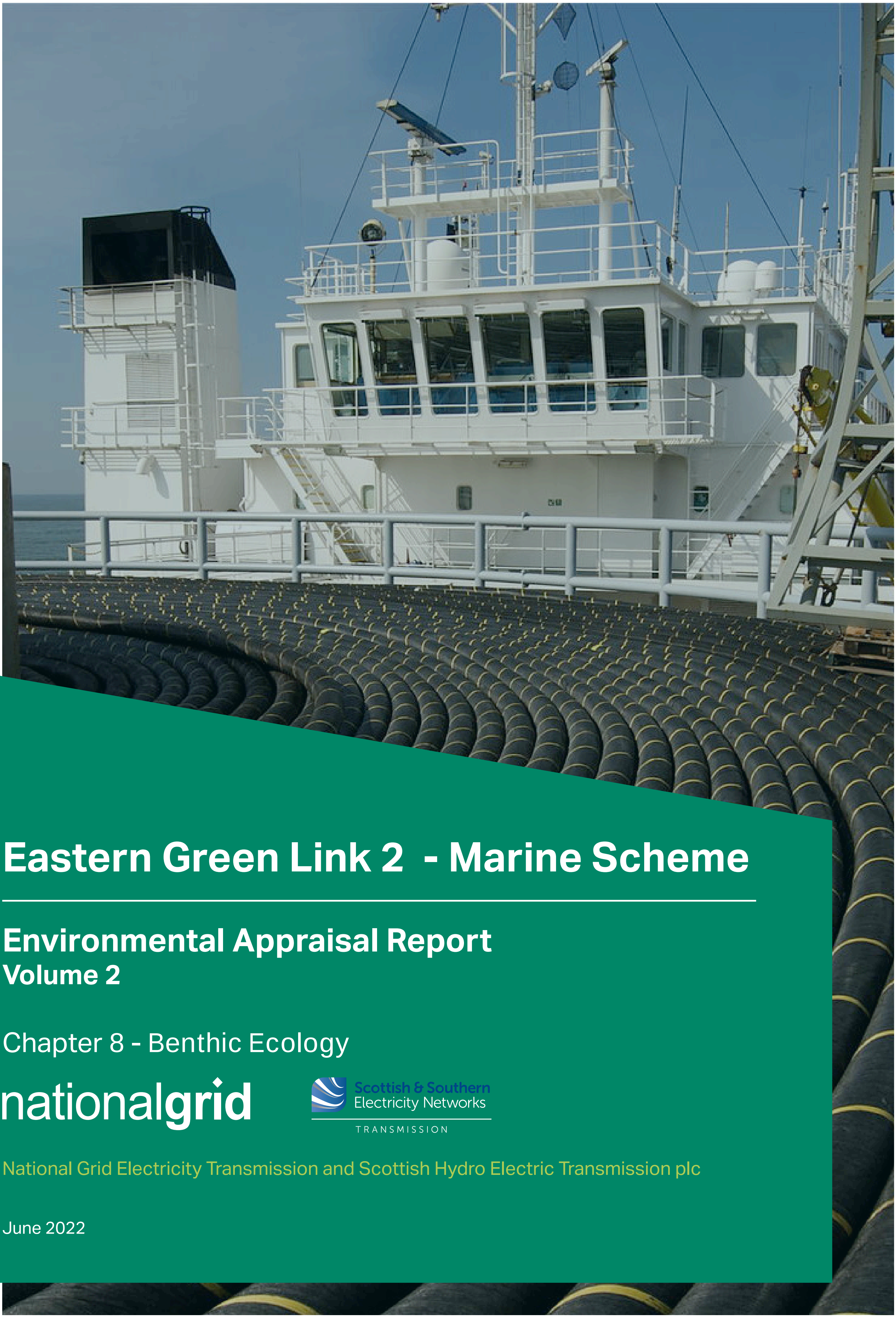

Eastern Green Link 2 - Marine Scheme

Environmental Appraisal Report
Volume 2

Chapter 8 - Benthic Ecology

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Scottish & Southern Electricity Networks
TRANSMISSION

National Grid Electricity Transmission and Scottish Hydro Electric Transmission plc

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Wessex Archaeology (Marine Archaeology); and

Brown and May Marine Ltd (Commercial Fisheries).

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Tables

8. Benthic Ecology

8.1 Introduction

This chapter of the Environmental Appraisal Report (EAR) presents an appraisal of the potential interaction of the Marine Scheme with benthic ecology.

A description of the works anticipated to be undertaken during the Installation, Operation and Maintenance and Decommissioning Phases of the Marine Scheme is provided in Chapter 2: Project Description. This chapter provides an overview of the benthic ecology baseline (Section 8.5) and considers the potential impacts of the Marine Scheme on these receptors (Section 8.6). Where appropriate, the chapter goes on to identify proportionate measures to avoid or mitigate for any identified adverse effects that would result (Section 8.7).

The potential for interaction between the Marine Scheme and other plans and / or projects, which may result in significant cumulative effects on benthic ecology, is considered in detail within Chapter 16: Cumulative and In-Combination Effects.

Impacts to benthic ecology may also be interrelated with impacts on fish and shellfish (Chapter 9) and ornithology (Chapter 11), as a result of predator-prey relationships between these groups. This chapter is supported by the following documents:

- Appendix 8.1: Eastern Green Link 2 Habitat Alignment Charts;
- Appendix 8.2: Eastern Green Link 2 Habitat Regulations Assessment (HRA); and
- Appendix 8.3: Eastern Green Link 2 Marine Protected Area (MPA) and Marine Conservation Zone (MCZ) Assessment.

8.2 Legislation, Policy and Guidance

This section outlines legislation, policy, and guidance relevant to the appraisal of the potential effects on benthic ecology associated with Installation, Operation and Maintenance, and Decommissioning Phases of the Marine Scheme. For further information regarding the legislative context, refer to Chapter 3: Legislative and Policy Framework and Appendix 3.2: Topic Specific Legislation.

8.2.1 International Legislation

The following international legislations concern the conservation and protection of benthic ecological receptors during the planning and execution of projects such as offshore cable developments:

- European Union Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora adopted in 1992.

8.2.2 National Legislation

The following national and devolved legislation concern the conservation and protection of benthic ecological receptors during the planning and execution of projects such as offshore cable development in UK waters:

8.2.2.1 UK (England and Scotland)

- Marine and Coastal Access Act (MCAA) 2009;
- Wildlife and Countryside Act 1981;
- The Marine Strategy Regulations 2010; and
- The Conservation of Offshore Marine Habitats and Species Regulations 2017.

8.2.2.2 Scotland

- Marine (Scotland) Act 2010;

- The Water Environment (Controlled Activities) (Scotland) Regulations 2011. Scottish Statutory Instrument 2011 No. 209 (as amended);
- The Conservation (Natural Habitats, &c.) Regulations 1994 (as amended);
- The Conservation (Natural Habitats, &c.) (EU Exit) (Scotland) (Amendment) Regulations 2019;
- Nature Conservation (Scotland) Act 2004;
- Water Environment and Water Services Act 2003; and
- Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended).

8.2.2.3 England

- The Conservation of Habitats and Species Regulations 2017 (as amended);
- The Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019;
- The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 (as amended); and
- Natural Environment and Rural Communities Act 2006.

8.2.3 International Policy

The following international policies concerning the conservation and protection of benthic ecology receptors during the planning and execution of projects such as offshore cable development:

- Convention for the Protection of the Marine Environment of the North-East Atlantic (the 'OSPAR Convention') adopted in 1998 and amended in 2007.

8.2.4 National Policy

The following national and devolved policies concerning the conservation and protection of benthic ecology receptors during the planning and execution of projects such as offshore cable development in UK waters:

8.2.4.1 UK (Scotland and England)

- UK Marine Policy Statement (MPS) (HM Government, 2011); and
- UK Post-2010 Biodiversity Framework, revised 2012–2019.

8.2.4.2 Scotland

- Scottish National Marine Plan (2015) (Scottish Government, 2015); and
- Scottish Planning Policy (Scottish Government, 2020).

8.2.4.3 England

- North East Inshore and North East Offshore Marine Plan (HM Government, 2021);
- East Inshore and East Offshore Marine Plans (HM Government, 2014);
- National Policy Statements (NPS) (National Policy Statements, 2011)[1];
- Biodiversity 2020: A strategy for England's wildlife and ecosystem services; and
- The revised National Planning Policy Framework (HM Government, 2021).

8.2.5 Guidance

In addition to the legislation and policies outlined above, the following guidance is also applicable for benthic ecology in UK waters:

[1] Recognising that EGL2 is not a Nationally Significant Infrastructure Project (NSIP), however NPS remains a useful source of guidance which can be drawn on as required.

- Chartered Institute for Ecology and Environmental Management (CIEEM) Guidelines for Ecological Impact Assessment in Britain and Ireland – Terrestrial, Freshwater, Coastal and Marine (CIEEM, 2018, and updated September 2019);
- Priority Marine Features (PMF) 2014 (Scottish waters only)[2];
- Refining the criteria for defining areas with a 'low resemblance' to Annex I stony reef (Golding, Albrecht, & McBreen, 2020);
- Defining and managing *Sabellaria spinulosa* reefs (Gubbay, 2007); and
- The identification of the main characteristics of Annex I stony reef habitats under the Habitats Directive (Irving, 2009).

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 (Marine Management Organisation, 2014) (Reviewed 2020). 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;
- UK Offshore Operators Association (UKOOA) sediment quality guidelines for the UK North Sea (UKOOA, 2001);
- Data from 'Clean Seas Environmental Monitoring Programme' at Tyne Tees (CSEMP, 2019) and a station at the Firth of Forth (Marine Scotland, 2020);
- OSPAR background concentrations and background assessment concentrations and effect range low (ERL) and effect range median (ERM) concentrations for contaminants (OSPAR, 2009); and
- Canadian Sediment Quality Guidelines (Canadian Council of Ministers of the Environment, 2001) 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 as broadly protective tools to support the functioning of healthy aquatic ecosystems.

8.3 The Study Area

The benthic ecology appraisal covers a 10 km wide study area centred on the Marine Installation Corridor (Figure 8-1). This Study Area has been defined to encompass all likely zones of influence for benthic habitats and species, as identified in Section 8.6.

The Marine Scheme installation will use Horizontal Directional Drilling (HDD) at both landfalls (Figure 8-2), avoiding work in the intertidal area. The breakouts, where the cable will be pulled for subsequent submarine installation, will be entirely in the subtidal environment. Indicative water depths for the breakout locations are as follows: Sandford Bay: 11 m to 20 m and Fraisthorpe Sands: 5 m to 6 m.

There will be no direct impacts to intertidal benthic ecology receptors and therefore these have not been considered further by this chapter. A benthic survey was undertaken to characterise benthic ecological conditions and map the distribution and extent of marine benthic habitats across and along the 500 m wide Marine Installation Corridor (NEXTGeosolutions, 2022).

[2] https://www.nature.scot/professional-advice/protected-areas-and-species/priority-marine-features-scotlands-seas

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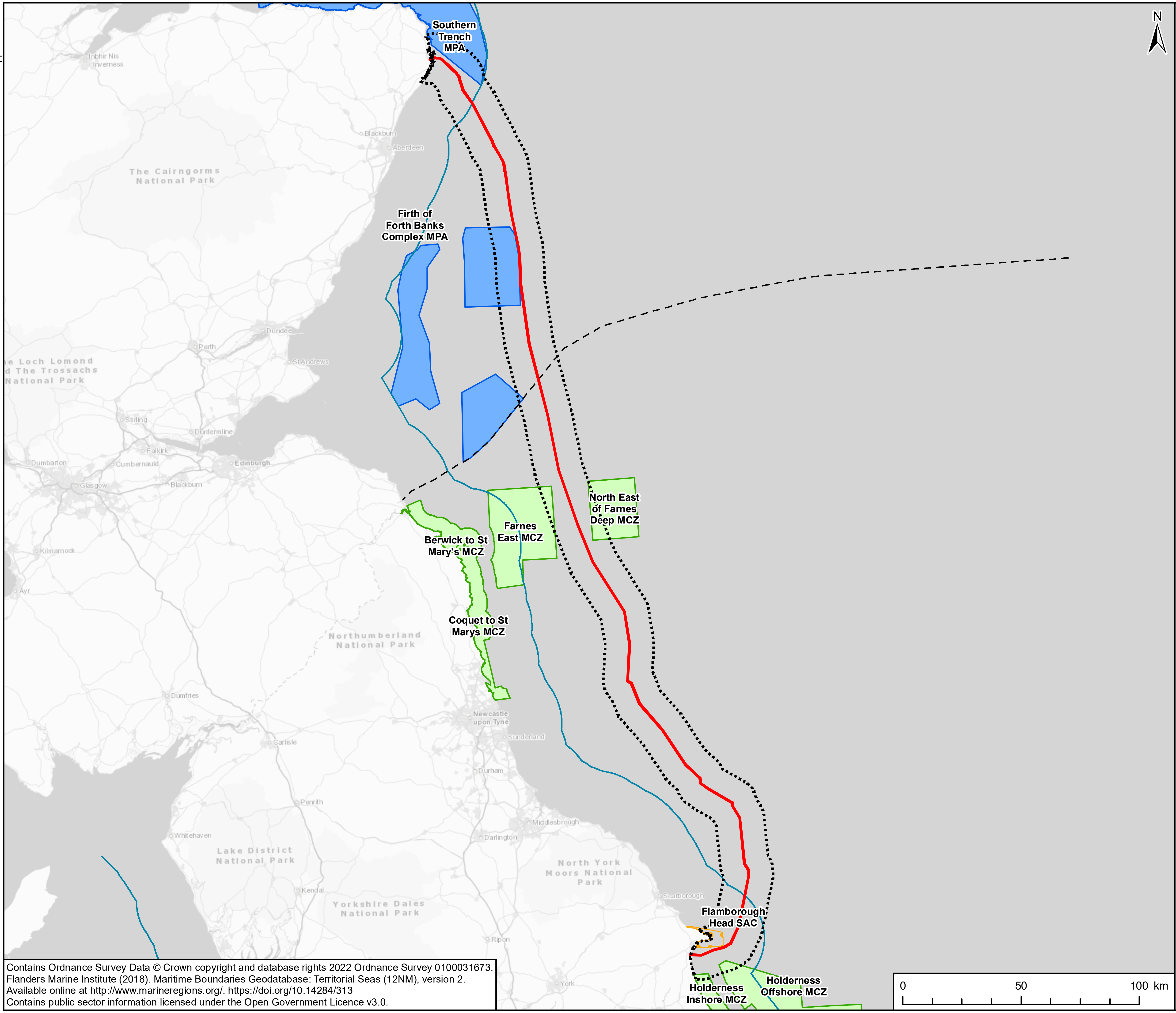

Coordinate System: WGS1984 Zone 30N

Scale @ A3 1:1,500,000

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PROJECT

Eastern Green Link 2

KEY

- Marine Installation Corridor
- 10km Study Area
- UK Territorial Sea Limit
- Scottish Adjacent Waters Boundary
- Special Area of Conservation (SAC)
- Nature Conservation Marine Protected Area (MPA)
- Marine Conservation Zone (MCZ)

TITLE

Figure 8-1
Overall Study Area and Marine Installation Corridor

REFERENCE

SEGL2_M_EAR_8-1_v3_20220615

SHEET NUMBER: 1 of 1

DATE: 15/06/2022

GIS: LC Checked: KB Approved: FF

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PROJECT
Eastern Green Link 2

KEY
- Marine Installation Corridor
- Kilometre Point (KP)
- Potential HDD Breakout Area
- Indicative HDD Compound Options

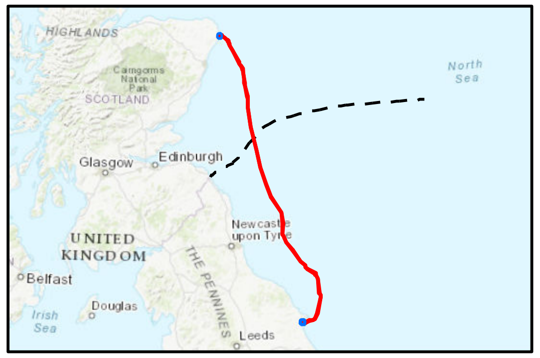

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Figure 8-2
Indicative Landfall Sites

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SHEET NUMBER 1 of 1
DATE 24/06/2022

8.4 Approach to Appraisal and Data Sources

8.4.1 Appraisal Methodology

This appraisal applies the methodology as detailed in Chapter 4: Approach to Environmental Appraisal. The identification and appraisal of effects and mitigation are based on a combination of professional judgment and the application of the guidelines listed in Section 8.2.5.

