NORTH FALLS

Offshore Wind Farm

PRELIMINARY ENVIRONMENTAL INFORMATION REPORT

Chapter 10 Benthic and Intertidal Ecology

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Offshore Wind Farm

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Glossary of Acronyms

BGS	British Geological Survey
BTO	British Trust for Ornithology
BWM Convention	The International Convention for the Control and Management of Ships' Ballast Water and Sediments
CEA	Cumulative Effects Assessment
CEFAS	Centre for Environment, Fisheries and Aquaculture Science
CEMP	Construction Environmental Management Plan
CIEEM	Chartered Institute of Ecology and Environmental Management
CMACS	Centre for Marine and Coastal Studies
CPA	Coast Protection Act 1949
DCO	Development Consent Order
DDV	Drop Down Video
EA	Environment Agency
EEA	European Environment Agency
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EMF	Electromagnetic Fields
ES	Environmental Statement
ETG	Expert Topic Group
EUNIS	European Nature Information System
FEPA	Food and Environment Protection Act 1985
FERA	Food and Environment Research Agency
GBS	Gravity Based Structure
GGOW	Greater Gabbard Offshore Wind Farm
GWF	Galloper Wind Farm
HDD	Horizontal Directional Drilling
HRA	Habitats Regulations Assessment
HVDC	High Voltage DC Cable
IEEM	Institute of Ecology and Environmental Management
INNS	Invasive Non-Native Species
IUCN	International Union for Conservation of Nature
JNCC	Joint Nature Conservation Committee
MarESA	Marine Evidence-based Sensitivity Assessment
MARPOL	International Convention for the Prevention of Pollution from Ships
MCZ	Marine Conservation Zone
MEEB	Measures of Equivalent Environmental Benefit
MHWS	Mean High Water Springs
MLWS	Mean Low Water Springs
MMO	Marine Management Organisation
MNCR	Marine Nature Conservation Review

MPA	Marine Protected Area
MPI	Multi-purpose Interconnector
MPS	Marine Policy Statements
MRED	Marine Renewable Energy Devices
NNS	Non-Native Species
NPL	National Physical Laboratory
NPS	National Policy Statements
NSIP	Nationally Significant Infrastructure Project
OSP	Offshore Substation Platform
OWF	Offshore Wind Farm
PAH	Polycyclic Aromatic Hydrocarbons
PEIR	Preliminary Environmental Information Report
PSD	Particle Size Distribution
RIAA	Report to Inform Appropriate Assessment
SAC	Special Area of Conservation
SBT	Sea Bottom Temperature
SMRU	Sea Mammal Research Unit
SPA	Special Protection Area
SQG	Sediment Quality Guidelines
SSC	Suspended Sediment Concentrations
SSSI	Sites of Special Scientific Interest
SST	Sea Surface Temperature
UXO	Unexploded Ordnance
WTG	Wind Turbine Generator
ZoI	Zone of Influence

Glossary of Terminology

Array areas	The two distinct offshore wind farm areas (including the 'northern array area' and 'southern array area') which together comprise the North Falls offshore wind farm.
Array cables	Cables which link the wind turbine generators with each other and the offshore substation platform(s).
Bathymetry	Topography of the seabed
Circalittoral	A subtidal zone where light penetration is limited and therefore communities are dominated by faunal species.
Evidence Plan Process	A voluntary consultation process with specialist stakeholders to agree the approach to the EIA and information to support the HRA
Infralittoral	A subtidal zone, above the circalittoral zone in which light penetration enables plant growth.
Interconnector cable	Cable between the northern and southern array areas
Interconnector cable corridor	The corridor of the seabed between the northern and southern array areas within which the interconnector cable will be installed

Intertidal	Area on a shore that lies between Lowest Astronomical Tide (LAT) and Highest Astronomical Tide (HAT)
Landfall	The location where the offshore cables come ashore.
Landfall search area	Locations being considered for the landfall, comprising the Essex coast between Clacton-on-Sea and Frinton-on-Sea within the PEIR.
Offshore cable corridor	The corridor of seabed from array areas to the landfall within which the offshore export cables will be located.
Offshore export cables	The cables which bring electricity from the array areas to the landfall.
Offshore project area	The overall area of the array areas and the offshore cable corridor.
Offshore substation platform(s)	Fixed structure(s) located within the array areas, containing electrical equipment to aggregate the power from the wind turbine generators and convert it into a more suitable voltage for export to shore via offshore export cables.
Sandwave	Bedforms with wavelengths of 10 to 100m, with amplitudes of 1 to 10m
Scour protection	Protective materials to avoid sediment being eroded away from the base of the wind turbine generator foundations and offshore substation platform foundations as a result of the flow of water.
The Applicant	North Falls Offshore Wind Farm Limited (NFOW)
The Project or 'North Falls'	North Falls Offshore Wind Farm, including all onshore and offshore infrastructure.
Wind turbine generator	Power generating device that is driven by the kinetic energy of the wind

10 Benthic and Intertidal Ecology

10.1 Introduction

1. This chapter of the Preliminary Environmental Information Report (PEIR) considers the likely significant effects of the North Falls Offshore Wind Farm (hereafter "North Falls" or "the Project") on benthic and intertidal ecology. The chapter provides an overview of the existing environment for the proposed offshore project area, followed by an assessment of the likely significant effects for the construction, operation, and decommissioning phases of the Project.

2. This chapter has been written by Royal HaskoningDHV, with the assessment undertaken with specific reference to the relevant legislation and guidance, of which the primary source are the National Policy Statements (NPS) and Marine Policy Statements (MPS). Details of these, and the methodology used for the Environmental Impact Assessment (EIA) and Cumulative Effects Assessment (CEA) are presented in Section 10.4.

3. The assessment is informed by the following chapters (Volume I):

   - Chapter 7 Marine Geology, Oceanography and Physical Processes;
   - Chapter 8 Marine Water and Sediment Quality;

4. Additional information to support the benthic and intertidal ecology assessment can be found in:

   - Appendix 10.1 Benthic Ecology; North Falls Offshore Site Investigation (Volume III).

10.2 Consultation

5. Consultation with regard to benthic and intertidal ecology has been undertaken in line with the general process described in Chapter 6 EIA Methodology (Volume I). The key elements to date have included scoping and the ongoing technical consultation via the Seabed Expert Topic Group (ETG). The feedback received has been considered in preparing the PEIR. Table 10.1 provides a summary of how the consultation responses received to date have influenced the approach that has been taken.

6. This chapter will be updated following the consultation on the PEIR in order to produce the final assessment that will be submitted with the Development Consent Order (DCO) application.

Table 10.1 Consultation responses

Consultee	Date / Document	Comment	Response / where addressed in the PEIR
Natural England	26/05/2021 Written response regarding benthic survey methodology	Natural England recommends that any desk study or review of existing information should … inform the benthic survey campaign. We assume that existing information was used to help inform data sampling locations for this campaign, but that is not made clear here. Furthermore, a review of the existing data here would help us to assess and advise on the adequacy of the benthic survey and sample sites, and to understand the rationale for the chosen methodology and sample site location selection.	A course habitat map was subsequently provided showing sample locations in relation to the EUNIS habitat classification which is based on physical datasets (such as BGS) as well as biological. This existing data was used to ensure samples would ground truth the range of habitats present.
Natural England	26/05/2021 Written response regarding benthic survey methodology	We also note that no information has been provided showing the indicative habitats present across the study area. We would normally expect to be provided with a coarse habitat map derived from British Geological Survey (BGS) data and other sources, which helps determine if the sampling array is of a suitable resolution to characterise the site.	
Natural England	26/05/2021 Written response regarding benthic survey methodology	Please also note that when considering the benthic survey data in the Environmental Impact Assessment, these data should be presented along with any existing data for the Galloper and Greater Gabbard offshore windfarm sites, in order to map sediments across the whole site.	Figure 10.4 (Volume II) shows the biotopes recorded from environmental investigations of North Falls, GGOW and GWF.
Natural England	26/05/2021 Written response regarding benthic survey methodology	We agree with the approach that the geophysical survey will precede and thus, inform the benthic survey. However, we would expect there to be some mention of the use of previous data here. If a desk study has been carried out with previous sample information, then it should be referenced here.	As above, a review of existing EUNIS habitat data was provided in response to this comment.
Natural England	26/05/2021 Written response regarding benthic survey methodology	It is worth noting that should the geophysical survey reveal more potential habitat changes than expected, then we would expect to see an increase in the number of sample stations to ensure that all potential habitats are sampled and mapped. In turn, this will also inform the impact assessment on the full range of habitats. This is particularly important within MPAs.	Review of geophysical data placed emphasis on areas of potential conservation value, boundaries between areas of differing sonic reflectivity, bathymetric highs and lows and areas representative of the general background conditions of the site. Following the initial 36 sample stations proposed, 49 were collected during the survey.

Consultee	Date / Document	Comment	Response / where addressed in the PEIR
Natural England	26/05/2021 Written response regarding benthic survey methodology	If a development is planned within an MPA, site characterisation also needs to consider potential impacts of the development that extend outside of the MPA, which may require additional survey work to increase confidence and precision on location and extent of the habitats and species present. This might entail more detailed geophysical and/or ground truthing surveys (e.g. video) to assist in locating and defining designated feature boundaries. Therefore, we would recommend that data of a sufficient resolution are gathered in order to clearly understand which features are present and likely to be impacted by the proposals.	In response to this feedback, additional samples were collected in the Kentish Knock East MCZ and Margate and Long Sands SAC, outside the North Falls offshore project area.
Natural England	26/05/2021 Written response regarding benthic survey methodology	Kentish Knock MCZ, for example, may require an increase in sample site locations, unless the habitat is demonstrated to be homogenous from the geophysical data. Furthermore, it will be necessary to understand development impacts by feature, hence, subtidal coarse sediment, mixed sediment and sand will need to be delineated. It should also be ensured that there are sufficient data captured where the cable route abuts Margate and Long Sands SAC to ensure that impacts on this site can be determined and assessed. These data should be put into context with existing MPA data available on Magic mapper or here: Habitat and species open data: https://data.gov.uk/dataset/bfc23a6d-8879-4072-95ed-125b091f908a/marine-habitats-and-species-open-data	Extra sample locations were added to the survey following consultation with Natural England. Five sample locations were taken within the MCZ, where all three designated features were identified. The draft MCZ Stage 1 Assessment (document reference 004447056-02) assesses these features. Two sample locations were taken within the Margate and Long Sands SAC, both samples provide evidence to support the sediment characteristics of 'Sandbanks which are slightly covered by sea water all the time' of which the SAC is designated.
Cefas (via the Marine Management Organisation (MMO))	15/06/2021 Written response regarding benthic survey methodology	The distribution of samples appears to cover each of the different habitat types present in the array and export cable corridors (as indicated by the EUNIS habitat map), although some habitats have only one proposed sample (presumably due to the proportion of the habitat in comparison with more extensive habitats). I would, however, advise additional samples to be placed in the habitats associated with EC07, EC03, IC02 and AS03 in addition to any further signatures identified from the geophysical survey.	Three samples (ST10, ST11 and ST12) were collected in proximity to the proposed EC07 location. EC03 was a proposed location to the north of the Margate and Long Sands SAC, with five samples ultimately collected along the north of the SAC (ST17, ST18, ST19, ST20 and ST21). IC02 was a proposed sample location in muddy sand. Across the array areas there are five grab samples of muddy habitat (ST28, ST33, ST35, ST36 and ST40. AS03 was a proposed sample location in sublittoral sand in the southern array area. Nine samples within the southern arrays

Consultee	Date / Document	Comment	Response / where addressed in the PEIR
			were collected in areas of sublittoral sand (ST41, ST42, ST43, ST44, ST45alt, ST46, ST47, ST48 and ST49
Cefas (via the MMO)	15/06/2021 Written response regarding benthic survey methodology	We recommend sieving through a 5mm mesh onto a 1mm sieve due to the coarse nature of the sediments within this area (with all material retained, but in separate containers if large amounts of material are retained on the 5mm mesh). This would enable comparisons to be made with data collected at Galloper and Gabbard OWFs.	Sieves were used in accordance with the latest North East Atlantic Marine Biological Association Quality Control scheme's (NMBAQC) best practice guidance. Faunal samples were sieved over 1 mm mesh.
Cefas (via the MMO)	15/06/2021 Written response regarding benthic survey methodology	We note that drop down video will be collected as standard prior to grab sampling. If any Annex I biogenic or geogenic reef is observed (either on the geophysical or in the DDV footage) we would like to understand how these habitats will be characterised/mapped e.g. length/number of tows. This information has not been provided in the documents supplied.	Transects were used or alternative stations were chosen if the presence of Annex I habitats were identified. Habitat mapping is based primarily on geophysical data with drop down video (DDV) used to ground truth. Additional stations/transects were selected after a review of the side scan sonar (SSS) and bathymetric data, with emphasis on locating areas of potential conservation importance (e.g. Annex I listed habitats), boundaries between areas of differing sonic reflectivity, bathymetric highs and lows and areas characteristic of the general background conditions of the site.
Natural England	05/07/2021 Seabed ETG 1	Temporary physical disturbance should be broken down into pressures, as it is in MarESA Assessment.	MarESA pressures have been incorporated into both construction and operation phases of the assessment. The relevant pressures used are: • Habitat structure changes – removal of substratum (extraction) • Abrasion/disturbance of the surface of the substratum or seabed • Penetration or disturbance of the substratum subsurface See Sections 10.6.1.1, 10.6.1.1.2 and 10.6.2.1
Cefas	05/07/2021 Seabed ETG 1	Concerns with using the pre-construction survey data from GGOW [Greater Gabbard Offshore Wind Farm] and GWF [Galloper Wind Farm] as the species/distribution may have changed.	A site-specific survey was undertaken in 2021 (see Section 10.5)

Consultee	Date / Document	Comment	Response / where addressed in the PEIR
Cefas	05/07/2021 Seabed ETG 1	Epifauna through beam trawls should be used to make characterisation more complete. These were last done prior to construction of GGOW and GWF and there may have been changes in composition and distribution.	Epifauna characterised by grab sampling drop down video. See Section 10.5.
Cefas	05/07/2021 Seabed ETG 1	EMF impacts should be scoped in. Studies undertaken to date in labs are now improving. Should be included based on construction timescales.	The effect of EMF on benthic receptors has been assessed in Section 10.6.2.6.
MMO	19/07/2021 Scoping Opinion	The proposed general approach to assessing impacts follows best practice and is appropriate (see Section 1.8.2 of the Scoping Report). This is also true of the approach proposed specifically for assessing impacts on benthic ecology receptors (see Section 2.5.4 of the Scoping Report).	Noted.
MMO	19/07/2021 Scoping Opinion	The Applicant has identified potential impacts on benthic ecology receptors during the construction, operation, and decommissioning phases of the proposed development (see Section 2.5.3 of the Scoping Report). The MMO agree with the potential impacts that have been screened in (see Table 2.13 of the Scoping Report) and have no recommendations for additional potential impacts that require consideration.	Noted.
MMO	19/07/2021 Scoping Opinion	The MMO would like to add that the assessment for 'colonisation of introduced substrate, including non-native species' must consider the potential for the installed infrastructure to act as steppingstones that facilitate the spread of non-native species. As benthic invertebrate larvae can disperse over distances of tens to over a hundred kilometres (Álvarez-Noriega, 2020), this potential impact will need to be considered in the Cumulative Impact Assessment (CIA).	The significance of effect has been assessed in Section 10.6.2.7 and the cumulative effect has been assessed in Section 10.7.3.3.
MMO	19/07/2021 Scoping Opinion	There are no information gaps that the MMO would expect to be addressed at this stage. Contemporary data on the identification and distribution of benthic ecology features is lacking, but this information gap will be filled by benthic surveys later this year (see Table 2.12 of the Scoping Report).	Noted.
MMO	19/07/2021 Scoping Opinion	The MMO note that the Array Areas and indicative Export Cable Corridor overlap areas where Annex I reef and Annex I sandbanks have previously been identified (see Figure 2.3 of the Scoping Report) and either overlap or run adjacent to designated sites that	Annex I reef has been discussed in Section 10.5.5. Mitigation methods are noted in section 10.3.3.

Consultee	Date / Document	Comment	Response / where addressed in the PEIR
		protect benthic habitats (See Table 2.10 of the Scoping Report). This is a concern from a conservation perspective. Depending on the findings of the upcoming benthic surveys (and potentially pre-construction surveys), it may be necessary for mitigation measures to be put in place to prevent or minimise impacts on features of conservation importance, particularly if impacts occur in sites designated to protect these features. The MMO defer to Natural England to comment on whether mitigation measures are required for specific features.	
MMO	19/07/2021 Scoping Opinion	Offshore inter-related impacts are considered in Section 2.14 of the Scoping Report and summarised in Table 2.32 of the Scoping Report. The MMO agree with The Applicant that changes to physical processes and water/sediment quality could have knock-on effects on benthic ecology receptors, and that changes to benthic ecology receptors could have knock-on effects on fish and shellfish ecology. The MMO have no recommendations for additional inter-related impacts that require consideration from a benthic ecology perspective.	Annex I reef has been discussed in Section 10.5.5. Mitigation methods are noted in section 10.3.3.
MMO	19/07/2021 Scoping Opinion	Cumulative impacts are briefly considered in Section 2.5.3.4 of the Scoping Report. The MMO agree with The Applicant that impacts will generally be localised, though there may be potential for non-local impacts due to the spread of non-native species. Increases in suspended sediments will also need to be considered alongside the direct impacts of disturbance.	Cumulative effects of physical disturbance, increased suspended sediment, loss of habitat, colonisation and INNS have been assessed in Section 10.7.3 .
MMO	19/07/2021 Scoping Opinion	Transboundary impacts are briefly considered in Section 2.5.3.5 of the Scoping Report. The MMO agree with The Applicant that transboundary effects are generally unlikely. However, potential transboundary impacts due to the spread of non-native species must considered prior to a final decision on scoping in or out, with consideration given to the dispersal potential of benthic invertebrate larvae.	The Planning Inspectorate advised that "*The Inspectorate is satisfied for transboundary impacts in relation to benthic and intertidal ecology to be scoped out of the assessment provided that any necessary mitigation and / or biosecurity precautions required to prevent and manage the spread of INNS are clearly described in the ES. Any measures relied upon in the ES should be discussed with relevant consultation bodies, including NE and the EA, in effort to agree the approach and should be adequately secured, e.g. through a Construction Environmental Management Plan (CEMP).*" Proposed mitigation has been provided in Section 10.3.3, detailing biosecurity measures to be employed to avoid the

Consultee	Date / Document	Comment	Response / where addressed in the PEIR
			spread of INNS. Therefore, there would be no transboundary impact from INNS and this is scoped out of the assessment. The mitigation measures and approach to securing these (e.g. through a CEMP) will be consulted upon through the Section 42 consultation and ongoing Evidence Plan Process, post-PEIR.
Natural England	16/08/2021 Scoping Opinion	Due to the insufficient information provided at this time, Natural England can only provide high level advice on the Benthic and Intertidal Ecology aspects of the North Falls Scoping Report.	The Applicant has engaged with NE subsequently.
Natural England	16/08/2021 Scoping Opinion	Section 2.5.1.1 Point 185 Please be advised that intertidal survey should be undertaken no later than mid-September 2021 Natural England has provided the applicant advice through our discretionary advice service regarding the surveys for the intertidal area and will engage with them further through the evidence plan process on the survey requirements.	Site investigations were carried out between 26th to 27th May 2021. Summary of the intertidal survey results is provided in Section 10.5.1, further information can be found in Appendix 10.1 (Volume III) and the assessment is provided in Sections 10.6.1 and 10.6.2.
Natural England	16/08/2021 Scoping Opinion	Section 2.5.1.2 Point 187 Whilst we welcome the export cable route avoiding Margate and Long Sands SAC there still needs to be consideration of potential indirect impacts from site preparation and/or installation activities to the site, and if appropriate suitable mitigation measures need to be adopted. Further consideration to indirect impacts on the SAC should be given throughout the EIA process.	A detailed assessment of the potential effects on the Margate and Long Sands SAC is provided in the draft Report to Inform Appropriate Assessment (RIAA) (document reference 004447089-02) and a summary of the baseline is in Section 10.5.7. The sedimentary habitats found within the SAC are assessed throughout Section 10.6.
Natural England	16/08/2021 Scoping Opinion	Section 2.5.1.3 Point 188 As stated in our advice on a similar situation with regard to the Hornsea Project Three OWF NSIP and Markham's Triangle MCZ, Natural England would expect further mitigation measures to be considered by North Falls, whereby all array infrastructure is removed from within Kentish Knock East MCZ. If it not possible to exclude the works from this MCZ then there may be a need to discuss measures of equivalent environmental benefit (MEEB) through the evidence plan process.	A full assessment of effect on Kentish Knock East MCZ has been provided in the Marine Conservation Zone Assessment.

Consultee	Date / Document	Comment	Response / where addressed in the PEIR
		Further consideration should be given throughout the EIA process and a consideration of MEEB provided, if required.	
Natural England	16/08/2021 Scoping Opinion	Section 2.5.1.5 Point 198 Please see Natural England advice provided during examination for EA1N and EA2 on the Outline *Sabellaria spinulosa* reef mitigation plan. We would expect to see something similar submitted with the North Falls Application. Applicant to consider approach taken for EA1N and EA2 and to engage in discussion through the evidence plan process.	Mitigation has been provided in Section 10.3.3. Should seabed obstacles (e.g. *Sabellaria* reef) be identified in the proposed wind turbine locations and/or cable routes during the pre-construction surveys, micrositing would be undertaken where practicable, to minimise potential impacts. The approach to securing the mitigation (e.g. through a *S. spinulosa* reef mitigation plan) will be consulted upon through the ongoing Evidence Plan Process, post-PEIR.
Natural England	16/08/2021 Scoping Opinion	Section 2.5.2 Point 200 Table 2.11 Natural England welcomes the undertaking of project specific benthic surveys as those listed within the table are considered to be too old to be relied upon. The details of survey design, analysis and findings should be discussed in more detail during the Evidence Plan process. Further discussion on surveys through the evidence plan process.	Site-specific investigations were carried out in July 2021.
Natural England	16/08/2021 Scoping Opinion	Section 2.5.3.2 Point 204 Please note that we support the view that cable protection is considered to be a persistent impact over the lifetime of the project. As set out in our advice for Hornsea Protect Three, Norfolk Vanguard and Norfolk Boreas OWF NSIPs, deployment for 30+ years is not considered to be temporary. Applicant should consider the impacts from cable protection as persistent and not temporary.	Noted, persistent impacts have been assessed in 10.6.2.2.
Natural England	16/08/2021 Scoping Opinion	Section 2.5.3.6 Point 209 Please note that assessment requirements and understanding of the marine environment has evolved since GGOW and GWT therefore any advice provided, analysis and/or conclusions drawn may have also changed.	The PEIR is predominantly based on data collected during the 2021 site specific survey and supplemented by the additional data sources in Table 10.6.

