidal benthic communities is generally regarded as incomplete.

4.3.4.22 Despite these limitations, every effort has been made to obtain data concerning the existing environment and to accurately predict the likely environmental effects of the Proposed Project. It is considered that the baseline information collected and used for this appraisal is representative of the Study Area.

4.3.5 Basis of Assessment

4.3.5.1 This section sets out the assumptions that have been made in respect of design flexibility maintained within the Proposed Project and the consideration that has been given to alternative scenarios and the sensitivity of the preliminary assessment to changes in the construction commencement year.

4.3.5.2 Details of the available flexibility and assessment scenarios are presented in **Volume 1, Part 1, Chapter 4 Proposed Project Description** and **Part 1, Chapter 5 PEIR Approach and Methodology**.

Flexibility Assumptions

4.3.5.3 The main preliminary assessments have been undertaken based on the description of the Proposed Project provided in **Volume 1, Part 1 Chapter 4 Description of the Proposed Project**. To take account of the flexibility allowed in the Proposed Project, consideration has been given to the potential for preliminary effects to be of greater or different significance should any of the permanent or temporary infrastructure elements be moved within the Limits of Deviation (LoD) or draft order Limits.

4.3.5.4 The assumptions made regarding the use of flexibility for the main assessment, and any alternatives assumptions are set out in Table 4.3.7 below.

Table 4.3.7: Flexibility assumptions

Element of flexibility	Proposed Project assumption for initial preliminary assessment	Flexibility assumption considered
Lateral LoD marine HVDC cable	The extent of the draft Order Limits for the Proposed Project (Offshore Scheme Boundary).	The worst-case scenario assessed for the Offshore Scheme is one bundled HVDC (x2) and one fibre optic cable in once trench. This bundled scenario maybe placed anywhere within the Offshore Scheme Boundary.

Coordination Including Co-location

4.3.5.1 The Proposed Project includes an option for co-location with National Grid Ventures proposed Nautilus and LionLink interconnector projects as explained in **Volume 1, Part 1, Chapter 5 PEIR Approach and Methodology.**

4.3.5.2 Table 4.3.8 details where the option of co-location is relevant to the preliminary benthic assessment and how this option has been assessed and reported in section 4.3.9 preliminary assessment of effects.

Table 4.3.8: Consideration of co-location

Element of coordination	How it has been considered within the preliminary assessment
Suffolk landfall	**Sea Link Only** Four Horizontal Directional Drilling (HDD) ducts (one per cable and one spare). **Sea Link (with co-location)** Up to ten HDD ducts.

Sensitivity Test

4.3.5.1 It is likely that under the terms of the draft DCO, construction could commence in any year up to five years from the granting of the DCO which is assumed to be 2026. Consideration has been given to whether the preliminary effects reported would be any different if the works were to commence in any year up to year five. Where there is a difference this is reported in section 4.3.9, preliminary assessment of effects.

4.3.6 Study Area

4.3.6.1 The Offshore Scheme Boundary runs from mean high-water springs (MHWS) at the landfall in Aldeburgh, Suffolk, to MHWS at the landfall in Pegwell Bay, Kent, crossing the outer Thames Estuary in the southern North Sea (**Figure 4.3.1 Benthic Ecology Study Area and Designated Sites**). The Offshore Scheme is situated entirely within UK territorial waters and is up to 130 km in length. The Offshore Scheme Boundary is 500 m wide for the majority of the Offshore Scheme (**Volume 1, Part 4, Chapter 1, Evolution of the Project in Marine Waters**) representing a typical offshore working corridor within which the cable can be laid.

4.3.6.2 The Study Area, a 10 km wide area around the Offshore Scheme centre line, has been selected to encompasses all potential impact pathways for benthic receptors (**Figure 4.3.1 Benthic Ecology Study Area and Designated Sites**) as identified in section 4.3.8.4. This is based on an understanding of the extent of likely impacts of the Offshore Scheme, providing a precautionary geographic context, and encompassing the relevant functional habitats and range of movement for mobile benthic species. This zone of influence (ZoI) has also been used to screen for designated sites for benthic ecology receptors.

4.3.6.3 The Offshore Scheme will use a trenchless solution at both landfall locations, avoiding any work in the intertidal area. The trenchless solution entry/exit pits, where the cable will be pulled for subsequent submarine installation, will be entirely in the subtidal environment (**Figure 4.3.4 Habitats present at, and location of, trenchless solution entry/exit entry/exit pits**). Indicative water depths at lowest astronomical tide for the entry/exit pit locations are 5-6 m at Aldeburgh and ~ 4 m at Pegwell Bay.

4.3.6.4 There will be no direct impacts to intertidal benthic ecology receptors and therefore these have not been considered further in the impact assessment. However, for completeness, a brief description of the intertidal environment has been provided in section 4.3.7.

4.3.7 Baseline Conditions

4.3.7.1 Benthic ecology refers to the diversity, abundance, and function of organisms living on (epifauna) or in (infauna) the seabed. Benthic communities are found in all marine habitats, from the deepest parts of the ocean to the intertidal zone. Physical factors such as water depth, seabed and/or sediment type, and supply of organic matter, determine habitat types and species present, and therefore the composition of benthic communities. The study area includes a range of benthic habitats including intertidal habitats, and infralittoral (shallow waters closest to the shore, usually dominated by algae) and circalittoral (waters >5 m, usually dominated by fauna) subtidal habitats.

4.3.7.2 A dedicated benthic survey was commissioned to characterise benthic ecological conditions and map the distribution and extent of marine benthic habitats within the extent of the Offshore Scheme (see survey report presented in **Appendix 4.3A**).

4.3.7.3 The following subsections provide an overview of the survey data as well as the published information that has been used to characterise baseline conditions for benthic ecology within the Study Area (section 4.3.6).

Intertidal Ecology

4.3.7.4 The northern landfall is located on the Suffolk coast, between Aldeburgh and Thorpeness (**Figure 4.3.1 Benthic Ecology Study Area and Designated Sites**). The intertidal area is largely composed of sandy habitats, but also includes a section of ‘coastal vegetated shingle’, a habitat of ‘principal importance’ under Section 41 of the 2006 NERC Act (Ref 3.7). This habitat is specifically protected by the Leiston-Aldeburgh Site of Special Scientific Interest (SSSI).

4.3.7.5 The southern landfall is located on the east coast in Kent, at Pegwell Bay, within the Sandwich Bay to Hacklinge Marshes SSSI. This site is designated for the protection of a range of benthic habitats. The Thanet Coast SSSI, located to the north of the Pegwell Bay landfall site, is designated for the protection of foreshore habitats, such as sand and mudflats and areas of saltmarsh and coastal lagoons (section 4.3.7). This area is characterised by mudflat and saltmarsh habitats; ‘mudflat’ is a habitat of ‘principal importance’ under Section 41 of the 2006 NERC Act (Ref 3.7). In addition, saltmarsh identified in the intertidal zone at Pegwell Bay as part of the Kent Habitat Survey Partnership (Ref 3.28), is representative of ‘coastal saltmarsh’, a habitat of ‘principal importance’ under Section 41 of the 2006 NERC Act (Ref 3.7).

4.3.7.6 However, as the Proposed Project will use trenchless solution under the transition zone between the onshore and offshore elements at both landfalls (**Volume 1, Part 1, Chapter 4. Description of the Proposed Project**), any impacts to intertidal habitats and species will be avoided and these areas are not considered further in the assessment.

Subtidal Ecology

4.3.7.7 The subtidal benthic habitats identified along the Offshore Scheme are generally dominated by mud, sand, and coarse sediments. A variety of other habitats, classified using the European Nature Information System (EUNIS) (Ref 3.30), are distributed throughout the length of the Offshore Scheme, as summarised below and reported in detail in **Appendix 4.3A**.

Subtidal Habitats and communities

4.3.7.8 The habitats and biotope complexes identified using subtidal survey data for the Offshore Scheme and existing habitat mapping data (Ref 3.29) are presented in **Figure 4.3.2 Subtidal habitat complexes within the Offshore Scheme Panels A-C** and Table 4.3.9, and described below. A total of 26 EUNIS biotopes, across six habitat complexes, were observed to be present within the Offshore Scheme (see Table 4.3.9).

4.3.7.9 The subtidal benthic habitats identified along the Offshore Scheme were generally dominated by areas of mud and sand in the northernmost sections of the route (**Figure 4.3.2 Subtidal habitat complexes within the Offshore Scheme**). Further south, the sediment becomes more mixed with the presence of soft rock in nearshore areas.

4.3.7.10 The shallow areas, in the northernmost sections of the landfall route, are characterised by areas of fine sediment with patches of soft circalittoral rock (**Figure 4.3.2 Subtidal habitat complexes within the Offshore Scheme**). The sediment habitat continues to MMT-KP5.8 of the Offshore Scheme, becoming increasingly mobile with rippled sands and sparse fauna, alternating between sediment habitats of sand and mud.

4.3.7.11 Further south, at around MMT-KP2.5, the seabed transitions into an area of coarser sediments dominated with species including *Sabellaria spinulosa*. However, an assessment of the extent, density and structure of the aggregations indicated no *S. spinulosa* reef formations were present. This habitat continues until MMT-KP14.8

4.3.7.12 The mixed sediment habitats cover the majority of the route to MMT-KP27.8. However, from MMT-KP14.8, this is interspersed with patches of sand, soft circalittoral rock and the minor presence of *S. spinulosa* (MMT-KP13.9 and MMT-KP19.3) and blue mussel *Mytilus edulis* beds (MMT-KP15.4). A mixture of grab and video survey data indicates there is no presence of reef formations of either species, indicating the presence of patches rather than areas of continuous reef or mussel bed.

