FOREWIND

DOGGER BANK
TEESSIDE A & B

March
2014

Environmental Statement Chapter 12 - Marine and Intertidal Ecology

Application Reference: 6.12

Cover photograph: Installation of turbine foundations in the North Sea

Document Title	Dogger Bank Teesside A & B Environmental Statement – Chapter 12 Marine and Intertidal Ecology
Forewind Document Reference	F-OFL-CH-012 Issue 4.1
Date	March 2014

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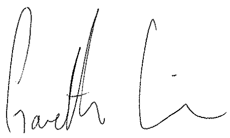
Forewind Approval			
Date / Reference approval		Gareth Lewis	14 February 2014

Title: Dogger Bank Teesside A & B Draft Environmental Statement Chapter 12 Marine and Intertidal Ecology		Contract No. (if applicable) Onshore ☐ Offshore ☒
Document Number: F-OFL-CH-012	Issue No: 4.1	Issue Date: 28 February 2014
Status: Issued for 1st. Technical Review ☐ Issued for 2nd. Technical Review ☐	Issued for PEI3 ☐ Issued for Application Submission ☒	
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Revision History

Date	Issue No.	Remarks / Reason for Issue	Author	Checked	Approved
31 May2013	1	Issued for 1st Technical review	JL	AL	AMP
08 July 2013	2	Issued for 2nd Technical review	JL	AL	AL
23 August 2013	2.1	Issued for Approval	JL	AL	AL
08 October 2013	3	Issued for PEI 3	JL	AL	RAH
07 February 2014	4	Pre-DCO Submission Review	JL	BLO	AL
28 February 2014	4.1	DCO Submission	JL	BLO	AL

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1. Introduction

1.1.1. This chapter of the Environmental Statement (ES) describes the existing environment with regard to marine and intertidal ecology and assesses the potential impacts of Dogger Bank Teesside A & B during the construction, operation and decommissioning phases. Where potential for significant impacts are identified, mitigation measures and residual impacts are presented.

1.1.2. Other chapters within the ES that are closely linked to marine and intertidal ecology are:

- **Chapter 8 Designated Sites**;
- **Chapter 9 Marine Physical Processes**;
- **Chapter 10 Marine Water and Sediment Quality**; and
- **Chapter 13 Fish and Shellfish Ecology**.

1.1.3. Throughout this chapter, the discussion in each section is presented in order from the offshore area to the intertidal as follows:

- Dogger Bank Teesside A & B project areas;
- Dogger Bank Teesside A & B Export Cable Corridor (offshore to the nearshore); and
- Intertidal (Mean Low Water Springs to Mean High Water Springs).

2. Guidance and Consultation

2.1. Legislation, policy and guidance

2.1.1. The assessment of potential impacts upon marine 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 (NSIP). Those relevant to Dogger Bank Teesside A & B are:

- Overarching NPS for Energy (EN-1) (Department of Energy and Climate Change (DECC) 2011a); and
- NPS for Renewable Energy Infrastructure (EN-3) (DECC 2011b).

2.1.2. The specific assessment requirements for marine and intertidal ecology, as detailed in the NPS, are summarised in **Table 2.1**, together with an indication of the paragraph numbers of the ES chapter where each is addressed. Where any part of the NPS has not been followed within the assessment an explanation as to why the requirement was not deemed relevant, or has been met in another manner, is provided.

Table 2.1 NPS assessment requirements

NPS requirements	NPS reference	ES reference
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.	Section 2.6.81 of NPS EN-3	**Chapter 5 Project Description** **Chapter 9 Marine Physical Processes**
Applicants are expected to have regard to guidance issued in respect of Food and Environmental Protection Act (FEPA) [now Marine Licence] requirements.	Section 2.6.83 NPS EN-3	Throughout this chapter
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	Section 2.6.113 of NPS EN-3	**Chapter 5 Project Description** **Chapter 9**

NPS requirements	NPS reference	ES reference
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.		**Marine Physical Processes**
Construction and decommissioning methods should be designed appropriately to minimise effects on subtidal habitats, taking into account other constraints. Mitigation measures which the Infrastructure Planning Commission (IPC) (now the Planning Inspectorate) should expect the applicants to have considered may include: • Surveying and micrositing of the export cable route to avoid; • Adverse effects on sensitive habitat and biogenic reefs; • Burying cables at a sufficient depth, taking into account other constraints, to allow the seabed to recover to its natural state; and • The use of anti-fouling paint might be minimised on subtidal surfaces, to encourage species colonisation on the structures.	Section 2.6.119 of NPS EN-3	Throughout this chapter
Where cumulative effects on subtidal habitats are predicted as a result of the cumulative effects of multiple cable routes, it may be appropriate for applicants for various schemes 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.	Section 2.6.120 of NPS EN-3	Section 10 of this chapter

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

- Guidelines for data acquisition to support marine environmental assessments of offshore renewable energy projects (Centre for Environment Fisheries and Aquaculture Science (Cefas) May 2012);
- Joint Nature Conservation Committee (JNCC) Marine Monitoring Handbook (Wyn & Brazier 2001);
- Guidance on the Assessment of Effects on the Environmental and Cultural Heritage from Marine Renewable Developments (Marine Management Organisation (MMO) *et al*. 2010);
- Guidance for the Conduct of Benthic Studies at Marine Aggregate Extraction Sites (Ware and Kenny 2011); and
- Guidelines for ecological impact assessment in Britain and Ireland (Institute of Ecology and Environmental Management (IEEM) 2010).

2.1.4. Due regard has also been given to the biodiversity considerations set out in EN-1 and EN-3, as well as the Marine Policy Statement (MPS).

2.2. Consultation

2.2.1. To inform the ES, Forewind has undertaken a thorough pre-application consultation process, which has included the following key stages:

- Scoping Report submitted to the Planning Inspectorate (May 2012);
- Scoping Opinion received from the Planning Inspectorate (June 2012);
- First stage of statutory consultation (in accordance with sections 42 and 47 of the Planning Act 2008) on Preliminary Environmental Information (PEI) 1 (report published May 2012); and
- Second stage of statutory consultation (in accordance with sections 42, 47 and 48 of the Planning Act 2008) on the draft ES designed to allow for comments before final application to the Planning Inspectorate.

2.2.2. In between the statutory consultation periods, Forewind consulted specific groups of stakeholders on a non-statutory basis to ensure that they had an opportunity to inform and influence the development proposals. Consultation undertaken throughout the pre-application development phase has informed Forewind's design decision making and the information presented in this document. Further information detailing the consultation process is presented in **Chapter 7 Consultation**. A Consultation Report is also provided alongside this ES, as part of the overall planning submission.

2.2.3. A summary of the consultation carried out at key stages throughout the project, of particular relevance to marine and intertidal ecology is presented in **Table 2.2**. This table only includes the key items of consultation that have defined the assessment. A considerable number of comments, issues and concerns raised during consultation have been addressed in meetings with consultees and hence have not resulted in changes to the content of the ES. In these cases, the issue in question has not been captured in **Table 2.2.** A full explanation of how the consultation process has shaped the ES, as well as tables of all responses received during the statutory consultation periods, is provided in the Consultation Report.

Table 2.2 Summary of key consultation and issues raised by consultees

Date	Consultee	Summary of issue	ES reference
December 2013 (Section 42 consultation on the draft ES, statutory)	JNCC/ Natural England	Section 3.5.12 (p. 81) Disposal of seabed preparation and drilling spoil arisings: Natural England notes that "*It is proposed that any spoil arisings generated by seabed preparation or drilling would be disposed of within the project area; near the location the material was derived. The spoil materials will then be winnowed away by the natural wave and tide driven processes*". Natural England would like further justification to be provided for this statement, as the potential for such side cast mounds to winnow away has not always proven to be realistic from the past experiences of other offshore wind farms (in addition please see comment 32, in relation to section 6.3.6).	Section 6.2
December 2013 (Section 42 consultation on the draft ES, statutory)	JNCC/ Natural England	Natural England advises that where cobbles (and boulders) have been identified, detailed pre-construction surveys should be undertaken to categorise the habitat and inform decisions on cable micro-siting.	Section 6.9.6
December 2013 (Section 42 consultation on the draft ES, statutory)	JNCC/ Natural England	JNCC has outstanding concerns regarding the sensitivity assessments, the biotope mapping which underpins the assessments and some of the conclusions drawn.	Section 3.3
December 2013 (Section 42 consultation on the draft ES, statutory)	JNCC/ Natural England	68. Section 4.4.15-16 (p.57) Cobble reef: It is not clear from these paragraphs if cobble reef was identified on the cable route. Natural England suggests that further clarification is provided to support the assessment.	Section 4.4.15
December 2013 (Section 42 consultation on the draft ES, statutory)	JNCC/ Natural England	69. Section 4.4.15-16 (p.57) Cobble reef: This paragraph states that „The trough areas within the cSAC will occasionally reveal an underlying cobble base and that this may shift according to the movement of the sand". Natural England requires further clarity on the evidence for this statement and clarification on the word „occasionally". Do these troughs extend onto the cable route and if so what is the likelihood that further Annex I habitat may be revealed before construction?	Section 4.4.16 to 4.4.18

Date	Consultee	Summary of issue	ES reference
December 2013 (Section 42 consultation on the draft ES, statutory)	JNCC/Natural England	70. Section 4.4.25 (p.58) Marine Conservation Zones (MCZs): The SNCB can confirm that DEFRA announced the designation of 27 Marine Conservation Zones on 20th November 2013. Of the 27 sites Swallow Sands and North East of Farnes Deep were designated as Marine Conservation Zones. We note that two Recommended Marine Conservation Zones (rMCZ"s)are located within the Dogger Bank Teesside A & B study area, the Compass Rose rMCZ, and the Runswick Bay rMCZ. We welcome the inclusion of these rMCZ"s in the assessment but have outstanding concerns regarding the potential impact the Teesside developments could have on these sites. These sites (as well as any others potentially affected by the Dogger Bank projects) should be given due consideration in any future assessments.	Section 6.8.7 to 6.8.12
December 2013 (Section 42 consultation on the draft ES, statutory)	JNCC/ Natural England	71. Section 4.14-4.18 (p.58) Measuring bar scale: Natural England can find no reference to the measuring bar scale on the drop down video stills (cm, inch?) Please confirm so that substrate sizes can be identified.	Section 3.2.18
December 2013 (Section 42 consultation on the draft ES, statutory)	JNCC/ Natural England	72. Table 5.1 (p.74) Habitat loss via export cable corridor cable protection: Natural England requires clarification on the loss of habitat via export cable protection. Is this suggesting that the worst case scenario is for protection of the full length of the cable as per page 78 Chapter 9? If so, Natural England question how realistic this is.	Table 5.1
December 2013 (Section 42 consultation on the draft ES, statutory)		74. Section 6.3.7 (p.86): Natural England requires further clarity on the phrase „near the coast" when describing suspended sediment concentration.	Section 6.3.7
December 2013 (Section 42 consultation on the draft ES, statutory)		75. Section 6.8.7-6.8.11 and Table 6.6 (p.97): This chapter needs updating based on the designation of 27 MCZ"s by DEFRA in November 2013.	Section 6.8.7

Date	Consultee	Summary of issue	ES reference
December 2013 (Section 42 consultation on the draft ES, statutory)	JNCC/Natural England	76. Section 6.9 (p.99) Monitoring of construction phase impacts: Natural England and JNCC are pleased to note that Forewind has plans to implement pre and post construction monitoring of marine ecological habitats and would expect to be consulted on these.	Section 6.9
December 2013 (Section 42 consultation on the draft ES, statutory)	JNCC/Natural England	77. Section 7.6 (p.98) Introduction of new habitats in the form of foundation structures, leading to potential colonisation: JNCC and Natural England are pleased to see consideration has been given to invasive species and the potential „stepping stone" impact of the introduction of hard substrate is included. It would be useful to ensure that the post construction monitoring of the benthic ecology pays particular attention to any changes in benthos. We would like to be consulted on any results in the future. As previously advised for the Dogger Bank Creyke Beck Project (please see Relevant Representation submitted 08/11/13) we would like Forewind to also consider its role in introducing invasive species into the environment through alternative pathways, for example in- in ballast water.	Section 7.6.14 to 7.6.15 Section 7.10.1
December 2013 (Section 42 consultation on the draft ES, statutory)	JNCC/Natural England	79. Section 10.7 (p.136) Cumulative impacts of the introduction of hard substrates in form of foundations/scour & cable protection into a mainly sedimentary environment: Section 10.7.2 concludes that the introduction and colonisation of new species would be unlikely on the basis of shipwrecks. Section 10.7.3 subsequently concludes that no form of cumulative impact between different projects is predicted. Natural England and JNCC do not consider these conclusions to be justified as the increased activity in the area along with the connectivity provided between operating windfarms would greatly increase such risk of introduction. As previously mentioned Forewind should also consider the chances of invasive species introduction through other pathways such as ballast water.	Section 7.6.14 to 7.6.15 Section 10.7.3
December 2013 (Section 42 consultation on the draft ES, statutory)	JNCC/Natural England	81. We have outstanding concerns regarding the biotope mapping presented in Chapter 12, Appendix D Tranche B Habitat Mapping Report and how it has been used in the ES, and the Information to inform the Appropriate Assessment.	Comments noted – however we need more information on these outstanding concerns before they can be addressed.
December 2013 (Section 42 consultation on the draft ES, statutory)	JNCC/Natural England	82. We have outstanding concerns regarding the cable route assessment and welcome further discussions with Forewind in the future.	Comments noted – however we need more information on these outstanding concerns before

Date	Consultee	Summary of issue	ES reference
			they can be addressed.
December 2013 (Section 42 consultation on the draft ES, statutory)	JNCC/Natural England	83. JNCC and Natural England note that in Chapter 12, Appendix A, Tranche B and Export Cable Corridor Benthic Survey Report that a stony reef assessment was conducted. Using the guidelines set out in Irving (2009) and Limpenny *et al.* (2010) two transects which could be classified as containing medium resemblance to stony reef were identified (Transects TB_TRAN_07 & TB_TRAN_09. Other transects were identified as having low resemblance to stony reef. This requires further consideration, and we would like further discussions with Forewind over these findings.	Section 4.4.15 to 4.4.18
December 2013 (Section 42 consultation on the draft ES, statutory)	JNCC/Natural England	84. JNCC notes that in Chapter 12, Appendix A, Benthic survey – Gardline biotope mapping was conducted. JNCC has outstanding questions regarding its use in the draft ES.	Section 3.2.38
December 2013 (Section 42 consultation on the draft ES, statutory)	JNCC/Natural England	85. JNCC notes that in some stations high numbers of brittle stars (*Ophrophrix*) and sea pens and the oceanic quahog *Artica islandica* were found. These species are listed on the OSPAR List of Threatened and/or Declining Species and Habitats (Region II North Sea and Region III – Celtic Sea) and we would like further discussions with Forewind over these findings	Comments noted
December 2013 (Section 42 consultation on the draft ES, statutory)	JNCC/Natural England	86. JNCC notes that further surveys and tests may be required before construction to provide a more detailed understanding of the characteristic biota and substrate composition within the project areas (Chapter 5, 6.2). Whilst we accept that these surveys will be required for environmental engineering purposes they may have the potential to impact on the marine environment. We would welcome further consultation with Forewind over the specific nature of these surveys.	Section 6.2.18
December 2013 (Section 42 consultation on the draft ES, statutory)	JNCC/Natural England	87. JNCC would like confirmation that disturbance in the temporary work areas, as outlined in Chapter 5, have been incorporated into the relevant receptor assessments, and have been included in the VER calculations.	Section 6.2.1

Date	Consultee	Summary of issue	ES reference
December 2013 (Section 42 consultation on the draft ES, statutory)	JNCC/Natural England	89. JNCC notes that if given consent, it is proposed that benthic monitoring is undertaken (Chapter 12, 6.9). We welcome this and would like to work with Forewind to develop appropriate monitoring plans.	Section 6.9.7
December 2013 (Section 42 consultation on the draft ES, statutory)	JNCC/Natural England	91. As per our advice regarding the Creyke Beck projects (see Section 42 submitted 10/06/13 and our Relevant Representation submitted 08/11/13) JNCC has outstanding concerns over how sensitivity has been assessed for Teesside A & B	Comments noted
November 2013 (Section 42 consultation on the draft ES, statutory)	MMO	a. The camera system and rationale employed for the drop down video survey (described is sections 3.2.16 to 19) is fit for purpose and conforms to currently accepted best practice guidance. However, no details are provided in relation to the scaling devise in the video or still images. It appears from the supporting still images provided in Appendix D that a scaling device was employed. Please provide clarification regarding the scaling devise used.	Section 3.2.18
November 2013 (Section 42 consultation on the draft ES, statutory)	MMO	Section 3.2.27 provides details of the Day grab sampling for contaminants and states that “Grab samples deemed acceptable for chemical analyses were photographed and described prior to sub-sampling. All containers were thoroughly washed with appropriate solvents and labelled externally prior to use”. Details are required in relation to the solvent used for rinsing of the glass storage jars. It may be appropriate that further confirmation is obtained from a Cefas sediment contaminant specialist to advise on the adequacy of methods employed for seabed sediment sampling and analysis for the contaminants listed in section 3.2.32 once these details have been supplied.	Section 3.2.27
November 2013 (Section 42 consultation on the draft ES, statutory)	MMO	Sections 6, 7 and 8 of Chapter 12 provide an assessment of the impacts during construction, operation and decommissioning. The rationale adopted for the purpose of the Environmental Impact Assessment (EIA), namely assessment of likely significance of impacts on Valued Ecological Receptors (VERs) based on the perceived sensitivity of their characteristic faunal communities, is underpinned by currently accepted methods, which have been applied for EIAs across a variety of marine developmental sectors. However, the true spatial impact of physical loss of the habitats identified to be present within the site will not be known prior to decisions on ‘micro-siting’ of given turbines within the individual tranches and across the zone as a whole, along with decisions on which foundation types are to be used. For example, it may be that spatial loss of habitat is spread relatively evenly across all habitats identified within the site. However, where relatively small, localised patches of a given habitat exist within the site, the proposed	6.2.19 to 6.2.23

Date	Consultee	Summary of issue	ES reference
		development may result in a disproportionate loss of such spatially restricted features. We welcome the opportunity to review the more detailed proposed survey design intended for future monitoring of impacts at the earliest opportunity.	
June 2012 (Scoping)	MMO	Request to be consulted on the more detailed proposed survey designs, sample collection protocols and sample processing protocols prior to the surveys being mobilised.	Section 3.2
June 2012 (Scoping)	Secretary of State	Clarification of the presence of the Annex 1 habitat reef should be provided in the ES. If the reef is present, a full assessment of the impacts on the reef should be carried out.	Section 4.4
June 2012 (Scoping)	Secretary of State	The impacts of the scour protection works on marine ecology should be carefully assessed and should consider the effects of seabed disturbance, increased suspended sediments and smothering, changes to water quality, accidental release of contaminants, and the noise and vibration disturbance during the construction phase and maintenance works of the proposed development.	Section 7.1 to 7.7
June 2012 (Scoping)	JNCC/Natural England	Biodiversity Action Plan Priority Habitats should be identified within the ES	Section 4.4
June 2012 (Scoping)	JNCC/Natural England	"*Temporary Loss of Intertidal Habitats*", may occur within designated sites, or have the potential to affect designated sites or their interest features, therefore the loss should be assessed considering area of loss, recovery period and effects upon the intertidal and the ecology and interest features it supports. The ES would also benefit if collected survey data was presented and discussed in relation to far-field regional data to set the site specific data into context.	Section 6.6
June 2012 (Scoping)	JNCC/Natural England	"*Loss of Subtidal Habitats*", Scoping Report states that the installation of turbine foundations, scour protection and ancillary structures will cause direct physical disturbance. We highlight that the installation of these structures will also lead to direct loss of sediment habitat. Any loss should be assessed considering area of loss, and effects upon the subtidal habitat and the ecology and interest features it supports.	Section 7.1
June 2012 (Scoping)	JNCC/Natural England	Scoping Report stated that maintenance activities will have a short-term localised impact upon intertidal habitats. Detail on the realistic requirements for maintenance operations should be provided in the ES along with an assessment of their potential impacts considering area of loss, recovery period, frequency of disturbance and effects upon the intertidal, and subtidal, and the ecology and interest features it supports. Experience from other developments has shown that whilst cabling activities were considered as a one off activity and maintenance impacts considered temporary, they have rarely been this in reality with many developments needing to undertake further remedial works to replace, repair, rebury or add additional scour protection at a point in the future, when the best environmental options are limited.	Section 7.2
June 2012 (Scoping)	JNCC/Natural England	Impacts on subtidal ecology as a result of changes in physical processes, identifies the effects of foundation structures, but should be extended to include all other infrastructure (e.g. collector substations, converter stations, platforms, moorings etc.) and scour protection on the foundations and cables. The impacts of maintenance should also be included.	Section 7.3 – 7.5

Date	Consultee	Summary of issue	ES reference
June 2012 (Scoping)	JNCC/Natural England	Detailed consideration should be given to operational and maintenance effects, identifying all works required and their frequency. The assessment should identify and assess the impacts of all maintenance activities, such as the addition or removal of scour protection; increased noise from maintenance works etc., and should not restrict this to pollution incidents	Section 7.2
June 2012 (Scoping)	JNCC/Natural England	Impact on subtidal ecology as a result of electromagnetic fields, identifies a lack of evidence regarding the effects of electromagnetic fields upon the benthic community and therefore proposes to scope this topic out of the Environmental Impact Assessment (EIA). Due to this lack of knowledge about impacts, this topic should be scoped into the EIA. High Voltage Direct Current (HVDC) is a new technology and the topic will require further assessment or monitoring and the approach consulted upon in more detail in the early stages of the EIA.	Section 7.7
June 2012 (Scoping)	JNCC/Natural England	The assessment should identify changes in the natural substrate by introduced structures, foundations and scour protection. This should include potential positive and negative impacts through increasing biodiversity; introduction of species and creation of habitat for species that would not naturally occur in that region; and facilitation of the spread of non-native species. The wider effects of this upon the ecological functioning of the surrounding sedimentary habitats should also be addressed	Section 7.6
June 2012 (Scoping)	JNCC/Natural England	Disturbance to intertidal habitats (Decommissioning) identifies the intention to leave cables in situ in the intertidal. This proposal should be considered in detail within the ES and encompass on-going coastal changes, coastal retreat and beach/seabed lowering. The potential for exposure of the cables and effects upon coastal processes as well as the requirement for later protection or removal of the cables should be included. The ES must consider the potential need for a monitoring plan for exposure, or effects upon the coastal processes caused by cables, over the lifetime of the project and if left permanently in situ.	Section 8.3
June 2012 (Scoping)	JNCC/Natural England	Decommissioning impacts upon subtidal ecology should also consider the potential impacts upon habitat and species that have developed and been supported by these structures.	Section 8.2
June 2012 (Scoping)	JNCC/Natural England	Cumulative Impacts should also consider the cumulative effects within the project that is the potential for a number of various activities or structures from the project to combine to have an adverse impact, rather than assessing each activity or structure independently.	Section 10

3. Methodology

3.1. Study area

3.1.1. Dogger Bank Teesside A & B lies within the overall Dogger Bank Zone which is located approximately 125km off the east coast of England in the southern North Sea (**Figure 4.1**). All of the Dogger Bank Teesside A site and the majority of Dogger Bank Teesside B site are located within part of the zone defined as Tranche B, with a small part of Dogger Bank Teesside B located within the part of the zone defined as Tranche A.

3.1.2. The project-specific survey work undertaken for the Dogger Bank Teesside A & B EIA focussed on Tranche B. However, data from Tranche A of relevance to the section of the Dogger Bank Teesside B project area that lies within this area has also been used to inform this assessment (data for Tranche A was collected to inform the EIA for Dogger Bank Creyke Beck).

3.1.3. The study area also comprises the Dogger Bank Teesside A & B Export Cable Corridor from where it exits the Dogger Bank Zone to landfall near Marske-by-the-Sea. The cable corridor study area includes the intertidal area between Mean Low Water Springs (MLWS) and Mean High Water Springs (MHWS). Specific survey extents are described in Section 3.2.

3.1.4. The area above MHWS is considered in **Chapter 25 Terrestrial Ecology**.

3.2. Characterisation of existing environment – methodology

Desk study

3.2.1. A desk study of available information was undertaken both to inform the initial survey design and to provide regional characterisation information for the assessment.

3.2.2. Sources included, but were not limited to:

- Dogger Bank Zonal Characterisation (Second Edition) (Forewind 2011);
- Published and unpublished literature;
- Marine Life Information Network (MarLIN);
- The Mapping European Seabed Habitat (MESH) project;
- Dogger Bank SAC Selection Assessment (JNCC 2012); and
- Consultation responses (Section 2).

Site specific surveys

3.2.3. A number of site specific surveys were commissioned to characterise the existing environment for marine and intertidal ecology. The following sections give a brief description of the methodologies used during the surveys; full details are available in the corresponding survey reports (**Appendices 12A– 12H**). The scope and specification of all surveys were subject to consultation with stakeholders, as previously identified in **Table 2.2**.

3.2.4. **Table 3.1** and **Figure 3.1** provide a summary of the surveys and reporting that has been conducted and how the outputs of each have contributed to the assessment process for marine and intertidal ecology.

Table 3.1 Summary of surveys and reporting

Date	Survey type / analysis	Contractor	Key outputs	Appendix
2011 /12	Geophysical Survey of Tranche B: side scan sonar, swath bathymetry, AGDS (Acoustic Ground Discrimination System)	Gardline Geosurvey Ltd. (GGL)	Geophysical data used to inform design of benthic grab sampling survey and in biotope classification	**N/A**
2012	Geophysical Survey of Dogger Bank Teesside Export Cable Corridor: side scan sonar, swath bathymetry, AGDS	GGL	Detailed survey to ascertain ground conditions along cable route	**N/A**
2012	Benthic grab sampling campaign of Tranche B and Dogger Bank Teesside A & B Export Cable Corridor,	Gardline Environmental Ltd. (GEL)	Sediment particle size (Particle Size Distribution (PSD) analysis) and benthic macrofaunal data (grab and DDV)	**Appendix 12A Tranche B and Export Cable Corridor Benthic Survey Report**
2012	Benthic grab sampling campaign of Tranche A and Dogger Bank Export Cable Corridor,	Emu Limited	Sediment particle size (Particle Size Distribution (PSD) analysis) and benthic macrofaunal data (grab and DDV)	**Appendix 12B Tranche A Benthic Survey Report**
2012	Intertidal and Phase 1 biotope survey of Teesside landfall	Institute of Estuarine Coastal Studies (IECS)	Biotope maps of intertidal region	**Appendix 12C Intertidal Benthic Survey Report**
2013	Tranche B Habitat Mapping Report	Envision	Biotope maps for Tranche B and wider Zone	**Appendix 12D Tranche B Habitat Mapping Report**

Date	Survey type / analysis	Contractor	Key outputs	Appendix
2012 /13	Nearshore fish surveys	Precision Marine Survey Ltd (PMSL)	Information on fish species in nearshore area of cable corridor	**Appendix 13C Nearshore Fish and Shellfish Surveys**
2011 /12	2m epibenthic beam trawl and otter trawl surveys across Dogger Bank Zone	Brown & May Marine (BMM)	Marine epibenthic macrofaunal data	**Appendix 13D Tranche A Fish and Shellfish Characterisation Surveys**
2012	Sandeel survey	BMM	Distribution of sandeels	**Appendix 13F Sandeel Survey Report**

Geophysical survey

3.2.5. Single beam, multibeam, side scan sonar, pinger, sparker and magnetometer data were collected by Gardline Geosurvey Limited across Tranche B over two periods; June to October 2011 and March to May 2012, using two vessels *MV L'Espoir* and the *MV Tridens1*.

3.2.6. The objectives of the survey were to gather accurate bathymetric data, gain information on the thickness and sediment cover of the seabed sediments and shallow geology, produce evidence for the on-going movement in seabed sediments, and provide information on any hazards or factors of operational significance for wind farm locations across the region.

3.2.7. Outputs from this survey were used by Envision to produce biotope maps of Tranche B. Full details of the survey specification and data outputs are presented in the Gardline survey report..

3.2.8. Gardline also carried out a geophysical survey of the Dogger Bank Teesside A & B Export Cable Corridor from the proposed Dogger Bank Offshore Wind Farm area to the landfall area south of Teesside. Although two cable corridors were surveyed (designated as a North cable corridor and a South cable corridor), the focus of this chapter is on data relevant to the southern cable route as this is the relevant cable corridor for Dogger Bank Teesside A & B (northern cable corridor is relevant to future Dogger Bank Teesside C & D projects). The main exception to this statement above is the section covering the outputs of macrofaunal data analysis as these outputs were done using a combined data-set from the two cable corridors (Dogger Bank Teesside A & B and Dogger Bank Teesside C & D). This approach is judged to be valid as the outputs of these benthic grab surveys across both Dogger Bank Teesside A & B and Dogger Bank Teesside C & D Export Cable Corridors have been used (along with data from the wider Zone and Tranches A and B) to inform the habitat mapping and biotope classification work undertaken by Envision (see "Biotope Classification Methodology" paragraphs 3.2.55 – 3.2.62 for more details). The same data was acquired for the cable corridors as for Tranche B.

3.2.9. Titan Environmental Surveys Ltd acquired data for the nearshore survey cable corridors from landfall to 10.5km offshore. *MV Ivero* and *MV Tridens1* completed the geophysical survey of the remainder of the cable corridors between 10.5km offshore and the location of the offshore substations within Tranche B.

Sublittoral survey

3.2.10. A benthic characterisation survey covering all of Tranche B and the associated Dogger Bank Teesside A & B Export Cable Corridor (and Dogger Bank Teesside C & D) route was carried out by GEL in 2012.

3.2.11. Survey work for the benthic characterisation survey of Tranche B was conducted during July 2012 onboard the *MV Vigilant* with the survey of the Dogger Bank Teesside Cable Corridor routes conducted during September and October onboard the *MV Vigilant* for the offshore section and during November on the *MV Titan Endeavour* for the inshore section of the route.

3.2.12. The overall objective of this survey was to collect data that would enable the subtidal benthic ecology of both Tranche B and the Dogger Bank Teesside Cable Corridor routes to be characterised. This data would then be used to inform the on-going EIA for Dogger Bank Teesside A & B and Dogger Bank Teesside C & D. The data collected from this survey have also been used to inform on-going, zone-wide characterisation studies.

3.2.13. The survey design was informed by work undertaken by Envision who reviewed and interpreted geophysical data from these areas in order to identify potentially different habitat types and then derive a sampling design based on the indicative habitat map.

3.2.14. As outlined above, for the parts of Dogger Bank Teesside B that lie within Tranche A, previous survey data from Tranche A collected as part of the Dogger Bank Creyke Beck A & B EIA were used to inform the final assessment (primarily the final habitat mapping and biotope classification work undertaken by Envision).

3.2.15. The benthic sublittoral survey comprised sampling via drop down video/camera, mini Hamon grab and Day grab. Details of each of these survey elements are provided below.

Drop down camera

3.2.16. Within Tranche B, a total of 55 stations were pre-selected by the client to undertake camera investigation of the habitat. Along the Dogger Bank Teesside A & B Export Cable Corridor routes, 120 stations were pre-selected for camera investigation.

3.2.17. Environmental seabed images were taken by means of a digital stills camera system with a dedicated strobe and video lamps, mounted within a stainless steel frame. Footage was viewed in real time via an umbilical assisting in the control of the digital stills camera. This allowed for shot selection, in the event that the system recorded a sediment change or feature at the seafloor.

3.2.18. A visual scale comprising black and white intervals of 10mm was attached to the video frame to enable the scaling and measuring of sediment sizes and key habitat features.

3.2.19. Data from the drop down video survey were used to ground truth the geophysical survey data collected over Tranche B and the Dogger Bank Teesside Cable Corridors and to also investigate the survey area for the presence of features of conservation importance such as biogenic reefs or stony/rocky reefs and sand banks in less than 20m of water. This data was also used to inform the habitat mapping process undertaken by Envision (see ‘biotope classification methodology’ section). Areas of high reflectivity identified from the geophysical data and areas of coarse sediment observed in seabed imagery were further investigated with camera transects in order to assess these areas for resemblance to potential stony reef.

3.2.20. A minimum of five seabed photographs were taken at each station using a hover and drift technique, separated by a time gap of approximately 5-10 seconds. This technique allowed the frame to move progressively along the seabed as the vessel traversed the work area on its thrusters or drifted. The images were captured remotely using the surface control unit and stored on the camera’s internal memory card. Video footage was overlaid with time, position and depth, and recorded directly onto VHS video and DVD.

Grab sampling

3.2.21. Within Tranche B, a total of 55 stations were pre-selected by the client to undertake grab sampling for particle size and faunal analyses, 11 of which were also to be sampled for contaminant analyses. Along the Dogger Bank Teesside A & B Export Cable Corridor route, 39 were selected for grab sampling for particle size and faunal analyses, including 9 stations for contaminant analyses.

3.2.22. A modified mini-Hamon grab was used to acquire one $0.1m^2$ sample at each station, with a sub-sample also taken for particle size analysis (PSA). One $0.1m^2$ grab sample was acquired at all but four of the 55 Tranche B sampling locations and three of the 39 Dogger Bank Teesside A & B Export Cable Corridor sampling locations. A Day grab was used to acquire two $0.1m^2$ samples at each station specified for contaminant sampling. Two $0.1m^2$ Day grab samples were acquired at all of the 11 Tranche B sampling locations and all of the nine Dogger Bank Teesside A & B Export Cable Corridor sampling locations.

3.2.23. For accuracy, the mini-Hamon grab was lowered to just above the seabed, then, using positioning information relayed from the surveyors on bridge, once directly over the target location the grab was lowered to the seabed and then quickly recovered. Positional fixes were captured immediately for each grab sample when the grab reached the sea floor.

3.2.24. On recovery of a mini-Hamon grab sample, the grab would first be examined for acceptability following strict quality assurance (QA) criteria. Brief descriptions of the collected sediments were made at the time of sampling. Sediment colour was determined using Munsell colour charts and recorded onto survey log sheets.

3.2.25. Sediment samples were thoroughly washed from the grab into a plastic tray. A subsample was taken using a plastic scoop for PSA analysis and subsequently transferred to an onboard freezer for storage at <-18°C. Once all of the equipment was washed free of sediment, the remaining sediment sample was transferred to a sieving machine where it was broken down using a low-powered seawater spray. All materials retained by the 1mm sieve were transferred to a squat jar or bucket by means of a scoop and funnel, making sure that none of the sample was lost or trapped in the mesh. The sample was fixed with a <20% formalin solution of known concentration, and buffered with borax, then subsequently diluted to a final concentration of approximately 4% formalin. Biological samples were placed in 1 litre polypropylene screw-top squat jars, 5- or 10-litre buckets, depending on sample size, and provided with an additional internal waterproof label.

3.2.26. Benthic macrofaunal identification was undertaken by Marine Ecological Surveys Ltd (MESL), Bath, UK who participate in the National Marine Biological Analytical Quality Control (NMBAQC) scheme.

3.2.27. With respect to Day grab sampling for contaminants, prior to deployment at any station the Day grab was thoroughly washed down using a diluted solution of Decon 90 to prevent hydrocarbon cross contamination. Positional fixes were taken for each grab sample immediately following the grab reaching the sea floor and grab samples were examined following the same strict QA criteria as per the mini Hamon grab methodology.

3.2.28. Grab samples deemed acceptable for chemical analyses were photographed and described prior to sub-sampling. The chemical analysis grab samples were then transferred to glass jars which were supplied sealed and ready to use by the analytical laboratory, NLS. NLS participates in the contaminated land scheme (CONTEST) and Aquacheck schemes administered by the Laboratory of Government Chemists (LGC) and take part in the Quasimeme proficiency testing scheme and in sediment sample exchange and organic parameters (SETOC).

3.2.29. All chemical sub-samples were kept frozen and biological samples stored at room temperature. Contaminant samples from each station were then sent frozen, in cool boxes kept cool with ice packs, along with biological samples, to their respective analytical sub-contractors.

Particle size distribution analysis

3.2.30. PSA was undertaken in-house by GEL based on BS1377: Parts 1-3: 1990 (dry sieving). Sediments were homogenised and a sub-sample sample dried to constant weight. The sample was then weighed and wet sieved to 63μm under running water. The retained material was dried then separated using nested stainless-steel sieves with a range of mesh apertures from 63mm to 63μm into a clean receiver. Each size fraction was weighed and the weights expressed as a percentage of the weight of the total sub-sample.

3.2.31. Using a second sub-sample, sediment particle size distributions below 63μm were determined using a Malvern Mastersizer 2000 particle sizer. No dispersants were used and the sediment was not treated to remove carbonates or organic matter prior to analysis.

3.2.32. The sediments were classified, statistics calculated and log sheets produced using the GRADISTAT program (Blott and Pye 2001). The sediment samples were also classified within GRADISTAT using the modified Folk triangle classification, which uses the sand:mud ratio and the percentage of gravel. It should be noted that GRADISTAT defines sediment with any trace of gravel as 'slightly gravelly'. This is in contrast with the traditional Modified Folk triangle which requires a minimum of 1% gravel to define 'slightly gravelly' sediment, but is consistent with the previous Dogger Bank OWF Benthic Ecology Characterisation Report (EMU 2012).

Contaminant analysis

3.2.33. Samples collected via the Day grab were analysed for the following contaminants;

- Hydrocarbons;
- Polychlorinated biphenyls (PCBs);
- Organotins;
- Metals; and
- Metalloids and non-metals.

3.2.34. Sediment hydrocarbon, metals, organotin, selenium, boron, PCB and total organic carbon (TOC) analyses were carried out by the National Laboratory Service (NLS) of the Environment Agency, Leeds, UK.

Statistical Analysis

3.2.35. Univariate community analyses of the macrofaunal data collected via the mini Hamon grab survey were undertaken by GEL using the PRIMER version 6 (Clarke and Warwick 2006) software package. In addition to univariate analyses, the data were also subjected to multivariate analysis using a number of different methods available within the PRIMER v6 package.

3.2.36. The following univariate analyses were undertaken on the macrofaunal data:

- Shannon-Wiener Diversity Index;
- Simpson's Dominance Index; and
- Pielou's Evenness.

3.2.37. The following multivariate analyses were undertaken on the macrofaunal data:

- Cluster Analysis and SIMPROF;
- Ordination Analyses using non-Metric Multidimensional Scaling;
- SIMPER; and
- RELATE.

3.2.38. The outputs from this statistical analysis enabled key characteristics of sublittoral benthic communities within Tranche B and the Dogger Bank Teesside A & B Export Cable Corridor to be identified. Although GEL identified provisional biotopes based on the outputs of the data analysis, the final classification of biotopes across the study area was undertaken by Envision.

3.2.39. Envision undertook further analysis of the benthic data from Tranche B and the Dogger Bank Teesside A & B Export Cable Corridor that involved combining all available benthic and geophysical data from all surveys across the zone to date, i.e. Tranche A and the wider Dogger Bank Zone.

3.2.40. The underlying rationale of this approach is to ensure that data from the different areas within the overall Dogger Bank Zone can support the interpretation of adjacent areas and improve the performance/accuracy of the habitat maps. The benefit of re-analysing the data in this way is so that there is a continuum in the analysis across the Zone Wide areas and Dogger Bank Teesside A & B Export Cable Corridors to obtain a synoptic view of the biota throughout the areas of interest.

3.2.41. Further details of this final stage of the benthic data analysis are provided below under the ‘biotope classification methodology’ sub-heading.

Trawl surveys

3.2.42. In addition to the benthic grab and drop down video surveys, a series of fish ecology surveys across Tranche B and the Dogger Bank Teesside A & B Export Cable Corridor were undertaken by BMM and PMSL.

3.2.43. A commercial scraper otter trawl with a 130mm mesh cod end was used for sampling at all sampling stations, and at most of those along the export cable. A commercial rock-hopper otter trawl with a 130mm mesh cod end was used for sampling at stations OT13 to OT18 due to the presence of hard ground and large boulders on the seabed. A 2m scientific beam trawl with a 5mm cod end was also used.

3.2.44. Data from these surveys included epibenthic species composition and abundance, in addition to data on fish species. Epibenthic data from these trawl surveys have been used alongside data from the drop down video surveys to inform the benthic characterisation of Tranche B and the Dogger Bank Teesside A & B Export Cable Corridor.

Intertidal survey

3.2.45. An intertidal walkover survey was undertaken by the IECS to characterise the communities present at the landfall site, and to identify any species or habitats of national or international conservation importance for the purpose of the EIA.

3.2.46. Six transect lines were placed approximately 500m apart for the entire length of the survey site, with a grid of sampling stations evenly distributed along the transect lines, at upper, middle and lower shore locations.

3.2.47. The survey was undertaken in a single deployment on 17 – 19 September 2012, during spring tides in order to maximise the extent of the intertidal area exposed at low tide. Mapping was carried out according to the Common Standards Monitoring Guidance littoral sediment and Procedural Guideline 3.1 of the JNCC Marine Monitoring Handbook (Wyn and Brazier 2001).

3.2.48. At each distinct habitat along each transect, the nature of the substratum (including the depth of the redox potential discontinuity) was recorded together with the surface features and dominant species. These details were recorded using the standard Marine Nature Conservation Review (MNCR) forms (survey, habitat and site). Recording of such features took place where notable changes in the substratum (e.g. sediment type or surface features such as standing water, ripples etc.) occurred and where there was a notable change in biological surface features (e.g. tubes, casts, feeding pits, faecal mounds) which may indicate a change in species composition.

3.2.49. The density of conspicuous organisms (e.g. *Arenicola marina*) was estimated by counting the number of surface features / m^2 (casts, surface siphon holes etc.). The density of less conspicuous characterising species such as bivalves was estimated by digging a $1m^2$ area (or 0.1 m^2 if densities are high). At each site, two spade loads of sediment (as indicated by Wyn & Brazier 2001), dug to a depth 15-20cm, were sieved through a 0.5 mm mesh and the infaunal organisms identified. All holes were back-filled after sampling. This resulted in 41 samples being collected, sorted in the field and the specimens inspected and then stored in 70% Industrial Methylated Spirits (IMS) for further analysis in the laboratory.

3.2.50. A rapid *in situ* analysis of the sediment particle size was undertaken within each distinct biotope. The sediment was visually compared to pre-sieved samples prepared in accordance with the Wentworth Scale.

3.2.51. The geographic position of all sample locations and biotope boundaries were recorded using handheld Differential GPS (DGPS) to an accuracy of 1m. Target notes on any supplementary information (other than in MNCR forms) that could prove useful when interpreting maps of the area were taken in survey log books, and digital images were taken of the sediment surface, characteristic species and features to enable geo-referencing.

3.2.52. In addition to sediment and biotope analysis, samples were required to assess contaminant levels in the sediment. Three samples were taken from three different transects, one each from the upper shore, middle and lower shore locations. Sampling procedure for the contaminant analysis followed those outlined in the Clean Seas Environment Monitoring Programme (CSEMP) Green Book. Surface sediment samples were collected using a clean plastic 6cm internal diameter corer, which was washed with clean seawater between each sample collection.