Consultee	Date / Document	Comment	Response / where addressed in the PEIR
		The ES should be based on up-to-date assessment methodologies rather than assume data requirements and analysis approaches from previous cases are sufficient.	
Natural England	16/08/2021 Scoping Opinion	Section 2.13.1.4 Para 384 Overlapping sub-sea cables in the southern array area could lead to the placing of cable crossings/protection within the Kentish Knock East MCZ, which partially overlaps with the southern array. The potential impact of cable crossings/protection in the Kentish Knock MCZ will need to be assessed.	A full assessment of effect on Kentish Knock East MCZ has been provided in the Marine Conservation Zone Assessment.
Natural England	16/08/2021 Scoping Opinion	Section 2.13.1.4 Para 386 Proposed cables in the study area. The potential impact of cable crossings/protection in the Kentish Knock MCZ will need to be assessed.	A full assessment of effect on Kentish Knock East MCZ has been provided in the Marine Conservation Zone Assessment.
The Planning Inspectorate	26/08/2021 Scoping Opinion	Inter-array cabling and offshore export cables are described as having a target minimum cable depth of 0.5m to 3m where buried; indicative maximum diameters and lengths of cabling are noted but it is stated that the final layout will be determined post consent to fit with the final layout of the WTG. The ES should describe the range of burial depths that have been considered as part of the assessment and the degree of confidence in these parameters. It should establish the parameters likely to result in the maximum adverse effects and include an assessment of these to determine likely significance of effects.	The worst case scenario provided in Table 10.2 is based on a conservative average burial depth of 1.2m. This is based on a preliminary cable burial assessment commissioned by NFOW and lessons learned from construction of GGOW and GWF.
The Planning Inspectorate	26/08/2021 Scoping Opinion	Paragraph 140 of the Scoping Report identifies a potential need for seabed preparation for installation of cables and foundations, including sandwave clearance and boulder removal. The ES should identify the worst case footprint of seabed disturbance that would arise from offshore construction activities, and the maximum footprints of all permanent components should also be identified. Should seabed preparation involve dredging, the ES should identify the quantities of dredged material and likely location for disposal.	Table 10.2 provides a worst case scenario for the footprint of seabed disturbance during construction and footprint of habitat loss from the Project components. The volumes of sediment arising from seabed preparation are also provided in Table 10.2 and it is confirmed that the sediment will be disposed of within the boundary of the offshore project area.

Consultee	Date / Document	Comment	Response / where addressed in the PEIR
The Planning Inspectorate	26/08/2021 Scoping Opinion	Paragraph 86 of the Scoping Report (detailing the overarching assessment methodology for the EIA) states that study areas defined for each receptor are based on the Zone of Influence (ZoI) and relevant characteristics of the receptor (eg mobility / range). However, the Inspectorate notes that for many of the aspect chapters included, study areas and ZoIs have not been stated. Where this detail has been provided, it is not clear how these study areas relate to the extent of the impacts and likely significant effects associated with the Proposed Development, how they have been used to determine a ZoI, and what receptors have been identified within the ZoI. The ES should provide a robust justification as to how study areas have been defined and why the defined study areas are appropriate for assessing potential impacts.	The study area for benthic ecology has been defined on the basis of the potential Zone of Influence (ZoI) from North Falls. The ZoI has been analysed based on an understanding of the tidal regime, discussed further in Chapter 8 Marine Geology and Physical Processes (Volume I).
The Planning Inspectorate	26/08/2021 Scoping Opinion	Section 2.5.3.1 Table 2.13 Potential impacts during construction and decommissioning – habitat loss and introduction of marine invasive non-native species (INNS). The Scoping Report identifies potential impacts associated with the construction and decommissioning phases of the Proposed Development, including, habitat loss and the potential introduction of marine INNS via colonisation of introduced substrate. Table 2.13 shows that these impacts will be assessed as part of the operation phase assessment and scoped out for the construction and decommissioning phases. The Inspectorate is satisfied with this approach and for these matters to be scoped out of the construction and decommissioning phase assessment."	Noted.
The Planning Inspectorate	26/08/2021 Scoping Opinion	Para 205 Table 2.13 Interactions of electric and magnetic fields (EMF) – construction and decommissioning. The Scoping Report states that potential impacts EMF from operational cables will be considered as part of the ES. Table 2.13 shows that this matter will be assessed as part of the operation	Noted.

Consultee	Date / Document	Comment	Response / where addressed in the PEIR
		phase assessment and scoped out for the construction and decommissioning phases. The Inspectorate is satisfied with this approach and for EMF impacts to be scoped out of the construction and decommissioning phase assessment."	
The Planning Inspectorate	26/08/2021 Scoping Opinion	Para 208 Transboundary effects. The Applicant proposes to scope transboundary effects out of the assessment on the basis that the likely impacts of the Proposed Development will be localised and small scale and, as such, transboundary impacts on benthic and intertidal ecology are unlikely to occur or are unlikely to be significant. The Inspectorate considers the potential for transboundary impacts due to the spread of INNS, including via the dispersal of benthic invertebrate larvae. The Inspectorate is satisfied for transboundary impacts in relation to benthic and intertidal ecology to be scoped out of the assessment provided that any necessary mitigation and / or biosecurity precautions required to prevent and manage the spread of INNS are clearly described in the ES. Any measures relied upon in the ES should be discussed with relevant consultation bodies, including NE and the EA, in effort to agree the approach and should be adequately secured, eg through a Construction Environmental Management Plan (CEMP)."	Noted.
The Planning Inspectorate	26/08/2021 Scoping Opinion	Para 199 Table 2.10 Designated sites and study areas. Table 2.10 lists the nearest designated sites to the North Falls array areas but does not state the study area(s) that have been applied. The Inspectorate notes that there are several other offshore designated sites within the vicinity of the Proposed Development (as shown on Figure 1.2) and it’s not evident in the report as to why impacts on these sites and their qualifying / protected features have been discounted.	Offshore Habitats Regulations Assessment (HRA) screening was undertaken in consultation with the Seabed ETG and is provided in Appendix 1 to the draft RIAA. Section 4.3 of the HRA screening details the conservative study area (50km range) used to identify designated sites for consideration in the HRA screening, as agreed with NE. Section 10.3.1 of this PEIR chapter details the study area for the benthic and intertidal ecology project alone impact assessment which is based on the zone of influence identified

Consultee	Date / Document	Comment	Response / where addressed in the PEIR
		The ES should clearly define the study area and explain how the assessment has been undertaken, taking into relevant guidance and using an aspect specific methodology where this is relevant."	in Chapter 8 Marine Geology, Oceanography and Physical Processes (Volume I). A conservative 30km study area is then used in the cumulative effects assessment (Section 10.7.2).
The Planning Inspectorate	26/08/2021 Scoping Opinion	Para 188 Kentish Knock East Marine Conservation Zone (MCZ). The Inspectorate notes that part of the Proposed Development is situated within the Kent Knock East Marine MCZ. If this area is not to be avoided, the ES will need to precisely quantify the impacts on the protected features of the site to inform an MCZ assessment, including the potential impact of cable crossings / protection.	A detailed assessment of the potential effects on the Kentish Knock East MCZ is provided in the draft MCZ Stage 1 Assessment (document reference 004447056-02) and a summary of the baseline is in Section 10.5.6. The sedimentary habitats found within the MCZ are assessed throughout Section 10.6.
The Planning Inspectorate	26/08/2021 Scoping Opinion	Para 202 Table 2.13 Invasive non-native species (INNS). The ES should assess the potential for the introduction of hard substrate and vessel movements to facilitate the spread of INNS (eg through accidents and spillages and via ballast water and colonisation of installed infrastructure) and the potential for impacts upon benthic and intertidal ecology, where significant effects are likely to occur. Where significant effects are likely to occur, the ES should also consider the potential for climate change-related effects to facilitate the spread and exacerbate the impacts of INNS."	Section 10.6.2.7 concludes the effects on INNS is not significant and therefore the potential for climate change on the spread of INNS is not relevant. The effects of climate change have been discussed in Section 10.5.11.
The Planning Inspectorate	26/08/2021 Scoping Opinion	Para 207 Cumulative impacts The potential impact of INNS should be assessed within the Cumulative Impact Assessment (CIA). Increases in suspended sediments should also be considered in the CIA alongside the direct impacts of disturbance."	Cumulative effects have been assessed in Sections 10.7.3.1, 10.7.3.3 and 10.7.3.3.

Consultee	Date / Document	Comment	Response / where addressed in the PEIR
The Planning Inspectorate	26/08/2021 Scoping Opinion	Mitigation The Inspectorate notes that the proposed array areas and indicative export cable corridor overlap areas where Annex I reef and Annex I sandbanks have previously been identified (Figure 2.3) and either overlap or run adjacent to designated sites that protect benthic habitats. Depending on the findings of the proposed benthic surveys (and potentially pre-construction surveys), the Inspectorate considers that it may be necessary for mitigation measures to be put in place to prevent or minimise impacts on features of conservation importance, particularly if impacts occur in sites designated to protect benthic and intertidal features."	Mitigation has been presented in Section 10.3.3.

10.3 Scope

10.3.1 Study area

7. The study area for benthic and intertidal ecology has been defined based on the potential zone of influence (ZoI) from North Falls (Figure 10.2, Volume II). The ZoI has been analysed based on an understanding of the tidal regime, discussed further in Chapter 8 of the PEIR, Marine Geology and Physical Processes (Volume I). The effects arising from the construction, operation and maintenance and decommissioning of North Falls infrastructure are relatively localised and small in magnitude. It is expected that changes to the tidal regime would have returned to background levels immediately outside the excursion of one spring tidal ellipse (approximately 15km from the North Falls offshore project area).

8. For the CEA, a range of 30km from the North Falls offshore project area has been used to provide a conservative search area for the screening of plans and projects which have potential to interact with the impacts of North Falls.

9. The intertidal study area is the area between mean high-water springs (MWHS) and mean low water springs (MLWS) within the landfall search area shown in Figure 4.31 in Appendix 10.1 (Volume III).

10.3.2 Realistic worst-case scenario

10. The final design of North Falls will be confirmed through detailed engineering design studies that will be undertaken post-consent. In order to provide a precautionary but robust impact assessment at this stage of the development process, realistic worst-case scenarios have been defined in terms of the potential effects that may arise. This approach to EIA, referred to as the Rochdale Envelope, is common practice for developments of this nature, as set out in Planning Inspectorate Advice Note Nine (2018). The Rochdale Envelope for a project outlines the realistic worst-case scenario for each individual impact, so that it can be safely assumed that all lesser options will have less impact. Further details are provided in Chapter 6 EIA Methodology (Volume I).

11. The realistic worst-case scenarios for the benthic and intertidal ecology assessment are summarised in Table 10.2. These are based on North Falls parameters described in Chapter 5 Project Description (Volume I), which provides further details regarding specific activities and their durations.

Table 10.2 Realistic worst-case scenarios

Impact	Worst case	Notes
Construction		
Impact 1: Temporary physical disturbance	Array area: • Seabed preparation area of for GBS of 70m^2 x 72 WTG) = 277,088m^2. • Two OSP seabed preparation = 6,637m^2 (2 platforms with 65m preparation diameter) • Array/interconnector cable seabed preparation – 228km length with average 24m disturbance width = 5,472,000m^2 • Vessel jack up assuming 6 jack up location per WTG (275m^2 per jack up leg x 6 legs) = 732,600m^2 • Anchoring during WTG and OSP installation = 344,529m^2 (based on vessels with 8 anchors; and 5 anchoring events per WTG/OSP) • Anchoring during array/interconnector cable installation = 144,077m^2 (based on 9 anchors per vessel and 264 anchoring events) • Boulder clearance – 25 boulders of up to 5m diameter = 491m^2 • Worst case scenario total disturbance footprint in the array areas = 6.9km^2 Export cable: • Maximum temporary disturbance for seabed preparation within the offshore cable corridor = 6,019,200m^2 based on: • Maximum total export cable trench length of 250.8km. • Maximum width of temporary disturbance is approximately 24m • Anchor placement = 297,826m^2 • Boulder clearance = 295m^2 (up to 15 boulders of 5m diameter) • HDD exit – up to 8 bores (4 cables + 4 contingency). Within the worst-case scenario footprint for the seabed preparation area • Total disturbance footprint – 6.32km^2	Temporary disturbance relates to seabed preparation and installation activities. The persistent/ permanent footprint of infrastructure is assessed as an operation phase impact.
Impact 2: Increased suspended sediment concentrations	Array areas: • Seabed preparation area for GBS of 70m^2 x 72 WTG x average 5m sediment depth = 1,385,442m^3 • Two offshore substation platforms seabed preparation x average 5m sediment depth = 33,183m^3 • Worst case scenario volume for foundations = 1.4Mm^3 •	Seabed preparation (dredging using a trailing suction hopper dredger and installation of a bedding and levelling layer) may be required up to a sediment depth of 5m. The worst-case scenario assumes that sediment would be dredged and returned to the water column at the sea surface during disposal from the dredger vessel.

Impact	Worst case	Notes
	• Array/interconnector cable seabed preparation – 228km length with average 24m disturbance width x average 5m sediment depth = 27,360,000m^3 • Array/interconnector cable burial – 228km length with average 1m trench width x average 1.2m burial depth = 273,600m^3 • • Drill arisings at 10% of WTGs = 38,132.7m^3 (based on 42 of the largest turbines which is the worst case scenario) • Drill arisings at 1 x monopile OSPs = 10,687.7m^3 (based on 50% of the OSPs needing drilling) • Total = 48,820.3m^3 NB, drill arising would not occur in the event that the GBS is used and therefore this parameter cannot be added to the maximum seabed levelling for GBS described above. Export cable: • Export cable seabed preparation – 250.8km length with average 24 disturbance width x average 5m sediment depth = 30,096,000m^3 • Export cable burial – 250.8km length with average 1m trench width x average 1.2m burial depth = 300,960m^3	Sandwave levelling may be required prior to offshore cable installation. Any excavated sediment due to sandwave levelling would be disposed of within the North Falls offshore project area, meaning there will be no net loss of sediment from the site. Sediment will be disposed of within the boundary of the offshore project area. Assumes drilling at up to 10% WTG locations. The offshore HDD exit location will be subtidal in 1 to 8m water depth. Sediment displacement is included in the totals for the export cable.
Impact 3: Re-mobilisation of contaminated sediments	Maximum suspension of sediments as described above. No significant contaminated sediments were recorded in the offshore project area. See Chapter 9 Marine Water and Sediment Quality for more detail.	
Impact 4: Underwater noise and vibration	Maximum hammer energy: • 3,000kJ (pin-piles) • 6,000kJ (monopiles) Starting hammer energies of 15% would be used for 10 minutes. Ramp up will then be undertaken for the next 80-120 minutes up to the maximum hammer energy.	
Operation & Maintenance (O&M)		
Impact 1: Temporary physical disturbance	Unplanned repairs and reburial of cables may be required during O&M, the following estimates are included: • Reburial of c. 5km of array/interconnector cable is estimated over the life of the project (24m disturbance width) = 120,000m^2	This represents the maximum estimated total area of seabed disturbance from unplanned repairs and reburial of cables that may be required during O&M. Persistent/ permanent habitat loss as a result of infrastructure decommissioned *in situ* is assessed as an operational impact because the impacts begins

Impact	Worst case	Notes
	• Reburial of c. 5km of export cable is estimated over the life of the project (24m disturbance width) = 120,000m^2 • Five array/interconnector cable repairs are estimated over the project life. 600m section removed x 24m disturbance width = 72,000m^2 • Four export cable repairs are estimated over the project life. 600m section removed x 24m disturbance width = 57,600m^2 Anchored vessels placed during the no. of cable repairs included above = 4,914m^2 Maintenance of offshore infrastructure would be required during O&M. An estimated 180 major component replacement activities may be required per year, using jack up vessels and/or anchoring = 297,000m^2	when the operation phase starts once the wind farm infrastructure is in place.
Impact 2: Persistent habitat loss	Array areas: • WTG: • Total worst case WTG footprint with scour protection, based on 72 x 65m GBS diameter = 238,918m^2 • Scour protection – assumes all WTGs have scour protection area of up to 83,774m^2 (excluding WTG foundation footprint) = 6,031,728m^2 Array/interconnector cable protection – Up to 45.6km of cable protection may be required in the unlikely event that array/interconnector cables cannot be buried (based on 20% of the length) x 6m cable protection width = 273,600m^2 Two offshore electrical platforms with scour protection = 149,012m^2 (74,506m^2 each) Worst case scenario total persistent footprint in the array areas = 6.69km^2 Export cable: • Export cable protection – Up to 25km of cable protection may be required in the unlikely event that export cables cannot be buried (based on 10% of the length) x 6m cable protection width = 150,480m^2	This would result in the maximum area of seabed habitat loss for benthic receptors in respect of North Falls infrastructure.
Impact 3: Increased suspended sediment concentrations	Unplanned repairs and reburial of cables may be required during O&M, the following estimates are included: • Reburial of c. 5km of array/interconnector cable is estimated over the life of the project (24m disturbance width) x average 1.2m depth = 144,000m^3 • Reburial of c. 5km of export cable is estimated over the life of the project (24m disturbance width) x average 1.2m depth = 144,000m^3 • Five array/interconnector cable repairs are estimated over the project life. 600m section removed x 24m disturbance width x average 1.2m depth = 86,400m^3	Each O&M activity would be relatively short term and it is likely that the requirements for maintenance would be spread over the Project life, with suspended sediments becoming rapidly redeposited.

Impact	Worst case	Notes
	• Four export cable repairs are estimated over the project life. 600m section removed x 24m disturbance width x average 1.2m depth = 69,120m^3	
Impact 4: Remobilisation of contaminated sediments	Maximum suspension of sediments as described above. No significant contaminated sediments were recorded in the offshore project area. See Chapter 9 Marine Water and Sediment Quality for more detail.	
Impact 5: Underwater noise and vibration	WTG operational noise as described in Appendix 12.2 Underwater Noise Modelling Report.	
Impact 6: Interactions of EMF	Array/interconnector cables: • Maximum cable length: 228km • Maximum voltage: 132kV • Minimum burial depth: 0.5m (average burial depth: 1.2m) • Up to 20% of total array/interconnector cable length requiring protection (up to 45.6km) Export cables: • Up to 4 cable circuits with 3x unbundled power cables per circuit • Maximum offshore cable length: 250.8km • Maximum voltage: up to 400kV • Minimum burial depth: 0.5m (average burial depth: 1.2m) • Up to 10% of total export cable length requiring protection (up to 25.1km)	Embedded mitigation described in Section 10.3.3.
Impact 7: Colonisation of introduced substrate, including non-native species	72 WTG and 2 OSP Volume of array/interconnector cable protection = 383,040m^3 Volume of export cable protection = 210,672m^3	
Decommissioning		
Impact 1: Temporary physical disturbance	• Vessel jack up assuming 6 jack up locations per wind turbine (275m^2 per jack up leg x 6 legs x 6 locations) = 712,800m^2 • Jack up vessel footprints for OSPs = 19,800m^2 • Anchoring – 60.7m^2 anchor footprint x 8 anchors per vessel x 264 placements during array/interconnector cable removal (if required) = 144,077m^2 • Anchoring – 116.4m^2 anchor footprint x 9 anchors per vessel x 5 placements per wind turbine/OSP installation = 344,529 m^2 • Anchor placement for export cable removal (if required) = 297,826m^2	

Impact	Worst case	Notes
Impact 2: Increased suspended sediments	<u>Array areas:</u> Cutting of piles below the seabed surface: • 300 pin-piles of 3.5m diameter • 72 wind turbines x 4 piles • 2 OSPs x 6 piles Or • 74 monopiles of 17m diameter (72 wind turbines + 2 OSPs) Or Removal of largest foundations (GBS): • 72 WTG x 65m diameter • 2 OSPs x 60m diameter <u>Export cables:</u> Up to 250.8km of export cable (removal to be determined in consultation with key stakeholders as part of the decommissioning plan) <u>Array/interconnector cables:</u> Up to 228km of array/interconnector cable (removal to be determined in consultation with key stakeholders as part of the decommissioning plan)	No decision has yet been made regarding the final decommissioning arrangements for the offshore project infrastructure. It is also recognised that legislation and industry best practice change over time. However, the following infrastructure is likely to be removed, reused or recycled where practicable: • Turbines including monopile, steel jacket and GBS foundations; • OSPs including topsides and steel jacket foundations; and • Offshore cables may be removed or left in situ depending on available information at the time of decommissioning. The following infrastructure is likely to be decommissioned in situ depending on available information at the time of decommissioning, however where it represents the worst case scenario (e.g. for disturbance, removal is assessed): • Scour protection; • Offshore cables may be removed or left in situ; and • Crossings and cable protection. The detail and scope of the decommissioning works will be determined by the relevant legislation and guidance at the time of decommissioning and will be agreed with the regulator. Decommissioning arrangements will be detailed in a Decommissioning Plan, which will be prepared in accordance with the Energy Act 2004.
Impact 3: Re-mobilisation of contaminated sediments	Maximum suspension of sediments as described above. No significant contaminated sediments were recorded in the offshore project area. See Chapter 9 Marine Water and Sediment Quality for more detail.	
Impact 4: Underwater noise and vibration	WTG operational noise as described in Appendix 12.2 Underwater Noise Modelling Report.	

10.3.3 Summary of mitigation embedded in the design

12. This section outlines the embedded mitigation relevant to the benthic and intertidal ecology assessment, which has been incorporated into the design of North Falls (Table 10.3).

Table 10.3 Embedded mitigation measures

Parameter	Mitigation measures embedded into North Falls design
Export cable route	The offshore cable corridor was selected in consultation with key stakeholders to select a route which minimised impacts on designated sites, such as avoiding overlap with the Margate and Long Sands SAC. See Chapter 4 Site Selection and Assessment of Alternatives (Volume I).
Landfall	The Applicant is committed to using HDD from an onshore location to the subtidal zone. Therefore, there will be no impacts on the intertidal zone.
Scour protection	Following industry best-practice the Applicant will seek to minimise the use of scour protection. This will be secured through a Scour Protection and Cable Protection Plan that will be submitted for approval post consent.
Electromagnetic Fields (EMF)	The Applicant is committed to burying offshore export cables where practicable which reduces the effects of EMFs.
Micrositing	Should seabed obstacles (e.g. *Sabellaria* reef) be identified in the proposed wind turbine locations and/or cable routes during the pre-construction surveys, micrositing would be undertaken where practicable, to minimise potential impacts
Invasive Non-Native Species (INNS)	The risk of spreading INNS will be reduced by employing biosecurity measures in accordance with the following requirements: • International Convention for the Prevention of Pollution from Ships (MARPOL). The MARPOL sets out appropriate vessel maintenance; • The International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM Convention), which provide global regulations to control the transfer of potentially invasive species; and • The Environmental Damage (Prevention and Remediation (England) Regulations 2015, which set out a polluter pays principle where the operators who cause a risk of significant damage or cause significant damage to land, water or biodiversity will have the responsibility to prevent damage occurring, or if the damage does occur will have the duty to reinstate the environment to the original condition.