4.3.7.13 At MMT-KP27.5, the Offshore Scheme is dominated by sandy sediments, with the presence of Annex I habitat subtidal sandbanks (1110) identified between MMT-KP28.5 and MMT-KP32.0. From MMT-KP37.2, the seabed is dominated by alternating patches of coarse sediments, with further sections of Annex I habitat (1110) identified between MMT-KP43.9 and MMT-KP46.

4.3.7.14 From MMT-KP54.6, the seabed becomes more heterogenous, and includes areas of trawl marks, and ripples with coarser sediments and small areas of circalittoral rock. From MMT-KP59.9 to MMT-KP65.2 the seabed is dominated by softer sediments, thereafter it becomes dominated by coarser sediments and small areas of circalittoral rock.

4.3.7.15 These coarser sediments prevail southwards with occasional patches of finer sediments, including several large section areas of Annex I habitat subtidal sandbanks (1110) between MMT-KP67.4 and MMT-KP113.3.

4.3.7.16 Mixed sediments then extend towards MMT-KP119.8 with isolated patches of circalittoral rock. Soft circalittoral rock was found primarily in the southernmost areas between MMT-KP101.0 and MMT-KP127.3. As the route approaches the Kent landfall, the sediment becomes coarser, including areas of Annex I subtidal sandbank habitat (1110), and the aforementioned areas of soft rock.

Table 4.3.9: Summary of EUNIS subtidal broad scale habitats, habitat complexes and biotope complexes identified during the surveys of the Offshore Scheme

Broadscale habitat	Habitat complex	Biotope complex	E.g. MMT Survey Kilometre Point (KP)
A4 Circalittoral rock and other hard substrata	**A4.2** Atlantic and Mediterranean moderate energy circalittoral rock	**A4.23** Communities on soft circalittoral rock	KP15.4.
		A4.23/A5.44 Communities on soft circalittoral rock/Circalittoral mixed sediments	KP67.4.
A5 Sublittoral sediment	**A5.1** Sublittoral coarse sediments	**A5.13** Infralittoral coarse sediment	KP120.0.
		A5.14 Circalittoral coarse sediment	KP80.7; and KP118.1.
		A5.14/ A5.44 Circalittoral coarse sediment/Circalittoral mixed sediment	KP80.7.
		A5.141 *Pomatoceros triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles	KP116.7.
		A5.141/ A5.14 *Pomatoceros triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles/ Circalittoral coarse sediment	KP118.1.
		A5.141/ A5.44 *Pomatoceros triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles/ Circalittoral mixed sediment	KP107.7.
		A5.142 *Mediomastus fragilis*, *Lumbrineris* spp. And venerid bivalves in circalittoral coarse sand or gravel	KP52.6.
	A5.2 Sublittoral sand	**A5.23** Infralittoral fine sand	KP0.2.
		A5.231 Infralittoral mobile clean sand with sparse fauna	KP2.4.
		A5.233 *Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand	KP110.8; KP111.2; KP111.6; KP112.3;

Broadscale habitat	Habitat complex	Biotope complex	E.g. MMT Survey Kilometre Point (KP)
			KP113.5; KP114.6; and KP115.3.
		A5.24 Infralittoral muddy sand	KP0.2; and KP90.9.
		A5.25 Circalittoral fine sand	KP30.3; and KP55.3.
		A5.26 Circalittoral muddy sand	KP37.0; and KP93.1.
		A5.261 *Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment	KP3.2.
		A5.261/ A5.335 *Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment/*Ampelisca* spp., *Photis longicaudata* and other tube-building amphipods and polychaetes in infralittoral sandy mud	KP75.4.
	A5.3 Sublittoral mud	**A5.33** Infralittoral sandy mud	KP0.2.
		A5.35 Circalittoral sandy mud	KP6.2; KP12.3; and KP59.9.
		A5.355 *Lagis koreni* and *Phaxas pellucidus* in circalittoral sandy mud	KP34.7.
		A5.355/A5.44 *Ampelisca* spp., *Photis longicaudata* and other tube-building amphipods and polychaetes in infralittoral sandy mud/Circalittoral mixed sediment	KP34.7.
		A5.36 Circalittoral fine mud	KP90.0.
	A5.4 Sublittoral mixed sediments	**A5.43** Infralittoral mixed sediments	KP120.8.
		A5.44 Circalittoral mixed sediment	KP16.7; KP22.7; KP26.5; KP34.7; KP80.7; KP107.7; KP113.2; KP114.1; and KP114.2.
	A5.6 Sublittoral biogenic reefs	**A5.611** *Sabellaria spinulosa* on stable circalittoral mixed sediment	KP13.8; and KP19.3.

Broadscale habitat	Habitat complex	Biotope complex	E.g. MMT Survey Kilometre Point (KP)
		A5.625 *Mytilus edulis* beds on sublittoral sediment	KP15.4.

Subtidal Macrofauna

4.3.7.17 The subtidal survey area is generally comprised of rich and diverse macrofaunal communities, made up of infaunal and epifaunal invertebrates. A detailed assessment of the benthic macrofauna within the Offshore Scheme is presented in **Appendix 4.3A** and is summarised below.

4.3.7.18 Across the survey area polychaetes were the most abundant fauna, accounting for over half of all individuals collected from grab samples. They also accounted for just over 40% of taxa. Molluscs and crustaceans were also important components of benthic communities with molluscs accounting for 24% of individuals and 18% of taxa and crustaceans 15% of individuals and 30.5% of taxa. The molluscs were dominated by bivalves. These three taxonomic groups accounted for 91% of the individuals and 89% of the recorded taxa from the grab samples.

4.3.7.19 In terms of colonial epifauna, a total of 273 separate colonies were identified, consisting of 43 different taxa. Of these, the dominant phyla were bryozoans, with 53% of the total taxa, followed by cnidarians with 33% of the total. Abundance was also dominated by bryozoans with a total of 179 colonies, followed by cnidarians with a total of 85 colonies.

4.3.7.20 Throughout the Offshore Scheme, the sublittoral sediment was dominated by polychaete worms, with abundance peaking in areas where the '*Sabellaria spinulosa* on stable circalittoral mixed sediment' biotope occurred (MMT-KP19.3). Mollusc abundance was also at its highest when associated with biogenic reef (MMT-KP15.4). There are some areas, particularly in sandy habitats where fauna was sparse, such as between MMT-KP111.6 and MMT-KP115.3 within the Goodwin Sands MCZ.

4.3.7.21 Species richness and Shannon-Wiener diversity index[3] varied across the grab samples. Several communities were identified through multivariate analysis, with results showing that gravel and mud together constituted the variables that best explained the observed pattern of spatial distribution for fauna. However, the sediment composition within the Offshore Scheme does not fully explain the associated fauna found. This is possibly explained by other factors, such as depth and hydrodynamics, as well as stochastic events, which can also play a role in forming the faunal composition. However, it can also be an indication that the boundaries between sediment classes are not aligned with how they affect the species composition. Both of these explanations are likely affecting the faunal communities identified along the route.

[3] The Shannon-Weiner diversity index is a quantitative measure of the diversity of species in a community, taking into account the total number of different species and how evenly individuals are distributed among those species.

Subtidal habitats and species of conservation importance

4.3.7.22 Several subtidal habitats identified within the Study Area are listed as habitats of conservation importance, either under Annex I of the Habitats Directive (Ref 3.2) or as habitats of national conservation importance under Section 41 of the NERC Act 2006 (Ref 3.7) (Table 4.3.10). The presence of potential habitats of conservation importance is discussed in further below and within **Appendix 4.3A**.

Sandbanks which are slightly covered by sea water all the time

4.3.7.23 'Sandbanks which are slightly covered by sea water all the time' (H1110) are an Annex I habitat listed under the Habitats Directive (Ref 3.2) (Table 4.3.10). This habitat is composed of sandy well-sorted substrates that form banks, which remain permanently covered by shallow sea water, typically occurring in water depths of <20 m below Chart Datum (Ref 3.36). Sandbanks which are slightly covered by sea water all the time occur widely around the UK coast. Margate and Long Sands Special Area of Conservation (SAC), located approximately 2 km from the Offshore Scheme, is designated for the protection of this habitat (Ref 3.37) (Table 4.3.11).

4.3.7.24 Subtidal sandbanks are high energy environments, subject to physical disturbance from strong tidal currents. The sediment type of these habitats is the key driver of the diversity and type of associated communities, as well as physical, chemical, and hydrographic factors (e.g., exposure, temperature, topography, depth, turbidity, and salinity). Burrowing fauna such as worms, crustaceans, bivalve molluscs, and echinoderms typically colonise this habitat. Mobile shrimp, gastropods, crabs, and fish, including sandeel, may also be found. Where coarse sediments are stable, species of foliose algae, hydroids, bryozoans, and ascidians may be present.

4.3.7.25 During the benthic surveys of the Offshore Scheme, Annex 1 'sandbanks which are slightly covered by sea water all the time' were identified at several separate locations along the route (between MMT-KP1.5 and MMT-KP123.7) (**Figures 4.3.2 Subtidal habitat complexes within the Offshore Scheme**) though none were within a designated site.

Communities on circalittoral rock

4.3.7.26 Two subtypes of 'Communities on soft circalittoral rock' (A4.23) - clay outcrops and soft chalk, were identified in the Offshore Scheme.

4.3.7.27 The habitat 'Peat and clay exposures' is distributed along the south and east coast of England, in intertidal areas, but very little is known of the subtidal extent. The habitat can be difficult to assess with regards to distribution and extent due to periodic coverage of mobile sediments and subsequent emergence. 'Peat and clay exposures' and 'Subtidal chalks' are listed as 'Habitats of Principal Importance' under Section 41 of the 2006 NERC Act (Ref 3.7) (Table 4.3.10).