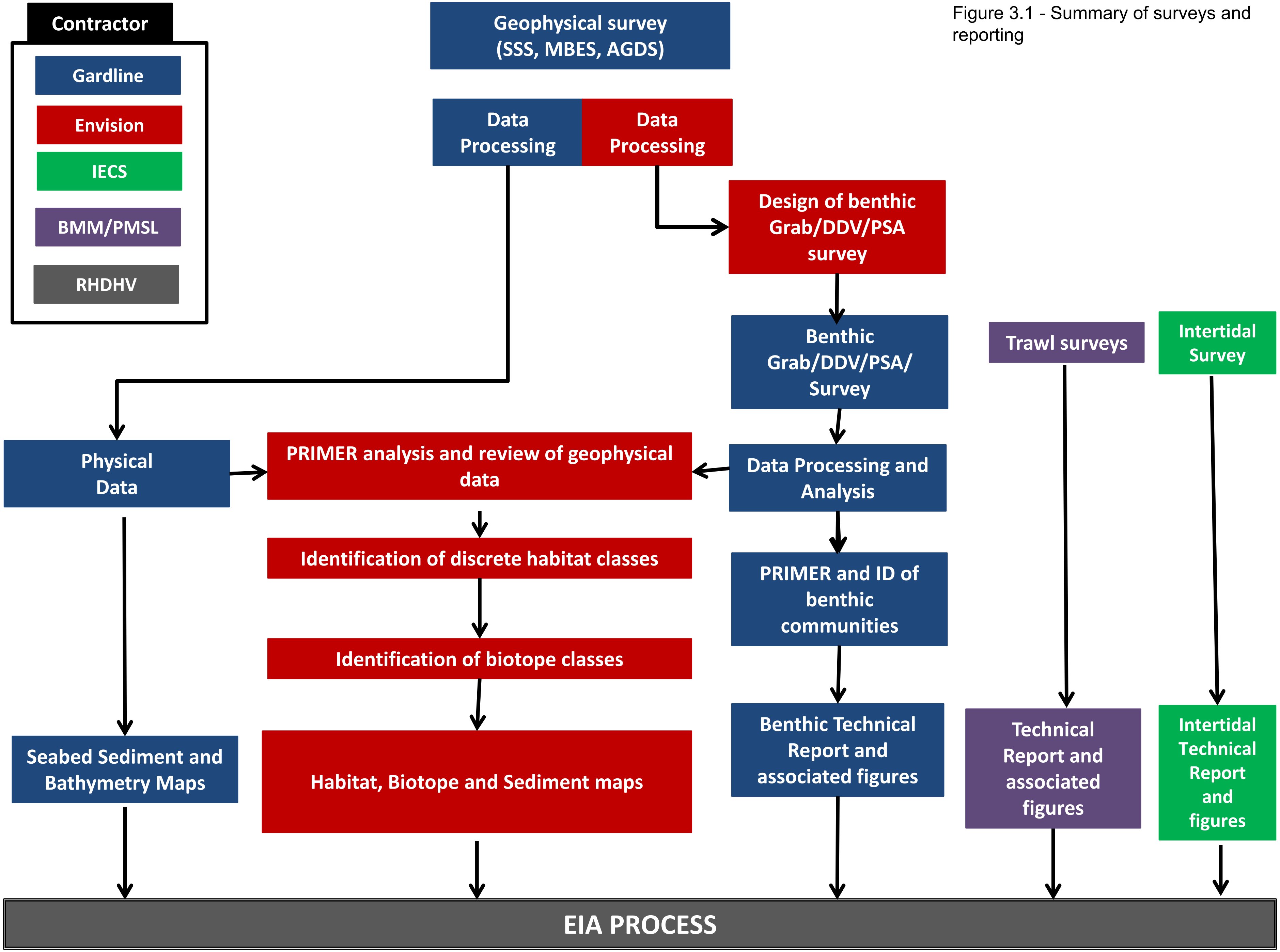
3.2.53. Notes on sediment characteristics, presence or absence of anoxic layering, presence or absence of algae, and distinguishing surface features were made for each sample. Digital images were also taken, incorporating the location of sample and scale bar for future reference.

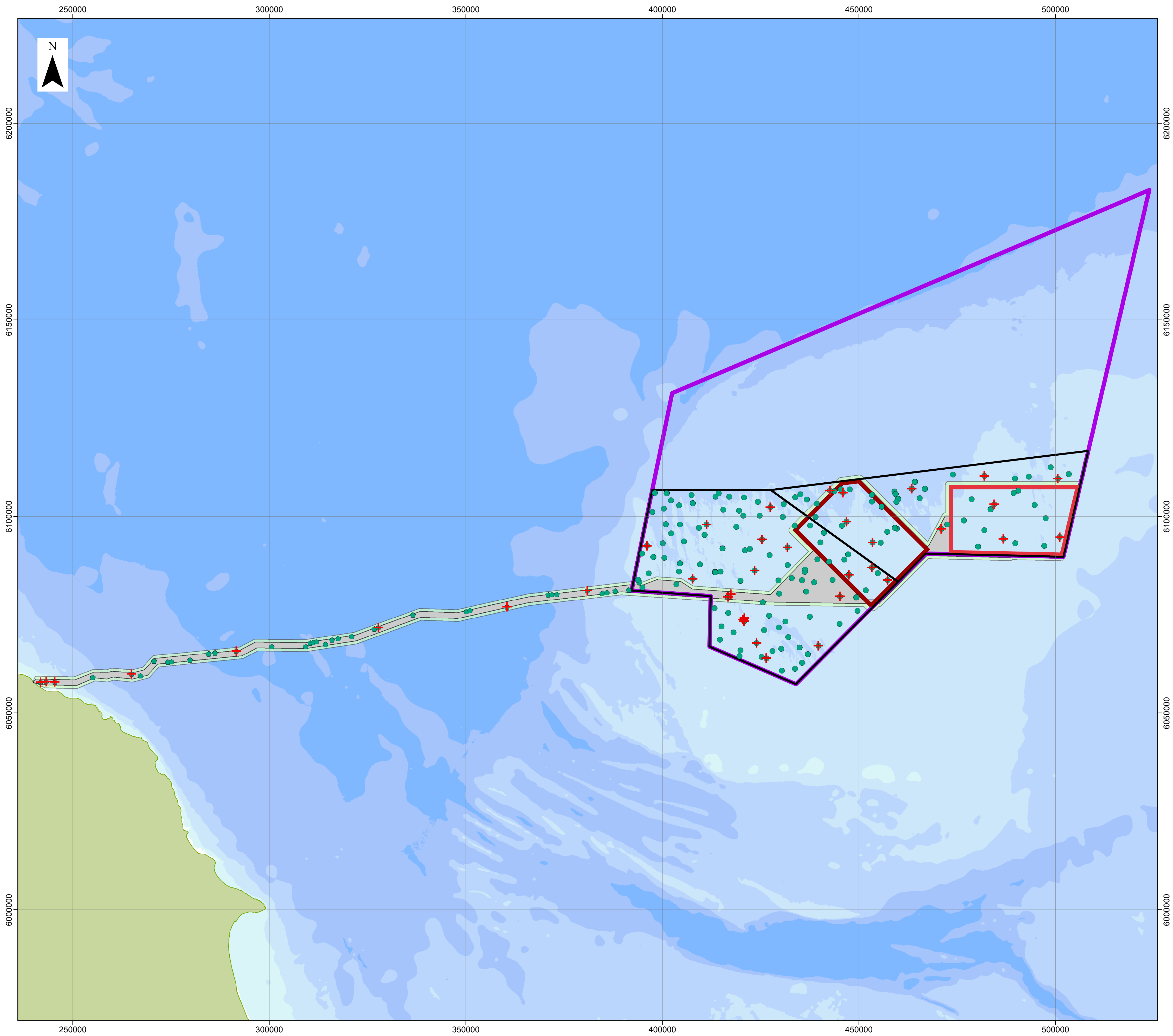
3.2.54. All contaminant samples were stored in appropriate containers pre-provided by the NLS. These were kept chilled during the survey, transferred to the IECS cold room at the earliest opportunity, and remained chilled until collected and analysed by the NLS.

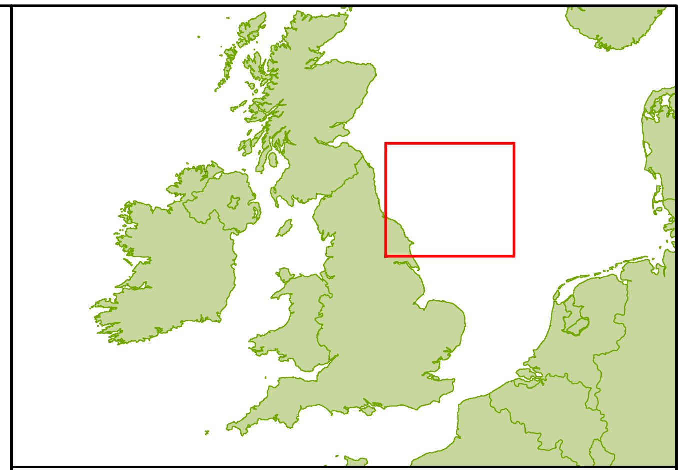
3.2.55. A total of 41 samples were collected along the six transects. Once transported to the laboratory, the infaunal specimens were removed from the IMS, in accordance with H&S procedures, and processed. Macrofauna were identified to species level were possible using standard taxonomic keys, low and high power stereoscopic microscopes and dissection (where applicable).

3.2.56. All species taxonomic names were standardised to match those currently accepted on the World Register of Marine Species (WoRMS) website. A photographic reference collection was compiled, identifying the dominant species within each biotope, as well as those with importance to nature conservation (listed in UK Biodiversity Acton Plan (UK BAP) or Annex 1 of Habitats Directive).

Figure 3.1 - Summary of surveys and reporting







LEGEND

- Dogger Bank Zone
- Tranche boundary
- Dogger Bank Teesside A
- Dogger Bank Teesside B
- Dogger Bank Teesside A & B Export Cable Corridor
- Temporary works area
- Chemical sample site
- Grab sample site

0 10 20 40
Kilometres

Data Source:
Sediment Samples © Gardline, 2012
Background bathymetry image derived in part from TCarta data © 2009

PROJECT TITLE

DOGGER BANK TEESSIDE A & B

DRAWING TITLE

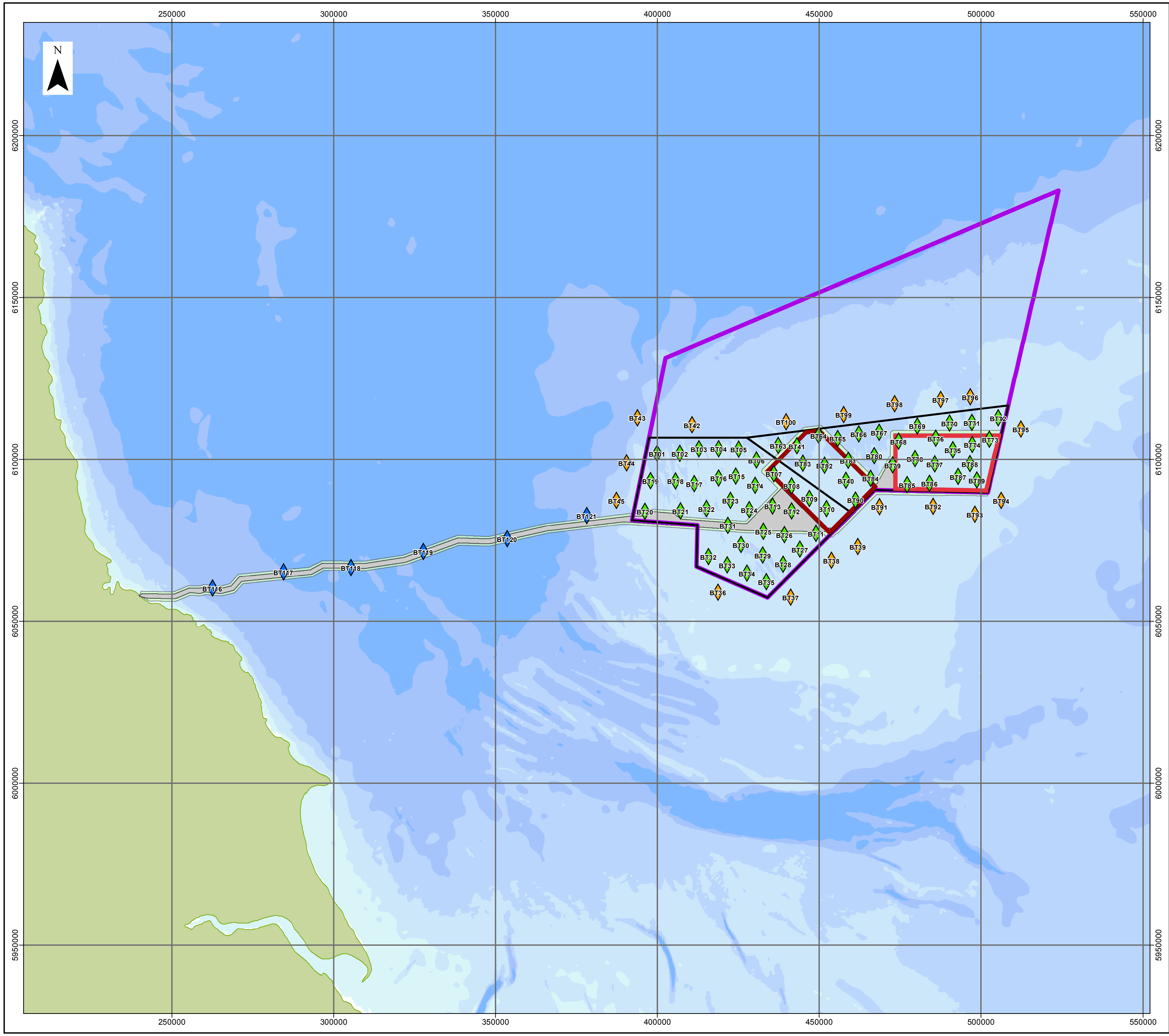
Figure 3.2 Benthic sampling stations

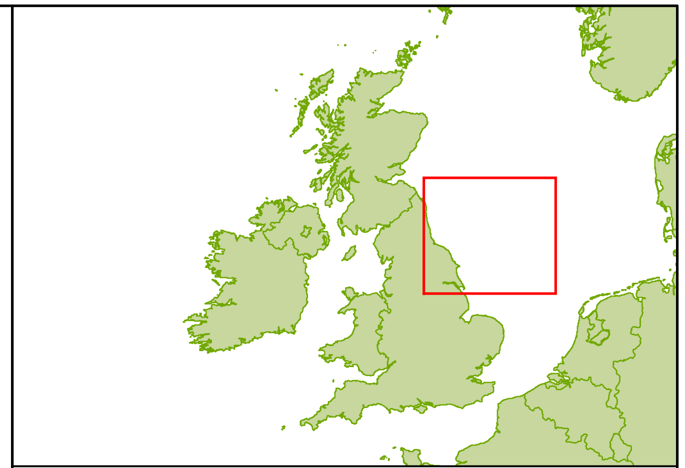
VER	DATE	REMARKS	Drawn	Checked
1	23/05/2013	Draft	LW	RZ
2	03/10/2013	PEI3	JE	RZ
3	07/02/2014	DCO Submission	JE	RZ

DRAWING NUMBER: **F-OFL-MA-200**

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

FOREWIND





LEGEND

- Dogger Bank Zone
- Tranche boundary
- Dogger Bank Teesside A
- Dogger Bank Teesside B
- Dogger Bank Teesside A & B Export Cable Corridor
- Temporary works area

Beam survey locations

- Export cable corridor
- Control
- Tranche A & B

0 10 20 40
Kilometres

Data Source:
Survey Locations © Brown & May Marine, 2013
Background bathymetry image derived in part from TCarta data © 2009

PROJECT TITLE

DOGGER BANK TEESSIDE A & B

DRAWING TITLE

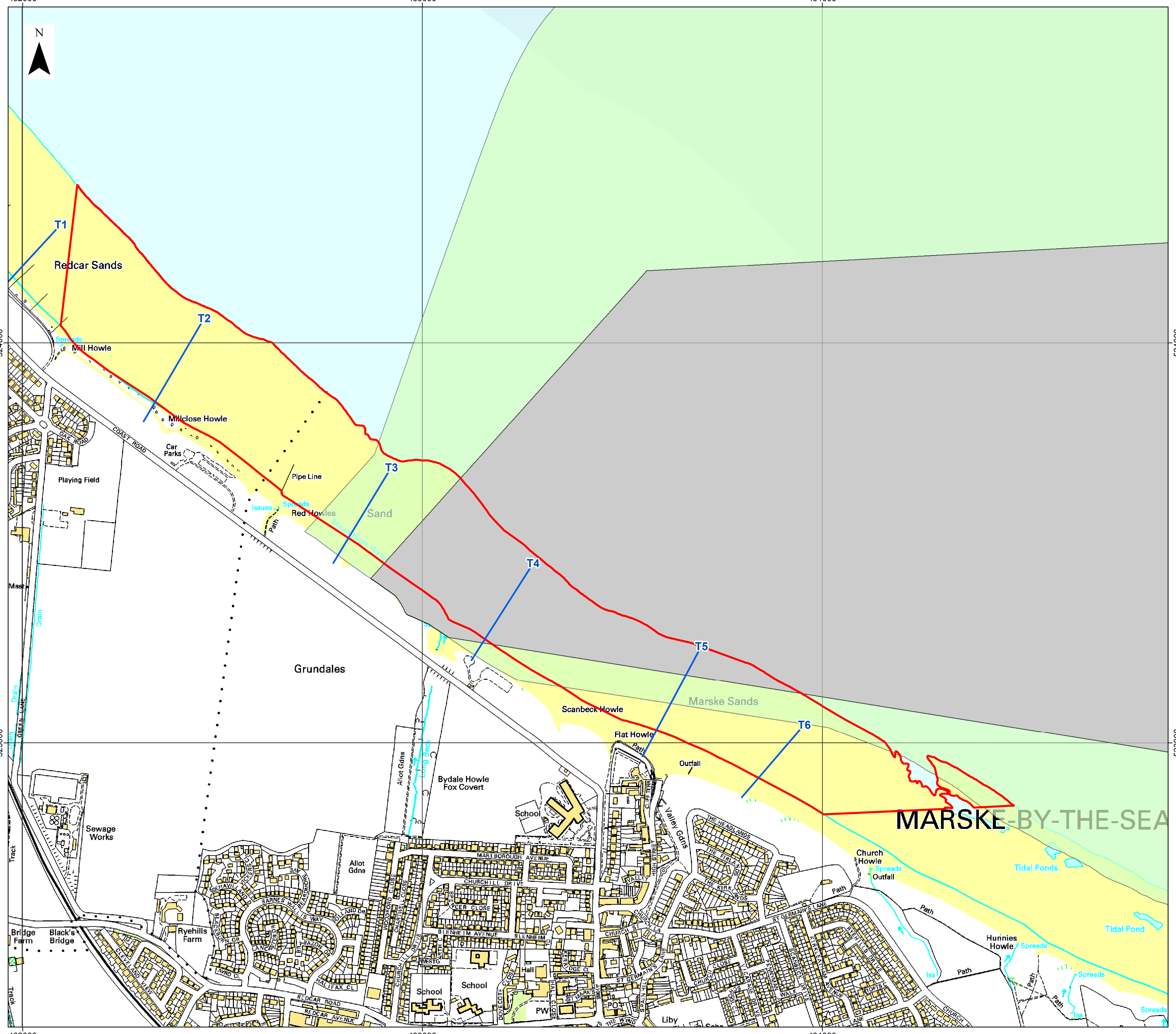
Figure 3.3 Epibenthic beam trawl sampling sites

VER	DATE	REMARKS	Drawn	Checked
1	04/10/2013	PEI3	LW	RZ
2	07/02/2014	DCO Submission	JE	RZ

DRAWING NUMBER: **F-OFL-MA-201**

SCALE	1:1,200,000	PLOT SIZE	A3	DATUM	WGS84	PROJECTION	UTM31N

FOREWIND



LEGEND

- Dogger Bank Teesside A & B Export Cable Corridor
- Temporary works area
- Intertidal study area
- Survey transect

0 100 200
Metres

Data Source:
Intertidal Survey © IECS 2012
Ordnance Survey data © Crown copyright, All rights reserved, 2013. Licence number 0100031673

PROJECT TITLE

DOGGER BANK TEESSIDE A & B

DRAWING TITLE

Figure 3.4 Teesside landfall intertidal survey extent and position of transects

VER	DATE	REMARKS	Drawn	Checked
1	26/06/2013	Draft	LW	RZ
2	03/10/2013	PEI3	LW	RZ
3	07/02/2014	DCO Submission	JE	RZ

DRAWING NUMBER:

F-OFL-MA-203

SCALE	1:10,000	PLOT SIZE	A3	DATUM	OSGB	PROJECTION	BNG

FOREWIND

Biotope classification methodology

3.2.57. As outlined above, biotope classification for Tranche B and the Dogger Bank Teesside A & B Export Cable Corridor was undertaken by Envision (**Appendix 12D**). The approach to biotope classification for Tranche B was slightly different to that used for Dogger Bank Creyke Beck in that an updated interpretation of all of the data available from the surveys to date was undertaken.

3.2.58. Therefore, grab (infaunal) data from both Tranche A and Tranche B were combined into a single dataset for the whole of the surveyed area. The benefit of re-analysing the data in this way is so that there is a continuum in the analysis across the Zone Wide areas and Dogger Bank Teesside A & B Export Cable Corridors to obtain a synoptic view of the biota throughout the areas of interest. This is so that the data from the different areas can support the interpretation of adjacent areas and improve the performance of the maps.

3.2.59. The geophysical data, however, were interpreted in separate areas because the types of data available and the processing involved changes between the different surveys. The Zone Wide area (Tranches A and B and the moderate coverage Zone Wide data that includes Tranche C) were interpreted as a single entity. However, the Creyke Beck Cable Corridor and the Dogger Bank Teesside A & B Export Cable Corridor were interpreted separately.

3.2.60. Multivariate analysis (using PRIMER v6) was then performed on the combined benthic dataset to identify statistically significant clusters of benthic communities. These clusters were then analysed in order to match them to biotope classes. An initial short-list was derived of the most similar biotope classes for each cluster. These were inspected and options ruled out on the basis of depth zone (infra- and circalittoral) and sediment. The edited short list was then inspected for key species and differences in significant contributors to the statistical classes.

3.2.61. Consideration was given to previous studies and an attempt was made to reach a consensus on the biotopes found within the area. Particular attention was given to the study by Diesing *et al.* (2009) which formed the basis of the candidate Special Area of Conservation (SAC) designation of the Dogger Bank by the JNCC.

3.2.62. Video data from the drop down video surveys were also used to inform the biotope classification, albeit not as extensively as the grab infaunal data. Epifaunal biotope classes were assigned individually to each sample record (as opposed to the infaunal records which were first assigned to statistical clusters). The epifauna were not integrated with the infauna to create a single biotope class for each sample. This left the option open for separate interpretation of the geophysical data after which the distribution of the epibiota could be overlain onto the distribution of the infauna.

3.2.63. The main outputs from this stage in the analysis were ground truth datasets for use in integrated analysis of the geophysical data. The subsequent interpretation of the geophysical data to derive the predicted distribution of the infaunal biotopes and epifaunal biotopes was undertaken separately and the epifaunal layer was overlain onto the distribution of the infauna.

3.2.64. With respect to the intertidal region, the methodology for assigning was based on Procedural Guideline No. 3-1 "*In situ intertidal biotope recording*" from the JNCC Marine Monitoring Handbook (Wyn & Brazier 2001). Data from photographs and sediment samples were all used to assign key biotopes, with the biotope code allocations also based on the current UK Marine Classification System v4.05 (Connor *et al*. 2004).

3.3. Assessment of impacts – methodology

3.3.1. The assessment of impacts includes: (a) the definition of the sensitivity of any receptor; (b) the definition of the magnitude of effect; and (c) the interaction between these two parameters to inform the overall level of impact (see **Chapter 4 EIA Process**).

3.3.2. Underpinning the approach to the marine and intertidal ecology impact assessment is the concept of Valued Ecological Receptors (VERs). The concept of assigning value to marine ecological receptors is set out within "*Guidelines for Ecological Impact Assessment in Britain and Ireland – Marine and Coastal*" (Institute of Ecology and Environmental Management (IEEM) 2010).

Valued Ecological Receptors

3.3.3. The value of ecological features is dependent upon their biodiversity, social and economic value within a geographic framework of appropriate reference (IEEM 2010). The most straightforward context for assessing ecological value is to identify those habitats and species that have a specific biodiversity value recognised through international or national legislation, or through local, regional or national conservation plans (e.g. Annex I habitats under the Habitats Directive, BAPs, existing and recommended Marine Conservation Zones (MCZ and rMCZ, respectively)).

3.3.4. However, only a very small proportion of marine habitats and species fall within the legislative or policy framework and, therefore, evaluation must also assess value according to the functional role of the habitat or species. For example, some features may not be protected under conservation legislation in their own right, but may be functionally linked to a feature of high conservation value.

3.3.5. In the marine environment, the assessment of status / conservation value within a geographic framework is more difficult, particularly at the local scale. The best available method identified is that of professional judgement and consensus through peer review. For this assessment, 'County' and 'District' levels have been combined into a single 'Local' category. **Table 3.2** shows the criteria applied to determining the ecological value of VERs within the geographic frame of reference applicable to the Dogger Bank Teesside study area.

Table 3.2 Geographic frame of reference applied to valuing ecological receptors in the Dogger Bank Study area

Value of VER	Criteria to define VER
International	Internationally designated sites. Habitats (and species) protected under international law (i.e. Annex I habitats within an SAC boundary).
National	Nationally designated sites. Habitats protected under national law. Annex I habitats not within an SAC boundary. UK BAP priority habitats and species and Nationally Important Marine Species that have nationally important populations within study area, particularly in the context of species/habitat that may be rare or threatened in the UK.
Regional	Regional UK BAP priority habitats or Nationally Important Marine Species that have regionally important populations within the study area i.e. are locally widespread and/or abundant. Habitats and species that are listed as conservation priorities in regional plans. Habitats or species that provide important prey items for other species of conservation or commercial value.
Local	Habitats and species which are not protected under conservation legislation but which form a key component of the benthic ecology within the study area and which may also be a functional component of a feature of conservation value (e.g. BAP priority habitat)

Receptor sensitivity

3.3.6. As outlined above, the key receptors defined for benthic ecology are the VERs, which are comprised of groups of similar biotopes. The criteria used to classify the sensitivity of the VERs (**Table 3.3**) are based on a combination of the actual ecological sensitivity of the biotopes within the VER (based on sensitivity assessments produced by MarLIN guidelines www.marlin.ac.uk) and the importance/value of the VER. MarLIN classifies biotopes on a six-point scale of sensitivity (ranging from very high to not sensitive). The sensitivity of a biotope is assessed through the intolerance and recoverability of the species/community/ habitat combination which make up the overall biotope.

3.3.7. The underlying rationale for adopting VERs as the receptor against which any subsequent effect has been assessed, as opposed to just biotopes, is that the VER approach enables different "*values*" (see **Table 3.2**) to be assigned to the same biotope, dependent on the status of this biotope, i.e. within or outside the boundary of a designated site.

3.3.8. By way of example, the SS.SCS.ICS.SLan biotope was recorded both within the Dogger Bank Teesside A & B wind farms (i.e. within the Dogger Bank cSAC site boundary) and also within the Dogger Bank Teesside A & B Export Cable Corridor (outside the Dogger Bank cSAC site boundary). Without use of the VER approach, the overall sensitivity (in EIA terms) of this receptor (the SLan biotope) to any effects would have been based solely on its ecological sensitivity (as defined by MarLIN). Therefore, the same overall sensitivity (in EIA terms, not ecological terms) to a specific effect would be applied to this biotope irrespective of whether the effect was occurring within the cSAC boundary or outside. In practice, this approach would not have represented a robust approach to assessment as in EIA terms the biotope within the cSAC boundary is more sensitive to effects than the same biotope outside the SAC boundary, due to potential implications of disturbance to cSAC habitats on the overall integrity of the cSAC.

3.3.9. However, to reflect the increased value/importance of this biotope due to its location within the Dogger Bank cSAC, compared to the same biotope outside the cSAC boundary, it has been given a greater (EIA) sensitivity rating, even though the ecological sensitivity of this biotope to any given effect will be the same.

3.3.10. Importantly and as part of the worst case approach to the assessment, where biotopes within a single VER have slightly different sensitivities to certain effects (or 'factors', as defined by MarLIN), the most sensitive biotope to the effect being assessed has always been used as the receptor for assessment. **Appendix 12F Disposal Site Characterisation Document** summarises the sensitivities of all the relevant biotopes within each VER to the range of effects/factors predicted to arise during the construction, operation and decommissioning phases of the project.

Table 3.3 Marine and intertidal ecology criteria for classifying the sensitivity of the receptor to the effect

Sensitivity	Definition
Very High	Nationally and internationally important receptors with high vulnerability and no or limited ability for recovery.
High	Regionally important receptors with high vulnerability and no or limited ability for recovery. Nationally and internationally important receptors with high vulnerability and low recoverability.
Medium	Locally important receptors with high vulnerability and no ability for recovery. Regionally important receptors with medium to high vulnerability and low recoverability. Nationally and internationally important receptors with medium vulnerability and medium recoverability
Low	Locally important receptors with medium to high vulnerability and low to medium recoverability. Regionally important receptors with low vulnerability and medium to high recoverability. Nationally and internationally important receptors with low vulnerability and high recoverability.
Negligible	Receptor is not vulnerable to impacts regardless of value/importance. Locally important receptors with low vulnerability and medium to high recoverability

Magnitude of effect

3.3.11. The magnitude of effect has been considered in terms of the spatial extent, duration and timing (seasonality and / or frequency of occurrence) of the effect in question. Expert judgment was employed to consider and evaluate the likely effect on the species / population / habitat identified as a VER. The magnitude of effect was subsequently identified from a four point scale as given in **Table 3.4.**

Table 3.4 Marine and intertidal ecology criteria for classifying the magnitude of effect

Magnitude of effect	Definition
High	• Effects occur over large spatial extent (>10% of the wider study area); • Effects occur over long term (>2 years); • Effects occur continually over long-term; and • Baseline conditions are significantly altered (defined here as change in several pre-existing biotope types due to effect in question).
Medium	• Effects occur over medium spatial extent (5-10% of wider study area); • Effects occur over medium term (1-2 years); • Effects occur frequently over medium term; and • Baseline conditions are altered (defined here as change in at least one pre-existing biotope due to effect in question).
Low	• Effects occur over small spatial extent (1-5% of wider study area); • Effects occur over short term (< 1 year); • Effects occur intermittently over short-term; and • Baseline conditions show slight change (overall biotope distribution remains as per baseline).
Negligible	• Effects occur over limited spatial extent (<1% of wider study area); • Effects occur over very short term (days); • Effects occur infrequently / single event; and • No change in baseline conditions.

Overall impact

3.3.12. The overall impact is based on the interaction between the magnitude of the effect and the sensitivity of the receptor. **Table 3.5** presents the matrix used to derive the overall impacts on marine and intertidal ecology receptors. In this case, the sensitivity of the receptor is also linked to the value of the VER as defined in **Table 3.2**.

Table 3.5 Overall impact matrix using magnitude and sensitivity in combination

Sensitivity of receptor	Magnitude of effect			
	High	Medium	Low	Negligible
Very High	Major	Major	Moderate	Minor
High	Major	Moderate	Minor	Minor
Medium	Moderate	Moderate	Minor	Minor
Low	Minor	Minor	Negligible	Negligible
Negligible	Minor	Minor	Negligible	Negligible

3.3.13. Potential impacts identified within the assessment as major or moderate can be regarded as significant in terms of the EIA regulations. In these cases, appropriate mitigation has been identified, where possible, in consultation with the regulatory authorities and relevant stakeholders. The aim of mitigation measures is to avoid, reduce or offset the overall impact to determine a residual impact upon a given receptor.

3.3.14. Where relevant, mitigation measures that are incorporated as part of the project design process and/or can be considered to be industry standard practice (referred to as 'embedded mitigation') are considered throughout the chapter and are reflected in the outcome of the impact assessment.

4. Existing Environment

4.1. Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor

Regional context

Physical environment

4.1.1. All of Dogger Bank Teesside A and the majority of Dogger Bank Teesside B lie within Tranche B, therefore, much of the following text relates to Tranche B. However, as a small part of Dogger Bank Teesside B lies within Tranche A, some reference is also made to this area.

4.1.2. The majority of Tranche B is within a depth range of 21.5m in the east to 38.5m in the north relative to lowest astronomical tide (LAT). Generally across the central, southern and western sectors of Tranche B, water depths were between 25m and 35m LAT (Gardline 2012). By way of comparison, Tranche A ranges in depth from 20m to 30m relative to LAT, but includes a small number of banks with localised depths of less than 20m and one relatively small area in the southern corner with a localised depth of 30m to 40m.

4.1.3. Areas of depth less than 25m LAT occurred predominantly in the east of Tranche B, corresponding with a large plateau which extends to the south of Tranche B. Other minor areas with depths less than 25m occurred in the south and west of the study area, corresponding with topographic highs between seabed gullies (Gardline 2012).

4.1.4. Areas with depths greater than 35m LAT occurred in the central northern area and in the west of Tranche B, (coinciding with the site boundary of Dogger Bank Teesside B), comprising a series of elongated gullies, orientated north west-south east, up to 6m deep, with gradients of up 6^{o} along their edges. Gradients across the rest of the seabed within this area were generally less than 3^{o} (Gardline 2012).

4.1.5. With respect to seabed sediments, two distinct sediment zones were identified. The first comprised featureless seabed of predominantly sand with scarce patches of coarse sand and gravel with megaripples and the second predominantly sand with frequent exposures of boulder clay/till within erosional features such as gullies and depressions, and accumulations of coarse sand and gravel within depressions (Gardline 2012).

4.1.6. Megaripples were often observed within gravelly sand areas with wavelengths varying from 1.4m to 2.2m. The direction of these megaripples was predominantly east-north east/west-south west to east/west. Boulders with heights of $\geq$ 0.3m were recorded, ranging in distribution from scattered discrete boulders within a generally featureless seabed, to areas where boulders were more concentrated to areas of frequent boulders. These areas of frequent boulders are associated with gullies and till occurrences and also frequent cobbles (Gardline 2012) -see Section 4.4 for more details on potential Annex I cobble reef.

4.1.7. Gardline (2013b) mapped the bathymetry of the Dogger Bank Teesside A & B Export Cable Corridor. Water depths range from just above LAT near the coast to approximately 80m below LAT with the deepest point about 90km offshore.

4.1.8. At the landfall site, the seabed can be separated into two zones; a nearshore zone that extends 2.5km from the coast to 20m depth with a mean gradient of 0.4^{o} and an offshore zone that extends from 2.5km to 4km offshore, characterised by a mean gradient of 0.1^{o}.

4.1.9. Outcrops of mudstone dominated the Dogger Bank Teesside A & B Export Cable Corridor, up to KP39 a veneer of slightly gravelly sand was observed between outcrops. Occasional rock outcrops were then observed up to KP88.5 on the Dogger Bank Teesside A & B Export Cable Corridor. Occasional exposures of till were also observed throughout the cable route. Till consists of clay, silt, sand, gravel and boulders ranging widely in size and shape. In general, seabed sediments were predicted to vary from slightly gravelly sand to sandy gravel depending on the influence of the underlying geology (Gardline 2012).

4.1.10. Tidal ranges are interpreted to be between 1 and 2m across the Dogger Bank Zone, with those to the west (towards Tranche A) higher than those in the east. Tidal stream speed maxima for the eastern area of the Dogger Bank Zone are between 0.2 and 0.6m/s. Higher speeds are present in the west, associated with the flow of water around the western edge of the Dogger Bank (EMU 2010), as indicated by the presence of active sand bodies in the Sand Hills on Dogger Bank. Admiralty charts indicate that tidal stream speed maxima for the Dogger Bank Zone are between 0.2 and 0.6m/s.

Biological environment

4.1.11. The Dogger Bank Zone lies within the southern North Sea and contains a variety of benthic community types associated with the strongly thermally mixed waters resident all year round (EMU 2010).

4.1.12. The MESH project is developing seabed habitat maps for north west Europe. The offshore area of Tranche B has broadly been characterised as ‘Infralittoral fine sand’ or ‘Infralittoral muddy sand’, although the European Nature Information System (EUNIS) classification of ‘Infralittoral coarse sediment’ also occurs. Further studies that have broadly characterised the North Sea benthos and the associated habitats include:

- Glémarec (1973);
- Kröncke and Reiss (2007); and
- Rees *et al*. (2007).

4.1.13. Based on initial zonal-wide habitat mapping undertaken in 2010, the dominant biotope associated with the Dogger Bank Zone is SS.SSa.IFiSa.NcirBat (*Nephtys cirrosa* and *Bathyporeia spp*. in infralittoral sand) (EMU 2010) which appears to be found across the majority of the Dogger Bank Zone, this may also include areas comprising more mixed sediment types based on habitat maps published in Diesing *et al.* (2009) as well as the EUNIS map.

4.1.14. These community types correspond well with the ‘Bank’ community described by Wieking and Krönke (2001) which occupies the flat shallow seabed areas on top of the Dogger Bank.

4.1.15. Updated zone-wide habitat mapping has been carried out in 2012 by Envision. The results of this updated assessment indicate that the predominant benthic habitat is slightly gravelly sand sparsely populated by polychaetes, bivalves and amphipods. Both Tranche B (Dogger Bank Teesside A & B) and Tranche A (Dogger Bank Creyke Beck and Dogger Bank Teesside B) were predominantly sandy in nature although Tranche B was slightly less gravelly (Envision 2012).

4.1.16. Mixed sediment habitats (sand, gravel, cobble and gravel) appear in both the infaunal and epifaunal interpretations across the wider zone. There is extensive coverage of this mixed sediment habitat type in Tranche A with a more constrained, but very well defined feature in Tranche B running north-south and predicted to extend into Tranche C (Envision 2012).

4.1.17. The benthic habitats found on the Dogger Bank are among the most common habitats found below Mean Low Water Spring (MLWS) around the coast of the United Kingdom and correspond with the UK BAP habitat “*subtidal sands and gravel*” (UK BAP – see Maddock 2008). This habitat occurs in a range of environmental conditions, and the mix of sand or gravel, and any bedforms present on the surface of the seabed, depends on factors such as tidal and wave strengths.

4.1.18. The Annex I habitat “*Sandbanks which are slightly covered by sea water all the time”*, designated under the cSAC of Dogger Bank (site code UK0030352), corresponds with this UK BAP habitat (see Section 4.4).

4.1.19. The Dogger Bank candidate SAC (cSAC) boundary (**Figure 4.1**) covers the majority of the Dogger Bank Zone, where the primary habitat interest feature of conservation importance is “*sandbanks that are slightly covered by sea water all the time*” (Connor *et al.* 2004). Other conservation areas that are located near the Dogger Bank cSAC include a Dutch Site of Community Interest (SCI) and a German SCI.

Sediment composition

4.1.20. The sediment samples taken from Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor by grab sampling were subjected to Particle Size Distribution (PSD) analysis to identify the principal sediment components. Sediments across these areas were found to be broadly uniform, with the majority (73% of stations) described as moderately sorted to well sorted fine sand under the Wentworth classification system. The Wentworth system is based on mean particle size and is thus less reliable for poorly sorted sediments, for which the Modified Folk classification system is more useful.

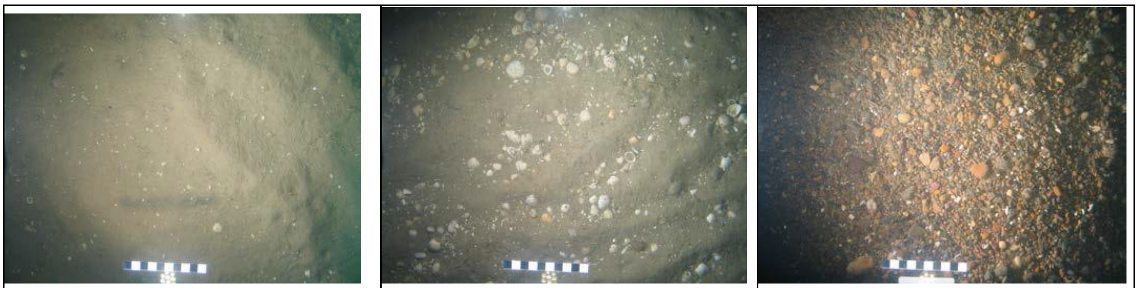
4.1.21. Modified Folk classifications for the remaining 27% of stations with poorly sorted or very poorly sorted sediments of gravelly sand, sandy gravel and gravel were generally consistent with coarser sediments delineated on the seabed features.

Using the Modified Folk classification system, 90% of all stations were dominated by sand, with low fines (<63µm) and gravel (>2mm) content. Highest fines were found at Stations TB_37 and TB_53 (3.7% and 7.2% respectively) with all other stations recording fines of ≤1.9%.

4.1.22. Gravel dominated the sediments at Stations TB_30 (72.1%), TB_48 (93.3%), TB_50 (81.6%) and TB_53 (72.4%) and at Station TB_49 the proportion of gravel equalled that of sand (49.0% gravel and 49.3% sand). These stations were located in areas of generally deeper water depth described as erosional features such as gullies and depressions, and accumulations of coarse sand and gravel within depressions.

4.1.23. Seabed photography and video footage supports the interpretation of seabed sediments via PSA and geophysical analysis, revealing a relatively uniform seabed across much of the site, with large areas of sand with shell fragments. Stations investigated in high reflectivity areas revealed coarse sediments comprising gravel, pebbles and cobbles.

4.1.24. Representative seabed images from the drop down video survey within Tranche B are shown below in **Figure 4.1**.



Slightly gravelly sand | **Gravelly sand** | **Gravel**

Figure 4.1 Representative seabed habitat types within Tranche B

4.1.25. Full results of the particle size distribution analyses are presented in **Appendix 12A**. **Figure 4.4** illustrates the distribution of these three principal sediment components across Tranche B, based on the data collected via grab sampling.

4.1.26. Sediments from grab samples across the Dogger Bank Teesside A & B Export Cable Corridor routes were found to be broadly uniform, with the 75% of stations described as fine sand under the Wentworth classification system.

4.1.27. Using the Modified Folk classification system, 83% of all stations were heavily dominated (≥80%) by sand sized particles with relatively low fines (<63µm) and gravel content (>2mm). Fine material dominated at the nearshore Station TCC_09 (62% fines), resulting in a Modified Folk classification of slightly gravelly sandy mud. High fines were also found at Stations TCC_06, TCC_10, and TCC_71 with fines contents of 21.2%, 35.3% and 20.7%, respectively. These stations were classified as slightly gravelly muddy sand (TCC_06, TCC_10) and gravelly muddy sand (TCC_71). Fines at all other stations ranged from 0.8% to 13.1%.

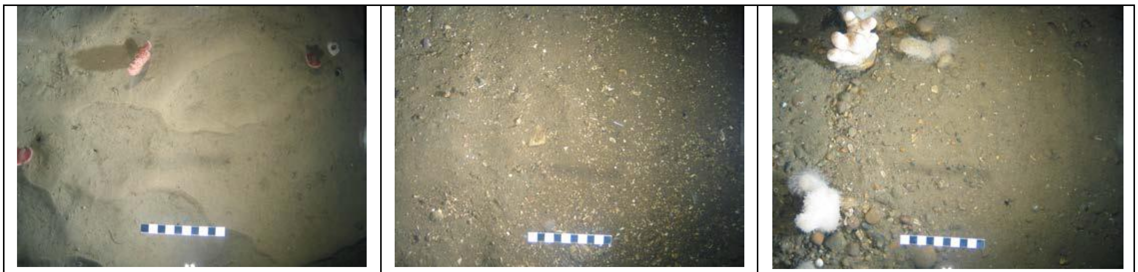
4.1.28. Gravel dominated the sediments at Stations TCC_76 (61.5%) in the west and TCC_115 (64.8%) in the east section of the cable route, resulting in Modified Folk classifications of muddy sandy gravel and sandy gravel, respectively. High gravel content was also found at Station TCC_75, in the west section (31.8% gravel).

4.1.29. These stations with high proportions of poorly sorted gravelly sediments were consistent with areas of gravelly sand or gravelly sand with outcropping rock or till delineated on the seabed features.

4.1.30. Seabed photography and video footage supports the interpretation of seabed sediments within the Dogger Bank Teesside A & B Export Cable Corridor via PSA and geophysical analysis, revealing a relatively uniform seabed across much of the surveyed routes, with large areas of low reflectivity displaying sand with shell fragments and occasional patches of gravel. These areas occurred across much of the offshore sections of both cable routes.