10.4 Assessment methodology

10.4.1 Legislation, guidance and policy

10.4.1.1 National Policy Statements

13. The assessment of potential impacts upon benthic and intertidal ecology has been made with specific reference to the relevant National Policy Statements (NPS). These are the principal decision making documents for Nationally Significant Infrastructure Projects (NSIPs). Those relevant to the Project are:

- NPS for Renewable Energy Infrastructure (EN-3) (DECC 2011); and
- Draft NPS for Renewable Energy Infrastructure (EN-3) (BEIS, 2021).

14. The specific assessment requirements for benthic ecology, as detailed in the NPS, are summarised in Table 10.4 together with an indication of the section of the PEIR chapter where each is addressed.

Table 10.4 NPS assessment requirements

NPS Requirement	NPS Reference	PEIR Reference
NPS for Renewable Energy Infrastructure (EN-3)		
An assessment of the effects of installing cable across the intertidal zone should include information, where relevant, about: • any alternative landfall sites that have been considered by the applicant during the design phase and an explanation for the final choice; • any alternative cable installation methods that have been considered by the applicant during the design phase and an explanation for the final choice; • potential loss of habitat; • disturbance during cable installation and removal (decommissioning); • increased suspended sediment loads in the intertidal zone during installation; and • predicted rates at which the intertidal zone might recover from temporary effects.	2.6.81	Chapter 4 Site Selection and Assessment of Alternatives (Volume I) provides the rationale for the location of the offshore project area. HDD will be used at the landfall under the intertidal zone, therefore there will be no significant effect to intertidal habitats, as described in Section 10.6.
Applicants are expected to have regard to guidance issued in respect of FEPA (now Marine Licence) requirements.	2.6.83	Other relevant guidance, including Marine Licencing, are outlined below.
Where necessary, assessment of the effects on the subtidal environment should include: • loss of habitat due to foundation type including associated seabed preparation, predicted scour, scour protection and altered sedimentary processes; • environmental appraisal of inter-array and cable routes and installation methods; • habitat disturbance from construction vessels' extendible legs and anchors; • increased suspended sediment loads during construction; and • predicted rates at which the subtidal zone might recover from temporary effects.	2.6.113	Assessment of the following impacts have been carried out in the following sections: • Loss of habitat – Section 10.6.2.2; • Temporary disturbance – Sections 10.6.1.1 and 10.6.2.1; • Increased suspended sediments – Sections 10.6.1.2 and 10.6.2.3; • Recovery of biotopes – the recovery of biotopes is discussed within each impact assessment; and • Site selection – site selection is discussed in Chapter 4 Site Selection and Assessment of Alternatives (Volume I).
Construction and decommissioning methods should be designed appropriately to minimise effects on subtidal habitats, taking into account other constraints. Mitigation measures which the [Secretary of State] should expect the applicants to have considered may include: • Surveying and micrositing of the export cable route to avoid adverse effects on sensitive habitat and biogenic reefs; • Burying cables at a sufficient depth, taking into account other constraints, to allow the seabed to recover to its natural state; and	2.6.119	Mitigation measures are set out in Section 10.3.3.

NPS Requirement	NPS Reference	PEIR Reference
• The use of anti-fouling paint might be minimised on subtidal surfaces, to encourage species colonisation on the structures.		
Draft NPS for Renewable Energy Infrastructure (EN-3)		
An assessment of the effects of installing cable across the intertidal zone should follow The Crown Estate's cable route protocol and include information, where relevant, about: • any alternative landfall sites that have been considered by the applicant during the design phase and an explanation for the final choice • any alternative cable installation methods that have been considered by the applicant during the design phase and an explanation for the final choice • potential loss of habitat • disturbance during cable installation, maintenance/repairs and removal (decommissioning) • increased suspended sediment loads in the intertidal zone during installation and maintenance/repairs • predicted rates at which the intertidal zone might recover from temporary effects, based on existing monitoring data • protected sites (e.g. HRA sites, MCZs and SSSIs)	2.27.3	Chapter 4 Site Selection and Assessment of Alternatives (Volume I) provides the rationale for the location of the offshore project area. HDD will be used at the landfall under the intertidal zone, therefore there will be no significant effect to intertidal habitats, as described in Section 10.6.
Effects on intertidal habitat cannot be avoided entirely. Review of up-to-date research should be undertaken and all potential mitigation options presented. Landfall and cable installation and decommissioning methods should be designed appropriately to minimise effects on intertidal habitats, taking into account other constraints. Where applicable, use of horizontal directional drilling (HDD) should be considered as a method to avoid impacts on sensitive habitats and species.	2.27.4	Chapter 4 Site Selection and Assessment of Alternatives (Volume I) provides the rationale for the location of the offshore project area. HDD will be used at the landfall under the intertidal zone, therefore there will be no significant effect to intertidal habitats, as described in Section 10.6.
Where cumulative effects on intertidal habitats are predicted as a result of the cumulative impact of multiple cable routes, applicants of various schemes are encouraged to work together to ensure that the number of cables crossing the intertidal zone are minimised and installation and decommissioning phases are coordinated to ensure that disturbance is also reasonably minimised. As identified in EN-1, (paragraphs 3.3.50 - 3.3.58 and Section 4.10), it is expected that a more co-ordinated approach to transmission from multiple offshore windfarms to onshore networks will be adopted in the future, compared with a radial connection approach for single windfarm projects. This will include connection with multi-purpose interconnectors (MPIs).	2.27.5	Information on potential options to co-operate with other projects is provided in Chapter 5 Project Description (Volume I) in Section 1. The worst case scenario assessed in this chapter is based on North Falls and other projects being developed independently to ensure a conservative assessment is provided.
The applicant should follow The Crown Estate's cable route protocol. Assessment of the effects on the subtidal environment should include:	2.30.2	Chapter 4 Site Selection and Assessment of Alternatives (Volume I) provides evidence of The Crown Estate's cable route protocol used to

NPS Requirement	NPS Reference	PEIR Reference
• loss of habitat due to foundation type including associated seabed preparation, predicted scour, scour protection and altered sedimentary processes • environmental appraisal of inter-array and export cable routes and installation/maintenance methods, including predicted loss of habitat due to predicted scour and scour protection • habitat disturbance from construction and maintenance/repair vessels' extendible legs and anchors • increased suspended sediment loads during construction and from maintenance/repairs • predicted rates at which the subtidal zone might recover from temporary effects • potential impacts from EMF on benthic fauna • impacts on protected sites (e.g. HRA sites and MCZs)		minimise impacts to the subtidal environment.
Construction, maintenance and decommissioning methods should be designed appropriately to minimise effects on subtidal habitats, taking into account other constraints. Review of up-to-date research should be undertaken and all potential mitigation options presented. Mitigation measures which the Secretary of State should expect the applicants to have considered may include: • surveying and micrositing or re-routing of the export and inter-array cables to avoid adverse effects on sensitive habitats, biogenic reefs or protected species • burying cables at a sufficient depth, taking into account other constraints, to allow the seabed to recover to its natural state • the use of anti-fouling paint might be minimised on subtidal surfaces, to encourage species colonisation on the structures	2.30.3	Mitigation measures are set out in Section 10.3.3.
Where cumulative impacts on subtidal habitats are predicted as a result of multiple cable routes, applicants for various schemes are encouraged to work together to ensure that the number of cables crossing the subtidal zone is minimised and installation/ decommissioning phases are coordinated to ensure that disturbance is reasonably minimised. As identified in EN-1, (paragraphs 3.3.50 - 3.3.58 and Section 4.10) and EN-5 (Section 2.5), it is expected that more co-ordinated approaches to transmission from multiple offshore windfarms to onshore networks will be adopted, compared with a radial connection approach for single windfarm projects. This will include connection with multi-purpose interconnectors (MPIs).	2.30.4	Information on potential options to co-operate or connect to interconnectors is provided in Chapter 5 Project Description (Volume I) in Section 1. The worst case scenario assessed in this chapter is based on North Falls and other projects being developed independently to ensure a conservative assessment is provided.

10.4.1.2 Other

15. In addition to the NPS, there are a number of pieces of legislation, policy and guidance applicable to the assessment of benthic ecology. These include:

16. The Marine Policy Statement (MPS) (HM Government, 2011; discussed further in Chapter 3 Policy and Legislative Context, Volume I) provides a high-level approach to marine planning and general principles for decision making that contribute to the NPS objectives. It also sets out the framework for environmental, social and economic considerations that need to be taken into account in marine planning. The high-level objective 'Living within environmental limits' covers points relevant to benthic ecology, and requires that:

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

17. England currently has nine marine plans; those relevant to North Falls are the East Inshore, The East Offshore Marine Plans and the South East Marine Plan. (HM Government, 2014, HM Government, 2021).

18. The East Inshore and Offshore Marine Plans contain the two objectives stated below, which are of relevance to benthic ecology, as they cover policies and commitments on the wider ecosystem set out in the MPS:

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

19. The South East Marine Plan contains the 3 objectives stated below, which are of relevance to benthic ecology:

- Objective 11: 'Biodiversity is protected, conserved and, where appropriate, recovered, and loss has been halted.'
- Objective 12: 'Healthy marine and coastal habitats occur across their natural range and are able to support strong, biodiverse biological communities and the functioning of healthy, resilient and adaptable marine ecosystems.'
- Objective 13: 'Our oceans support viable populations of representative, rare, vulnerable, and valued species.'

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

- Cefas (2004) Offshore Wind Farms: Guidance Note for Environmental Impact Assessment in Respect of FEPA and CPA requirements: Version 2;
- Cefas (2010) Strategic Review of Offshore Wind Farm Monitoring Data Associated with FEPA licence conditions, with input from the Food and

Environment Research Agency (FERA) and the Sea Mammal Research Unit (SMRU);

- Marine Management Organisation (MMO) (2014) Review of Post-Consent Offshore Wind Farm Monitoring Data Associated with Licence Conditions, with input from the British Trust for Ornithology (BTO), National Physical Laboratory (NPL) and the SMRU;
- Defra (2005) Nature Conservation Guidance on Offshore Windfarm Development. A guidance note on the implications of the EC Wild Birds and Habitats Directives for developers undertaking offshore windfarm developments. Version R1.9. 13.

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

- Cefas (2012) Guidelines for data acquisition to support marine environmental assessments of offshore renewable energy projects;
- Wyn & Brazier (2001); Joint Nature Conservation Committee (JNCC) Marine Monitoring Handbook;
- Ware and Kenny (2011) Guidance for the Conduct of Benthic Studies at Marine Aggregate Extraction Sites;
- Chartered Institute of Ecology and Environmental Management (CIEEM) (2018) Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater, Coastal and Marine; and
- The British Standards Institution (2015) Environmental impact assessment for offshore renewable energy projects – Guide. PD 6900:2015.

22. Further detail is provided in Chapter 3 Policy and Legislative Context (Volume I).

10.4.2 Data sources

10.4.2.1 Site specific

23. In order to provide site specific and up to date information on which to base the impact assessment, a site characterisation survey was conducted by Fugro in July 2021 (see Volume III, Appendix 10.1). Table 10.5 below provides details of site investigations carried out in 2021.

Table 10.5 Site-Specific Data

Data set	Spatial Coverage	Survey Date	Survey Techniques
Geophysical surveys	North Falls array area and cable corridor	May – August 2021	Multibeam echosounder, side-scan sonar, sub-bottom profiler, magnetometer.
Benthic survey	North Falls array area and cable corridor	12th July – 22nd July 2021	Grab sampling, including species identification, enumeration, wet weight biomass estimates for each taxa from each major phyla; particle size analysis; and contaminants analysis. Grab sample locations were determined based on an initial review of the geophysical data.
Intertidal survey	North Falls landfall search area (Clacton-	26th – 27th May 2021.	Phase 1 biotope mapping.

Data set	Spatial Coverage	Survey Date	Survey Techniques
	on-Sea to Frinton-on-Sea)		

10.4.2.2 Other available sources

24. The data sources that have been used to inform the assessment are listed in Table 10.6.

Table 10.6 Other available data and information sources

Data Set	Spatial Coverage	Year
Centre Marine and Coastal Studies (CMACS) benthic survey report	GGOW array area	November 2004 and April 2005
GGOW Baseline (Gardline)	GGOW array area	2009
CMACS benthic survey report. Three site specific surveys were undertaken to characterise the epibenthic faunal communities	GGOW/GWF array area	Autumn 2008, spring 2009 and summer 2010
OSIRIS geophysical survey report	GWF array area	2010
GGOW post-construction monitoring (CMACS)	GGOW array area	2014
MAREA surveys and MALSF Outer Thames Estuary Regional Environmental Characterisation	Outer Thames Estuary	August 2008 and September 2007

10.4.3 Impact assessment methodology

25. Chapter 6 EIA Methodology (Volume I) explains the general impact assessment methodology applied to North Falls. The following sections confirm the methodology used to assess the potential impacts on benthic and intertidal ecology.

26. A matrix approach has been used to assess impacts following best practice, EIA guidance and the approach outlined in the North Falls Scoping Report (Royal HaskoningDHV, 2021). An explanation of how this is applied within the benthic and intertidal ecology assessment is set out below.

27. The data sources summarised in Section 10.4.2 were used to characterise the existing environment, the description of which is presented in Section 10.5. Each impact, which has been identified using expert judgement and through the Scoping Process, is then assessed in terms of its significance using the methods described below.

10.4.3.1 Definitions

28. For each effect, the assessment identifies receptors sensitive to that effect and implements a systematic approach to understanding the impact pathways and the level of impacts on given receptors. The definitions of sensitivity, value and magnitude for the purpose of the benthic and intertidal ecology assessment are provided in sections below.

10.4.3.1.1 Sensitivity

29. The assessment identifies receptors for which there is a pathway for effect, and the sensitivity of those receptors to each effect. The definitions of sensitivity are

based on MarLIN's Marine Evidence based Sensitivity Assessment (MarESA) (Tyler-Walters et al., 2018) which determines sensitivity based on resistance (tolerance) and resilience (recoverability) which are defined as (Table 10.7):

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

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

31. For the purpose of this assessment, 'tolerance' has been used in place of 'resistance' and 'recoverability' has been used in place of 'resilience'. This terminology is in line with the Natural England (2022) best practice advice for evidence and data standards and the definitions are provided by MarESA.

32. The information from MarLIN incorporates the term 'No Evidence' within biotope characterisation. No evidence is recorded where there is not enough evidence to conclude the sensitivity of a specific impact on the biotope. Furthermore, there is no suitable proxy information on which to base decisions. No Evidence does not mean that there is no information available, but that evidence does not support an assessment. Potential barriers to identifying tolerances of biotopes and species mean that physical, chemical or biological tolerances cannot be determined. It is assumed that a lack of evidence will infer the use of information from other biotopes (Tyler-Walters et al., 2018).

Table 10.7 Resistance and resilience scale definitions

Level	Description
Resistance (Tolerance)	
None	Key functional, structural, characterising species severely decline and/or physicochemical parameters are also affected e.g. removal of habitats causing a change in habitats type. A severe decline/reduction relates to the loss of 75% of the extent, density or abundance of the selected species or habitat component e.g. loss of 75% substratum (where this can be sensibly applied).
Low	Significant mortality of key and characterising species with some effects on the physicochemical character of habitat. A significant decline/reduction relates to the loss of 25-75% of the extent, density, or abundance of the selected species or habitat component e.g. loss of 25-75% of the substratum.
Medium	Some mortality of species (can be significant where these are not keystone structural/functional and characterising species) without change to habitats relates to the loss <25% of the species or habitat component.
High	No significant effects on the physicochemical character of habitat and no effect on population viability of key/characterising species but may affect feeding, respiration and reproduction rates.
Resilience (Recovery)	
Very Low	Negligible or prolonged recovery possible; at least 25 years to recover structure and function.
Low	Full recovery within 10-25 years.

Level	Description
Medium	Full recovery within 2-10 years.
High	Full recovery within 2 years.

33. MarESA uses a matrix approach using both recovery and resilience to determine sensitivity. The sensitivity matrix used in this assessment, based on MarESA, is presented in Table 10.8.

Table 10.8 Sensitivity matrix

Resilience (Tolerance)		Resistance (Recovery)			
		None	Low	Medium	High
	High	High	High	Medium	Low
	Medium	High	High	Medium	Low
	Low	Medium	Medium	Medium	Low
	Negligible	Medium	Low	Low	Negligible

34. MarESA sensitivities are not available at the habitat level (European Nature Information System (EUNIS)[1] level 3). However, the confidence in the data at the habitat level is higher than at the biotope level (EUNIS level 5). Therefore, where sensitivity at the habitat level is assessed, it is based on the worst-case sensitivity of biotopes identified within the habitat.

35. It is important to note that where local evidence is available about habitat tolerance and recovery, for example from post construction benthic monitoring surveys at the GGOW and/or GWF, sensitivities are modified accordingly.

10.4.3.1.2 Value

36. In addition, the 'value' of the receptor forms an important element within the assessment, for instance if the receptor is a protected species or habitat. It is important to understand that high value and high sensitivity are not necessarily linked within a particular effect. A receptor could be of high value (e.g. Annex I habitat) but have a low or negligible physical/ecological sensitivity to an effect. Similarly, low value does not equate to low sensitivity and is judged on a receptor-by-receptor basis. The value will be considered, where relevant, as a modifier for the sensitivity assigned to the receptor, based on expert judgement. Table 10.9 states the definitions of value levels for benthic and intertidal ecology.

Table 10.9 Definition of value for benthic and intertidal ecology receptors

Value	Definition
High	Habitats (and species) protected under international law (e.g. Annex I habitats within a Special Area of Conservation (SAC) boundary).

[1] The European Nature Information System (EUNIS) habitat classification is a comprehensive pan-European system for habitat identification. More information is available at: https://www.eea.europa.eu/data-and-maps/data/eunis-habitat-classification-1

Value	Definition
Medium	Habitats protected under national law (e.g. Annex I habitats within an MCZ boundary). Species/habitat that may be rare or threatened in the UK.
Low	Habitats or species that provide prey items for other species of conservation value.
Negligible	Habitats and species which are not protected under conservation legislation and are not considered to be particularly important or rare.

10.4.3.1.3 Magnitude

37. The definitions of magnitude for the purpose of the benthic and intertidal ecology assessment are provided in Table 10.10.

Table 10.10 Definition of magnitude for benthic and intertidal ecology receptors

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

10.4.3.2 Significance of effect

38. The potential significance of an effect is a function of the sensitivity of the receptor and the magnitude of the impact (see Chapter 6 EIA Methodology (Volume I) for further details). The determination of significance is guided using an effect significance matrix, as shown in Table 10.11. Definitions of each level of significance are provided in Table 10.12.

39. Likely significant effects identified within the assessment as major or moderate are regarded as significant. Appropriate mitigation has been identified, where possible, in consultation with the regulatory authorities and relevant stakeholders. The aim of mitigation measures is to avoid or reduce the overall significance of effect to determine a residual effect upon a given receptor.

Table 10.11 Significance of effect matrix

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

Table 10.12 Definition of effect significance

Significance	Definition
Major	Very large or large change in receptor condition, both adverse or beneficial, which are likely to be important considerations at a regional or district level because they contribute

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

10.4.4 Cumulative effects assessment methodology

40. The CEA considers other plans, projects and activities that may impact cumulatively with North Falls. Chapter 6 EIA Methodology (Volume I) provides further details of the general framework and approach to the CEA.

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

10.4.5 Transboundary impact assessment methodology

42. Transboundary effects have been scoped out in line with the scoping opinion (Planning Inspectorate, 2021), therefore no further assessment has been undertaken.

10.4.6 Assumptions and limitations

43. A large amount of data has been collected during the 2021 site-specific surveys, in addition to that available from the neighbouring GGOW and GWF. Datasets for the latter projects include those from the characterisation (EIA), pre-construction and post-construction stages of development (Table 10.6). As a result, the benthic ecology of the Project areas has been thoroughly characterised and there is a high degree of confidence in the data for the purpose of informing the impact assessment. The temporal extent of these benthic surveys, from 2004 to 2021 shows the habitat in the study area is relatively consistent, however it is recognised that species such as *Sabellaria spinulosa* are ephemeral and therefore may change prior to construction. Pre-construction surveys will be undertaken to identify the presence of protected habitats and species.

44. During the analysis of benthic habitat maps, the EUNIS habitat classification (European Environment Agency [EEA], 2019) was used. Classifying benthic communities to biotope or EUNIS levels may be subject to recorder bias due to the potential for confusion between biotopes which occupy similar habitats e.g. Infralittoral sands (A5.23) mapped as Sublittoral sands (A5.2) or where the characteristic species could allow classification of multiple biotopes. However, this is a known characteristic of the habitat mapping process and is not

considered to materially affect the overall confidence in it for the purpose of informing the assessment.

45. The impact assessments in Section 10.6 describe the level of confidence in each assessment. There is high confidence in the understanding of the magnitude of impact based on the worst case scenarios provided in Section 10.3.2 and therefore confidence in the conclusions of effect significance is primarily driven by the level of confidence in the sensitivity of receptors. MarLIN provides information on the confidence associated with sensitivity classifications based on the following definitions:

- High confidence - "*based on peer reviewed papers (observational or experimental) or grey literature reports by established agencies on the feature, assessment based on the same pressures acting on the same type of feature in the UK, and studies agree on the direction and magnitude of impact or recovery*."
- Medium confidence - "*based on some peer reviewed papers but relies heavily on grey literature or expert judgement on feature or similar features, assessment based on similar pressures on the feature in other areas, and studies agree on the direction but not the magnitude of impact or recovery*".
- Low confidence - "*based on expert judgement, assessment based on proxies for pressures e.g. natural disturbance events, studies do not agree on concordance or magnitude of impact or recovery*."

46. Information from MarLIN, and specifically the MarESA method, provides a solid resource for the fundamentals of the significance of effect assessment. As taken from their online database "*MarLIN provides information to support marine conservation, management and planning. Our resources are based on available scientific evidence and designed for all stakeholders, from government agencies and industry to naturalists and the public. MarLIN hosts the largest review of the effects of human activities and natural events on marine species and habitats yet undertaken*." It is supported by organisations, such as Defra, JNCC and Natural England.