4.3.7.28 The data collected indicate the presence of scattered areas of outcropping clays or clay covered by a thin veneer of sediment, primarily in the northern and central parts of the route at MMT-KP0.0 and MMT-KP7.6, in the nearshore areas close to the northern landfall (**Appendix 4.3A**).

4.3.7.29 Soft chalk was identified primarily in the southernmost areas of the Offshore Scheme route (at MMT-KP101.1 and MMT-KP127.3) (**Figure 4.3.2 Subtidal habitat complexes within the Offshore Scheme**).

Subtidal sand and gravels

4.3.7.30 Subtidal Sands and Gravels were observed at several grab sample sites as subtypes of the EUNIS biotopes A5.1 and A5.2 (**Figure 4.3.2 Subtidal habitat complexes within the Offshore Scheme** and **Appendix 4.3A**). This broad habitat type is listed as a 'Habitat of Principal Importance' under Section 41 of the 2006 NERC Act (Ref 3.7) (Table 4.3.10).

4.3.7.31 There is an overlap between this habitat and Annex I 'sandbanks which are slightly covered by sea water all the time' (1110). Subtidal Sands and Gravels are a wider habitat not limited to sandbanks but include other sandy and gravelly habitats.

Sabellaria spinulosa reefs

4.3.7.32 The Ross-worm, *Sabellaria spinulosa*, is a small, tube-building polychaete worm found in the subtidal and lower intertidal/subtidal fringe and is widely occurring across the UK. *S. spinulosa* was identified at 16 grab sample sites across the majority of the survey area except for the nearshore (**Appendix 4.3A**).

4.3.7.33 When conditions are favourable, dense aggregations of worms can develop, forming biogenic reefs up to about 60 cm high and extending over several hectares (Ref 3.38). *S. spinulosa* qualifies for conservation interest under Section 41 of the NERC Act 2006 (Ref 3.7) where it forms reef features. However, analysis of 'reefiness', to assess the structure of the aggregations of *S. spinulosa* did not indicate large aggregations of tubes, and therefore no presence of reef formations was identified. Therefore, the *S. spinulosa* biotopes identified in the Offshore Scheme do not meet the qualifying criteria of Annex I habitat 'biogenic reefs' (1170) under the Habitats Directive.

4.3.7.34 Goodwin Sands Marine Conservation Zone (MCZ) is designated for the protection of 'Ross worm *Sabellaria spinulosa* reefs' (Ref 3.39) (Table 4.3.11). The Offshore Scheme crosses a small portion of the MCZ close to the Pegwell Bay landfall, between MMT-KP112.6 and MMT-KP116.6. However, data analysis of the reefiness of the *S. spinulosa* patches indicates *S. spinulosa* were not present in reef form, and therefore do not constitute Annex 1 habitat.

4.3.7.35 The Thanet Coast MCZ is also designated to protect 'Ross worm *Sabellaria spinulosa* reefs' (Table 4.3.11). However, this MCZ is located 1 km north of the Pegwell Bay landfall site, beyond the Offshore Scheme Boundary.

Blue mussel beds

4.3.7.36 Blue mussel beds, of the species *Mytilus edulis*, are listed as a Habitat of Principal Importance under Section 41 of the NERC Act 2006 (Ref 3.7). The habitat includes beds of mussels on some sediments, in various conditions. Blue mussel beds provide an area with enhanced biodiversity and play an important role in a healthy ecosystem.

4.3.7.37 During the benthic surveys, blue mussels were identified at grab sample sites and at several DDV transects at MMT-KP15.4 (**Appendix 4.3A**). However, aggregations of this species comprised patches rather than continuous reef, and therefore, this habitat does not meet the qualifying criteria of Annex I habitat 'biogenic reefs' (1170) under the Habitats Directive (Ref 3.2).

4.3.7.38 The Offshore Scheme passes through Goodwin Sands MCZ is which is designated to protect 'blue mussel *Mytilus edulis* beds' (Table 4.3.11). Of the five grab samples that were undertaken within this MCZ, juvenile *M. edulis* were identified in four of the grab samples but no mussel beds were observed from grab sampling, DDV or from remote sensing data (see also **Volume 1, Part 5, Chapter 4, Marine Conservation Zone Assessment**).

Table 4.3.10: Summary of subtidal habitats of conservation importance identified during the surveys of the Sea Link Offshore Scheme, and their associated designations

Habitat	Biotope complex	Habitats Directive Annex I (Ref 3.2)	Section 41 of the NERC Act 2006 (Ref 3.7)
Sandbanks which are slightly covered by sea water all the time	**A5.25** Circalittoral fine sand	**X**	**X**
Communities on circalittoral rock	**A4.23** Communities on soft circalittoral rock		**X**
Subtidal sand and gravels	**A5.1** Sublittoral coarse sediments **A5.2** Sublittoral sand		**X**

4.3.7.39 There are 12 invertebrate species nationally protected under the Wildlife and Countryside Act (1981) (Ref 3.4). However, none of these species were identified during the benthic survey (**Appendix 4.3A**).

Invasive and Non-Native Species

4.3.7.40 Five non-native species (NNS), two of which are invasive to the UK, were recorded within the survey area (**Appendix 4.3A**). These species were:

- *Goniadella gracilis* - a polychaete which is known to be widespread in the southern Irish Sea (Ref 3.40). However, unusually, only a single individual was recorded at one grab sample station, at MMT-KP113.5;
- *Austrominius modestus* (acorn barnacle) is an invasive species to the UK and has a well-established presence around the coast of England and Wales and in a few locations in Scotland and Ireland (Ref 3.41). This species is found at all levels of the shore but is more common mid-shore and may extend to shallow sublittoral. Six individuals were found across two grab sample stations at MMT-KP118.2 and MMT-KP121.0, in shallow nearshore areas;
- *Eusarsiella zostericola* is a benthic ostracod with a known distribution throughout the east of England, including the Thames Estuary (Ref 3.42). 54 individuals were found across four grab sample stations, two between MMT-KP6.0 and MMT-KP6.6, and one at each of MMT-KP10.4 and MMT-KP3.2;
- *Crepidula fornicata* (slipper limpet) is an invasive species first seen in the UK in 1872. Slipper limpet outcompetes other filter-feeding invertebrates and is now well established along much of the English coast (Ref 3.43). Five individuals were found

across four grab sample stations, three between MMT-KP52.6 and MMT-KP80.8 and one at MMT-KP116.7; and

- *Petricolaria pholadiformis* (American piddock) originates from North America and has been present in UK waters no later than 1890. There is no evidence that the species has displaced native piddocks and they are most commonly found off Essex and the Thames estuary (Ref 3.44). A single individual was recorded at MMT-KP4.5.

Fish supporting habitat

4.3.7.41 Benthic conditions, particularly the type of sediment present, is an important determinant of the presence of spawning grounds, for sandeel and herring in particular.

4.3.7.42 Raitt's sand-eel, *Ammodytes marinus*, is listed as a Species of Principal Importance under Section 41 of the NERC Act 2006 (Ref 3.7). Further, lesser sand-eel, *Ammodytes tobianus* is listed as DD (Data Deficient) by the IUCN Red List of Threatened Species (Ref 3.45).

4.3.7.43 Based on the sediment composition, five grab sample sites between MMT-KP111.2 and MMT-KP120.8 and one at MMT-KP2.4 were classified as "Preferred" sand eel habitat. A further eight sites between KP37.0 and MMT-KP118.2 and one at MMT-KP4.5, were classified as "Marginal" sand eel habitat (**Appendix 4.3A**). Additionally, two sand eel individuals were identified in grab samples at MMT-KP55.3 and MMT-KP110.8.

4.3.7.44 Furthermore, based on the sediment composition, two grab sample sites (MMT-KP113.2 and MMT-KP120.8) were classified as "Marginal" and "Suitable" for herring spawning ground preference (**Appendix 4.3A**).

4.3.7.45 For full details on fish spawning grounds, and potential impacts to this receptor from the Proposed Project see **Volume 1, Part 4, Chapter 4, Fish and Shellfish Ecology**.

Chemical analysis

4.3.7.46 Samples analysed for sediment chemistry were found to have levels of trace metals at all of the 34 sampling sites. However, none of the samples exceeded the CEFAS (Ref 3.24) Action Level (AL) 2 threshold. Analysis indicated that arsenic is the most prominent contaminant within the current survey, exceeding CEFAS (Ref 3.24) AL 1 threshold value at 15 of the grab sample sites, and the CCME Interim Sediment Quality Guidelines (ISQG) (Ref 3.25) assessment criteria at 32 sites. One of the sites, MMT-KP13.8, exceeded the CCME Probable Effect Level (PEL) (Ref 3.25) the level at which a substance is expected to have frequent adverse effects on aquatic ecosystems. However, previous studies have also demonstrated high concentrations of arsenic in several areas of the North Sea, including the outer Thames estuary (Ref 3.46), indicating high background levels.

4.3.7.47 The highest concentrations of lead and copper were measured at site MMT-KP118.1, 5 km southeast of the port of Ramsgate, exceeding both CEFAS (Ref 3.24) AL 1 and CCME ISQG assessment criteria (Ref 3.25), with lead exceeding CCME PEL assessment criteria (Ref 3.25). As the neighbouring survey sample sites have concentrations that do not exceed any thresholds, an explanation for the high concentrations of copper and lead could be the presence of many former licensed dredge spoil disposal sites in the area, combined with a sediment transport prediction made by CEFAS regarding the material disposed within Pegwell Bay and the Port of

Ramsgate (Ref 3.47). Since then, many more disposal sites have come into existence in the area, possibly increasing the distribution of contaminants.