4.1.31. Stations investigated in high reflectivity areas revealed rock, boulders, and coarse sediments comprising gravel, pebbles and cobbles, coinciding with areas delineated as outcropping bedrock, till or gravel on the seabed features charts.

4.1.32. Representative seabed images from the drop down video survey within the Dogger Bank Teesside A & B Export Cable Corridor are shown below in **Figure 4.2**.



Slightly gravelly sand	Gravelly sand	Sandy gravel

Figure 4.2 Representative seabed habitat types within the Dogger Bank Teesside A & B Export Cable Corridor

4.1.33. Full results of the particle size distribution analyses are presented in **Appendix 12A**. **Figure 4.6** illustrates the distribution of the three principal sediment components along the Dogger Bank Teesside A & B Export Cable Corridor.

Contaminants

4.1.34. Sediment samples for contaminant analysis were collected from 11 sites within Tranche B. Where available, hydrocarbon concentrations were compared to the OSPAR Effects Range Low (ERL) and Effects Range Medium (ERM) levels published by Long *et al*. (1995) as well as the Canadian Environmental Quality Guidelines for the Protection of Aquatic Life (Interim Sediment Quality Guidelines; ISQG) and Probable Effect Level (PEL; CCME 2002).

4.1.35. Out of the 11 investigated stations, only four (TB_CHEM_01,TB_CHEM_10, TB_CHEM_13 and TB_CHEM_17) presented PAH concentrations above the

Limit of Detection (LoD). All stations investigated presented individual PAHs concentrations below the Canadian ISQGs and PELs (CCME 2002), as well as their respective ERLs and ERMs (Long *et al*., 1995).

4.1.36. Where available metal concentrations were compared to the same guidelines and levels as per hydrocarbons, plus the Apparent Effects Threshold (AET; Buchman, 2008). As, Cadmium (Cd), Lead (Pb) and Zink (Zn) concentrations were all below their respective Action Level 1 (AL1) and Action Level 2 (AL2), ISQGs and PELs, ERLs and ERMs as well as AETs at all sampled stations. Of the remaining metals, concentrations were also below their respective threshold values at all stations, with the exception of Station TB_CHEM_17.

4.1.37. At this station, Cr presented a concentration superior to its AL1, ISQG, ERL and AET; Cu presented a concentration superior to its AL1, ISQG and PEL as well as ERL; Ni was above the AL1, ERL and ERM (CEFAS 2003; CCME 2002; Long *et al*., 1995; Buchman 2008).

4.1.38. The AET was the only background information available for concentrations of Mn, Sn, V and Se. Mn was above its AET (Long *et al*., 1995) at stations TB_CHEM_04, TB_CHEM_17, TB_CHEM_19 and TB_CHEM_36. Sn, V and Se presented concentrations below their respective AETs at all sampled stations across the survey area.

4.1.39. Concentrations of PCB's at all sampled stations were representative of background levels recorded in the wider region.

4.1.40. Concentrations of Tributyltin (TBT) in the sediments collected during this survey were below the limit of detection at all sampled stations (<4µg kg-1 = 0.004µg g-1), and were considered to be representative of the wider area of the North Sea.

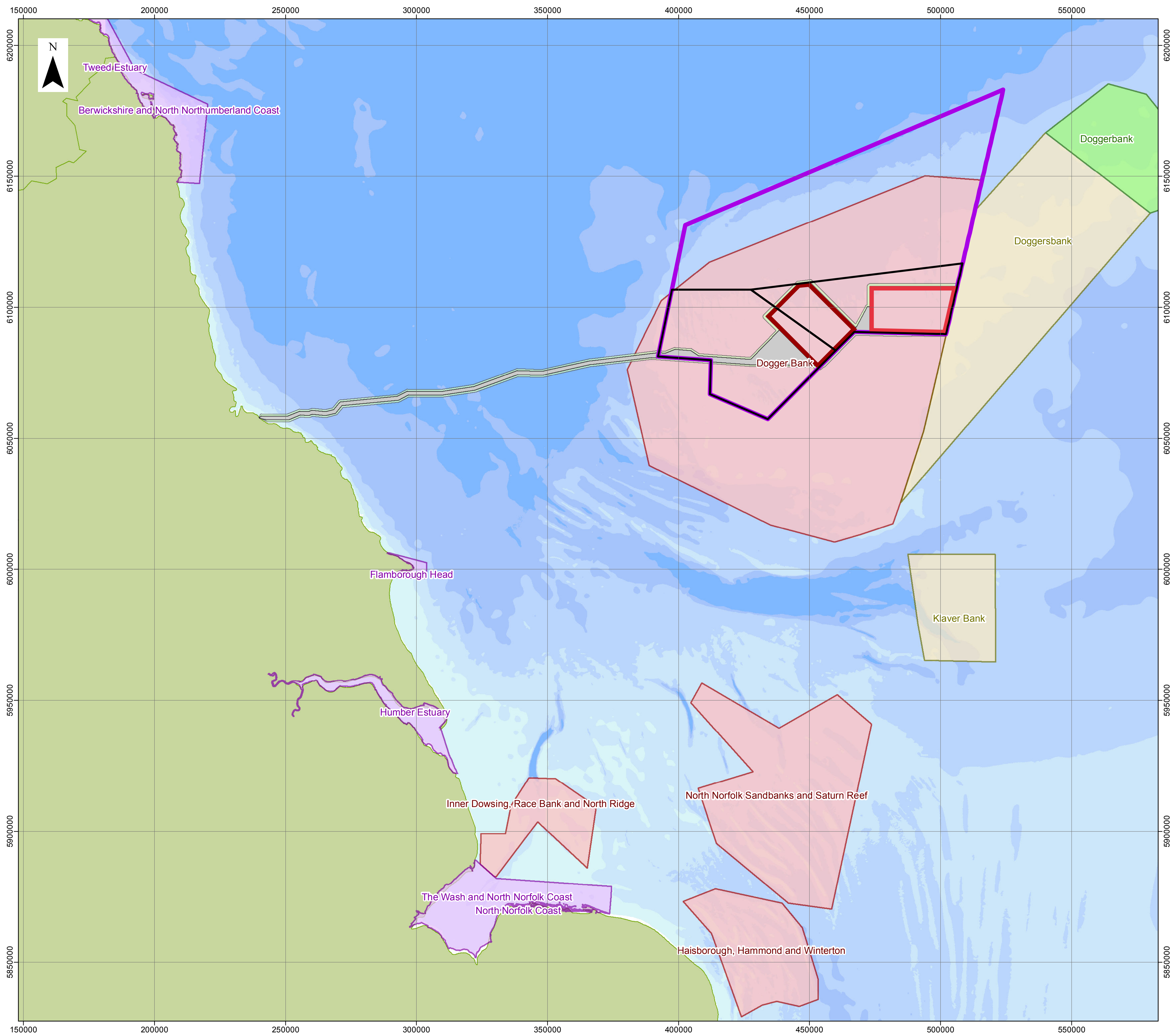
4.1.41. Sediment samples for contaminant analysis were also collected from nine locations within the Dogger Bank Teesside A & B Export Cable Corridor. Data from these samples indicated that whilst sediments from these 11 locations generally exceeded the Cefas AL1 for copper, chromium and nickel, the concentrations were only marginally above AL1 concentrations at the majority of sites. The near-shore areas appeared to indicate higher concentrations along the cable route (sites 62 and 64). There was only one exceedance of AL2 and this was for nickel at site 64.

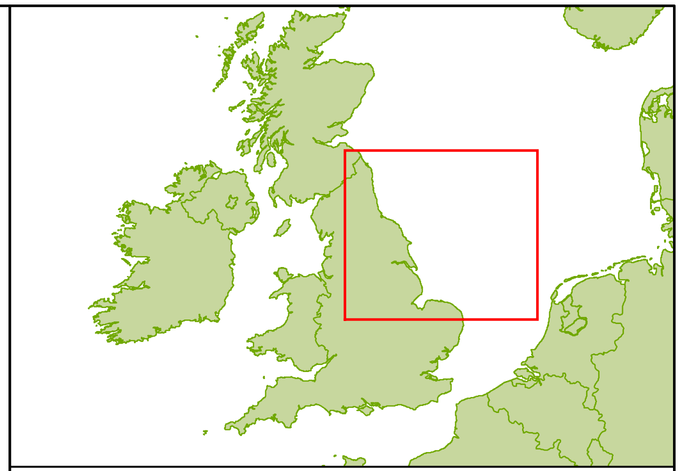
4.1.42. With respect to the Canadian ISQG scheme, the majority of sites indicated levels of contamination that could give rise to toxicological effects (i.e. exceed the PEL) in relation to copper and chromium levels. In the samples collected nearshore, additional parameters (arsenic, lead and PAH naphthalene) indicate potential exceedances of the TEL.

4.1.43. An assessment of the potential for sediment disturbance during the construction phase (via cable installation and seabed preparation) to impact on benthic receptors is provided in Section 5. Although sediments may continue to be mobilised in the operational phase (via scour), no assessment of potential sediment contaminant mobilisation in this phase is presented as no impacts are predicted. This conclusion is based on the assumption that any sediment contaminants that are present within the project area would have been mobilised via construction activities.

Plankton

4.1.44. Phytoplankton production on the Dogger Bank occurs throughout the year supporting a high biomass of species at higher trophic levels year-round, creating a region that is biologically unique in the North Sea (Kröncke & Knust 1995). Studies carried out during the winter 1987 – 88 (Richardson *et al*. unpublished data, cited in Nielsen *et al*. 1993) concluded that, because of the shallow depth of Dogger Bank, primary production is high throughout the winter. Richardson *et al*. (unpublished data, cited in Nielsen *et al*. 1993) have shown that primary production during the winter in the Dogger Bank region is higher than for all other regions of the North Sea. The shallowness of the area also causes the spring phytoplankton bloom to be initiated months before thermal stratification triggers the spring bloom in the northern North Sea. In the context of this environmental assessment this is important because the phytoplankton form the base of the food chain of the Dogger Bank. Blooming early provides a food source for organisms in an area which otherwise would be barren, therefore the Dogger Bank can support larger numbers of organisms year round than other areas in a similar location but with deeper waters.





LEGEND

- Dogger Bank Zone
- Tranche boundary
- Dogger Bank Teesside A
- Dogger Bank Teesside B
- Dogger Bank Teesside A & B Export Cable Corridor
- Temporary works area
- SAC with Marine Components
- Offshore cSAC
- Germany SCI
- Netherlands SCI

0 10 20 40
Kilometres

Data Source:
SAC & SCI data © JNCC, 2012.
Background bathymetry image derived in part from TCarta data © 2009

PROJECT TITLE

DOGGER BANK TEESSIDE A & B

DRAWING TITLE

Figure 4.3 Regional context of the study area including SACs and SCIs

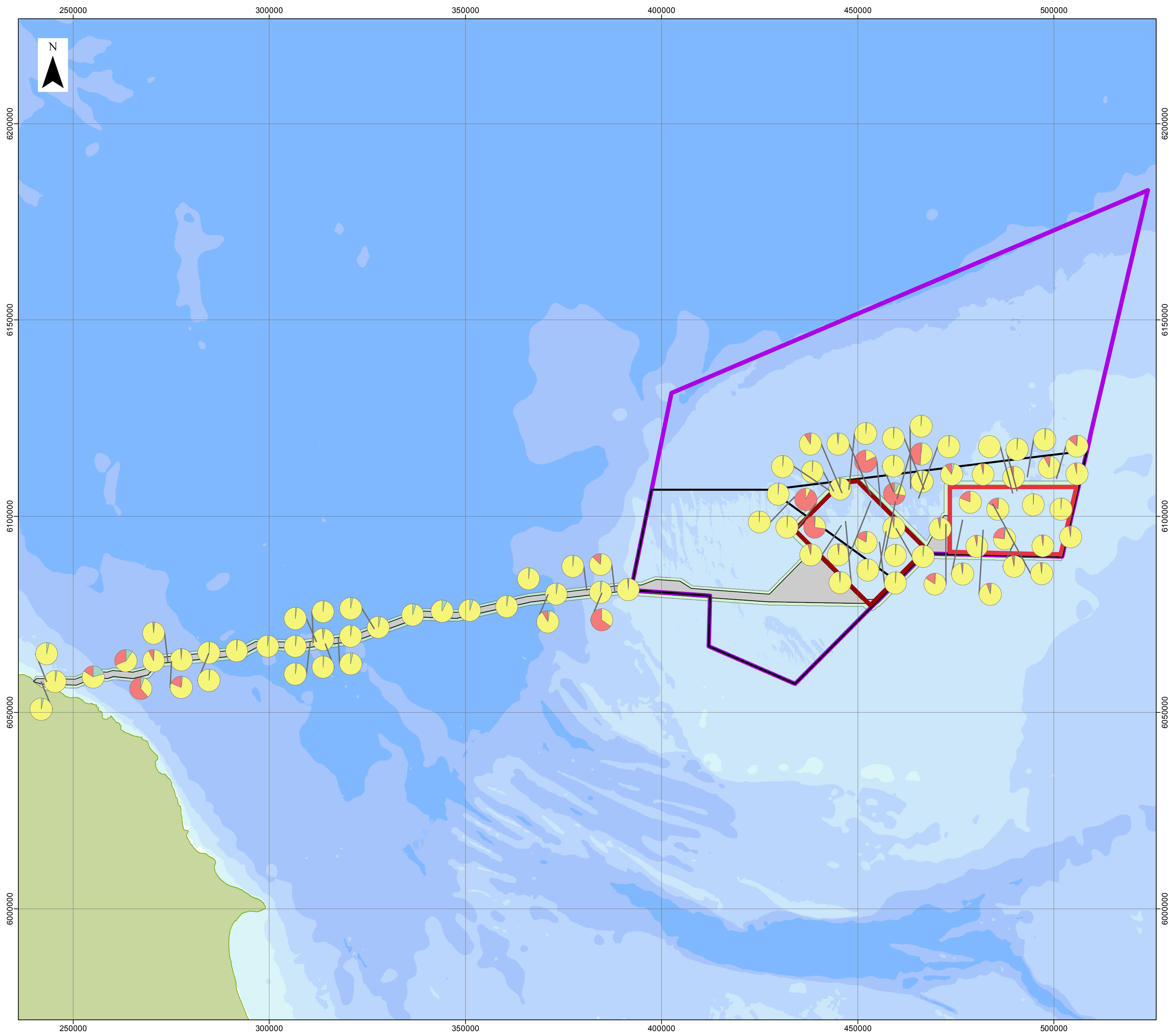
VER	DATE	REMARKS	Drawn	Checked
1	24/05/2013	Draft	LW	RZ
2	03/10/2013	PEI3	LW	RZ
3	07/02/2014	DCO Submission	JE	RZ

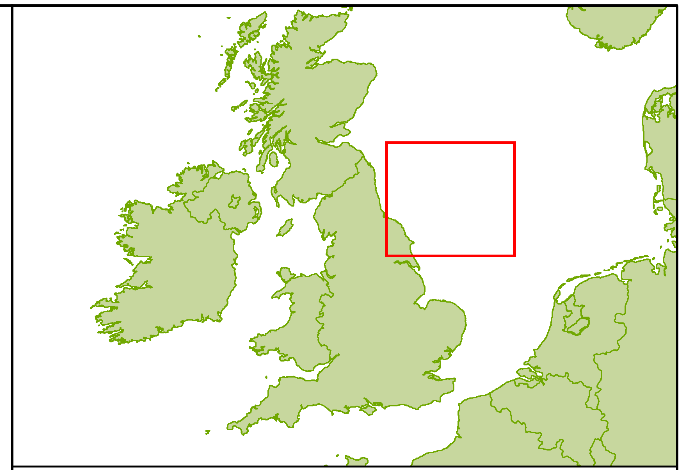
DRAWING NUMBER:

F-OFL-MA-203

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

FOREWIND





LEGEND

- Dogger Bank Zone
- Tranche boundary
- Dogger Bank Teesside A
- Dogger Bank Teesside B
- Dogger Bank Teesside A & B Export Cable Corridor
- Temporary works area

Marine sediment fractions (%)

- Fines
- Sand
- Gravel

0 10 20 40
Kilometres

Data Source:
Sediment Samples © Gardline Environmental Limited, 2012
Background bathymetry image derived in part from TCarta data © 2009

PROJECT TITLE

DOGGER BANK TEESSIDE A & B

DRAWING TITLE

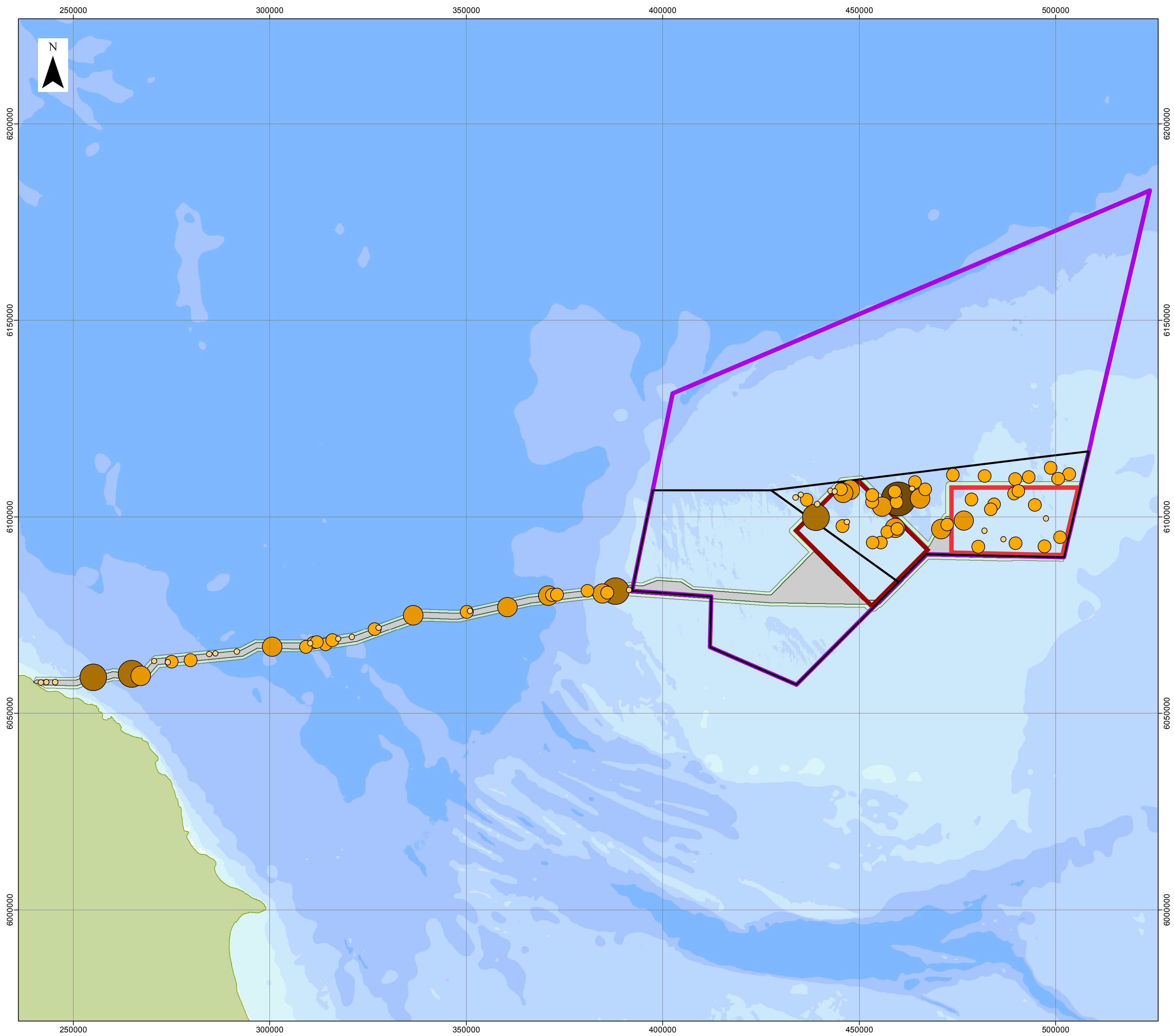
Figure 4.4 Distribution of the principal sediment components across Tranche B and Dogger Bank Teesside A & B export cable corridor

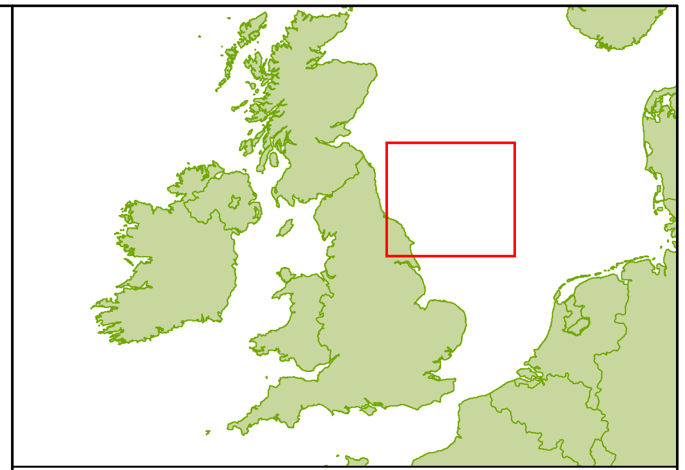
VER	DATE	REMARKS	Drawn	Checked
1	03/10/2013	PEI3	LW	RZ
2	07/02/2014	DCO Submission	JE	RZ

DRAWING NUMBER: **F-OFL-MA-233**

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

FOREWIND





LEGEND

- Dogger Bank Zone
- Tranche boundary
- Dogger Bank Teesside A
- Dogger Bank Teesside B
- Dogger Bank Teesside A & B Export Cable Corridor
- Temporary works area

Total numbers of taxa

- < 25
- 26 - 35
- 36 - 45
- 46 - 55
- > 55

0 10 20 40
Kilometres

Data Source:
Sediment Samples © Gardline Environmental Limited, 2012
Background bathymetry image derived in part from TCarta data © 2009

PROJECT TITLE

DOGGER BANK TEESSIDE A & B

DRAWING TITLE

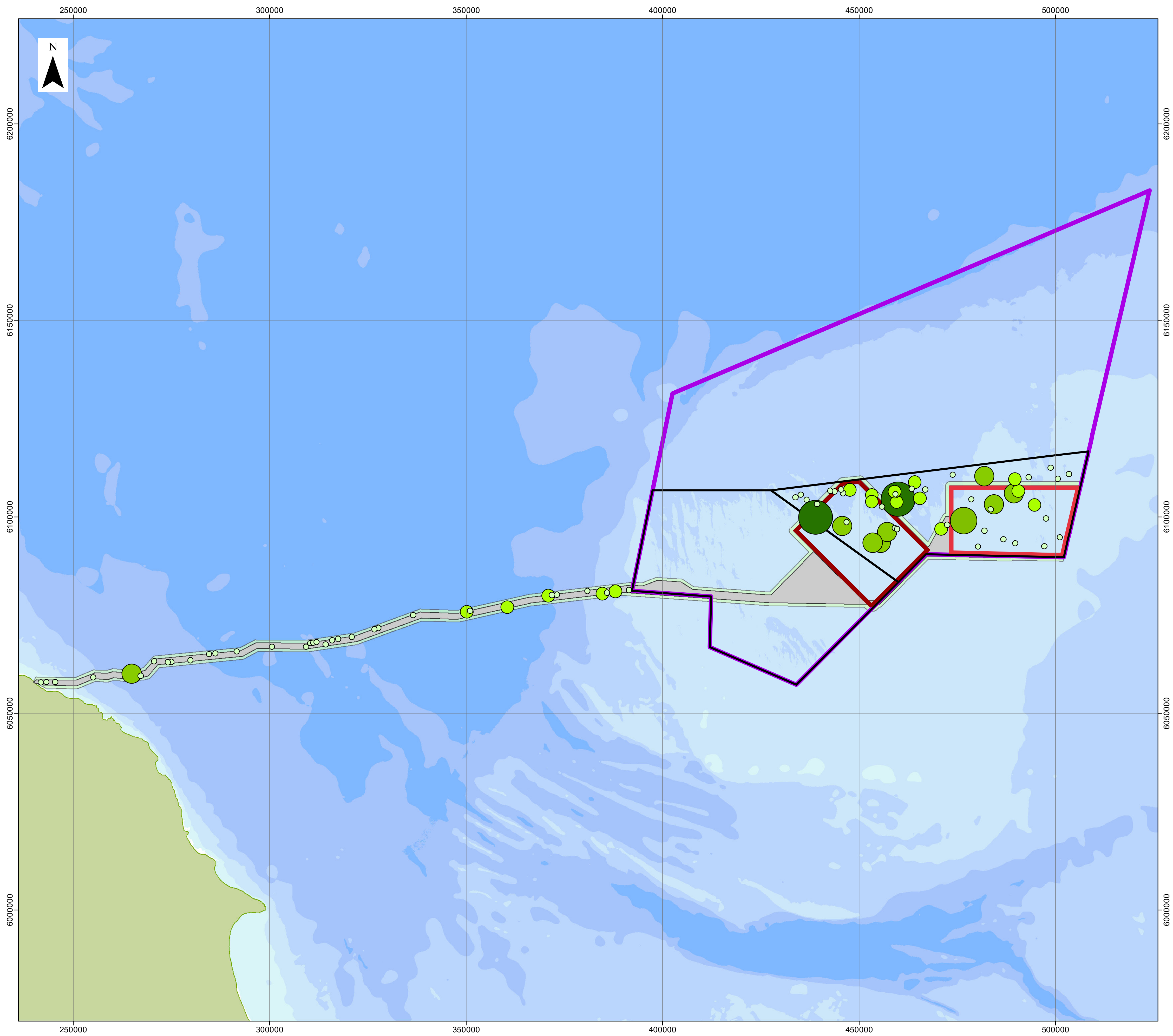
Figure 4.5 Distribution of total numbers of taxa

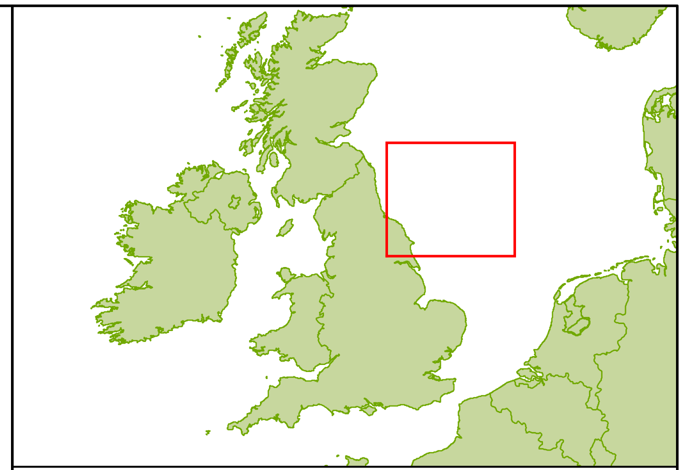
VER	DATE	REMARKS	Drawn	Checked
1	04/10/2013	PEI3	LW	RZ
2	07/02/2014	DCO Submission	GC	RZ

DRAWING NUMBER: **F-OFL-MA-234**

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

FOREWIND





LEGEND

Dogger Bank Zone

Tranche boundary

Dogger Bank Teesside A

Dogger Bank Teesside B

Dogger Bank Teesside A & B Export Cable Corridor

Temporary works area

Total numbers of individuals

< 150

151 - 200

201 - 250

251 - 300

> 300

0 10 20 40

Kilometres

Data Source:
Sediment Samples © Gardline Environmental Limited, 2012
Background bathymetry image derived in part from TCarta data © 2009

PROJECT TITLE

DOGGER BANK TEESSIDE A & B

DRAWING TITLE

Figure 4.6 Distribution of total numbers of individuals

VER	DATE	REMARKS	Drawn	Checked
1	04/10/2013	PEI3	LW	RZ
2	07/02/2014	DCO Submission	JE	RZ

DRAWING NUMBER: **F-OFL-MA-235**

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

FOREWIND

Macrofaunal grab data (univariate data analysis)

4.1.46. The following section of the ES chapter presents a summary of the key outputs of macrofaunal data analysis across Tranche B and also the two Dogger Bank Teesside Export Cable Corridors, namely the cable corridor for Dogger Bank Teesside A & B and also the cable corridor for Dogger Bank Teesside C & D. As detailed earlier in this chapter (see the Methodology Section 3), whilst the focus of this chapter is on data relevant to the Dogger Bank Teesside A & B Export Cable Corridor, the benthic data from both cable corridors (and Tranches A and B and the wider Zone) were used to inform the eventual habitat mapping work by Envision. Therefore, key details of the combined benthic data from the Dogger Bank Teesside A & B and Dogger Bank Teesside C & D Dogger Bank Export Cable Corridors are presented below.

4.1.47. Following data rationalisation (i.e. removal of algae, meiofauna, pelagic organisms and reconciliation of the same species recorded at different taxonomic levels), a total of 7,902 individuals from 211 taxa were recorded from the 51 successful grab samples collected from within Tranche B. Juveniles accounted for 795 individuals from 33 taxa, making up 10% of the total individuals and 16% of the total taxa.

4.1.48. Analysis using the RELATE programme within Primer v6 indicated that juveniles may not be exerting an influence on the overall community structure, therefore, the data analyses were performed using the full data set inclusive of juvenile counts.

4.1.49. Overall, the macrofaunal community within Tranche B was dominated by polychaete annelids, contributing 63% of the total individuals and 38% of the total taxa. Molluscs were the second most dominant group, with 19% of the total individuals and 26% of the total taxa, while crustaceans contributed just 10% of individuals and 23% of the taxa. The dominance of polychaete taxa is not unusual. Studies by Gage (2001) show polychaetes consistently dominating soft bottom benthos from continental shelves to abyssal plains and revealed that over 50% of total macrofaunal individuals are generally composed of polychaete worms.

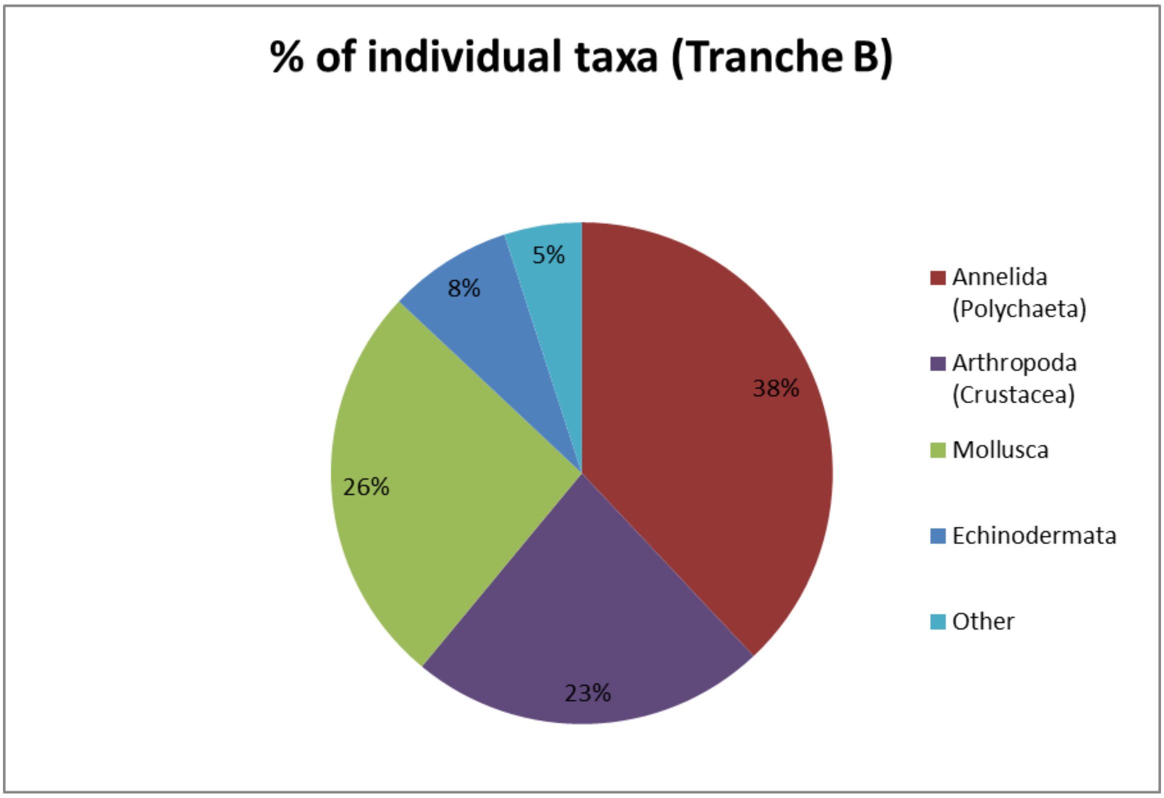


Figure 4.7 Proportion of Individual taxa recorded from Tranche B

4.1.50. The highest macrofaunal density and diversity was seen at Station Tranche B_49 (413 individuals and 62 taxa). The faunal community at this station was dominated by polychaetes, contributing 74% of individuals and 48% of taxa. Stations Tranche B_30 and Tranche B_18 had the second and third highest faunal density with 316 individuals and 297 individuals, respectively.

4.1.51. Molluscs dominated at Station Tranche B_30, contributing 57% of the individuals but just 22% of the taxa; this can be attributed to the high abundance of the bivalve *Kurtiella bidentata* (n=155) at this station.

4.1.52. Lowest macrofaunal densities were found at Stations Tranche B_09, Tranche B_10 and Tranche B_21 which recorded 67, 70 and 64 individuals, respectively. The majority of stations (80%) recorded <200 individuals per $0.1m^2$.

4.1.53. The most abundant and most frequently recorded species within Tranche B, with 2,899 individuals identified in all but one (98%) of the 51 samples, was the polychaete *Spiophanes bombyx*. *S. bombyx* is commonly found in sublittoral sands and sandy muds (Rees *et al*., 2007) and is known to be tolerant to both smothering and substratum loss and to be intolerant to changes in nutrients (Hiscock *et al*., 2005). *S. bombyx* was also the most frequently recorded species in the benthic survey of Tranche A (Emu 2012).

4.1.54. *S. bombyx* was observed to be the most frequently distributed species in the entire North Sea in a pooled data set of the North Sea Benthos Survey and the Ministry of Agriculture, Fisheries and Food cruises (Heip and Craeymeersch 1995).

4.1.55. Other abundant species (>300 individuals in total) were the mollusc *Angulus fabula* and the polychaete *Lanice conchilega*. *A. fabula* is found at depths of up to 100m in fine and medium sands (Van Hoey *et al*., 2004). *L. conchilega* is commonly known as the sand mason worm due to its characteristic tube constructed from sand grains and shell fragments. Van Hoey *et al*. (2008) suggested that *L. conchilega* has relatively little habitat specialisation and thus may be found across most sediment types and a range of depths (<1900m), although there is preference for shallow sandy environments.

4.1.56. Overall, univariate data analysis indicated that that the faunal community within Tranche B is relatively diverse. Highest diversity was generally found in areas of increased seabed complexity, in particular among the patches of boulder clay and coarse sand across the centre of Tranche B. In general, lower diversity values were found to the east of the survey area.

4.1.57. In general, faunal communities across the north and centre of the survey area were relatively even, with lower evenness values concentrated in the east.

4.1.58. In terms of biomass, total biomass was relatively consistent across Tranche B, with the majority of sites recording ≤25g. Highest biomass was found at Station Tranche B_02, with 100.35g recorded, over 99g of which was contributed by echinoderms (three individuals of the sea potato *Echinocardium cordatum*).

4.1.59. Univariate data from the 71 grab samples over the Dogger Bank Teesside A & B Export Cable Corridors indicated a total of 6,745 individuals from 329 taxa. As per the dataset from Tranche B, RELATE analysis was undertaken to determine the influence of juveniles on the overall dataset and this concluded that, as per Tranche B, juveniles may not be exerting an influence on the overall community structure, therefore, the data analyses were performed using the full data set inclusive of juvenile counts.

4.1.60. Overall, the macrofaunal community within the Dogger Bank Teesside A & B and Dogger Bank C & D Export Cable Corridors were similar to that recorded within Tranche B, in that it was dominated by polychaete annelids which contributed 52% of the total individuals and 43% of the total taxa. Echinoderms were the next most dominant taxonomic group in terms of individual abundance, accounting for 18% of total individuals with just 7% of the total taxa. This dominance was caused largely by high abundances of Ophiuroidea and Echinoidea juveniles. The next most abundant taxonomic group in terms of total individuals was Mollusca with 15% of all individuals. The second most dominant group in terms of taxa abundance was Arthropoda, which contributed 25% of all taxa. Contributions of the gross taxonomic groups at each station are presented in **Appendix 12A**.

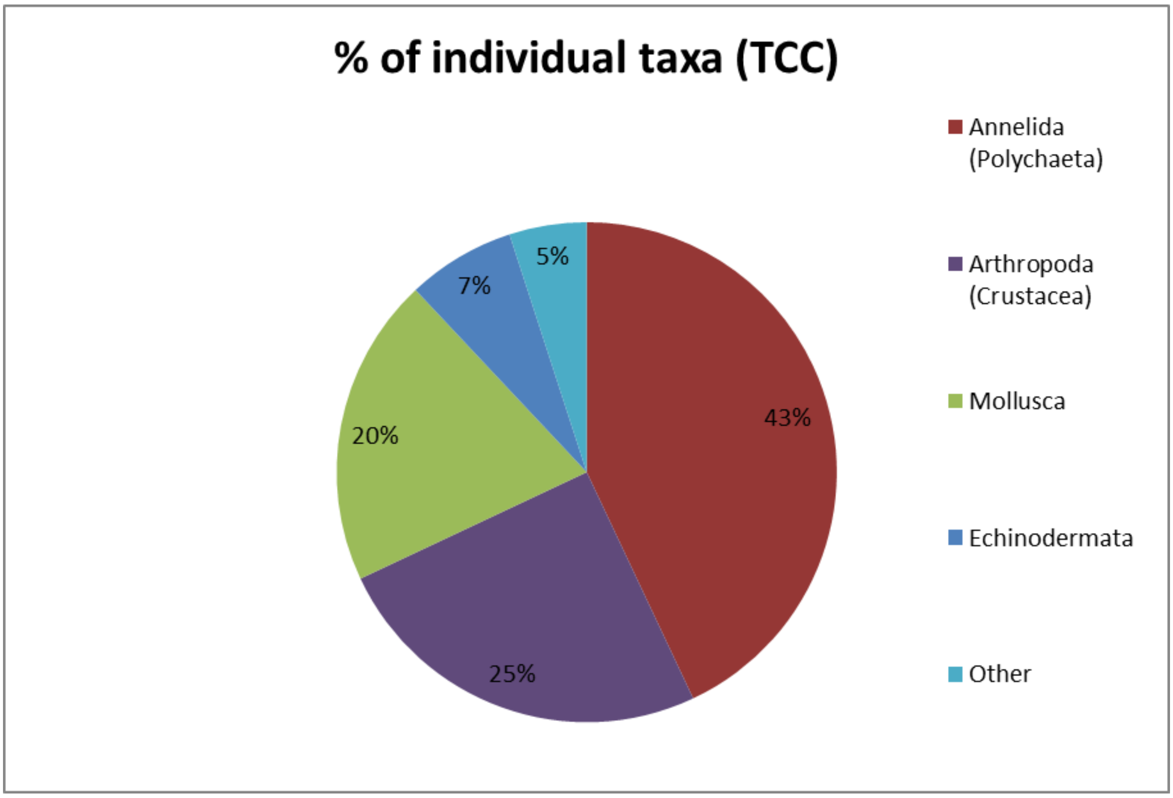


Figure 4.8 Proportion of Individual taxa recorded from Dogger Bank Teesside A & B Export Cable Corridor

4.1.61. The highest macrofaunal density was seen at Station TCC_56 (312 individuals). The faunal community at this station was dominated by polychaetes, contributing 75% of individuals and 42% of taxa. Station TCC_75 has the second highest faunal density with 221 individuals. Again, polychaetes dominated at this station, contributing 65% of the individuals and 49% of the taxa.

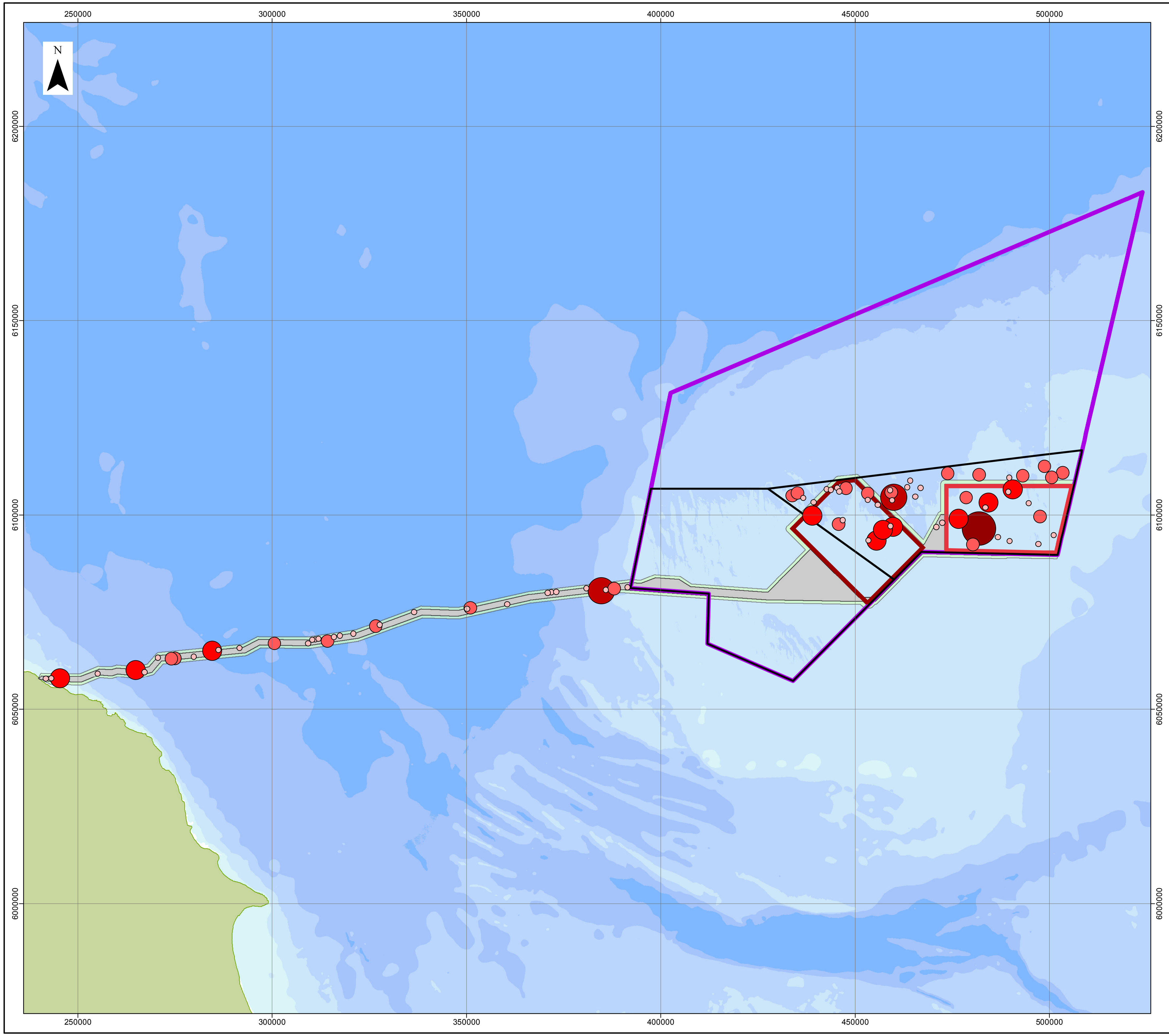
4.1.62. Lowest macrofaunal densities were recorded at Stations TCC_25 and TCC_27 (Dogger Bank Teesside C & D Dogger Bank Teesside A & B Export Cable Corridor) with 26 and 24 individuals, respectively. Faunal distributions of the number of individuals and taxa throughout the survey area are presented in **Figures 4.5** and **4.6**.