10.5 Existing environment

47. The environmental baseline, including descriptions of sediment type, infauna and epifauna, is presented for the intertidal, wind farm sites and the offshore cable corridors. A description of protected areas and important species in the vicinity of the Project is also provided. Analysis of the various benthic ecology data sets is provided in Volume III, Appendix 10.1.

10.5.1 Intertidal

48. Intertidal habitats and associated fauna and flora were identified during a modified Phase I walkover habitat mapping survey, discussed further in Volume III, Appendix 10.1. To supplement data collected from the walkover survey, occasional qualitative dig-overs of sediment were retrieved. 0.1m^2 of surface sediment was processed through a 1mm mesh sieve to provide a rapid in situ assessment of substrate type and conspicuous benthic infauna.

49. Table 10.13 below provides a summary of biotopes present across the width of the landfall search area within the intertidal zone, with details of their characteristic species and features. Figure 4.31 in Appendix 10.1 (Volume III) presents the spatial distribution of biotopes using field maps of the survey area.

50. The survey area is dominated by the habitat A2.2 Littoral sand and muddy sand. At low shore there were an abundance of lugworm (*Arenicola marina*) and low densities of tube-building polychaetes (in particular, *Lanice conchilega*).

51. Hard substrate and rock habitats recorded in the survey area were artificial coastal defence structures. Further information on these biotopes can be found in Table 10.13 and distribution of these biotopes can be found in Appendix 10.1 (Volume III).

52. A notable species found in the intertidal survey was Pacific oyster *Magallana gigas*, recorded in the habitat 'A2.245 *Lanice conchilega* in littoral sand'. However this is a non-native species with a large spatial extent across the southern part of the UK, with the largest populations recorded in the Essex estuaries and north Thanet coast (Herbert et al., 2012).

Table 10.13 Habitats and biotopes within the intertidal and their characteristics

Habitat/Biotope	Characteristic species and features
A1 Littoral Rock and Other Hard Substrata	This habitat includes rock habitats (e.g. bedrock, boulders and cobbles) that occur in both the intertidal and the splash zone (EEA, 2019). Often these areas have a lack of epifauna or flora.
A1.11 Mussel and/or Barnacle communities	Exposed to moderately exposed upper to mid shores and is associated with bedrock boulders. Dominated by mussels (*Mytilus edulis*), barnacles (*Sessilia*) and limpets (*Patella vulgata*) (EEA, 2019).
A1.113 *Semibalanus balanoides* on exposed to moderately exposed or vertical shelter eulittoral rock	Exposed to moderately exposed upper to mid shore bedrock and boulders characterised by dense barnacles (*S. balanoides*) and limpets (*Patella vulgata*) (EEA, 2019).
A1.12 Robust fucoid and/or red seaweed communities	Located on exposed to moderately exposed lower shores. The seaweeds present are able to tolerate wave action, such as *Palmaria palmata*, *Ceramium* spp., *Corallina officinalis* and *Osmundea pinnatifida*. The green seaweeds, *Ulva* spp. are also occasionally present. Fauna associated with this biotope complex include limpets (*P. vulgata*), mussels (*M. edulis*) and barnacles (*S. balanoides*) (EEA, 2019).
A1.212 *Fucus spiralis* on full salinity exposed to moderately exposed upper eulittoral rock	Characterised by bedrock with the wrack *Fucus spiralis* and lichens (*V. maura* and *Verrucaria mucosa*). Fauna associated with this biotope include limpets (*P. vulgata*), winkles (*L. littorea*) and barnacles (*S. balanoides*). The seaweed *Ulva intestinalis* can be prevalent in summer months (EEA, 2019).
A1.213 *Fucus vesiculosus* and barnacle mosaics on moderately exposed mid eulittoral rock	This biotope is characterised by the wrack *F. vesiculosus*. Other taxa associated with this biotope include limpets (*P. vulgata*) and whelk (*Nucella lapillus*). A community of red seaweeds develops underneath the *F. vesiculosus* canopy. (EEA, 2019).
A1.214 *Fucus serratus* on moderately exposed lower eulittoral rock	This biotope is found on stable boulder and bedrock on the lower shore. A canopy of the wrack *Fucus serratus* characterises this biotope. Fauna associated with this biotope include limpets (*P. vulgata*), barnacles (*S. balanoides*), whelks (*N. lapillus*) and anemones (*Actinia equina*). Green seaweeds (*Ulva* spp.) are usually present underneath the canopy of *F. serratus* (EEA, 2019).

Habitat/Biotope	Characteristic species and features
A1.451 *Enteromorpha* spp. on freshwater influenced and/or unstable upper eulittoral rock	This biotope is found on the upper shore on unstable soft rock or on stable rock which is subject to freshwater input. This biotope is species poor and subject to seasonal variations (EEA, 2019). The green seaweed *Enteromorpha* spp. is now referred to as *Ulva* spp. (WoRMS Editorial Board, 2021).
A1.452 *Porphyra purpurea* or *Enteromorpha* spp. on sand-scoured mid or lower eulittoral rock	This biotope occurs on moderately exposed bedrock and boulders in the mid to lower shore and is adjacent to areas of sand. Due to sand abrasion, the abundance of wracks (*Fucus* spp.) is reduced. Other species associated with this biotope are barnacles (*Semibalanus balanoides* and *Eliminius modestus*), limpets (*P. vulgata*) and winkles (*Littorina* spp.) (EEA, 2019). The barnacle *Eliminis modestus* has undergone a classification change and is now referred to as *Austrominius modestus*.
A2.2 Littoral Sand and Muddy Sand	This habitat is described on clean sand or muddy sand shores. The infaunal community is dependent on the extent of drying, sediment grade and stability (EEA, 2019).
A2.111 Barren littoral shingle	This biotope is characterised by shingle or gravel shores (mixed with coarse sand at some locations). These sediments support almost no fauna (EEA, 2019).
A2.245 *Lanice conchilega* in littoral sand	This biotope is found on the lower shore, or in waterlogged mid shores and can occur in patches of sand or muddy sand between boulders and rock on the lower shore. Dense populations of the tube-building polychaete *Lanice conchilega* can occur, together with other polychaete which are tolerant of sand scour and sediment mobility (EEA, 2019).
B3.1132 *Verrucaria maura* on very exposed to very sheltered upper littoral fringe rock	This sub-biotope occurs on upper littoral fringe bedrock, boulders and stable cobbles on very exposed to very sheltered shores which are colonised by the black lichen *V. maura*. The winkle *L. saxatilis* is often present. This biotope is species poor, but occasionally a range of species occur in low abundance. These species include the yellow lichen *C. marina* and the winkle *Melaraphe neritoides*, the barnacles *Chthamalus montagui* and *S. balanoides* or the ephemeral seaweeds *Porphyra umbilicalis* and *Ulva* spp. can be present in low abundance (EEA, 2019).

10.5.2 Sediment

53. Grab samples were taken at 39 sample stations. Sediment characterisation was classified using The Folk (British Geological Survey (BGS) modified) classification (Long, 2006) and the Wentworth (1922) sediment classification. Univariate analysis was used to describe three core sediment types – sand, gravel and fines (or mud) (Figure 10.1, Volume II). Further information about the sediments recorded can be found in Appendix 10.1 (Volume III).

54. Across the 39 sample stations, eight sediment classes were identified using the Folk (BGS modified) classification. Appendix 10.1 (Volume III) names them as: 'Sand', which typified 11 stations; 'Muddy, sandy gravel', which typified 11 stations; 'Gravelly sand', which typified 7 stations; 'Gravelly muddy sand', which typified 4 stations; 'Muddy sand', which typified 2 stations; 'Gravelly mud', which typified 2 stations; 'Sandy gravel', which typified 1 station; 'Sandy mud', which typified 1 station.

55. Across the survey area the mean sand content stood at 66.90%, the mean gravel content was 19.13% and the mean fines content was 13.97%. However, it must be noted that gravel was absent from one sample station (ST42) and

fines were absent from 13 sample stations, 10 of which were located in the South array.

56. Variation in sediment particle size was classified into nine grain class sizes (Wentworth, 1922) as: 'Coarse sand', which typified 11 stations; 'Medium sand', which typified 11 stations; 'Very coarse sand', which typified 8 stations; 'Coarse silt', which typified 3 stations; 'Very fine sand', which typified 2 stations; 'Fine pebble', which typified 1 station; 'Fine sand', which typified 1 station; 'Granule', which typified 1 station; 'Medium silt', which typified 1 station.

57. Figure 10.1 (Volume II) shows the distribution of sediment composition along the survey area. Sample sites located in the intertidal were dominated by fine and gravel sediment. Whereas sample sites in the North and South array had a higher composition of sand.

58. The median sediment particle size ranged from 11µm (fine silt) (station ST02) to 11718µm (medium pebble), with a mean of 1028µm (very coarse sand) and a median of 547µm (coarse sand). The median sediment particle size at stations along the offshore cable corridor varied more compared to that of stations in the north array and south array.

59. The sorting coefficient reflected the heterogeneity of the sediment and ranged from well sorted to extremely poorly sorted, with most stations having very poorly sorted sediments.

60. Polycyclic aromatic hydrocarbons (PAHs) were recorded at six stations in the south array with concentrations below the limit of detection for all PAHs analysed in this study. At the remaining stations, the PAH concentrations were below the marine sediment quality guidelines (SQGs) and are therefore not considered to be detrimental to the marine environment. A spatial pattern of distribution was identified, with stations along the nearshore section of the offshore cable corridor having higher concentration of PAHs, compared to the offshore stations. Regional contextualisation of the results indicated that the total concentration of the 22 PAHs analysed was higher than the range of 0.3µg/kg to19µg/kg reported for station CSEMP 475 in the Outer Gabbard area (Cefas, 2012).

61. Metal concentration in sediment samples from the North Falls survey area were below the marine SQGs for most metals analysed. The exceptions were arsenic and nickel, which were above the Cefas AL1 at nine and three stations, respectively, with station ST38 having arsenic concentration above also the ERM value. However, the increased levels of arsenic and nickel are not isolated results. Similar concentrations were found in site investigations conducted for Dogger Bank and GGOW and are representative of the region. See Chapter 9 Marine Water and Sediment Quality (Volume I).

10.5.3 Macrofauna

62. Seabed video and photography was acquired, and faunal samples were taken in grab samples. The resolution of intertidal mapping using this combination of methods is between Phase 1 terrestrial mapping (JNCC, 2010) and the Marine Nature Conservation Review (MNCR) Phase 2 methods (Hiscock, 1996). Sediment Macrofauna Samples were analysed by APEM benthic laboratory in accordance with the NMBAQC scheme (Worsfold et al., 2010).

63. More information on macrofaunal communities recorded during the benthic characterisation surveys are provided in Appendix 10.1 (Volume III).

64. The survey recorded a total of 246 taxa of which 116 were annelids (47.2%), 62 were arthropods (25.2%), 45 were molluscs (18.3%), 10 were echinoderms (4.1%) and 13 made up other phyla (5.3%).

65. 6957 individuals were recorded in which molluscs and annelids dominated, 47.2% and 37.3% respectively. Arthropods (7.8%), echinoderms (3.3%) and other phyla (4.3%) accounted for the remaining individuals.

66. Annelids have the highest species richness across the survey area with highest representation from polychaetes. Specifically, *Lagis koreni, Scalibregma inflatum, Lumbrineris cingulate, Sabellaria spinulosa* and species of genus *Notomastus/Pseudonotomastus. S. spinulosa* is found solitary or in small groups and favours encrusting pebbles, shells and bedrock (OSPAR, 2013), which correlates with the location of their distribution in the site specific survey as highest abundance was found at ST01 and ST48. ST01 has almost 50% gravel composition and ST48 provides the highest proportion of gravel in southern part of the south array.

67. Surveys for GGOW identified *S. spinulosa* on stable circalittoral mixed sediment (A5.611) as one of the most abundant taxa at the Greater Gabbard site (GGOWL, 2005). The Ross worm (*S. spinulosa)* was a common organism recorded during the grab survey of the GWF site, but it was not evenly distributed. The highest abundances were found outside of the boundaries of the array area – there was a single station outside of the GWF boundary to the south-east of the wind farm development area where *S. spinulosa* dominated in possible reef form (CMACS, 2010).

68. Molluscs had the highest species abundance across the survey area, in particular bivalves. *Kurtiella bidentata* and *Abra alba* were in the top five most frequent species. Mollusca comprised most of the abundance at stations ST01 to ST05 and ST22. Analysis of the species indicated a numerical dominance of the bivalves *Nucula nucleus*, *Nucula nitidosa*, *Musculus discors*, *A. alba* and *Saxicavella jeffreysi at* stations ST01 to ST05, and a numerical dominance of *S. jeffreysi* and *K. bidentata* at station ST22.

69. The most common echinoderms that were found across the survey area were brittlestars. Specifically, *Ophiura albida*, *Ophiura fragilis* and *Amphipholis squamata*. Echinodermata had the highest abundance at station ST28, which was associated mainly with the abundance of *O. albida*. ST28 was located in the north array and comprised of mostly gravel. This correlates with previous findings as brittlestars are typical to habitats of high disturbance – strong tidal currents and exposed, mixed coarse sediment (Jackson, 2008). Sea urchins *Echinocyamus pusillus* and *Psammechinus miliaris* were also reported.

70. Brittlestar species were also found in the surveys conducted at GGOW (CMACS, 2005) and GWF (CMACS, 2009).

71. *Ampelisca spinipes* and *Gastrosaccus spinifer* were among the most abundant and frequently occurring Arthropods and are indicative of species found in habitats subject to a degree of surface sediment disturbance.

72. Colonial epifauna from the grab samples, along with mobile epibiota recorded through the seabed video and photography comprised assemblages comparable to those reported to be typical of the shallower sediment areas of the southern North Sea (Callaway et al., 2002; Jennings et al., 1999).

10.5.4 Habitat distribution

73. Table 10.14 below provides a summary of the biotopes present across the North Falls offshore project area and their characteristic species and features. Figure 10.4 (Volume II) presents the spatial distribution of biotopes interpolated utilising the geophysical, seabed video and grab sample data.

Table 10.14 Biotopes and benthic characteristics

Component of the offshore project area	Biotopes	Characteristic species and features
North array	A5.13 Circalittoral coarse sediment (SS.SCS.CCS) (1 station)	These stations featured coarse sediments with low species richness and abundance, represented by robust polychaetes. Infralittoral coarse sediments are typical of areas subject to strong tidal currents. As such, only invertebrate capable to withstand or escape from sand abrasion can inhabit these habitats (Roche et al., 2007).
	A5.451 Polychaete-rich deep Venus community in offshore mixed sediments (SS.SMx.OMx.PoVen) (1 station)	This biotope is part of the 'Deep Venus Community' and the 'Boreal Offshore Gravel Association' (EEA, 2019).
	A5.143 *Protodorvillea kefersteini* and other polychaetes in impoverished circalittoral mixed gravelly sand (SS.SCS.CCS.Pkef) (1 station)	These stations featured gravelly sand and an impoverished faunal community, characterised by the polychaete *P. kefersteini*. This biotope is considered a disturbed or transitional variant of coarse sediment biotopes, due to physical disturbance (JNCC, 2015). Consequently, this biotope may be variable spatially and temporally in terms of community structure and sediment type which is often borderline between the 'Sublittoral coarse sediment' (A5.1) and 'Sublittoral mixed sediment' (A5.4) (EEA, 2019).
South array	A5.2 Sublittoral sands (SS.SSa) (6 stations)	These stations featured mobile sand with low species richness and abundance, represented by fast swimming crustaceans and robust polychaetes.
	A5.13 Circalittoral coarse sediment (SS.SCS.CCS) (1 station)	These stations featured coarse sediments with low species richness and abundance, represented by robust polychaetes. Infralittoral coarse sediments are typical of areas subject to strong tidal currents. As such, only invertebrate capable to withstand or escape from sand abrasion can inhabit these habitats (Roche et al., 2007).
	A5.231 Infralittoral mobile clean sand with sparse fauna (SS.SSa.IFiSa.IMoSa) (2 stations)	These stations featured mobile sands with low species richness and diversity represented by fast swimming crustaceans.
	A5.451 Polychaete-rich deep Venus community in offshore mixed sediments	This biotope is part of the 'Deep Venus Community' and the 'Boreal Offshore Gravel Association' (EEA, 2019).

Component of the offshore project area	Biotopes	Characteristic species and features
	(SS.SMx.OMx.PoVen) (5 stations)	
	A5.143 *Protodorvillea kefersteini* and other polychaetes in impoverished circalittoral mixed gravelly sand (SS.SCS.CCS.Pkef) (2 stations)	These stations featured gravelly sand and an impoverished faunal community, characterised by the polychaete *P. kefersteini*. This biotope is considered a disturbed or transitional variant of coarse sediment biotopes, due to physical disturbance (JNCC, 2015). Consequently, this biotope may be variable spatially and temporally in terms of community structure and sediment type which is often borderline between the 'Sublittoral coarse sediment' (A5.1) and 'Sublittoral mixed sediment' (A5.4) (EEA, 2019).
	A5.611 *Sabellaria spinulosa* on stable circalittoral mixed sediment (SS.SBR.PoR.SspiMx) (1 station)	Was assigned to station ST39, in the south array, which was surveyed by means of seabed video and photography only, owing to the presence of S. spinulosa crusts.
Export cable route (offshore and nearshore sections)	A5.231 Infralittoral mobile clean sand with sparse fauna (SS.SSa.IFiSa.IMoSa) (1 station)	These stations featured mobile sands with low species richness and diversity represented by fast swimming crustaceans.
	A5.13 Infralittoral coarse sediment (SS.SCS.ICS) (5 stations)	These stations featured coarse sediments with low species richness and abundance, represented by robust polychaetes. Infralittoral coarse sediments are typical of areas subject to strong tidal currents. As such, only invertebrate capable to withstand or escape from sand abrasion can inhabit these habitats (Roche et al., 2007).
	A5.13 Circalittoral coarse sediment (SS.SCS.ICS) (1 station)	These stations featured coarse sediments with low species richness and abundance, represented by robust polychaetes. Infralittoral coarse sediments are typical of areas subject to strong tidal currents. As such, only invertebrate capable to withstand or escape from sand abrasion can inhabit these habitats (Roche et al., 2007).
	A5.451 Polychaete-rich deep Venus community in offshore mixed sediments (SS.SMx.OMx.PoVen) (4 stations)	This biotope is part of the 'Deep Venus Community' and the 'Boreal Offshore Gravel Association' (EEA, 2019).
	A5.333 *Mysella bidentata* and *Abra* spp. In infralittoral sandy mud (SS.SMu.ISaMu.MysAbr) (3 stations)	These stations featured gravelly mud and muddy gravel, hosting high abundances of the bivalves *A. alba*, *K. bidentata*, *N. nucleus* and *S. jeffreysi*.
	A5.261 *Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment (SS.SSa.CMuSa.AalbNuc) (5 stations)	These stations featured muddy sand hosting high abundances of the bivalves *N. nitidosa*, *A. alba* and *K. bidentata*. This biotope is part of the 'Abra community' (EEA, 2019) and the 'infralittoral étage' described by Glémarec (1973).
Interconnector	A5.451 Polychaete-rich deep Venus community in offshore mixed sediments	This biotope is part of the 'Deep Venus Community' and the 'Boreal Offshore Gravel Association' (EEA, 2019).

Component of the offshore project area	Biotopes	Characteristic species and features
	(SS.SMx.OMx.PoVen) (1 station)	

74. The number of colonial epifauna was generally higher at stations featuring coarse and/or mixed sediment, owing to the sediment coarseness and heterogeneity which provide microhabitats and hard substrate for the settlement of epifaunal species. This in turn increases the structural complexity of the habitat and may provide additional microhabitats for smaller fauna, thus increasing the overall richness and diversity.

75. The following biotopes/communities were recorded in the GGOW site (GGOWL, 2005):

- SS.SSA.IiSa.ImoSa Infralittoral mobile clean sand with sparse fauna;
- SS.SCS.ICS.Glap *Glycera lapidum* in impoverished infralittoral mobile gravel and sand;
- SS.SCS.CCS.MedLumVen *Mediomastus fragilis, Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel
- SS.SBR.PoR.SspiMx *Sabellaria spinulosa* on stable circalittoral mixed sediment
- *Scalibregma* dominated sands/muddy sands

76. The following biotopes were recorded in the GWF site (Royal Haskoning, 2011):

- SS.SCS.CCS.MedLumVen *Mediomastus fragilis, Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel;
- SS.SMx.OMx.PoVen, Polychaete-rich deep Venus community in offshore mixed sediments;
- SS.SSa.IFiSa.NcirBat, *Nephtys cirrosa* and B*athyporeia* spp. in infralittoral sand; and
- SS.SCS.CCS.PomB, *Pomatoceros triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles.

77. As discussed in Section 10.4.6, the classification of biotopes can be subject to recorder bias, however the biotopes identified at North Falls, GGOW and GWF are characterised by similar sandy, coarse sediments and mixed sediment habitats.

78. Figure 10.4 (Volume II) shows the biotopes recorded in the GGOW and GWF EIA baseline characterisation surveys.

10.5.5 Potential Annex I Reef

79. *S. spinulosa* crusts were reported from seabed video and photography at ST39 in the south array. Hence ST39 being assigned the biotope '*S. spinulosa* on Stable Circalittoral Mixed Sediment' (A5.611).

80. The biotope '*Sabellaria spinulosa* on stable circalittoral mixed sediment' (A5.611), is part of the Annex I habitat 'Reefs' when it occurs as biogenic reef (JNCC, 2018). As a biogenic reef, this habitat is also on the OSPAR list of threatened and/or declining species and habitats (OSPAR, 2021).

81. ST39 was described as having high abundances of the tube-building polychaete *S. spinulosa* on mixed sediments in the circalittoral zone. It was characterised by gravelly muddy sand interspersed with rippled sand with shell fragments and varying proportions of pebbles, cobbles, consolidated clay and clay clasts.

82. Owing to the presence of *S. spinulosa* crusts, no grab sampling was undertaken at station ST39, therefore video transects were undertaken to assess the potential for reef.

83. *S. spinulosa* was found along all the transects studied around ST39. Most of *S. spinulosa* aggregations along the transects at stations ST39 and 50m east (ST39_50E) and west (ST39_50W) of station ST39, were classified as 'Not a reef' owing to an elevation of < 2 cm and/or a cover < 10 %. Some areas along all transects associated with station ST39 were classified as 'Low reef'. One area was classified as 'Medium reef' along transect ST_39Eb. One area classified as 'High reef' occurred at the start of transect ST39_50Ea and along transect ST39_50Eb (Table 10.15).