4.3.7.48 It was found that the levels of metals showed no geographical trends and did not correlate with sediment composition, total organic carbon (TOC), or organic matter.

4.3.7.49 The concentration of TOC and organic matter varied along the survey route. Polycyclic aromatic hydrocarbon (PAH) concentrations exceeded CEFAS (Ref 3.24) AL 1 and CCME ISQG (Ref 3.25) threshold values for one or multiple PAHs at six grab sample sites. Concentrations were noted to be higher at the northern sites of the Offshore Scheme, but no correlation was found with either TOC, organic matter, or sediment composition.

Designated Sites

4.3.7.50 The key sites designated for the protection of benthic features within the benthic ecology Study Area, comprise four SACs, two Special Protection Areas (SPAs), four MCZs, and three SSSIs. These are listed below in Table 4.3.11 and shown on **Figure 4.3.1 Benthic Ecology Study Area and Designated Sites**.

Table 4.3.11: Sites designated for benthic ecology

Site name	Distance from Offshore Scheme (km)	Summary
Leiston-Aldeburgh Site of Special Scientific Interest (SSSI)	0	The SSSI covers the intertidal area of the landfall at Thorpeness (MMT-KP7.5). The site is designated for a range of habitats including wetlands, heathland, and woodlands, as well as a range of breeding and non-breeding bird features. The intertidal area is largely comprised of sandy habitat with a section of 'coastal vegetated shingle', a habitat of 'principal importance' under Section 41 of the 2006 NERC Act (Ref 3.7). Cables will be installed between the marine environment and onshore via a trenchless solution. There will be no activities in the intertidal environment, and thus, this site is not considered further.
Outer Thames Estuary Special Protection Area (SPA)	0	The Offshore Scheme crosses the SPA at three separate locations. The SPA was designated to protect a large wintering population of red-throated diver, *Gavia stellata*, breeding populations of common tern, *Sterna hirundo,* and little tern, *Sternula albifrons* (Ref 3.48). The grab sample sites located within the SPA, MMT-KP4.4 and MMT-KP80.7, are classified as 'Marginal' for sand eels, KP2.4 had sediment classified as 'Preferred'. Sand eels

Site name	Distance from Offshore Scheme (km)	Summary
		are an important food source for many seabirds, including those protected by the SPA.
Southern North Sea Special Area of Conservation (SAC)	0	The Offshore Scheme crosses the SAC at three separate locations. The SAC is designated to protect harbour porpoise, *Phocoena phocoena* (Ref 3.37). This species is known to prefer foraging in areas of coarser sediment, like sand and gravel, over fine sediment such as mud. Of the grab sample sites located within the SAC, the sediment consisted mainly of sand and gravel.
Orford Inshore Marine Conservation Zone (MCZ)	9	This site is located to the east of the Suffolk landfall and is designated for the protection of 'subtidal mixed sediments'. Subtidal mixed sediments were identified between MMT-KP15.4 and MMT-KP30.3 of the Offshore Scheme. However, these observations were made beyond the boundary of the MCZ.
Margate and Long Sands SAC	2	Located west of the Offshore Scheme, designated for the protection of the Annex I habitat 'sandbanks which are slightly covered by sea water all the time' (Ref 3.37). There were several large areas of this Annex I habitat identified along the Offshore Scheme, none of which were located within this SAC. However, it is worth noting the dynamic and mobile nature of the fine sediment associated with this protected feature.
Kentish Knock East MCZ	1	This site is located to the east of the central part of the Offshore Scheme and is designated for the protection of 'subtidal sand', 'subtidal coarse sediment', and 'subtidal mixed sediment'. The Offshore Scheme was found to be dominated by subtidal mixed sediments. These observations were made beyond the boundary of the MCZ. However, it is worth noting the dynamic and mobile nature of these sediment features.
Thanet Coast MCZ	<1	The MCZ is located north of the Pegwell Bay landfall site, west of the Offshore Scheme, and is designated to protect 'blue mussel *Mytilus*

Site name	Distance from Offshore Scheme (km)	Summary
		edulis beds', 'moderate energy circalittoral rock', 'moderate energy infralittoral rock', 'peat and clay exposures', 'Ross worm *Sabellaria spinulosa* reefs, 'stalked jellyfish *Calvadosia cruxmelitensis*' '*Haliclystus* spp.', 'subtidal chalk', 'subtidal coarse sediment', 'subtidal mixed sediments', and 'subtidal sand' (Ref 3.39). The survey of this section of the Offshore Scheme closest to this MCZ did not identify any of the protected features of the site. However, subtidal sand, mixed sediments, and juvenile blue mussel these were identified beyond the boundaries of the MCZ.
Thanet Coast SAC	<1	Adjacent to the Offshore Scheme close to Pegwell Bay, this SAC is designated for the protection of 'reefs' and 'submerged or partially submerged sea caves'.
Thanet Coast SSSI	1	The Thanet Coast SSSI is located to the north of the Pegwell Bay landfall site, and is designated for the protection of foreshore habitats, such as sand and mudflats and smaller areas of saltmarsh and coastal lagoons.
Sandwich Bay SAC	0	Covers the intertidal area of Pegwell Bay, where the Kent Landfall is located. This site is designated for the protection of a range of dune habitats.
Thanet Coast and Sandwich Bay SPA	0	The Offshore Scheme crosses the SPA between MMT-KP124.9 and MMT-KP127.0. The SPA is designated to protect a breeding population of little tern, *Sternula albifrons,* and wintering populations of European golden plover, *Pluvialis apricaria,* and ruddy turnstones, *Arenaria interpres* (Ref 3.48). None of the sample sites located within the SPA comprised a sediment composition suitable for sandeel or herring spawning.
Sandwich Bay to Hacklinge Marshes SSSI	0	The Sandwich Bay to Hacklinge Marshes SSSI covers the intertidal area of Pegwell Bay, where the Kent landfall is located. This site is designated for the protection of a range of benthic habitats. Cables will be installed between the marine environment and onshore via a trenchless

Site name	Distance from Offshore Scheme (km)	Summary
		technique. There will be no activities in the intertidal environment, and thus, this site will not be considered further.
Goodwin Sands MCZ	0	Offshore Scheme crosses the site close to the Pegwell Bay landfall, between MMT-KP112.6 and MMT-KP116.6. The MCZ is designated for the protection of 'subtidal coarse sediment', 'subtidal sand', 'blue mussel beds', 'moderate energy circalittoral rock' and 'Ross worm *Sabellaria spinulosa* reefs' (Ref 3.39). Of the five grab samples taken from within the MCZ, the protected feature 'subtidal sand' was identified at three of the samples. Of these grab samples fauna was found to be particularly sparse, although juvenile blue mussels were identified within four of the grab samples at sites between MMT-KP113.2 and MMT-KP114.6.

4.3.7.51 Detailed HRA and MCZ Assessments have been undertaken for the Offshore Scheme and are provided in **Volume 1, Part 5, Chapter 3, Habitat Regulations Screening Report** and **Part 5, Chapter 4, Marine Conservation Zone Assessment**.

Summary of Receptors

4.3.7.52 The benthic ecology receptors taken forward for consideration in the appraisal have been determined based upon the potential interactions between benthic receptors and the project activities identified in Table 4.3.12.

Table 4.3.12: Benthic ecology receptors and their assigned value

Receptor group	Description	Rationale	Value
Benthic Habitats	Sandbanks which are slightly covered by seawater all the time	• Annex I habitat (Ref 3.2), does not overlap with Offshore Scheme; • NERC Section 41 habitat (Ref 3.7); and • Have some capacity to absorb change.	**High**
	Communities on circalittoral rock	• NERC Section 41 habitat (Ref 3.7).	**Medium**

Receptor group	Description	Rationale	Value
	Subtidal sands and gravels	• NERC Section 41 habitat (Ref 3.7). • Protected feature of Goodwin Sands MCZ; • Have some capacity to absorb change; and • Common and widespread habitats.	**Medium**

Future Baseline

4.3.7.53 The benthic ecology chapter within the ES will include an outline of the likely evolution of the baseline environment without the implementation of the development as far as natural changes from the baseline scenario can be assessed.

4.3.8 Mitigation

4.3.8.1 As set out in **Part 1, Chapter 5, PEIR Approach and Methodology**, mitigation measures typically fall into one of the three categories: embedded measures; control and management measures; and mitigation measures.

Embedded Measures

4.3.8.2 Embedded measures have been integral in reducing the benthic ecology of the Proposed Project. Measures that that have been incorporated are:

- Sensitive routeing and siting of infrastructure and temporary works; and
- Commitments made within **Appendix 1.4.F Outline Schedule of Environmental Commitments**.

Control and Management Measures

4.3.8.3 The following measures have been included within **Appendix 1.4.A Outline Code of Construction Practice** relevant to the control and management of impacts that could affect benthic ecology receptors:

- BE01 - A biosecurity plan will be produced for the project, following the latest guidance on INNS from the GB non-native species secretariat.
- BE02 - All project vessels must adhere to the International Maritime Organisation (IMO) Guidelines for the control and management of ships' biofouling to minimize the transfer of invasive aquatic species (Biofouling Guidelines 2011).
- BE03 - Any material introduced into the marine environment, such as rock protection material, will be from a suitable source to ensure no INNS can be introduced.
- BE04 – Where possible, cable protection materials will be selected to match the environment (e.g. when cables are installed in areas of cobbles or other natural rock

features, rock of similar diameter and material as the receiving environment should be used as an alternative to the current normal approach of using terrestrially sourced granite) (NE and JNCC, 2022 (Ref 4.20)).