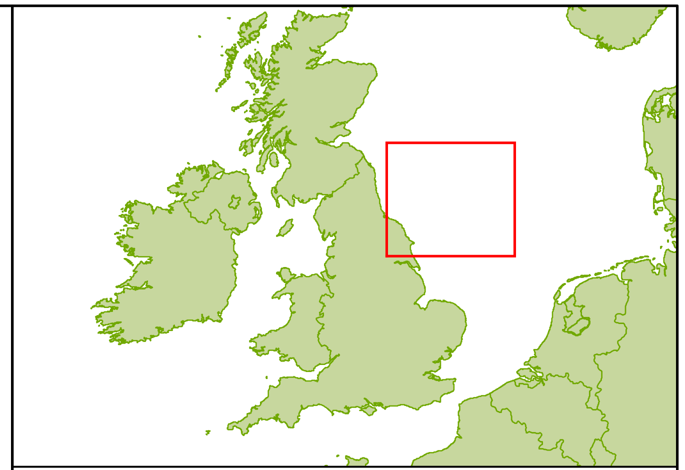
4.1.63. As per Tranche B, the most abundant and most frequently recorded species within the Dogger Bank Teesside A & B Export Cable Corridor, with 581 individuals identified in all but one (98%) of the 51 samples, was the polychaete *Spiophanes bombyx*.

4.1.64. The second most abundant taxon, the polychaete *Galathowenia oculata*, is commonly found in mixed sublittoral sediments, muddy sands, or sandy muds (Hiscock *et al*., 2005). The third most abundant taxon was juveniles from the class Ophiuroidea (brittle stars). Brittle stars are found in a wide range of marine habitats ranging from stony muddy shores to muddy sediments in deeper water. The large number of juveniles found in the current survey maybe indicative of a recent recruitment event.

4.1.65. Overall, univariate data analysis indicated that that the faunal community within the Dogger Bank Teesside A & B and Dogger Bank C & D Export Cable Corridors were generally diverse, but variable. Highest diversity was observed at Stations TCC_14 (H'=5.10) and at Station TCC_47 (H'=5.04) on the Northern Route. Lowest diversity was observed at Station TCC_01 (H'=2.12). In general, lower diversity values were found close to shore on both routes.

4.1.66. Evenness values suggested a relatively even spread of fauna across the majority of both survey routes.





LEGEND

- Dogger Bank Zone
- Tranche boundary
- Dogger Bank Teesside A
- Dogger Bank Teesside B
- Dogger Bank Teesside A & B Export Cable Corridor
- Temporary works area

Total Biomass (g AFDW)

- ≤0.50
- 0.51 - 1.50
- 1.51 - 3.50
- 3.5 - 7.00
- ≥7.00

0 10 20 40
Kilometres

Data Source:
Sediment Samples © Gardline Environmental Limited, 2012
Background bathymetry image derived in part from TCarta data © 2009

PROJECT TITLE

DOGGER BANK TEESSIDE A & B

DRAWING TITLE

Figure 4.9 Distribution of macrofaunal biomass

VER	DATE	REMARKS	Drawn	Checked
1	19/10/2013	PEI3	LW	RZ
2	07/02/2014	DCO Submission	JE	RZ

DRAWING NUMBER:

F-OFL-MA-236

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

FOREWIND

Macroinfauna (multivariate data analysis)

4.1.67. Multivariate analysis of benthic grab data from Tranche B identified two main groups (clusters) of stations, with the first group (Cluster h) containing Stations Tranche B_30, Tranche B_48 to Tranche B_50 and Tranche B_53 and the second group containing all other stations, separated further into six clusters (b to g) and one statistically distinct station.

4.1.68. Differences within the data set and associated groupings are due to the species composition of the retained samples at each station. *S. bombyx*, the most abundant species within the Tranche B survey was identified as the most influential species in Clusters b through to g. *A. fabula*, the second most common species across the survey, was identified as one of the top four influential species in clusters d to g. These results suggest that a relatively even distribution of the most dominant taxa across most of Tranche B.

4.1.69. In contrast, the top three most influential taxa within cluster h belonged to the genus Spirobranchus. Abundances of *S. bombyx* were the lowest observed across the survey area, and *A. fabula* was absent from these five stations in cluster h. Spirobranchus are tube-building polychaetes which encrust pebbles, cobbles and rock surfaces, while *S. bombyx* is common to sandy and muddy sediments.

4.1.70. The MDS ordination overlain with the Modified Folk results revealed that stations belonging to cluster h (Stations Tranche B_30, Tranche B_48 to Tranche B_50 and Tranche B_53) were classified as muddy sandy gravel, sandy gravel or gravel, sampled in areas of exposures of boulder clay while all stations within clusters b to g were classified as slightly gravelly sand or gravelly sand.

Table 4.1 Characteristics of clusters within Tranche B identified via multivariate analysis

Cluster	No. of stations	Water depths (m)	Predominant sediments	Dominant taxa
b	4	23-27	Sand and gravelly sand	*Spiophanes bombyx* *Bathyporeia guilliamsoniana* *Sigalion mathildae* *Edwardsiidae*
c	3	26-30	Gravelly sand	*Spiophanes bombyx* *Lanice conchilega* *Echinoidea juv.* *Owenia fusiformis*
d	6	26-29	Sand and gravelly sand	*Spiophanes bombyx* *Angulus fabula* *Lanice conchilega* *Magelona filiformis*
e	17	23-33	Sand and gravelly sand	*Spiophanes bombyx* *Bathyporeia guilliamsoniana* *Angulus fabula* *Sigalion mathildae*

Cluster	No. of stations	Water depths (m)	Predominant sediments	Dominant taxa
f	4	29-34	Sand	*Spiophanes bombyx* *Angulus fabula* *Nephtys juv.* *Owenia fusiformis*
g	11	30-36	Sand and gravelly sand	*Spiophanes bombyx* *Angulus fabula* *Lanice conchilega* *Ensis juv.*
h	5	28-34	Sandy gravel, gravel and muddy sandy gravel	*Spirobranchus* *Spirobranchus triqueter* *Spirobranchus lamarcki* *Pholoe baltica*

4.1.71. With respect to the Dogger Bank Teesside Export Cable Corridors multivariate analysis of benthic grab data identified four large clusters in the dendrogram (Clusters a, g, k and m) consisting of a combined total of 46 stations, with a further five smaller clusters each encompassing three to four stations (Clusters d, e, I, n and o). The remaining three stations (TCC_18, TCC46 and TCC_71) were distinct from each other and all other stations.

4.1.72. A total of nine stations did not belong to or form any clusters, suggesting highly variable community compositions. Stations TCC_09, TCC_10, TCC12, TCC_14, TCC_18 and TCC_71 were all located relatively nearshore in poorly sorted mixed sediments. Stations TCC_09 and TCC_10 recorded the highest fines and TOC and highest levels of hydrocarbons within the survey. Taxa which contributed to the separation of Stations TCC_09 and TCC_10 included higher abundances of *Phoronis*, *Amphiura filiformis* and an absence of the most dominant species *S. bombyx*. Stations TCC_57 and TCC_120 occur at the end of each survey route on the Dogger Bank, where depths are shallower

4.1.73. Cluster a was identified as distinct from all other stations and consisted of the stations closest to shore on both routes (TCC_01, TCC_03, TCC_05, TCC_06, TCC_61, TCC_62 and TCC_64). Cluster k dominated the offshore section of the Northern route, while the majority of stations belonging to cluster g were located on the Southern route.

4.1.74. Unlike for the Tranche B data, which showed a distinct relationship between certain stations and sediment types, the MDS ordination overlain with the Modified Folk results for the Dogger Bank Teesside Export Cable Corridors did not reveal any clear association with sediment type, although stations grouped in the centre of the plot appear to consist of mainly slightly gravelly sand, with more loosely associated stations consisting of gravelly sand, gravelly muddy sand and muddy sandy gravel.

Table 4.2 Characteristics of clusters within Dogger Bank Teesside Export Cable Corridors identified via multivariate analysis

Cluster	No. of stations	Water depths (m)	Predominant sediments	Dominant taxa
a	7	6 -24m	Sand and muddy sand	*Magelona johnstoni* *Angulus fabula* *Nephtys juv.* *Abra prismatica*
d	3	52-55m	Gravelly sand and muddy sandy gravel	*Echinocyamus pusillus* *Hydroides norvegicus* *Serpulidae* *Lumbrineris cingula*
e	3	57-58m	Sand and gravelly sand	*Echinocyamus pusillus* *Ophelia borealis* *Spiophanes bombyx*
g	14	59-73m	Sand	*Astrorhiza* *Scoloplos (Scoloplos) armiger* *Ennucula tenuis* *Paramphinome jeffreysii*
i	4	63-81m	Sand	*Ophiuroidea juv.* *Paramphinome jeffreysii* *Scoloplos (Scoloplos) armiger* *Harpinia antennaria*
k	17	67-83m	Sand and gravelly sand	*Galathowenia oculata* *Paramphinome jeffreysii* *Ophiuroidea juv.* *Owenia fusiformis*
m	8	43-62	Sand and gravelly sand	*Spiophanes bombyx* *Ophiuroidea juv.* *Amphiura filiformis* *Nucula nitidosa*
n	3	37-43m	Gravelly sand and sandy gravel	*Spiophanes bombyx* *Lagis koreni* *Pholoe baltica (Sensu Peterson)* *Nemertea*
o	3	57-66m	Sand	*Ophiuroidea juv.* *Chaetozone setosa* *Echinoidea juv.* *Spiophanes bombyx*

Epibenthos

4.1.75. Epibenthic communities across Tranche B and the Dogger Bank Teesside Export Cable Corridors were characterised by a series of 2m scientific beam trawl surveys and also data collected via the drop down video surveys undertaken as part of the wider benthic survey campaign (Gardline 2012).

4.1.76. Within Tranche B, seabed photography and video footage supported the initial interpretation of the geophysical data, revealing a relatively uniform seabed across much of the site, with large areas of low reflectivity displaying sand with shell fragments.

4.1.77. Visible fauna within the sandy sediments predominantly comprised mobile species, including echinoderms (*Ophiura* sp., *Astropecten irregularis*, *Asterias rubens*), crustaceans (Brachyura, Paguridae, *Cancer pagurus*) and fish (Pleuronectiformes, *Buglossidium luteum*, *Eutrigula gurnardus*) in addition to occasional molluscs and hydrozoans.

4.1.78. In areas of coarse sediment including pebbles and cobbles, higher densities of encrusting fauna were visible, including the tube-building polychaete *Spirobranchus* sp. (*Pomatoceros* sp. synonym), soft coral (*Alcyonium* sp.), hydrozoans and bryozoans, including *Bugula* sp. Increased densities of brittlestars Ophiotrichidae were also observed in these areas, along with sea urchins *Echinus esculentus* and *Psammechius* sp.

***Asterias rubens* on fine sand with gravel and shell fragments** **Water Depth: 30m** **Fix 697**	***Spirobranchus* sp., *Ophiothrix* fragilis and *Alcyonium* sp. on gravelly sand** **Water Depth: 33** **Fix: 819**

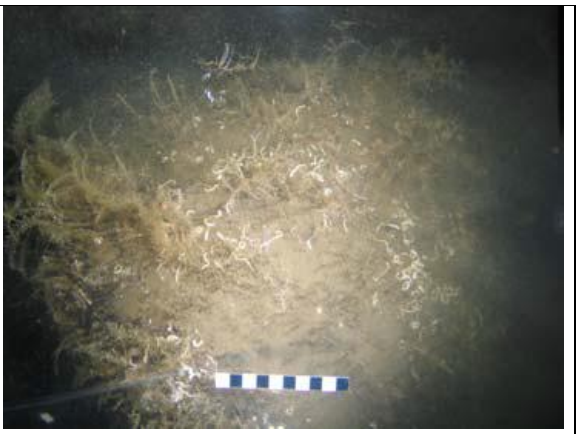
Figure 4.10 Epifauna recorded via DDV from Dogger Bank Teesside A & B

4.1.79. As per Tranche B, seabed photography and video footage supported the initial interpretation of the geophysical data within Dogger Bank Teesside A & B Export Cable Corridor, revealing a relatively uniform seabed across much of the surveyed routes, with large areas of low reflectivity displaying sand with shell fragments and occasional patches of gravel.

4.1.80. Visible faunal density and diversity were relatively low within the dominant sandy sediments and noticeably increased within areas of high reflectivity and corresponding coarse sediments, boulders and outcropping bedrock. Common fauna visible within the low reflectivity sandy sediments were seapens (*Pennatula phosphorea, Virgularia mirabilis*), foraminifera (largely *Astrorhiza* sp.) and mobile epifauna including echinoderms (*Astropecten irregularis*, *Asterias rubens*) and crustaceans. Polychaete tubes were also frequently observed in these homogenous sandy sediments.

4.1.81. In areas of increased seabed complexity, high densities of encrusting fauna were visible, including the tube-building polychaete *Spirobranchus* sp., soft coral (*Alcyonium* sp.), hydrozoans (including Sertulariidae, *Abientinaria* sp., *Tubularia* sp., *Hydrallmania* sp. and *Thuiria thuja*) and bryozoans (mainly Flustridae). At several of the shallower nearshore stations, kelp (*Laminiaria* sp.) was observed. Increased densities of mobile fauna such as crustaceans (Caridea, Majidae, *Munida* sp.), brittlestars (Ophiuroidea) and sea urchins (*Echinus esculentus*) were also observed.

Polychaete tubes, *Alcyonium* sp., *Pennatula phosphorea*
Water Depth: 73m
Fix 1005



Spirobranchus sp. Ophiothrix fragilis, Ophiurae, Sertulariidae, Hydrallmania sp., Abietinaria sp.
Water Depth:56m
Fix: 99

Figure 4.11 Epifauna recorded via DDV from Dogger Bank Teesside A & B Export Cable Corridor

4.1.82. Data on epibenthic communities within Dogger Bank Teesside A & B and the Dogger Bank Teesside C & D Export Cable Corridors have also been obtained via the review of data from 2m beam trawl surveys, which were primarily undertaken to characterise the fish and shellfish ecology of the study area, along with otter trawl and potting surveys.

4.1.83. Data from these surveys indicate that the following epibenthic species were recorded at the greatest abundances in the 2m beam trawl surveys; amphipods *Stenothoidae* sp. indet, *Atylus swammerdami*, *Scopelocheirus hopei* and *Abludomelita obtusata*, shrimp, *Crangon allmanni*, common starfish, *Asteria rubens*, Green sea urchin *Psammechinus* miliaris, sand star *Astropecten* irregularis, Common hermit crab *Pagurus bernhardus* and common brittlestar *Ophiothrix fragilis*.

4.2. Intertidal

General

4.2.1. The Dogger Bank Teesside A & B Export Cable Corridor landfall is located between the towns of Redcar and Marske-by-the-Sea, Tees Estuary, Teesside. As detailed in Section 3, six transects were sampled within the study area, each extending the length of the beach from MHWS to MLWS.

Sediment composition

4.2.2. Sediment composition of the study area in general predominantly consisted of coarse sand and gravel at high shore, transitioning into finer sand at low shore, containing small amounts of gravel and shell fragments. Dune systems were noted at high shore on some of the transects, and nearly all transects included cobbles and boulders at high shore, strategically placed by Redcar and Cleveland Borough Council in an attempt to diminish the effects of coastal erosion.

Contaminants

4.2.3. Sediment contaminant concentrations from the three sample locations (upper, mid and lower shore) were compared against several assessment criteria in order to ascertain whether the levels found at landfall were an acceptable level in terms of their biological effects. Environmental Assessment Criteria (EACs) were used, as well as Effects Range (ER) values, Background Concentrations (BCs) and Background Assessment Concentrations (BACs) (OSPAR Commission 2009) and Canadian Sediment Quality Guidelines (CCME 2002).

4.2.4. All sediment samples were identified as marine fine sand with small amount of gravel and shell fragments. The results of the survey were compared to the Canadian Sediment Quality Guidelines as these levels are more conservative than the Cefas Action Levels and overall, levels of contaminants are generally low.

4.2.5. All data for PCBs and Organotins recorded levels of contamination below the detection levels (0.1µg/kg for PCBs and 3µg/kg for TBT). There were only two exceedances of the Threshold Effects Level (TEL) for arsenic and these were marginal. As a result, the material is not considered to be high risk in terms of contaminant levels and potential toxicological effects.

Macroinfauna

4.2.6. Species compositions did not differ greatly between the transects, perhaps due to the small study area and similar sediment compositions. Evidence of Talitrids was found at the strandline of most transects, and the most abundant species throughout the survey were the amphipods *Scolelepsis* spp. and *Bathyporeia* spp.

4.2.7. Polychaete worms of the genus Pontocrates were one of the most frequently recorded macroinfauna, being noted in 21 of the 41 samples

4.3. Biotopes and habitats

General

4.3.1. The methodology adopted by Envision for biotope classification within Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor is outlined in Section 3. Biotopes at the landfall location were assigned using the current UK Marine Classification System v4.05 (Connor *et al*. 2004).

Biotope classification – Tranche B

4.3.2. The sediment distribution within Dogger Bank Teesside A & B indicated a gradual transition from gravelly sand to slightly gravelly sand from south to north. Areas of coarser sediment and a coarse sediment feature coincident with a depression running north-south in the eastern sector were also identified.

4.3.3. The range of biotopes that occurred in Dogger Bank Teesside A & B is given in **Table 4.3**. This also gives the frequency with which the assigned biotopes were found, bearing in mind that most of the samples were assigned to more than one biotope to reflect the uncertainty of the biotope matching process. Note also that fine sand and mixed sediment at Level 3 in the biotope classification would also encompass any of the subsidiary Level 4 biotopes and these latter records have been included in the totals for the Level 3 biotopes in brackets.

4.3.4. The infauna is characterised by polychaetes, razor shells and heart urchins – all typical of moderately disturbed fine sandy sediments and more often assigned to shallow infralittoral habitats. The water depth over Tranche B is approximately 25-30m, which is at the deeper end of what could be considered infralittoral and this may reflect the extent of disturbance through the water column over the Dogger Bank.

4.3.5. Mixed sediments are not well represented in Dogger Bank Teesside A & B (as compared to Dogger Bank Creyke Beck). However, aggregations of brittle stars on coarse sediment were common in some areas close to predicted mixed sediment habitats and probably form part of a continuum of these coarser habitats.

Biotope classification – Dogger Bank Teesside A & B Export Cable Corridor

4.3.6. The Dogger Bank Teesside A & B Export Cable Corridor has a greater number of biotopes assigned, as would be expected from the greater range of depths and substrate types within this area compared to Tranche B. All biotopes identified via habitat mapping of the Dogger Bank Teesside A & B Export Cable Corridor are shown in **Table 4.3**.

4.3.7. The predominant sediment was classed as slightly gravelly sand although the fauna were more typical of muddier sediments. It is possible that the deep sediment may have been more stable and cohesive than the PSA results would indicate.

4.3.8. The distribution of habitats along the cable corridor follows a trend that is typical of those parts of the North Sea that are bordered by a rocky coastline. A wave-cut platform extends out some kilometres forming rocky outcrops interspersed by sand and mixed sediments. The kelp rocky biotopes are found in shallow water and faunal crusts and turf below this depth. Thereafter, mixed sediments predominate out to 15-20km and then give way to sandy mud habitats dominated by ThyNten/AfilNten biotopes. There are also frequent muddy areas with sea pens and burrowing megafauna and linear ribbons of coarser sediment.

4.3.9. Coarse sediments become more frequent as the sea floor rises close to the Dogger Bank at the eastern end of the Dogger Bank Teesside A & B Export Cable Corridor.

Biotope classification – landfall

4.3.10. Biotopes recorded at the Dogger Bank Teesside A & B Export Cable Corridor landfall were typical of similar English east coast locations (see **Table 4.3**). One of the dominant biotopes recorded at all six transects was LS.LSa.MoSa.AmSco.Pon, which is characterised by the presence of *P. arenarius* in littoral mobile sand. A similar biotope, LS.LSa.MoSa.AmSco characterised by the presence of *Bathyporeia spp*. and *Scolelepsis spp*. in mobile sand, was also recorded at several locations within the six transects.

4.3.11. The biotopes LS.LSa.MoSa.BarSa and LS.LSa.MoSa (mobile sand characterised by the presence of the amphipod *B. elegans*) were also recorded at most of the six transects.

4.3.12. At the high shore top end of some of the six transects was a steep boulder clay cliff approximately 6 metres high. At the bottom of the cliff there was a narrow band of medium sand scattered with cobbles and saltmarsh plants. The area around the strandline at the base of the cliff was identified as LS.LSa.St.tal, characterised by a community of sandhoppers (talitrid amphipods) which generally occur at the strandline where debris and seaweed are found.

4.3.13. In the mid to lower shore on some of the transects small areas of littoral rock biotopes were recorded, including LR.FLR.Eph.EntPor, and a mosaic of LR.FLR.Eph.EntPor/ LS.LSa.MoSa. These two areas were characterised by the presence of the seaweed species *Enteromorpha* spp. and *Porphyra purpurea* on lower shore eulittoral rock.

4.3.14. In the lower shore, dominant biotopes included LS.LSa.FiSa.Po.Ncir, which is characterised by the presence of *Nephtys cirrosa* in medium fine sand and LS.LSa.MoSa.AmSco.Sco.

(a) LS.LSa.MoSa.BarSa

(b) LS.LSa.MoSa

(c) LS.LSa.MoSa.AmSco.Pon

(d) LR.FLR.Eph.EntPor/ LS.LSa.MoSa

Figure 4.12 Intertidal biotopes recorded at Dogger Bank Teesside A & B Export Cable Corridor landfall

4.3.15. As per the approach to identifying VERs outlined in Section 3.2, the biotopes identified within Dogger Bank Teesside A & B, the Dogger Bank Teesside A & B Export Cable Corridor and landfall and listed below in **Table 4.3** have been grouped into VERs according to their general ecology and species richness, their conservation status/interest and their ecological sensitivity to the effects likely to be experienced at this site. In total, nine VERs have been identified across these parts of the study area, three in the main Dogger Bank Teesside A & B sites (VERs A, B and C), seven in the Dogger Bank Teesside A & B Export Cable Corridor (VERs A to G) and two in the intertidal (landfall) region (VERs H and I). Further details of these VERs are provided in **Table 4.4** and their spatial distribution across Dogger Bank Teesside A & B, the Dogger Bank Teesside A & B Export Cable Corridor and landfall shown in **Figures 4.14** to **4.18**.

Table 4.3 Benthic biotopes identified within Dogger Bank Teesside A & B, Dogger Bank Teesside A & B Export Cable Corridor and landfall (intertidal)

JNCC Marine Habitats Classification (V04.05) biotope codes	Biotope description (frequency in samples)
Dogger Bank Teesside A & B	
SS.SSa.CFiSa.ApriBatPo	*Abra prismatica*, *Bathyporeia elegans* and polychaetes in circalittoral fine sand (44)
SS.Ssa.CFiSa	Circalittoral fine sand (1) (45 total)
SS.SMx.CMx	Circalittoral mixed sediment (3) (18 total)
SS.SSa.IMuSa.EcorEns	*Echinocardium cordatum* and *Ensis* spp. in lower shore or shallow sublittoral muddy fine sand (45)
SS.SCS.CCS.MedLumVen	*Mediomastus fragilis*, *Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel (5)
SS.SMx.CMx.OphMx	*Ophiothrix fragilis* and/or *Ophiocomina nigra* brittlestar beds on sublittoral mixed sediment (15)
SS.SCS.ICS.SLan	Dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand (40)
SS.SSa.CMuSa.AbraAirr	*Amphiura brachiata* with *Astropecten irregularis* and other echinoderms in circalittoral muddy sand (2)
SS.SMu.CFiMu.SpnMeg	Seapens and burrowing megafauna in circalittoral fine mud (1)
Dogger Bank Teesside A & B Export Cable Corridor	
CR.MCR.EcCr.FaAlCr	Faunal and algal crusts on exposed to moderately wave-exposed circalittoral rock (4)
SS.SCS.ICS.SLan	Dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand (1)
SS.SMu.CFiMu.SpnMeg	Seapens and burrowing megafauna in circalittoral fine mud (5)
SS.SMu.CSaMu.ThyNten/AfilNten	*Thyasira* spp. and *Nuculoma tenuis* in circalittoral sandy mud / *Amphiura filiformis* and *Nuculoma tenuis* in circalittoral and offshore sandy mud (24)
SS.SMx.CMx	Circalittoral mixed sediment (10) (20 total)
SS.SMx.CMx.OphMx	*Ophiothrix fragilis* and/or *Ophiocomina nigra* brittlestar beds on sublittoral mixed sediment (4)
SS.SMx.OMx.PoVen	Polychaete-rich deep *Venus* community in offshore mixed sediments (6)

JNCC Marine Habitats Classification (V04.05) biotope codes	Biotope description (frequency in samples)
SS.Ssa.CFiSa	Circalittoral fine sand (1)
SS.SSa.CFiSa.ApriBatPo	*Abra prismatica*, *Bathyporeia elegans* and polychaetes in circalittoral fine sand (13) (21 total)
SS.SSa.CFiSa.EpusOborApri	*Echinocyamus pusillus*, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand (8)
SS.SSa.IFiSa.NcirBat	*Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand (3)
Landfall (Intertidal)	
LS.LSa.MoSa.AmSco.Pon	*Pontocrates arenarius* in littoral mobile sand
LS.LSa.MoSa.AmSco.Sco	*Eurydice pulchra* in littoral mobile sand
LS.LSa.FiSa.Po.Ncir	*Nephtys cirrosa*-dominated littoral fine sand
LS.LSa.MoSa.BarSa	Barren littoral coarse sand
LS.LSa.MoSa	Barren or amphipod-dominated mobile sand shores
LS.LSa.St.tal	Talitrids on the upper shore and strand-line
LS.LSa.MoSa.AmSco.Eur	*Eurydice pulchra* in littoral mobile sand
LS.LSa.FiSa.Po.Ncir,	*Nephtys cirrosa*-dominated littoral fine sand
LR.FLR.Eph.EntPor	*Porphyra purpurea* and *Enteromorpha* spp. on sand-scoured mid or lower eulittoral rock

4.4. Habitats and species of conservation importance

Annex I Habitats - subtidal sandbanks

4.4.1. The key seabed habitats of conservation importance that occur within the study area are those that form component parts of the Annex I habitat “subtidal sandbanks which are slightly covered by seawater at all times” for which the Dogger Bank cSAC has been proposed for designation by the UK Government. A brief summary of the reason for this cSAC designation (from the Dogger Bank SAC Selection Assessment Document, Version 9.0, August 2011 JNCC) is provided below.

4.4.2. The Dogger Bank is located within the southern North Sea 125km off the east coast of Yorkshire (**Figure 4.3**). This site represents an offshore non-vegetated sandy mound, composed of moderately mobile, clean sandy sediments (sands and gravelly sands) in full salinity. In general the biological communities on the Dogger Bank are typical of fine sand and muddy sand sublittoral sediments. Species typical of these communities include the polychaetes *Nephtys cirrosa* and *Magelona* sp., mobile amphipods of the genus *Bathyporeia*, the brittlestar *Amphiura filiformis*, and bivalve molluscs such as *Tellina fabula* (formerly *Fabulina fabula*) and *Mysella bidentata* (Wieking & Kröncke 2001).

4.4.3. Epifaunal species include the hermit crab *Pagurus bernhardus*, sandeels *Ammodytes spp*., plaice *Pleuronectes platessa* and the starfish *Asterias rubens.* The grade for the feature is A as it is a typical example of this type of Annex I sandbank habitat (JNCC 2010).

4.4.4. As outlined in Section 3.2 the habitat mapping work undertaken to inform the EIA for Dogger Bank Teesside A & B also considered previous ecological studies relevant to the Dogger Bank in order that a consensus on the biotopes found within the area could be reached. Particular attention was given to the study by Diesing *et al.* (2009) which formed the basis of the SAC designation of the Dogger Bank by the JNCC. Therefore, the current characterisation of benthic communities within Tranche B (and the wider zone) represents the most up-to-date and accurate interpretation of seabed habitats in this area and allows existing habitats to be considered in the context of the cSAC designation and qualifying features.

4.4.5. In summary, it is considered that all of the seabed habitats within the Dogger Bank Teesside A & B wind farm boundaries, and part of the Dogger Bank Teesside A & B Export Cable Corridor, represent Annex I habitat due to them forming component parts of the “*subtidal sandbanks which are slightly covered by seawater at all times*” feature habitat for which the Dogger Bank cSAC has been designated.

Annex I Habitats – geogenic (cobble) reefs

4.4.6. The main benthic characterisation survey (Gardline 2012) also included an assessment for the potential for Annex I geogenic reef habitat to exist within both Tranche B and the Dogger Bank Teesside A & B Export Cable Corridor.

4.4.7. Within Tranche B, initial interpretation of the geophysical data and seabed imagery identified several areas as having possible resemblance to stony reef habitat. These were generally in areas identified as predominantly boulder clay/till.

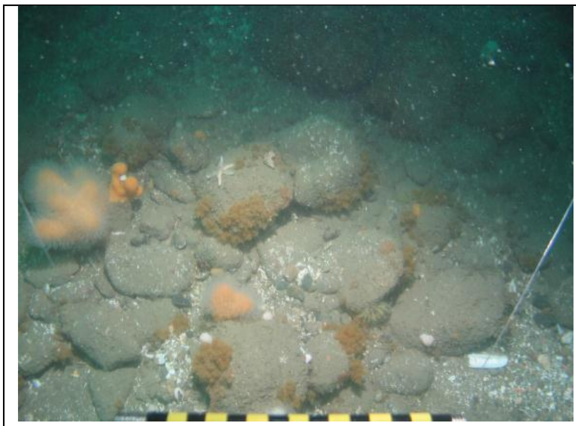
4.4.8. Nine transects (ranging from 270m^2 to 479m^2) assessed using both digital stills and video footage were analysed for interpretation. Reef assessment was based solely on the seabed imagery (digital stills and video footage) in line with the established Gardline protocol and guidelines on the assessment of stony reef published by Irving (2009).

4.4.9. At least 10% of cobble and boulder material, across an area greater than 25m^2 is required for an area to be classified as low resemblance to stony reef. Results from the analysis of the video footage and digital stills revealed a patchy distribution of pebbles, cobbles and boulders on sand. On average, transects contained areas between 1% and 29% cobble and boulder material. Patches of up to 65% cobble and boulder material (indicating medium resemblance to stony reef), were recorded at Transects TB_TRAN_05, 07 and 09. However, these patches did not cover a large enough area (>25m^2) at TB_TRAN_05 to constitute medium resemblance stony reef.

4.4.10. Five transects were identified as having passed over areas >25m^2 of low resemblance to stony reef (Tranche B_TRAN_03, 04, 05, 06 and 08); these contained up to 35% cobble and boulder material and had an associated greater abundance of epifauna. Two transects (TB_TRAN_01 and TB_TRAN_02) showed no resemblance to stony reef. Although Transect TB_TRAN_02 contained small patches of 10 – 40% cobbles, none of these patches extended to above 25m^2.

4.4.11. Abundant epifauna were recorded across all transects, with particularly high densities of echinoderms (*Ophiothix fragilis*) and cnidarians (*Alcyonium* sp.) evident at transects Tranche B_TRAN_04, 05 and 06.

4.4.12. Transects TB_TRAN_07 and TB_TRAN_09 contained areas >25m^2 which could be classified as medium resemblance to stony reef when all criteria were considered. Assessment of the video footage revealed patches of up to 60% boulders, 20% cobbles and association with abundant epifauna. Although slightly lower epifaunal abundances were observed along TB_TRAN_09, medium resemblance to stony reef was scored overall due to large areas of cobbles and boulders.



(a) TB_TRAN_07 Fix 64 - Boulders and cobbles with silty-sand and gravel

(a) TB_TRAN_09 Fix - Sand and gravel with cobbles and boulders

Figure 4.13 "Medium" stony reef identified within boundary of Tranche B

4.4.13. Along the Dogger Bank Teesside A & B Export Cable Corridor, after initial interpretation of the geophysical data and seabed imagery, one additional transect (TRAN_89) was investigated for potential stony reef structures.

4.4.14. TRAN_89 measured 304m^2, and footage and images were recorded across features of interest and surrounding featureless seabed.

4.4.15. Flat seabed with <10% cobble and boulder material was recorded across the majority of Dogger Bank Teesside A & B Export Cable Corridor _TRAN_89, which is not indicative of a stony reef. Therefore, it was concluded that no Annex I cobble reef habitat currently exists within either the offshore or inshore parts of the export cable corridor for Dogger Bank Teesside A & B. A full Annex I habitat assessment will be undertaken as part of formal pre-construction benthic surveys, with the design and methodologies to be adopted to be fully agreed via consultation with the MMO and JNCC/NE. Unless superceded at the time of survey design, reference will be made to the ALSF funded report by Limpenny *et al.* (Limpenny *et al.*, 2010) which produced best practice guidance for surveys of Annex I reef habitats.

4.4.16. In summary, drop down video survey and subsequent assessment of the Dogger Bank Teesside A & B sites and cable corridor identified potential areas of low to medium reef (as per Irving 2009). However, these areas are not judged to represent discrete Annex I habitat in their own right but are interpreted as forming a component part of the wider sandbank-and-trough system that characterises large parts of the Dogger Bank cSAC. The trough areas within the cSAC will occasionally reveal an underlying cobble base and that this may shift according to the movement of the sand, therefore, these areas identified by drop down video survey are not judged to represent discrete Annex I stony reef (geogenic) habitat.

4.4.17. This interpretation of these coarser substrate features within the site has been provided via discussions with Envision, who undertook the habitat mapping for this project but were also involved in the April 2008 survey undertaken in partnership with Cefas and the British Geological Survey (BGS) (Diesing *et* al. 2009) on behalf of the JNCC, in order to provide them with evidence on the distribution and extent of Annex I habitats on the Dogger Bank in advance of its possible designation as a Special Area of Conservation (SAC).

4.4.18. With respect to quantifying the term "occasional" used above, it is not possible to do this with any great accuracy due to the inherent variation that exists in the site. More importantly, as part of the design of pre-construction benthic surveys that will be required to provide the baseline against which future monitoring can take place, Forewind will, via consultation with the MMO, include plans for an Annex I habitat assessment. This will provide a more up-to-date picture of the potential presence of Annex I cobble reef habitat within the entire study area.

Designated Sites

4.4.19. Apart from the location of Dogger Bank Teesside A & B wind farms and parts of the Dogger Bank Teesside A & B Export Cable Corridor within the boundary of the Dogger Bank cSAC, no other parts of Dogger Bank Teesside A & B lie within the boundaries of any other SAC, Special Protection Area (SPA) or Site of Special Scientific Interest (SSSI) designation. However, the proposed landfall location between Redcar and Marske-by-the-Sea is just 1km south of the boundaries of the Teesmouth and Cleveland Coast SPA and Ramsar site and approximately 0.5km south of the boundary of the Redcar Rocks SSSI.

4.4.20. The benthic impact assessments presented within this chapter do not include an assessment of the potential for the favourable conservation status or achievement of conservation objectives of either any SAC (overall) or its features to be compromised. Instead, the assessment presented within this section enable the magnitude of effects, and subsequent significance of impacts on benthic habitats that lie within SAC boundaries to be determined. These conclusions have then been taken in to account by the **Habitats Regulations Assessment Report** (HRA Report) which assesses potential impacts on the conservation objectives of SACs potentially affected by the Dogger Bank Teesside A & B development – see **HRA Report** (**Appendix A HRA Screening Report**).

UK BAP Habitats

4.4.21. Many of the biotopes identified across Tranche B and the Dogger Bank Teesside A & B Export Cable Corridor are judged to represent the UK BAP habitat 'subtidal sands and gravel' (JNCC 2010), though some crossover with the Annex I habitat "*sandbanks which are slightly covered by sea water at all times*" exists. Sand and gravel habitats are widespread around the British Isles. They occur in a range of environmental conditions, which determine the type of faunal communities found in this habitat.

4.4.22. Offshore gravel and sand habitats around the British Isles support internationally important commercial fisheries, such as those for scallops and flatfish, and industrial fisheries, such as sandeels.

4.4.23. They can also be important nursery grounds for the young of commercial fish species such as flatfish, bass, skates and rays, as well as sharks (Maddock 2008).

4.4.24. Deeper waters within the Dogger Bank Teesside A & B Export Cable Corridor which had higher mud content than other areas also support certain biotopes (e.g. SS.SMu.CFiMu.SpnMeg – 'seapens and burrowing megafauna in circalittoral fine mud' which are considered to fall within the UK BAP habitat 'mud habitats in deep water' (JNCC 2011).

4.4.25. None of the species or habitats found at the intertidal landfall transect locations are currently listed as UK BAP species or habitats.

4.4.26. Further details on marine BAP habitats are provided in **Chapter 8**.

Marine Conservation Zones

4.4.27. Marine Conservation Zones (MCZs) will augment the Natura 2000 network for species and habitats that are either not covered by the Habitats Directive, or for which the Directive might not provide adequate coverage, providing added protection to marine ecosystems, ecological processes, habitats and species.

4.4.28. Three rMCZs were initially screened into the Dogger Bank Teesside A & B assessment:

- **NG16 Swallow Sand**: north of the Dogger Bank Zone. Recommended as a representative example of subtidal coarse sediment, subtidal sand broadscale habitats and the 'subtidal sands and gravels' Habitat of Conservation Importance.
- **NG12 Compass Rose**: is located approximately 8km to the south of the Dogger Bank Teesside A & B Export Cable Corridor. This rMCZ has been recommended due to the presence of the broad scale habitat, moderate energy circalittoral rock.
- **NG11 Runswick Bay**: The Dogger Bank Teesside A & B Export Cable Corridor is located 0.5km to the north of the boundary of the Runswick Bay rMCZ. This rMCZ has been recommended for designation due to the presence of seven broad scale habitat types:

  - Moderate energy infralittoral rock;
  - High energy infralittoral rock;
  - Moderate energy circalittoral rock;
  - High energy circalittoral rock;
  - Subtidal coarse sediment;
  - Subtidal mixed sediment; and
  - Subtidal sand.

4.4.29. However, on 21st November 2013, Defra announced the designation of 27 MCZ's from the initial long-list of 127 rMCZs that had been developed. The two rMCZ's that were located closest to the Dogger Bank Teesside A & B study area (Compass Rose rMCZ) and Runswick Bay rMCZ) and, therefore, had the potential to be impacted by construction activities, were not designated as MCZs but remain as rMCZs.

4.4.30. Following further review of sediment plume extents, Swallow Sands rMCZ was also screened out of the assessment for Dogger Bank Teesside A & B.

4.4.31. The subtidal sands and gravels habitat of conservation importance and the bivalve ocean quahog *Arctica islandica* are also recommended as features of this site.

4.4.32. Further details on these MCZs are provided in **Chapter 8**.

OSPAR

4.4.33. There was no evidence from the assessment of seabed imagery of any features of conservation importance on the OSPAR (2008) list of threatened and/or declining species and habitats within either Tranche B or the Dogger Bank Teesside A & B Export Cable Corridor or at the landfall location.

4.4.34. Juveniles of *A. islandica* were recorded at some sampling stations within Tranche B and the Dogger Bank Teesside A & B Export Cable Corridor. However, no adults of this species, which is listed by OSPAR as a threatened and/or declining species for the Greater North Sea (OSPAR Region II), were recorded.

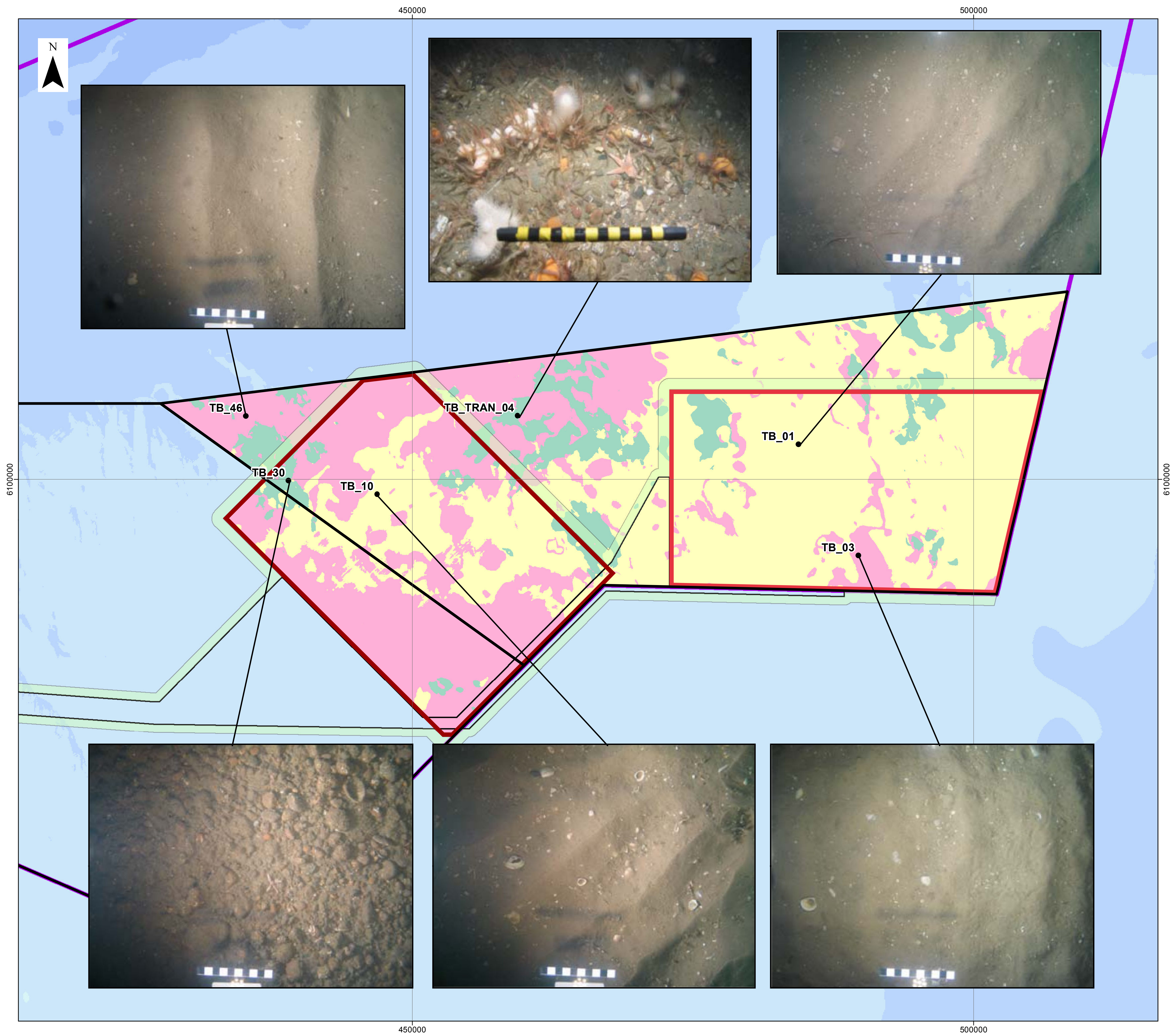
Table 4.4 Valued Ecological Receptor (VER) protection status and conservation interest and their importance/value within the study area

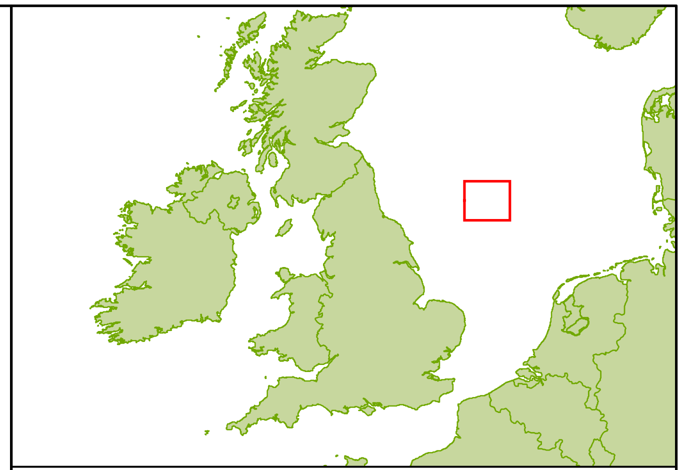
VER	Representative biotopes	Actual conservation interest	Value[1] within study area and justification
A - Sandy sediment supporting relatively low diversity benthic communities which form part of the Annex I Sandbank Feature **(within boundary of cSAC)**	SS.SSa.CFiSa.ApriBatPo SS.Ssa.CFiSa SS.SCS.ICS.SLan	Annex I Habitat "*sandbanks that are slightly covered by seawater all the time*"- qualifying features of the Dogger Bank cSAC UK BAP Priority Habitat – 'Subtidal sands and gravels'	**International** The benthic communities listed here form component parts of the Annex I subtidal sandbank habitat listed as a qualifying feature of the Dogger Bank cSAC. Certain elements may also be representative of the UK BAP Priority Habitat - Subtidal sands and gravels
B - Coarse sediments with medium to high diversity benthic communities which form part of the Annex I Sandbank Feature **(within boundary of cSAC)**	SS.SMx.CMx SS.SCS.CCS.MedLumVen SS.SMx.CMx.OphMx	Annex I Habitat "*sandbanks that are slightly covered by seawater all the time*"- qualifying features of the Dogger Bank cSAC UK BAP Priority Habitat – 'Subtidal sands and gravels'	**International** The benthic communities listed here form component parts of the Annex I subtidal sandbank habitat listed as a qualifying feature of the Dogger Bank cSAC. Certain elements may also be representative of the UK BAP Priority Habitat - Subtidal sands and gravels
C - Muddy sand sediments with medium diversity benthic communities (including sea pens) which form part of the Annex I Sandbank Feature **(within boundary of cSAC)**	SS.SSa.IMuSa.EcorEns SS.SSa.CMuSa.AbraAirr SS.SMu.CFiMu.SpnMeg	Annex I Habitat "*sandbanks that are slightly covered by seawater all the time*" - qualifying features of the Dogger Bank cSAC UK BAP Priority Habitat – 'Mud habitats in deep water'	**International** The benthic communities listed here form component parts of the Annex I subtidal sandbank habitat listed as a qualifying feature of the Dogger Bank cSAC. Certain elements may also be representative of the UK BAP Priority Habitat – Mud habitats in deep water
D - Sandy sediment supporting relatively low diversity benthic communities **outside cSAC boundary)**	SS.Ssa.CFiSa SS.SCS.ICS.SLan SS.SSa.CFiSa.ApriBatPo SS.SSa.CFiSa.EpusOborApri	Not Annex I Habitat UK BAP Priority Habitat 'Subtidal sands and gravels'	**Regional** Biotopes fall within descriptions of UK BAP Priority Habitat 'Subtidal sands and gravels'. Regionally important habitats within the study area, i.e. are locally widespread and/or abundant

[1] See definitions in **Tables 3.2** and **3.3**.