Advice received from Marine Scotland Licensing Operations Team (MS-LOT) on 03 September 2021 and the Marine Management Organisation (MMO) on 03 November 2021 identified aspects of the Marine Scheme that have the potential to impact the benthic ecology during Installation, Operation and Maintenance, and Decommissioning Phases[3]. Details of the advice received and how it is addressed in the appraisal are provided in Chapter 6: Consultation and Stakeholder Engagement and its supporting appendices.

The design for the Marine Scheme comprises two high-voltage direct current (HVDC) cables laid either in two separate parallel trenches (unbundled) or else in a single trench with the cables bundled together. If the two-trench approach is used the cables will be spaced up to a maximum of 30 m apart (referred to as a '30 m separated bi-pole'). For both approaches, the target depth of lowering is 1.5 m and the minimum depth of lowering without cable protection will be 0.6 m. Therefore, the appraisal considers the two-trench scenario only, as the worst case situation that will also encompass any potential effect should the cables be bundled.

8.4.2 Data Sources and Consultations

8.4.2.1 Data Sources

The benthic ecology baseline has been established by a combination of desktop review of published information, project-specific survey data, and consultation with relevant organisations. This aims to provide a robust and up-to-date characterisation of the benthic environment within the study area.

Field Surveys

A dedicated benthic characterisation survey (NEXTGeosolutions, 2022) programme was undertaken along the 500 m wide Marine Installation Corridor, a summary of which is provided below.

The approximate route length between the Scottish landfall (Peterhead, Aberdeenshire) to the English landfall (Fraisthorpe Sands, East Riding of Yorkshire) is 436 km. Intertidal survey operations were conducted between 24 to 30 April 2021. Nearshore survey operations were conducted between 19 April to 20 May 2021, with offshore survey operations conducted between 14 to 30 July 2021.

Geophysical, geotechnical and environmental surveys along the subtidal regions of the Marine Installation Corridor included an offshore section, in water depths between 0.6 m in nearshore areas to 101 m in the offshore areas.

Geophysical, geotechnical and benthic survey techniques were used to:

- Identify obstructions and debris on the seabed;
- Inform the route engineering;
- Determine whether any features and/or habitats of conservation importance were present; and
- Characterise seabed conditions.

The benthic environmental survey comprised drop-down video (DDV) and benthic grab sampling using a 0.1 m^2 dual van Veen (DVV) grab in muddy and sandy sediments and a 0.1 m^2 Hamon grab in coarse sediment. A total of 63 environmental sampling stations and 146 video and camera ground truthing stations were selected across the Marine Installation Corridor. A modified Phase I walkover habitat mapping survey and core sampling of the intertidal habitats was also undertaken at the landfall

[3] The non-statutory scoping report is publicly available at: https://marine.gov.scot/sites/default/files/segl2_el2_marine_scheme_non-statutory_scoping_report_eastern_link_2_marine_scoping_report_v5.0_finalcombined_ifi_-_issued_for_information_01_1_redacted.pdf

locations. A further 30 grab and core samples were acquired to characterise the intertidal benthic environment in terms of physiochemical characteristics and biological communities.

The results of video and grab samples were combined to classify the habitats and associated biological communities in terms of biotopes in line with the EUNIS habitat classification. This allowed evaluation of presence and extent of habitats, with a focus on features / habitats of conservation importance (FOCI / HOCI) including Annex I habitats and species, Priority Marine Features (PMFs), and any designated features of nearby MPAs and MCZs.

Desk Study

Desk study information was collected for the Study Area along the Marine Installation Corridor. A large amount of publicly available benthic ecology data exists for the North Sea, including information that is relevant to the Study Area. Much of this information has been produced for existing and historical offshore developments such as offshore wind farms and subsea cable projects that have been subjected to statutory environmental impact assessment (EIA) or non-statutory environmental assessment / appraisal procedures.

In addition, a range of other data sources have been examined to establish the baseline, including:

- The MAGIC website (https://magic.defra.gov.uk/home.htm), which provides authoritative geographic information about the natural environment from across government;
- Marine Scotland National Marine Plan Interactive (NMPI) https://marinescotland.atkinsgeospatial.com/nmpi/ which enables access to spatial information relating to the marine environment and activities, and has been designed to assist in the development of national and regional marine planning;
- European Marine Observation Data Network (EMODnet) (EUSeaMap 2021) Seabed Habitats Project (https://www.emodnet-seabedhabitats.eu/) for broad-scale predictive habitat maps of the Study Area;
- European Union Nature Identification System (EUNIS) (European Environment Agency, 2012) (updated in 2022) for classifying benthic habitats;
- European Environment Agency (European Environment Agency, 2019). European Nature Information Service [EUNIS] habitat type hierarchical view. (http://eunis.eea.europa.eu/habitats-code-browser.jsp);
- Joint Nature Conservation Committee Marine Protected Area (MPA) Habitat Mapper for detailed information on MPAs in the region (https://jncc.gov.uk/our-work/marine-protected-area-mapper/); and
- Historical survey outputs as available.

8.4.2.2 Summary of Consultation

Advice from the MMO and MS-LOT and their respective consultees and advisers provided feedback on the Marine Scheme and EAR scope. Those consultees and advisors include NatureScot, Scottish Environment Protection Agency (SEPA), Cefas, Joint Nature Conservation Committee (JNCC), Natural England, Environment Agency and Inshore Fisheries and Conservation Authorities (IFCAs).

Comments received confirmed that consultees were content with the proposed scope of the benthic ecology EAR chapter as proposed by the non-statutory scoping report. Requests were made to include an appraisal of the potential effects of electromagnetic fields, and this has been provided in Section 8.6. Full details of the consultation process and associated responses are presented in Appendix 6.1: Scoping Responses.

8.4.3 Data Gaps and Limitations

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. In particular, there is still poor coverage of circalittoral rock and sediment habitats occurring in waters deeper than 50 m (see jncc.defra.gov.uk/MarineHabitatClassification).

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 Marine Scheme. It is considered that the baseline information collected and used for this appraisal is representative of the Study Area.

8.5 Baseline Conditions

This section covers the benthic ecology baseline, intertidal and subtidal, for the Marine Scheme, with regards to the diversity, abundance, and function of organisms living on (epifauna) or in (infauna) the seabed. Physical factors such as seabed or sediment type, water depth and associated level of available light and supply of organic matter determine the habitats present, and therefore the composition of benthic communities.

8.5.1 Intertidal Ecology

Although no intertidal works are proposed associated with the Marine Scheme, as the landfalls will be completed via HDD, an intertidal survey was undertaken for the Marine Scheme (NEXTGeosolutions, 2022). Whilst the use of HDD under the transition zone between the onshore and offshore elements will avoid direct impacts on intertidal habitats and species, a summary of the baseline conditions at each landfall is provided below for completeness.

The Scottish landfall at Sandford Bay, Peterhead (KP0) was considered diverse with a wide range of habitats identified and twenty different biotopes recorded. The western central shore area of the bay was characterised by sand dunes at the top of the shore transitioning to a mixture of shingle, cobbles, pebble, and coarse sediments closer to the low water mark. Either side of the bay were areas of moderately exposed to extremely exposed rocky shore habitats dominated by barnacles and a typical succession of fucoid communities moving down shore to infralittoral kelp habitats on shingle, boulders, and bedrock. Thirteen of the habitats were listed as potential sensitive habitats for Scottish environment (NEXTGeosolutions, 2022). The brown algae *Fucus distichus*, which is listed as a UK Post 2010 Biodiversity Framework and Scottish Biodiversity List species, was also recorded in Sandford Bay. Moderately exposed to extremely exposed rocky shore communities, such as those listed above, are commonly found on the Scottish coast, predominantly in the west (Marine Scotland NMPI tool).

The English landfall at Fraisthorpe Sands, Bridlington (KP436), was described as a mobile sediment beach, characterised by eight different biotopes. This included vegetated softs cliffs at the upper shore with mobile sands supporting infaunal communities stretching along the rest of the shore. Seven of the habitats observed at Fraisthorpe Sands were listed as potential sensitive habitats for the UK but are considered widely distributed for this region (NEXTGeosolutions, 2022).

8.5.2 Subtidal Ecology

The subtidal benthic habitats identified along the subtidal Marine Installation Corridor were generally dominated by four broad scale sediment types: muddy sand, coarse sediment, rippled sand, and mixed sediments. A high diversity of benthic habitats was identified in the high energy, coastal areas of the Scottish landfall. Existing habitat mapping data (EUSeaMap 2021) are presented in Figure 8-3 with detailed habitat classification data from the benthic characterisation survey (NEXTGeosolutions, 2022) presented in Appendix 8.1: Habitat Alignment Charts.

8.5.2.1 Subtidal Habitats and Communities

A detailed interpretation of benthic habitats across the Marine Installation Corridor is presented in Appendix 8.1: Habitat Alignment Charts. These are summarised in Table 8-1 and in the sections below.

The sediment characteristics of the Marine Installation Corridor comprised varying proportions of gravel, sand, and fine sediments with some areas of rock (Table 8-1). A detailed overview of protected habitats and species of conservation interest is presented in Section 8.5.4.

Infralittoral and Circalittoral Rock

The Scottish landfall nearshore survey area (KP0.7 to KP4.2) was characterised by well-defined cobble and boulder matrices with depth-dependent associated fauna intermixed with areas of sand dominated mixed sediment. The Scottish landfall also contained cobbles and boulders of sufficient density and area that a stony reef assessment was performed to assess the reef structure (Irving, 2009). This assessment highlighted areas of both low and medium stony reef at two of the transects at the Scottish landfall. Details of the assessment are outlined in Section 8.5.4.

Further offshore across the Marine Installation Corridor, sparse patches of *Sabellaria spinulosa* on circalittoral rock were identified (between KP15.3 to KP29.4, KP52.2 to KP56.3 and KP341.9 to KP348.9). No infralittoral or circalittoral rock habitats were identified at the English landfall (KP436).

Sublittoral Sediment

As expected, based on the routeing and siting work for the Marine Scheme, most of the Marine Installation Corridor comprised sediment-based habitat types (Appendix 8.1; EUSeaMap 2021) (Figure 8-3). In particular, the data show the seabed is characterised by the following broad scale sublittoral sediment habitats:

- Sand (MD521) was the most frequently occurring habitat along the Marine Installation Corridor and was present intermittently between KP56.3 to KP390.4 in variable water depths ranging between 57 m and 80 m.
- Mixed sediments (MD42) (with stones and shells) were present predominantly in water depths between 35 m to 67 m occurring at the approaches to both landfall sites (Scottish: KP2.7 to KP15.3; English: KP390.4 to KP426.6) and also in slightly deeper waters (60 m to 80 m) between KP29.4 to KP52.1.
- Coarse sediment (MC32) was present in water depths of 60 m to 88 m between KP15.3 to KP29.4 and between KP52.2 to KP56.3. This sediment type was characterised by mega-rippled coarse sand with shell debris and contained rocks encrusted with *S. spinulosa* aggregations.
- Muddy sand (MC52) occurred in the deepest sections of the Marine Installation Corridor in water depths that ranged between 66 m and 94 m but most within a 72 m to 77 m depth band. Three sections along the Marine Installation Corridor, KP227.3 to KP258.0, KP278.6 to KP 288.5, and KP314.1 to KP336.4 presented this habitat type. Within this overarching habitat type, three smaller scale habitat types were identified which corresponded to areas of bioturbated muddy sand, muddy sand with patches of mixed sediment and muddy sand with the presence of *S. spinulosa* encrusting on rocks.
- Analysis of ground-truthing data confirmed the presence of a generally homogeneous sediment type throughout the English landfall (KP426.8 to KP435.3). On the western section of the nearshore survey area close to shore the sediment was dominated by coarse sands, with increasing contributions of finer sediment observed toward the eastern side.

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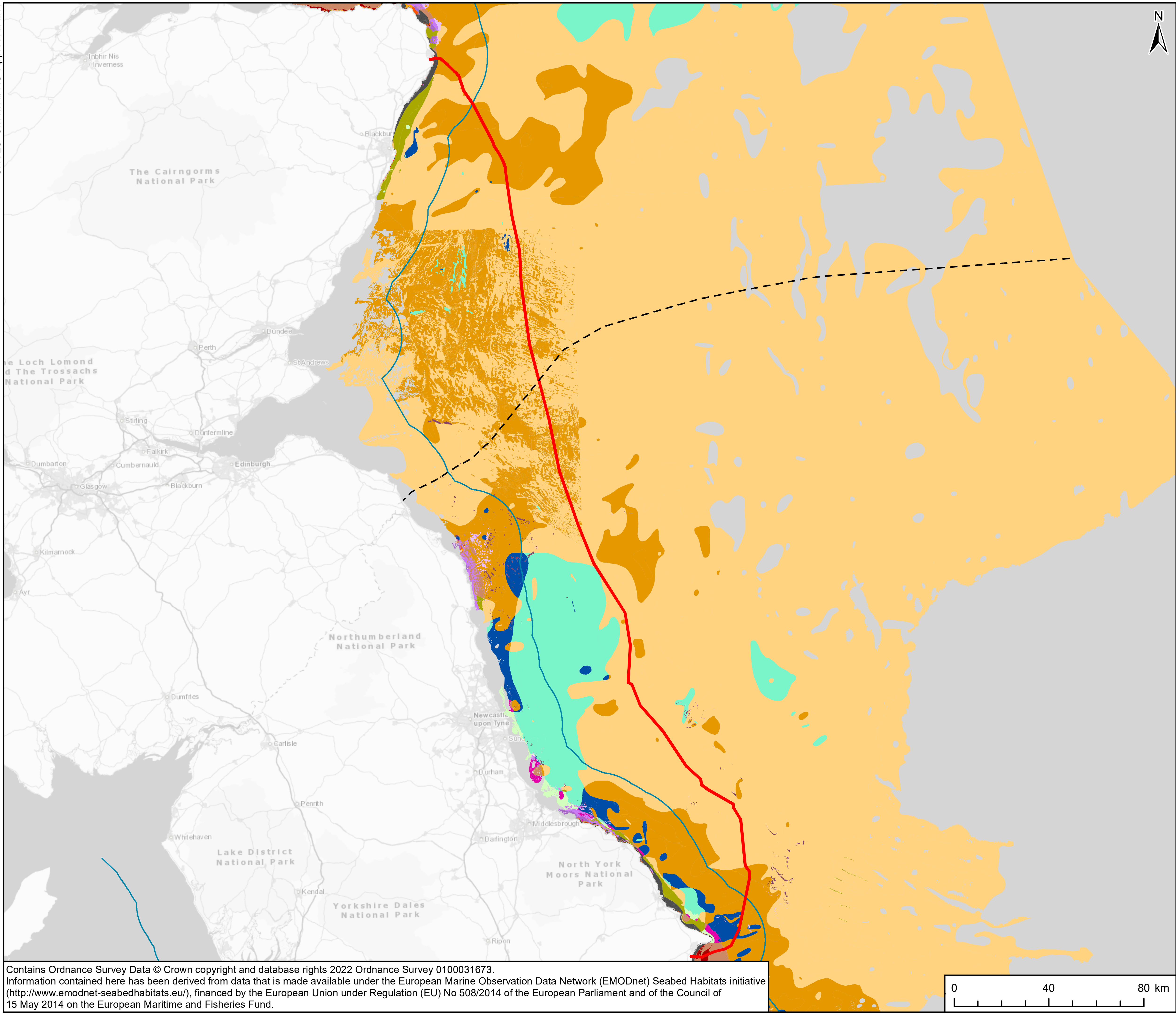