- FSF01 In accordance with the Department of Energy and Climate Change report and MMO recommendations, the target DOL will be between 1.5 m to 2.5 m (subject to local geology and obstructions) to minimise the effects of EMF for fish receptors.
- LVS01 - All project vessels must adhere to the International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004 (BWM Convention) (IMO, 2017).
- LVS02 - All project vessels must comply with the International Regulations for Preventing Collisions at Sea (1972) (IMO, 2019a), regulations relating to International Convention for the Prevention of Pollution from Ships (the MARPOL Convention 73/78) (IMO, 2019e) with the aim of preventing and minimising pollution from ships and the international Convention for the Safety of Life at Sea (SOLAS, 1974).
- LVS04 - All oil, fuel and chemical spills will be reported to the MMO Marine Pollution response team;
- LVS05 - Drilling fluids required for trenchless operations will be carefully managed to minimise the risk of breakouts into the marine environment. Specific avoidance measures would include:
  - the use of biodegradable drilling fluids (PLONOR substances) where practicable;
  - drilling fluids will be tested for contamination to determine possible reuse or disposal; and
  - If disposal is required drilling fluids would be transported by a licensed courier to a licensed waste disposal site.
- GM03 - An offshore Construction Environmental Management Plan (CEMP) including an Emergency Spill Response Plan and Waste Management Plan, Marine Pollution Contingency Plan (MPCP), Shipboard Oil Pollution Emergency Plan (SOPEP) and a dropped objects procedure will be produced prior to installation;
- GG15 - Fuels, oils and chemicals will be stored responsibly, away from sensitive water receptors.

Mitigation Measures

4.3.8.4 As set out in **Volume 1, Part 1, Chapter 5, PEIR Approach and Methodology**, mitigation measures typically fall into one of the three categories: embedded measures; control and management measures; and mitigation measures.

4.3.8.5 No additional mitigation measures have been identified to mitigate impacts on benthic ecology, as none are considered necessary beyond the embedded, control and management measures listed above.

4.3.9 Preliminary Assessment of Effects

4.3.9.1 The preliminary assessment of the effects of the Offshore Scheme reported in this section considers the embedded, control and management measures described in section 4.3.8.

4.3.9.1 For the sensitivity test outlined in section 4.3.5, preliminary effects reported would not be any different if the works were to commence in any year up to year five.

4.3.9.2 The preliminary benthic ecology assessment of the effects of the Offshore Scheme is presented in Table 4.3.13.

4.3.9.3 The preliminary effects reported below are the same for the Proposed Project on its own, and the Proposed Project with co-location.

Table 4.3.13: Preliminary assessment of benthic ecology effects

	Preliminary assessment
Receptor	Benthic ecology
Potential impact	**Temporary physical disturbance to subtidal benthic habitats and species** A number of project activities will result in temporary physical disturbance to intertidal and subtidal benthic habitats and species, including: • boulder plough or grab (swathe of 30 to 40 m, length to be confirmed after final route position list); • pre-lay grapnel run (swathe of 1 to 3 m, length of ~116.7 km); • sandwave lowering (sidecasting/controlled flow excavators) (swathe of 30 to 40 m, length of ~7.3 km); • sandwave lowering (pre-sweeping) (swathe of 20 to 25 m, length of ~25 km); • sea trials (not currently envisaged) (swathe of 20 to 40 m, length of 1 km minimum); and • cable trenching – expected to include a number of different methods depending on seabed conditions (e.g., ploughing, jet trenching, and/or mechanical trenching) (swathe ranges from 5 m to 20 m, length of cable route).
Proposed Project phase	Construction, maintenance, and decommissioning
Duration	After the construction phase this could occur intermittently throughout cable lifetime
Mitigation	N/A

	Preliminary assessment
Preliminary sensitivity	Sensitivity to the impact of habitat disturbance varies between habitats and species, depending on the stability of the habitat and its resilience to disturbance, and the vulnerability of individual species to mechanical disturbance. The Offshore Scheme is characterised by six broadscale habitat complexes: Atlantic and Mediterranean moderate energy circalittoral rock; sublittoral coarse sediments; sublittoral sand; sublittoral mud; sublittoral mixed sediments; and sublittoral biogenic reef. Within these some habitats of conservation importance have been identified. The only Annex I habitat observed within the Offshore Scheme, was 'sandbanks which are slightly covered by sea water all the time' (Ref 3.2), but it is not specifically protected under any designated site. Margate and Long Sands SAC, 2 km west of the Offshore Scheme, is the nearest site designated for the presence of Annex I sandbanks. Sandbanks in shallow water are subject to significant wave and tidal energy, are often low in biodiversity because of the natural disturbance regime, and so are considered to have high capacity to tolerate physical disturbance. This habitat is therefore, considered to have low sensitivity to temporary disturbance. Within the Offshore Scheme there are two additional NERC habitats of principal importance – 'communities on circalittoral rock' and 'subtidal sands and gravels' (Ref 3.7). These are not specifically protected by a designated site but are still considered to be of medium importance. These habitats can support high diversity, stable communities that are likely to be more vulnerable to physical disturbance. For many infaunal species, displacement will have only a temporary impact as fauna will be able to redistribute once the installation spread has moved away. However, epifaunal species are generally unable to move away and so are vulnerable to physical disturbance. These habitats are, therefore, considered to have medium sensitivity to temporary disturbance. The Offshore Scheme passes through the Goodwin Sands Marine Conservation Zone (MCZ). The only feature of this designated site identified within the Offshore Scheme was 'subtidal sands'. This habitat is considered to be of medium value and grab samples from within the MCZ were found to have sparse fauna. Sandy habitats such as this are dynamic as they are frequently exposed to significant wave and tidal energy.

	Preliminary assessment
	Considering the low biodiversity, this habitat is considered to have high capacity to tolerate physical disturbance and so has a low sensitivity to temporary disturbance. The remaining habitats within the Offshore Scheme comprise subtidal muds and mixed sediments, which are widespread in this region of the North Sea and so are considered to be of low importance. The communities in these habitats are likely to be dominated by infauna, that can tolerate some physical disturbance, and so are also considered to have low sensitivity to temporary disturbance.
Preliminary magnitude	Temporary disturbance as a result of Construction Phase activities will occur along the entire Offshore Scheme (a maximum of ~ 130 km in length). During maintenance and decommissioning any activities are expected to be similar in nature but of lower intensity than installation. Boulder plough or grabs would result in the widest disturbance swathe, of up to 40 m for the bundled cable trench. The length over which this method will be employed is currently unknown. However, for a worst-case estimate and to encompass any temporary disturbance by other cable installation methods, it is assumed that this will be for the entire length of the cable. In this scenario, the total area of temporary disturbance will be 5.2 km^2.'Subtidal sands and gravels' (Ref 3.7) were identified at 21 sites across the Offshore scheme and are known to be extensive along the adjacent coastline and wider North Sea area. Temporary physical disturbance is therefore likely to have a negligible effect on the wider distribution and extent of these benthic habitats, and thus have a small magnitude of effect. Furthermore, given the highly dynamic nature of subtidal sand and gravel habitats, sediments would be expected to recover from penetration, abrasion and disturbance, returning to baseline conditions within a short period of time (expected to be <12 months) (Ref 3.49). 'Communities on circalittoral rock' (Ref 3.7) was identified in very small patches throughout the Offshore Scheme. This habitat was the least common broadscale habitat seen throughout the Offshore Scheme but was identified in higher concentrations in nearshore areas close to both landfalls, particularly around MMT-KP16 and MMT-KP124 (**Figure 4.3.2 Subtidal habitat complexes within the Offshore Scheme** and **Figure 4.3.4 Habitats present at, and location of, trenchless solution entry/exit entry/exit pits**). Due to the temporary and localised nature of installation activities

	Preliminary assessment
	and the small-scale installation footprint compared to wider available area of habitat, the physical disturbance and/or temporary loss of this habitat is predicted to be of small magnitude.
Preliminary likely significance of effect	Based on the low-high sensitivity and small magnitude, the effect on subtidal benthic habitats and species from temporary physical disturbance as a result of the Offshore Scheme construction, maintenance and decommissioning activities is considered to be **Not Significant**.
Confidence in prediction	High – the impact assessment will be refined at ES stage when more information regarding installation methods is available. However, a worst-case scenario has been adopted for PEIR so any change to a not-significant assessment is expected.
Receptor	Benthic ecology
Potential Impact	**Direct loss of subtidal benthic habitats and species due to placement of hard substrates on the seabed** Cable installation, and repair, may require protection measures, and thus the placement of hard substrate (e.g., rock placement, concrete mattresses) at some locations. Introduction of hard substrate would replace other natural substrates, leading to permanent loss of these habitats and associated species. Options for external cable protection include: • rock placement (planned berms) (13.207 km planned prey-lay and post-lay rock berm, 10 m wide – area of 0.13207 km^2); • concrete mattresses (80 mattresses, over 480 m in length – area of 0.00144 km^2); • rock/gravel/sand/grout bags (to be confirmed); and • protection sleeves/cast-iron shells.
Proposed Project phase	Construction and maintenance
Duration	During construction and maintenance activities
Mitigation	BE04 Where possible, cable protection materials will be selected to match the environment (e.g. when cables are installed in areas of cobbles or other natural rock features, rock of similar diameter and material as the receiving environment should be used as an alternative to the current normal approach of using terrestrially sourced granite) (NE and JNCC, 2022).
Preliminary sensitivity	Rock placement has been identified as required at locations along the route, within all six of the habitat

complexes: Atlantic and Mediterranean moderate energy circalittoral rock; sublittoral coarse sediments; sublittoral sand; sublittoral mud; sublittoral mixed sediments; and sublittoral biogenic reef.