Table 10.15 Summary of estimated *S. spinulosa* 'reefiness in the North Falls study area

Transect	Total Length of Transect [m]	Proportion of Total Transect Length					
		No Reef [%]	Not a Reef [%]	Low Reef [%]	Medium Reef [%]	High Reef [%]	Not Usable [%]
ST39	145	0	50	19	0	0	31
ST39_50W	59	0	80	20	0	0	0
ST39_50E	72	20	59	4	0	0	18
ST39_50Ea	72	0	11	34	0	46	9
ST39_50Eb	70	0	32	44	7	4	13
Reefiness Assessment							
No reef	Not a reef	Low reef	Medium reef	High reef			

84. Due to the presence of cobbles and occasional boulders, ten stations were assessed in relation to the Annex I habitat 'Reef' (geogenic). No grab samples were collected at these stations and DDV transects were conducted to characterise the existing biotopes. (Volume III, Appendix 10.1)

10.5.6 Kentish Knock East MCZ

85. The southern array area overlaps with the Kentish Knock East MCZ as shown in Figure 10.3 (Volume II). The MCZ is located 35km off the east coast. The site is designated for the following broadscale habitat features:

- Subtidal coarse sediment (A5.1)
- Subtidal sand (A5.2)
- Subtidal mixed sediments (A5.4)

86. Kentish Knock East MCZ screening report determines the North Falls south array overlaps with all three broadscale habitat features of the MCZ.

87. In the benthic site investigation report (Volume III Appendix 10.1), seabed habitats representative of subtidal sand and mixed sediments have been recorded in the south array of North Falls (Figure 10.4, Volume II).

10.5.7 Margate and Long Sands SAC

88. Margate and Long Sands SAC lies adjacent to the offshore cable corridor for North Falls over a distance of 4.8km, as shown in Figure 10.3 (Volume II). The SAC is designated for Annex I 'Sandbanks which are lightly covered by sea water all the time'.

89. The sandbanks are composed of well-sorted sandy sediments, with the occurrence of muddy and gravelly sediments connecting sandbanks (JNCC, 2017).

90. The results of the benthic survey (Appendix 10.1, Volume III) correlate with the characteristics of Margate and Long Sands in that low species diversity was found, and of those present, they were commonly found in mobile sand environments.

91. Polychaete worms were the most abundant species found along the sampling points adjacent to the SAC. Three out of five stations were classified as A5.451 Polychaete-rich deep *Venus* community in offshore mixed sediments. The other two sampling stations were classified as A5.13 Infralittoral coarse sediment and A5.261 *Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment.

92. In the offshore cable corridor survey no *S. spinulosa* aggregations were reported*.* This is in contrast to previous suggestions that the SAC houses a significant amount of the worms (JNCC, 2017), although the difference may be attributed to *S. spinulosa* aggregations having a patchy distribution.

10.5.8 Outer Thames Estuary SPA

93. The Outer Thames Estuary SPA overlaps with the offshore cable corridor over a 17km^2 area (Figure 10.3, Volume II). The SPA covers an area of *c.* 3,924km^2 and is designated for the following Annex I bird species:

- Red-throated diver *Gavia stellata*
- Common tern *Sterna hirundo*
- Little tern *Sternula albifrons*

94. The SPA supports the largest aggregation of wintering red-throated divers in Great Britain (38% of the population) and provides feeding and nesting areas for common terns and little terns (JNCC, 2017). Characteristics of the SPA consist of high tidal current streams, mobile sediments and the presence of sandbanks.

95. The survey conducted by Fugro found multiple biotopes across the area in which the offshore cable corridor overlaps with the SPA. These consisted of A5.43 Infralittoral mixed sediments, A5.26 Circalittoral muddy sand, A5.45 Deep circalittoral mixed sediments and A5.13 Infralittoral coarse sediment.

10.5.9 Other subtidal features of interest

96. The biotope ‘Piddocks with Sparse Associated Fauna in Sublittoral Very Soft Chalk or Clay’ (A4.231), was assigned to areas of consolidated mud in the north array, south array, interconnector and far east of the offshore cable corridor, based on analysis of seabed and photographic data only (detailed in Volume III, Appendix 10.1). This biotope, reported to occur along the east coast of England, is a priority habitat for being fragile and irreplaceable (BRIG, 2011) and may occur in the habitat ‘Peat and clay exposure’ which is a Habitat of Conservation Importance (HOCI) in MCZ (JNCC, 2018).

97. Fish and shellfish species of conservation importance within the study area are discussed in Chapter 11 Fish and Shellfish Ecology (Volume I).

98. A single specimen of the nationally scarce thumbnail crab *Thia scutellata* was recorded in the grab sample from station ST46. Small numbers have previously

been reported from Fugro, 2021b. The most abundant known populations for this species are off the North Wales coast (Rees, 2001).

10.5.10 Non-native species

99. The following section provides a brief summary of the non-native species found in the survey area as described in Appendix 10.1 (Volume III).

100. Non-native species recorded across the North Falls survey area included the brown alga *Sargassum muticum* and the bivalves *Ruditapes philippinarum*, *Petricolaria pholadiformis* and *Magallana gigas*.

101. Drift material of *S. muticum* was recorded at station ST47, in the south array, through the seabed video and photography. A single juvenile of *R. philippinarum* was recorded in the grab sample from station ST01. A single individual of *P. pholadiformis* was recorded in the grab sample from station ST02. Individuals of *M. gigas* were recorded throughout the intertidal survey area at the low water mark associated with hard substrate.

102. The cryptogenic species recorded in the grab samples included the polychaetes *Polydora cornuta* and *Aphelochaeta* (formerly *Tharyx*) *marioni* and the crustacean amphipod *Crassicorophium crassicorne*.

103. The polychaete *P. cornuta* is widely distributed from the Atlantic to the Pacific. The polychaete *A. marioni* has been recorded in estuarine sediments throughout northern Europe, as one of the most common and characteristic species of the habitat (Kakkonen et al., 2019). The distribution of the crustacean amphipod *C. crassicorne* is reported to be Holarctic and subarctic (Bousfield & Hoover, 1997).

10.5.11 Future trends in baseline conditions

104. The baseline conditions for benthic and intertidal ecology are considered to be relatively stable within North Falls and the wider area, with multiple data sets covering several years exhibiting similar patterns, including GGOW and GWF post-construction monitoring.

105. The existing environment within North Falls is influenced by the physical processes which exist within the southern North Sea, including waves and tidal currents driving changes in sediment transport and then seabed morphology (see Chapter 8 Marine Geology, Oceanography and Physical Processes, Volume I). Long term established patterns may be affected by climate change driven sea-level rise, however this will have a reduced impact offshore compared to along the coastline. Warming sea temperatures and ocean acidification are likely to result in changes to the composition and geographical distribution of benthic communities, with a general north westerly shift (Hiddink et al., 2015) in the latitudinal ranges of many species.

106. Long term analyses of the North Sea benthos have led to the conclusions that it is under severe threat from climate change. Sea bottom temperature (SBT) has increased by 1.6°C between 1980 and 2004 (Dulvy et al., 2008) and sea surface temperature (SST) has increased by ~0.06°C yr^{-1} when the average global SST rise is 0.017±0.005 (Good et al., 2007). Using predictions for increasing ocean temperature, key benthic species will suffer by 2099 with

dramatically reduced population sizes, including *S. spinulosa* (Weinert et al., 2016).

107. Anthropogenic pressures that currently exist across the study area such as commercial fishing, particularly using bottom towed gear, have the potential to influence future change in the existing benthic environment (Chapter 14 Commercial Fisheries, Volume I).

10.6 Assessment of significance

108. The likely significant effects to benthic and intertidal ecology that may occur during construction, operation, maintenance and decommissioning of North Falls are assessed in this section. The worst-case scenarios listed in Table 10.2 for each impact are assessed.

109. As described in Section 10.4.3.1.1, the sensitivity of benthic receptors will be assessed using the MarESA method in relation to MarESA pressures. The MarESA method assesses sensitivity of biotopes identified in the survey area. Where habitats or biotope complexes have been identified as the highest EUNIS classification, biotopes commonly found within these habitats have been used to assess the sensitivity as a proxy.

10.6.1 Potential impacts during construction

10.6.1.1 Impact 1: Temporary physical disturbance

10.6.1.1.1 Temporary physical disturbance in the array areas

110. During construction there will be disturbance in the array areas due to cable laying operations, jack-up operations and construction works for foundations. This will cause temporary habitat loss and physical disturbance to the seabed.

111. Where disturbed sediments (e.g. preparation areas for foundations) are subsequently covered with infrastructure, habitat loss is long term or permanent, therefore this has been assessed as an operational impact in Section 10.6.2.2 and Section 10.6.2.2.2 and is not considered further here.

<u>Sensitivity of receptor</u>

112. The sensitivity of the biotopes identified in the North Falls array area have been assessed in relation to the following MarESA pressures relevant to the construction phase temporary habitat loss / physical disturbance:

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

113. The sensitivity of identified habitats and biotopes to temporary habitat loss / disturbance pressures are summarised in Table 10.16 below.

114. *S. Spinulosa* reef was identified at one station in the south array. As previously described in Section 10.5.5, the reef coverage ranged from low to high along various transects coming from the station. It has therefore been considered in this assessment.

115. In the North Falls offshore site investigation, habitat A5.2 Sublittoral sand was identified as the most prevalent habitat. However, no MarESA sensitivity

information is available for sublittoral sand and so, for A5.2, biotope A5.231 Infralittoral mobile clean sand with sparse fauna has been used as a proxy to represent A5.2 stations. A5.231 has been used as a proxy as the characteristic species of this biotope including *Pagarus bernhardus*, *Carcinus maenas* and *Asterias rubens*, are similar to those found in the site investigations. Furthermore, the sediment descriptions show similarities.

Table 10.16 The sensitivity of biotopes to temporary physical disturbance

Impact pressure pathway: Habitat structure changes – removal of substratum (extraction)				
Receptor	**Tolerance**	**Recoverability**	**Sensitivity**	**Confidence assessment**
A5.231 Infralittoral mobile clean sand with sparse fauna (Tillin *et al.*, 2019)	None	High	Medium	High
A5.451 Polychaete-rich deep *Venus* community in offshore mixed sediments (Tillin, 2016)	None	Medium	Medium	High
A5.143 *Protodorvillea kefersteini* and other polychaetes in impoverished circalittoral mixed gravelly sand (Tillin, 2016)	None	Medium	Medium	Low
A5.611 *Sabellaria spinulosa* on stable circalittoral mixed sediment (Tillin *et al.* 2020)	None	Medium	Medium	High
A4.231 Piddocks with a sparse associated fauna in sublittoral very soft chalk or clay (Tillin and Hill, 2016)	None	Very low	High	High
Impact pressure pathway: Abrasion/disturbance of the surface of the substratum or seabed				
Receptor	**Tolerance**	**Recoverability**	**Sensitivity**	**Confidence assessment**
A5.231 Infralittoral mobile clean sand with sparse fauna (Tillin *et al.* 2019)	Low	High	Low	High
A5.451 Polychaete-rich deep *Venus* community in offshore mixed sediments (Tillin, 2016)	Medium	High	Low	Medium
A5.143 *Protodorvillea kefersteini* and other polychaetes in impoverished circalittoral mixed gravelly sand (Tillin, 2016)	Medium	High	Low	Low

A5.611 *Sabellaria spinulosa* on stable circalittoral mixed sediment (Tillin *et al.* 2020)	Low	Medium	Medium	Medium
A4.231 Piddocks with a sparse associated fauna in sublittoral very soft chalk or clay (Tillin and Hill, 2016)	Medium	Very Low	Medium	Medium
Impact pressure pathway: Penetration or disturbance of the substratum subsurface				
Receptor	**Tolerance**	**Recoverability**	**Sensitivity**	**Confidence assessment**
A5.231 Infralittoral mobile clean sand with sparse fauna (Tillin *et al.* 2019)	Medium	High	Low	High
A5.451 Polychaete-rich deep *Venus* community in offshore mixed sediments (Tillin, 2016)	Medium	High	Low	High
A5.143 *Protodorvillea kefersteini* and other polychaetes in impoverished circalittoral mixed gravelly sand (Tillin, 2016)	Medium	High	Low	High
A5.611 *Sabellaria spinulosa* on stable circalittoral mixed sediment (Tillin *et al.* 2020)	None	Medium	Medium	High
A4.231 Piddocks with a sparse associated fauna in sublittoral very soft chalk or clay (Tillin and Hill, 2016)	Low	Very Low	High	Medium

116. The sediment and benthic species around the North Falls array areas are characteristic of highly disturbed environments. They mostly have medium to high recoverability and will therefore recover rapidly from disturbance as a result of construction. Consequently, temporary physical disturbance and habitat loss will not have a long-term impact on the communities. However, due to the presence of Piddocks with a sparse associated fauna in sublittoral very soft chalk or clay, this high sensitivity is used as the worst case scenario.

117. The sensitivity of habitats can be modified based on their value (Section 10.4.3.1.2), but the worst case sensitivity remains high for biotope A4.231.

Magnitude of impact

118. Together, seabed preparation, offshore substation platform seabed preparation, array and interconnector cable trench, vessel jack up or anchor footprints, jack up vessel footprints and boulder clearance will generate a worst-case scenario total disturbance footprint of 3.1km^2 in the array areas (Table 10.2). As discussed in Section 10.5, the habitat and species in the North Falls array area are consistent with those found in the wider region. Therefore, this extent of disturbance is relatively small in the context of these communities across the southern North Sea.

119. Due to the temporary and relatively localised nature of the impact, and extent of the receptors across the wider region, temporary physical disturbance is considered to be of negligible magnitude.

10.6.1.1.2 Temporary physical disturbance in the offshore cable corridor

120. During construction there will be disturbance in the offshore cable corridor due to seabed preparation (e.g. sandwave levelling), cable installation, anchor placement and boulder clearance. This will cause temporary habitat loss and physical disturbance to the seabed.

121. Where disturbed sediments are subsequently covered with infrastructure, habitat loss is long term or permanent, therefore this has been assessed as an operational impact in Section 10.6.2.2 and Section 10.6.2.2.2 and is not considered further here.

Sensitivity of receptor

122. The sensitivity of the biotopes identified in the offshore cable corridor have been assessed in relation to the following MarESA pressures relevant to the construction phase temporary habitat loss / physical disturbance:

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

123. The sensitivity of identified habitats and biotopes to temporary habitat loss / disturbance pressures are summarised in Table 10.17 below.

124. The biotopes presented in Table 10.17 were identified along the offshore cable corridor in the North Falls offshore site investigation. However, during the investigation the biotope complex A5.13 Infralittoral coarse sediment was identified as one of the most prevalent EUNIS groups and there is no MarESA sensitivity information available. For A5.13, the biotope A5.135 *Glycera lapidum* in impoverished infralittoral mobile gravel and sand has been used as a proxy for infralittoral coarse sediment. This biotope has been chosen as the stations where A5.13 were identified had the species *Glycera alba* present, and the sediment description is similar to that of A5.135.

Table 10.17 The sensitivity of biotopes to temporary physical disturbance

Impact pressure pathway: Habitat structure changes – removal of substratum (extraction)				
Receptor	**Tolerance**	**Recoverability**	**Sensitivity**	**Confidence assessment**
A5.333 *Mysella bidentata* and *Abra*	None	Medium	Medium	Low

Impact pressure pathway: Habitat structure changes – removal of substratum (extraction)				
Receptor	**Tolerance**	**Recoverability**	**Sensitivity**	**Confidence assessment**
spp. In infralittoral sandy mud (De-Bastos, 2016)				
A5.261 *Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment (Tillin & Budd, 2016)	None	Medium	Medium	High
A5.135 *Glycera lapidum* in impoverished infralittoral mobile gravel and sand (Tillin, 2016)	None	Medium	Medium	High
A5.143 *Protodorvillea kefersteini* and other polychaetes in impoverished circalittoral mixed gravelly sand (Tillin, 2016)	None	Medium	Medium	Low
A5.451 Polychaete-rich deep *Venus* community in offshore mixed sediments (Tillin, 2016)	None	Medium	Medium	High
A4.231 Piddocks with a sparse associated fauna in sublittoral very soft chalk or clay (Tillin and Hill, 2016)	None	Very Low	High	High
Impact pressure pathway: Abrasion/disturbance of the surface of the substratum or seabed				
Receptor	**Tolerance**	**Recoverability**	**Sensitivity**	**Confidence assessment**
A5.333 *Mysella bidentata* and *Abra* spp. In infralittoral sandy mud (De-Bastos, 2016)	Low	High	Low	Low
A5.261 *Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment (Tillin & Budd, 2016)	Medium	High	Low	Low

Impact pressure pathway: Habitat structure changes – removal of substratum (extraction)				
Receptor	**Tolerance**	**Recoverability**	**Sensitivity**	**Confidence assessment**
A5.135 *Glycera lapidum* in impoverished infralittoral mobile gravel and sand (Tillin, 2016)	Medium	High	Low	Medium
A5.143 *Protodorvillea kefersteini* and other polychaetes in impoverished circalittoral mixed gravelly sand (Tillin, 2016)	Medium	High	Low	Low
A5.451 Polychaete-rich deep *Venus* community in offshore mixed sediments (Tillin, 2016)	Medium	High	Low	Medium
A4.231 Piddocks with a sparse associated fauna in sublittoral very soft chalk or clay (Tillin and Hill, 2016)	Medium	Very Low	Medium	Medium
Impact pressure pathway: Penetration or disturbance of the substratum subsurface				
Receptor	**Tolerance**	**Recoverability**	**Sensitivity**	**Confidence assessment**
A5.333 *Mysella bidentata* and *Abra* spp. In infralittoral sandy mud (De-Bastos, 2016)	Low	High	Low	Low
A5.261 *Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment (Tillin & Budd, 2016)	Medium	High	Low	High
A5.135 *Glycera lapidum* in impoverished infralittoral mobile gravel and sand (Tillin, 2016)	Medium	High	Low	High
A5.143 *Protodorvillea kefersteini* and other polychaetes in impoverished circalittoral mixed	Medium	High	Low	High

Impact pressure pathway: Habitat structure changes – removal of substratum (extraction)				
Receptor	**Tolerance**	**Recoverability**	**Sensitivity**	**Confidence assessment**
gravelly sand (Tillin, 2016)				
A5.451 Polychaete-rich deep *Venus* community in offshore mixed sediments (Tillin, 2016)	Medium	High	Low	High
A4.231 Piddocks with a sparse associated fauna in sublittoral very soft chalk or clay (Tillin and Hill, 2016)	Low	Very Low	High	Medium

125. The characteristic species of the biotopes named in Table 10.17 are typical of habitats exposed to sediment disturbance, e.g. as a consequence of wave action, so the species present are mostly resilient and have low to medium sensitivities to physical changes in the environment. Therefore, they are likely to recover from temporary disturbance at a fast rate.

126. However, due to the presence of Piddocks with a sparse associated fauna in sublittoral very soft chalk or clay, this high sensitivity is used as the worst case scenario.

Magnitude of impact

127. During installation of the offshore export cables there will be impacts from temporary disturbance caused by export cable trenching, anchor placement and boulder clearance. The maximum total disturbance footprint is 3km^2 (Table 10.2).

128. Due to the temporary and relatively localised nature of the impact, temporary physical disturbance is considered to be of negligible magnitude.

10.6.1.1.3 Summary: Significance of effect from temporary physical disturbance

129. The total worst-case footprint for temporary physical disturbance is 6.1km^2 which represents 4.09% of the offshore project area. As the habitats recorded in the offshore project area are representative of the wider southern North Sea region, the impact magnitude is negligible.

130. Due to the presence of Piddocks with a sparse associated fauna in sublittoral very soft chalk or clay, this high sensitivity is used as the worst case scenario.

131. Due to the negligible magnitude and high sensitivity to each impact pathway for physical disturbance, the effect is considered to be of minor adverse significance from temporary physical disturbance.

132. The overall confidence in this assessment is medium (as per MarLIN). There are a number of biotopes with high confidence, however due to a few occurrences of low confidence the overall assessment cannot be of high confidence. See Section 10.4.6.

10.6.1.2 *Impact 2: Increased suspended sediment concentrations*

10.6.1.2.1 Increased suspended sediment concentrations in the array areas

133. Increases in suspended sediment concentrations (SSC) and subsequent deposition onto the seabed may occur as a result of seabed preparation for the installation of offshore infrastructure, including foundations and cables. Activities such as seabed disturbances from jack-up vessels and placement of cable protection are not expected to increase suspended sediment concentrations to the extent which there would be a significant effect to benthic ecology receptors. Chapter 8 Marine Geology, Oceanography and Physical Processes (Volume I) provides details of changes to SSC and subsequent sediment deposition.

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

135. As previously stated in Section 10.6.1.1, biotope A5.231 Infralittoral mobile clean sand with sparse fauna has been used to represent A5.2 stations.

Sensitivity of receptor

136. The sensitivity of the biotopes identified in the North Falls array area have been assessed in relation to MarESA pressures relevant to construction phase increased SSC and deposition. The relevant pressures are:

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

137. The pressure 'Smothering and siltation rate changes (light)' has been used to assess the significance of effect as the MarESA justification for light smothering and siltation is 'up to 5cm' and in Chapter 8 Geology, Oceanography and Physical Processes (Volume I) the worst-case level sediment smothering and deposition is approximately <1mm.

138. The sensitivity of identified habitats and biotopes to increased suspended sediment pressures are summarised in Table 10.18 below.

Table 10.18 The sensitivity of biotopes to increased suspended sediments

Impact pressure pathway: Changes in suspended solids (water clarity)				
Receptor	**Tolerance**	**Recoverability**	**Sensitivity**	**Confidence assessment**
A5.231 Infralittoral mobile clean sand with sparse fauna (Tillin *et al.*, 2019)	Medium	High	Low	Low
A5.451 Polychaete-rich deep *Venus* community in offshore mixed sediments (Tillin, 2016)	Medium	High	Low	Medium
A5.143 *Protodorvillea kefersteini* and other polychaetes in impoverished	High	High	Not sensitive	Low

Impact pressure pathway: Changes in suspended solids (water clarity)				
Receptor	**Tolerance**	**Recoverability**	**Sensitivity**	**Confidence assessment**
circalittoral mixed gravelly sand (Tillin, 2016)				
A5.611 *Sabellaria spinulosa* on stable circalittoral mixed sediment (Tillin *et al.* 2020)	High	High	Not sensitive	High
A4.231 Piddocks with a sparse associated fauna in sublittoral very soft chalk or clay (Tillin and Hill, 2016)	High	High	Not sensitive	Medium
Impact pressure pathway: Smothering and siltation rate changes (light)				
Receptor	**Tolerance**	**Recoverability**	**Sensitivity**	**Confidence assessment**
A5.231 Infralittoral mobile clean sand with sparse fauna (Tillin *et al.* 2019)	High	High	Not sensitive	High
A5.451 Polychaete-rich deep *Venus* community in offshore mixed sediments (Tillin, 2016)	Medium	High	Low	High
A5.143 *Protodorvillea kefersteini* and other polychaetes in impoverished circalittoral mixed gravelly sand (Tillin, 2016)	No evidence	No evidence	No evidence	N/A
A5.611 *Sabellaria spinulosa* on stable circalittoral mixed sediment (Tillin *et al.* 2020)	High	High	Not sensitive	High
A4.231 Piddocks with a sparse associated fauna in sublittoral very soft chalk or clay (Tillin and Hill, 2016)	Medium	Medium	Medium	Medium

139. The identified biotopes in the array areas have no to medium sensitivity to the MarESA pressures and will therefore recover rapidly from an increase in SSC and subsequent deposition.