VER	Representative biotopes	Actual conservation interest	Value[1] within study area and justification
	SS.SSa.IFiSa.NcirBat		
E - Coarse sediments with medium to high diversity benthic communities **outside cSAC boundary**	SS.SMx.CMx SS.SMx.CMx.OphMx SS.SMx.OMx.PoVen	Not Annex I Habitat UK BAP Priority Habitat 'Subtidal sands and gravels'	**Regional** Biotopes fall within descriptions of UK BAP Priority Habitat 'Subtidal sands and gravels'. Regionally important habitats within the study area, i.e. are locally widespread and/or abundant
F - Muddy sediments with medium diversity benthic communities (including sea pens) **outside cSAC boundary**	SS.SMu.CFiMu.SpnMeg SS.SMu.CSaMu.ThyNten/AfilNten	Not Annex I Habitat UK BAP Priority Habitat 'Mud habitats in deep water'	**National** Biotopes fall within descriptions of UK BAP Priority Habitat 'Mud habitats in deep water'. Nationally important populations within study area
G - Rock-based infralittoral and circalittoral habitats	CR.MCR.EcCr.FaAlCr	None	**Local** Habitats and species which are not protected under conservation legislation but which form a key component of the benthic ecology within the study area and which may also be a functional component of a feature of conservation value (e.g. BAP priority habitat)
H - Intertidal sand-based habitats	LS.LSa.MoSa.AmSco.Pon LS.LSa.MoSa.AmSco.Sco LS.LSa.FiSa.Po.Ncir LS.LSa.MoSa.BarSa LS.LSa.St.tal LS.LSa.MoSa.AmSco.Eur LS.LSa.FiSa.Po.Ncir,	None	**Local** Habitats and species which are not protected under conservation legislation but which form a key component of the benthic ecology within the study area and which may also be a functional component of a feature of conservation value (e.g. BAP priority habitat)

VER	Representative biotopes	Actual conservation interest	Value[1] within study area and justification
I - Intertidal rock-based habitats	LR.FLR.Eph.EntPor	None	**Local** Habitats and species which are not protected under conservation legislation but which form a key component of the benthic ecology within the study area and which may also be a functional component of a feature of conservation value (e.g. BAP priority habitat)





LEGEND

- Dogger Bank Zone
- Tranche boundary
- Dogger Bank Teesside A
- Dogger Bank Teesside B
- Dogger Bank Teesside A & B Export Cable Corridor
- Temporary works area

Valued Ecological Receptor (VER)

- A
- B
- C

0 2.5 5 10
Kilometres

Data Source:
VERS © Envision, 2013
Background bathymetry image derived in part from TCarta data © 2009

PROJECT TITLE

DOGGER BANK TEESSIDE A & B

DRAWING TITLE

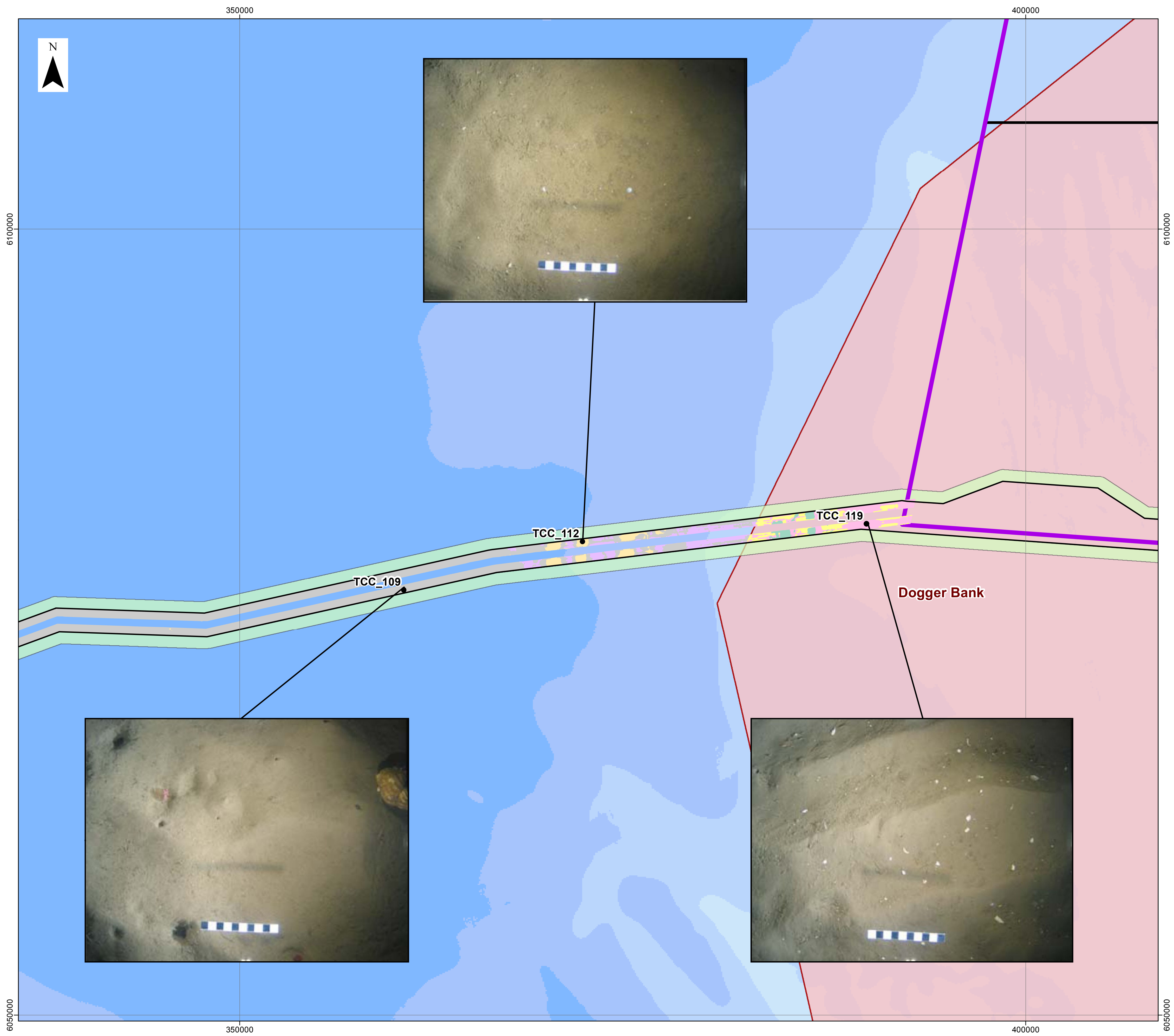
Figure 4.14 Spatial distribution of VERs across Dogger Bank Teesside A and Dogger Bank Teesside B

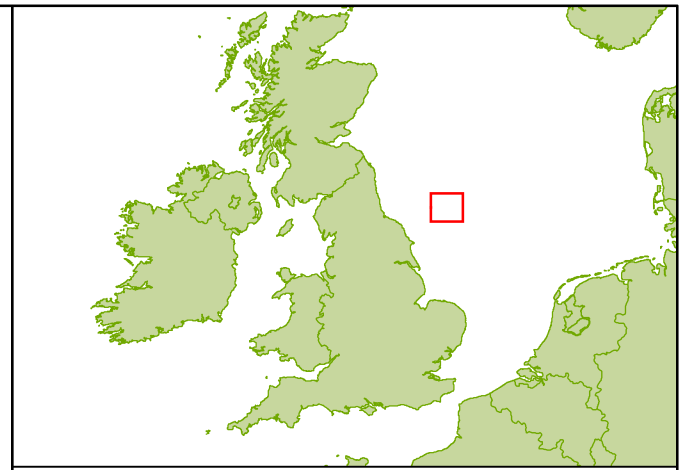
VER	DATE	REMARKS	Drawn	Checked
1	29/05/2013	Draft	LW	RZ
2	03/10/2013	PEI3	LW	RZ
3	07/02/2014	DCO Submission	JE	RZ

DRAWING NUMBER: **F-OFL-MA-204**

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

FOREWIND





LEGEND

- Dogger Bank Zone
- Tranche boundary
- Dogger Bank Teesside A & B Export Cable Corridor
- Temporary works area
- Offshore cSAC

Valued ecological receptor (VER)

- A
- B
- C
- D
- E
- F

0 2.5 5 10
Kilometres

Data Source:
VERS © Envision, 2013
SAC © JNCC, 2013
Background bathymetry image derived in part from TCarta data © 2009

PROJECT TITLE

DOGGER BANK TEESSIDE A & B

DRAWING TITLE

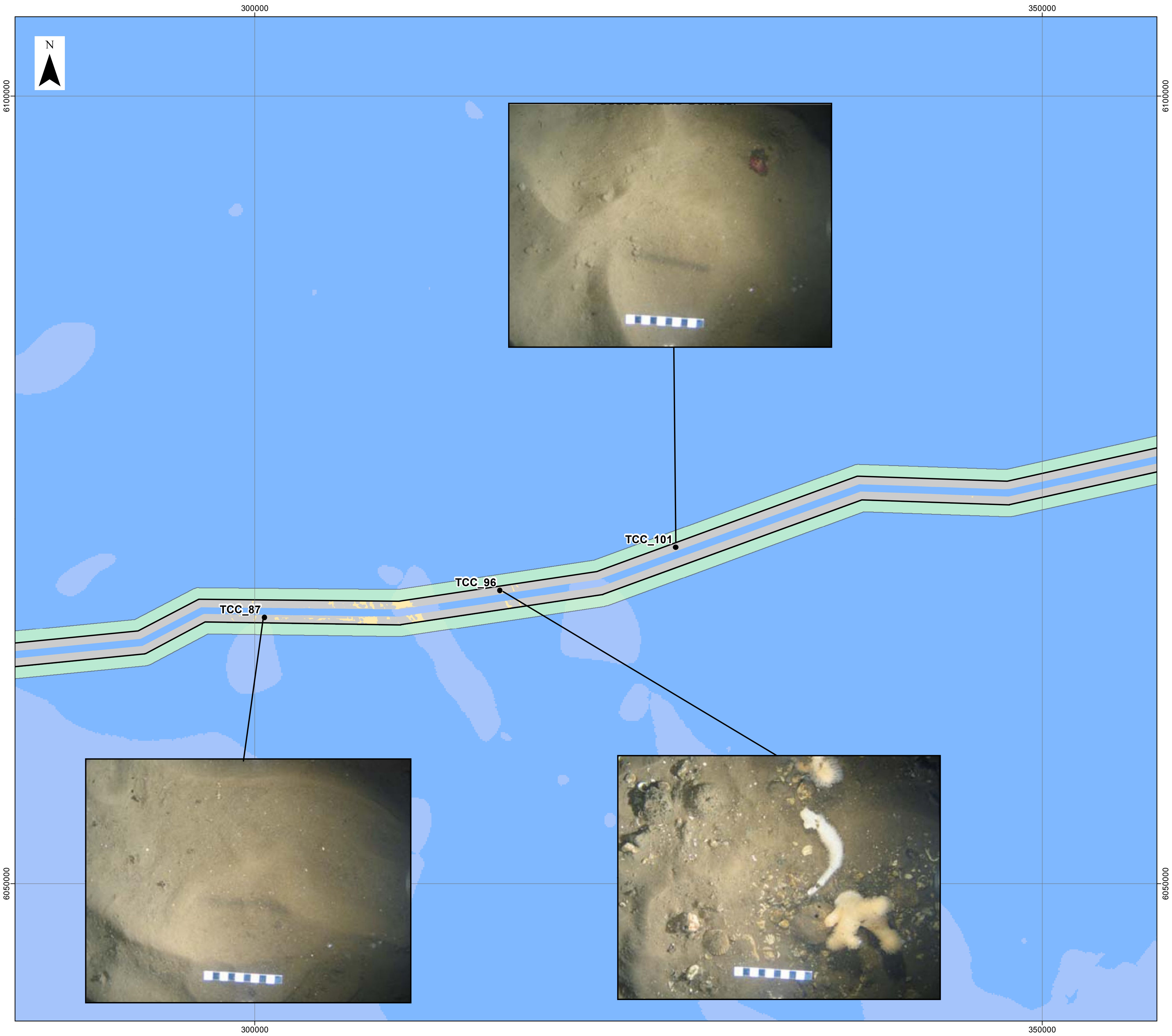
Figure 4.15 Spatial distribution of VERs across Dogger Bank Teesside A & B Export Cable Corridor (eastern section)

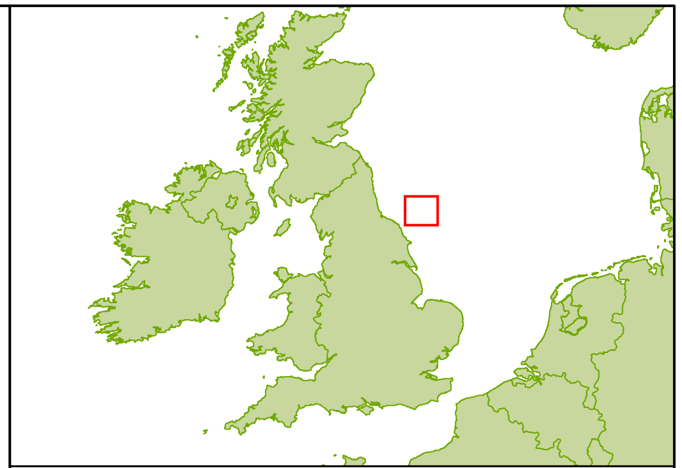
VER	DATE	REMARKS	Drawn	Checked
1	28/05/2013	Draft	LW	RZ
2	03/10/2013	PEI3	LW	RZ
3	07/02/2014	DCO Submission	JE	RZ

DRAWING NUMBER: **F-OFL-MA-205**

SCALE	1:250,000	PLOT SIZE	A3	DATUM	WGS84	PROJECTION	UTM31N

FOREWIND



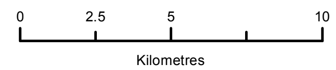


LEGEND

White box, black outline	Dogger Bank Teesside A & B Export Cable Corridor
Light green	Temporary works area

Valued ecological receptor (VER)

Pink	A
Green	B
Yellow	C
Purple	D
Orange	E
Grey	F



Data Source:
VERS © Envision, 2013
Background bathymetry image derived in part from TCarta data © 2009

PROJECT TITLE

DOGGER BANK TEESSIDE A & B

DRAWING TITLE

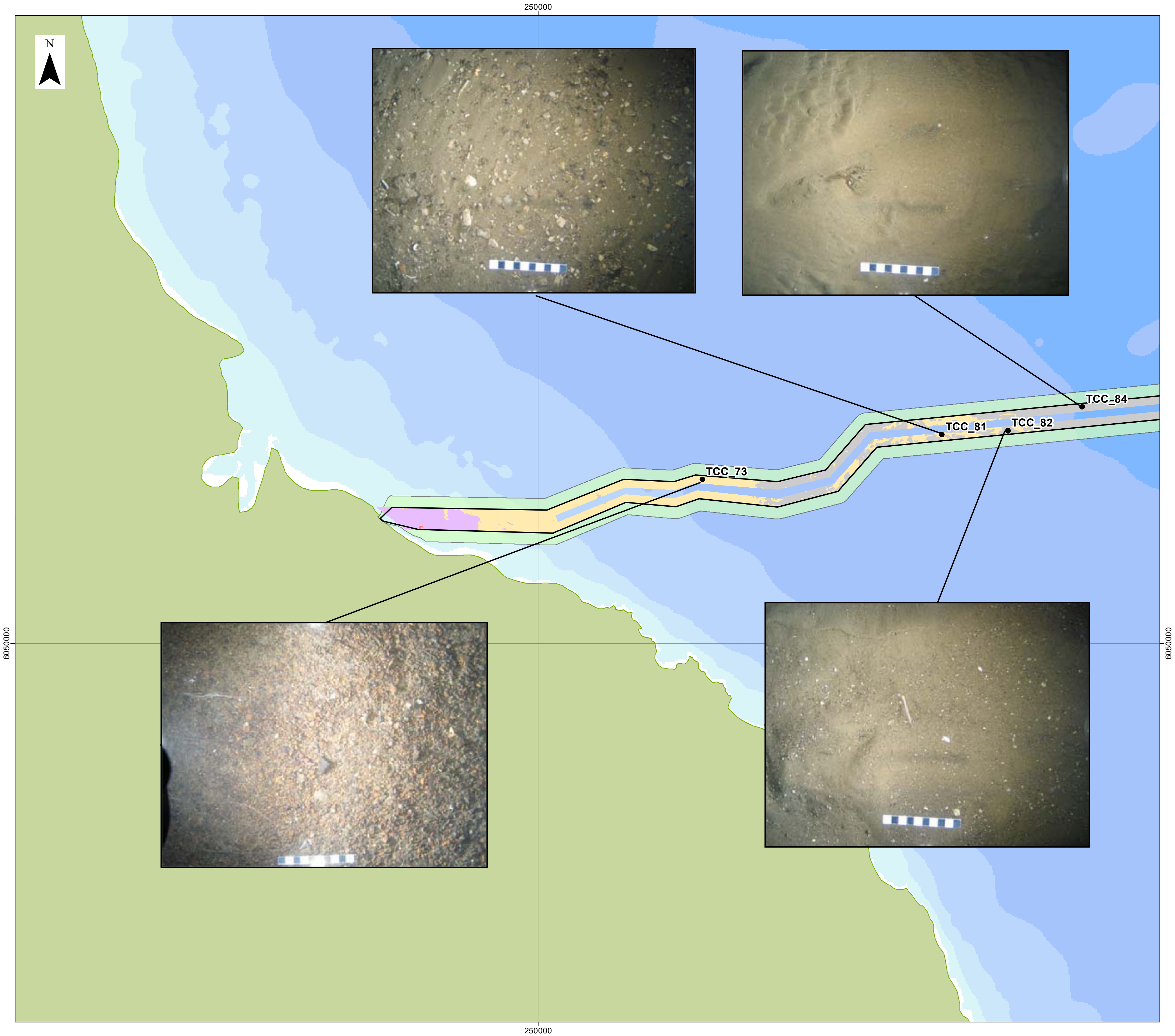
Figure 4.16 Spatial distribution of VERs across Dogger Bank Teesside A & B Export Cable Corridor (central section)

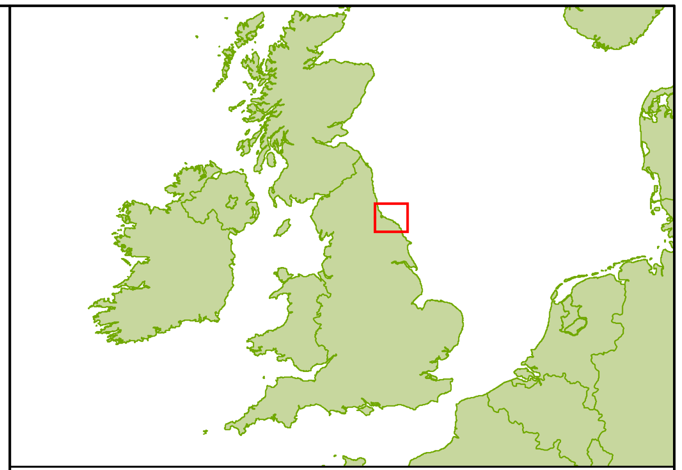
VER	DATE	REMARKS	Drawn	Checked
1	24/05/2013	Draft	LW	RZ
2	03/10/2013	PEI3	LW	RZ
3	07/02/2014	DCO Submission	JE	RZ

DRAWING NUMBER: **F-OFL-MA-206**

SCALE	1:250,000	PLOT SIZE	A3	DATUM	WGS84	PROJECTION	UTM31N

FOREWIND





LEGEND

- Dogger Bank Teesside A & B Export Cable Corridor
- Temporary works area

Valued ecological receptor (VER)

- A
- B
- C
- D
- E
- F
- G

0 2.5 5 10
Kilometres

Data Source:
VERS © Envision, 2013
Background bathymetry image derived in part from TCarta data © 2009

PROJECT TITLE

DOGGER BANK TEESSIDE A & B

DRAWING TITLE

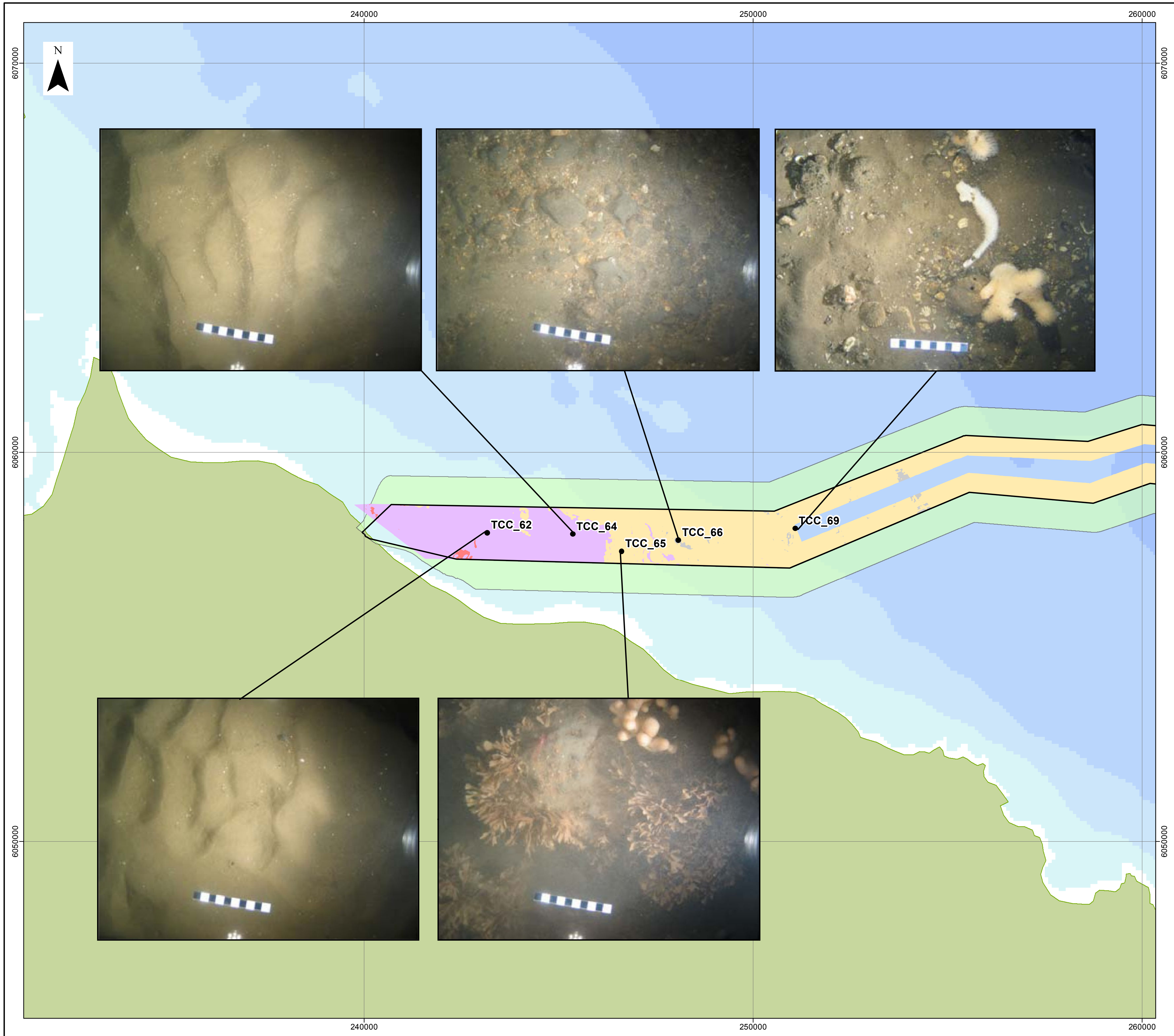
Figure 4.17 Spatial distribution of VERs across Dogger Bank Teesside A & B Export Cable Corridor (western section)

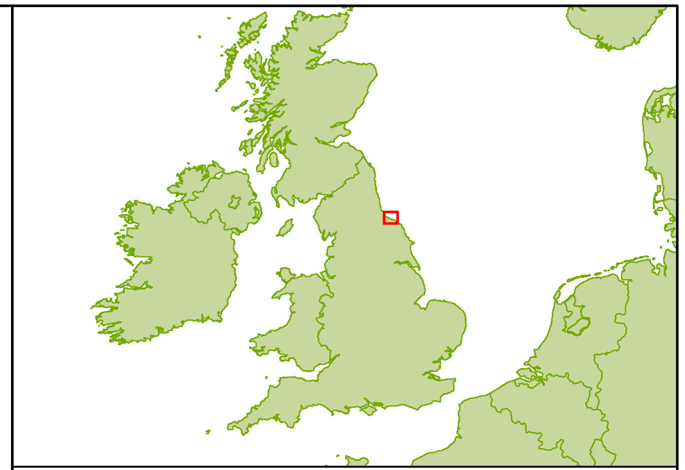
VER	DATE	REMARKS	Drawn	Checked
1	24/05/2013	Draft	LW	RZ
2	03/10/2013	PEI3	LW	RZ
3	07/02/2014	DCO Submission	JE	RZ

DRAWING NUMBER: **F-OFL-MA-207**

SCALE	1:250,000	PLOT SIZE	A3	DATUM	WGS84	PROJECTION	UTM31N

FOREWIND





LEGEND

Dogger Bank Teesside A & B Export Cable Corridor

Temporary works area

Valued ecological receptor (VER)

A

B

C

D

E

F

G

0 1 2 4
Kilometres

Data Source:
VERS © Envision, 2013
Background bathymetry image derived in part from TCarta data © 2009

PROJECT TITLE

DOGGER BANK TEESSIDE A & B

DRAWING TITLE

Figure 4.18 Spatial distribution of VERs across Dogger Bank Teesside A & B Export Cable Corridor

VER	DATE	REMARKS	Drawn	Checked
1	28/05/2013	Draft	LW	RZ
2	03/10/2013	PEI3	LW	RZ
3	07/02/2014	DCO Submission	JE	RZ

DRAWING NUMBER:

F-OFL-MA-208

SCALE	1:100,000	PLOT SIZE	A3	DATUM	WGS84	PROJECTION	UTM31N

FOREWIND

5. Assessment of Impacts – Worst Case Definition

5.1. General

5.1.1. This section establishes the realistic worst case scenario for each category of impact as a basis for the subsequent impact assessment. For this assessment this involves both a consideration of the construction scenarios (i.e. the manner in which Dogger Bank Teesside A & B will be built out), as well as the particular design parameters of each project (such as the maximum construction footprint at the landfall) that define the Rochdale Envelope[2].

5.1.2. Full details of the range of development options being considered by Forewind are provided within **Chapter 5 Project Description**. For the purpose of the marine and intertidal ecology impact assessment, the key project parameters which form the realistic worst case are set out in **Table 5.1**.

5.1.3. Only those design parameters with the potential to influence the level of impact are identified. Therefore, if the design parameter is not described, it is not considered to have a material bearing on the outcome of the assessment.

5.1.4. The realistic worst case scenarios identified here are also applied to the Cumulative Impact Assessment (CIA). When the worst case scenarios for the project in isolation do not result in the worst case for cumulative impacts, this is addressed within the cumulative Section of this chapter (see Construction Scenarios).

5.2. Construction Scenarios

5.2.1. There are a number of key principles relating to how the projects will be built, and that form the basis of the Rochdale Envelope (see **Chapter 5**). These are:

- The two projects may be constructed at the same time, or at different times;
- If built at different times, either project could be built first;
- Offshore construction will commence no sooner that 18 months post consent, but must start within seven years of consent (as an anticipated condition of the development consent order); and
- Assuming a maximum construction period per project of six years, and taking the above into account, the maximum construction period over which the construction of Dogger Bank Teesside A & B could take place is 11 years and six months.

[2] As described in **Chapter 5** the term 'Rochdale Envelope' refers to case law (R.V. Rochdale MBC Ex Part C Tew 1999 "the Rochdale case"). The 'Rochdale Envelope' for a project outlines the realistic worst case scenario or option for each individual impact, so that it can be safely assumed that all lesser options will have less impact.

5.2.2. To determine which offshore construction scenario is the worst realistic case for a given receptor, two types of effect exist with the potential to cause a maximum level of impact on a given receptor:

- Maximum duration effects; and
- Maximum peak effects.

5.2.3. To ensure that the Rochdale Envelope incorporates all of the possible construction scenarios (as outlined in **Chapter 5**), both the maximum duration effects and the maximum peak effects have been considered for each receptor. Furthermore, the option to construct each project in isolation is also considered ('Build A in isolation' and 'Build B in isolation'), enabling the assessment to identify any differences between the two projects. The three construction scenarios for Dogger Bank Teesside A & B considered within the marine and intertidal ecology assessment are, therefore:

- Build A or Build B in isolation;
- Build A and B concurrently – provides the worst 'peak' impact and maximum working footprint; and
- Build A, then Build B (sequential) – provides the worst duration of impact.

5.2.4. Any differences between the two projects, or differences that could result from the manner in which the first and the second projects are built (concurrent or sequential and the length of any gap) are identified and discussed in the impact assessment section of this chapter (Section 6).

5.2.5. For each potential impact only the worst case construction scenario for two projects is presented, i.e. either concurrent or sequential. The justification for what constitutes the worst case is provided, where necessary, in Section 6.

5.2.6. As such, the construction scenarios presented within the impact assessment are:

- Single project (Dogger Bank Teesside A or B in isolation); and
- Two projects – concurrent or sequential (Dogger Bank Teesside A & B together).

5.3. Operation Scenario

5.3.1. **Chapter 5** provides details of the operational scenarios for Dogger Bank Teesside A & B. Flexibility is required to allow for the following three scenarios:

- Dogger Bank Teesside A to operate on its own;
- Dogger Bank Teesside B to operate on its own, and
- For the two projects to operate concurrently.

5.3.2. Only one assessment is presented for the single project scenario, although any differences between Dogger Bank Teesside A & B are clearly identified in the discussion.

5.4. Decommissioning scenarios

5.4.1. **Chapter 5** provides details of the decommissioning scenarios for Dogger Bank Teesside A & B. Exact decommissioning arrangements will be detailed in a Decommissioning Plan (which will be drawn up and agreed with the DECC and The Crown Estate prior to construction); however, for the purpose of this assessment it is assumed that decommissioning of Dogger Bank Teesside A & B could be conducted separately, or at the same time.

5.5. Realistic Worst case Scenario

5.5.1. **Table 5.1** identifies the key design parameters for the impact assessment. The parameters identified have been derived from a desktop review and through consultation with stakeholders.

5.5.2. Forewind is considering two wind turbine sizes:

- Six megawatt (6MW) with a maximum of 200 wind turbine foundations in each Dogger Bank Teesside project (A **or** B) (total of 1.2GW capacity); and
- 10MW with a maximum of 120 wind turbine foundations in each Dogger Bank Teesside project (A **or** B) (total capacity 1.2GW per project).

5.5.3. Both the above scenarios are considered within the realistic worst case scenario identification table (**Table 5.1**).

Table 5.1 Key design parameters forming the realistic worst case scenario for the assessment of impacts on marine and intertidal ecology

Impact	Key design parameters forming the realistic worst case scenario	Rationale
Construction		
Physical disturbance to habitat and species and temporary habitat loss (each project)	Maximum footprint of temporary disturbance (Dogger Bank Teesside A & B sites and Dogger Bank A & B Dogger Bank Teesside A & B Export Cable Corridor) during construction assessed as **21.72km^2** (Dogger Bank Teesside A) and **20.83km^2** (Dogger Bank Teesside B) (a) Seabed prepared area for 200 (6MW) x GBS foundations (0.845km^2) (b) Residual mounds of sediment left *in situ* following seabed preparation/disposal of drill arisings (0.657km^2) (c) Seabed prepared areas for 5 x met-masts (0.019km^2) (d) Seabed prepared area for 4 x collector stations (0.032km^2) (e) Seabed prepared area for 1 x converter station (0.016km^2) (f) Seabed prepared area for 2 x accommodation platforms (0.032km^2) (g) Jack up barge seabed footprint for 200 turbines (1.008km^2) (h) Anchor footprint from foundation installation (0.372km^2) (i) Anchor footprint from wind turbine generators and topside installation of up to 950 km of inter array cables (with worst-case disturbance width via jetting of 10m) (0.093km^2) (j) Installation of up to 320 km of inter platform cables (with worst-case disturbance width via jetting of 10m) (3.20km^2) (k) Installation of up to 950km of inter-array cables (with worst-case disturbance width via jetting of 10m) (9.50km^2) (l) Installation of up to 573 km (**Dogger Bank Teesside A**) and 484 km (**Dogger Bank Teesside B**) of export cables (with worst-case disturbance width via jetting of 10m (**Dogger Bank Teesside A** 5.73km^2) (**Dogger Bank Teesside B** 4.84km^2) (m) Anchor footprint from export cable installation (0.176km^2) (n) Construction buoys (0.034km^2)	All values shown here are for Dogger Bank Teesside A alone. For Dogger Bank Teesside A and Dogger Bank Teesside B combined, values should be doubled apart from export cable disturbances where different cable lengths for **Dogger Bank Teesside A** and **Dogger Bank Teesside B** = different impact footprints. Greatest footprint of temporary habitat disturbance via seabed preparation for Gravity Base Structure (GBS) foundations All Met mast foundation dimensions are based upon the 4MW turbine dimensions that were included previously Assumes export cable installation via anchor spread barge only required from KP0 (landfall) to KP80 (80km offshore)
Increased suspended sediment concentration and sediment deposition	Release of sediments into water column (and subsequent re-deposition) resulting from following activities: • Seabed preparation works and subsequent disposal of removed material next to foundation location • Disposal of *in situ* drill arisings from drilled concrete 12m monopiles; and • Installation of array, inter-platform, inter-project and export cables via trenching.	In order to define the realistic worst case scenario for release of suspended sediments during the foundation installation and cable laying processes a conservative approach was adopted. In this approach, 24 x 12m monopole foundations, a set of inter-array cables

Impact	Key design parameters forming the realistic worst case scenario	Rationale
	With modelled outputs as detailed below (concentrations presented are excesses over the natural background concentration (2mg/l)): **Suspended sediment concentration (bottom layer)** **Tranche B** • Maximum predicted suspended sediment concentration of greater than 200mg/l occurring within the confines of the 24 foundations and along the in-Zone cable route and between approximately 1km and 11km either side of the route. • Maximum distance from the centre of the foundations to where background concentration of 2mg/l is reached is up to 40km to the south and north; • Average suspended sediment concentration between 50mg/l and 100mg/l occurring within the confines of the 24 foundations and within a band approximately 9km either side of the in-Zone cable route; • Average suspended sediment concentration reduces to 2mg/l approximately 18km (south) to 32km (north) from the in-Zone cable route; • 2mg/l (baseline) is exceeded >90% of the 30-day simulation period for 15km southwest of the centre of the foundations along the in-Zone cable route. **Dogger Bank Teesside A & B Export Cable Corridor** • Maximum predicted suspended sediment concentration is 100-200mg/l in two small patches. One near the coast and one 50km offshore. However, maximum SSC are typically less than 100mg/l along large proportions of the Dogger Bank Teesside A & B Export Cable Corridor. • Maximum distance from the Dogger Bank Teesside A & B Export Cable Corridor to where background concentration of 2mg/l is reached is up to 50km to the north and 45km to the south; • Only small changes in average suspended sediment concentration (of up to 10mg/l) are predicted along the Dogger Bank Teesside A & B Export Cable Corridor; **Sediment Deposition** **Tranche B** • Small patch within the confines of the foundation layout where the maximum deposition reaches 10-50mm; • Predicted maximum deposition reduces to 0.5mm up to approximately 35km north of the in-Zone cable route; • Average deposition of 1-5mm occurs within and 10km to the north of the foundations; • At the end of the 30-day simulation, the predicted thickness of sediment resting on the	connecting them and one export cable were all installed together within a 30-day period. It is considered that this provided a conservative representation of the possible construction process (see **Chapter 9 Marine Physical Processes**). The foundations have been located near to the habitats most sensitive to increases in suspended sediment concentration. Sandeels are considered the most sensitive, and the highest densities (proxy data from Danish satellite vessel monitoring system) occur in the western corner of Dogger Bank Teesside B and outside and adjacent to its north and west boundaries.

Impact	Key design parameters forming the realistic worst case scenario	Rationale
	seabed is less than 0.1mm. **Dogger Bank Teesside A & B Export Cable Corridor** • Along the Dogger Bank Teesside A & B Export Cable Corridor, the maximum deposition decreases to less than 5mm • Predicted maximum deposition reduces to 0.5mm up to 25km north of the Dogger Bank Teesside A & B Export Cable Corridor; • Average deposition of 1-5mm occurs in small patches along the cable corridor; • Average deposition decreases to less than 0.5mm along the remainder cable corridor, and is effectively zero in places; • At the end of the 30-day simulation, the predicted thickness of sediment resting on the seabed is less than 0.1mm.	
Release of sediment contaminants resulting in potential effects on benthic ecology	As above	As above
Increased suspended sediment concentration leading to impacts on plankton and primary productivity	Release of sediments into water column (and subsequent re-deposition) resulting from following activities: • Seabed preparation works and subsequent disposal of removed material next to foundation location • Disposal of *in situ* drill arisings from drilled concrete 12m monopiles; and • Installation of array, inter-platform, inter-project and export cables via trenching. Values as above	As above
Physical disturbance to intertidal habitats and species during landfall works	**Single Project in isolation** 10m wide open-cut trenching x 300m length of intertidal region = $0.003km^2$ 2 x 10x10x3m coffer dams = $200m^2$ **Both projects built together** 20m wide open-cut trenching x 300m length of intertidal region = $0.006km^2$ 4 x 10x10x3m coffer dams = $400m^2$	Dimensions provided are for single project built in isolation (minimum footprint) and both projects built at same time (worst-case footprint)
Potential impacts on sites of marine conservation interest	Values for temporary habitat disturbance and increased suspended sediment concentrations and deposition as above for other impacts	As above

Impact	Key design parameters forming the realistic worst case scenario	Rationale
Operation		
Permanent loss of habitat via placement of project infrastructure (foundations, cable protection, scour protection, vessel moorings etc.)	Maximum footprint of permanent habitat loss assessed as **7.509 km^2** (Dogger Bank Teesside A) **and 7.239 km^2** (Dogger Bank Teesside B). (a) 200 x Gravity Base Foundations – 1.005 km^2 (b) GBS foundations for 5 x met-masts – 0.023 km^2 (c) GBS foundations for 4 x collector stations – 0.036 km^2 (d) GBS foundation for 1 x converter station – 0.017 km^2 (e) GBS foundation for 2 x accommodation blocks – 0.035 km^2 (f) Footprint of vessel moorings and buoy chains – 0.470 km^2 (g) Inter-array cable protection (incl. cable ends) – 1.000 km^2 (h) Inter-platform cable protection – 1.000 km^2 (i) Inter-platform cable crossings – 0.147 km^2 (j) Export cable protection – 2.570 km^2 (**Dogger Bank Teesside A**) / 2.300 km^2 (**Dogger Bank Teesside B**) (k) Export cable crossings – 0.098 km^2 * all footprints for foundations inclusive of scour protection	All values shown here are for Dogger Bank Teesside A alone. For Dogger Bank Teesside A and Dogger Bank Teesside B combined, values should be doubled apart from export cable disturbances where different cable lengths for **Dogger Bank Teesside A** and **Dogger Bank Teesside B** = different impact footprints. The scenario described gives rise to the greatest area of permanent seabed habitat loss. Any other development scenario or installation technique considered would result in no greater or less habitat loss. Cable protection estimates are based on approximately 25% of the entire length of the export and array cables requiring cable protection. This equates to a potential maximum of 84.2km of remedial protection per export cable for Teesside A and a maximum of 75.7km of remedial protection per export cable for Teesside B.
Temporary impact on benthos due to physical disturbance caused by maintenance activities	Maximum footprint of temporary habitat disturbance due to jacking-up activities required during operational phase of project = **0.904km^2** which equates to 0.161% of the overall area of Dogger Bank Teesside A (wind farm only) and 0.152% of Dogger Bank Teesside B (wind farm only).	Direct impact on benthos due to physical disturbance caused by maintenance activities.