The only Annex I habitat observed within the Offshore Scheme, was ‘sandbanks which are slightly covered by sea water all the time’ (Ref 3.2), but it is not specifically protected under any designated site. Margate and Long Sands SAC, 2 km west of the Offshore Scheme, is the nearest site designated for the protected of Annex I sandbanks. Therefore, rock placement is not being considered in any areas of designated Annex I habitat.

Within the Offshore Scheme there were two additional NERC habitats of principal importance observed – ‘communities on circalittoral rock’ and ‘subtidal sands and gravels’ (Ref 3.7). These are not specifically protected by a designated site but are still considered to be of medium value; these habitats can support high diversity, stable communities that are likely to be more vulnerable to physical disturbance. For many infaunal species, displacement will have only a temporary impact as fauna will be able to redistribute once the installation spread has moved away. However, epifaunal species are likely to show a level of mortality as they are unable to move away from material added on top. These habitats are therefore, considered to have medium sensitivity to direct loss.

The Offshore Scheme currently passes through the Goodwin Sands MCZ (additional marine surveys in summer 2023 are being conducted to assess potential routeing to avoid this MCZ, see **Volume 1, Part 4, Chapter 1: Evolution of the Offshore Scheme**). The only protected feature of this designated site identified within the Offshore Scheme was ‘subtidal sands’. This habitat is considered to be of medium value and grab samples from within the MCZ were found to have sparse fauna. Sandy habitats such as this are dynamic as they are frequently exposed to significant wave and tidal energy. Thus, they are often low in biodiversity and so are considered to have high capacity to tolerate physical disturbance. This habitat is therefore, considered to have a low sensitivity to habitat loss.

The remaining habitats within the Offshore Scheme comprise subtidal muds and mixed sediments, which are widespread in this region of the North Sea and so are of low importance, and so are considered to have low sensitivity to direct loss.

	Preliminary assessment
Preliminary magnitude	The total footprint of permanent habitat loss as a result of placement of cable protection, including rock berms and concrete mattresses is approximately 0.13 km^2 (0.13 km^2 + 0.001 km^2), which equates to approximately 2.3 % of the Offshore Scheme. The habitat type most commonly identified as requiring rock placement was A5.142 *Mediomastus fragilis*, *Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel, which would lead to a loss of 0.04 km^2 of the total Offshore Scheme. The pre- and post-lay rock berms in 'subtidal sands and gravels' (Ref 3.7) are anticipated to cover a length of approximately 9.1 km, leading to an area of 0.10 km^2 habitat loss (1.8 % of the Offshore Scheme). The rock berms in 'communities on circalittoral rock' (Ref 3.7) are anticipated to be approximately 0.0002 km^2 (0.004 % of the Offshore Scheme). Furthermore, it is anticipated that an area of 0.01 km^2 of habitat will be permanently lost within Goodwin Sands MCZ. Given the prevalence of these habitats within the wider North Sea area, the dominance of these habitats across the Offshore Scheme, and the small spatial scale of permanent losses, this effect would not be expected to compromise the functional integrity of general habitats and species or diminish biodiversity at the regional scale. Therefore, any loss would be highly localised and small in scale, limited to isolated areas, and thus the magnitude is considered to be small. Also, where possible the rock protection will be of a similar material to the receiving environment though this may only be achievable in small areas.
Preliminary likely significance of effect	Although low-medium value habitats are potentially present within sections requiring external cable protection, any loss would be highly localised and small in scale, limited to isolated areas. Therefore, the overall effect is considered **Not Significant**.
Confidence in prediction	High – there is a good understanding of the nature of seabed habitats and an assessment of likely cable protection locations has been determined and used to undertake habitat specific assessments.
Receptor	Benthic ecology
Potential Impact	**Temporary increase in suspended sediment concentration (SSC) and sediment deposition leading to increased turbidity and smothering effects and possible contaminant mobilisation** Seabed disturbance from pre-installation (cable route clearance and pre-sweeping, if required) and installation or maintenance activities (cable trenching) have the

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	potential to increase SSC. The removal of the cable during decommissioning would also be expected to increase SSC. This can create a sediment plume in the water column that can travel away from the Offshore Scheme before the sediment is deposited on the seabed. There are several potential effects to benthic receptors, associated with increased SSC and sediment deposition including: • Reduced photosynthesis due to increased turbidity, resulting in reduced primary production in marine seaweed and algae; • Smothering of invertebrate species and clogging of respiratory and feeding apparatus; and • Indirect effects of the release of contaminants, such as heavy metals and hydrocarbons, during sediment mobilisation, on benthic species.
Proposed Project phase	Construction, maintenance, and decommissioning
Duration	Predominantly during the construction phase but may also occur periodically throughout the cable lifetime if maintenance is required.
Mitigation	N/A
Preliminary sensitivity	SSC and depositional loads will vary along the Offshore Scheme depending on the local environmental conditions, particularly the sediment type. The Offshore Scheme is characterised by six broadscale habitat complexes: Atlantic and Mediterranean moderate energy circalittoral rock; sublittoral coarse sediments; sublittoral sand; sublittoral mud; sublittoral mixed sediments; and sublittoral biogenic reef. Habitats with sediments with a high proportion of fine particulate material will remain in suspension longest and settle to the seabed more slowly (**Volume 1, Part 4, Chapter 2 Physical Environment**). The only Annex I habitat observed within the Offshore Scheme, was ‘sandbanks which are slightly covered by sea water all the time’ (Ref 3.2), but it is not specifically protected under any designated site. Margate and Long Sands SAC, 2 km west of the Offshore Scheme, is the nearest site designated for the protected of Annex I sandbanks. Sandbanks in shallow water are dynamic and are usually subject to varying levels of natural turbidity and energy. This natural disturbance regime means they generally support only a low level of

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	biodiversity Thus, the sensitivity of sandbanks to increased SSC and deposition is considered to be low. Within the Offshore Scheme there two additional NERC habitats of principal importance – 'communities on circalittoral rock' and 'subtidal sands and gravels' (Ref 3.7). These are not specifically protected by a designated site but are still considered to be of medium importance. These habitats can support diverse epifaunal communities, with some species vulnerable to increased SSC. Thus, sensitivity is considered to be medium. The remaining habitats within the Offshore Scheme comprise subtidal muds and mixed sediments, which are widespread in this region of the North Sea and so are of low importance and are considered to have low sensitivity to increased SSC. These benthic habitats support infaunal communities, as well as some mobile species including crustaceans and echinoderms which are able to move away from the effects. The infaunal communities that dominate this habitat type are generally tolerant of the levels of SSC and sediment deposition anticipated to result from installations of the Offshore Scheme and therefore it is expected that they will have a good capacity to quickly recover. As a result, benthic habitats are considered of low sensitivity. The Offshore Scheme passes through the Goodwin Sands MCZ. The only feature of this designated site identified within the Offshore Scheme was 'subtidal sands'. This habitat is considered to be of medium value and grab samples from within the MCZ were found to have sparse fauna. Sandy habitats, with low diversity, such as this are dynamic and are usually subject to varying levels of turbidity and energy. Thus, their sensitivity to increased SSC is considered to be low.
Preliminary magnitude	Sediments across the Offshore Scheme are dominated by sandy sediments. However, the largest sediment plumes, and highest levels of SSC, will be associated with disturbance of sediments with a high proportion of fine particulate material. Areas of sublittoral muds were limited to approximately 2.9 % of the Offshore Scheme, with the largest areas located near the northern landfall between MMT-KP0.0 and 7.6. Dispersion processes will act to dilute the small proportion of fine and very fine sediment carried in suspension. These finer fractions that are transported further will also be rapidly diluted (**Volume 1, Part 4, Chapter 2 Physical Environment**), and the deposition

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	thickness on the seabed, where the sediment will settle, will be negligible and highly localised. Sediment contaminants could also be mobilised at these locations if above threshold levels. Heavy metal concentrations were found to vary throughout the route with the highest arsenic concentrations in the north of the Offshore Scheme, and highest lead and copper concentrations in southern sections of the Offshore Scheme but at levels consistent with general background levels for this region of the North Sea. PAHs (which were elevated in the northernmost section of the Offshore Scheme), were generally associated with finer material such as silts and clays. However, dilution processes are considered to result in no detectable changes in sediment bound contaminants above background levels. Therefore, the overall magnitude of the impact is considered to be negligible.
Preliminary likely significance of effect	Any mobilised sediment as a result of construction activities will be highly localised and short-term. Therefore, for the Offshore Scheme w, the overall impact is predicted to be **Not Significant**.
Confidence in prediction	Moderate – a precautionary approach to sediment dispersion has been taken.
Receptor	Benthic ecology
Potential Impact	**Introduction and spread of INNS via the addition of cable protection during construction and maintenance** The use of cables is expected to require protection at some locations, which will introduce hard substrates in the form of rock protection or mattresses, to habitats dominated by sediments ranging from mud to sand and gravel. This could provide additional habitat for any existing epifaunal INNS populations allowing for localised spreading. The potential impact of the introduction of INNS via vessel hull or ballast water was considered unlikely and scoped out due to the implementation of control and management measures.
Proposed Project phase	Construction and maintenance
Duration	During and after construction and maintenance activities
Mitigation	BE01, BE02, BE03, LVS01
Preliminary sensitivity	Sensitivity to the impact of INNS varies between habitats and the vulnerability of individual species associated with them. Whilst most non-native species are unlikely to