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Coordinate System: WGS1984 Zone 30N

Scale @ A3 1:1,500,000

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PROJECT

Eastern Green Link 2

KEY

- Marine Installation Corridor
- UK Territorial Sea Limit
- Scottish Adjacent Waters Boundary

EUNIS Classification

- A3: Infralittoral rock and other hard substrata
- A3.1: Atlantic and Mediterranean high energy infralittoral rock
- A3.2: Atlantic and Mediterranean moderate energy infralittoral rock
- A3.3: Atlantic and Mediterranean low energy infralittoral rock
- A4: Circalittoral rock and other hard substrata
- A4.1: Atlantic and Mediterranean high energy circalittoral rock
- A4.2: Atlantic and Mediterranean moderate energy circalittoral rock
- A4.3: Atlantic and Mediterranean low energy circalittoral rock
- A4.27: Faunal communities on deep moderate energy circalittoral rock
- A4.33: Faunal communities on deep low energy circalittoral rock
- A5: Sublittoral sediment
- A5.13: Infralittoral coarse sediment
- A5.14: Circalittoral coarse sediment
- A5.15: Deep circalittoral coarse sediment
- A5.23 or A5.24: Infralittoral fine sand or Infralittoral muddy sand
- A5.25 or A5.26: Circalittoral fine sand or Circalittoral muddy sand
- A5.27: Deep circalittoral sand
- A5.33: Infralittoral sandy mud
- A5.35: Circalittoral sandy mud
- A5.37: Deep circalittoral mud
- A5.43: Infralittoral mixed sediments
- A5.44: Circalittoral mixed sediments
- A5.45: Deep circalittoral mixed sediments
- Na

TITLE

Figure 8-3
Subtidal Habitats (EUSeaMap 2019)

REFERENCE

SEGL2_M_EAR_8-2_v1_20220524

SHEET NUMBER	DATE
1 of 1	24/05/2022

Table 8-1: Summary of subtidal broad-scale habitats and biotope complexes identified

EUNIS Classification (2022)				
Level 1	**Level 2**	**Level 3**	**Level 4**	**Level 5**
Infralittoral	Infralittoral rock (MB1)	Atlantic infralittoral rock (MB12)	Kelp and seaweed communities on sediment-affected or disturbed Atlantic infralittoral rock (MB123)	-
	Infralittoral coarse sediment (MB3)	Atlantic infralittoral coarse sediment (MB32)	Faunal communities in full salinity Atlantic infralittoral coarse sediment (MB323)	Dense *Lanice conchilega* and other polychaetes in Atlantic tide-swept infralittoral sand and mixed gravelly sand (MB3237)
	Infralittoral sand (MB5)	Atlantic infralittoral sand (MB52)	Faunal communities of full salinity Atlantic infralittoral sand (MB523)	Sparse fauna in Atlantic infralittoral mobile clean sand (MB5231)
Circalittoral	Circalittoral rock (MC1)	Atlantic circalittoral rock (MC12)	Faunal turf communities on Atlantic circalittoral rock (MC121)	-
	Circalittoral biogenic habitat (MC2)	Atlantic circalittoral biogenic habitat (MC22)	Worm reefs in the Atlantic circalittoral zone (MC221)	*Sabellaria spinulosa* on stable Atlantic circalittoral mixed sediment (MC2211)
				Sabellaria spinulosa encrusted Atlantic circalittoral rock (MC2213)
	Circalittoral coarse sediment (MC3)	Atlantic circalittoral coarse sediment (MC32)	-	-
	Circalittoral mixed sediment (MC4)	-	-	-
	Circalittoral sand (MC5)	Atlantic circalittoral sand (MC52)	-	-
Offshore circalittoral	Offshore circalittoral mixed sediment (MD4)	Atlantic offshore circalittoral mixed sediment (MD42)	-	-
	Offshore circalittoral sand (MD5)	Atlantic offshore circalittoral sand (MD52)	-	-

8.5.3 Subtidal Macrofauna

The subtidal section of the Marine Scheme survey area identified macrofaunal communities dominated by polychaetes, molluscs and crustaceans (NEXTGeosolutions, 2022). An assessment of the benthic macrofauna across the Marine Installation Corridor is summarised below with biotope complexes identified presented in Table 8-1.

The subtidal phase of the survey recorded between five and 2,188 individuals per grab sample (i.e., per 0.1 m^2), of which most were polychaetes, followed by molluscs and arthropods (crustaceans in the main). The variation in the number of individuals was significantly positively correlated with depth and mean particle size. This highlights that sediment type, particularly gravel content is an important determinant of community composition. Other physiochemical parameters, such as total organic carbon (TOC), total organic matter (TOM) and heavy metal concentrations, were secondary factors in the distribution of macrofaunal communities.

Habitats with coarse or mixed sediments were identified as having higher taxonomic abundance and richness compared to sand habitats, in part due to the presence of a higher diversity of epifaunal species, and in part due to the presence of *S. spinulosa*, especially towards the nearshore stations, although this was also true for some stations located along the offshore survey route stations. Characterising species of coarse or mixed sediment habitats included the polychaetes *Mediomastus fragilis*, *Lumbrineris spp*, *Glycera lapidum*, the sea urchin *Echinocyamus pusillus* and a range of encrusting fauna. Habitats dominated by sand were characterised by species such as the brittlestar *Amphiura filiformis,* the polychaetes *Goniada maculata, Diplocirrus glaucus and Spiophanes kroyeri and* the bivalve *Timoclea ovata.*

The diversity of fauna observed ranged between six and 135 species per grab sample (0.1 m^2). Macrofauna across the Marine Installation Corridor was dominated by annelids (comprised of mostly polychaete worms) accounting for 62.5% of total individuals and 259 species. Crustaceans were represented by 184 species (8.8% of total averaged individuals), molluscs by 116 species (10.6% of total averaged individuals) and echinoderms by 31 species (2.8% of total averaged individuals). Solitary epifauna accounted for 22 species, and included cnidarians, ascidians and barnacles. All other groups (nematodes, nemerteans, platyhelminthes and sipunculids) were represented by a total of 12 species, accounting for 13.6% of the total averaged individuals.

The distribution of epifaunal assemblages across the subtidal survey area highlighted the variation in infaunal and epifaunal richness. Epifaunal richness was generally greater at stations in the shallower, nearshore subtidal area, from KP3.5 towards the Scottish landfall nearshore area and between KP404.4 to KP420.6 for the English landfall and between KP164 to KP172.1. All were classified as medium or coarse sand respectively. Gravel was often recorded as a component of the sediment at these stations, which is expected for coarse sediment habitats where epifaunal species utilise the hard substrate for attachment and colonisation.

8.5.4 Protected Habitats and Species of Conservation Importance

A number of sensitive habitats and species, typical of the North Sea, have been identified as occurring within the Marine Installation Corridor or the wider Study Area as outlined below in Table 8-2 and discussed in detail in the following sections.

Table 8-2: Summary of sensitive benthic habitats and species relevant to Eastern Green Link 2.

Protected Feature	Legislation	Description	Designation / Status
Subtidal sands and gravels	UK Post-2010 Biodiversity Framework	Broad scale habitat	Priority habitat; HOCI in MCZ; PMF in offshore waters
Sandbanks which are slightly covered by seawater all the time	Conservation of Habitats and Species (Amendment (EU Exit) Regulations 2019	Sandbanks	Annex I habitat
Mud habitats in deep water	UK Post-2010 Biodiversity Framework	Broad scale habitat	Priority habitat; HOCI in MCZ; PMF in offshore waters

Protected Feature	Legislation	Description	Designation / Status
Sea pens and burrowing megafauna communities	UK Post-2010 Biodiversity Framework	Broad scale habitat	HOCI in MCZ; PMF
	OSPAR List of Threatened and/or Declining Species and Habitats		Threatened species (region II and III)
Sabellaria spinulosa, bedrock and stony reefs	UK Post-2010 Biodiversity Framework	Annex I Geogenic reef Annex I Biogenic reef	Priority habitat; HOCI in MCZ
	Conservation of Habitats and Species (Amendment (EU Exit) Regulations 2019		Annex I habitat
Modiolus modiolus beds	Conservation of Habitats and Species (Amendment (EU Exit) Regulations 2019	Horse mussel Biogenic reef	Annex I habitat
	UK Post-2010 Biodiversity Framework		Priority habitat; HOCI in MCZ; PMF in offshore waters
	OSPAR List of Threatened and/or Declining Species and Habitats		Threatened species (region II and III)
Arctica islandica	UK Post-2010 Biodiversity Framework	Ocean quahog	Priority species; FOCI in MCZ; PMF
	OSPAR List of Threatened and/or Declining Species and Habitats		Threatened and declining species

8.5.4.1 Annex I Reefs

Reefs are rocky marine habitats or biological concretions that rise from the seabed. They are generally subtidal but may extend as an unbroken transition into the intertidal zone, where they are exposed to the air at low tide. Annex I reef habitats are protected under the European Commission Habitats Directive 92/43/EEC. The definition of an Annex I reef based on the Interpretation Manual of European Union Habitats is as follows:

'Reefs can be either biogenic concretions or of geogenic origin. They are hard compact substrata on solid and soft bottoms, which arise from the sea floor in the sublittoral and littoral zone. Reefs may support a zonation of benthic communities of algae and animal species as well as concretions and corallogenic concretions'

Within UK waters, three types of Annex I reef have been identified: stony, bedrock and biogenic, (Golding, Albrecht, & McBreen, 2020).

'Rocky reefs' (stony and bedrock) are variable in structure and in the communities they support. A range of topographical reef forms meet the definition of this habitat type under the current conservation regulations. These range from vertical rock walls to horizontal ledges, sloping or flat bed rock, broken rock, boulder fields, and aggregations of cobbles. Rocky reefs are characterised by communities of attached algae on the shore and in the shallow subtidal, where there is sufficient light, invertebrates, and fish. In deeper water, where photosynthesis is not possible, rocky reefs are dominated by animals. The specific communities that occur vary according to the nature and topography of the substrate, light penetration, as well as exposure to waves and tides (Joint Nature Conservation Committee, 2022).

Biogenic reefs are those created by animals and include reef-building worms such as the ross worm *S. spinulosa*. *S. spinulosa* is a small, tube-building polychaete worm found in the subtidal and lower intertidal/sublittoral fringe and is widely occurring throughout waters around the UK. In most parts of its geographical range, it does not form reefs but is solitary or found in small groups, encrusting pebbles, shell, kelp holdfasts and bedrock. When conditions are favourable, dense aggregations may be found, forming reefs up to about 60 cm high and extending over several hectares (OSPAR Commision, 2013).

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Coordinate System: ETRS 1989 UTM Zone 30N

Scale @ A3 1:7,500

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PROJECT
Eastern Green Link 2

KEY
- Marine Installation Corridor
- Kilometre Point (KP)

Stony Reef Assessment - Camera Station
- Camera Transect (Low Reef)
- Camera Transect (Medium Reef)
- Camera Transect (Not a Reef)

Stony Reef Assessment - Reef Structure
- Area of Low to Medium Reef Structure

TITLE
Figure 8-4
Protected Habitats
Stony Reef - Peterhead

REFERENCE
SEGL2_M_EAR_8-4_v1_20220614

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Stony Reef

Cobbles and boulders were recorded along two of the four transects (EL_HG_B1_01 (KP0.5)) and EL_HG_B2_01 (KP1.4)) within the Scottish landfall nearshore survey area, while matrices of gravelly sand with cobbles and boulders were frequently present in patches throughout the offshore extent of the Marine Installation Corridor, with these areas classed as circalittoral mixed sediment.

Areas of potential stony reef interpreted from the SSS data extend from ~KP0.2 to KP2.5 (Figure 8-). Evidence from review of camera transect data indicate that cobbles and boulders were present in sufficient density with sufficient key reef species which presents characteristics of 'low' to 'medium' resemblance Annex I stony reef habitats within the Scottish landfall nearshore survey area at KP0.5 and KP1.4. The assessment conducted at Env_11 (KP339.4) also revealed that the seabed at this location also presented characteristics of 'low' resemblance Annex I stony reef habitat due to the abundance of key reef species as per Golding et al. (2020) (NEXTGeosolutions, 2022) (Appendix 8.1: Habitat Alignment Charts).

Bedrock Reef

No evidence of Annex I bedrock reef was identified across the Marine Installation Corridor during the benthic characterisation survey (NEXTGeosolutions, 2022).

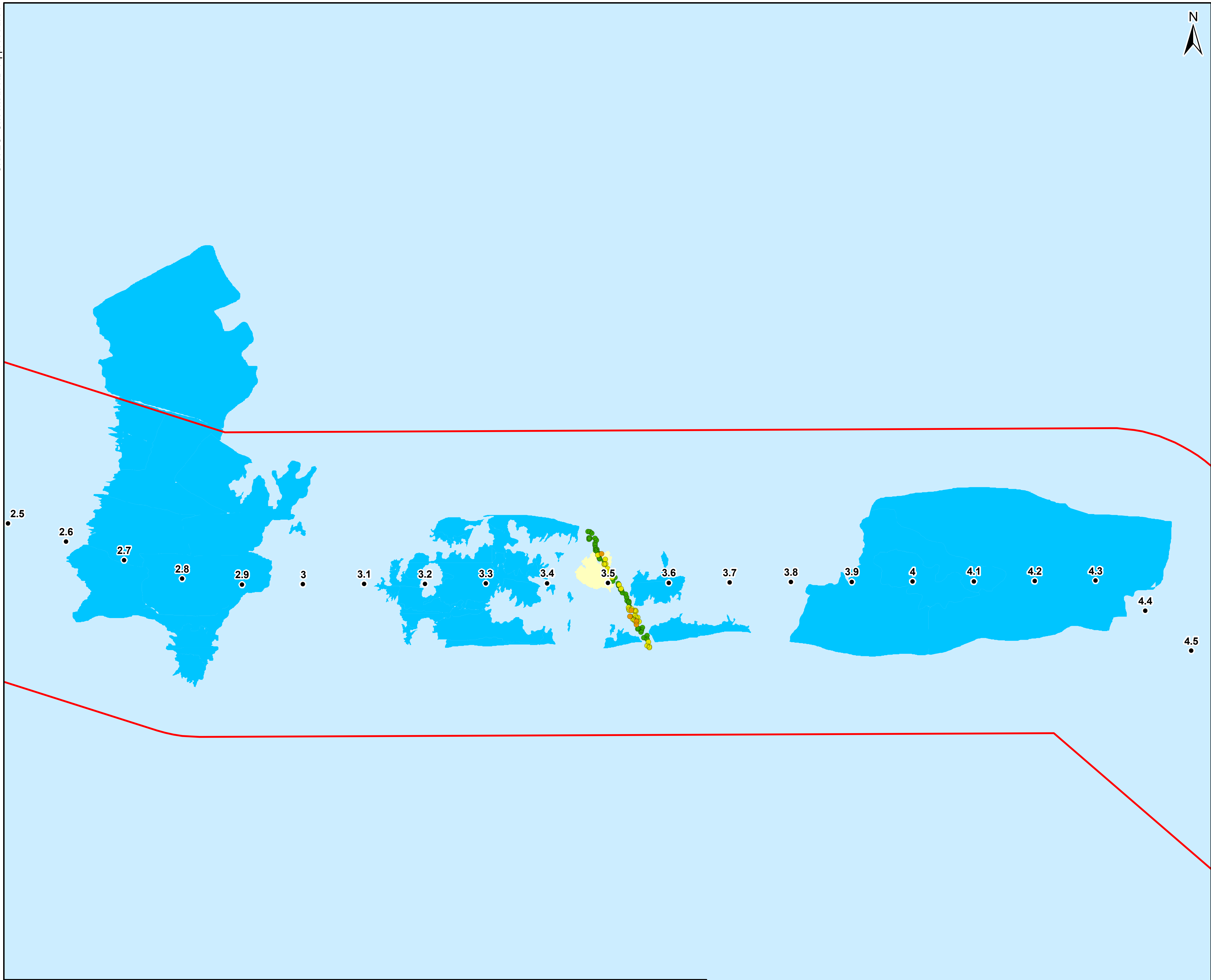
Sabellaria spinulosa Reef

Previous surveys on the east coast of Scotland have identified *S. spinulosa* aggregations (Pearce & Kimber, 2020) that have the potential to qualify as reef based on the criteria proposed by Gubbay (2007). The best examples of reef were found at the Rattray Head and Southern Trench sites, although the total extent of these features has yet to be established. The influence of *S. spinulosa* reefs on epifaunal communities was found to be quite site specific, with the same species seemingly being excluded at one site whilst being more prevalent at another in the presence of *S. spinulosa* reef. It is likely that the patterns observed are driven largely by the nature of the surrounding sediments. At sites where the reefs are surrounded by rock habitats, epilithic species may show a preference for the surrounding habitat. Conversely, where the reef is surrounded by mobile sediments, the reef structure itself may be the only available space for settlement.