140. In the case of A5.143 *Protodorvillea kefersteini* and other polychaetes in impoverished circalittoral, MarLIN concludes No Evidence for sensitivity. However, *P. kefersteini* lives underneath the sediment surface and so

smothering and siltation rate changes are unlikely to have a significant effect on their ability to survive.

141. The sensitivity of habitats can be modified based on their value (Section 10.4.3.1.2), but the worst case sensitivity remains not sensitive to medium.

Magnitude of impact

142. Chapter 8 Marine Geology, Oceanography and Physical Processes (Volume I) describes the expected movement of sediment suspended during the construction phase for the above construction activities.

143. In the northern array, coarse sand seabed sediments are most prevalent and in the southern array it is mostly medium to coarse sand sediments. Therefore, disturbed sediment in the arrays is likely to settle rapidly back to the seabed and within close proximity of the activity.

144. Finer sand and mud that is present in the sediment are likely to stay in suspension for longer and form a passive plume which would become advected by tidal currents. Due to the sediment sizes present this is likely to exist as a measurable but modest concentration plume for around half a tidal cycle (up to six hours). Sediment would eventually settle to the seabed in proximity to its release (within a few hundred metres up to around 1km) within a short period of time (hours to days). SSCs with a lower particle size would extend further from the site of construction activity however magnitudes would be indistinguishable from background levels.

145. Seabed preparation for foundations is expected to generate the largest deposition of sediment, see Table 10.2.

146. Overall, increases in SSC are expected to be localised and short-term. Fine suspended sediment may be transported a further distance than coarse sediments however due to the small fraction of fine sediment and mud, it is likely to be widely and rapidly dispersed. Sediment deposition from a plume will deposit a maximum 1mm but less than 0.1mm over large areas of the seabed.

147. Given the localised and short-term increases in SSC around the point of discharge, and negligible changes in seabed level expected due to deposition, the magnitude of impact is considered to be negligible.

10.6.1.2.2 Increased suspended sediment concentrations in the offshore cable corridor

148. As previously stated in Section 10.6.1.1.2 biotope A5.135 *Glycera lapidum* in impoverished infralittoral mobile gravel and sand has been used as a proxy for A5.13 stations.

Sensitivity of receptor

149. The sensitivity of the biotopes identified in the North Falls offshore cable corridor have been assessed in relation to the following MarESA pressures relevant to construction phase increased SSC and deposition:

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

150. The pressure 'Smothering and siltation rate changes (light)' has been as described in section 10.6.1.2.2.

151. The sensitivity of identified habitats and biotopes to increased suspended sediment pressures are summarised in Table 10.19 below.

Table 10.19 The sensitivity of biotopes to increased suspended sediments

Impact pressure pathway: Changes in suspended solids (water clarity)				
Receptor	**Tolerance**	**Recoverability**	**Sensitivity**	**Confidence assessment**
A5.333 *Mysella bidentata* and *Abra* spp. In infralittoral sandy mud (De-Bastos, 2016)	Low	High	Low	Low
A5.261 *Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment (Tillin & Budd, 2016)	Medium	High	Low	Low
A5.135 *Glycera lapidum* in impoverished infralittoral mobile gravel and sand (Tillin, 2016)	High	High	Not sensitive	High
A5.143 *Protodorvillea kefersteini* and other polychaetes in impoverished circalittoral mixed gravelly sand (Tillin, 2016)	High	High	Not sensitive	Low
A5.451 Polychaete-rich deep *Venus* community in offshore mixed sediments (Tillin, 2016)	Medium	High	Low	Medium
A4.231 Piddocks with a sparse associated fauna in sublittoral very soft chalk or clay (Tillin and Hill, 2016)	High	High	Not Sensitive	Medium
Impact pressure pathway: Smothering and siltation rate changes (light)				
Receptor	**Tolerance**	**Recoverability**	**Sensitivity**	**Confidence assessment**
A5.333 *Mysella bidentata* and *Abra* spp. In infralittoral sandy mud (De-Bastos, 2016)	High	High	Not sensitive	Low
A5.261 *Abra alba* and *Nucula nitidosa* in	Medium	High	Low	Medium

Impact pressure pathway: Changes in suspended solids (water clarity)				
Receptor	Tolerance	Recoverability	Sensitivity	Confidence assessment
circalittoral muddy sand or slightly mixed sediment (Tillin & Budd, 2016)				
A5.135 *Glycera lapidum* in impoverished infralittoral mobile gravel and sand (Tillin, 2016)	Medium	High	Low	Medium
A5.143 *Protodorvillea kefersteini* and other polychaetes in impoverished circalittoral mixed gravelly sand (Tillin, 2016)	No evidence	No evidence	No evidence	N/A
A5.451 Polychaete-rich deep *Venus* community in offshore mixed sediments (Tillin, 2016)	Medium	High	Low	High
A4.231 Piddocks with a sparse associated fauna in sublittoral very soft chalk or clay (Tillin and Hill, 2016)	Medium	Medium	Medium	Medium

152. The identified biotopes in the offshore cable corridor mostly have no to low sensitivity to the MarESA pressures and will therefore recover rapidly from an increase in SSC and subsequent deposition.

153. However, due to the presence of Piddocks with a sparse associated fauna in sublittoral very soft chalk or clay, this medium sensitivity is used as the worst case scenario.

Magnitude of impact

154. Chapter 8 Marine Geology, Oceanography and Physical Processes (Volume I) describes the expected movement of sediment suspended during the construction phase for the above construction activities.

155. Fine sands and mud are most prevalent along the offshore cable corridor, with finer sands being the larger sediment type of the two. For GWF a plume modelling simulation was carried out which indicated that fine sands would result in the greatest bed thickness changes, however the maximum seabed thickness simulated was <1mm. Mud-sized sediment would be advected a further distance and persist in the water column for hours to days, before depositing a thin layer on the seabed. Overall changes from SSC and deposition

of fine sands and mud-sized sediment will not be measurable due to prevailing hydrodynamic conditions with high wave activity agitating the seabed regularly.

156. Given the localised and short-term increases in SSC around the point of discharge, and negligible changes in seabed level expected due to deposition, the magnitude of impact is considered to be negligible.

Intertidal

157. As discussed in Section 8.6.2.5 of Chapter 8 Marine Geology, Oceanography and Physical Processes (Volume I), during cable installation the suspended sediment concentrations are likely to remain within the range of background nearshore levels (which are high close to the coast due to increased wave activity). There will therefore be no change to the intertidal ecology as a result of North Falls.

158. Further to this, as discussed in Section 10.5.1, the most prevalent species identified in the intertidal survey area were *Arenicola marina* and *Lanice conchilega*. Therefore, the biotopes A2.245 *Lanice conchilega* in littoral sand and A2.241 *Macoma balthica* and *Arenicola marina* in muddy sand shores have been used to assess increased SSC and deposition.

159. The sensitivities of the identified biotopes to increased SSC and deposition are summarised in Table 10.20 below.

Table 10.20 The sensitivity of intertidal biotopes to increased suspended sediments

Impact pressure pathway: Changes in suspended solids (water clarity)				
Receptor	**Tolerance**	**Recoverability**	**Sensitivity**	**Confidence assessment**
A2.245 *Lanice conchilega* in littoral sand (McQuillan, R. M. & Tillin, H,M., 2016)	High	High	Not Sensitive	Medium
A2.241 *Macoma balthica* and *Arenicola marina* in muddy sand shores (Ashley, 2016)	High	High	Not Sensitive	Medium
Impact pressure pathway: Smothering and siltation rate changes (light)				
Receptor	**Tolerance**	**Recoverability**	**Sensitivity**	**Confidence assessment**
A2.245 *Lanice conchilega* in littoral sand (McQuillan, R. M. & Tillin, H,M., 2016)	High	High	Not Sensitive	High
A2.241 *Macoma balthica* and *Arenicola marina* in muddy sand shores (Ashley, 2016)	High	High	Not Sensitive	Medium

160. Both biotopes are Not Sensitive to the effects of increased SSC and deposition and have high tolerance and recoverability.

161. Due to the negligible magnitude and not sensitive to each impact pathway for increased suspended sediment concentrations, the overall worst-case effect is considered to be of negligible significance from increased suspended sediment concentrations.

162. The effects of nearshore cable protection are considered under the operational phase (Section 10.6.2.3.2).

10.6.1.2.3 Summary: Significance of effect from increased suspended sediment concentrations

163. As the habitats recorded in the offshore project area are representative of the wider southern North Sea region, the impact magnitude is negligible when in context of the entire offshore project area.

164. Due to the negligible magnitude and not sensitive to medium sensitivity to each impact pathway for increased suspended sediment concentrations, the overall worst-case effect is considered to be of minor adverse significance in the offshore project area from increased suspended sediment concentrations.

165. The overall confidence in this assessment is medium (as per MarLIN). There are a number of biotopes with high confidence, however due to a few occurrences of low confidence the overall assessment cannot be of high confidence.

10.6.1.3 Impact 3: Re-mobilisation of contaminated sediments

10.6.1.3.1 Re-mobilisation of contaminated sediments in the offshore project area

166. Sediment disturbance during construction (e.g. through drilling for foundation installation) could lead to the mobilisation of contaminants which may be lying dormant within sediment and which could be harmful to the benthos.

167. As described in Section 10.5.2, benthic samples collected during the offshore site investigation were analysed for contaminants. Chapter 9 Marine Water and Sediment Quality (Volume I) has conducted a comparison of levels of sediment contamination against recognised sediment quality guidelines. Sediment contamination levels are not to be of significant concern and are low risk in terms of potential impacts on the marine environment.

<u>Sensitivity of receptor</u>

168. The MarESA pressure benchmark for ‘Pollution and other chemical changes’ is named as ‘Exposure of marine species or habitat to one or more relevant contaminants via uncontrolled releases or incidental spills’ (Tyler-Walters et al., 2022). Given contaminant levels are within environmental protection standards, all receptors are not sensitive to changes that remain within these standards.

<u>Magnitude of impact</u>

169. Therefore, there is negligible magnitude of risk to benthic ecology receptors from re-mobilisation of contaminated sediments.

10.6.1.3.2 Summary: Significance of effect from the re-mobilisation of contaminated sediments

170. Due to the negligible magnitude and no sensitivity to the presence of existing contamination, the overall worst-case effect is considered to be of negligible significance from the re-mobilisation of contaminated sediments.

10.6.1.4 Impact 4: Underwater noise and vibration in the offshore project area

171. Underwater noise and vibration from UXO clearance, pile driving for the installation of some foundation types, cable installation and other construction activities including seabed preparation, rock placement and vessel activity (as

described in Chapter 5 Project Description, Volume I) have the potential to impact on benthic ecology receptors.

172. As previously stated in Section 10.6.1.1, biotope A5.231 Infralittoral mobile clean sand with sparse fauna has been used to represent A5.2 stations and as previously stated in Section 10.6.1.1.2 biotope A5.135 *Glycera lapidum* in impoverished infralittoral mobile gravel and sand has been used as a proxy for A5.13 stations.

Sensitivity of receptor

173. The sensitivity of biotopes identified in the North Falls array area and offshore cable corridor have been assessed in relation to the following MarESA pressures relevant to underwater noise and vibration as a result of construction activities:

- Underwater noise changes

174. There is evidence to suggest that some benthic species perceive and react to noise, however the MarESA sensitivity assessment for all of the biotopes recorded in the array areas is that noise impacts are 'Not Relevant'. 'Not Relevant' is recorded where the evidence suggests that there is no direct interaction between the pressure and biotope or characteristic species within. Therefore, the sensitivity of biotopes and species to underwater noise and vibration is considered to be negligible.

Magnitude of impact

175. Underwater noise from construction activities may result in temporary, discernible change over a small area of the assessed biotopes. Therefore, the magnitude of impact from noise and vibration is considered to be negligible.

10.6.1.4.1 Summary: Significance of effect from underwater noise and vibration

176. Studies have shown that some benthic species are able to detect sound. Horridge (1966) found the hair-fan organ of the common lobster *Homarus gammarus* to act as an underwater vibration receptor. Lovell *et al*. (2005) showed that the common prawn *Palaemon serratus* is capable of hearing sounds within a range of 100 to 3,000Hz, and the brown shrimp *Crangon crangon*, which was recorded in the North Falls offshore project area, has shown behavioural changes at frequencies around 170Hz (Heinisch and Weise, 1987).

177. Further research into the effects of vibration on common benthic species was carried out by Roberts *et al*., 2016. Common hermit crabs *Pagurus bernhardus* exhibited behaviours associated with shell rapping as a consequence of vibrations within the sediment. At high amplitudes, individuals lifted their shells, and some left their shell completely. High amplitudes in the study matched levels within those produced by construction works such as pile-driving, therefore further understanding into the effects of vibration is needed to form a conclusive argument.

178. The biotopes and organisms within the array areas and cable corridors are likely to be habituated to ambient noise as they are located within a heavy shipping area. Noise created from piling and UXO clearance will cause temporary disturbance to the benthos, however the MarESA sensitivity assessment

concludes that there will be no effect from noise or vibration to the relevant biotopes.

179. Based on the worst-case negligible sensitivity of biotopes and the negligible magnitude of impact of underwater noise on benthic ecology receptors during the construction phase, the significance of effect is assessed as negligible significance from noise and vibration.

10.6.2 Potential impacts during operation

10.6.2.1 Impact 1: Temporary physical disturbance

10.6.2.1.1 Temporary physical disturbance in the offshore project area

180. Temporary physical disturbance will occur during the operational phase of North Falls through activities such as cable repairs and reburial, turbine repairs, and potentially requiring deployment of jack up vessels or vessel anchors. The area disturbed would be extremely small in comparison to during construction (Table 10.2). For this impact it is considered that there is no clear difference in the assessment outcomes between the different development areas. As such a single assessment is provided that applies to the entire offshore project area. The following planned and unplanned maintenance activities are assumed as worst-case scenarios:

- Reburial of c. 5km of array/interconnector cable is estimated over the life of the Project (24m disturbance width) = 120,0000m^2
- Reburial of c. 5km of export cable is estimated over the life of the Project (24m disturbance width) = 120,000m^2
- Five array/interconnector cable repairs are estimated over the Project life. 600m section removed x 24m disturbance width = 72,000m^2
- Four export cable repairs are estimated over the Project life. 600m section removed x 24m disturbance width = 57,600m^2
- Maintenance of wind turbine generators would be required during O&M. An estimated 180 major component replacement activities may be required per year, using jack up vessels and/or anchoring. However, the same footprint for jack up vessels will be used as the initial placement during construction; and
- Anchored vessels placed during the no. of cable repairs are estimated at 4,914m^2.

181. As previously stated in Section 10.6.1.1, biotope A5.231 Infralittoral mobile clean sand with sparse fauna has been used to represent A5.2 stations. Furthermore, as stated in Section 10.6.1.1.2 biotope A5.135 *Glycera lapidum* in impoverished infralittoral mobile gravel and sand has been used as a proxy for A5.13 stations.

Sensitivity of receptor

182. The sensitivity of the biotopes identified in the offshore project area have been assessed in relation to MarESA pressures relevant to construction phase temporary physical disturbance, set out in Table 10.16 and Table 10.17.

183. Whilst there is potential for recurring disturbance during maintenance, initial micro-siting, where possible, would avoid any sensitive features and therefore the potential for recurring impacts during operation would be minimised. The worst case would be temporary disturbance to Piddocks which results in a classification of high sensitivity. Regarding maintenance of cables, it is highly unlikely that the same stretch of cable would repeatedly fail and therefore recurring disturbance in the same location is considered highly unlikely.

184. The sensitivity of habitats can be modified based on their value (Section 10.4.3.1.2), but the worst case sensitivity remains high.

Magnitude of impact

185. In general, the impacts from planned maintenance and changes in physical processes would be temporary, localised and small scale and overall there would be less impact than during construction.

186. The area of disturbance is considered to be very small in the context of the extent of the biotopes present across the wider southern North Sea. A discernible, temporary change, over a small area of the receptor is anticipated and therefore the magnitude of this effect is considered to be negligible.

10.6.2.1.2 Summary: Significance of effect from temporary physical disturbance

187. Habitats in the study area predominantly have a medium or low sensitivity to disturbance. However due to the presence of piddocks with a sparse associated fauna in sublittoral very soft chalk or clay which high sensitivity, this is used as the worst case scenario. Given the negligible magnitude of temporary physical disturbance during the operation phase, the effect is assessed as minor adverse significance for the offshore project area.

10.6.2.2 Impact 2: Persistent habitat loss

10.6.2.2.1 Persistent habitat loss in the array areas

188. Habitat loss will occur during the lifetime of the Project as a result of structures installed on the seabed. The effects of scour and external cable protection are likely to be permanent.

Sensitivity of receptor

189. The sensitivity of biotopes identified in the array areas have been assessed in relation to the following MarESA pressure relevant to persistent habitat loss:

- ‘Physical change to another seabed type’

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

191. The sensitivity of identified habitats and biotopes to habitat loss is summarised in Table 10.21 below. As previously stated in Section 10.6.1.1, biotope A5.231 Infralittoral mobile clean sand with sparse fauna has been used to represent A5.2 stations.

Table 10.21 The sensitivity of biotopes to physical change to another seabed type

Impact pressure pathway: Physical change to another seabed type				
Receptor	**Tolerance**	**Recoverability**	**Sensitivity**	**Confidence assessment**
A5.231 Infralittoral mobile clean sand with sparse fauna (Tillin *et al.*, 2019)	None	Very Low	High	High
A5.451 Polychaete-rich deep *Venus* community in offshore mixed sediments (Tillin, 2016)	None	Very Low	High	High
A5.143 *Protodorvillea kefersteini* and other polychaetes in impoverished circalittoral mixed gravelly sand (Tillin, 2016)	None	Very Low	High	High
A5.611 *Sabellaria spinulosa* on stable circalittoral mixed sediment (Tillin *et al.* 2020)	None	Very Low	High	Medium
A4.231 Piddocks with a sparse associated fauna in sublittoral very soft chalk or clay (Tillin and Hill, 2016)	None	Very low	High	High

192. By definition, the sensitivity of benthic ecology receptors to permanent/ persistent habitat loss is high.

193. The sensitivity of habitats can be modified based on their value (Section 10.4.3.1.2), but the worst case sensitivity remains high.

<u>Magnitude of impact</u>

194. Within the array areas it is estimated that a worst-case permanent loss of habitat would represent an area of approximately 6.69km^2 which is 4.46% of the array areas. Although the effect is long term, it is over a small proportion of the total benthic ecology resource due to the presence of comparable biotopes within the wider southern North Sea as identified in the offshore investigations.

Therefore, loss of habitat is considered to be of negligible magnitude in relation to the site and the wider region.

10.6.2.2.2 Persistent habitat loss in the offshore cable corridor

195. Habitat loss will occur during the lifetime of the Project as a result of cable protection installed on the seabed.

196. As previously stated in Section 10.6.1.1.2 biotope A5.135 *Glycera lapidum* in impoverished infralittoral mobile gravel and sand has been used as a proxy for A5.13 stations.

Sensitivity of receptor

197. The sensitivity of biotopes identified in the offshore cable corridor have been assessed in relation to the following MarESA pressure relevant to persistent habitat loss:

- ‘Physical change to another seabed type’

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

199. The sensitivity of identified habitats and biotopes to habitat loss is summarised in Table 10.22 below.

Table 10.22 The sensitivity of biotopes to physical change to another seabed type

Impact pressure pathway: Physical change to another seabed type				
Receptor	**Tolerance**	**Recoverability**	**Sensitivity**	**Confidence assessment**
A5.333 *Mysella bidentata* and *Abra* spp. In infralittoral sandy mud (De-Bastos, 2016)	None	Very Low	High	High
A5.261 *Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment (Tillin & Budd, 2016)	None	Very Low	High	High
A5.135 *Glycera lapidum* in impoverished infralittoral mobile gravel and sand (Tillin, 2016)	None	Very Low	High	High
A5.143 *Protodorvillea kefersteini* and other polychaetes in impoverished circalittoral mixed gravelly sand (Tillin, 2016)	None	Very Low	High	High
A5.451 Polychaete-rich deep *Venus* community in offshore mixed sediments (Tillin, 2016)	None	Very Low	High	High
A4.231 Piddocks with a sparse associated fauna in	None	Very low	High	High

Impact pressure pathway: Physical change to another seabed type				
Receptor	**Tolerance**	**Recoverability**	**Sensitivity**	**Confidence assessment**
sublittoral very soft chalk or clay (Tillin and Hill, 2016)				

200. By definition, the sensitivity of benthic ecology receptors to persistent habitat loss is high.

201. The sensitivity of habitats can be modified based on their value (Section 10.4.3.1.2), but the worst case sensitivity remains high.

Magnitude of impact

202. Within the offshore cable corridor, the estimated worst-case loss of habitat is approximately 0.15km^2. Although the effect is long term, it is over a small proportion of the total benthic ecology resource due to the presence of comparable biotopes within the wider southern North Sea as identified in the offshore investigations. Therefore, loss of habitat is considered to be of negligible magnitude in relation to the site and the wider region.

10.6.2.2.3 Summary: Significance of effect from long term habitat loss

203. Due to the worst-case scenario of high sensitivity of biotopes and a negligible magnitude to long term habitat loss, the significance of effect is assessed as minor adverse.

10.6.2.3 Impact 3: Increased suspended sediment concentrations

10.6.2.3.1 Increased suspended sediment concentrations in the offshore project area

204. Increases in SSC within the water column and subsequent deposition onto the seabed may occur as a result of operation activities. This includes the need for jack-up vessels, cable repair, and replacement and reburial activities.