Impact	Key design parameters forming the realistic worst case scenario	Rationale
Change in Hydrodynamic regime (wave/tides) and inter-related effects on benthos	Maximum change in current velocity is **less than 2%** along narrow (up to 3km wide) bands restricted to the project boundaries. This maximum percentage change is within the natural variation of tidal current velocity across Dogger Bank and surrounding sea areas. Predicted change in tidal current velocities is so small (**up to only 2%)** that it is unlikely to affect the form of recent sediments over and above the natural tidal processes.	The assessment of effects on waves and tidal currents is based on the use of a precautionary worst case scenario that assumes the whole of each project area (Dogger Bank Teesside A and Dogger Bank Teesside B) is filled with foundations. For the purpose of predicting effects on waves and tidal currents, the worst case scenario is considered to be a perimeter of foundations at their minimum spacing with a wider spaced grid of foundations across the bulk of each project.
Increase in suspended sediment concentration due to scour associated with foundations	**Modelled outputs as detailed below (concentrations presented are excesses over the natural background concentration (2mg/l)):** Maximum suspended sediment concentrations predicted by the model at any time over the 30-day simulation period of >200mg/l. These concentrations occur as 20km long, 6km wide patches along the north and south perimeters of Dogger Bank Teesside A and also the southwest perimeter of Dogger Bank Teesside B. Maximum suspended sediment concentrations are >20mg/l across all of Dogger Bank Teesside A and B, gradually reducing with distance from the foundations until they are 2mg/l approximately 40-54km south of the projects boundaries and 20-37km north of the projects boundaries. The average suspended sediment concentrations in the bottom layer are between 10mg/l and 50mg/l across both projects. These concentrations extend up to approximately 19km to the south of the projects boundaries. Average suspended sediment concentrations reduce to 2mg/l up to approximately 36km south of the projects southern boundaries and up to 26km north of the Dogger Bank Teesside A northern boundary 2mg/l is exceeded > 90% of the 30-day simulation period in two patches, one to the south of Dogger Bank Teesside B and one within and to the south of Dogger Bank Teesside B, up to 15km south of their southern boundaries. Exceedance is generally greater 70% across both Dogger Bank Teesside A and Dogger Bank Teesside B.	Maximum and average changes in suspended sediment concentration in the bottom layer and sediment thickness deposited from the plume based on 30-day model run at the end of Year Two. Assumes that all 400 foundations have been installed and both projects are subject to a 50-year storm with the storm releasing the full sediment load through scour.

Impact	Key design parameters forming the realistic worst case scenario	Rationale
Increase in sediment deposition following increase in suspended sediment concentration due to scour associated with foundations	Predicted maximum thickness over the simulation period is 5mm with the majority of the project areas subject to maximum deposition between 0.5mm and 5mm. Thicknesses reduce to below 0.1mm approximately 16-30km from the southern boundaries of the projects and 13-35km from the northern boundaries. Average deposition is predicted to be between 0.5mm and 5mm in a 32km long, 14km wide area located between the two projects. Elsewhere the maximum average deposition is less than 0.5mm reducing to less than 0.1mm approximately 23km southwest of Dogger Bank Teesside B and 19km north of Dogger Bank Teesside A. Maximum sediment thickness is 1.7mm at R5.	
Introduction of new habitat from colonisation of the foundation structures	The introduction of new hard structures with a maximum surface area provided by the following project infrastructure: Gravity Base Foundations for wind turbine generators and offshore platforms, vessel moorings, inter-array cable protection, inter-platform cable protection and crossings and export cable protection and crossings.	The exact surface area (km2) available for colonisation is not able to be calculated but it will be greater than the figure presented for "footprint" of impact as the former is a 3-D metric, whilst the latter is 2-D.
Potential impacts on sites of marine conservation interest	Values for all operational phase impacts presented above apply to this impact.	As above
Decommissioning		
Increased suspended sediment concentration and sediment deposition	As per details (above) for increased suspended sediment concentration and sediment deposition during construction (although predicted to be much less in reality – see comment under rationale).	Any effects produced during decommissioning will be less than those described during the construction phase due to absence of seabed preparation or pile drilling, which are the main sources of increased suspended sediment concentration during the construction phase.

Impact	Key design parameters forming the realistic worst case scenario	Rationale
Loss of species colonising hard structures	As per details (above) for loss of permanent habitat during operation.	Assumed that all project infrastructure above seabed level will be removed during decommissioning.
Temporary disturbance to habitats via removal of cables	• Removal of up to 950km of inter array cables; • Removal of up to 320km of inter platform cables; and • Removal of up to 573km (**Dogger Bank Teesside A**) and 484 km (**Dogger Bank Teesside B**) of export cables.	Assumed that all cables will be removed during decommissioning.

6. Assessment of Impacts during Construction

6.1. General

6.1.1. Within the Development Consent Order (DCO) the construction scenarios for Dogger Bank Teesside A & B are set out as described in Section 5 to allow for flexibility in the programme. This flexibility is taken into account in the assessment of impacts during the construction phase.

6.1.2. As all the impact assessments presented within Section 6 (construction phase impacts), Section 7 (operational phase impacts) and Section 8 (decommissioning impacts) rely on sensitivity assessments provided by MarLIN (www.marlin.ac.uk), the relevant "factors" as defined by MarLIN are listed within each impact assessment to provide a clear link between the impact statements presented below and these factors.

6.1.3. As outlined in Section 3, the most sensitive biotope to the relevant effect/factor being assessed has been used as the basis of assessment at all times. A full listing of which biotope sensitivity assessments have been used to inform this chapter is provided in **Appendix 12E**.

6.2. Physical disturbance to habitats and species and temporary habitat loss

Dogger Bank Teesside A or Dogger Bank Teesside B in isolation

6.2.1. Works during construction required for installation of the offshore wind farm and the associated infrastructure (array cables, converters, substations, Met masts, GBS foundations, export cables etc.), will result in the physical disturbance of 15.81km^2 of benthic habitats and species within the study area (defined as the Dogger Bank Teesside A & B wind farm sites/export cable corridor and the temporary working areas surrounding these sites). This will include the physical disturbance of habitats due to the introduction of side-cast and/or drill arising material from seabed preparation/foundation drilling works (note that the disposal site characterisation document for Dogger Bank Teesside A & B is provided at **Appendix 12F**).

6.2.2. Based on the marine physical processes assessment (**Chapter 9**), the worst-case scenario with respect to amounts of material released into the water column from seabed preparation and/or drilling of foundations (and subsequent formation of residual mounds of this material on the seabed), arises via installation of 12m monopole foundations.

6.2.3. For installation of a 12m monopole foundation, a worst case volume of 6,220m^3 is estimated for the drill arisings which are released at the sea surface. An estimate of the average particle size characteristics for drill arisings was made by RPS Energy (2012b). Using these data and data from seabed sediment samples shows that about 63% of the sediment (3,919m^3) is suspended in the plume model and 37% (2,301m^3) settles rapidly to the seabed without entering the plume.

6.2.4. The deposition of sediment from drill arisings is, therefore, considered as the worst case scenario in terms of the amount of residual material that will be deposited on the seabed. The following sections provide more details of the fate and behaviour of this 2,301m^3 of material which will be deposited on the seabed. It is important to fully understand these details of the type, behaviour and fate of this material before the implications for benthic habitats that occur in these areas are discussed.

6.2.5. The assessment set out below is not based on any specific computational modelling or monitoring. This is because computational modelling would not be suitable for this issue and a conceptual analysis of the likely behaviour of this sediment is more appropriate. The type of modelling that is suggested would have to be morphological modelling. There is low confidence in this form of modelling and it would not provide the solution in terms of timescale and types of change. Hence, a conceptual approach was adopted.

Footprint / form of deposited material

6.2.1. The results from geotechnical assessments of the surface sediments show that the friction angle of the top 15-20cm of seabed sediment is around 30°, exemplary of that applying to loose granular sand (**Appendix 9A Marine Physical Processes Assessment of Effects Technical Report**). Immediately beneath the loose upper layer, the friction angle quickly rises indicatively to 45-50°.

6.2.2. An assumption is made that the non-suspended sediment initially forms a cone on the seabed with a friction angle of 30^o. In its undisturbed state this would produce a 9m high cone with a circular seabed footprint of about 750m^2 (diameter approximately 31m). However, due to subsequent reworking of the sediment pile by waves and tidal currents, it will be reduced in height and distributed over a wider area of seabed.

6.2.3. This is an extremely idealised worst case situation in that an assumption is made that the sand drops vertically through the water column from a point source without the effect of at least some dispersion by tidal currents and waves as it settles through the water column. In reality, as the sediment settles through the column it will be transported horizontally as well as vertically and would not deposit as the idealised cone, but as a flatter and wider based 'mound'. The geometry of this mound would depend on the particle size of the sediment, the settling velocity and the different forces applied to it as it falls through the water column (waves and tidal currents). It is difficult to determine what this shape would be so a cone shape has been chosen, because this was quantifiable.

6.2.4. Over time, due to subsequent reworking of the sediment pile, it will be reduced in height and distributed over a wider area of seabed. Given that the predominant driver for sediment transport across Dogger Bank is waves, it is believed conceptually that a cone that stands 9m proud of the seabed would be impacted regularly by waves and the sediment both transported along the bed through this process. The sediment that is initially moved by the waves would also be temporarily entrained close to the seabed by the prevailing tidal currents and transported a short distance by both mechanisms.

6.2.5. Over time the gradual erosion of the top of the cone through wave action and its transport would lower the cone height, and its shape would be adapted into some form of low mound with a larger footprint than the original cone.

6.2.6. The shape of the mound would be difficult to determine precisely (and could not be modelled), but given the predominant waves from the north and the predominant north and south tidal current directions, it is assumed that most transport would be north and south forming an elongate north-south mound.

6.2.7. The closest analogy to the mound would be natural sand waves across Tranche A, which have an average wavelength of 100m (range 50-150m) and average crest height of 0.5m (maximum 2m). As a best estimate, if an elongate mound created by installation of a single foundation is assumed to form from 2,301m^3 of sediment (total sediment minus dispersed sediment in the plume), that is 100m in length and 31m wide, it will have a crest height of about 1.5m. The mound footprint will be about 3,100m^2.

Potential changes in seabed particle size

6.2.8. With respect to how the drill arising material may potentially change the particle size of existing seabed sediments, the seabed sediments of Dogger Bank are the surface expression of the thicker Holocene sands that sit on top of the Dogger Bank Formation which is predominantly mud. The build-up of these sand bodies has taken place over a long period of time under similar conditions to the present day, and hence they are expected to have similar particle sizes at depth to those on the seabed.

6.2.9. Hence, in the modelling of the drill arisings scenario the sand fraction is broken down into its constituent particle sizes based on the surface averages.

6.2.10. The average particle size distribution of the drill arisings (this includes the Holocene sands and the Dogger Bank Formation mud) is described in **Appendix 9A**Table 2.9. It shows that about 41% of the sediment is mud which is predominantly derived from the Dogger Bank Formation. The Holocene sands contain very low quantities of mud. About 55% of the sediment (on average) is sand-sized, with a particle size distribution similar to that of the seabed sediments (**Appendix 9A** Table 2.8). This sand is mainly derived from the Holocene unit.

6.2.11. Sediment particles larger than 0.18mm will deposit at the source position. **Appendix 9A** Table 2.8 shows that a high proportion (87%) of the sand in the drill arisings falls between 0.125 and 0.25mm (fine sand). On average, the sand of the drill arisings contains 60% between 0.125mm and 0.18mm and 27% between 0.18mm and 0.25mm. The 0.125-0.18mm component will be dispersed in the plume, but the 0.18-0.25mm component will deposit at the source position. This means that the median particle size of the disposed sediment will become slightly coarser (i.e. the median will shift towards the coarser part of the 0.125-0.25mm range) but will still remain within the fine sand classification. The particle size distribution of the sediment deposited at the source position will not be significantly different from the surrounding seabed sediments.

6.2.12. The mud fraction and the fraction of sand less than 0.18mm are assumed to disperse in the plume. This means that the sediment deposited at the source position will contain no mud regardless of how much mud the drill arisings contained at the initial time of dispersal. Hence, although there is a difference between the mud contents of the drill arisings and the surrounding seabed, this variance does not make any difference with respect to the effect on the seabed at the disposal site.

6.2.13. Forewind notes the concerns raised via PEI3 consultation by JNCC/NE about statements in the previous (Draft) ES related to the behaviour of these drill arising mounds. Specifically, Forewind acknowledges that data from monitoring surveys of drill arising mounds on other offshore wind farm sites indicates that in some instances mounds have not dispersed with time and remain as semi-permanent seabed features.

6.2.14. However, it is important to recognise the fact that the sediment that will be deposited within Dogger Bank Teesside A & B in the form of drill arisings will be almost identical (in terms of PSA) to that which already exists on the seabed surface in these areas. On other sites, where drill arising mounds remain as the semi-permanent features referred to above, the material deposited via drill arisings is fundamentally different to that which exists at the seabed surface in those areas, i.e. the deposit of chalk on the sandy/gravelly seabed within the Lynn, Inner Dowsing and Lincs wind farm sites.

6.2.15. All aspects of temporary habitat loss and physical disturbance on benthic habitats, including via the deposit of drill arisings are discussed further below in the context of the potential for these effects to impact on benthic communities.

6.2.16. The MarLIN factor relevant to the overall impact assessed here (physical disturbance to habitats and species and temporary habitat loss) is “physical disturbance and abrasion”.

6.2.17. The largest source of this physical disturbance will be the installation of up to 950km of inter-array cables (assumed worst-case impact width of 10m giving impact footprint of 9.5km^2), with disturbance via installation of inter-platform cables (3.2km^2) and jacking-up of vessels (1.0km^2) also being key elements of temporary disturbance during this phase. This figure of 1.0km^2 also includes any temporary disturbance of habitats that may occur due to pre-construction geotechnical surveys, both in the subtidal and intertidal environment.

6.2.18. Based on information presented in Section 5, a number of calculations were made to illustrate the specific maximum footprint of temporary habitat disturbance for each VER within each area of the development. **Table 6.1** illustrates these maximum footprints of habitat disturbance of VERs for Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor.

6.2.19. In the absence of a finalised project layout showing exact locations of project infrastructure, the approach that has been adopted to assess potential impacts on benthic habitats has been to calculate the % of each habitat (VER) in both the wind farm and the Dogger Bank Teesside A & B Export Cable Corridor and then to apportion the overall footprint of any disturbance effects using the same proportions.

6.2.20. Forewind acknowledge the comment made by the MMO with respect this approach and accept that where relatively small, localised patches of a given habitat exist within the site, the proposed development may result in a disproportionate loss of such spatially restricted features. However, in the absence of a final project design, it is felt that the current approach provides a realistic and defensible approach to allocating the spatial extent of disturbance effects on benthic habitats within Dogger Bank Teesside A & B.

6.2.21. Forewind also acknowledge and support MMO's additional comment on this matter related to the need to ensure any future benthic monitoring survey(s) are designed in a way that ensures potential impacts on all types of habitats present are monitored. See Section 6.9 for more details on construction phase monitoring.

6.2.22. As an example, of the three VERs identified within Dogger Bank Teesside A, VER A (sandy sediment supporting relatively low diversity benthic communities but which still form part of the Annex I Sandbank Feature, i.e. within boundary of cSAC) represents 9.27% of the overall site area, VER B (coarse sediments with medium to high diversity benthic communities which form part of the Annex I Sandbank Feature, i.e. within boundary of cSAC) represents 5.01% and VER C (muddy sand sediments with medium diversity benthic communities (including sea pens) which form part of the Annex I Sandbank Feature, i.e. within boundary of cSAC) comprises the remaining 85.72%.

6.2.23. The worst-case scenario for physical disturbance during the construction phase amounts to 15.33km^2 within the main Dogger Bank Teesside A site. Therefore, for the purpose of this assessment, it is assumed that for Dogger Bank Teesside A, 9.27% of this footprint (1.42km^2) will affect VER A, 5.01% of the footprint (0.77km^2) will affect VER B and the remaining 85.72% (13.14km^2) will affect VER C. Using these assumptions for both sites and the Dogger Bank Teesside A & B Export Cable Corridor, a realistic worst case assessment can be made as to the relative impact on these three habitat types for Dogger Bank Teesside A or Dogger Bank Teesside B in isolation.

Table 6.1 Proportion of VER habitats affected by temporary disturbance during the construction phase

	Dogger Bank Teesside A			Dogger Bank Teesside B			Dogger Bank Teesside A and B combined		
VER *	**Total area(km^2) of VER within wind farm**	**% of area covered by VER within wind farm**	**Area (km^2) of VER potentially affected**	**Total area(km^2) of VER within wind farm**	**% of area covered by VER within wind farm**	**Area (km^2) of VER potentially affected**	**Total area(km^2) of VER within wind farm**	**% of area covered by VER within wind farm**	**Area (km^2) of VER potentially affected**
Wind farm sites									
A	51.9km^2	9.27%	1.46km^2	359.04km^2	60.52%	9.57km^2	410.94km^2	35.63%	11.27km^2
B	28.06km^2	5.01%	0.79km^2	33.74km^2	5.69%	0.90km^2	61.8km^2	5.36%	1.69km^2
C	480.15km^2	85.72%	13.55km^2	200.43km^2	33.79%	5.34km^2	680.58km^2	59.01%	18.66km^2
TOTAL	**560.11km^2**	**100.00%**	**15.81km^2 (2.8% of main site)**	**593.21km^2**	**100.00%**	**15.81km^2 (2.7% of main site)**	**1153.32km^2**	**100%**	**31.62km^2 (2.7% of main site)**
Dogger Bank Teesside A & B Export Cable Corridor (including in-zone cables)									
A	126.62km^2	3.84%	0.23km^2	126.80km^2	4.01%	0.20km^2	253.42km^2	3.93%	0.43km^2
B	12.05km^2	1.15%	0.07km^2	11.66km^2	0.65%	0.03km^2	23.71km^2	0.90%	0.10km^2
C	19.98km^2	1.53%	0.0 km^2	20.03km^2	1.57%	0.08km^2	40.01km^2	1.55%	0.17km^2
D	6.80km^2	8.51%	0.50km^2	6.32km^2	7.81%	0.39km^2	13.12km^2	8.16%	0.89km^2
E	18.66km^2	23.35%	1.38km^2	16.55km^2	20.44%	1.03km^2	35.21km^2	21.89%	2.39km^2
F	48.73km^2	60.98%	3.60km^2	52.51km^2	64.87%	3.26km^2	101.24km^2	62.93%	6.88km^2
G	0.07km^2	0.09%	0.01km^2	0.07km^2	0.09%	0.00km^2	0.15km^2	0.09%	0.01km^2

	Dogger Bank Teesside A			Dogger Bank Teesside B			Dogger Bank Teesside A and B combined		
VER *	**Total area(km^2) of VER within wind farm**	**% of area covered by VER within wind farm**	**Area (km^2) of VER potentially affected**	**Total area(km^2) of VER within wind farm**	**% of area covered by VER within wind farm**	**Area (km^2) of VER potentially affected**	**Total area(km^2) of VER within wind farm**	**% of area covered by VER within wind farm**	**Area (km^2) of VER potentially affected**
H	$0.40km^2$	0.50%	$0.03km^2$	$0.40km^2$	0.49%	$0.02km^2$	$0.80km^2$	0.50%	$0.05km^2$
I	$0.05km^2$	0.06%	$0.00km^2$	$0.05km^2$	0.06%	$0.00km^2$	$0.10km^2$	0.06%	$0.01km^2$
TOTAL	**$233.36km^2$**	**100.00%**	**$5.91km^2$ (2.5% of main site)**	**$234.40km^2$**	**100.00%**	**$5.02km^2$ (2.1% of main site)**	**$467.66km^2$**	**100.00%**	**$10.93km^2$ (2.3% of main site)**

*

VER A: Sandy sediment supporting relatively low diversity benthic communities which form part of the Annex I Sandbank Feature (within boundary of cSAC)
VER B: Coarse sediments with medium to high diversity benthic communities which form part of the Annex I Sandbank Feature (within boundary of cSAC)
VER C: Muddy sand sediments with medium diversity benthic communities (including sea pens) which form part of the Annex I Sandbank Feature (within boundary of cSAC)
VER D: Sandy sediment supporting relatively low diversity benthic communities outside cSAC boundary)
VER E: Coarse sediments with medium to high diversity benthic communities outside cSAC boundary
VER F: Muddy sediments with medium diversity benthic communities (including sea pens) outside cSAC boundary
VER G: Rock-based infralittoral and circalittoral habitats
VER H: Intertidal sand-based habitats
VER I: Intertidal rock-based habitats

6.2.24. From **Table 6.1** it can be noted that the main VER affected by temporary habitat disturbance within Dogger Bank Teesside A will be VER C with VER A being exposed to the largest amount of disturbance in Dogger Bank Teesside B.

6.2.25. Using the assumption outlined above with respect to the proportion of this VER that will be affected by temporary disturbance within the wind farm it is predicted that 1.46km^2 of VER A in the Dogger Bank Teesside A wind farm will be impacted. 0.79km^2 of VER B and 13.55km^2 of VER C will also be impacted.

6.2.26. In Dogger Bank Teesside B, it is predicted that 9.57km^2 of VER A will be affected by temporary disturbance as well as 0.90km^2 of VER B and 5.34km^2 of VER C.

6.2.27. Based on sensitivity assessments provided by MarLIN for component biotopes of the three VERs that have been identified within Dogger Bank Teesside A and Dogger Bank Teesside B, the ecological sensitivity of the VER's to physical disturbance and abrasion (as would be temporarily produced during construction) varies from low (VER A and B) to moderate (VER C). In terms of predicting the impact, although the value of VERs A, B and C are defined as international (see **Table 3.2**), the actual sensitivity of these VERs in EIA terms (as defined in **Table 3.3**), varies due to the different vulnerability and recoverability to this effect (physical disturbance) of these three VERs.

6.2.28. Therefore, for VERs A and B, a sensitivity of low is assigned due to the high recoverability of these habitats to physical disturbance and abrasion, whilst for VER C, a sensitivity of medium is assigned due to the greater vulnerability and longer recovery time of these habitats to physical disturbance.

6.2.29. In terms of the magnitude of the effect in question, based on the criteria in **Table 3.4**, this is judged to be low, as the amount of predicted temporary habitat disturbance will amount to less than 3% of the overall wind farm areas for Dogger Bank Teesside A & B and this effect will be temporary, i.e. will only occur for the duration of construction works. Therefore, for VER A and B, the low sensitivity and low magnitude result in a **negligible** impact on these receptors in both Dogger Bank Teesside A & B via temporary disturbance during construction. For VER C, the medium sensitivity and low magnitude combine to result in a **minor adverse** impact via physical disturbance within the Dogger Bank Teesside A & B wind farm.

6.2.30. With respect to the Dogger Bank Teesside A & B Export Cable Corridor, nine VERs are recorded within this area (two VER's located in intertidal region only), with VERs E and F representing the most widely distributed habitat groups in this area (For Dogger Bank Teesside A Export Cable Corridor, VER E covers 23.35% and VER F covers 60.98%; For Dogger Bank Teesside B Export Cable Corridor, VER E covers 20.44% and VER F 64.87%). In terms of impacts via temporary disturbance on the VERs present within the cable corridors, the overall (EIA) sensitivity of VERs A and B is still judged to be low with VER C still having a medium sensitivity, as per the reasons outlined in the preceding paragraphs.

6.2.31. For the remaining VERs that are located within the Dogger Bank Teesside A & B Export Cable Corridor, the sensitivity to physical disturbance and abrasion, as would arise via construction activities, is judged to be low as they represent regionally important receptors with low vulnerability and high recoverability to this effect/factor.

6.2.32. The total footprint of temporary habitat disturbance from export cable installation (including impacts from anchors deployed outside the main cable corridor during cable installation) is assessed as 5.91km^2 for Dogger Bank Teesside A and 5.02km^2 for Dogger Bank Teesside B. This represents 2.5% and 2.1% of the total Dogger Bank Teesside A & B Export Cable Corridors (including the areas of "in-zone" Dogger Bank Teesside A & B Export Cable Corridors) for Dogger Bank Teesside A & B respectively.

6.2.33. Based on the criteria in **Table 3.4**, the magnitude of effect of physical disturbance from export cable installation works is judged to be low as the spatial extent of this disturbance will affect less than 5% of the overall cable corridors and will be short-term for the duration of the cable installation only. Therefore, for either Dogger Bank Teesside A or Dogger Bank Teesside B in isolation, there will be **negligible** impact on all VERs A – G (apart from VER C) due to temporary disturbance via export cable installation. For VER C, the medium sensitivity of this habitat, combined with a low magnitude of effect results in a **minor adverse** impact.

6.2.34. Temporary habitat disturbance will also occur at landfall via the beach works and erection of coffer dams required to support the proposed Horizontal Directional Drilling (HDD) works. The assessment of impacts on VERs in the intertidal and shallow sub-tidal region is assessed in a separate impact assessment below.

Dogger Bank Teesside A and Dogger Bank Teesside B together

6.2.35. If both Dogger Bank Teesside A and Dogger Bank Teesside B are constructed together, the increased amount of project infrastructure will result in an increased footprint of temporary disturbance across the two projects, as shown in **Table 6.1**. All calculations for the wind farms were based on 200 x 6MW turbines in each of the two project areas (Dogger Bank Teesside A & B), and a similar inter-array cable layout. The footprint of temporary habitat disturbance also includes inter-platform cables.

6.2.36. From **Table 6.1**, it can be noted that 31.62km^2 of the total area of Dogger Bank Teesside A & B wind farm sites combined will be affected by temporary disturbance during the construction phase. The overall area of the two sites is 1153.920 km^2, therefore this footprint of temporary habitat disturbance equates to 2.7% of the total wind farms.

6.2.37. As noted above, the only VERs present in both sites are VERs A, B and C, with VERs A and B assessed as having a low (ecological) sensitivity to physical disturbance based on MarLIN sensitivity assessments and VER C a moderate (ecological) sensitivity.

6.2.38. As per the conclusions above with regard to Dogger Bank Teesside A or Dogger Bank Teesside B in isolation, the overall (EIA) sensitivity of these receptors is judged to be low for VER A and B and medium for VER C. The magnitude of effect is still judged to be low as the spatial extent of this effect as a proportion of the overall area of Dogger Bank Teesside A & B is small (less than 3%), therefore, a similar conclusion of **negligible** impact on VER A and B and a **minor adverse** impact on VER C is predicted via temporary habitat disturbance within the Dogger Bank Teesside A & B wind farms during the construction phase.

6.2.39. For the Dogger Bank Teesside A & B Export Cable Corridor, the footprint of effect is greater for both projects combined due to the installation of more export cables. However, the proportions of VERs along the Dogger Bank Teesside A & B Export Cable Corridor affected by temporary disturbance remain small, with the predicted 10.93km^2 of disturbance representing 2.34% of the total habitats within the Dogger Bank Teesside A & B Export Cable Corridor of Dogger Bank Teesside A & B.

6.2.40. As per the assessment of each project in isolation, the sensitivity of all of the VERs is judged to be low apart from VER C, which has a medium sensitivity. The magnitude of effect is judged to be low, resulting in **negligible** impacts on all VERs within the Dogger Bank Teesside A & B Export Cable Corridor apart from VER C, for which a **minor adverse** impact is predicted via temporary habitat disturbance due to installation of Dogger Bank Teesside A & B cables.

6.3. Increased suspended sediment concentration and sediment deposition

Dogger Bank Teesside A or Dogger Bank Teesside B in isolation

6.3.1. During the construction phase, there will be temporary increases in suspended sediment concentration and subsequent deposition of sediment as a result of a range of activities, including cable installation, seabed preparation for foundation installation and jacking-up activities. The worst-case scenario for this impact, as defined in **Table 5.1** is based on the installation of 24 x 12m diameter monopile foundations via drilling, with subsequent release of drill arisings into the water column and also installation of inter-array and export cables within a 30-day period. The location of these 24 foundations in terms of the modelling process was chosen as the western part of the site, due to the proximity of more sensitive ecological receptors (specifically, sandeel habitat).

6.3.2. The MarLIN factors relevant to this impact, and, therefore, used to inform this assessment are "*increased suspended sediment concentrations*" and "*smothering*". Data from the physical process modelling relevant to these factors are presented below, with outputs related to suspended sediment concentrations presented first, followed by outputs relevant to sedimentation (smothering).

6.3.3. Outputs of plume modelling have been used to define predicted suspended sediment concentration changes as a result of construction, with levels of suspended sediment concentration above background levels (assessed as <2mg/l, based on Eisma and Kalf 1987) generated for a range of scenarios. Suspended sediment concentrations in both the bottom layer (seabed to 5m above seabed) and surface layer have been assessed but for the purpose of the worst-case, the suspended sediment concentrations presented here are bottom-layer values. Although surface layer concentrations are similar in magnitude to the bottom layer their spatial extent above background concentrations is less than the bottom layer values.

6.3.4. Based on the worst-case scenario with respect to suspended sediment concentration outlined above in **Table 5.1**, a maximum suspended sediment concentration of >200mg/l is predicted to occur within the confines of the 24 foundations and along the in-zone export cable route in a band of 1km and 11km either side of the cable route.

6.3.5. The model outputs also predict that the maximum distance from the source that suspended sediment concentrations will remain above background levels (of 2mg/l) is approximately 40km to the north and south of the release point.

6.3.6. In terms of average suspended sediment concentrations, within the 24 foundations, and up to approximately 20km along the in-zone cable route (in a 9km wide band), the predicted average value is between 50mg/l and 100mg/l. These average values reduce to background (2mg/l) approximately 18km and 32km to the south and north of the in-zone cable route respectively.

6.3.7. With respect to the Dogger Bank Teesside A & B Export Cable Corridor outside of the zone, the maximum suspended sediment concentration predicted is 100-200mg/l, noted in two discrete patches, one near the coast (within 5km) and one about 50km offshore. Values remain above background up to 50km to the north and 45km to the south of the corridor.

6.3.8. Average values along the Dogger Bank Teesside A & B Export Cable Corridor only increase up to 10mg/l above background along the entire length of the route.

6.3.9. Apart from the maximum and average values of suspended sediment concentrations, another key output of the modelling work which is of importance in assessing potential ecological effects, is the persistence of any increased suspended sediment concentrations.

6.3.10. From consultation responses received on both the Dogger Bank Creyke Beck and Dogger Bank Teesside A & B projects, it is apparent that JNCC/NE have concerns around this issue. It is felt that the existing plume (and deposition) modelling work undertaken to date is sufficient for informing the assessment of impacts on epibenthos from (potential) persistent suspended sediment plumes.

6.3.11. This existing modelling, which considers sediment release ‘additively’ from 24 foundations over a 30 day period, inherently captures the potential ‘additive’ nature of the releases. However, in order to provide further reassurance that the assessment of impacts on benthic and epibenthic communities has not been underestimated, the existing modelling was re-visited and new plots were produced which show the % of the 30 day modelling period where suspended sediment levels of 100mg/l and above are exceeded.

6.3.12. The reason that the exceedance of 100mg/l was used as the basis of new model outputs was because the benchmark for the “Increased Suspended Sediment Levels” factor in MarLIN is defined as: “*An arbitrary short term, acute change in background suspended sediment concentration e.g. a change of 100* *mg/l for 1 month. The resultant light attenuation effects are addressed under turbidity, and the effects of rapid settling out of suspended sediment are addressed under smothering*".

6.3.13. Therefore, this re-assessment work aimed to identify any areas where the sediment plume created during construction exceeded 100mg/l for more than 30 days, i.e. 100% of the 30 day modelling period. If any such areas were identified, then the benchmark value for the Increased Suspended Sediment Level MarLIN factor would no longer be relevant and the existing impact assessments related to this effect may need to be reconsidered.

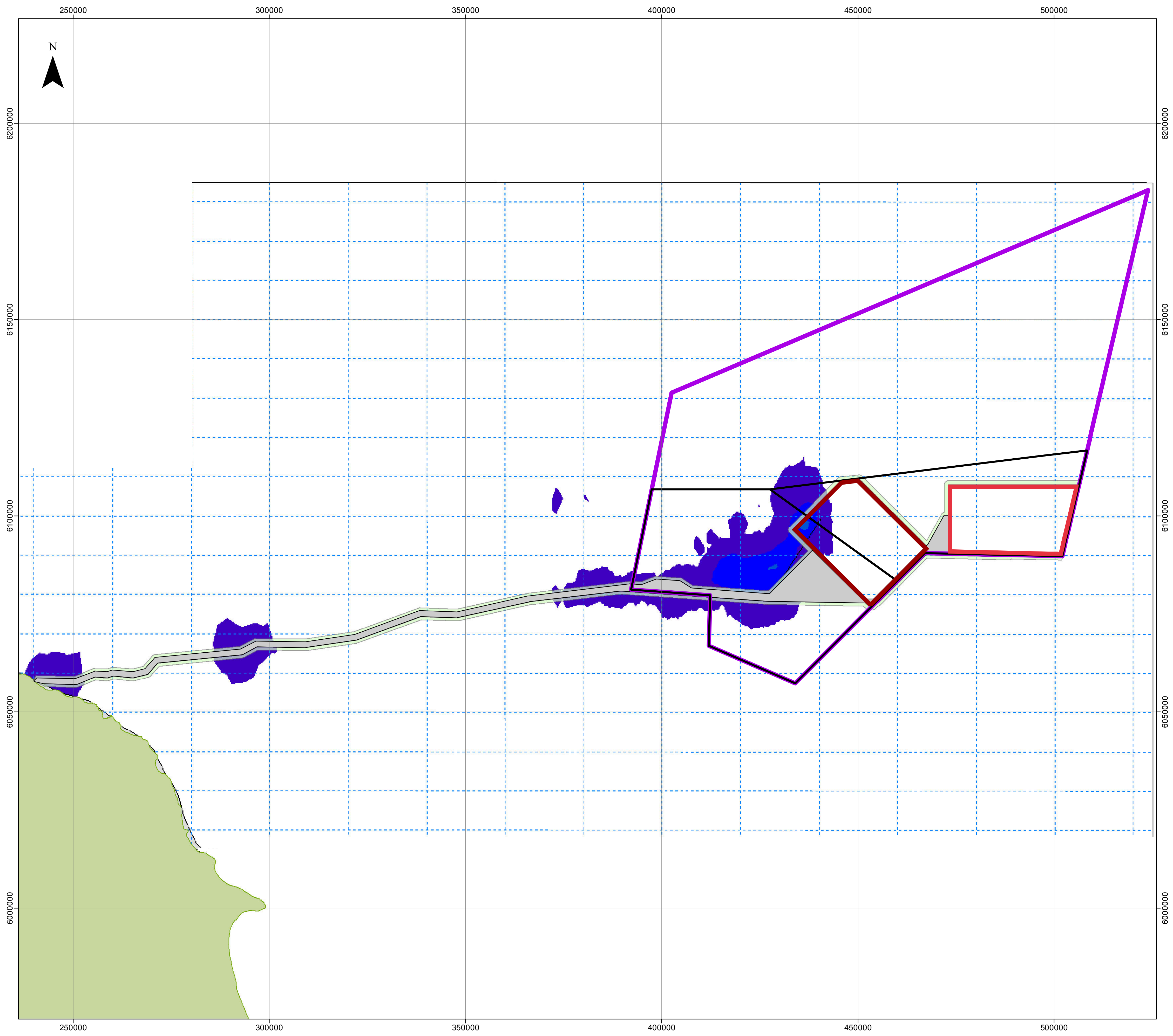
6.3.14. This updated figure is shown below (**Figure 5.1**) and clearly indicates that the benchmark value of 100mg/l was not persistent (i.e. values of >100mg/l only occurred within the site for up to 30% of the 30 day simulation period (9 days).

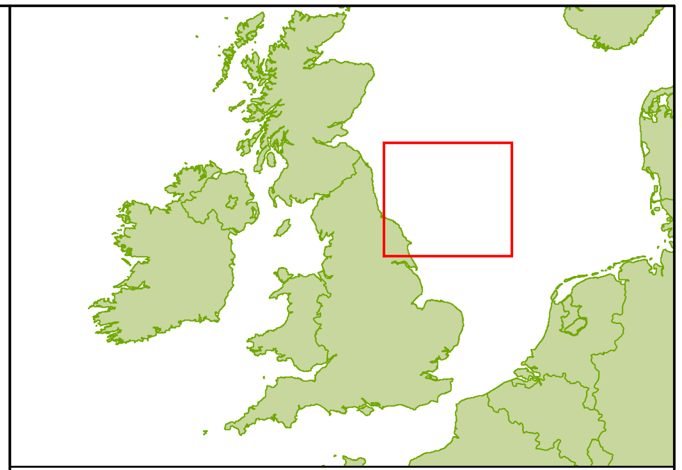
6.3.15. On the basis that there are no areas where the 100mg/l values are exceeded for more than the MarLIN benchmark "short term acute change in background suspended sediment concentration" of 100mg/l for one month, it is concluded that the existing impact statements presented here in relation to increased suspended sediment levels fully consider the issue of potential for longer-term, low-level, persistent plumes raised by JNCC/NE.

6.3.16. Whilst increased suspended sediments represent an important potential effect on ecological receptors, subsequent sedimentation of these mobilised sediments is also of importance. Sedimentation values generated by the modelling work indicate that in a small patch within the wind farm a maximum deposition of 10-50mm occur. Away from the foundations and along the Dogger Bank Teesside A & B Export Cable Corridor, maximum deposition values decreases to <5mm.

6.3.17. Average deposition of 1-5mm occurs within and 10km to the north of the foundations and in small patches along the Dogger Bank Teesside A & B Export Cable Corridor, with average deposition reducing to <0.5mm along the rest of the Dogger Bank Teesside A & B Dogger Bank Teesside A & B Export Cable Corridor (effectively zero in many places).

6.3.18. In terms of the persistence of deposited sediment, time series analysis of sediment thickness at several discrete points within and outside the site indicate that within the modelled foundation layout, deposited sediment will persist at thicknesses greater than 3mm for a maximum continuous period of 10 hours, whereas 1mm thick sediment persists for a maximum continuous period of 22 hours. Within the foundations, sediment thicknesses greater than 10mm and 7mm persist for maximum continuous periods of 32 hours and 38 hours respectively.





LEGEND

- Dogger Bank Zone
- Tranche boundary
- Dogger Bank Teesside A
- Dogger Bank Teesside B
- Dogger Bank Teesside A & B Export Cable Corridor
- Temporary works area

Exeedance of 100 mg/l

- Above 0.900
- 0.800 - 0.900
- 0.700 - 0.800
- 0.600 - 0.700
- 0.500 - 0.600
- 0.400 - 0.500
- 0.300 - 0.400
- 0.200 - 0.300
- 0.100 - 0.200
- 0.001 - 0.100
- Below 0.001
- Undefined Value

0 10 20 40
Kilometres

Data Source:
Sediment Samples © Gardline Environmental Limited, 2012
Background bathymetry image derived in part from TCarta data © 2009

PROJECT TITLE

DOGGER BANK TEESSIDE A & B

DRAWING TITLE

Figure 5.1 Fraction of time (expressed as % of 30 day modelling period) where suspended sediment concentration of 100mg/l is exceeding in the bottom layer during construction

VER	DATE	REMARKS	Drawn	Checked
1	07/02/2014	Pre DCO Submission	JE	RZ

DRAWING NUMBER: **F-OFL-MA-266**

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

FOREWIND

6.3.19. The predicted bed thickness at the end of the 30-day simulation was equal to or less than 0.1mm across the whole of the footprint. This latter statement is important because it indicates the lack of potential for any “additive” effect of sediment deposition in parts of the site and, therefore, the maximum depths outlined above represent the actual maximum values predicted to arise.

6.3.20. In terms of impact on benthic and epibenthic communities, any increase in suspended sediment concentration (and sedimentation) would have different effect depending on the nature of the species affected. Deposit feeders, including many polychaetes, are likely to favour an increase in sedimentation as this can often lead to introduction of organic materials from a greater proportion of fine sediments in the substrate. In contrast, suspension (filter) feeders, which will form part of more diverse epibenthic communities within the site, will be more sensitive to increased suspended sediment concentration as this may have adverse impacts on fitness (due to clearing fine sediment from pores and canals (Jackson and Hiscock 2008).

6.3.21. Based on sensitivity assessments provided by MarLIN, of the three main VERs identified within the boundaries of Dogger Bank Teesside A & B (where the greatest increases in suspended sediments and sedimentation (smothering) are predicted to arise), VER A is judged to be not sensitive to increased suspended sediment concentrations and smothering whilst VER B has a very low sensitivity to both these effects. VER C has a very low sensitivity to increased suspended sediments and is not sensitive to smothering.

6.3.22. In terms of overall (EIA) sensitivity of VERs A, B and C to increased suspended sediment concentration, based on **Table 3.3** this is judged to be negligible for VER A and low for VER B and C.

6.3.23. In terms of the magnitude of this effect (increased suspended sediment), based on the criteria in **Table 3.4**, this is judged to be low as although the spatial extent of any will be large (>10% of the study area), the effect of increased suspended sediments are not judged to occur continually and no change in the distribution of biotopes across either Dogger Bank Teesside A or Dogger Bank Teesside B is also predicted.

6.3.24. Therefore, for the three VERs in Dogger Bank Teesside A & B, the negligible/low sensitivity of these receptors to increased suspended sediments and the low magnitude of effect results in a **negligible** impact.

6.3.25. For the remaining VER’s D to I, i.e. those present within the Dogger Bank Teesside A & B Export Cable Corridor and outside the boundary of the cSAC, these also exhibit either very low or no sensitivity to increased suspended sediments and based on criteria in **Table 3.3** are judged to have a negligible (EIA) sensitivity to this effect.

6.3.26. In terms of the magnitude of the effect in question, based on the criteria in **Table 3.4**, this is judged to be low, resulting in a **negligible** impact on all of the VERs along the Dogger Bank Teesside A & B Export Cable Corridor via increased suspended sediment concentrations produced via construction.

6.3.27. In terms of sedimentation (smothering) within the main Dogger Bank Teesside A & B site boundaries, VERs A and C are judged to be not sensitive to this effect, resulting in a negligible (EIA) sensitivity, with VER B having a very low ecological sensitivity and thus, a low sensitivity in EIA terms. The lack of sensitivity of biotopes within the Dogger Bank Teesside A & B site to smothering effects reflects the fact that these areas will be subject to smothering effects under existing conditions, via winter storm events and also exposure to bottom trawling activities and, therefore, these biotopes are adapted to this effect.

6.3.28. The magnitude of effect is also judged to be low based on the criteria in **Table 3.4** as changes in the biotope distribution of the wind farm sites via smothering effects are not predicted. Therefore, a, **negligible** impact on all VER's within the wind farms is predicted via sedimentation (smothering).

6.3.29. With respect to the Dogger Bank Teesside A & B Export Cable Corridor, the same conclusions apply with regard to sensitivity as per the VERs within the wind farms, i.e. low sensitivity to smothering. The magnitude of effect is also assessed as low, although it is noted that any sedimentation effects via cable installation will be even less than those noted within the wind farms via foundation and cable installation. Therefore, a **negligible** impact is predicted on benthic habitats (VERs D to I) within the Dogger Bank Teesside A & B Export Cable Corridor due to sedimentation produced via the construction process.

Dogger Bank Teesside A and Dogger Bank Teesside B together

6.3.30. As set out in **Chapter 5**, Dogger Bank Teesside A & B may either be constructed simultaneously, or sequentially with a gap between construction. Should construction of both projects take place at the same time, there is the potential for increased levels of effect due to the potential interaction of sediment plumes and their deposition on the seabed.

6.3.31. However, given the conclusions drawn from the modelling studies for each project in isolation (namely that any increases in suspended sediment concentration and sedimentation will be low level and short-lived, and the receptors are of low sensitivity to the effect), additional impacts from the construction of both projects together are unlikely. Any impacts are predicted to remain as **negligible**.

6.4. Release of sediment contaminants resulting in potential effects on benthic ecology

Dogger Bank Teesside A or Dogger Bank Teesside B in isolation

6.4.1. The mobilisation of sediments via the same processes outlined in preceding impact assessments, i.e. cable installation, seabed preparation and foundation installation, could lead to the release of any contaminants that may be present within the sediments.

6.4.2. Data on contaminant levels within the main Dogger Bank Teesside A & B wind farm sites and the Dogger Bank Teesside A & B Export Cable Corridor were obtained via site-specific surveys. These data indicate that the levels of contaminants in the offshore wind farm areas where sediment re-suspension concentrations are predicted to be the largest (via foundation installation and cable installation), is relatively low i.e. the majority of the contaminant levels are below the Cefas Action Level 1 and Canadian Sediment Quality Guidelines TEL values.

6.4.3. Within the main Dogger Bank Teesside A & B sites, the three VERs present (VERs A, B and C) have low and moderate ecological sensitivities (as defined by MarLIN) to contamination via synthetic compounds, heavy metals and hydrocarbons. Based on criteria in **Table 3.3**, the overall sensitivity of these receptors is judged to be medium as although they are internationally important habitats, they will exhibit at least a medium recoverability to this effect should it ever arise.