A review of the deck log and underwater video observations during the benthic characterisation survey (NEXTGeosolutions, 2022) revealed the presence of muddy sand with pebbles corresponding to a mixed sediment habitat with associated *S. spinulosa* clumps and hummocks. Further review of the underwater video footage from offshore stations revealed the changeable nature of habitats along the Marine Installation Corridor with the seabed sediment oscillating between muddy sand, rippled sand, and mixed sediment, which was not always well reflected in the particle size distribution (PSD) analysis.

Areas of potential *S. spinulosa* reef interpreted from the SSS data extend from ~KP2.5 to KP4.5 (Figure 8-5) and KP338 to KP349 (Figure 8-6). The presence of *S. spinulosa* was ground-truthed at KP2.5 to KP56.3, KP69.4 to KP90, KP111.4 to KP111.8, KP157.3 to KP164.5, KP341.9 to KP348.9 and KP409.6 to KP426.6 along the Marine Installation Corridor and was typically found encrusting hard substrate such as boulders, cobbles and pebbles. A reef-like structure was also noted on one camera transect (EL_HG_B3_02) within the Scottish landfall nearshore survey area (KP3.5) and at three camera transects located along the offshore section of the Marine Installation Corridor at KP160.8 (Cam_Env_33.2), KP163.8 (Cam_Env_33.1) and KP347.8 (Env_10).

Following an assessment of 'reefiness' as described by Gubbay (2007), localised structures representing a 'low to medium reefiness' were identified at KP3.5, KP160.8, KP163.5 and KP347.8 which qualified as an Annex I reef habitat. No evidence of 'high reefiness' structures were observed along the Marine Installation Corridor (NEXTGeosolutions, 2022) (Appendix 8.1: Habitat Alignment Charts).



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PROJECT

Eastern Green Link 2

KEY

- Marine Installation Corridor
- Kilometre Point (KP)

Saballaria Reef Assessment - Camera Station

- Camera Transect (Low Reef)
- Camera Transect (Medium Reef)
- Camera Transect (Not a Reef)

Sabellaria Reef Assessment - Reef Structure

- Ground-truthed Low to Medium Reef Structure
- Potential Low to Medium Reef Structure

TITLE

Figure 8-5
Protected Habitats
Sabellaria Reef - Peterhead

REFERENCE

SEGL2_M_EAR_8-5_v1_20220614

SHEET NUMBER	DATE
1 of 1	14/06/2022

8.5.4.2 Horse Mussel Beds

Modiolus modiolus (horse mussel) forms dense beds at depths of 5 m to 70 m in fully saline, often moderately tide-swept areas off northern and western parts of the British Isles and can occur as relatively small, dense beds of epifaunal mussels carpeting steep rocky surfaces. In some limited examples within the UK, beds are more-or-less continuous and may be raised up to several metres above the surrounding seabed by an accumulation of shell, faeces, pseudofaeces and sand. *M. modiolus* is a long-lived species and individuals within beds can be 25 years old or more. Juvenile *M. modiolus* are heavily preyed upon, especially by crabs and starfish, until they are about three to six years old, but predation is low thereafter. Recruitment is slow and may be very sporadic; there may be poor recruitment over a number of years in some populations (Biodiversity Reporting and Information Group, 2011).

M. modiolus was recorded in small numbers from macrofaunal samples at the Scottish landfall stations and at offshore stations between KP4.1 and KP20.6 (ENV_51 to ENV53), and between KP85.0 to KP92.2 (ENV_42 and ENV_43). However, no live individuals were noted during video analysis and still photographs, and no bed forming structures were observed (NEXTGeosolutions, 2022). This habitat is therefore not considered further in the appraisal.

8.5.4.3 Mud Habitats in Deep Water

Mud habitats in deep water are a listed UK Post-2010 Biodiversity Framework Priority habitat under Section 2(4) of the Nature Conservation (Scotland) Act 2004) and Section 41 of the NERC Act 2006 (England) (formally UK BAP Priority Habitat) (Table 8-2).

Mud habitats in deep water (circalittoral muds) occur below 20 m to 30 m in many areas of the UK's marine environment. The relatively stable conditions associated with these deep mud habitats often lead to the establishment of communities of burrowing megafaunal species where bathyal species may occur with coastal species. The burrowing megafauna species include burrowing crustaceans such as the Norway lobster *Nephrops norvegicus* and *Callianassa subterranea*. The mud habitats in deep water can also support seapen populations and communities with the brittlestar *Amphiura* spp. (Biodiversity Reporting and Information Group, 2011).

Although areas of circalittoral muddy sand (MC52) were identified across the Marine Installation Corridor between KP227.3 to KP258.0, KP278.6 to KP288.5 and KP314.1 to KP336.4, these were not considered representative of mud habitats in deep water on the basis of the sediment type and the dominance of the sand fraction (NEXTGeosolutions, 2022). This habitat is therefore not considered further in the appraisal.

8.5.4.4 Seapens and Burrowing Megafauna

This habitat type occurs in muddy areas at water depths from 15 m to over 200 m. It is characterised by mounds and burrows caused by the burrowing of animals, such as the Norway lobster *N. norvegicus*, mud shrimps and Fries' goby *Lesueurigobius friesii*. The burrows offer shelter to smaller animals, and large invertebrates may be seen scavenging on the surface of the mud. The tall sea pen *Funiculina quadrangularis,* rare in UK waters, can occur within this habitat, as can the burrowing fireworks anemone *Pachycerianthus multiplicatus*, which is scarce in the UK and appears to be restricted to this habitat. The inclusion of this habitat in the OSPAR list of threatened and/or declining habitats and species habitats and species is based on its ecological significance and its decline, the latter associated with habitat quality rather than extent (OSPAR Commision, 2020). It is also listed as a PMF in Scottish waters (Table 8-2). This habitat is a designated feature of the Farnes East MCZ (4.88 km from the Marine Installation Corridor) and Southern Trench MPA (1.96 km from the Marine Installation Corridor) (Appendix 8.3).

Individual slender seapens *Virgularia mirabilis* and phosphorescent seapens *Pennatula phosphorea* were observed at stations characterised by "lebensspuren[4]" and burrows were observed on the seabed video footage at stations ground-truthed between KP213.2 to KP225.9. Despite being observed on the video footage, only a single individual of *P. phosphorea* was recovered at KP225.9 (NEXTGeosolutions, 2022).

[4] Lebensspuren is a German term meaning 'life traces' and is the collective name for the physical imprints and structures, such as tracks, trails, burrows, borings and faecal casts, left behind by benthic organisms in sedimentary conditions.

The environmental conditions described by OSPAR for this habitat are comparable with those recorded between KP213.2 and KP225.9 (Figure 8-6) of the Marine Installation Corridor, although the sediment was dominated by sand rather than mud. An assessment of the burrow density was conducted, which showed that burrows were present in circalittoral muddy sand, together with patches of offshore circalittoral mixed sediment, at a density ranging from a SACFOR scale of ‘frequent’ to ‘common’.

Given the presence of burrows, the environmental habitat between KP213.2 to KP225.9 would be considered a poor example of the OSPAR ‘Seapen and Burrowing Megafauna Communities’. It should however be noted that neither of the two level five EUNIS burrowing megafauna biotopes MC6216 - Seapens and burrowing megafauna in circalittoral fine mud’ or MC6217 - Burrowing megafauna and *Maxmuelleria lankesteri* in circalittoral mud could be applied to any stations along the Marine Installation Corridor due to the low abundances of key characterising species such as *N. norvegicus* (one individual recorded), *P. phosphorea,* (recorded less than five individuals for each transect), *V. mirabilis*, *Turritella communis* and *Maxmuelleria lankesteri* (absent at all stations) (NEXTGeosolutions, 2022).

8.5.4.5 Subtidal Sands and Gravels

Subtidal sands and gravels are a listed UK Post-2010 Biodiversity Framework Priority habitat under Section 2(4) of the Nature Conservation (Scotland) Act 2004 and Section 41 of the Natural Environment and Rural Communities (NERC) Act 2006 (England) (formally UK BAP Priority Habitat) (Table 8-2).

These habitats occur in a variety of environments, from sheltered to very exposed conditions. The sediment of these habitats ranges from mainly sand, through various combinations of sand and gravel, to mainly gravel. While very large areas of seabed are covered by sand and gravel in various mixes, much of this area is covered by very thin deposits over bedrock, glacial drift or mud (Joint Nature Conservation Committee, 2016). The strength of tidal currents and exposure to wave action are important determinants of the topography and stability of sand and gravel habitats. The diversity of flora and fauna living within the biotopes varies according to the level of environmental stress to which they are exposed. In nearshore areas, sand and gravel habitats are ecologically important as nursery grounds for juvenile commercial species such as flatfishes and bass, whereas offshore they support internationally important fish and shellfish fisheries (Biodiversity Reporting and Information Group, 2011).

This habitat was recorded across all of the subtidal Marine Installation Corridor (NEXTGeosolutions, 2022).

8.5.4.6 Sandbanks Which are Slightly Covered by Seawater all the Time

Sandbanks which are slightly covered by seawater all the time are protected under the European Commission Habitats Directive 92/43/EEC. They comprise sandy sediments that are permanently covered by shallow sea water, typically occurring at depths of less than 20 m. The diversity and types of community associated with this habitat are determined particularly by sediment type together with a variety of other physical, chemical, and hydrographic factors. This habitat type houses habitat sub-types, which include eelgrass *Zostera marina* beds and maerl beds, which are both particularly distinctive and are of high conservation value because of the diversity of species they may support and their general scarcity in UK waters (Table 8-2).

The JNCC identify Smithic Bank at Bridlington Bay as a potential Annex I habitat feature (subtidal sandbank) noting this feature is not presently designated and there are currently no proposals to designate it. The bank extends south from Flamborough Head for over 12 km (Figure 8-6). The Marine Installation Corridor overlaps with the southern extent of the bank on the approach to the English landfall (Chapter 7: Physical Environment). Transect EL_HG_B22_04 at KP 431.3 within the English landfall, contained features comparable to this habitat, including its shallow depth (5 m to 6 m) as the transect was located over an area of raised shallow sand compared to the rest of the nearshore survey area. The sediment type at this station was dominated by fine sand. However, both the visible epifauna and the macrofauna community were comparable to other transects/stations between KP426.8 and KP435.3 (NEXTGeosolutions, 2022).

8.5.4.7 Ocean Quahog

The ocean quahog *Arctica islandica* is a marine bivalve that occurs in sandy and muddy sediments from the low intertidal zone to 400 m water depths. The species occurs on both sides of the North Atlantic and within the OSPAR Maritime Area its distribution includes the Irish Sea and North Sea. The ocean quahog is one of the longest lived and slowest growing marine bivalves, with recorded specimens of over 100 years old. It is a protected feature of the Firth of Forth Banks Complex MPA (directly adjacent to the Marine Installation Corridor between KP84 and KP118) and Farnes East MCZ (4.88 km from the Marine Installation Corridor) and is a PMF in Scottish waters. It is also included in the OSPAR list of threatened and/or declining species (OSPAR, 2008), the main threat associated with seabed disturbance from anthropogenic activities (OSPAR Commision, 2009).

Single juvenile specimens of *A. islandica* were present in three macrofauna samples obtained in the Peterhead nearshore area (KP0.7 to KP4.2) from stations EL_HG_B1_01, EL_HG_B2_01 and EL_HG_B3_02. In addition, juvenile *A. islandica* individuals were recorded at 34 offshore stations with maximum of 38 individuals found at Env_24 (KP233.8). Adult *A. islandica* were also record in a total of five stations with four individuals recorded at station Env_45 (KP69.0) and one individual found within each of the grab data of Env_33 (KP164.0), Env_35 (KP148.2), Env_36 (KP140.0) and Env_46 (KP61.2). It should also be noted that no live individuals were noted during analysis of seabed video footage and still photographs from the survey area (NEXTGeosolutions, 2022).

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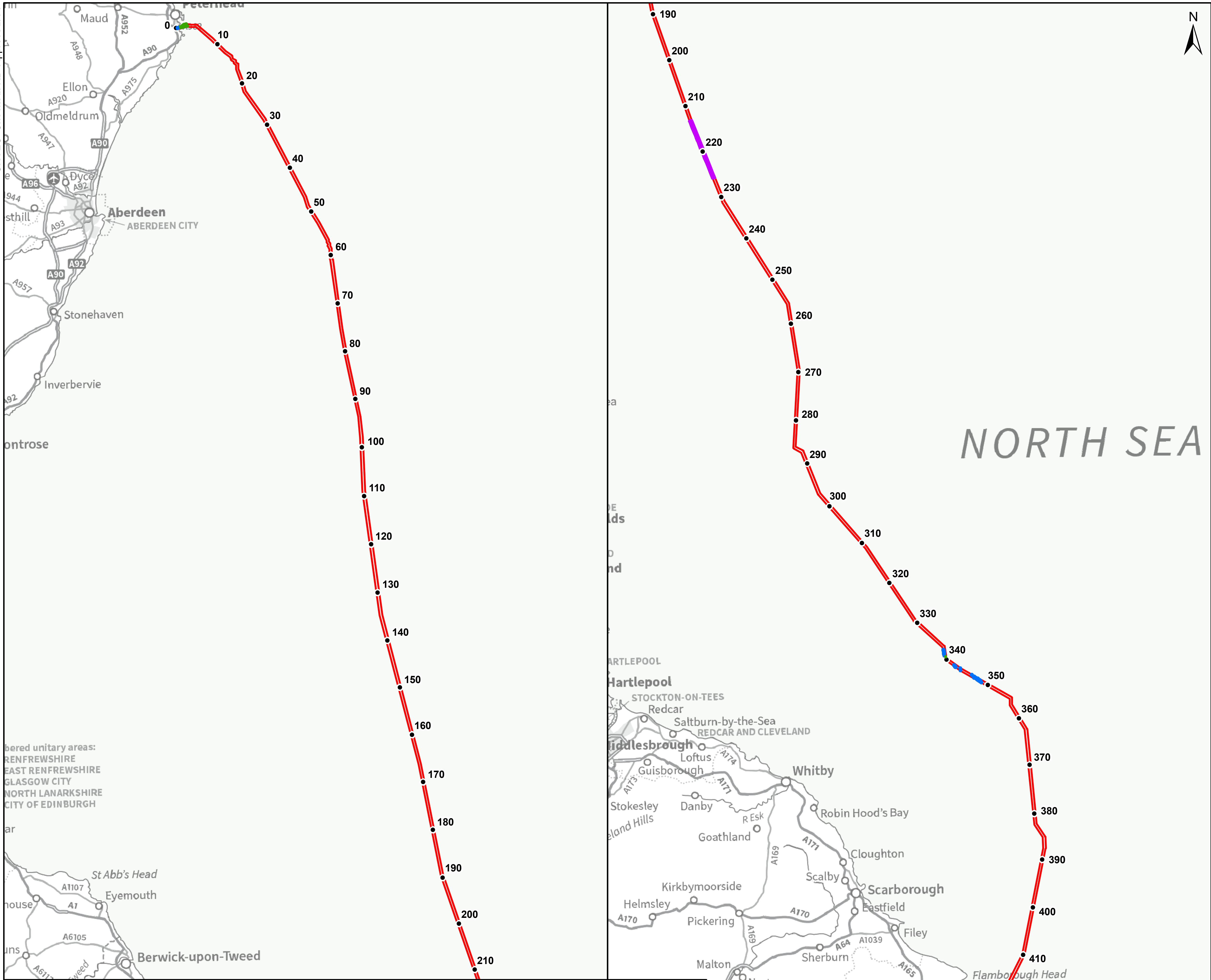