205. Changes in coastal processes in the area caused by the deployment of the wind farm may also lead to increased sediment deposition on the seabed however it is not expected that there would be significant smothering effects during operation.

206. Significant effects of increased suspended sediment concentrations have been assessed in Chapter 8 Marine Geology, Oceanography and Physical Processes (Volume I). The assessment found that the worst-case volumes of sediment released following operation activities are considerably less than in the construction phase.

207. As previously stated in Section 10.6.1.1, biotope A5.231 Infralittoral mobile clean sand with sparse fauna has been used to represent A5.2 stations. Furthermore, as stated in Section 10.6.1.1.2 biotope A5.135 *Glycera lapidum* in impoverished infralittoral mobile gravel and sand has been used as a proxy for A5.13 stations.

Sensitivity of receptor

208. The sensitivity of biotopes have been assessed in relation to MarESA pressures relevant to the operational phase increases in suspended sediment concentrations, set out in Table 10.18 and Table 10.19.

209. Biotopes within the offshore project area were determined to have medium sensitivity to the effects of increased suspended sediment concentrations during construction, and as operation activities are temporary, localised and small scale the same has been concluded here.

210. The sensitivity of habitats can be modified based on their value (Section 10.4.3.1.2), but the worst case sensitivity remains medium.

Magnitude of impact

211. As described in Section 10.6.1.2 and 10.6.1.2.2, increased SSCs and subsequent deposition is likely to occur when any form of maintenance is carried out. These will be small in magnitude relative to construction activities. Increases in SSC and deposition as a result of operation phase activities are expected to cause localised and short-term increases in SSC at the point of discharge. However, negligible changes to seabed level due to deposition are expected, and therefore the magnitude of impact is considered to be negligible.

Intertidal

212. As discussed in Section 8.6.2.5 of Chapter 8 Marine Geology, Oceanography and Physical Processes (Volume I), the placement of cable protection nearshore would have an effect of negligible significance on the physical attributes of the intertidal zone due the presence of coastal protection along the Tendring Peninsula. In reality, cable protection is likely to provide a similar function to the existing groynes, which are aimed at restricting the flow of sediment to protect the coastline.

213. The potential receptors along the intertidal are Not Sensitive and have high tolerance and recoverability to the effects of SSC and deposition (Table 10.20).

214. Due to the negligible magnitude from the impact and receptors being Not Sensitive to each impact pathway for increased suspended sediment concentrations, the overall worst-case effect is considered to be of negligible significance from increased suspended sediment concentrations.

10.6.2.3.2 Summary: Significance of effect from increased suspended sediment concentrations

215. The worst-case sensitivity assessment for the offshore project area is medium and the magnitude of impact is negligible. Therefore, the significance of effect from increased suspended sediments and subsequent deposition is assessed as minor adverse significance.

10.6.2.4 Impact 4: Re-mobilisation of contaminated sediments

10.6.2.4.1 Re-mobilisation of contaminated sediments in the offshore project area

216. During maintenance activities, there is a risk of disturbing contaminated sediment and remobilising it back into the water column. However, Chapter 9 Marine Water and Sediment Quality (Volume I) assessed the impact in more detail and concluded that even though there are some elevated levels of

contaminants within the sediments, they align with typical levels for the region and do not pose a high risk.

217. As previously stated in Section 10.6.1.1, biotope A5.231 Infralittoral mobile clean sand with sparse fauna has been used to represent A5.2 stations. Furthermore, as stated in Section 10.6.1.1.2 biotope A5.135 *Glycera lapidum* in impoverished infralittoral mobile gravel and sand has been used as a proxy for A5.13 stations.

Sensitivity of receptor

218. The MarESA pressure benchmark for 'Pollution and other chemical changes' is named as 'Exposure of marine species or habitat to one or more relevant contaminants via uncontrolled releases or incidental spills' (Tyler-Walters et al., 2022). Given contaminant levels are within environmental protection standards, marine species and habitats are not sensitive to changes that remain within these standards.

Magnitude of impact

219. As described in Section 10.6.1.3, sediment analysis has been conducted and sediment contamination levels are not to be of significant concern and are low risk in terms of potential impacts on the marine environment.

220. Therefore, there is negligible magnitude of risk to benthic ecology receptors from re-mobilisation of contaminated sediments during maintenance activities.

10.6.2.4.2 Summary: Significance of effect from the re-mobilisation of contaminated sediments

221. With the biotopes holding no sensitivity to contaminated sediment and negligible magnitude of impact, negligible significance is determined.

10.6.2.5 Impact 5: Underwater noise and vibration

10.6.2.5.1 Underwater noise and vibration in the offshore project area

222. During maintenance works, the majority of underwater noise and vibration will occur as a result of vessel activity. There is, however, the possibility that noise produced by operational wind turbines could have an effect on benthic species.

Sensitivity of receptor

223. As described in 10.6.1.4, the biotopes identified over the entire offshore project area have MarESA sensitivity of 'Not Relevant' to the impact of underwater noise and vibration. 'Not Relevant' is recorded where the evidence suggests that there is no direct interaction between the pressure and biotope or characteristic species within. Therefore, the sensitivity of biotopes and species to underwater noise and vibration is considered to be negligible.

224. Equally, it is likely that the benthic species in the southern North Sea are habituated to noise created by existing shipping occurring in the area therefore limiting sensitivity to maintenance vessel activities within the offshore project area.

225. As previously stated in Section 10.6.1.1, biotope A5.231 Infralittoral mobile clean sand with sparse fauna has been used to represent A5.2 stations. Furthermore, as stated in Section 10.6.1.1.2 biotope A5.135 *Glycera lapidum* in impoverished infralittoral mobile gravel and sand has been used as a proxy for A5.13 stations.

Magnitude of impact

226. Noise associated with the operational phase is primarily related to vessel movements on site. The impact of vessel noise on benthic species will be very localised and of a small-scale nature.

227. However, noise produced from the operation of wind turbines has also been considered. Norro *et al*., 2011 found that steel pile wind turbines produce a sound pressure level increase of 20 to 25 dB re 1µ Pa for a wind farm with 3MW turbines. Measurement data from operational offshore wind farms in the UK, collated in MMO (2014), indicated low noise levels which were broadly comparable to ambient noise at ranges of only a few hundred metres. It is noted however that these measurements were taken from smaller wind turbines than those that will be installed for the North Falls, however, it is considered that, while the distances over which noise would propagate from the wind turbines would likely increase with size, they would still be expected to reach ambient levels within a few hundred metres. Appendix 12.2 (Volume III) provides underwater noise modelling for North Falls and shows the effects of operational noise from wind turbines would be within 100m for noise sensitive marine mammal species and therefore the impact ranges for benthic receptors would be significantly less. Therefore, any impact magnitude on benthic receptors would be negligible.

10.6.2.5.2 Summary: Significance of effect from underwater noise and vibration

228. As the biotopes, and subsequent benthic species within, have no to negligible sensitivity to underwater noise and vibration, and the magnitude is concluded low, the significance of effect from underwater noise and vibration is assessed as negligible significance.

10.6.2.6 Impact 6: Interactions of EMF

10.6.2.6.1 Interactions of EMF in the offshore project area

229. There is potential for offshore export cables and the interconnector cable to produce electromagnetic fields (EMFs) that interfere with the behaviour of benthic species.

230. The effect of EMFs on benthic species has received increasing interest consisting of a variety of studies conducted both in the field and under controlled environments. Boles and Lohmann (2003) found the Spiny lobster *Panulirus argus* exhibits annual migrations and homing behaviours. They use geomagnetic fields to return to known locations after displacement. Therefore, other lobsters and crabs became the focus of EMF studies, assuming they would all display similar behaviour.

231. Similar responses have been found in subsequent studies. Hutchinson et al., 2020 found the American lobster *Homarus americanus* showed an increase in exploratory response when exposed to EMF from a high voltage DC (HVDC) cable compared to their natural geomagnetic response. Similarly, Scott et al., 2018 studied the edible crab *Cancer pagarus* in a controlled environment and found individuals to have a strong attraction to EMF sources. Their roaming decreased by 21% and focus was turned to the EMF source. They concluded that with increased EMF around Marine Renewable Energy Devices (MREDs), it is likely that there will be an increase in Individuals populating these areas. They suggest further research into the effects on different life stages of *C.*

pagarus as eggs and juveniles are highly likely to be found surrounding EMF sources in the future.

232. In contrast, yellow rock crabs *Metacarcinus anthonyu* and red rock crabs *Cancer productus* have shown no preferences to EMF sources (Love et al., 2015). When placed in in situ chambers, the crabs were able to get closer and farther away from energised or unenergised cables. No preference was exhibited. Further support for the findings from Love et al., 2017 found no significant differences among fish and invertebrate communities between energised cables, pipe and natural habitat.

233. As previously stated in Section 10.6.1.1.2 biotope A5.135 *Glycera lapidum* in impoverished infralittoral mobile gravel and sand has been used as a proxy for A5.13 stations.

Sensitivity of receptor

234. The sensitivity of biotopes identified in the offshore cable corridor and the interconnector cable have been assessed in relation to the MarESA pressure relevant to the impact of EMF:

- Electromagnetic changes

235. There is a lack of evidence as to the impacts of EMF on benthic species. There is a real need for further research so understanding can be complete for how EMF impacts the behavioural, physiological and biological aspects of the benthos.

236. The biotopes identified over the entire offshore project area have MarESA sensitivity of 'Not Relevant' to the impact of EMF. 'Not Relevant' is recorded where the evidence suggests that there is no direct interaction between the pressure and biotope or characteristic species within. Therefore, the sensitivity of biotopes and species to EMF is considered to be negligible.

Magnitude of impact

237. The presence of increased EMF will last over the entirety of the operational phase, however indiscernible alteration to baseline EMF levels is predicted. Therefore, the magnitude of the interactions of EMF is considered negligible.

10.6.2.6.2 Summary: Significance of effect from EMF

238. Due to the negligible sensitivity of biotopes present in the offshore cable corridor and interconnector cable, and the negligible magnitude of impact, the overall significance of effect from interactions of EMF is negligible.

10.6.2.7 Impact 7: Colonisation of introduced substrate, including non-native species

10.6.2.7.1 Colonisation of introduced substrate, including non-native species in the offshore project area

239. Artificial hard substrates introduced via infrastructure such as foundations, scour and cable protection could act as potential 'steppingstones' or vectors for INNS.

240. The primary pathway for the potential introduction of INNS is from the use of vessels and infrastructure that has originated from an ecologically different location than the southern North Sea. Though the initial introduction of INNS will most likely be in the construction phase, it has been assessed in the

operation phase as vector capability on artificial hard substrate would be most pronounced and establishment would take place. Therefore, the significance of effect would be greater in this phase.

241. The colonisation of marine fauna on introduced hard substrate has been widely recognised across the southern North Sea. Schrieken et al., 2013 found that new species were colonising on wrecks around the Dogger Bank and Cleaver Bank regions. 29 species were identified on the wrecks that had not been previously known to reside in the entire Dogger Bank area.

242. The introduction of hard substrate into an open, sandy marine environment such as that of the southern North Sea, could provide a potentially detrimental transition for benthic communities to hard-bottom or intertidal communities (Kerckhof et al., 2011). With this, the increase in biodiversity previously demonstrated on hard substrate may not represent a positive shift.

243. Due to a natural lack of hard substrate in the southern North Sea, many species were not able to successfully colonise (Cameron & Askew, 2011). However, increasing numbers of wreck, oil and gas rigs, and now offshore wind turbines, are making it possible for more species to successfully colonise and establish communities in sheltered, productive zones. Kerckhof et al., 2011 looked at the colonisation of benthic fauna on wind turbines in the North Sea and found over a third of species to be non-indigenous. These included the oyster *Crassostrea gigas* and the limpet *Patella vulgata*. Their study provides strong evidence to suggest INNS use hard infrastructure as 'steppingstones' to colonise in new communities.

244. As previously stated in Section 10.6.1.1, biotope A5.231 Infralittoral mobile clean sand with sparse fauna has been used to represent A5.2 stations. Furthermore, as stated in Section 10.6.1.1.2 biotope A5.135 *Glycera lapidum* in impoverished infralittoral mobile gravel and sand has been used as a proxy for A5.13 stations.

<u>Sensitivity of receptor</u>

245. The most relevant MarESA pressure in relation to the presence of new artificial structures is:

- 'Physical change to another seabed type'

246. However, this impact has already been assessed in relation to loss of habitat in Section 10.6.2.2 and Section 10.6.2.2.2, indicating a high sensitivity.

247. Although the relevant pressure is the same, the impact itself is different to loss of habitat. The presence of hard substrata, establishing an artificial reef, will provide refuge and niche habitat, however, potentially increasing feeding opportunities for a range of larger, more mobile species. This could consequently have adverse or indirect effects on the existing benthic species through predation or competition for resources.

248. As a newly introduced substrate would be a change from the existing environment, the effect on any ecological receptors cannot be considered beneficial in ecological terms.

249. Therefore, due to the presence of artificial hard substrate in an area of predominantly sediment habitats, species that colonise the artificial hard substrate would represent a change in biodiversity to the area.

250. The sensitivity of habitats can be modified based on their value (Section 10.4.3.1.2), but the worst case sensitivity remains high.

Magnitude of impact

251. Although the effect is long term, it is over a small proportion of the total benthic ecology resource due to the presence of comparable biotopes within the wider southern North Sea as identified in the offshore investigations. There will be a long-term change to species and substrate within the offshore project area, however this will be localised to where infrastructure is present, and settlement will only be on new infrastructure and barely discernible in the context of the wider North Sea. There will be potential for negative interactions with other species, but overall, it will not be detrimental to the existing benthic environment. Therefore, the magnitude of impact is negligible.

10.6.2.7.2 Summary: Significance of effect from the colonisation of introduced substrate, including non-native species

252. As the sensitivity of present biotopes across the offshore project area are high and the magnitude of impact is negligible, the overall significance of effect from the colonisation and introduction of INNS is minor adverse effect.

10.6.3 Potential impacts during decommissioning

253. The impacts of the offshore decommissioning of the Project have been assessed on benthic and intertidal ecology. The worst case scenarios arising from the decommissioning of the Project are listed in Table 10.2. A description of the significance of effect upon benthic and intertidal receptors caused by each identified impact is provided below.

254. A decision regarding the final decommissioning policy is yet to be decided as it is recognised that rules and legislation change over time in line with best industry practice. The decommissioning methodology and programme would need to be finalised nearer to the end of the lifetime of the proposed North Falls to ensure it is in line with the most recent guidance, policy and legislation.

255. The scope of the decommissioning works would most likely involve removal of the accessible installed components. This is outlined in Chapter 5 Project Description (Volume I) and the detail would be agreed with the relevant authorities at the time of decommissioning. Offshore, this is likely to include removal of all of the wind turbine components and part of the foundations (those above seabed level), removal of some or all of the array and export cables. Scour and cable protection would likely be left in situ.

10.6.3.1 Impact 1: Temporary physical disturbance

256. The nature and extent of temporary physical disturbance during decommissioning is assumed (for the purposes of this assessment) to be similar to that described for the equivalent activities during the construction phase, however seabed preparation, such as sandwave levelling required during the construction phase would not be required during decommissioning and so this is likely to be conservative.

Significance of effect

257. Based on the assessment undertaken for construction, the worst case sensitivity of benthic receptors is high and magnitude of the impact is negligible. This would result in a minor adverse effect during the decommissioning phase.

10.6.3.2 Impact 2: Increased SSC

258. Increased SSC and subsequent deposition from decommissioning works are expected to be less than that for construction activities and therefore of a reduced magnitude.

259. Decommissioning activities that are expected to cause increased SSC and subsequent deposition include the removal of foundations to below the seabed surface and the possible removal of cables in the offshore cable corridor, arrays and interconnector.

Significance of effect

260. Based on the assessment undertaken for construction, the worst case sensitivity of benthic receptors is medium and magnitude of the impact is negligible. This would result in a minor adverse effect.

261. For the intertidal, as discussed in Section 10.6.1.2.2, receptors are not sensitive to increased SSC and magnitude of the impact is negligible. Resulting in a negligible effect significance.

10.6.3.3 Impact 3: Re-mobilisation of contaminated sediments

262. As described in Section 10.6.1.3, sediment analysis has been conducted and sediment contamination levels are not to be of significant concern and are low risk in terms of potential impacts on benthic receptors.

Significance of effect

263. Based on the assessment undertaken for construction, the worst case sensitivity of benthic receptors is not sensitive and magnitude of the impact is negligible. This would result in a negligible effect.

10.6.3.4 Impact 4: Underwater noise and vibration

264. Underwater noise and vibration from decommissioning works are expected to be less than that for construction activities and therefore of a reduced magnitude.

265. Underwater noise and vibration would primarily arise from pile cutting and infrastructure removal, as well as vessel activity.

Significance of effect

266. Based on the assessment undertaken for construction, the worst case sensitivity of benthic receptors is negligible and magnitude of the impact is negligible. This would result in a negligible effect.

10.7 Cumulative effects

10.7.1 Identification of potential cumulative effects

267. The first step in CEA process is the identification of which residual effects assessed for North Falls on their own have the potential for a cumulative effect

with other plans, projects and activities. This information is set out in Table 10.23 below.

Table 10.23 Potential cumulative effect

Impact	Potential for cumulative effect	Rationale
Construction		
Temporary physical disturbance	Yes	Effects will occur at isolated locations for a time-limited duration and are local in nature. However, due to nearby offshore wind farms, cumulative effects must be assessed.
Increased suspended sediment concentrations	Yes	Increases in SSC are expected to be localised at the point of discharge and short-term. The small quantities of fine sediment may be transported further; however, it will be widely and rapidly dispersed and not increase the volume of sediment already present in the benthos. The elevation of SSC is expected to be lower than concentrations that would develop in the water column during storm conditions. However, due to nearby offshore wind farms, cumulative effects must be assessed.
Remobilisation of contaminated sediments	No	The level of contaminated sediment found in the offshore site investigation are not of significant concern and present a negligible magnitude for effect on the benthic environment.
Underwater noise and vibration	No	The sensitivity of benthic ecology receptors to underwater noise and vibration is considered to be negligible and underwater noise effects will be localised, with the highest magnitude noise sources being short term and intermittent.
Operation		
Temporary physical disturbance	Yes	Effects will occur at isolated locations for a time-limited duration and are local in nature with a negligible impact magnitude. However, due to nearby offshore wind farms, cumulative effects must be assessed.
Persistent habitat loss	Yes	Additive habitat loss across the region. Other developments in the region have the potential to have cumulative habitat loss impacts.
Increased suspended sediment concentrations	Yes	Effects will occur at isolated locations for a time-limited duration and are local in nature with a negligible impact magnitude. However, due to nearby offshore wind farms, cumulative effects must be assessed.
Remobilisation of contaminated sediments	No	The level of contaminated sediment found in the offshore site investigation are not of significant concern and present a negligible magnitude for effect on the benthic environment.
Underwater noise and vibration	No	The sensitivity of benthic ecology receptors to underwater noise and vibration is considered to be negligible and underwater noise effects will be localised.
Interactions of EMF	Yes	EMF will be highly localised around the offshore cable corridor and interconnector cables. However, due to nearby offshore wind farms, cumulative effects must be assessed.
Colonisation of introduced substrate, including non-native species	Yes	It is likely that benthic organisms will successfully colonise introduced infrastructure. Biosecurity measures will be used to prevent the introduction of INNS. The risk of introduction to the southern North Sea is not considered to be significantly increased as a result of the Project. However, due to the potential for larvae to disperse over distances greater than one hundred kilometres (Álvarez-Noriega et al., 2020), this impact must be considered.
Decommissioning		

Impact	Potential for cumulative effect	Rationale
Temporary physical disturbance	Yes	Effects will occur at isolated locations for a time-limited duration and are local in nature with a negligible impact magnitude. However, there is potential for overlap in decommissioning programmes therefore potential cumulative effects.
Increased suspended sediment concentrations	Yes	Effects will occur at isolated locations for a time-limited duration and are local in nature with a negligible impact magnitude. However, there is potential for overlap in decommissioning programmes therefore potential cumulative effects.
Remobilisation of contaminated sediments	No	The level of contaminated sediment found in the offshore site investigation are not of significant concern and present a negligible magnitude for effect on the benthic environment.
Underwater noise and vibration	No	The sensitivity of benthic ecology receptors to underwater noise and vibration is considered to be negligible and underwater noise effects will be localised, with the highest magnitude noise sources being short term and intermittent.

10.7.2 Other plans, projects and activities

268. The second step in the cumulative assessment is the identification of the other plans, projects and activities that may result in cumulative effects for inclusion in the CEA (described as 'project screening'). This information is set out in Table 10.24 below, together with a consideration of the relevant details of each, including current status (e.g. under construction), planned construction period, closest distance to North Falls, status of available data and rationale for including or excluding from the assessment.

269. The project screening has been informed by the development of a CEA project list which forms an exhaustive list of plans, projects and activities within the study area (Section 10.3.1) relevant to North Falls. The list has been appraised, based on the confidence in being able to undertake an assessment from the information and data available, enabling individual plans, projects and activities to be screened in or out.