6.4.4. Based on **Table 3.4**, the magnitude of this effect is judged to be negligible due to the low level of contaminants recorded within the main sites, therefore, an overall impact of **negligible** significance is predicted on the benthic receptors (VERs A, B and C) within the main sites due to contamination from sediments mobilised in the construction phase.

6.4.5. With regard sediment contaminant levels from within the Dogger Bank Teesside A & B Export Cable Corridor, these are generally higher than within the wind farm sites, particularly in locations nearer the coast where sample sites exceeded Cefas AL1.

6.4.6. Similarly to the VERs within the main wind farm sites, the receptors present within the Dogger Bank Teesside A & B Export Cable Corridor (VERs A to I) have ecological sensitivities to contamination ranging from low to moderate (based on MarLIN sensitivities). The overall sensitivity of the receptors within the cable corridor is judged to be low based on the criteria in **Table 3.3**.

6.4.7. Even though sediment contaminant levels are higher in the nearshore cable area compared to the offshore wind farm sites, the magnitude of any potential contaminant re-mobilisation effect is judged to be low due to the much lower levels of sediments likely to be mobilised via construction in this area compared to levels of sediment release within the main wind farm sites via seabed preparation associated with foundations). Therefore, the combination of low receptor sensitivity and low magnitude of effect results in a **minor adverse** impact being predicted on benthic receptors along the Dogger Bank Teesside A & B Export Cable Corridor via sediment contaminant re-mobilisation.

Dogger Bank Teesside A and Dogger Bank Teesside B together

6.4.8. As set out in **Chapter 5**, Dogger Bank Teesside A and Dogger Bank Teesside B may either be constructed simultaneously or sequentially with a gap between construction. Should construction of both projects take place at the same time, there is the potential for interaction of sediment plumes and their deposition on the seabed.

6.4.9. Should deposition from construction activities of the two projects (Dogger Bank Teesside A & B) occur in the same area, there is the potential that benthic receptors in these areas may be subject to increased levels of contaminants.

6.4.10. However, given the conclusions drawn from the modelling studies for each project in isolation (namely that any increases in suspended sediment concentration and sedimentation will be low level and short-lived, and the fact that the receptors within the wind farm sites are judged to have an overall low (EIA) sensitivity to this effect, additional impacts of sediment contamination on VERs A, B and C in the wind farm sites from the construction of both projects together are unlikely. Any impacts are predicted to remain as **negligible**.

6.4.11. The same principle applies with respect to potential liberation of contaminated sediments from installation of the export cable, therefore, a **minor adverse** impact is predicted to arise.

6.5. Increased suspended sediment concentration leading to impacts on plankton and primary productivity

Dogger Bank Teesside A or Dogger Bank Teesside B in isolation

6.5.1. Phytoplankton production on the Dogger Bank occurs throughout the year supporting a high biomass of species at higher trophic levels year-round (Section 4).

6.5.2. As outlined in the previous impact statement, the construction phase of this project will lead to an increase in suspended sediment concentration via foundation installation and cable installation within the wind farm and cable installation within the Dogger Bank Teesside A & B Export Cable Corridor.

6.5.3. Whilst the potential impacts of these effects on benthic habitats are assessed above, this assessment addresses the potential for increased suspended sediment concentration, and the consequent increase in turbidity produced as a result, to create adverse impacts on phytoplankton and hence, primary productivity.

6.5.4. A detailed assessment of the impact on increased suspended sediment concentration and related turbidity on phytoplankton production in the Dogger Bank region is not possible, due to a lack of specific data on the sensitivity of phytoplankton assemblages to different levels of suspended sediment concentrations. However, it is possible to state, in a relatively broad sense that increased suspended sediment concentration, and the resultant increase in turbidity, can adversely affect phytoplankton productivity, due to the reduction in light penetration through the water column. From the outputs of the modelling work done in relation to suspended sediment concentration, increases of >200 mg/l above baseline suspended sediment concentration can be noted in the construction phase, which has the potential to create adverse effects on phytoplankton.

6.5.5. However, the spatial extent of any such increases are small when compared to the wider North Sea region, or even the wider Dogger Bank feature itself, which is noted to be a particular focus for primary production, even in winter months. As such, any temporary increases created via the construction phase are predicted to create a **negligible** impact.

Dogger Bank Teesside A and Dogger Bank Teesside B together

6.5.6. If Dogger Bank Teesside A & B are built together the spatial extent of any increases in suspended sediment concentration (and turbidity) will be greater than when either project is built in isolation. However, when built together only half the number of wind turbines would be constructed at the same time in each individual site. From this it follows that the actual increase in suspended sediment concentration (and turbidity) are likely to be lower in both sites when Dogger Bank Teesside A & B are built together than when either project is built alone. Taking the above in to account the same predictions of **negligible** impact that were predicted for the in isolation scenario apply for the build together scenario.

6.6. Physical disturbance to intertidal habitats and species during landfall works

Dogger Bank Teesside A or Dogger Bank Teesside B in isolation

6.6.1. HDD will be undertaken at the landfall in order that marine export cables and terrestrial export cables can be joined. There will also be a need to construct a joint transition bay to enable cable jointing works to take place. The main uncertainties in the construction methodology are where and how the HDD component of the onshore cables will be connected to the landing points of the export cables at the coast.

6.6.2. There are three potential exit points for HDD in the nearshore zone:

- On the beach, above the high water mark;
- In the intertidal zone between the low water and high water marks; and
- Offshore in the subtidal zone seaward of the low water mark.

6.6.3. Whichever option is chosen, there will be temporary disturbance to intertidal habitats at the landfall via construction of these joint transition bays, which are likely to be maintained by the use of temporary coffer dams. There will also be a need for open-cut trenching on the beach to bury cables, with a maximum working width of 10m (x300m beach length) assumed for EIA.

6.6.4. The MarLIN factor relevant to this impact, and, therefore, used to inform this assessment is “physical disturbance and abrasion”.

6.6.5. Scenarios for a single project only (Dogger Bank Teesside A or Dogger Bank Teesside B) are assumed to require installation of either two small cofferdams (10m x 10m x 3m) or one large cofferdam (15m x 10m x 3m) over a two-month period, with two small cofferdams creating a larger footprint (200m^2 compared to 150m^2).

6.6.6. Two VERs (H and I) have been assigned to cover the intertidal biotopes which have been defined as having very low and low ecological sensitivity respectively to physical disturbance, as may occur during landfall works.

6.6.7. The magnitude of effect is assessed as low (3200m^2 which represents 0.35% of the overall intertidal habitats within the landfall study area. Therefore, a **negligible** impact on intertidal habitats is predicted.as a result of proposed landfall works for either Dogger Bank Teesside A or Dogger Bank Teesside B built in isolation.

Dogger Bank Teesside A and Dogger Bank Teesside B together

6.6.8. For the development of Dogger Bank Teesside A & B together, the scenario is the same above, but with a larger area of effect due to a need for either four small cofferdams or two large cofferdams and up to a 20m wide open-cut trench for cables (x300m beach length).

6.6.9. However, the same conclusions with respect to the sensitivity of the intertidal VERs and magnitude of effect apply, and a **negligible** impact is predicted.

6.7. Potential construction phase impacts on the Dogger Bank cSAC

Dogger Bank Teesside A or Dogger Bank Teesside B in isolation

6.7.1. As outlined in Section 4.4**,** all of Dogger Bank Teesside A & B and part of the Dogger Bank Teesside A & B Export Cable Corridor lie within the boundary of the Dogger Bank cSAC. Although many of the seabed habitats within these areas may not conform exactly to the main habitat interest feature of the cSAC, namely "*subtidal sandbanks which are slightly covered by seawater at all times"* from an ecological perspective, all the habitats present form a key part of this overall sandbank feature.

6.7.2. Impacts on these habitats via temporary habitat disturbance and increased suspended sediments and deposition have been assessed in preceding sections. Therefore, this specific impact assessment aims to describe and quantify these potential construction phase impacts in the context of the Dogger Bank cSAC.

6.7.3. No assessment is presented with regard the favourable conservation status of the Dogger Bank cSAC or the achievement of conservation objectives of either the entire cSAC, or its qualifying features as this is the remit of the HRA which is separate to the main EIA process. The magnitude of potential effect relative to the Dogger Bank cSAC is presented but this is primarily to assist the HRA process.

6.7.4. An important point to note with respect to assessment of impacts on the Dogger Bank cSAC and the key seabed habitats, for which it has been designated, is that the overall approach to EIA for marine and intertidal ecology already factors in the importance of these habitats (as qualifying features of a cSAC) in the overall impact assessment methodology. This is reflected in **Tables 3.2**, **3.3** and **3.4** which illustrate that the overall sensitivity of the receptor, against which magnitude of effect is combined to produce overall significance, is defined via a combination of not only ecological sensitivity but the importance/value of the receptor from a conservation perspective.

6.7.5. By adopting this approach, an assessment of potential impacts on the cSAC habitats is intrinsic to the overall assessment and is the reason why different VER groups were assigned for this assessment, VERs A, B and C are the same habitats as VERs D, E and F but the former are defined as having greater (EIA) sensitivity as these habitats lie within the boundaries of the Dogger Bank cSAC.

6.7.6. Therefore, the following assessment should be read in conjunction with the **HRA Report** for Dogger Bank Teesside A & B.

6.7.7. The previous impact assessments have focussed on VERs within the wind farm and Dogger Bank Teesside A & B Export Cable Corridor, in terms of the amount of these habitats affected as a proportion (%) of the overall habitats in the site/corridor and the overall ecological sensitivity of the habitats. For this impact, the footprint of effects is defined in the context of the Dogger Bank cSAC site boundary, as defined in the latest SAC Selection Assessment Document (JNCC, Version 9.0, August 2011).

6.7.8. Based on the SAC Selection Assessment Document (JNCC, Version 9.0, August 2011), the overall area of the Dogger Bank cSAC is 12,331km^2. A summary of the areas (km^2) of Dogger Bank Teesside A and Dogger Bank Teesside B that lie within the boundaries of the cSAC are provided below in **Tables 6.2** and **6.3**, with the predicted footprint of construction phase effects as identified in preceding impact statements, presented as a proportion of the cSAC in **Table 6.4**.

Table 6.2 Dogger Bank Teesside A as a proportion of the Dogger Bank cSAC

Area	Value
Area of cSAC	12,331km^2
Area of Dogger Bank Teesside A wind farm within cSAC boundary	560.110km^2
Area of Dogger Bank Teesside A Export Cable Corridor in cSAC boundary *	(a) 4.87 + (b) 153.45 = 158.32km^2
Total area of Dogger Bank Teesside A (wind farm and Dogger Bank Teesside A & B Export Cable Corridor) within cSAC boundary	718.43km^2
Total area of Dogger Bank Teesside A (wind farm and Dogger Bank Teesside A & B Export Cable Corridor) within cSAC as % of overall cSAC	5.82%

* (a) area of Dogger Bank Teesside A Export Cable Corridor outside the Dogger Bank zone boundary; (b) area of Dogger Bank Teesside A Export Cable Corridor within Dogger Bank zone boundary.

Table 6.3 Dogger Bank Teesside B as a proportion of the Dogger Bank cSAC

Area	Value
Area of cSAC	12,331km^2
Area of Dogger Bank Teesside B wind farm within cSAC boundary	593.810km^2
Area of Dogger Bank Teesside B Export Cable Corridor in cSAC boundary *	(a) 4.87 + (b) 153.45 = 158.32km^2
Total area of Dogger Bank Teesside B (wind farm and Dogger Bank Teesside A & B Export Cable Corridor) within cSAC boundary	752.13km^2
Total area of Dogger Bank Teesside B (wind farm and Dogger Bank Teesside A & B Export Cable Corridor) within cSAC as % of overall cSAC	6.10%

* (a) area of Dogger Bank Teesside B Export Cable Corridor outside the Dogger Bank zone boundary; (b) area of Dogger Bank Teesside B Export Cable Corridor within Dogger Bank zone boundary.

Table 6.4 Dogger Bank Teesside A and/or B (and Dogger Bank Teesside A and B) combined construction phase effect footprints as a proportion of the Dogger Bank cSAC

Area	Dogger Bank Teesside A	Dogger Bank Teesside B	TOTAL (Dogger Bank Teesside A and Dogger Bank Teesside B)
Area of cSAC (12,331km$^{2)}$	N/A	N/A	N/A
Maximum footprint of construction phase effects (temporary disturbance) within Dogger Bank Teesside A/B wind farm(s) / cSAC	15.81km^2	15.81km^2	31.62km^2
Maximum footprint of construction phase effects (temporary disturbance) within Dogger Bank Teesside A/B Dogger Bank Teesside A & B Export Cable Corridor(s) * / cSAC	2.48km^2	1.60km^2	4.08km^2
Total footprint of construction phase effects (temporary disturbance) within Dogger Bank Teesside A/B wind farms(s) and Dogger Bank Teesside A & B Export Cable Corridor(s) * / cSAC	18.29km^2	17.41km^2	35.70km^2
Dogger Bank Teesside A/B construction phase effect footprint as % of overall cSAC	0.15%	0.14%	0.29%

* Only the footprint of effect within the parts of the Dogger Bank Teesside A & B Export Cable Corridor that lie within the cSAC boundary are listed here. Cable corridor "within SAC boundary" includes all of export cable within the main zone and the small section outside the main zone but still within the SAC boundary.

6.7.10. From **Tables 6.2** and **6.3**, it can be noted that the entire area of Dogger Bank Teesside A & B and relevant parts of their Dogger Bank Teesside A & B Export Cable Corridors lie within the Dogger Bank cSAC boundary. For Dogger Bank Teesside A, the total area of wind farm and Dogger Bank Teesside A & B Export Cable Corridor (including the in-zone cable corridor) that lies within the SAC boundary totals 718.43km^2 (5.82%) of the overall cSAC area). For Dogger Bank Teesside B, this figure is 752.13km^2 (6.10%).

6.7.11. In terms of actual footprint of construction phase effects via temporary disturbance (including jetting of cables), the overall footprint of effects that will affect habitats within the cSAC totals 18.29km^2 (0.15% of overall cSAC) for Dogger Bank Teesside A and 17.41km^2 (0.14% of overall cSAC for Teesside B) – see **Table 6.4**.

6.7.12. Whilst noting the very small proportion of the overall cSAC that would be affected by temporary disturbance during construction of either Dogger Bank Teesside A or Dogger Bank Teesside B, it is also important to note that the majority of habitats that would be affected within the cSAC boundary also have a low sensitivity to temporary disturbance, with only **negligible** and **minor adverse** impacts predicted on these habitats via earlier impact assessments.

6.7.13. With respect to effects of suspended sediment concentration and sedimentation, the spatial extent of this effect footprint is greater than that for direct physical disturbance, but will still be a relatively small proportion of the overall cSAC area. As outlined in earlier impact assessments, the habitats present within the Dogger Bank cSAC (VERs A, B and C) also exhibit a low sensitivity to suspended sediment concentrations and sediment deposition.

Dogger Bank Teesside A and Dogger Bank Teesside B together

6.7.14. **Table 6.4** indicates a total footprint of temporary disturbance from both Dogger Bank Teesside A and Dogger Bank Teesside B of 0.29% of the cSAC, representing a very small proportion of the overall habitats within the cSAC (which can be expected from the information available to be similar to those recorded in the study area). Therefore, the same conclusions made above in relation to Dogger Bank Teesside A or Dogger Bank Teesside B in isolation and the conservation objectives of the cSAC are predicted to remain valid for Dogger Bank Teesside A & B together.

6.7.15. As outlined above, an assessment of the potential for these impacts to affect the integrity of the cSAC, from a Habitats Regulations perspective, is contained in the **HRA Report**. The **HRA Report** provides sufficient information to enable a competent authority to undertake an Appropriate Assessment of the proposals should one be required.

6.7.16. The HRA process will formally consider any marine ecological impacts (and other impacts) against the structure and function and conservation objectives of the Dogger Bank cSAC (as well as other SAC/SPA sites) so that a determination of potential effects on the integrity of these sites can be undertaken.

6.8. Potential construction phase impacts on sites of marine conservation interest

Dogger Bank Teesside A or Dogger Bank Teesside B in isolation

6.8.1. The preceding impact assessments have discussed the potential for construction activities to produce effects that may impact benthic habitats in the Dogger Bank Teesside A & B study area. The benthic habitats have been grouped into VERs as per the approach set out in Section 3.3, with these VERs representing the receptors against which impacts have been assessed.

6.8.2. This particular impact assessment discusses the effects on benthic habitats described previously in the context of the following sites of marine nature conservation interest, for which examples occur within and around the Dogger Bank Teesside A & B study area;

- UK BAP Habitats;
- rMCZs; and
- OSPAR habitats and species.

6.8.3. It is important to note that potential impacts on the ecological elements of the sites of marine conservation interest listed above have already been assessed via the individual impact assessments presented up to this point. Therefore, to avoid repetition in the assessment process, the assessment of potential construction phase impacts on sites of marine conservation interest are presented below as a series of summary tables which make reference to the conclusions of previous impact assessments.

6.8.4. It should also be recognised that the preceding impact assessments have all been undertaken via an assessment of the sensitivity of receptors and the magnitude of effect. For the benthic receptors (VERs), the overall EIA sensitivity has been determined via a combination of ecological sensitivity of the receptor to a particular effect, as well as the value of the receptor, for example, whether or not it represents Annex I habitat. The value element of receptor sensitivity (see **Table 3.2**) already takes account of whether or not a habitat or species may be of conservation interest, which is therefore inherent within the assessment methodology.

6.8.5. The "receptor" heading in the following tables refers to the habitat/species of marine conservation interest (BAP Habitats in **Table 6.5** and rMCZs in **Table 6.6**) with the column headed "relevant VERs" identifying the VERs (as defined in **Table 4.4**) that apply to those habitats/species. The impact descriptions are those assessed previously via individual impact assessments, with any relevant mitigation and the residual impact from these previous impact assessments also presented.

Table 6.5 Potential construction phase impacts on BAP habitats

Receptor	Relevant VERs (see Table 4.4)	Impact description	Mitigation	Residual impact
"Subtidal sands and gravels" BAP Habitat **and** "Mud habitats in deep water" BAP Habitat	A, B, C, D, E and F	Physical disturbance to habitats and species, and temporary habitat loss	None	**Negligible** (VERs A, B, D, E, F) **Minor adverse** (VER C)
		Increased suspended sediment concentration and sediment deposition	None	**Negligible** (All relevant VERs)
		Release of sediment contaminants resulting in potential effects on benthic ecology	None	**Negligible** (VERs A, B and C in main site) **Minor adverse** (VERs A, B, C, D, E & F in cable corridor)
		Increased suspended sediment concentration leading to impacts on plankton and primary productivity	None	**Negligible** (all relevant VERs)
		Physical disturbance to intertidal habitats and species during landfall works *	N/A *	N/A *

* This impact (intertidal) not relevant to the two subtidal and deep water BAP habitats relevant to the study area. Therefore, no residual impact listed.

6.8.6. Based on the previous impact assessments conducted on the benthic receptors (VERs) that are also representative of these two BAP habitats, it is concluded that, overall, there will be a **negligible** impact on some of the benthic habitats that are component parts of the two marine BAP habitats within the Dogger Bank Teesside A & B study area, with **minor adverse** impacts on other habitats (**Table 6.5**).

6.8.7. With respect to MCZs, on 21st November 2013, Defra announced the designation of 27 MCZ's from the initial long-list of 127 rMCZs. The two rMCZ's that exist in the Dogger Bank Teesside A & B study area (Compass Rose rMCZ) and Runswick Bay rMCZ), that have the potential to be impacted by construction activities, were not designated as MCZs but remain as rMCZs.

6.8.8. The Compass Rose rMCZ is located approximately 8km to the south of the Dogger Bank Teesside A & B Export Cable Corridor whilst the Runswick Bay rMCZ is 0.5km to the south of the cable corridor near landfall.

6.8.9. Compass Bay rMCZ has been recommended due to the presence of the broad scale habitat "moderate energy circalittoral rock. Based on the distribution of habitats within the Dogger Bank Teesside A & B Export Cable Corridor, similar rock-based biotopes also occur within the cable corridor (represented by VER G).

6.8.10. The detailed assessment of construction phase impacts on benthic habitats has concluded that **negligible** to **minor adverse** impacts will arise on these receptors during construction. The Compass Rose rMCZ does not overlap spatially with the Dogger Bank Teesside A & B Export Cable Corridor, therefore, scope for direct impacts via construction does not exist. However, scope does exist for potential indirect impacts via increased suspended sediments and deposition which may adversely affect habitats within this rMCZ. Any such impacts on habitats in this rMCZ will be no more significant than the impacts already assessed on habitats within the cable corridor. Therefore, it is concluded that there will be, at worst, **minor adverse** impacts on habitats within the Compass Rose rMCZ via construction activities associated with the Dogger Bank Teesside A & B Export Cable Corridor.

6.8.11. With respect to Runswick Bay, this rMCZ is recommended due to the presence of subtidal sedimentary environments and circalittoral and infralittoral rock habitats. As per Compass Bay rMCZ, the lack of spatial overlap between this rMCZ and the Dogger Bank Teesside A & B Export Cable Corridor means that direct impacts will not arise. The scope for indirect impacts (via increased suspended sediment and deposition) is greater than for Compass Rose rMCZ due to closer proximity of Runswick Bay to the cable corridor. However, it is concluded that the significance of impact son habitats within Runswick Bay rMCZ will be no greater than those already assessed on habitats within the Dogger Bank Teesside A & B Export Cable Corridor.

6.8.12. Therefore, it is concluded that there will be, at worst, **minor adverse** impacts on habitats within the Runswick Bay rMCZ via construction activities associated with the Dogger Bank Teesside A & B Export Cable Corridor.

Table 6.6 Potential construction phase impacts on rMCZs

Receptor	Relevant VERs (see Table 4.4)	Impact description	Mitigation	Residual impact
Compass Rose rMCZ	G	Physical disturbance to habitats and species and temporary habitat loss	None	**Negligible**
		Increased suspended sediment concentration and sediment deposition	None	**Negligible**
		Release of sediment contaminants resulting in potential effects on benthic ecology	None	**Minor adverse**
		Increased suspended sediment concentration leading to impacts on plankton and primary productivity	None	**Negligible**
		Physical disturbance to intertidal habitats and species during landfall works *	None	N/A *
Runswick Bay rMCZ	D, E, G	As above	As above	As above

* This impact (intertidal) not relevant to Compass Rose rMCZ or Runswick Bay rMCZ as neither rMCZ is designated for intertidal habitats.

6.8.13. With respect to potential impacts on OSPAR threatened species and habitats, no such species or habitats are recorded within the Dogger Bank Teesside A & B study area, therefore, no impacts are predicted.

Dogger Bank Teesside A and Dogger Bank Teesside B together

6.8.14. The previous VER based impact assessments concluded that even if Dogger Bank Teesside A & B were constructed together, there would be no change in the level of any of the impacts predicted via either project being constructed in isolation. Therefore, the conclusions with respect to potential impacts on BAP habitats and rMCZs presented above are also relevant to this scenario.

6.9. Monitoring of construction phase impacts

6.9.1. Although no significant adverse impacts are predicted on marine and intertidal ecology from the construction phase of the project, it is proposed that monitoring of benthic communities is undertaken to confirm these predictions.

6.9.2. The objectives and design of benthic monitoring programmes for offshore wind farm developments are well established and it is expected that the elements of the benthic monitoring programme for Dogger Bank Teesside A & B will be similar to other programmes on existing offshore wind farms.

6.9.3. A pre-construction survey will be carried out no more than 12 months prior to the start of offshore construction. The data from this survey will represent the formal baseline against which future changes will be monitored via post-construction surveys in the operational phase. The exact time-frame/frequency of post-construction monitoring will be decided via consultation with key regulatory bodies but it is noted that under (deemed) Marine Licences it is possible to carry out monitoring over the lifetime of the project. Therefore, it is expected that post-construction monitoring of marine ecological habitats will be conducted at more infrequent intervals throughout the lifetime of the development (in contrast to previous FEPA requirements for surveys in years one to three post-construction only).

6.9.4. It is proposed that sampling stations will include several locations within the main wind farm site(s), several locations outside of the wind farm(s), but within the near-field and several locations that are outside of the area of influence of the wind farm(s) to act as controls. The selection of sampling locations will also take account of the outputs of the physical process modelling work undertaken as part of the EIA.

6.9.5. Each sampling location will include a minimum of three grab-sampling (mini-hamon grab) replicates for infaunal invertebrate analysis with sub-sampling of one of these samples for particle size analysis. Grab sampling will be preceded by a drop down video survey to record epibenthic flora and fauna and to ensure that the grab is not deployed over sensitive benthic habitats.

6.9.6. The pre-construction marine ecology survey will include an Annex I habitat survey that will be designed such that the potential presence and spatial distribution of potential Annex I reef habitat (specifically cobble reef habitat in relation to Dogger Bank Teesside A & B) is fully determined prior to construction commencing. The design of this survey will be based upon guidance presented in the ALSF Report "Best methods for identifying and evaluating *Sabellaria spinulosa* and cobble reef" (Limpenny *et a.l* 2010).

6.9.7. The final objectives, design and methodology of both the wider benthic habitat survey and the focussed Annex I habitat survey will be issued to statutory bodies for review and sign-off prior to the survey commencing.

7. Assessment of Impacts during Operation

7.1. Permanent loss of habitat via placement of project infrastructure (foundations, cable protection, scour protection)

Dogger Bank Teesside A or Dogger Bank Teesside B in isolation

7.1.1. Long-term habitat loss will occur directly under all foundation structures and associated scour protection, and also under all inter-array and export cables where secondary cable protection is required for the lifetime of the project. The MarLIN factor relevant to this impact, and, therefore, used to inform this assessment is “substratum loss.

7.1.2. Based on the worst-case scenario of 200 x GBS foundations, along with all other related project infrastructure (see **Table 5.1**), a total permanent habitat loss of 6.40km^2 is predicted for Dogger Bank Teesside A, of which 3.73km^2 will occur within the wind farm boundaries (foundations, array cable protection, scour protection and vessel mooring) and the remaining 2.67km^2 will occur within the Dogger Bank Teesside A & B Export Cable Corridor (via cable protection and cable crossings).

7.1.3. For Dogger Bank Teesside B, the same permanent habitat loss figure of 3.73km^2 applies for the wind farm) with the permanent habitat loss within the Dogger Bank Teesside A & B Export Cable Corridor being less (2.40km^2) due to the shorter length of the Dogger Bank Teesside A & B Export Cable Corridor (therefore, less cable protection needed)

7.1.4. Using the same approach as outlined in Section 6, of the overall footprint of impact being allocated on a percentage basis in line with the percentage coverage of the study area by the VERs, the permanent habitat losses within the wind farm and Dogger Bank Teesside A & B Export Cable Corridor are expressed as percentage of the total VERs below in **Table 7.1**.

7.1.5. In terms of the three VERs identified within the wind farm of Dogger Bank Teesside A, it is predicted that 0.35km^2 of VER A would be lost along with 0.19km^2 and 3.20km^2 of VERs B and C respectively, representing a total of 3.73km^2 of habitat loss (0.66% of the entire site).

7.1.6. For Dogger Bank Teesside B, 2.26km^2 of VER A would be lost along with 0.21km^2 and 1.26km^2 of VERs B and C respectively. This total of 3.73km^2 represents (0.63% of the entire Dogger Bank Teesside B site).

7.1.7. In terms of sensitivity of these VERs to this effect (substratum loss), VERs A, B and C are all judged to have a moderate (ecological) sensitivity to this effect, based on the most sensitive biotope within each VER to this specific effect. Therefore, an overall (EIA) sensitivity of medium (see **Table 3.3**) is assigned to these three VERs as they are internationally important receptors (Annex I habitats in a cSAC boundary) but with medium vulnerability and recoverability.

7.1.8. The magnitude of this effect is judged to be low as the spatial extent of this effect is less than 5% of the main wind farm site(s) and there will be a slight change in baseline conditions due to the introduction of hard substrate (see separate impact assessment related to this below). Therefore, the combination of medium sensitivity and low magnitude results in a prediction of a **minor adverse** impact on existing benthic habitats (VER's A, B and C) within the main Dogger Bank Teesside A or Dogger Bank Teesside B site boundaries due to permanent habitat loss.

7.1.9. With respect to the Dogger Bank Teesside A & B Export Cable Corridor, permanent habitat loss will arise through the placement of export cable protection and material for cable crossings. For Dogger Bank Teesside A this has been calculated as totalling 2.67km^2, which represents 1.14% of the Dogger Bank Teesside A & B Export Cable Corridor (233.36km^2). For Dogger Bank Teesside B, 2.40km^2, representing 1.02% of the Dogger Bank Teesside A & B Export Cable Corridor would be lost. As for the wind farm, the distribution of this habitat loss across the nine VERs that occur within the Dogger Bank Teesside A & B Export Cable Corridor will vary, depending on the final cable route but for the purpose of this assessment, it has been assumed that the impact will be spread across all VERs in the same proportion as they appear in the corridor (see **Table 7.1**).

7.1.10. VERs A, B and C also occur within the Dogger Bank Teesside A & B Export Cable Corridor, as part of the export cable lies within the zone and the boundary of the SAC also overlaps with the export cable at the most eastern section. As per the assessment for the wind farm, the (EIA) sensitivity of these three VERs within the Dogger Bank Teesside A & B Export Cable Corridor is assessed as medium, which with a low magnitude of effect (due to the small amount of permanent habitat loss and lack of impact on the SAC interest features), results in a **minor adverse** impact on these VERs within the Dogger Bank Teesside A & B Export Cable Corridor.

7.1.11. Although it is recognised that VER's D to H have a moderate (ecological) sensitivity to this effect (substratum loss), based on the criteria in **Table 3.3**, these VER's are judged to have a low (EIA) sensitivity as they represent locally important receptors. When combined with a low magnitude of effect a **negligible** impact is predicted via permanent habitat loss on VER's D to H within the Dogger Bank Teesside A & B Export Cable Corridor.

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Table 7.1 Proportion of VER habitats affected by permanent habitat loss during the operational phase

	Dogger Bank Teesside A			Dogger Bank Teesside B			Dogger Bank Teesside A and B combined		
VER *	Total area (km^2) of VER within wind farm	% of area covered by VER within wind farm	Area (km^2) of VER potentially affected	Total area (km^2) of VER within wind farm	% of area covered by VER within wind farm	Area (km^2) of VER potentially affected	Total area (km^2) of VER within wind farm	% of area covered by VER within wind farm	Area (km^2) of VER potentially affected
Wind Farm sites									
A	51.9km^2	9.27%	0.35km^2	359.04km^2	60.52%	2.26km^2	410.94km^2	35.63%	2.66km^2
B	28.06km^2	5.01%	0.19km^2	33.74km^2	5.69%	0.21km^2	61.8 km^2	5.36%	0.40km^2
C	480.15km^2	85.72%	3.20km^2	200.43km^2	33.79%	1.26km^2	680.58km^2	59.01%	4.40km^2
TOTAL	**560.11km^2**	**100.00%**	**3.73km^2**	**593.21km^2**	**100.00%**	**3.73km^2**	**1153.32km^2**	**100%**	**7.46km^2**
Dogger Bank Teesside A & B Export Cable Corridor (including in-zone cables)									
A	126.62km^2	54.26%	1.45km^2	126.80km^2	54.09%	1.30km^2	253.42km^2	54.18%	2.75km^2
B	12.05km^2	5.16%	0.14km^2	11.66km^2	4.98%	0.12km^2	23.71km^2	5.07%	0.26km^2
C	19.98km^2	8.56%	0.23km^2	20.03km^2	8.55%	0.21km^2	40.01km^2	8.55%	0.43km^2
D	6.80km^2	2.91%	0.08km^2	6.32km^2	2.70%	0.06km^2	13.12km^2	2.80%	0.14km^2
E	18.66km^2	7.98%	0.21km^2	16.55km^2	7.06%	0.17km^2	35.21km^2	7.53%	0.38km^2
F	48.73km^2	20.88%	0.56km^2	52.51km^2	22.40%	0.54km^2	101.24km^2	21.64%	1.10km^2
G	0.07km^2	0.03%	0.00km^2	0.07km^2	0.03%	0.00km^2	0.15km^2	0.03%	0.00km^2
H	0.40km^2	0.17%	0.00km^2	0.40km^2	0.17%	0.00km^2	0.80km^2	0.17%	0.01km^2
I	0.05km^2	0.02%	0.00km^2	0.05km^2	0.02%	0.00km^2	0.10km^2	0.02%	0.00km^2
TOTAL	**233.36km^2**	**100.00%**	**2.67km^2 ***	**234.40km^2**	**100.00%**	**2.40km^2**	**467.76km^2**	**100.00%**	**5.07km^2**

*
VER A: Sandy sediment supporting relatively low diversity benthic communities which form part of the Annex I Sandbank Feature (within boundary of cSAC)
VER B: Coarse sediments with medium to high diversity benthic communities which form part of the Annex I Sandbank Feature (within boundary of cSAC)
VER C: Muddy sand sediments with medium diversity benthic communities (including sea pens) which form part of the Annex I Sandbank Feature (within boundary of cSAC)
VER D: Sandy sediment supporting relatively low diversity benthic communities outside cSAC boundary)
VER E: Coarse sediments with medium to high diversity benthic communities outside cSAC boundary
VER F: Muddy sediments with medium diversity benthic communities (including sea pens) outside cSAC boundary
VER G: Rock-based infralittoral and circalittoral habitats
VER H: Intertidal sand-based habitats
VER I: Intertidal rock-based habitats

Dogger Bank Teesside A and Dogger Bank Teesside B together

7.1.12. The combined permanent habitat loss across Dogger Bank Teesside A & B if both projects are built is shown in **Table 7.1**. Loss of 7.46km^2 of the total wind farm area of 1153.920 km^2 represents 0.64% of the overall habitat in the two sites combined.

7.1.13. In terms of overall impact, as per the assessment of each project in isolation, the (EIA) sensitivity of VERs A, B and C (both within the wind farm and in the offshore section of the Dogger Bank Teesside A & B Dogger Bank Teesside A & B Export Cable Corridor that overlaps with the SAC boundary) to this effect is judged to be medium. The magnitude of effect is judged to be low, based on the fact that only 0.64% of habitats represented by VER A, B and C in the wind farms will be affected.

7.1.14. Therefore, a prediction of **minor adverse** impact on existing benthic habitats within the wind farm boundary due to permanent habitat loss is concluded via Dogger Bank Teesside A and Dogger Bank Teesside B together.

7.1.15. With respect to the combined Dogger Bank Teesside A & B Export Cable Corridors, loss of 5.07km^2 from a total area of 467.76km^2 represents a loss of 1.08% of overall habitats within the cable corridor. Therefore, a low magnitude effect is predicted.

7.1.16. VER's A, B and C exist in the cable corridor and are assigned a medium sensitivity to this effect. Coupled with a low magnitude of effect, a **minor adverse** impact on VERs A, B and C which lie within the Dogger Bank Teesside A & B Export Cable Corridor is predicted via permanent habitat loss.

7.1.17. For VERs D to I the sensitivity of these receptors to the effect of permanent habitat loss is defined as low based on the criteria in **Table 3.3**. When combined with a low magnitude of effect a **negligible** impact is predicted.

7.2. Temporary impact on benthos due to physical disturbance caused by maintenance activities

Dogger Bank Teesside A or Dogger Bank Teesside B in isolation

7.2.1. During the operation of the wind farm, there will be the need for regular and unplanned maintenance from jack up vessels and other heavy offshore equipment. This will cause localised disturbance to benthic habitats within the site.

7.2.2. The MarLIN factor relevant to this impact, and, therefore, used to inform this assessment is "physical disturbance and abrasion".

7.2.3. Based on sensitivity assessments provided by MarLIN for component biotopes of the three VERs that have been identified within Dogger Bank Teesside A and Dogger Bank Teesside B, the ecological sensitivity of the VER's to physical disturbance and abrasion (as would be temporarily produced via jacking-up activities in the operational phase) varies from low (VER A and B) to moderate (VER C). In terms of predicting the impact, although the value of VERs A, B and C are defined as International (see **Table 3.2**), the actual sensitivity of these VERs in EIA terms (as defined in **Table 3.3**), varies due to the different vulnerability and recoverability to this effect (physical disturbance) of these three VERs.

7.2.4. Therefore, for VERs A and B, a sensitivity of low is assigned due to the high recoverability of these habitats to physical disturbance and abrasion, whilst for VER C, a sensitivity of medium is assigned due to the greater vulnerability and longer recovery time of these habitats to physical disturbance.

7.2.5. Based on information provided in **Chapter 5**, a worst-case scenario for maintenance activities in relation to benthic impacts has been provided. This predicts a maximum footprint for temporary habitat disturbance due to jacking-up activities during the operational phase of a project of 0.904km^2 which equates to 0.161% of the overall area (wind farm) of Dogger Bank Teesside A. For Dogger Bank Teesside B the same area is impacted (0.904km^2) equating to 0.152% of the overall area (wind farm).

7.2.6. The magnitude of effect is judged to be low due to limited spatial extent of any jacking-up activities and the intermittent nature of this effect.

7.2.7. Therefore, for VERs A and B, their low sensitivity to this effect combined with a low magnitude of effect is predicted to result in a **negligible** impact. For VER C, the increased sensitivity of this VER (medium - based on the moderate ecological sensitivity of certain biotopes in this VER to this effect) results in a **minor adverse** impact via maintenance activities (jacking-up) in the operational phase.

Dogger Bank Teesside A and Dogger Bank Teesside B together

7.2.8. With both projects in operation, the potential for temporary disturbance to benthic habitats would be greater than for one project in isolation. Based on the worst-case scenarios identified via the project description, the amount of habitat that could be affected across both projects via temporary habitat disturbance in the operational phase (via jacking-up) amounts to 1.808km^2, which represents 0.156% of the total 1153.920km^2 area of the Dogger Bank Teesside A and Dogger Bank Teesside B sites (excluding the Dogger Bank Teesside A & B Export Cable Corridor) combined.

7.2.9. The sensitivity of VERs A, B and C will be as defined above and the magnitude of effect is judged to remain low due to the small spatial extent in comparison to the overall wind farm area. Therefore, a **negligible** impact is predicted on VERs A and B, with a **minor adverse** impact on VER C due to vessel interactions with the seabed (jacking-up) during the operational phase of these projects.

7.3. Change in hydrodynamics and inter-related effects on benthos

Dogger Bank Teesside A or Dogger Bank Teesside B in isolation

7.3.1. During the operational phase of the project, the presence of physical structures within the site, including foundations, scour protection and vessel moorings, has the potential to change existing hydrodynamic conditions (wave and tidal currents) within the site.

7.3.2. The existing benthic communities are distributed mainly according to sediment type, which is itself linked to over-arching hydrodynamic processes so any change in the latter could result in eventual changes to benthic communities.

7.3.3. The MarLIN factors relevant to this impact, and, therefore, used to inform this assessment are “increase/decrease in wave exposure” and “increase/decrease in water flow rate”.

7.3.4. The worst-case scenario for modelling hydrodynamic changes in the operational phases was considered to be a grid of foundations that filled each project area (Dogger Bank Teesside A & B) with 200 x 6MW turbines with GBS#1 foundations (400 in total), with a minimum spacing of turbines (750m) around the perimeter and a wider internal spacing. This provides the maximum potential for interaction of tidal current and wave processes between foundations.

7.3.5. Based on this worst-case scenario, a maximum change in tidal current velocity of less than 2% along narrow (up to 3km wide) bands restricted to the project boundaries is predicted to occur.

7.3.6. This maximum percentage change is within the natural variation of tidal current velocity across Dogger Bank and surrounding sea areas and is so small that it is unlikely to affect the form of recent sediments over and above the natural tidal processes.

7.3.7. With respect to changes in wave regime, based on the same worst-case scenario as per tidal currents, a maximum increase in significant wave height of 1% along the south/southwest perimeter of Dogger Bank Teesside B (in a band about 12km wide) and the north perimeter of Dogger Bank Teesside A is predicted. As per tidal currents, these predicted changes in wave regime are within the natural variation of wave heights across Dogger Bank and surrounding sea areas and are unlikely to affect the form of recent sediments over and above the natural wave regime.

7.3.8. In terms of the potential impacts of these changes on benthic communities, the sensitivity of the key habitats within the wind farms to changes in hydrodynamic processes needs to be understood.

7.3.9. Of the three VERs identified within the wind farm, VER A and C are judged to have a moderate (ecological) sensitivity to increased wave exposure and increased water flow (tidal currents), with VER B having a low (ecological) sensitivity to these effects. However, the benchmark increase in wave exposure required to trigger the moderate sensitivity to this factor is a change from existing conditions to `exposed’ and ‘very exposed’ categories. Such increases in wave exposure are not predicted to arise at Dogger Bank Teesside A & B during the operational phase, with a maximum increase in significant wave height of 1% predicted along the south/southwest perimeter of Dogger Bank Teesside B (in a band about 12km wide).

7.3.10. Similarly, the benchmark increase in water flow (tidal current) required to trigger these moderate sensitivities to this factor is a change of at least two classes from the existing “Weak” flow rate (<0.5m/s - typical tidal currents are less than 0.4m/s in the study area) to “Strong” (1.5 – 3m/s).

7.3.11. Such increases in tidal currents are not predicted to arise at Dogger Bank Teesside A & B during the operational phase, with the maximum change in current velocity predicted to be less than 2% along narrow (3km) bands restricted to the project boundaries.

7.3.12. Therefore, the overall (EIA) sensitivity of the VERs within the Dogger Bank Teesside A & B wind farm sites due to the changes in the hydrodynamic regime predicted to arise is negligible. The magnitude of this effect is also judged to be negligible as the changes in wave and tidal conditions during the operational phase are judged to be within natural limits of variation.

7.3.13. Overall, a **negligible** impact on all benthic receptors within the main wind farm sites and Dogger Bank Teesside A & B Export Cable Corridor is predicted via changes in the hydrodynamic regime caused by the presence of project infrastructure.

7.3.14. None of the component biotopes that comprise these groups are judged to have a high sensitivity to changes in tidal flows or wave regime. This low sensitivity, coupled with the low magnitude of effect, results in a prediction of **negligible** impact on benthic habitats within the wind farms, as a result of changes to hydrodynamic processes in the operational phase.

7.3.15. Changes in hydrodynamic processes due to the potential presence of export cable protection are judged to be negligible and, as such, any subsequent impacts on benthic communities in the Dogger Bank Teesside A & B Export Cable Corridor are also judged to be **negligible**.

Dogger Bank Teesside A and Dogger Bank Teesside B together

7.3.16. As outlined above, the physical process modelling undertaken as part of the EIA for Dogger Bank Teesside A & B is based on a worst-case layout of a grid of foundations that fills both Dogger Bank Teesside A and Dogger Bank Teesside B with a total of 400 x turbines. Therefore, the predicted effects described above with regard to Dogger Bank Teesside A or Dogger Bank Teesside B in isolation also apply to the scenario whereby Dogger Bank Teesside A & B are operated together.

7.3.17. Therefore, the results and predictions relevant to benthic ecology presented above also apply to both projects operating together and the impact is predicted to remain as **negligible**.

7.4. Increase in suspended sediment concentration due to scour associated with foundations

Dogger Bank Teesside A or Dogger Bank Teesside B in isolation

7.4.1. During the operational phase of the project, the presence of foundation structures for wind turbines and other project infrastructure (converter stations, accommodation platforms etc.) will lead to the formation of scour around these structures.

7.4.2. The material scoured from each foundation location will become liberated into the water column and lead to increased suspended sediment concentration (SSC). The worst case scenario for this effect is presented in **Table 5.1** and is based on two 30-day model runs after (i) end of year 1 operation (200 x turbine foundations subjected to a 1-in-1 year storm event) and (ii) end of year 2 operation (400 x turbine foundations subjected to a 1-in-50 year storm event). This modelling scenario is actually based on Dogger Bank Teesside A & B being constructed together (400 turbine foundations in total, 200 constructed each year; 100 in Dogger Bank Teesside A & B respectively). Therefore, the findings presented below with regard to benthic ecology represent the worst-case and any effects for Dogger Bank Teesside A or Dogger Bank Teesside B built in isolation will be less than those described in reality.