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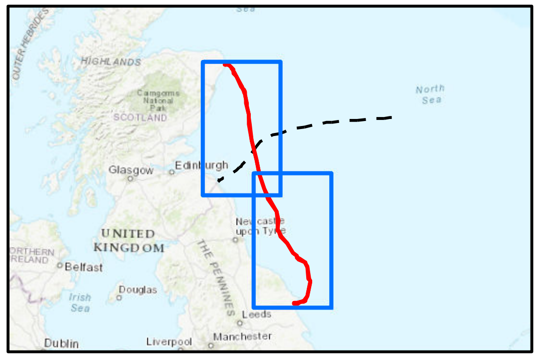
PROJECT
Eastern Green Link 2

KEY
- Marine Installation Corridor
- Kilometre Point (KP)
- Seapens and Burrowing Megafauna
- Sabellaria Reef Assessment - Low to Medium Reef Structure
- Stony Reef Assessment - Low to Medium Reef Structure
- Smithic Bank



TITLE
Figure 8-6
Protected Habitats - Overview

REFERENCE
SEGL2_M_EAR_8-6_v1_20220614

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8.5.5 Fish Spawning Grounds

Benthic conditions, particularly the type of sediment present, is an important determinant of the presence of spawning grounds, for sandeel and herring in particular. Data collected during the benthic survey were used to assess the potential for key habitat for these species (NEXTGeosolutions, 2022). For full details on the presence of sandeel and herring habitat, and potential impacts to this receptor from the Marine Scheme see Chapter 9: Fish and Shellfish.

8.5.6 Invasive and Non-Native Species (INNS)

No evidence of INNS was recorded during the benthic characterisation survey (NEXTGeosolutions, 2022).

8.5.7 Relevant Designated Sites

The Marine Scheme runs directly adjacent to the following designated site for the protection of benthic features:

- **Firth of Forth Banks Complex MPA**: This site is located in offshore waters to the east of Scotland, and the boundary of the Marine Installation Corridor runs directly adjacent between KP84 and KP118 to the eastern boundary of this MPA (Appendix 8.3). This MPA includes the Berwick, Scalp and Montrose Banks, and the Wee Bankie shelf banks and mounds. It is designated for the protection of ocean quahog aggregations, offshore subtidal sands and gravels, shelf banks and mounds, and moraines representative of the Wee Bankie Key Geodiversity Area.

Other key sites designated for the protection of benthic features within 10 km of the Marine Installation Corridor in Scottish Waters are as follows, with distance to sites from the Marine Installation Corridor provided in parentheses:

- **Southern Trench MPA (1.96 km):** This site is located off the Aberdeenshire coast, stretching from Buckie in the west to Peterhead in the east. It is designated for the protection of Minke whale (*Balaenoptera acutorostrata*), burrowed mud, Fronts, Shelf deeps.

The Farnes East MCZ (4.88 km) and Holderness Offshore MCZ (5.50 km) and Holderness Inshore MCZ (7.74 km) were screened out as they exceed the maximum ZOI of 1.5 km. Other key sites designated for the protection of benthic features within 10 km of the Marine Installation Corridor in English Waters are:

- **Flamborough Head SAC (0.12 km):** Flamborough Head has been designated for the protections of Annex I reefs, vegetated sea cliffs of the Atlantic and Baltic Coasts and submerged or partially submerged sea caves. It lies close to the biogeographic boundary between two North Sea waterbodies and encompasses a large area of hard and soft chalk on the east coast of England. The site covers around 14% of UK and 9% of European coastal chalk exposure, represents the most northern outcrop of chalk in the UK, and includes bedrock and boulder reefs which extend further into deeper water than at other subtidal chalk sites in the UK, giving one of the most extensive areas of sublittoral chalk in Europe.

8.5.8 Summary of Receptors

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 8-3. Those species considered to have the greatest sensitivity have been assessed at the species level, whereas those species with lower sensitivity have been assessed either at broad scale habitat level (e.g., subtidal sands and gravel) or by higher level biotope (e.g., *Sabellaria spinulosa* reef or seapens and burrowing megafauna) as appropriate.

Table 8-3: Benthic ecology receptors and their assigned value

Receptor group	Description	Rationale	Value
Benthic habitats	Subtidal sands and gravels	• Priority Marine Feature in Scotland • NERC Section 41 habitat • Have some capacity to absorb change	Medium

Receptor group	Description	Rationale	Value
		• Common and widespread habitats	
	Subtidal mixed and coarse sediments	• Common and widespread habitats • Have some capacity to absorb change	Low
	Mud Habitats in Deep Water	• Priority Marine Feature in Scotland • NERC Section 41 habitat • Have some capacity to absorb change	Medium
	Annex I Sandbanks which are slightly covered by seawater all the time	• Annex 1 habitat • Priority Marine Feature • Have some capacity to absorb change	High
	Annex 1 Reef: Stony, Bedrock and *Sabellaria spinulosa*	• Annex 1 habitat • Priority Marine Feature • Have some capacity to absorb change	High
	Seapens and burrowing megafauna	• Priority Marine Features in Scotland • OSPAR Threatened habitats and species	High
Benthic species	Ocean quahog	• Priority Marine Feature in Scotland • NERC Section 41 species • OSPAR Threatened Species	High

8.6 Appraisal of Potential Impacts

This section describes the potential impacts of the Marine Scheme on the benthic ecology receptors during Installation, Operation and Maintenance and Decommissioning Phases of the Marine Scheme (Chapter 2: Project Description). The appraisal has been undertaken in accordance with the methodology presented in Chapter 4: Approach to Environmental Appraisal. The following pathways detailed in Table 8-4 have been scoped into the appraisal.

Table 8-4: Summary of impacts pathways and ZOIs

Potential impact	Zone of influence (ZOI)
Landfall preparation and installation	
HDD operations and cable pull in.	Up to 0.01 km^2 at each landfall
Vessel anchoring and use of spud legs	Up to 0.0003 km^2 at each landfall
Route preparation and cable installation	
Temporary physical disturbance to subtidal benthic habitats and species	106.0 km of boulder clearance plough (25 m swathe) and 340.0 km of mechanical trenching (15 m swathe). Giving a total footprint of 7.6 km^2 per cable, so 15.2 km^2 for separate lay.
Permanent loss of subtidal benthic habitats and species due to placement of hard substrates on the seabed	Remedial and planned rock berm up to 138 km totaling approximately 1 km^2 per cable or 2 km^2 for separate lay.
	Crossings 6 x pipeline crossings with an approximate footprint of 4,750 m^2 each 18 x cable crossings with an approximate footprint of at 4,100 m^2 each Totaling approximately 0.1 km^2 per cable or 0.2 km^2 if separate lay.
	Rock protection at landfalls 0.01 km^2 per landfall, 0.02 km^2 total (same for separate lay/bundled cables).

Potential impact	Zone of influence (ZOI)
Temporary increase in suspended sediment concentrations (SSC) sediment deposition leading to contaminant mobilisation, turbidity and smothering effects on subtidal habitats and species.	Footprint of the proposed works plus 1.5 km buffer; based on professional judgement and consideration of worst-case for fine particulates (Chapter 7: Physical Environment).
Changes to marine water quality effects from the use of HDD drilling fluids and accidental leaks and spills from vessels, including loss of fuel oils	Footprint of the proposed works plus 1.5 km buffer; based on professional judgement and consideration of worst-case for fine particulates (Chapter 7: Physical Environment).
Cable operation and maintenance	
Disturbance to subtidal benthic habitats and species due to subsea cable thermal emissions	~1 m from the cable, dependent upon the heat carrying capacity of particular sediments.
Disturbance to subtidal benthic habitats and species due to subsea cable electromagnetic field (EMF) emissions	For the separated cables, the magnetic field resulted in a combined field slightly above the background level at 20 m from the cable.
Maintenance the same as route preparation and cable installation	See route preparation and cable installation, noting that durations and extents of activities will be significantly reduced.
Decommissioning	
Potential effects the same as route preparation and cable installation	Anticipated to be analogous to route preparation and cable installation.

The unintentional or inadvertent loss of drilling fluids during drilling operations from the borehole to the ground surface from points other than its entry and exit points (known as frac-out) has not been considered in the appraisal as drilling fluid parameters such as circulation pressure, gel strength, mud weight, and viscosity will be continuously monitored and regular inspection along the drill path during pilot hole drilling conducted.

8.6.1 Embedded Mitigation

The following mitigation has been built into the Marine Scheme to avoid and/or minimise impacts to benthic ecology receptors:

Table 8-5: Benthic ecology embedded mitigation

Activity / Issue	Embedded mitigation commitment
All phases	
Marine Scheme vessel requirements	• All vessels will follow the International Regulations for Preventing Collisions at Sea 1972 (COLREGS) and International Convention for the Safety of Life at Sea 1974 (SOLAS); • All vessels will be in compliance with the International Convention for the Prevention of Pollution from Ships (MARPOL) regulations and will therefore be equipped with waste disposal facilities onboard. The discharging of contaminants is not permitted within 12 nm from the coast to preserve bathing waters; • Control measures and shipboard oil pollution emergency plans (SOPEP) will be in place and adhered to under MARPOL Annex I requirements for all vessels; • Ballast water discharges from all vessels will be managed under International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004 (BWM Convention); • All vessels will adhere to the IMO guidelines for the control and management of ships' biofouling to minimise the transfer of invasive aquatic species (Biofouling Guidelines) (resolution MEPC.207(62); and • Where possible, vessels will operate with dynamic positioning which will minimise anchor disturbance on the seabed.

Activity / Issue	Embedded mitigation commitment
Installation Phase	
Route selection	The Marine Installation Corridor has been selected to optimise the balance of environmental, technical, commercial and financial considerations, such as avoiding designated sites, known archaeological sites, recreational activities, key fishing grounds and third-party infrastructure as far as possible.
Micro-routeing / detailed design post-consent	Detailed route development and micro-routeing will be undertaken within the Marine Installation Corridor, informed by pre-installation evaluation of site-specific survey data to avoid or minimise localised engineering and environmental constraints. This will include minimising the footprint as much as possible.
Construction Environmental Management Plan (CEMP)	Prior to cable installation activities commencing, a CEMP, including an Emergency Spill Response Plan (ESRP), Waste Management Plan and Marine Non-native Species (MNNS) Plan, will be developed and agreed with relevant stakeholders in accordance with the coastal and marine environment site guide.
Landfall installation	Horizontal Directional Drilling (HDD) will be used at both landfalls for the installation of the cables in the transition zone between the Onshore Schemes and the Marine Scheme which avoids any works in the intertidal environment; and This will keep sediment disturbance to a minimum, minimising the use of cable protection measures inshore of the 11 m depth contour at Sandford Bay and the 5 m depth contour at Fraisthorpe Sands. This avoids direct impacts on sensitive coastal and intertidal habitats and features.
Drilling fluids	Drilling fluids for HDD operations will be biologically inert and selected from the OSPAR List of Substances/Preparations Used and Discharged Offshore which are Considered to Pose Little or No Risk to the Environment (PLONOR); During drilling, drilling fluids will be recycled, treated, and reused as far as possible, and any waste drilling fluid will be transported offsite for treatment and disposal; and Losses of drilling fluids are unavoidable; however they will be minimised insofar as practicable through the implementation of industry best practice for example, clearing runs or reducing the volume of drilling fluids in the borehole prior to breakout to the marine environment.
Cable protection	Cables will be trenched to a minimum depth of lowering of approximately 0.6 m, with a target depth of lowering of approximately 1.5 m; and The use of external protection will be limited to areas where cables cannot be trenched to the minimum depth of lowering, at crossings with third-party infrastructure and in some limited areas at both landfalls (as required).
Rock placement	Rock utilised in berms will be igneous, clean with low fines; and A vessel able to undertake a targeted placement method will be used, such as one fitted with a flexible fall pipe.

8.6.2 Installation Phase

8.6.2.1 Temporary physical disturbance to subtidal benthic habitats and species

There are a number of installation phase activities that will temporarily disturb seabed habitats, resulting in short term physical disturbance to, and temporary loss of seabed habitats, and in some instances physical damage to less mobile benthic species such as bivalves, other molluscs, and echinoderms.

Sensitivity to the impact of habitat disturbance varies between habitats and species; it depends upon the stability of the habitat and its resilience to disturbance, and the vulnerability of an individual species to mechanical disturbance. Mobile sands, or habitats in shallow water where there is significant wave and tidal energy, are considered to have greater capacity to accommodate physical disturbance. The same is true for mobile species, such as crabs, that can avoid installation activities.

Installation Phase activities at the landfall location, which have the potential to cause temporary disturbance to and/or loss of benthic habitats and species are presented in Chapter 2: Project Description. The maximum footprint of temporary disturbance is approximately 0.0103 km^2 at each landfall, accounting for exit pit excavation, pre-trenching, and anchoring (Table 8-4).

Temporary disturbance as a result of Installation Phase activities will occur along the entire Marine Installation Corridor (436 km in length). The dominant habitat types along the Marine Installation Corridor were muddy sand, coarse sediment, rippled sand, and mixed sediments. Sand was the most frequently occurring habitat along the proposed route, occurring intermittently between KP56.3 to KP390.4 in variable water depths ranging between 57 m and 80 m.

Boulder clearance ploughs would result in the widest disturbance swathe, of up to 25 m per cable trench. It is anticipated that this method will be employed over a total of up to 106.0 km of the Marine Installation Corridor for each cable. In addition to this, 340 km of the Marine Installation Corridor may be subject to mechanical trenching (15 m swathe) giving a total footprint of 7.6 km^2 per cable, and 15.2 km^2 for separate lay (Table 8-4).

Sensitivity to physical disturbance varies between habitats and receptors. For sandy sediment (including Sandbanks which are slightly covered by seawater all the time), particularly in shallow waters where there may be natural disturbance of the seabed from waves and tides, communities are expected to be relatively tolerant of disturbance. Most animals will be sediment dwelling and will be disturbed as those sediments are ploughed or jetted aside to an adjacent location. As sediments are displaced and backfilled there will be some mortality of larger and less mobile species but for many animals, displacement will have only a temporary impact, and fauna will be able to redistribute within the sediment once the installation spread has moved away. Recovery of habitats is expected to be relatively rapid.

Annex I reefs

Areas of potential stony reef interpreted from the SSS data extend from approximately KP0.2 to KP2.5. Evidence from review of camera transect data indicated that cobbles and boulders were present in sufficient density with sufficient key reef species which presents characteristics of ‘low’ to ‘medium’ resemblance Annex I stony reef habitats within the Scottish landfall nearshore survey area at transects located at KP0.5 and KP1.4 (NEXTGeosolutions, 2022). Given the proximity of potential Annex I stony reef habitats to the Scottish HDD exit location at approximately KP0.9 (with the breakout areas extending to approximately KP1.3), temporary disturbance to Annex I stony reefs at this location is unavoidable as they mostly occur across the width of the Marine Installation Corridor at this location.