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	become invasive, those that do can out-compete native species and introduce diseases which could result in significant changes to community composition and mortality. The Offshore Scheme is characterised by six broadscale habitat complexes. Within these some habitats of conservation importance have been identified. The only Annex I habitat observed within the Offshore Scheme, was 'sandbanks which are slightly covered by sea water all the time' (Ref 3.2), but it is not specifically protected under any designated site. Margate and Long Sands SAC is 2 km west of the Offshore Scheme and is the nearest site designated for the protection of Annex I sandbanks. Sandbanks in shallow water are subject to significant wave and tidal energy, are often low in biodiversity and so are considered to have high capacity to tolerate disturbance. This habitat is therefore, considered to have a low sensitivity to the introduction and spread of INNS. Within the Offshore Scheme there two additional NERC habitats of principal importance – 'communities on circalittoral rock' and 'subtidal sands and gravels' (Ref 3.7). These are not specifically protected by a designated site but are still considered to be of medium importance. Furthermore, the remaining habitats within the Offshore Scheme comprise subtidal muds and mixed sediments, which are widespread in this region of the North Sea and so are considered to be of low importance. These habitats can support high diversity, stable communities. Individual species associated with these habitats have the potential to be vulnerable to competition from INNS, allowing INNS to spread throughout the habitat. These habitats are therefore, considered to have medium sensitivity to the introduction and spread of INNS. The Offshore Scheme passes through the Goodwin Sands MCZ. The only feature of this designated site identified within the Offshore Scheme was 'subtidal sands'. This habitat is considered to be of medium value and grab samples from within the MCZ were found to have sparse fauna. Thus, the sensitivity of this habitat to INNS is considered to be low. Therefore, the sensitivity of benthic ecology to the introduction and spread of INNS is considered to be low to medium.
Preliminary magnitude	Rock placement and concrete mattresses are proposed for a number of locations along the Offshore Scheme to

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	protect the cable at intersections with other cables or pipeline infrastructure and in areas where burial cannot be achieved. These locations are anticipated to consist of an area of 0.13 km^2. Some studies have demonstrated the ability for artificial hard structures to function as artificial rocky reef, which are known to be preferred habitat for many INNS acting as 'ecological steppingstones' (Ref 3.50). This could facilitate the colonisation and spread of INNS in areas of the benthos which may have previously been unsuitable. However, there remain uncertainties surrounding this theory (Ref 3.51) and the function of artificial structures as 'steppingstones' remains unclear. Two INNS were recorded within the survey area (**Appendix 4.3A**; section 4.3.7). The acorn barnacle, *Austrominius modestus* was found within two grab samples, and the slipper limpet, *Crepidula fornicata,* was found within four grab samples. Both of these species already have a very well-established presence along the coasts of England (Ref 3.41; Ref 3.43) and no spread of invasive species directly caused by subsea cables has been documented (Ref 3.52; Ref 3.53). To ensure, that the potential impact of INNS introduction is reduced, all rock and concrete mattresses used for cable protection will be clean, so do not provide a vector for INNS directly. Furthermore, although there are concerns around introduced substrata providing habitat for INNS, particularly given the substantial growth of marine infrastructure in the North Sea, to date, no spread of INNS caused by submarine cabling has been documented (Ref 3.52). Therefore, the overall magnitude of the impact to a small magnitude.
Preliminary likely significance of effect	Based on the adherence to best practise guidelines and mitigation measures in line with international standards, any impact from the introduction and spread of INNS is considered to be **Not Significant**
Confidence in prediction	Moderate – there is no evidence that the installation of subsea cables has been responsible for the spread of INNS. Most routes relate to vessel activities and mitigation measures in relation to the release of ballast water are in place for this.
Receptor	Benthic ecology
Potential Impact	**Underwater sound impacts on marine invertebrates** There are a number of activities associated with the construction, maintenance and decommissioning of the Offshore Scheme that generate underwater sound. The

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	sources of underwater sound include geophysical surveys, UXO clearance, route preparation, cable installation and project related vessel movement.
Proposed Project phase	Construction, maintenance, and decommissioning
Duration	Periodically during all project phases
Mitigation	N/A
Preliminary sensitivity	Sensitivity to the impact of underwater sound on benthic ecology, depends on the sensitivity of the species associated with the habitats. Marine invertebrates are believed to be sensitive to particle motion rather than to sound pressure (Ref 3.54), although few formal studies have been conducted on the impacts of underwater sound. At present there are no published sensitivity thresholds for invertebrates and observed responses are generally in relation to higher intensity sound sources such as from seismic surveys. The effects of underwater sound on invertebrates have been demonstrated within the literature. For example, anatomical damage was observed in rock lobster up to a year following seismic surveys (which usually generate very high intensity sound), but no effects were observed on snow crabs (Ref 3.55). Furthermore, the crustacean, *Nephrops norvegicus*, and the bivalve, *Ruditapes philip pinarum*, demonstrated behavioural responses to impact pile driving sound source levels in a controlled laboratory environment, including physiological stress responses (Ref 3.56). However, some species tested in this study, such as the brittlestar, *Amphiura filiformis,* demonstrated no behavioural response to underwater sound. In other laboratory experiments, a stress response in green shore crab, *Carcinus maenas*, subject to ship playback sound was observed (Ref 3.57), although, repeated exposure resulted in the crabs' habituation or tolerance to it. Moreover, responses can be subtle and may take extended periods of time to be expressed across a population or become detectable at an ecosystem level. In the absence of suitable anatomical studies, mortality may be a useful indicator of impacts to marine invertebrates. Field based studies revealed no evidence of increased mortality in scallops, clams, or lobsters following airgun exposure, or of reduced catch-rates for plankton, reef associated invertebrates, snow crab, shrimp, or lobster (Ref 3.62). These studies found responses in invertebrates ranged depending on species, with little evidence of increased

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	mortality or ecosystem impacts. Although there was evidence of anatomical damage and behavioural responses in lab studies with specific species (e.g., rock lobster (Ref 3.58) and green shore crab (Ref 3.59), respectively) there was also evidence that habituation is possible. Furthermore, there is an understanding that these more mobile species are able to move away from a sound source before the effects are realised. Thus, the overall magnitude of underwater noise on benthic ecology is considered to be negligible. A detailed appraisal of the underwater sound impacts to fish and shellfish is presented in **Volume 1, Part 4, Chapter 4, Fish and Shellfish Ecology**. Due to the value of the habitats present in the Offshore Scheme, and the understanding of the sensitivity of associated invertebrate species, benthic ecology is considered to be low sensitivity to underwater sound.
Preliminary magnitude	The activities associated with the construction, maintenance and decommissioning of the Offshore Scheme include: • Sub-bottom profiler – operating frequency of 0.5-12 kHz; • Acoustic positioning – operating frequency of 21-31 kHz; • Cable installation – operating frequency of 1-15 kHz; • Cable lay vessel (operating with dynamic positioning) – operating frequency of 0.005-3.2 kHz; • Support vessels – operating at a variety of frequencies, as vessels are continuously moving, any impacts will be transient and short term; and • Clearance of UXO - the loudest source of underwater sound that could be generated by the project, with a large impact radius. The sound associated with these activities will be operating at frequencies that are not expected to have an impact benthic ecology. Therefore, the type and duration of underwater sound generated by the activities is considered to have a negligible magnitude.
Preliminary likely significance of effect	Although there is currently very limited evidence on the effects of underwater sound on marine invertebrates, current data suggest that the effect of the type and

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	duration of underwater sound generated by the activities will be **Not Significant**.
Confidence in prediction	Moderate – there is evidence for only limited effects in invertebrates, but this is an ongoing area of research, and the rating reflects the need for additional studies.
Receptor	Benthic ecology
Potential Impact	**Disturbance to benthic habitats and species due to subsea cable thermal emissions** Marine HVDC power cables have been shown to generate and dissipate heat when active, reaching cable surface temperatures of up to 70°C (Ref 3.60). Such heat has the potential to cause sediment dwelling and demersal mobile organisms to move away from the affected area. Increased heat may also alter physio-chemical conditions for epifaunal species and bacterial activity (with shifts in bacterial community composition and changes in nitrogen cycling) in surrounding sediments, contributing to altered faunal composition and localised ecological shifts (Ref 3.61; Ref 3.62).
Proposed Project phase	Operation
Duration	Lifetime of the active cable
Mitigation	None specific to thermal emissions but the cable will be buried, to a target depth of between 1.5 m and 2.5 m (FSF01), for most of its length, reducing thermal effects at the seabed.
Preliminary sensitivity	Sensitivity to the thermal emissions depends on the sensitivity of the species associated with benthic habitats, as well as the sediment particle size composition (Ref 3.52), with coarser sediments with higher permeability transferring heat further but with a lower increase in temperature (Ref 3.60) . The Annex I habitat ‘sandbanks which are slightly covered by sea water all the time’ (Ref 3.2), was observed in the Offshore Scheme. However, it is not specifically protected under any designated site. Margate and Long Sands SAC, 2 km west of the Offshore Scheme, is the nearest site designated for the protected of Annex I sandbanks. Sandbanks are often low in biodiversity as they are often subject to significant wave and tidal energy. Furthermore, sediment particle size composition has been found to influence heat transfer, with sandy habitats experiencing a smaller temperature change than finer sediments (Ref 3.60). Thus, this habitat is considered to have a low vulnerability and low sensitivity to thermal emissions.