Table 10.24 Summary of projects considered for the CEA in relation to benthic and intertidal ecology (project screening)

Plan or project	Status	Construction period	Closest distance from the array areas(km)	Closest distance from the offshore cable corridor (km)	Confidence in Data	Included in the CEA (Y/N)	Rationale
NeuConnect Interconnector	Pre-construction	2022-2028	2	0	High	Yes	The NeuConnect Interconnector bisects the North Falls export cable corridor and interconnector cable corridor and there is potential for temporal overlap of cable installation activities.
BritNed Interconnector	Operational since 2009	N/A	0	10.9	High	No	The BritNed Interconnector passes through the south of the south array but has been operational since 2009. There is therefore no potential for cumulative impact on the identified receptors.
Nautilus Interconnector	Pre-application	2025-2028	Cable route unknown	Cable route unknown	Low	Yes (Subject to available information)	The offshore study area for Nautilus intersects with the North Falls offshore project area, Therefore, there is potential for cumulative effects, subject to the final location and programme for the interconnector.
Sea Link	Pre-application	2026-2030	Cable route unknown	c. 3.5km	Medium	Yes, for offshore construction effects only (Subject to available information)	The emerging preferred and alternative routes for Sea Link intersect with the North Falls offshore cable corridor. Therefore, there is potential for cumulative effects, subject to the final location and programme for the interconnector.
Tarchon Energy Interconnector	Pre-planning	N/A	Cable route unknown	Cable route unknown	N/A	Yes	Interconnector between UK and Germany with potential to be in

Plan or project	Status	Construction period	Closest distance from the array areas(km)	Closest distance from the offshore cable corridor (km)	Confidence in Data	Included in the CEA (Y/N)	Rationale
						(Subject to available information)	proximity to the North Falls offshore project area.
Greater Gabbard offshore wind farm	Operational since 2012	N/A	0	5.6	Medium	Yes (maintenance disturbance only)	Both GGOW and GWF are operational therefore there is potential cumulative effect on benthic ecology from ongoing maintenance activities.
Galloper offshore wind farm	Operational since 2018	N/A	0	8.5	Medium	Yes (maintenance disturbance only)	
Five Estuaries offshore wind farm	In Planning	Unknown	0	14.8	Medium	Yes	Potential for cumulative effect due to the proximity of the projects.
East Anglia TWO offshore wind farm	Consent granted	Construction planned mid 2020s	14.8	37.2	High	Yes	
Thanet offshore wind farm	Operational since 2010	N/A	24.4	36.2	Medium	No	Any ongoing effects of maintenance activity from these offshore wind farms will be highly localised and therefore, given the distance from the North Falls offshore project area, there is no
London Array offshore wind farm	Operational since 2013	N/A	19.4	15.5	Medium		

Plan or project	Status	Construction period	Closest distance from the array areas(km)	Closest distance from the offshore cable corridor (km)	Confidence in Data	Included in the CEA (Y/N)	Rationale
Gunfleet Sands offshore wind farm	Operational since 2010	N/A	43.3	10.3	Medium		pathway for significant cumulative effects. This approach is in keeping with the Galloper EIA, where it was agreed with Cefas and Defra that no assessment of cumulative effects was required with other Round 2 sites in the Thames strategic area (except GGOW).
Outer OTE aggregate exploration and option area 528/2	Unknown	N/A	8.4	14	Low	Yes, subject to available information	There is potential for some interaction between dredging and aggregate exploration on benthic ecology. Removal of sediment and sediment plumes have the potential to have a cumulative effect.
East Orford Ness aggregate exploration and option area 1809	Unknown	N/A	2	24.8	Low	Yes, subject to available information	
Thames D aggregates production agreement area 524	Production agreement secured 2022	2022-2036	0	12.5	Low	Yes, subject to available information	
Southwold East aggregates production agreement area 430	Operational since 2012	N/A	27.3	48.4	Medium	No	Sites which were operational at the time of the North Falls characterisation surveys are a component of the baseline environment.
North Inner Gabbard	Operational since 2015	N/A	1.7	24	Medium	No	

Plan or project	Status	Construction period	Closest distance from the array areas(km)	Closest distance from the offshore cable corridor (km)	Confidence in Data	Included in the CEA (Y/N)	Rationale
aggregate production area 498							
Shipwash aggregate production agreement area 507	Operational since 2016	N/A	0.2	9.8	Medium	No	
Longsand aggregate production agreement area 508	Operational since 2014	N/A	11.7	5.8	Medium	No	
Longsand aggregate production agreement area 509	Operational since 2015	N/A	11.7	2.1	Medium	No	
Longsand aggregate production agreement area 510	Operational since 2015	N/A	7.3	3.5	Medium	No	
North Falls East aggregate production agreement area 501	Operational since 2017	N/A	13.2	27.5	Medium	No	

10.7.3 Assessment of cumulative effects

10.7.3.1 Cumulative effect 1: Temporary physical disturbance and increased suspended sediment concentrations

270. Temporary physical disturbance and increased sediment concentrations have been assessed collectively as a cumulative effect due to increased suspended sediment in the water column being a direct consequence of temporary physical disturbance.

271. There is potential for works associated with all phases of North Falls to be conducted at the same time, or similar time, to works associated with all phases of the Five Estuaries offshore wind farm, as well as maintenance works at GGOW, GWF and East Anglia TWO. There is also potential for overlap with the latter stages of the NeuConnect, Nautilus and/or Sea Link interconnectors construction programmes and dredging works from the Thames D aggregates production agreement area 524.

272. Temporary physical disturbance to the benthos will cause an increase in suspended sediment concentrations within the ZoI. As discussed in Sections 10.6.1.1 and 10.6.1.2, the effects of North Falls will be localised and relatively short term, through the duration of the construction period. Works occurring in multiple different projects could act cumulatively, however it should be noted that these temporary disturbance effects are unlikely to all occur at the same time and therefore the seabed may have recovered from some disturbance events before other effects arise. In the context of the study area of c.3000km^2 (based on a 30km radius around North Falls), the footprint of cumulative works on the seabed is likely to represent a minority of the available habitat. Given the presence of coarse sediment across the study area, it is likely that the majority of suspended sediment arising from cumulative works would settle rapidly to the seabed and therefore the impact magnitude would be low.

Table 10.25 Cumulative physical disturbance

Plan or project	Area of disturbance	Data source
NeuConnect Interconnector	Not quantified	Aecom (2019)
Nautilus Interconnector	Unknown cable route at time of writing	N/A
Sea Link Interconnector	Unknown cable route at time of writing	N/A
Tarchon Energy Interconnector	Unknown cable route at time of writing	N/A
Outer OTE aggregate exploration and option area 528/2	47.37 km^2 (assumes whole area disturbed)	TCE (2023)
East Orford Ness aggregate exploration and option area 1809	38.88 km^2 (assumes whole area disturbed)	TCE (2023)
Thames D aggregates production agreement area 524	37.53 km^2 (assumes whole area disturbed)	TCE (2023)
Greater Gabbard offshore wind farm	Quantification of ad hoc maintenance impacts unavailable. Assumed similar to North Falls maintenance estimates (<1 km^2)	N/A

Plan or project	Area of disturbance	Data source
Galloper offshore wind farm	Quantification of ad hoc maintenance impacts unavailable. Assumed similar to North Falls maintenance estimates (<1 km^2)	N/A
Five Estuaries	Unknown (estimate similar to North Falls construction, 13.22km^2)	N/A
East Anglia TWO	11.3 km^2	ScottishPower Renewables (2019)
North Falls	13.22 km^2 (6.9 km^2 in the array areas and 6.32 km^2 in the offshore cable corridor during construction.	Section 10.3.2
Indicative total	**163.52km^2** It should be noted that these temporary disturbance effects are unlikely to all occur at the same time and therefore the seabed may have recovered from some disturbance before other effects arise	

273. Habitats in the study area predominantly have a medium or low sensitivity to disturbance. However due to the presence of piddocks with a sparse associated fauna in sublittoral very soft chalk or clay which have high sensitivity, this is used as the worst case scenario.

274. Therefore, potential cumulative effects from temporary physical disturbance and increased suspended sediment concentrations on benthic ecology is assessed to be of moderate adverse significance, however this is likely to be over precautious, using the worst case scenario magnitudes for each project along with the high sensitivity of one benthic receptor. Typically the final build scenarios are significantly less than the worst case scenarios assessed in the EIA.

275. Regarding cumulative effects on the intertidal ecology, Five Estuaries is expected to follow a similar offshore cable corridor and make landfall within a similar area of search to North Falls. Cables are unlikely to be installed simultaneously in the same locations and therefore the cumulative effects during construction are likely to be similar to those for North Falls alone, spread over a longer duration. As the effects for each project are likely to remain within the range of background nearshore levels there will be no change to the intertidal ecology cumulatively.

10.7.3.2 Cumulative effect 2: Loss of habitat during construction, operation and decommissioning

276. It is recognised that North Falls will result in a worst case loss of habitat of 6.84km^2 (6.69km^2 in the array areas and 0.15km^2 in the offshore cable corridor) through the placement of infrastructure on the seabed (foundations, scour protection and cable protection). Of the projects screened into the CEA, only those shown below would result in the long term placement of infrastructure on the seabed and therefore habitat loss. Habitat loss of GGOW and GWF is a feature of the baseline environment.

Table 10.26 Cumulative habitat loss

Plan or project	Area of habitat loss (km^2)	Data source
NeuConnect Interconnector	0 (assumed buried)	Aecom (2019)

Plan or project	Area of habitat loss (km²)	Data source
Nautilus Interconnector	Unknown (assumed buried as per NeuConnect)	N/A
Sea Link	Unknown (assumed buried as per NeuConnect)	N/A
Tarchon Energy Interconnector	Unknown (assumed buried as per NeuConnect)	N/A
Five Estuaries	Unknown (estimate similar to North Falls 6.84)	N/A
East Anglia TWO	2.02	ScottishPower Renewables (2019)
North Falls	6.84	Section 10.3.2
Indicative total	**15.7**	

277. In a study area of c. 3000km², the cumulative habitat loss would represent a worst case scenario of 0.5% of the study area, with a likelihood that some or all of the as-built project scenarios will reduce the final cumulative effect. In cases where sensitive habitats are present (e.g. *Sabellaria* reef), effects would be avoided where possible by micrositing. This represents a low magnitude of impact.

278. The habitats in the study area are of high sensitivity to habitat loss. Therefore, potential cumulative effects from loss of habitat would be of moderate adverse significance.

279. As with temporary physical disturbance (Section 10.7.3.1), this is likely to be over precautious, using the worst case scenario magnitudes for each project. Typically the final build scenarios are significantly less than the worst case scenarios assessed in the EIA.

10.7.3.3 Cumulative effect 3: Colonisation of introduced substrate, including non-native species

The introduction of hard substrate to the benthic environment has the potential to provide a steppingstone for the colonisation of INNS. With GGOW and GWF adjacent to the north and south arrays, the construction of North Falls will cumulatively provide more opportunities for INNS to establish themselves on the infrastructure. However, as the surrounding region has existing hard infrastructure in place, for example from wrecks and existing OWFs, the construction of the Project, along with East Anglia Two and Five Estuaries, will not significantly increase the risk of INNS, as ‘steppingstones’ have existed in the study area for a prolonged period of time.

280. The benthic habitats in the study area are of high sensitivity to habitat loss.

281. The cumulative risk is also associated with the movement of vessels in and out of the region. However, as previously considered in Table 10.3, the introduction of INNS through vessels will be mitigated through adherence with MARPOL, BWM and The Environmental Damage Regulations 2015 guidelines. Therefore, a low magnitude of impact is concluded.

282. The overall potential cumulative effects from the colonisation of introduced substrate, including INNS would be of moderate adverse significance.

283. As discussed in Section 10.7.3.2, this is likely to be over precautious as typically the final build scenarios are significantly less than the worst case scenarios assessed in the EIA.

10.7.3.4 Cumulative effect 4: Interaction of EMF

284. EMFs associated with cables within the offshore project area, cables associated with other OWF projects and the Interconnector cables could result in a cumulative effect on the benthic environment.

285. As described in the assessment of EMFs for the Project alone, the areas affected by EMFs would be expected to be very small, being limited to the immediate vicinity of the offshore cables (i.e. within metres). It is anticipated therefore that only a relatively small proportion of the benthic communities would be affected cumulatively in the context of the wider southern North Sea. The magnitude of impact is therefore considered to be negligible.

286. The sensitivity of the benthic receptors is as described in Section 10.6.2.6. The sensitivity of benthic receptors is 'Not Relevant' meaning there is no direct interaction between the impact and the receptor. The sensitivity is therefore considered to be negligible.

287. Therefore, potential cumulative effects from interactions of EMF is negligible.

10.8 Transboundary impacts

288. Due to the distance of North Falls from the EEZ and given that there will not be a significant effect on benthic and intertidal ecology, transboundary impacts are unlikely to occur and therefore transboundary impacts are scoped out of further assessment in accordance with the scoping opinion (Planning Inspectorate, 2021).

10.9 Interactions

289. Interactions exist between the benthic and intertidal ecology topic and several other topics that have been considered within this PEIR. Table 10.27 provides a summary of the principal interactions, related chapters and signposts to where those issues have been addressed in this chapter.

Table 10.27 Benthic and intertidal ecology interactions

Topic and description	Related chapter (Volume I)	Where addressed in this chapter	Rationale
Construction			
Fish and Shellfish – edible crabs, prey resources, nursery and spawning ground	Chapter 11 Fish and Shellfish Ecology	This chapter informs Chapter 11.	The benthic environment represents a habitat for many fish and shellfish species. Additionally, a number of benthic species are prey for fish and shellfish. Therefore, impacts on benthic ecology can lead to indirect impacts on fish and shellfish.
Suspended sediments and deposition	Chapter 8 Marine Geology, Oceanography and Physical Processes	Impacts as a result of suspended sediment and deposition are assessed in Section 10.6.1.2.	Changes in suspended sediment concentrations are assessed in Chapter 8 Marine Geology, Oceanography and Physical Processes (Volume I). Changes in suspended sediment concentrations

Topic and description	Related chapter (Volume I)	Where addressed in this chapter	Rationale
			and associated sediment deposition could have potential impacts on benthic habitats and species.
Re-mobilisation of contaminated sediments	Chapter 9 Marine Water and Sediment Quality	Re-mobilisation of contaminated sediments during construction is assessed in Section 10.6.1.3.	Chapter 9 Marine Water and Sediment Quality (Volume I) provides an assessment of the potential for contaminants to be present in the study area. Re-mobilisation of contaminated sediments and associated deposition could have potential impacts on benthic habitats and species.
Operation			
Fish and Shellfish – edible crabs, prey resources, nursery and spawning ground	Chapter 11 Fish and Shellfish Ecology	This chapter informs Chapter 11.	The benthic environment represents a habitat for many fish and shellfish species. Additionally, a number of benthic species are prey for fish and shellfish. Therefore, impacts on benthic ecology can lead to indirect impacts on fish and shellfish.
Suspended sediments and deposition	Chapter 8 Marine Geology, Oceanography and Physical Processes	Impacts as a result of suspended sediments and deposition are assessed in Section 10.6.2.3.	Changes in suspended sediment concentrations are assessed in Chapter 8 Marine Geology, Oceanography and Physical Processes (Volume I). Changes in suspended sediment concentrations and associated sediment deposition could have potential impacts on benthic habitats and species.
Decommissioning			
Interactions for impacts during the decommissioning phase will be the same as those outlined above for the construction phase.			

10.10 Inter-relationships

290. The impacts identified and assessed in this chapter have the potential to interrelate with each other. The areas of potential inter-relationships between impacts are presented in Table 10.28. This provides a screening tool for which impacts have the potential to interrelate. Table 10.29 provides an assessment for each receptor (or receptor group) as related to these impacts.

291. Table 10.29 provides an assessment for each receptor (or receptor group) related to these impacts in two ways. Firstly, the impacts are considered within a development phase (i.e. construction, operation or decommissioning) to see if, for example, multiple construction impacts could combine. Secondly, a lifetime assessment is undertaken which considers the likely significant effects on relevant receptors across development phases. The significance of each individual effect is determined by the sensitivity of the receptor and the magnitude of impact; the sensitivity is constant whereas the magnitude may differ. Therefore, when considering the potential for effects to be additive it is the magnitude of impact which is important – the magnitudes of the different impacts are combined upon the same sensitivity receptor.

292. None of the potential inter-relationships identified with respect to benthic and intertidal ecology are expected to result in a synergistic or greater impact than those assessed in Section 10.6.

Table 10.28 Inter-relationships between impacts – screening

Potential interaction between impacts				
Construction				
	Impact 1: Temporary physical disturbance	Impact 2: Increased suspended sediment concentrations	Impact 3: Remobilisation of contaminated sediments	Impact 4: Underwater noise and vibration
Impact 1: Temporary physical disturbance		Yes	No	No
Impact 2: Increased suspended sediment concentrations	Yes		No	No
Impact 3: Remobilisation of contaminated sediments	No	No		No
Impact 4: Underwater noise and vibration	No	No	No	

Operation							
	Impact 1: Temporary physical disturbance	Impact 2: Long term habitat loss	Impact 3: Increased suspended sediment concentrations	Impact 4: Remobilisation of contamination sediments	Impact 5: Underwater noise and vibration	Impact 6: Interactions of EMF	Impact 7: Colonisation of introduced substrate, including non-native species
Impact 1: Temporary physical disturbance		Yes	Yes	No	No	No	No
Impact 2: Long term habitat loss	Yes		No	No	No	No	No
Impact 3: Increased suspended sediment concentrations	Yes	No		No	No	No	No
Impact 4: Remobilisation of contamination sediments	No	No	No		No	No	No
Impact 5: Underwater noise and vibration	No	No	No	No		No	No

Impact 6: Interactions of EMF	No	No	No	No	No		No
Impact 7: Colonisation of introduced substrate, including non-native species	No	No	No	No	No	No	
Decommissioning							
The magnitude of decommissioning effects will be comparable to or less than those identified for the construction and operational phases.							

Table 10.29 Inter-relationships between impacts – phase and lifetime assessment

	Highest significance level				
Receptor	**Construction**	**Operation**	**Decommissioning**	**Phase assessment**	**Lifetime assessment**
Benthic habitats and biotopes	Minor adverse	Minor adverse	Minor adverse	No greater than individually assessed impacts. Construction Temporary physical disturbance, increased SSC and re-mobilisation of contaminated sediments are separately assessed as having low to negligible magnitudes. These impacts are intrinsically linked, with the main impact pathway being from physical disturbance which, depending on the impact, is either related to volume or areas of sediment/habitat affected and whether the impact is direct or indirect. Each impact would manifest through many of the same construction activities and therefore, there is potential for an interaction between the impacts. Only receptors within the direct footprint of seabed preparation and associated activities would be physically disturbed, therefore beyond the immediate footprint of construction, there is no pathway for interaction of direct and indirect impacts. Within the footprint of direct disturbance, the greatest effect will come from the temporary physical disturbance, rather than increased SSC. It is therefore considered that the interaction of these impacts would not represent an increase in the significance level.	No greater than individually assessed impacts. As with the phase assessment, all potential effects are non-significant and localised in nature, limiting the potential for different impacts to interact across the different phases. Effects across all project phases are temporary in nature, limiting their potential to result in a synergistic or greater impact with those considered in other phases. Given the scale of effect and ubiquity of receptors across the Southern North Sea region it is considered that over the Project lifetime these effects would not represent an increase in the significance level.

Receptor	Highest significance level Construction	Operation	Decommissioning	Phase assessment	Lifetime assessment
				Underwater noise and vibration would potentially interact with all other impacts with the level of interaction being dependent on the sensitivity of individual biotopes. However, any receptors in the immediate footprint of construction would be most affected by temporary physical disturbance. Given that this will include mortality of individuals in this footprint, there is no pathway for greater impact through interactions with noise. Therefore, there is no pathway for a greater effect significance. Beyond the immediate footprint of construction works, interactions of underwater noise and vibration would be limited to within the footprint of sediment plumes. Given that the magnitude of impact for these impacts is low to negligible with limited sensitivity of the receptors, it is not considered that there would be any greater impact significance. Operation Temporary physical disturbance and increased SSC have potential to interact however given the scale of disturbance during operation there would be limited pathways for interaction for these impacts during the operational stage. It is therefore considered that the interaction of these impacts would not represent an increase in the significance level. There would only be potential for interaction with noise or EMF effects where these footprints overlapped with physical disturbance. Given that such overlaps will be highly localised and episodic it is considered that any interaction would not result in any greater effect significance.	

10.11 Potential monitoring requirements

293. As described in this chapter, a large amount of geophysical and benthic ecology monitoring information is available from the existing GGOW and GWF, much of which will be highly relevant to North Falls given their close proximity and the similarity of developments. The Applicant intends to focus any further monitoring requirements on addressing any remaining areas of uncertainty and on those features of greatest sensitivity e.g. the Kentish Knock East MCZ.

294. Monitoring requirements will be discussed with stakeholders in the preparation of the final Environmental Statement (ES) which will be submitted alongside the DCO application.

10.12 Summary

295. This chapter has provided a characterisation of the existing environment for benthic and intertidal ecology based on both existing data and extensive site-specific surveys.

296. Seabed sediments across the array areas, cable corridor and interconnector, are dominated by sand and mixed sediment. Benthic communities corresponding to these sediment types were recorded, consistent with typical communities found in the southern North Sea.

297. The assessment has established that there will be some minor adverse residual effects during the construction, operation and decommissioning phases of North Falls. Effects are generally localised in nature, being restricted to the Project boundaries and immediate surrounding area. A summary of the significance of effect assessment for benthic and intertidal ecology is provided in Table 10.30.

Table 10.30 Summary of potential effects on benthic and intertidal ecology

Potential impact	Receptor	Sensitivity	Magnitude of impact	Pre-mitigation effect	Additional mitigation measures	Residual effect
Construction						
Impact 1: Temporary physical disturbance	Benthic habitats and species within the benthic ecology study area.	High	Negligible	Minor	N/A	Minor
Impact 2: Increased suspended sediment concentrations	Benthic habitats and species within the benthic ecology study area.	Medium	Negligible	Minor	N/A	Minor
Impact 3: Remobilisation of contaminated sediments	Benthic habitats and species within the benthic ecology study area.	Not sensitive	Negligible	Negligible	N/A	Negligible
Impact 4: Underwater noise and vibration	Benthic habitats and species within the benthic ecology study area.	Negligible	Negligible	Negligible	N/A	Negligible
Operation						
Impact 1: Temporary physical disturbance	Benthic habitats and species within the benthic ecology study area.	High	Negligible	Minor	N/A	Minor
Impact 2: Long term habitat loss	Benthic habitats and species within the benthic ecology study area.	High	Negligible	Minor	N/A	Minor
Impact 3: Increased suspended sediment concentrations	Benthic habitats and species within the benthic ecology study area.	Medium	Negligible	Minor	N/A	Minor
Impact 4: Remobilisation of contaminated sediments	Benthic habitats and species within the benthic ecology study area.	Not sensitive	Negligible	Negligible	N/A	Negligible
Impact 5: Underwater noise and vibration	Benthic habitats and species within the benthic ecology study area.	Negligible	Negligible	Negligible	N/A	Negligible

Potential impact	Receptor	Sensitivity	Magnitude of impact	Pre-mitigation effect	Additional mitigation measures	Residual effect
Impact 6: Interactions of EMF	Benthic habitats and species within the benthic ecology study area.	Negligible	Negligible	Negligible	N/A	Negligible
Impact 7: Colonisation of introduced substrate, including non-native	Benthic habitats and species within the benthic ecology study area.	High	Negligible	Minor	N/A	Minor
Decommissioning						
Impact 1: Temporary physical disturbance	Benthic habitats and species within the benthic ecology study area.	High	Negligible	Minor	N/A	Minor
Impact 2: Increased suspended sediment concentrations	Benthic habitats and species within the benthic ecology study area.	Medium	Negligible	Minor	N/A	Minor
Impact 3: Remobilisation of contaminated sediments	Benthic habitats and species within the benthic ecology study area.	Not sensitive	Negligible	Negligible	N/A	Negligible
Impact 4: Underwater noise and vibration	Benthic habitats and species within the benthic ecology study area.	Negligible	Negligible	Negligible	N/A	Negligible

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