The quality of Annex I stony reef habitat was assessed as ‘low’ to ‘medium’. Although features are deemed representative of Annex I stony reef across the Marine Installation Corridor, these areas do not form part of a designated site under the EC 92/43/EEC or other protected area. Furthermore, the area of disturbance is over a small area within this habitat and so the magnitude of the impact has been appraised as low. Combined with a low to medium sensitivity of associated epifaunal assemblages (Maher, Cramb, de Ros Moliner, Alexander, & Rengstorf, 2016) but high value of this habitat, the effect is determined to be **minor** and therefore **not significant**.

Areas of potential *S. spinulosa* reef interpreted from the SSS data extend from approximately KP2.5 to KP4.5 and approximately KP338 to KP349. Following an assessment of ‘reefiness’ as described by Gubbay (2007), localised structures of *S. spinulosa* representing a ‘low to medium reefiness’ were identified at camera transects located at KP3.5, KP160.8, KP163.5 and KP347.8. No evidence of ‘high reefiness’ structures was observed along the Marine Installation Corridor (NEXTGeosolutions, 2022).

HDD and landfall operations are not expected to impact Annex I *S. spinulosa* reef, however, disturbance from boulder clearance and trenching is expected. The patches of *S. spinulosa* reef offshore (KP160.8, KP163.5 and between KP338 to KP349) are avoidable, with embedded mitigation including micro-routeing to avoid these sensitive habitats, therefore no temporary disturbance during the Installation Phase is expected for these locations.

However, for nearshore works at the Scottish landfall between approximately KP2.5 to KP4.5, disturbance to Annex I *S. spinulosa* reef is unavoidable due to its current extent across the width of the

Marine Installation Corridor. Currently, the extent of the Annex I *S. spinulosa* reef at the Scottish landfall is largely based on geophysical interpretation, with limited ground truthing. Embedded mitigation for the Marine Scheme includes detailed route development and micro-routeing, informed by pre-installation evaluation of site-specific survey data, to avoid or minimise localised engineering and environmental constraints.

The 'reefiness' of Annex I *S. spinulosa* reef habitat in this area was assessed as low to medium though the areas of medium reefiness were present as patches within larger areas of low reefiness (Figure 8-4). The features are deemed representative of Annex I *S. spinulosa* reef across the Marine Installation Corridor, though they do not form part of a designated site under the EC 92/43/EEC or any other protected site.

Due to the sporadic nature of medium resemblance reef ground truthed across the camera transects, the limited extent of the area identified, the ephemeral nature of *S. spinulosa*, and the embedded mitigation to minimise disturbance to these sensitive features, the magnitude of the impact has been appraised as low. Combined with a medium sensitivity (but high value) of *S. spinulosa* to disturbance (Gibb, Tillin, Pearce, & Tyler-Walters, 2014) the effect is determined to be **minor** and therefore **not significant**.

Seapens and burrowing megafauna communities

The benthic habitat between KP213.2 to KP225.9 was identified as a poor example of the OSPAR 'Seapen and Burrowing Megafauna Communities' (Section 8.5.4.4), this feature is unavoidable within the Marine Installation Corridor. The magnitude of disturbance to this habitat will be temporary and localised and has been appraised as negligible. Combined with the poor example of habitat observed (NEXTGeosolutions, 2022) within the Marine Installation Corridor and therefore its medium value and sensitivity, the effect is determined to be **negligible** and therefore **not significant**.

Subtidal sands and gravels

The subtidal sediments, which dominate the HDD breakout locations and Marine Installation Corridor, are 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. Given the highly dynamic nature of subtidal sand and gravel habitats, particularly in shallow waters, 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) (RPS, 2019). Thus, the magnitude of the disturbance to this benthic habitat as a result of HDD breakout is considered to be negligible.

Subtidal sands and gravels, which are present within the Marine Installation Corridor, have a low sensitivity to disturbance. They are highly mobile and resilient to a level of natural disturbance (RPS, 2019) and are commonly found in the North Sea. The effect has been determined to be **negligible** and therefore **not significant**.

Sandbanks which are slightly covered by water all of the time

The Marine Installation Corridor overlaps with the southern extent of the Smithic Bank, currently undesignated but noted as a potential Annex I subtidal sandbank, on the approach to the English landfall (Chapter 7: Physical Environment). No pre-sweeping of sandwaves using dredgers is required or proposed within the Marine Installation Corridor, however, sandwave lowering using mass flow excavation (MFE) where disturbed material is retained within the system and pushed to either side, is still an option.

The features of the system are likely to reform and recover as the sediment will be reworked by wave action and tidal currents and sediment will migrate, filling the area cleared and trenched. Timescales for recovery are expected to be in the order of one to two years, for the area disturbed by trenching to be covered. The magnitude of the impact has been assessed as negligible as disturbance will be a one-off event causing very localised change. The sensitivity of the receptor has been assessed as medium and the value high, with the effect determined to be **negligible** and therefore **not significant**.

Ocean quahog

Juvenile ocean quahog were identified across the Marine Installation Corridor with low abundances of adults recorded across a total of five stations during the benthic characterisation survey (NEXTGeosolutions, 2022). Previous research into the impacts of dredging on this species has shown effects to be drastic and long lasting with mortality linked with shell damage (Ragnarsson, Thorarinsdóttir, & Gunnarsson, 2015). The magnitude of disturbance to this species will however be temporary and localised and has therefore been appraised as negligible. Combined with their high sensitivity, the effect has been appraised **negligible** and therefore **not significant**.

8.6.2.2 Temporary increase in suspended sediment concentrations and sediment deposition leading to contaminant mobilisation, turbidity, and smothering effects

Disturbance from installation activities has the potential to increase SSC and turbidity, creating a sediment plume in the water column that can travel away from the Marine Installation Corridor 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 resulting in reduced primary production in marine seaweed and algae;
- Smothering of invertebrate species and clogging of respiratory apparatus;
- Reduced success of filter feeding in invertebrates by clogging of feeding apparatus; and
- Indirect effects of the release of sediment contaminants, such as heavy metals and hydrocarbons, on benthic species.

The largest sediment plumes and highest levels of SSC will be associated with disturbance of sediments that have a high proportion of fine particulate material, such as muds and clays, that will remain in suspension longest and settle to the seabed more slowly. Coarse material, such as sand and gravel, are expected to settle quickly i.e., within a few hours of disturbance, with the sediment plume extending to only tens of metres from the source. Finer sediments such as fine sand, silt and clay present in deeper waters are expected to produce a more persistent plume lasting up to a few days depending on the duration of disturbance. The average particle size distribution across all stations sampled in the Marine Installation Corridor was 10.5 ± 8.3 % fines, 83.6 ± 11.4 % sand and 5.9 ± 9.7 % gravel (NEXTGeosolutions, 2022), suggesting the majority of the disturbed sediment particles are larger and will therefore settle to the seabed within hours.

Calculations have been undertaken to estimate the extent of sediment dispersion before deposition as a result of trenching activities. The method for these calculations, and the results, are reported in further detail in Chapter 7: Physical Environment.

The distance travelled by suspended coarse sand typical of the majority of the sediments affected, before deposition from Installation Phase activities, is expected to be around 247 m. Fine sands, silts and clay may, however, be transported beyond the Marine Installation Corridor with any fine sand settling on the seabed up to 1.5 km from the point where it is mobilised. Based on the calculated settling velocities, silt-sized material could remain in suspension for several days and may therefore travel significant distances. For example, the finest clay particles are estimated to travel up to 4.3 km. However, given the small proportion of fine and very fine sediment, primarily between KP210 and KP241 only, and that dispersion processes will also act to dilute the concentration of sediments carried in suspension, elevated concentration levels at 1.5 km and beyond from the source will be negligible. It is considered that there will be no significant elevated concentration levels beyond the travel distance calculated for fine sand which corresponds to a maximum 1.5 km from the point of mobilisation within the Marine Installation Corridor.

Based on these calculations, any measurable change in suspended sediment concentrations will be temporary and localised. Finer fractions that are transported further also be rapidly diluted so that the suspended sediment concentration will be low and the deposition thickness on the seabed, where the sediment will settle, will be negligible.

Annex I reefs

Areas of potential stony reef were identified from ~KP0.2 to KP2.5, with 'low' to 'medium' resemblance Annex I stony reef habitats within the Scottish landfall nearshore survey area at KP0.5 and KP1.4 and 'low' resemblance reef at KP339.4 (NEXTGeosolutions, 2022).

Sessile assemblages such as coral, sponges and ascidians associated with both stony and bedrock reefs will be unable to avoid increases in SSC. Characterising fauna including *Alcyonium digitatum, Nemertesia antennina,* kelp and various foliose red seaweeds associated with many sections which were described as having low and medium resemblance to stony reefs. Although species such as these are sessile, their height results in low sensitivity to turbidity and smothering (Budd, 2008). The duration of any sediment plumes will be dependent on the sediment composition in which the activity is occurring. Given the patchy nature of these rocky habitats, the presence of high proportions of large particles, and the travel distance calculated for SSC, the magnitude of impact to stony reefs in considered to be negligible. The value of this receptor would typically be considered as being high with a medium sensitivity. However, the examples along the cable route are only considered to have low and medium resemblance to stony reefs, and, as such, are usually associated with lower biodiversity and abundance compared to those with high resemblance. This, coupled with the dispersal of sediment by water movements in the coastal area and likely high tolerance of such assemblages to turbid conditions and smothering mean the effect of SSC is considered to be **negligible** and therefore **not significant**.

Areas of potential *S. spinulosa* reef were found to extend from ~KP2.5 to KP4.5 and KP338 to KP349 with Annex I reef of 'low to medium reefiness' at KP3.5, KP160.8, KP163.5 and KP347.8. No evidence of 'high reefiness' structures were observed along the Marine Installation Corridor (NEXTGeosolutions, 2022).

The Ross worm requires a supply of suspended sediment sufficient for feeding and tube formation activities, meaning they thrive in turbid conditions. It has been reported that *S. spinulosa* are likely to be able to tolerate 5 cm of sediment deposition over several weeks, which suggests their adaptability to sediment deposition is high (Holt, Rees, Hawkins, & Seed, 1998) (Jackson & Hiscock, 2008).

Given the expected short-term duration of Installation Phase activities and the quick dispersal and settlement of coarser sediment plumes, which account for the majority of sediments affected along the Marine Installation Corridor, the magnitude of impact to *S. spinulosa* is considered low. This receptor is considered to be of medium value but with low sensitivity to increased SSC and depositional loads, the overall effect is predicted to be **negligible** and therefore **not significant**.

Seapens and megafauna burrowing communities

Several locations in the deeper waters of the Marine Scheme were observed to support the seapens *P. phosphorea* and *Virgularia* spp and showed evidence of burrows. Although sessile organisms such as seapens are unable to avoid SSC and sediment deposition they appear relatively insensitive to smothering and turbid conditions, with quick recovery rates reported where there are short-term changes in conditions (Hill, Tyler-Walters, & Garrard, 2020).

Given the presence of burrows, the environmental habitat between KP213.2 to KP225.9 would be considered a poor quality example of the OSPAR 'Seapen and Burrowing Megafauna Communities' (Section 8.5.4.4). Neither of the two level five EUNIS burrowing megafauna biotopes A5.361 - *Seapens and burrowing megafauna in circalittoral fine mud'* and A5.362 - *Burrowing megafauna and Maxmuelleria lankesteri in circalittoral mud* could be applied to any stations along the Marine Installation Corridor due to the low abundances of key characterising species such as *N. norvegicus* (one individual recorded), *P. phosphorea,* (recorded less than five individuals for each transect), *V. mirabilis*, *Turritella communis* and *M. lankesteri* (absent at all stations).

The expected short-term increase in SSC associated with Installation Phase activities would result in a low magnitude impact and given the species' low sensitivity to smothering and the poor quality example of this habitat identified within the Marine Installation Corridor, the effect would be **negligible** adverse effect and therefore **not significant**.

Subtidal sands and gravels

The most common habitat in the Marine Installation Corridor was sublittoral sand (NEXTGeosolutions, 2022). This habitat supports infaunal communities but there may also be some mobile species including crustaceans and echinoderms. SSC and depositional loads will vary along the Marine Installation Corridor depending upon the local environmental conditions. The infaunal communities that dominate this habitat type are generally tolerant of the levels of SSC and sediment deposition anticipated to result from construction of the Marine Scheme and therefore it is expected that they will have a good capacity to quickly recover. As a result, this receptor is considered of low sensitivity. The short-term and highly localised increases of SSC, turbid conditions are considered to be of negligible magnitude given the wiser extent of this habitat in the North Sea. The overall effect is considered to be **negligible** and therefore **not significant**.

Sandbanks which are slightly covered by seawater all the time

The Marine Installation Corridor intersects the Smithic Bank (identified as potential Annex I subtidal sandbank but not currently designated) between KP426.5 and KP431.5. Footage collected at KP431.3 within the English landfall contained features comparable to Sandbanks which are slightly covered by seawater all the time, including its shallow depth (5 m to 6 m). Sandbank features are dynamic, usually located in depths less than 20 m in environments subject to varying levels of turbidity and energy. Given the limited extent of these features identified during the benthic characterisation survey, and the dynamic environments in which they are found, sensitivity to increased SSC is considered to be low. The value of this receptor is considered as being medium with the magnitude considered negligible. The effect is therefore predicted to be **negligible** and therefore **not significant**.

Ocean quahog

Juvenile ocean quahog were identified across the Marine Installation Corridor with low abundances of adults recorded across a total of five stations during the benthic characterisation survey (NEXTGeosolutions, 2022). Previous studies into the resilience of the ocean quahog to changes in suspended solids in the water column (Morton, 2011) have found that this species naturally occurs in silty sediments in sheltered to wave exposed conditions, where the surface of the sediment is probably regularly mobilised, and where accretion rates are moderate to high. Therefore, increase in turbidity (suspended sediments) may not adversely affect the species, especially as it can avoid sudden changes by burrowing for several days.

The expected short-term increase in SSC and smothering associated with Installation Phase activities would result in a low magnitude impact and given the species' low sensitivity to smothering, despite its high value, the effect would be **negligible** adverse effect and therefore **not significant**.

8.6.2.3 Reduction in marine water quality

Release of HDD Drilling Fluids

The discharge of drilling fluids from HDD works at the breakout location of the Marine Scheme has the potential to alter water quality and affect benthic habitats and ecology at each of the landfall locations. Drilling fluids will be selected from the OSPAR List of Substances/Preparations Used and Discharged Offshore (2021) which are Considered to Pose Little or No Risk to the Environment (PLONOR). For example, the most widely used fluid, bentonite, consists predominately of clay minerals and is biologically inert (OSPAR, 2019). A review by Aslan et al. (2019) found no evidence of a lethal response or reduced survival in bivalve molluscs or crustaceans, in conditions representative of realistic concentrations for discharges in an open marine environment such as the open coasts where the breakouts are located.

Embedded mitigation measures will be implemented to minimise the release of drilling fluid leaks from the end of the ducts and any associated impacts (Section 8.6.1). The discharged drilling fluids will also be subject to immediate dilution and rapid dispersal within the marine environment, particularly as the release will be in the shallow nearshore area where there is likely to be significant wave and tidal water movement. The release of drilling fluids and drilled solids at HDD breakout (Chapter 2: Project Description) will reduce water quality at the locally for a period of time during and immediately after release of the fluids. Any drilled solids released are predicted to settle rapidly in the vicinity of the breakout. Constituents of the drilling fluids, including silt-clay sized particles such as bentonite have a maximum theoretical range of approximately 4.3 km, however, dilution processes over this distance will result in no detectable change from the baseline beyond 1.5 km, therefore the ZoI is considered to be 1.5 km.