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	The Offshore Scheme passes through the Goodwin Sands MCZ. The only feature of this designated site identified within the Offshore Scheme was 'subtidal sands'. This habitat is considered to be of medium value and grab samples from within the MCZ were found to have sparse fauna. Thus, the sensitivity of this habitat is considered to be low. Within the Offshore Scheme there two additional NERC habitats of principal importance – 'communities on circalittoral rock' and 'subtidal sands and gravels' (Ref 3.7). These are not specifically protected by a designated site but are still considered to be of medium importance. These habitats support a range of benthic organisms, including infaunal species that may be directly affected by increases in sediment temperature. Coarser sediments may have higher biodiversity but with greater porosity will experience a lower temperature change than sandy habitats (Ref 3.60). Thus, the potential sensitivity of these habitats is also considered low.
Preliminary magnitude	The installation approach for the Offshore Scheme is two HVDC cables and one fibre optic cable bundled as one in one trench buried to a target depth of 1.5 m (subject to local geology and obstructions). Increased sediment temperature has the potential to affect infaunal species and assemblages directly. Whilst the sediment surrounding the cable may be heated, there is negligible capability to heat the overlying water column because of the very high heat capacity of water, meaning there would be no effects on epibenthic communities. Heat dissipation modelling undertaken for a similar cable installation project, the Eastern Green Link 2 submarine HVDC transmission link between Peterhead in Aberdeenshire and Drax in North Yorkshire (Ref 3.63) for bundled cables buried at a depth of 1.5 m, indicated that within 500 mm of the seabed surface the increase in sediment temperature was limited to approximately 3°C. However, seawater at the seabed surface will have a cooling effect and will dissipate any temperature increases further. Although thermal effects would be long-term and occurring continuously for the operational lifetime of the Offshore Scheme, the temperature increase is low level and likely to be only a few degrees higher than ambient at the shallow sediment depths (<20 cm) at which infauna species are typically found. Due to natural seasonal changes in water temperature, a temperature

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	change of a few degrees higher than ambient is regarded as an insignificant temperature increase. Coupled with the fact that any impacts would be highly localised, the overall magnitude of impact on benthic ecology is considered to be negligible.
Preliminary likely significance of effect	A range of sediment types have been classified within the Offshore Scheme. Increased sediment temperature has the potential to affect infauna species and assemblages directly. However, the area affected is very limited and benthic fauna are able to move away. Whilst the sediment surrounding the cable may be heated there is negligible capability to heat the overlying water column because of the very high heat capacity of water, meaning there would be no effects on epibenthic communities and impacts on benthic ecology are considered **Not Significant**.
Confidence in prediction	High – there are natural changes in sediment and water temperature seasonally and evidence indicates only very localised effects from buried cables.
Receptor	Benthic ecology
Potential Impact	**Electromagnetic field (EMF) emissions** Operation of the HVDC cables generates EMF emissions which may be detected by invertebrate species and could impact behaviour and ability to navigate (for mobile crustaceans for example). The worst-case scenario for the Offshore Scheme (**Appendix 4.8B**), indicates field intensities between 53 and 126 µT at the seabed surface.
Proposed Project phase	Operation
Duration	Lifetime of active cable
Mitigation	FSF01
Preliminary sensitivity	Sensitivity to the EMF emissions depends on the sensitivity of the species associated with benthic habitats. The Annex I habitat ‘sandbanks which are slightly covered by sea water all the time’ (Ref 3.2), was observed in the Offshore Scheme. However, it is not specifically protected under any designated site. Margate and Long Sands SAC is 2 km west of the Offshore Scheme and is the nearest site designated for the protected of Annex I sandbanks. Sandbanks are often low in biodiversity as they are often subject to significant wave and tidal energy. Thus, this habitat is

considered to have a low vulnerability and low sensitivity to EMF emissions.

The Offshore Scheme passes through the Goodwin Sands MCZ. The only feature of this designated site identified within the Offshore Scheme was 'subtidal sands'. This habitat is considered to be of medium value and grab samples from within the MCZ were found to have sparse fauna. Sandy habitats such as this are often low in biodiversity as they are often subject to significant wave and tidal energy. Thus, this habitat is considered to have a low vulnerability and low sensitivity to thermal emissions.

Within the Offshore Scheme there two additional NERC habitats of principal importance – 'communities on circalittoral rock' and 'subtidal sands and gravels' (Ref 3.7). These are not specifically protected by a designated site but are still considered to be of medium importance. These habitats support a range of benthic organisms, however, there are few studies that indicate that benthic species are adversely impacted by the increases in EMF expected from the Offshore Scheme. Thus, the sensitivity of these habitats is considered low.

There is very little information about the sensitivity of benthic species to EMF but there have been a small number of investigations in laboratory experiments. There is evidence from studies that some benthic invertebrates are able to detect EMF. For example, the brown crab, *Cancer pagurus*, showed a clear attraction to EMF of 2,800 µT (microtesla) and reduced their time spent roaming. In another study, the blue mussel, *Mytilus edulis*, the brown shrimp, *Crangon crangon* and the crab, *Rhithropanopeus harrisii*, were all exposed to a static B-field of 3,700 µT for three months, and no differences in survival between experimental and control animals were detected (Ref 3.64).

Similarly, in another laboratory study with common rag worm, *Hediste diversicolor,* there was no evidence of avoidance or attraction behaviours at an EMF of 1000 µT (Ref 3.65) a much higher intensity than will the emitted by the Offshore Scheme. A recent study exposed embryonic and larval brown crab and European lobster, *Homarus Gammarus*, to an EMF 2,800 µT in laboratory conditions, noting increased occurrence of physical deformities in larvae, but no effect to development time or swim speed (Ref 3.66).

The edible crab has been subject to EMF exposure experiments, testing stress related parameters and behavioural response to lower intensity emissions. EMF

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	strengths of 250 µT were found to have limited physiological and behavioural impacts (Ref 3.67). At exposure of 500 µT and 1000 µT stress responses were detected in histological indicators but crabs also showed a clear attraction at these EMF levels. However, this attraction has been observed to not impact overall crab movements (Ref 3.68) and, in an experiment with American lobsters, only subtle behavioural responses to HVDC EMF were observed (Ref 3.69). There were notable changes in movement and distribution within an enclosed space, but the EMF did not represent a barrier to lobster movements, and no significant impact was observed overall. The worst-case scenario for the Offshore Scheme (**Appendix 4.8B**), indicates field intensities between 53 and 126 µT at the seabed surface, which is significantly lower than the field strength used in these studies, which showed no effect. Therefore, after consideration of the available literature (Ref 3.70; Ref 3.71) and project specific EMF modelling analyses (Ref 3.72), it is concluded that detection by invertebrates may be possible, but that at the levels of EMF produced by the cable responses are either negligible or absent and thus the sensitivity of benthic ecology is considered to be **low**. A detailed appraisal of EMF impacts to fish and shellfish is presented in **Volume 1, Part 4, Chapter 4, Fish and Shellfish Ecology**.
Preliminary magnitude	In a worst-case scenario, the HVDC cables will be bundled, which are known to emit significantly lower magnetic fields due to cancellation of the magnetic fields between poles. Modelling of the predicted EMF emissions for the Offshore Scheme (**Appendix 4.8B**) shows that the geometric field for a bundled cable design buried at 1 m, indicates field intensities between 53 and 126 µT at the seabed surface, and that the geometric field was reduced to background levels within around 8 m from the cable, having only a very localised effect. Considering the localised nature of the impact, the preliminary magnitude has been assessed as small.
Preliminary likely significance of effect	Any effects to benthic ecology would likely be highly localised to the immediate vicinity of the buried cable and only expose a very small area to EMF. Furthermore, in accordance with MMO recommendations, the cable burial depth will further minimise effects of EMF. Furthermore, some detection in benthic invertebrates may be possible but there have been no negative impacts observed at the EMF levels predicted for the

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	Offshore Scheme, with most species having the ability to move away from any effects. Therefore, the effect of EMF in relation to benthic ecology is appraised as negligible and therefore **Not Significant**.
Confidence in prediction	Moderate. There is scientific evidence to show that, at the levels of EMF predicted to be generated by a bundled HVDC cable, responses of invertebrates are low level. However, long-term effects are unknown but likely to also be low level.

4.3.10 Transboundary Effects

4.3.10.1 A transboundary effect is any significant adverse effect on the environment resulting from human activity, the physical origin of which is situated wholly or in part within an area under the jurisdiction of another State.

4.3.10.2 All works associated with the Proposed Project fall within the UK jurisdiction (12 NM). Given the distance of the Proposed Project from French waters (approximately 25 km), no significant transboundary effects have been identified. Predicted disturbance from the Proposed Project is short term and local and are therefore not anticipated to be sufficient to influence benthic ecology receptors outside UK waters, and subsequently cause transboundary effects.

4.3.10.3 Furthermore, the PEIR has concluded no significant effects for benthic ecology receptors in UK waters.

4.3.11 Summary

4.3.11.1 In summary:

- The subtidal benthic habitats identified along the Offshore Scheme are generally dominated by mud, sand, and coarse sediments, with the presence of very small areas of soft rock in nearshore areas close to both landfalls;
- The subtidal survey area is generally comprised of rich and diverse macrofaunal communities, made up of communities of infaunal and epifaunal invertebrates, with polychaetes found to be the most abundant fauna;
- Several subtidal habitats are listed as habitats of conservation importance. The Annex I (Ref 3.2) habitat ‘sandbanks which are slightly covered by sea water all the time’ is observed within the Offshore Scheme but is not specifically protected under any designated site. Moreover, habitats listed under Section 41 of the NERC Act 2006 (Ref 3.7) identified - ‘communities on circalittoral rock’ and ‘subtidal sands and gravels’, at several locations throughout the Offshore Scheme;
- The Offshore Scheme is located partially within the Goodwin Sands MCZ which is designated for several habitats including ‘subtidal sands’, although grab samples found that fauna was sparse within the MCZ. Additional relevant designated sites are located outside of the Offshore Scheme but within the study area are Thanet Coast MZC (located > 1 km southwest of the Offshore Scheme); and

- The preliminary assessment of effects indicates that after embedded, control and management mitigation measures, there are **no likely significant effects** from project activities on benthic ecology present within the Offshore Scheme Boundary.

4.3.12 References

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