The drilling fluid discharges from the Marine Scheme's HDD operations will be single events over a short period of time and rapidly dispersed in an open sea coastal environment. Due to dilution/dispersal (Section 8.6.2.2), SSC above background levels resulting from releases of drilling fluids will be restricted to the immediate vicinity of the HDD exits. Therefore, only receptors in the immediate vicinity of the HDD breakouts are likely to be in contact with drilling fluids, which pose little risk to the environment. Overall, the magnitude of impact on benthic receptors is low, combined with a low sensitivity of habitats in the immediate areas, effects are predicted to be **negligible** and therefore **not significant**.

Mobilisation of contaminants

Contaminants, such as heavy metals and polycyclic aromatic hydrocarbons (PAHs), present in concentrations above thresholds of concern, could also have detrimental impacts on benthic species when resuspended into sediment plumes or redeposited to the seabed. For example, hydrocarbons in sediments are known to reduce the abundance of some species, particularly crustaceans such as amphipods. Details of contaminants present across the Marine Installation Corridor are described in Chapter 7: Physical Environment.

Contaminants will be associated with finer material such as silts and clays, which are limited within the mostly sandier sediments within the Marine Installation Corridor. Where finer sediments do occur, the potential for mobilisation of contaminants is limited, in the same way as the mobilisation of the sediments themselves will be limited, as set out above. In addition, dilution of suspended particulate matter, is anticipated to occur rapidly. Thus, the concentration of contaminants is not expected to exceed the background levels reported from the Firth of Forth and the Tyne Tees monitoring stations. In addition, natural disturbance to the sediment such as during storm events and periods of strong wave action will mobilise contaminants and subject benthic habitats and species to temporary and localised changes in water quality and as a result, these habitats and species will have a tolerance to moderate changes in the surrounding water quality. These factors mean that the resulting magnitude of impact will be negligible. Irrespective of the value and sensitivity of benthic species, it can therefore be concluded that the effect on benthic receptors from the disturbance of sediment-bound contaminants is also **negligible** and therefore **not significant**.

Discharges, leaks and spills from vessels, including loss of oils

The accidental release of pollutants (e.g., oil, fuels, lubricants, chemicals) and planned release of wastewater could occur from any of the vessels associated with the Installation Phase activities and any support vessels present and has the potential to alter water quality. Vessels involved in Installation Phase activities could have cleaning fluids, oils, and hydraulic fluids onboard (as well as fuels), which could be accidentally discharged, releasing hydrocarbons and chemical pollutants into the surrounding seawater, which could then settle on the seabed with consequences for benthic habitats and species.

The benthic habitats within the Marine Scheme route are dominated by muddy sand, coarse sediment, rippled sand, and mixed sediments. These habitats support diverse communities of benthic invertebrates, which can be highly susceptible to effects from spills, as contaminants can settle into and remain in the sediments. Studies have indicated that benthic sediments contaminated with oils and hydrocarbons can contribute to reduced densities of macrofauna, as well as differences in recruitment and development of assemblages (Berge, 1990; Stark, Snape, & Riddle, 2003). However, these effects are related to extensive spills such as from large oil tankers rather than small spills from other vessels.

To ensure the risk of accidental spills is as low as reasonably practicable, the project will adhere to relevant guidance (e.g., Pollution Prevention Guidance). A Construction Environmental Management Plan (CEMP) including an Emergency Spill Response Plan and Waste Management Plan will be implemented during the installation phase of the project to minimise releases (Chapter 2: Project Description). Appropriate Health, Safety, and Environment (HSE) procedures (identified in the CEMP) will also be implemented, with strict weather and personnel limits to reduce any risk of accidental spillage. Furthermore, preparedness and swift response is essential for effective spill management and as such, response plans will be in place should an incident occur. Control measures and Shipboard Oil Pollution Emergency Plans (SOPEP) will be in place and adhered to under MARPOL Annex I requirements for all vessels. Planned effluent dischargers will be compliant with MARPOL Annex IV ‘Prevention of Pollution from Ships’ standards.

Thus, the risk of an accidental spill occurring is considered to be unlikely. Should an accidental spill or leak occur, it would be very small in extent and subject to immediate dilution and rapid dispersal within the marine environment and thus would have only a low magnitude. Combined with a low to high sensitivity, the overall appraisal of the effect to benthic ecology from accidental leaks and spills from vessels and equipment is appraised to be **minor risk** and therefore **not significant**.

8.6.2.4 Accidental introduction of invasive non-native species

The accidental introduction of INNS, such as from international vessels ballast water or through the addition of substrate in the water, has the potential to cause detrimental changes to benthic habitats. Whilst most non-native species are unlikely to 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 introduction of INNS could occur from the different vessels that may be required during various phases of the Marine Scheme.

If INNS were to be introduced by vessels, the effect on benthic habitats could be significant and long-term. For this reason, all project vessels will adhere to the International Convention for the Control and

Management of Ships' Ballast Water and Sediments (BWM Convention) with the aim of preventing the spread of INNS (IMO, 2022). In addition, vessels will be required to adhere to the IMO guidelines for the control and management of ships' biofouling to minimise the transfer of invasive aquatic species (Biofouling Guidelines) (resolution MEPC.207(62). These measures lower the probability of INNS transmission from vessels to the benthic habitat.

Rock placement and concrete mattresses are proposed for a number of locations along the Marine Installation Corridor, to protect the cable in areas where the target or minimum depth of lowering cannot be achieved and at HDD exits. They will also be used at intersections with other cables or pipeline infrastructure, with further detail presented Chapter 2: Project Description. All rock and concrete mattresses used for cable protection will be terrestrially sourced and clean, so do not provide a vector for INNS directly, but these artificial hard structures can function as artificial rocky reef, which are known to be preferred habitat for many INNS acting as 'ecological stepping stones' (Adams, Miller, Aleynik, & Burrows, 2014). This could facilitate the colonisation and spread of INNS in areas of the benthos which may have previously been unsuitable. However, to date, no spread of INNS caused by submarine cabling has been documented (Taormina, et al., 2018), though this remains a concern given the exponential growth of marine infrastructure in the North Sea.

The GB Invasive Non-Native Species Strategy also provides guidance for the prevention, detection, eradication and management of INNS, including marine species (NBN, 2021). Best practice measures will be adopted, in particular, compliance with the relevant IMO guidance regarding ballast water and biofouling, which will be implemented through the CEMP. These measures will reduce the overall risk of introduction of INNS.

No INNS were identified in the Study Area (NEXTGeosolutions, 2022) and so the risk of the spread of any existing non-native species is considered **unlikely**. The introduction and subsequent risk of non-native invasive species is appraised to be unlikely and **minor** and therefore **not significant.**

8.6.3 Operation and Maintenance Phase

8.6.3.1 Permanent loss of subtidal benthic habitats and species due to placement of hard substrates on the seabed

As part of the Installation Phase activities, there is a requirement to use rock protection and/or concrete mattressing within the subtidal (including nearshore and offshore zones) Marine Installation Corridor to protect the HDD exits, third-party asset crossings, cable joints, and in locations where the minimum depth of lowering cannot be achieved through trenching (Chapter 2: Project Description). The footprints of rock protection across the Marine Installation Corridor (Table 8-4) are as follows:

- **Planned/remedial rock berms** – 1 km^2 per cable or 2 km^2 if separate lay;
- **Crossings** - 0.1 km^2 per cable or 0.2 km^2 if separate lay; and
- **Landfall protection** - 0.01 km^2 per landfall, 0.2 km^2 in total.

A total of 24 crossings have been identified for the Marine Scheme. The benthic habitats present at each or these are presented below:

- The habitat present at eight crossings is a mosaic of *Circalittoral Muddy Sand with patches of Offshore Circalittoral Mixed Sediment* (MC52 / MD42 / A5.25 / A5.26 / A5.54);
- The habitat at five crossings is *Circalittoral Muddy Sand* (MC52 / A5.25 / A5.26);
- The habitat at three crossings is a mosaic of *Circalittoral Coarse Sediment (mega rippled) with patches of encrusting Sabellaria spinulosa on Circalittoral Rock* (MC32 / MC2213 / A5.14 / A4.22);
- The habitat at four crossings is *Offshore Circalittoral Sand (rippled) with occasional patches of Offshore Circalittoral Mixed Sediment* (MD52 / MD42 / A5.27 / A5.45); and
- The habitat at two crossings is *Offshore Circalittoral Mixed Sediment with patches of encrusting Sabellaria spinulosa* (MD42 / A5.42).

Due to the unknown locations of two crossings, habitat information was unavailable for these locations.

Rock protection will also be required at locations to protect the cable where the target depth of lowering cannot be achieved through trenching (see Chapter 2: Project Description). The actual amount of rock placement will vary depending on seabed conditions and not all of the identified areas will need full coverage by rock. Categories 1, 2, 3, 4 and 5 (3%, 25%, 50%, 75% and 100% length of each zone of the installation corridor requiring rock placement respectively) have been used to estimate the anticipated levels of rock protection required within each section of the Marine Installation Corridor, based on worst case assumptions of trenching success taking account of seabed conditions and available trenching tools (Chapter 2: Project Description). This results in a worst-case estimate of approximately 138 km of rock berm being required to protect each cable.

The total length of rock berm anticipated to be required for protection at crossings, cable joints, and the HDD exit pits is approximately 16.6 km per cable. As such the total length of rock berm per cable is approximately 154.3 km, equating to 308.6 km if the cables are laid separately.

The need for rock placement has been identified for the four broad scale sediment types present in the marine installation corridor: mixed sediment, coarse sediment, rippled sand and muddy sand. Most areas comprise a mosaic of these habitats and rock protection is more commonly required where there is presence of mixed, coarse, and rock habitats (Table 8-6).

As these habitats often occur as a mosaic, with multiple habitats recorded within each zone of the installation corridor, the estimation of the area of habitat types affected by rock placement, using the rock placement categories, is not possible. Therefore, this appraisal is based on a worst-case assumption of maximum possible area of habitat lost, given the extent of the habitat within each zone, and the maximum potential berm length based on category/distance.

Table 8-6: Summary of length and area of rock placement and habitats affected

EUNIS code 2022	Habitat Description	Area of habitat loss (km^2) for two cables	% Area of marine installation corridor
Rock Placement			
MC121	Bedrock and boulders	0.009	<0.01 %
MC3	Coarse sediment (cobbles and pebbles, gravels, and coarse sands)	0.008	<0.01 %
MC32	Coarse sand and gravel with a minor sand fraction	0.007	<0.01 %
MC32 / MC2213	Circalittoral coarse sediment (mega rippled) with patches of encrusting *Sabellaria spinulosa* on circalittoral rock	0.208	0.10 %
MC4	Mixed sediment (with stones and shells)	0.002	<0.01 %
MC52	Circalittoral muddy sand	0.348	0.16 %
MC52 / MD42	Circalittoral muddy sand with patches of offshore circalittoral mixed sediment	0.930	0.43 %
MC52 / MD42 / MC2213	Circalittoral muddy sand with patches of offshore circalittoral mixed sediment and *Sabellaria spinulosa* on circalittoral rock	0.099	0.05 %
MD42	Offshore circalittoral mixed sediment with patches of encrusting *Sabellaria spinulosa*	0.208	0.10 %
MD42 / MC32	Offshore circalittoral mixed sediment with patches of encrusting *Sabellaria spinulosa* and mega rippled circalittoral coarse sediment	0.057	0.03 %
MD42 / MD52 / CR	Offshore circalittoral mixed sediment with patches of offshore circalittoral sand and circalittoral rock	0.268	0.12 %
MD52	Offshore circalittoral sand	0.030	0.01 %
MD52 / MC1	Offshore circalittoral sand with exposed underlying circalittoral rock and occasional mega rippled sand waves	0.136	0.06 %

EUNIS code 2022	Habitat Description	Area of habitat loss (km^2) for two cables	% Area of marine installation corridor
MD52 / MC32	Offshore circalittoral sand with patches of circalittoral coarse sediment	0.020	0.01 %
MD52 / MD42	Offshore circalittoral sand with patches of offshore circalittoral mixed sediment	0.310	0.14 %
MD52 / MD42 / MC2213	Offshore circalittoral sand with patches of offshore circalittoral mixed sediment and *Sabellaria spinulosa* on circalittoral rock	0.126	0.06 %
Crossings			
MC32 / MC2213	Circalittoral coarse sediment (mega rippled) with patches of encrusting *Sabellaria spinulosa* on circalittoral rock	0.036	0.02 %
MC52	Circalittoral muddy sand	0.060	0.03 %
MC52 / MD42	Circalittoral muddy sand with patches of offshore circalittoral mixed sediment	0.096	0.04 %
MD42	Offshore circalittoral mixed sediment with patches of encrusting *Sabellaria spinulosa*	0.024	0.01 %
MD52 / MD42	Offshore circalittoral sand with patches of offshore circalittoral mixed sediment	0.048	0.02 %

Yellow = Sand (no mosaic), Green = Rock / Mixed / Coarse, Blue = Sandy mosaic

The habitat type most commonly identified as requiring rock placement was *Circalittoral muddy sand (MC52)* and *Offshore circalittoral sand (MD52)* present within in a mosaic with patches of one or more of the following habitats:

- *Circalittoral Rock (MC1);*
- *Sabellaria spinulosa encrusted Circalittoral Rock (MC2213);*
- *Circalittoral Coarse Sediment (MC32); and*
- *Offshore Circalittoral Mixed Sediment (MD42).*

Annex I reefs

The length of rocky and mixed habitat mosaics is approximately 54.7 km (0.77 km^2) (Table 8-6) with locations of rock placement overlapping areas of Annex I 'low resemblance' stony reef between KP0.9 and KP2.9 and at KP339.4. Due to the localised extent of Annex I stony reef at KP339.4, impacts from rock placement at this location is considered avoidable, however permanent loss of habitat between KP0.9 and KP2.9 (characterised as the biotope *Offshore Circalittoral Mixed Sediment with patches of encrusting Sabellaria spinulosa* (MD42)) is unavoidable as the reef occurs across the total width of the Marine Installation Corridor at this location (NEXTGeosolutions, 2022). Potential recoverability of stony habitats is considered to be moderate given that alternative suitable habitat is available nearby and, considering the presence of large particulate material already present in stony reefs, the rock replacement will be able to support some of the same epifaunal species (Tillin & Tyler-Walters, 2014). Given the localised loss of habitat, the scale of change is also expected to be small. Therefore, the magnitude of this impact on potential stony reef is expected to be low. Combined with the high value and medium sensitivity of this receptor, the effect of rock placement on potential stony reef habitat is expected to be **minor,** and therefore **not significant.**

Although *S. spinulosa* was present at seven crossing locations offshore, these were not deemed to correspond to potential Annex I reef habitat. The crossing location close to the Scottish landfall at approximately KP0.8 will be crossed by HDD and will therefore not require rock placement at this location.

In offshore areas of the Marine Installation Corridor, rock placement is also required in areas of *Offshore Circalittoral Sand with patches of Offshore Circalittoral Mixed Sediment and Sabellaria spinulosa on Circalittoral Rock* (MD52 / MD42 / MC2213) between KP160.8 to KP160.95 and KP163.4 to KP163.7

(NEXTGeosolutions, 2022) and in areas of *Circalittoral Muddy Sand with Patches of Offshore Circalittoral Mixed Sediment and Sabellaria spinulosa on Circalittoral Rock* (MC52 / MD42 / MC2213) between KP338 to KP349 which also correspond to 'low to medium' quality Annex I *S. spinulosa* reef. These instances are considered patchy and isolated, and therefore avoidable following micro-routeing post-consent.

Although rock placement would result in direct loss of this habitat, the area of loss would be small and highly localised. Research has previously shown that *S. spinulosa* can colonise artificial structures associated with renewable energy installation (Karlsson, et al., 2022). An increase in the availability of hard substratum may therefore be beneficial in areas where sedimentary habitats were previously unsuitable for colonisation. For instance, it has been identified that impacts to *Sabellaria* reefs from the addition of hard substrate are more prominent in areas dominated by soft sediment in comparison to rocky and mixed sediment habitats such as those present at the Scottish landfall (Gibb, Tillin, Pearce, & Tyler-Walters, 2014).

However, patchy 'low to medium' Annex I *S. spinulosa* reef was ground truthed at KP3.5, near the Scottish landfall, and also delineated on the SSS data at approximately KP2.5 to KP4.5 (NEXTGeosolutions, 2022). This coincides with areas of rock protection predicted between KP1 and KP11.7 in the biotope *Offshore Circalittoral Mixed Sediment with Patches of encrusting Sabellaria spinulosa and Mega Rippled Circalittoral Coarse Sediment* (MD42 / MC32). As the potential areas of *S. spinulosa* Annex I biogenic reef at this location mostly covers the width of the Marine Installation Corridor, impacts to this habitat at this location is considered unavoidable.

The 'reefiness' of Annex I *S. spinulosa* reef habitats in this nearshore area was assessed as low to medium though the areas of medium reefiness were present as patches within larger areas of low reefiness (Figure 8-4). Although features are deemed representative of Annex I *S. spinulosa* reef across the Marine Installation Corridor, these areas do not form part of a designated site under the EC 92/43/EEC or any other protected site.

However, the current reported extent of the Annex I *S. spinulosa* reef at the Scottish landfall is largely based on geophysical interpretation, with limited ground truthing. Embedded mitigation for the Marine Scheme includes detailed route development and micro-routeing, informed by pre-installation evaluation of site-specific survey data, to avoid or minimise localised engineering and environmental constraints. Thus, considering the sporadic nature of medium resemblance reef ground truthed across the camera transects, the limited extent of the area identified, the ephemeral nature of *S. spinulosa*, and the embedded mitigation to minimise disturbance to sensitive features with further survey work, the magnitude of the impact has been appraised as low. Combined with a medium sensitivity (but high value) of *S. spinulosa* to disturbance (Gibb, Tillin, Pearce, & Tyler-Walters, 2014) the effect is determined to be **minor** and therefore **not significant**.

Seapens and burrowing megafauna communities

An area of approximately 0.07 km^2 of *Circalittoral Muddy Sand with patches of Offshore Circalittoral Mixed Sediment* between KP214.4 and KP223.7, where poor examples of the OSPAR '*Seapen and Burrowing Megafauna Communities*' were identified, may also be impacted by rock placement (NEXTGeosolutions, 2022). Although rock placement would result in direct loss of this sensitive habitat, the area of loss would be small and highly localised and is characterised by low quality examples of this habitat. Burrowing megafauna such as *N. norvegicus* are highly intolerant to substrate loss, but they show moderate recovery, provided there is suitable substrate nearby (Hill & Wilson, 2000). Only one individual was identified during the benthic characterisation survey (NEXTGeosolutions, 2022). The magnitude of this impact on potential muddy sand and mixed sediments is expected to be low. Combined with the poor example of this habitat within the Marine Installation Corridor and medium sensitivity of this receptor, the effect of rock placement is expected to be **minor** and therefore **not significant**.

Subtidal sands and gravels

The length of rock berms in sandy habitat mosaics is anticipated to be approximately 115.7 km (1.6 km^2), with the length in sand (no mosaic habitats) approximately 27 km (0.38 km^2) (Table 8-6). These areas have been identified as section of the Marine Installation Corridor where the minimum depth of lowering may not be achieved, despite the presence of sand, because of the regular presence of coarser sediment types, boulders, cobbles, sub-cropping till or bedrock. Given the prevalence of the habitats and species subject to habitat loss within the wider North Sea area, the dominance of this habitat across the Marine Installation Corridor 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. Although 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.

Compared to the extent of these habitats elsewhere in the North Sea and the Marine Installation Corridor alongside the small-scale loss, the magnitude of impact from rock placement is predicted to be negligible. Combined with the medium value of this receptor and low sensitivity, the overall effect is appraised as **negligible** and therefore **not significant**.

Sandbanks which are slightly covered by water all of the time
Rock placement is not anticipated where the Marine Installation Corridor intersects the Smithic Bank. The magnitude of impact from rock placement on sandbanks which are slightly covered by water all of the time is negligible. The overall effect is appraised as **negligible** and therefore **not significant**.

Ocean Quahog
Juvenile ocean quahog were identified across the Marine Installation Corridor with low abundances of adults recorded across a total of five stations during the benthic characterisation survey (NEXTGeosolutions, 2022). Due to the localised scale of permanent habitat loss, the magnitude of disturbance from rock placement to this species has been appraised as negligible. Combined with the high value and sensitivity, the effect has been assessed **negligible** and therefore **not significant**.

8.6.3.2 Potential effects on benthic habitats and species due to subsea cable electromagnetic field emissions

Modelling completed for the Marine Scheme provides data on the level and attenuation of the EMF emissions for both possible design options (see Chapter 2: Project Description). The modelling accounts for cable configuration, the design of HVDC cable, and the properties of electromagnetic fields in water, with and without the influence of background geomagnetic fields. These estimates indicate that EMF from a 30 m separated bipole configuration, buried at a depth of 1 m reduces to background levels at a distance of around 20 m from the cable, both vertically and horizontally.

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. For example, it has been shown that in addition to visual and hydrodynamic cues, the spiny lobster *Panulirus argus* uses the Earth's magnetic field to orient (Boles & Lohmann, 2003). This lobster is a Caribbean species, but it does indicate some crustaceans have the ability to detect EMF. 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 differences in survival between experimental and control animals was detected (Bochert & Zettler, 2004). In context the maximum EMF strength predicted to result from the operation of the Marine Scheme cables is 404 μT, which is an order of magnitude below the tested field strength, which showed no effect. Similarly, in another laboratory study with common rag worm *Hediste diversicolor*) there was no evidence of avoidance or attraction behaviours at an EMF of 1 mT (Jakubowska, Urban-Malinga, Otremba, & Andrulewicz, 2019) a much higher intensity than will the emitted by the Marine Scheme. A detailed appraisal of EMF impacts to fish and shellfish is presented in Chapter 9 of this EAR.

Therefore, it appears some detection in benthic invertebrates may be possible but there have been no negative impacts observed at the EMF levels predicted for the Marine Scheme, with most animals having the ability to move away from any effects. Thus, whilst EMF will be emitted whenever the cable is active, and is therefore a permanent effect during cable operation, the spatial extent is very small, and effects are restricted to small short-term behavioural responses. Thus, the magnitude of the impact to all benthic habitats and species is considered to be negligible. Combined with a low to high sensitivity, the effect of EMF in relation to benthic ecology is appraised as **negligible** and therefore **not significant**.

8.6.3.3 Potential effects on benthic habitats and species due to subsea cable thermal emissions

Submarine power cables have been shown to generate and dissipate heat when active, reaching cable surface temperatures of up to 70°C (Emeana, et al., 2016). 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 physico-chemical conditions and bacterial activity in surrounding sediments, contributing to altered faunal composition and localised ecological shifts (Meissner, Schabelon, Bellebaum, & Sordyl, 2008). While the full effect of temperature changes on sediment composition and related biogeochemical cycling are unknown, preliminary studies have indicated shifts in bacterial community composition with increased temperatures, with corresponding changes in NH_4 concentration and nitrogen cycling (Hicks, et al., 2018).

Sediment particle size composition has been found to influence heat transfer, with coarse silts experiencing the greatest temperature change, but to a shorter distance from the source, while fine and coarse sands had a lower temperature change but a greater affected distance (Emeana, et al., 2016).

The Marine Scheme cable design comprises two HVDC cables, installed either in a 30 m separated bipole or bundled together in a single trench. Heat dissipation modelling for bundled cables trenched to a depth of 1.5 m indicates that within 50 cm of the seabed surface the increase in sediment temperature is limited to approximately 3°C which has been calculated based upon a maximum seabed ambient surface sediment temperature of 15°C (see Chapter 2: Project Description). For unbundled cables the heat profile of each individual cable at the surface may be lower but the affected area will be around two cables, rather than one.

A range of sediment types have been classified within the Marine Scheme, with the majority classified as coarse sediment and sand. These contribute to a wide variety of habitats and biotopes, which support a range of infaunal and epifaunal benthic organisms, including polychaetes, crustaceans, bivalve molluscs (such as the ocean quahog) and echinoderms. Increased sediment temperature has the potential to affect infaunal species and assemblages directly. However, 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, such as Annex I reefs, and these are therefore not considered further.

Seapens and burrowing megafauna communities

There are areas along the Marine Installation Corridor that support *N. norvegicus* fisheries, distributed according to the extent of cohesive muddy sediments, in which they construct their burrows (Howard, 1989) (see Chapter 14: Commercial Fisheries). These sediment conditions allow the excavation of an often extensive but shallow system of branching unlined *N. norvegicus* burrows (Atkinson, 1974). Burrow systems are regularly flushed with water, from both the behaviour of *N. norvegicus* and natural water movement. This water movement is expected to increase heat dissipation. Although a number of burrows were observed during the characterisation survey, only a single *N. norvegicus* was present within the only large burrow observed at KP213.3. Seapens are also found in similar sediment types to *N. norvegicus.* Such species have part of their body buried in the sediment but only in the upper layers where any thermal effects will be negligible. These species are relatively sedentary but can move, for example in response to disturbance or to avoid unfavourable conditions. Thus, these species can also avoid any highly localised effects.

The magnitude of impact is predicted to be negligible, coupled with the medium sensitivity of seapens and burrowing megafauna communities, the effect is considered to be **negligible** and **not significant**.

Subtidal sands and gravels

Although thermal effects would be long-term and occurring continuously for the operational lifetime of the Marine 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 infaunal species are typically found. Coupled with the fact that any impacts would be highly localised, the overall magnitude of impact on subtidal sands and gravels is considered to be negligible. The value of this habitat has been appraised to be medium, with sensitivity low, the effect of thermal emissions from the Marine Scheme, on subtidal sands and gravels, is predicted to be **negligible** and therefore **not significant**.

Sandbanks which are slightly covered by water all of the time

Although thermal effects would be long-term and occurring continuously for the operational lifetime of the Marine 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 infaunal species are typically found. Coupled with the fact that any impacts would be highly localised, the overall magnitude of impact on sandbanks which are slightly covered by water all of the time is considered to be negligible. The value of this habitat has been appraised to be high, with sensitivity medium, the effect of thermal emissions from the Marine Scheme, on subtidal sands and gravels, is predicted to be **negligible** and therefore **not significant**.

Ocean Quahog

Ocean quahog are mobile and will have the opportunity to move away from the area of temperature increase after activation of the current. This species will become redistributed and whilst there may be a lower abundance of individuals directly above the cable this will be very localised, within a metre or so, and affect only local distribution. Also, sediment temperature does change seasonally and so some animals may tolerate an increase in temperature of a degree or two, without the need for avoidance behaviour. Thus, for a receptor of low to medium sensitivity and an impact of negligible magnitude the impact for ocean quahog is appraised to be **negligible** and therefore **not significant**.

8.6.3.4 Maintenance and Cable Repair Effects

Maintenance and cable repair activities, where required, will be carried out using the same or similar methods as the Installation Phase activities, and therefore the potential pathways for impact to benthic ecology are expected to be the same as those identified for the Installation Phase of the Marine Scheme.

Repair works are likely to be highly localised to the area of concern and therefore the spatial extent of any impacts would be small in extent. Furthermore, any maintenance or repairs works would be of a significantly shorter duration.

The only exception is where rock protection would be required (where previously rock was not placed) as part of maintenance and cable repair works to achieve cable protection when trenching is not possible. In the event of additional placement of external protection on the seabed, further permanent physical disturbance to and/or loss of benthic habitats would likely arise.

The Marine Installation Corridor will be routed to avoid any unstable habitats and to achieve the precautionary target depth of lowering of 0.6 m as much as possible. Furthermore, a detailed review of rock placement requirements has already been undertaken and this will be refined following appointment of the Contractor.

Maintenance and unforeseen cable repair (although unlikely) is considered routine, and the procedures and processes are well defined and common in the industry. Impacts of maintenance and cable repair works would be of smaller magnitude than Installation Phase activities, and the effect is predicted to be **negligible** and therefore **not significant**.

8.6.4 Decommissioning Phase

At the end of the operational life of the cable the options for decommissioning will be evaluated and taking into consideration with other Project constraints (e.g., safety and liability), with the least environmentally damaging option chosen if possible.

The principal options for decommissioning described in Chapter 2: Project Description are:

- Leave the cable *in-situ*, buried;
- Leave *in-situ* and provide additional protection;
- Remove sections of the cable that present a risk; or
- Remove the entire cable.

Should full removal from the seabed be required, this would have the potential to cause similar impacts to the Installation Phase of the Marine Scheme.

Thus, as a worst-case scenario, impacts during decommissioning may be of a similar magnitude to cable installation, depending upon the decommissioning option chosen. Therefore, as a worst case, the effects to benthic ecology are predicted to be **negligible / minor** and therefore **not significant**.

8.7 Mitigation and Monitoring

Aside from the embedded mitigation measures described in Section 8.6.1, no additional mitigation measures or monitoring have been identified as required following the appraisal.

8.8 Residual Effects

As no additional mitigation was required because there were no significant effects on benthic ecology identified, the residual effects of the Marine Scheme remain as reported in Section 8.6.

8.9 Summary of Appraisal

Table 8-7: Summary of environmental appraisal

Phase	Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Additional Mitigation	Magnitude after Mitigation	Residual Significance
Installation	Temporary physical disturbance to subtidal benthic habitats and species	Annex I reefs	Medium	Low	Minor	None required	Low	Not significant
		Seapens and burrowing megafauna	Medium	Negligible	Negligible	None required	Negligible	Not significant
		Subtidal sands and gravels	Low	Negligible	Negligible	None required	Negligible	Not significant
		Annex I sandbanks	Medium	Negligible	Negligible	None required	Negligible	Not significant
		Ocean quahog	High	Negligible	Negligible	None required	Negligible	Not significant
	Temporary increase in SSC and sediment deposition leading to contaminant mobilisation, turbidity and smothering effects	Annex I reefs	Low to Medium	Negligible to Low	Negligible	None required	Negligible	Not significant
		Seapens and burrowing megafauna	Low	Low	Negligible	None required	Negligible	Not significant
		Subtidal sands and gravels	Low	Negligible	Negligible	None required	Negligible	Not significant
		Annex I sandbanks	Low	Negligible	Negligible	None required	Negligible	Not significant
		Ocean quahog	Low	Low	Negligible	None required	Negligible	Not significant
	Changes to marine water quality from the use of HDD drilling fluids and accidental spills from vessels, including loss of fuel oils and INNS	All benthic habitats and species	Negligible to high	Unlikely / Low	Negligible / Minor Risk	None required	Unlikely / Low	Minor Risk

Phase	Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Additional Mitigation	Magnitude after Mitigation	Residual Significance
Operation and Maintenance	Permanent loss of subtidal benthic habitats and species due to placement of hard substrates on the seabed	Annex I reefs	Medium	Low	Minor	None required	Low	Not significant
		Seapens and burrowing megafauna	Medium	Low	Minor	None required	Low	Not significant
		Subtidal sands and gravels	Low	Low	Negligible	None required	Negligible	Not significant
		Annex I sandbanks	High	Negligible	Negligible	None required	Negligible	Not significant
		Ocean quahog	High	Negligible	Negligible	None required	Negligible	Not significant
	Effects of EMF emissions from buried cable	All benthic habitats and species	Medium	Negligible	Negligible	None required	Negligible	Not significant
	Effects of thermal emissions from buried cable	All benthic habitats and species	Low to Medium	Negligible	Negligible	None required	Negligible	Not significant
	Maintenance effects the same as Installation Phase							
Decommissioning	Effects of decommissioning the same as Installation Phase							

8.10 References

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