7.4.3. The outputs of the modelling work indicated a maximum increase in suspended sediment concentrations of >200mg/l. These concentrations occur as 20km long, 6km wide patches along the north and south perimeters of Dogger Bank Teesside A and also the southwest perimeter of Dogger Bank Teesside B. Maximum suspended sediment concentrations are >20mg/l across all of Dogger Bank Teesside A & B, gradually reducing with distance from the foundations until they are 2mg/l approximately 40-54km south of the projects boundaries and 20-37km north of the project boundaries.

7.4.4. With respect to average suspended sediment concentration in the bottom layer, the modelling work predicted a value of between 10mg/l to 50mg/l across both projects and for up to approximately 19km to their south. Average suspended sediment concentration reduces to 2mg/l up to approximately 36km south of the projects southern boundaries and up to 26km north of the Dogger Bank Teesside A northern boundary.

7.4.5. The 2mg/l (background level) is exceeded > 90% of the 30-day simulation period in two patches, one to the south of Dogger Bank Teesside B and one within and to the south of Dogger Bank Teesside A, up to 15km south of their southern boundaries. Exceedance is generally greater than 70% across both Dogger Bank Teesside A & B.

7.4.6. These maximum values are similar to those predicted for increased suspended sediment concentration during the construction phase, although the spatial extent of concentrations that exceed background levels (2mg/l) is greater for this effect that for construction effects (levels above background of 2mg/l occur up to 54km south of the boundaries of Dogger Bank Teesside A & B for this operational effect whereas during construction, levels above background (2mg/l) only occur up to 40km from the project boundary.

7.4.7. As discussed with respect to the impact assessment of increased suspended sediment concentration in the construction phase, of the three VERs identified in the wind farm sites (VERs A, B and C), VER A is judged to be not sensitive to increased suspended sediment concentrations whilst VER B and C are judged to have very low and low ecological sensitivities respectively.

7.4.8. VER C is judged to have a greater ecological sensitivity to increased suspended sediment than VERs A and B due to the presence of the SS.SSa.IMuSa.EcorEns biotope within this receptor group. However, based on the MarLIN sensitivity assessment for this biotope (Hill 2008), VER C still only has a low sensitivity to this effect (although it is noted that other biotopes within VER C have even less sensitivity to this effect.

7.4.9. In terms of actual impact, although the values of VER A, B and C are defined as International (see **Table 3.2**), the actual sensitivity of VER A is classed as negligible as this is not sensitive to this effect. VERs B and C are defined as a low sensitivity as the biotopes within these groups exhibit low vulnerability to increased suspended sediment concentration and high recoverability to any such effects.

7.4.10. In terms of the magnitude of the effect in question, based on the criteria in **Table 3.4**, this is judged to be low as the effects are not predicted to affect the conservation status of the site, although it is accepted that there will be some effect on these habitats.

7.4.11. Therefore, as per the impact assessment for increased suspended sediment concentrations in the construction phase, for the same effect via scour in the operational phase, the negligible sensitivity of VER A and low magnitude of effect results in a **negligible** impact. A **negligible** impact is also predicted for VER B due to the Low sensitivity and Low magnitude of effect. For VER C, a **minor adverse** impact is predicted as although the overall sensitivity and magnitude of effect is the same as per VER B, the slightly increased sensitivity of biotopes within VER C to this effect results in an increased significance of impact.

7.4.12. In terms of VERs D to I, these habitats are located away from the Dogger Bank Teesside A & B site boundaries along the Dogger Bank Teesside A & B Export Cable Corridor and are all judged to be either not sensitive, or have a low sensitivity to increased suspended sediment concentrations. In terms of the magnitude of the effect in question, based on the criteria in **Table 3.4**, this is judged to below for all of the VERs, resulting in a **negligible** impact on all of the VERs along the Dogger Bank Teesside A & B Export Cable Corridor via increased suspended sediment concentrations produced via scour during the operational phase.

Dogger Bank Teesside A and Dogger Bank Teesside B together

7.4.13. The outputs and impact assessment defined above for Dogger Bank Teesside A & B in isolation are based on a worst-case modelling scenario of Dogger Bank Teesside A & B being constructed/operated together (400 turbine foundations in total, 200 constructed each year; 100 in Dogger Bank Teesside A & B respectively). Therefore, the findings presented above with regard to benthic ecology can also be applied to the scenario whereby Dogger Bank Teesside A & B are operated together.

7.5. Increase in sediment deposition following increase in suspended sediment concentration due to scour associated with foundations

Dogger Bank Teesside A or Dogger Bank Teesside B in isolation

7.5.1. The increased suspended sediment concentration via scour that will occur in the operational phase, as detailed above, will result in a related increase in sediment deposition. Based on the same modelling scenarios as per suspended sediment concentration (after year one operational and after year two operational), the outputs of the modelling work indicated that within Dogger Bank Teesside A & B, maximum thicknesses over the 30-day simulation period of 5mm are predicted in discrete areas, with the majority of the Dogger Bank Teesside A & B areas subject to deposition of between 0.5 and 5mm. Thickness then reduces to less than 0.1mm approximately 16-30km from the southern boundaries of the sites and 13-35km from the northern boundaries.

7.5.2. With respect to average deposition, this is predicted to be between 0.5mm and 5mm in a 32km long, 14km wide area located between Dogger Bank Teesside A & B. Elsewhere, the average deposition is less than 0.5mm, reducing to less than 0.1mm approximately 23km southwest of Dogger Bank Teesside B and 19km north of Dogger Bank Teesside A.

7.5.3. In terms of persistency of deposited sediment, the model predicts that deposition depth will be <0.1mm (i.e. returning to baseline) by the end of the 30-day model period for all locations modelled. In reality, this removes the potential for any "additive" effect of sediment deposition in parts of the site and, therefore, the maximum depths outlined above represent the actual maximum values predicted to arise.

7.5.4. Based on these values and the behaviour of any deposited sediment over a 30-day model period, together with the sensitivity of VERs within the wind farms and Dogger Bank Teesside A & B Export Cable Corridor, a **negligible** impact is predicted via sediment deposition on benthic habitats during the operational phase of the project.

Dogger Bank Teesside A and Dogger Bank Teesside B together

7.5.5. The outputs and impact assessment defined above for Dogger Bank Teesside A & B in isolation are based on a worst-case modelling scenario of Dogger Bank Teesside A & B being constructed/operated together (400 turbine foundations in total, 200 constructed each year; 100 in Dogger Bank Teesside A & B respectively). Therefore, the findings presented above with regard to benthic ecology can also be applied to the scenario whereby Dogger Bank Teesside A & B are operated together.

7.6. Introduction of new habitat in the form of foundation structures, leading to potential colonisation

Dogger Bank Teesside A or Dogger Bank Teesside B in isolation

7.6.1. All project infrastructure that has a sub-surface element will represent a suitable surface for colonisation by marine fauna and flora, including species that may not currently be found within the existing environment. This is of particular note in sedimentary environments like Dogger Bank where current substrates for colonisation by encrusting epifauna are very limited.

7.6.2. Therefore, the presence of foundations for wind turbines, accommodation platforms etc. will represent new areas for such colonisation, with potential to change the nature of benthic communities in the study area.

7.6.3. Based on the worst-case scenario for this impact presented in **Table 5.1**, up to a total of 6.40km^2 of hard substrate will be introduced via installation of either

Dogger Bank Teesside A or Dogger Bank Teesside B in isolation, via the range of project infrastructure including foundations, vessel moorings, scour and cable protection etc.

7.6.4. Noting the presence of epifaunal species and colonising fauna within discrete parts of the site and Dogger Bank Teesside A & B Export Cable Corridor already (associated with coarser sediments), it is predicted that colonisation of any introduced hard substrates will occur. Although exact species assemblages are difficult to predict, it is likely that fairly common species will colonise these areas, including species of bryozoans, ascidians and bivalve molluscs.

7.6.5. Whether such a change represents an adverse or beneficial impact in terms of the wider benthic ecological status of the study area is difficult to determine. It is possible that the colonisation of hard substrates by certain flora and fauna will produce an additional food source for some marine species, including commercially exploited fish. When coupled with any potential "reef" effect of the foundation structures, this may represent a beneficial impact to certain fish and shellfish species (see **Chapter 13** for more discussion on this issue). However, in contrast, the introduction of hard substrate in an area currently characterised as a sedimentary environment may create habitat that could be colonised by alien marine species, such as the Pacific marine midge *Telmatogeton japonicus* and the Japanese skeleton shrimp *Caprella mutica*.

7.6.6. Although not currently listed as an alien species in the UK (Non-Native Species Secretariat (NNSS) 2010), an increase in a population of *T. japonicus* has been noted from on-going monitoring studies of the Danish Horns Rev offshore wind farm in the North Sea (Bioconsult 2006).

7.6.7. The issue of potential colonisation of hard substrate by alien species, and in effect these structures acting as "stepping-stones" for introduction of these species into UK coastal waters has been raised by consultees on other offshore wind farm projects but it is not possible to assign a clear impact to this potential issue. However in 2009 Cefas conducted a review of the state of the benthic ecology around round one wind farms (Cefas 2009), in this review no invasive or alien species were observed though monitoring was recommended throughout the life span of the wind farms.

7.6.8. As per previous impact assessments, it is important to link this effect with the most relevant MarLIN factor, which in this instance, is the "introduction of non-native species" factor. All the component biotopes of the seven VERs identified in the study area are judged to be either not sensitive to this effect/factor or there is insufficient evidence to base any sensitivity assessment. Therefore, it is concluded that, in the absence of any clear beneficial or adverse impact with respect to this issue, a **negligible** impact is predicted. However, this conclusion is not based on any firm, tangible evidence of the long-term impact (or lack of) of colonisation of hard substrates in predominantly sedimentary environments as will occur within this area.

7.6.9. Of potential note is a recent inspection by Envision of video footage from a dive survey of the Dogger Bank region (including a number of wrecks) undertaken by Dutch divers in summer 2011. The review by Envision showed that the species associated with the wrecks appeared to be typical of a North Sea rocky reef in a moderate to strong current. Dominant species were *Alcyonium digitatum, Metridium senile*, *Gadus morhua, Homarus gammarus, Cancer pagurus, Spirobranchus* sp. and various ascidians.

7.6.10. These communities differ from those occurring on the Dogger Bank itself (which are predominantly sediment-dwelling species), and those which characterise the cSAC.

7.6.11. Some of the species recorded during the expedition, such as the sea slug *Polycera faroensis*, the sea squirt, *Acidia mentula*, and the cowrie *Trivia* sp. were at the time thought to be newly recorded for the Dutch marine fauna. However, these are not unusual for the UK North Sea fauna. Subsequently, however, it has been discovered that not all of these are new for Holland. A scientific paper subsequently written up from the expedition noted that two sea slugs, *Polycera faroensis* and *Doto dunnei,* were newly recorded for the Dutch marine fauna (Gittenberger *et al*. 2011).

7.6.12. This brief review of this 2011 dive survey indicated that the fauna that are likely to colonise turbine subsea structures are those that already occur commonly in the region on comparable substrates.

7.6.13. Long-term monitoring during the period of operation will be the only means to provide evidence to ascertain how long-term presence of introduced substrate and its colonisers influences the surrounding sedimentary habitats (see Section 7.9).

7.6.14. It is also recognised that in addition to the potential colonisation of hard substrates (foundations) by invasive species, another potential pathway via which invasive species may reach the Dogger Bank site, and therefore, potentially colonise areas where they had not previously occurred, is via ballast water.

7.6.15. During the operational phase of the project, there will be regular, on-going movement of vessels to and from the site. Some of these vessels may look to discharge ballast water on site. In order to control this activity, the Environmental Management Plan for the operational phase of the Dogger Bank Teesside A & B project will make reference to the International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM).

Dogger Bank Teesside A and Dogger Bank Teesside B together

7.6.16. With Dogger Bank Teesside A & B operating together, the potential area of hard substrate available for colonisation would increase (12.53km^2) due to the larger number of foundations and associated structures. However, the same conclusions and the difficulty in predicting whether this represents a beneficial or adverse impact remains (as outlined above), therefore the impact is predicted to remain as **negligible**.

7.7. Effect of electromagnetic fields on benthic communities

Dogger Bank Teesside A or Dogger Bank Teesside B in isolation

7.7.1. The Dogger Bank Teesside Scoping Report (Forewind 2012) proposed to scope out potential effects of electromagnetic fields (EMF) on benthic communities due to lack of data to inform any such assessment. However, the JNCC/Natural England response to the Scoping Report requested that this potential issue be assessed due to the fact that there is a lack of clear evidence indicating no impact on the benthos from EMF.

7.7.2. EMF is both the electric fields, measured in volts per metre (V/m) and the magnetic fields, measured in tesla (T). Therefore, when discussing EMF in the context of potential effects on marine organisms, in this case, benthic and epibenthic communities, it is the magnetic field and the resultant induced electric field that need to be considered (Normandeau *et al*., 2011).

7.7.3. For either Dogger Bank Teesside A or Dogger Bank Teesside B in isolation, a total of 1270km of array/inter-platform/inter/project cables plus up to 573km of export cables may be installed, of which the export cables will transmit HVDC with the array cables being High Voltage Alternating Current (HVAC) – see **Chapter 5**. Average magnetic fields of DC cables are higher than those of equivalent AC cables with the strength of the magnetic field (and consequently, induced electrical fields) decreasing rapidly horizontally and vertically with distance from source, in the order of 10m each side of the cable (assuming 1m burial) (Normandeau *et al*., 2011).

7.7.4. In terms of magnitude of effect, current literature suggests that EMF influenced behavioural and physiological effects in benthic invertebrates, if any are observed, will be closely related to the proximity of the individual to the source. EMF are strongly attenuated, therefore, any effects will be highly localised. Based on criteria in **Table 3.4**, a negligible magnitude of effect is predicted.

7.7.5. With respect to sensitivity of benthic and epibenthic receptors to this effect, there is very limited experimental data that demonstrates a clear adverse response to EMF by these species groups. Whilst some studies have demonstrated physiological responses to EMF in invertebrates, these have been at higher intensity fields much greater than would be recorded within on offshore wind farm (Normandeau *et al*., 2011).

7.7.6. Based on **Table 3.3**, the sensitivity of all the benthic VER's present within the Dogger Bank Teesside A & B and Dogger Bank Teesside A & B Export Cable Corridor is judged to be low, which combined with the negligible magnitude of effect results in a **negligible** impact on benthic receptors due to EMF in the operational phase.

Dogger Bank Teesside A and Dogger Bank Teesside B together

7.7.7. The same conclusions as presented above for Dogger Bank Teesside A or Dogger Bank Teesside B in isolation will apply for both projects built together. Even though the overall length of array and export cables will almost double for both projects together, and therefore, more benthic receptors will be exposed to EMF, a **negligible** impact is still predicted.

7.8. Potential operational phase impacts on the Dogger Bank cSAC

Dogger Bank Teesside A or Dogger Bank Teesside B in isolation

7.8.1. As outlined in Section 4.4**,** all of Dogger Bank Teesside A & B and part of the Dogger Bank Teesside A & B Export Cable Corridor lie within the boundary of the Dogger Bank cSAC. Although many of the seabed habitats within these areas may not conform exactly to the main habitat interest feature of the cSAC, namely "*subtidal sandbanks which are slightly covered by seawater at all times"* from an ecological perspective, all the habitats present form a key part of this overall sandbank feature.

7.8.2. Potential operational Impacts on these habitats via permanent habitat loss and increased suspended sediment and deposition generated via scour have been assessed in preceding sections. Therefore, this specific impact assessment aims to describe and quantify these potential operational phase impacts in the context of the Dogger Bank cSAC.

7.8.3. As per the approach for construction phase impacts, no assessment is presented with regard the favourable conservation status of the Dogger Bank cSAC or the achievement of conservation objectives of either the entire cSAC or its qualifying features as this is the remit of the HRA which is separate to the main EIA process. The magnitude of potential effect relative to the Dogger Bank cSAC is presented but this is primarily to assist the HRA process.

7.8.4. Therefore, the following assessment should be read in conjunction with the **HRA Report** for Dogger Bank Teesside A & B.

7.8.5. The previous operational phase impact assessments have focussed on VERs within the wind farms and Dogger Bank Teesside A & B Export Cable Corridor, in terms of the amount of these habitats affected as a proportion (%) of the overall habitats in the site/corridor and the overall ecological sensitivity of the habitats. For this impact, the footprint of effects is defined in the context of the Dogger Bank cSAC site boundary, as defined in the latest SAC Selection Assessment Document (JNCC, Version 9.0, August 2011).

7.8.6. Based on the SAC Selection Assessment Document (JNCC, Version 9.0, August 2011), the overall area of the Dogger Bank cSAC is 12,331km^2. A summary of the areas (km^2) of Dogger Bank Teesside A and Dogger Bank Teesside B that lie within the boundaries of the cSAC are provided earlier in **Tables 6.2** and **6.3**, with the predicted footprint of operational phase effects as identified in preceding impact statements, presented as a proportion of the cSAC in **Table 7.2**.

Table 7.2 Dogger Bank Teesside A and/or Dogger Bank Teesside B (and Teesside A & B) combined operational phase effect footprints as a proportion of the Dogger Bank cSAC

Area	Dogger Bank Teesside A	Dogger Bank Teesside B	TOTAL (Dogger Bank Teesside A and B)
Area of cSAC (12,331km^2)	N/A	N/A	N/A
Maximum footprint of operational phase effects within Teesside A & B wind farm(s) / cSAC	3.73km^2	3.73km^2	7.46km^2
Maximum footprint of operational phase effects (cable protection and crossings) within Teesside A/B Dogger Bank Teesside A & B Export Cable Corridor(s) * / cSAC	1.15km^2	0.79km^2	1.94km^2
Total footprint of operational phase effects within Teesside A/B wind farm(s) and Dogger Bank Teesside A & B Export Cable Corridor(s) * / cSAC	4.88km^2	4.52km^2	9.40km^2
Teesside A/B operational phase effect footprint as % of overall cSAC	0.04%	0.04%	0.08%

* Only the footprint of effect within the parts of the Dogger Bank Teesside A & B Export Cable Corridor that lie within the cSAC boundary are listed here. Cable corridor "within SAC boundary" includes all of export cable within the main zone and the small section outside the main zone but still within the SAC boundary.

7.8.7. Operational phase effects on habitats within the cSAC will arise via permanent habitat loss caused by foundation installation and inter-array cable protection within the main sites as well as temporary habitat disturbance via jacking up activities and also via the placement of cable protection along the export cables (both along export cables within the zone and outside the zone but within the boundary of the cSAC). The overall footprint of operational effects that will affect habitats within the cSAC totals 4.88km^2 (0.04% of overall cSAC) for Dogger Bank Teesside A and 4.52km^2 (0.04% of overall cSAC for Dogger Bank Teesside B) – see **Table 7.2**.

7.8.8. The main impact assessment addressing permanent habitat loss of marine habitats within the main Dogger Bank Teesside A & B sites concluded a **minor adverse** impact on these habitats (VERs A, B and C) which fall within the cSAC boundary.

7.8.9. VERs A, B and C also occur within the Dogger Bank Teesside A & B Export Cable Corridor, as the boundary of the cSAC overlaps with the export cable at the most eastern section. A **minor adverse** impact on the VERs within the Dogger Bank Teesside A & B Export Cable Corridor via operational phase impacts is predicted.

7.8.10. With respect to effects of suspended sediment concentration and sedimentation, the spatial extent of this effect footprint is greater than that for direct physical disturbance but will still be a relatively small proportion of the overall cSAC area. As outlined in earlier impact assessments, the habitats present within the Dogger Bank cSAC (VERs A, B and C) also exhibit a low sensitivity to suspended sediment concentrations and sediment deposition and, therefore, a **negligible** impact on VERs A and B was concluded, with a **minor adverse** impact on VER C due to the component biotopes of this receptor exhibiting a slightly increased sensitivity to this effect.

Dogger Bank Teesside A and Dogger Bank Teesside B together

7.8.11. **Table 7.4** indicates a total footprint of temporary disturbance from both Dogger Bank Teesside A & B of 0.08% of the cSAC, representing a very small proportion of the overall habitats within the cSAC (which can be expected from the information available to be similar to those recorded in the study area). Therefore, the same conclusions made above in relation to Dogger Bank Teesside A or Dogger Bank Teesside B in isolation are predicted to remain valid for Dogger Bank Teesside A & B together.

7.8.12. As outlined above, an assessment of the potential for these impacts to affect the integrity of the cSAC, from a Habitats Regulations perspective, is contained in the **HRA Report**. The **HRA Report** provides sufficient information to enable a competent authority to undertake an Appropriate Assessment of the proposals.

7.8.13. The Appropriate Assessment process will formally consider any marine ecological impacts (and other impacts) against the structure and function and conservation objectives of the Dogger Bank cSAC (as well as other SAC/SPA sites) so that a determination of potential effects on the integrity of these sites can be undertaken.

7.9. Potential operational phase impacts on sites of marine conservation interest

Dogger Bank Teesside A or Dogger Bank Teesside B in isolation

7.9.1. The preceding impact assessments have discussed the potential for operational phase activities to produce effects that may impact benthic habitats in the Dogger Bank Teesside A & B study area. The benthic habitats have been grouped into VERs as per the approach set out in Section 3.3, with these VERs representing the receptors against which impacts have been assessed.

7.9.2. This particular impact assessment discusses the effects on benthic habitats described previously in the context of the following sites of marine nature conservation interest, for which examples occur within and around the Dogger Bank Teesside A & B study area;

- UK BAP Habitats;
- rMCZs; and
- OSPAR habitats and species.

7.9.3. It is important to note that potential impacts on the ecological elements of the sites of marine conservation interest listed above have already been assessed via the individual impact assessments presented up to this point. Therefore, to avoid repetition in the assessment process, the assessment of potential operational phase impacts on sites of marine conservation interest are presented below as a series of summary tables which make reference to the conclusions of previous impact assessments.

7.9.4. It should also be recognised that the preceding impact assessments have all been undertaken via an assessment of the sensitivity of receptors and the magnitude of effect. For the benthic receptors (VERs), the overall EIA sensitivity has been determined via a combination of ecological sensitivity of the receptor to a particular effect, as well as the value of the receptor, for example, whether or not it represents Annex I habitat. The value element of receptor sensitivity (see **Table 3.2**) already takes account of whether or not a habitat or species may be of conservation interest, which is therefore inherent within the assessment methodology.

7.9.5. The "receptor" heading in the following tables refers to the habitat/species of marine conservation interest (BAP Habitats in **Table 7.3** and rMCZs in **Table 7.4**) with the column headed "relevant VERs" identifying the VERs (as defined in **Table 4.4**) that apply to those habitats/species. The impact descriptions are those assessed previously via individual impact assessments, with any relevant mitigation and the residual impact from these previous impact assessments also presented.

Table 7.3 Potential operational phase impacts on BAP habitats

Receptor	Relevant VERs (see Table 4.4)	Impact description	Mitigation	Residual impact
"Subtidal sands and gravels" BAP Habitat **and** "Mud habitats in deep water" BAP Habitat	A, B, C, D, E and F	Permanent loss of habitat via placement of project infrastructure (foundations, cable protection, scour protection)	None	**Negligible** (VERs D, E, F, G, H, I) **Minor adverse** (VERs A, B, C)
		Temporary impact on benthos due to physical disturbance caused by maintenance activities	None	**Negligible** (All VERs apart from VER C) **Minor Adverse** (VER C)
		Change in hydrodynamics and inter-related effects on benthos	None	**Negligible** (All VERs)
		Increase in suspended sediment concentration due to scour associated with foundations	None	**Negligible** (All VERs apart from VER C) **Minor Adverse** (VER C)
		Increase in sediment deposition following increase in suspended sediment concentration due to scour associated with foundations	None	**Negligible** (All VERs)
		Introduction of new habitat in the form of foundation structures, leading to potential colonisation	None	**Negligible** (All VERs)
		Effect of electromagnetic fields on benthic organisms	Burial of cables where feasible	**Negligible** (All VERs)

7.9.6. Based on the previous impact assessments conducted on the benthic receptors (VERs) that are also representative of these two BAP habitats, it is concluded that, overall, there will be a **negligible** impact on some of the benthic habitats that are component parts of the two marine BAP habitats within the Dogger Bank Teesside study area, with **minor adverse** impacts on other habitats (VER C).

7.9.7. With respect to rMCZs, neither Compass Rose and Runswick Bay rMCZs overlap spatially with the Dogger Bank Teesside A & B Export Cable Corridor. The only potential source of operational impact on these habitats is via the placement of cable protection and as this will only occur within the Dogger Bank Teesside A & B Export Cable Corridor and not on the habitats within these rMCZ boundaries, **no impact** is predicted via the operational phase on these rMCZs.

7.9.8. With respect to potential impacts on OSPAR threatened species and habitats, no such species or habitats are recorded within the Dogger Bank Teesside A & B study area, therefore, no impacts are predicted.

Dogger Bank Teesside A and Dogger Bank Teesside B together

7.9.9. The previous VER based impact assessments concluded that even if Dogger Bank Teesside A & B operated at the same time there would be no change in the level of any of the impacts predicted via either project operating in isolation. Therefore, the conclusions with respect to potential impacts on BAP habitats and rMCZs presented above are also relevant to this scenario.

7.10. Monitoring of operational phase impacts

7.10.1. Potential operational phase impacts on benthic ecology include direct loss of habitat, indirect loss/alteration of benthic habitats due to changes in local hydrodynamic processes, increased suspended sediments and deposition due to scour effects and colonisation of structures, potentially by invasive species.

7.10.2. The benthic monitoring outlined in Section 6.9 will be designed in a way that enables these potential operational phase impacts to be determined. The location of sampling stations within close proximity to installed foundations will ensure that any near-field changes in benthic habitats will be identified. Any monitoring programme will also include assessment of selected foundation structures in order to gather data on the long-term behaviour of colonising species on these structures.

7.10.3. Post-construction annual benthic grab and DDV survey data will be compared against pre-construction baseline data to determine any statistically significant changes in benthic habitats. These data will be combined with sidescan data from geophysical surveys to monitor any broad-scale benthic habitat changes.

7.10.4. The exact time-frame/frequency of post-construction monitoring will be decided via consultation with key regulatory bodies but it is noted that under (deemed) Marine Licences it is possible to carryout monitoring over the lifetime of the project. Therefore, it is expected that post-construction monitoring of marine ecological habitats will be conducted at more infrequent, intervals throughout the lifetime of the development (in contrast to previous FEPA requirements for surveys in years one to three post-construction only).

8. Assessment of Impacts during Decommissioning

8.1. Increased suspended sediment concentration and sediment deposition

Dogger Bank Teesside A or Dogger Bank Teesside B in isolation

8.1.1. During the decommissioning phase the worst case scenario is for all components of the project to be removed, i.e. foundations, scour protection etc.

8.1.2. During removal of these project components there will be short-term increases in suspended sediment concentration (and subsequent deposition) from the plume generated by the disturbance of the seabed required to remove these structures.

8.1.3. Based on the outputs of the physical process modelling work, any effects produced during decommissioning are considered to be less than those described during the construction phase, due to absence of seabed preparation or pile drilling, which are the main sources of increased suspended sediment concentration during the construction phase.

8.1.4. Assuming that the general benthic habitats and communities of the site remain as per the existing environment, with the same sensitivities to suspended sediment concentration and sediment deposition, this decommissioning impact will be no greater than that assessed in the construction phase. Therefore, a **negligible** impact on benthic habitats via increased suspended sediment concentration and sediment deposition during the decommissioning phase is predicted.

Dogger Bank Teesside A and Dogger Bank Teesside B together

8.1.5. As for Dogger Bank Teesside A or Dogger Bank Teesside B in isolation above, a **negligible** impact is predicted on benthic habitats via increased suspended sediment concentration and sediment deposition during the decommissioning phase.

8.2. Loss of species colonising hard structures

Dogger Bank Teesside A or Dogger Bank Teesside B in isolation

8.2.1. Removal of all structures that represent hard substrate from the boundaries of the wind farm and Dogger Bank Teesside A & B Export Cable Corridor (foundations, scour protection, cable protection etc.) will lead to a loss of habitat for any colonising species that may have utilised these hard substrates. Based on the worst-case scenario of permanent habitat loss defined in the operational phase impact section, it can be noted that 6.40km^2 of hard substrate will be lost (Dogger Bank Teesside A) via the decommissioning phase. Following removal of these structures, areas of bare, un-colonised sediment will be created, which will be similar in nature to areas subjected to activities such as marine aggregate extraction.

8.2.2. Based on data on recovery of benthic communities from this activity, and noting that the dominant hydrodynamic and sedimentary processes in the wider study area are assumed to remain following decommissioning, it is predicted that recovery of these areas of un-colonised sediment to communities found pre-construction will occur within five years of the end of decommissioning.

8.2.3. Due to the localised nature and limited extent of the loss of species colonising the hard substrate foundations, and the high recoverability of the subsequently exposed substrate and communities associated with VER A and B back to their preconstruction state (i.e. within five years), it is predicted that the impact will be **negligible**.

Dogger Bank Teesside A and Dogger Bank Teesside B together

8.2.4. The same effects as outlined above are predicted to arise for the decommissioning phase of both Dogger Bank Teesside A and Dogger Bank Teesside B together, with the only difference being a greater amount of hard substrate lost (12.53km^2). A **negligible** impact is predicted.

8.3. Temporary disturbance to habitats via removal of cables

Dogger Bank Teesside A or Dogger Bank Teesside B in isolation

8.3.1. The specific removal of buried cables, which during the operational phase were covered by sediment that will have supported benthic communities, will result in a temporary loss of these habitats, with subsequent impact on these benthic communities. As per the temporary disturbance impacts assessed during the construction phase, these will be localised and will only affect a small proportion of habitats that are widespread throughout this region. As any temporary disturbed areas will return to pre-disturbance levels within a period of between six months to five years, this impact is judged to be **negligible**.

Dogger Bank Teesside A and Dogger Bank Teesside B together

8.3.2. The same effects as outlined above are predicted to arise for the decommissioning phase of both Dogger Bank Teesside A and Dogger Bank Teesside B together, with the only difference being a greater area of disturbance to benthic habitats as a result of having to remove a greater amount of export and array cables for the two projects together. A **minor adverse** impact is predicted.

8.4. Potential decommissioning phase impacts on the Dogger Bank cSAC

Dogger Bank Teesside A or Dogger Bank Teesside B in isolation

8.4.1. Decommissioning phase impacts on the Dogger Bank cSAC are predicted to be no greater than those predicted during the construction phase, with **negligible** and/or **minor adverse** impacts on the various habitats within the cSAC.

Dogger Bank Teesside A and Dogger Bank Teesside B together

8.4.2. Decommissioning phase impacts on the Dogger Bank cSAC are predicted to be no greater than those predicted during the construction phase, with **negligible** and/or **minor adverse** impacts on the various habitats within the cSAC.

8.5. Monitoring of decommissioning phase impacts

8.5.1. In order to monitor potential decommissioning phase impacts, a similar survey design and programme as developed in the pre-construction and first three years of the operational phase will be developed during decommissioning.

8.5.2. A pre-decommissioning survey will be undertaken to determine the baseline conditions prior to decommissioning, followed by a minimum of one survey once all decommissioning works are completed.

9. Inter-relationships

9.1.1. In order to address the environmental impact of the proposed development as a whole, this section establishes the inter-relationships between marine and intertidal ecology and other physical, environmental and human receptors. The objective is to identify where the accumulation of residual impacts on a single receptor, and the relationship between those impacts, gives rise to a need for additional mitigation.

9.1.2. **Table 9.1** summarises the inter-relationships that are considered of relevance to marine and intertidal ecology and identifies where they have been considered within this ES. No inter-relationships have been identified where an accumulation of residual impacts on marine and intertidal ecology, and the relationship between those impacts, gives rise to a need for additional mitigation.

9.1.3. **Chapter 31 Inter-relationships** provides a holistic overview of all the inter-related impacts associated within the proposed development.

Table 9.1 Inter-relationships relevant to the assessment of marine and intertidal ecology

Inter-relationships	Section where addressed	Linked chapter
All phases		
Impacts on benthos due to a change in hydrodynamics	Impacts on benthos are discussed throughout Sections 6 – 8 of this chapter	**Chapter 9 Marine Physical Processes**
Impacts on benthos due to the potential release of pollutants from sediment and accidental spillages as well as an increase in turbidity	As above	**Chapter 10 Marine Water and Sediment Quality**
Impacts on benthos in context of prey item for ornithological resources.	As above	**Chapter 11 Marine and Coastal Ornithology**
Impacts on benthos/benthic habitat in context of (a) prey items for fish species and (b) spawning /nursery habitats for fish.	As above	**Chapter 13 Fish and Shellfish Ecology**
Effects on benthos / benthic habitats as a result of potential changes in commercial fishing activity within the project site	An assessment of the effects of commercial fishing activity on the benthos is beyond the scope of this assessment. However, it is noted that if there was a reduction in trawling and dredging activity around the wind farm areas (note that this is not confirmed as being the case), there could be a positive effect on the benthic environment in general.	**Chapter 15 Commercial Fisheries**.

10. Cumulative Impacts

10.1. CIA strategy and screening

10.1.1. This section describes the CIA for marine and intertidal ecology taking into consideration other plans, projects and activities. A summary of the CIA is presented in **Chapter 33 Cumulative Impact Assessment**.

10.1.2. Forewind has developed a strategy (the 'CIA Strategy') for the assessment of cumulative impacts in consultation with statutory stakeholders including the MMO, the JNCC, Natural England and Cefas. Details of the approach to cumulative impact assessment adopted for this ES are provided in **Chapter 4.**

10.1.3. In its simplest form the Strategy involves consideration of:

- Whether impacts on a receptor can occur on a cumulative basis between the wind farm project(s) subject to the application(s) and other wind farm projects, activities and plans in the Dogger Bank Zone (either consented or forthcoming); and
- Whether impacts on a receptor can occur on a cumulative basis with other activities, projects and plans outwith the Dogger Bank Zone (e.g. other offshore wind farm developments), for which sufficient information regarding location and scale exist.

10.1.4. The strategy recognises that data and information sufficient to undertake an assessment will not be available for all potential projects, activities, plans and / or parameters, and seeks to establish the 'confidence' Forewind can have in the data and information available.

10.1.5. There are two key steps to the Forewind CIA strategy, which both involve 'screening' in order to arrive, ultimately, at an informed, defensible and reasonable list of other plans, projects and activities to take forward in the assessment.

The first step in the CIA for marine and intertidal ecology involved an appraisal of the key impacts relevant to each of the receptors that have been identified (**Table 10.1**). For each impact, the potential for impacts to occur on a cumulative basis has been identified, both within and beyond the Dogger Bank Zone; the confidence in the data and information available to inform the CIA has been appraised (following the methodology set out in **Chapter 4**); and the other activities that could contribute to these impacts has been identified.

10.1.6. This also identifies where cumulative impacts are not anticipated, thereby screening them out from further assessment. For marine and intertidal ecology, the potential for cumulative impacts is identified in relation to direct habitat loss and / or disturbance (via placement of project infrastructure), indirect impacts via increased suspended sediment concentration and sediment deposition, indirect impact via changes in hydrodynamic processes and the introduction of hard substrate leading to colonisation.

Table 10.1 Potential cumulative impacts (impact screening)

Impacts	Dogger Bank Zone Dogger Bank Teesside A & B Export Cable Corridor (within 1km)		Beyond 1km from the Dogger Bank Zone and Dogger Bank Teesside A & B Export Cable Corridor		Rationale for where no cumulative impact is expected
	Potential for cumulative impact	**Data confidence**	**Potential for cumulative impact**	**Data confidence**	
Direct impact via habitat disturbance and/or loss (due to placement of project infrastructure	Yes	High	Yes	Medium	N/A
Indirect impact via increased suspended sediment concentration and sediment deposition (construction phase)	Yes	Medium-High	Yes	Low-Medium	N/A
Direct impact via permanent habitat loss (presence of project infrastructure in operational phase)	Yes	High	Yes	Medium	N/A
Indirect impact via increased suspended sediment concentration and sediment deposition (via scour in operational phase)	Yes	Medium-High	Yes	Low	N/A
Direct impact via vessel activity (jacking-up and anchoring) in operational phase for operation and maintenance activities	Yes	High	Yes	Low-Medium	N/A

Impacts	Dogger Bank Zone Dogger Bank Teesside A & B Export Cable Corridor (within 1km)		Beyond 1km from the Dogger Bank Zone and Dogger Bank Teesside A & B Export Cable Corridor		Rationale for where no cumulative impact is expected
	Potential for cumulative impact	Data confidence	Potential for cumulative impact	Data confidence	
Direct impact of introduction of hard substrate leading to colonisation	Yes	High	Yes	Low-Medium	N/A

10.1.7. Where the first step has indicated the potential for cumulative impacts, the second step in the CIA for marine and intertidal ecology has involved the identification of the actual individual plans, projects and activities that may result in cumulative impacts on marine and intertidal habitats for inclusion in the CIA.

10.1.8. In order to inform this, Forewind has produced an exhaustive list of plans, projects and activities occurring within a very large study area encompassing the greater North Sea and beyond (referred to as the 'CIA Project List', (see **Chapter 4**). The list has been appraised, based on the confidence Forewind has 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.

10.1.9. The plans, projects and activities relevant to marine and intertidal ecology are presented in **Table 10.2** and **Figure 4.19** along with the results of the screening exercise that identifies whether there is sufficient confidence to take these forward in a detailed cumulative assessment.

10.1.10. It should be noted that:

- Where Forewind is aware that a plan, project or activity could take place in the future, but has no information on how the plan, project or activity will be executed, it is screened out of the assessment; and
- Existing projects, activities and plans are already having an impact and so are part of the existing environment as it has been assessed throughout this ES. Therefore these projects have not been included in the cumulative assessment. This includes commercial fishing, whereby the benthic habitats that currently exist within the Dogger Bank Zone and wider North Sea region are already widely influenced by this activity.

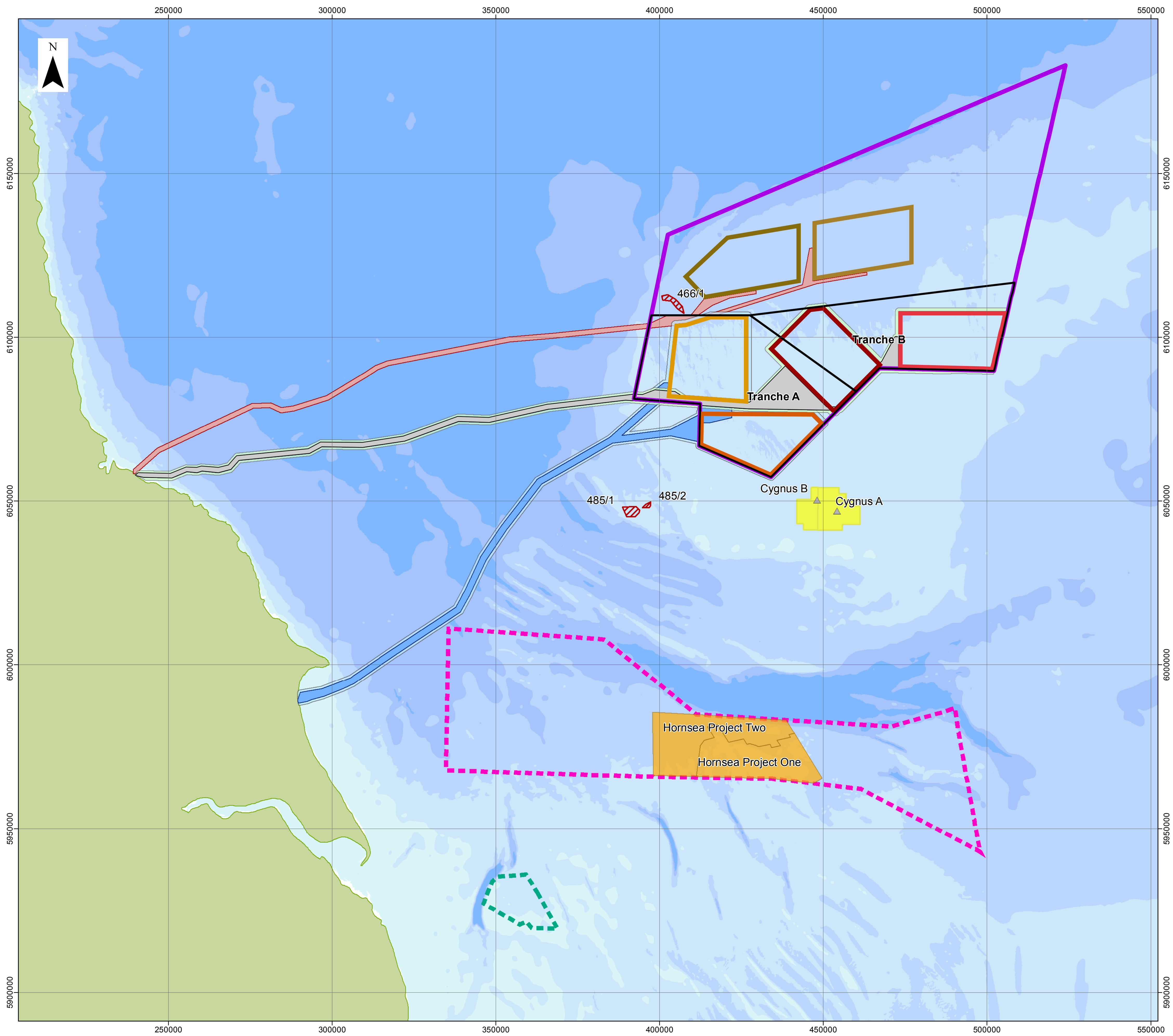
10.1.11. The potential impacts identified during the construction, operation and decommissioning phases of Dogger Bank Teesside A & B (Sections 6 to 8) that could result in cumulative impacts are described below.

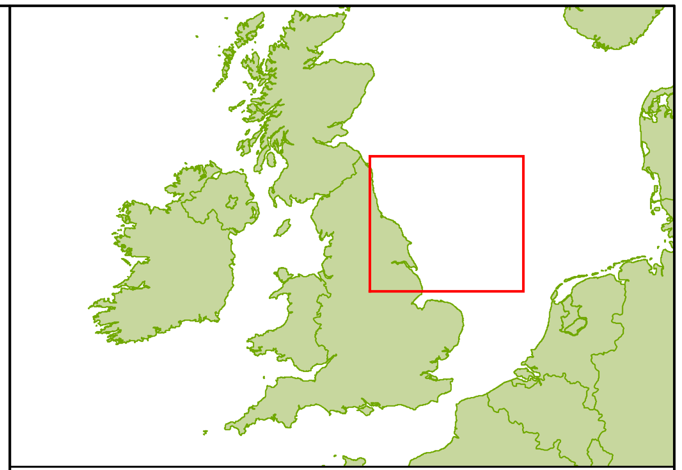
Table 10.2 Cumulative impact assessment screening for marine and intertidal ecology (project screening)

Type of project	Project title	Project status	Predicted construction / development period	Distance from Dogger Bank Teesside A & B (km)	Confidence in project description	Confidence in project data	Carried forward to CIA	Rationale for not carrying into CIA
Offshore Wind Farm	Dogger Bank Creyke Beck A	Application	Construction may start from 2016	28.05 / 4.05 km from Dogger Bank Teesside A / B (wind farm boundary 0.78km from Dogger Bank Teesside A & B Export Cable Corridor	High	High	Yes	N/A
Offshore Wind Farm	Dogger Bank Creyke Beck B	Application	Construction may start from 2016	45.97/ 6.20 km from Dogger Bank Teesside A / B (wind farm boundary Overlaps Dogger Bank Teesside A & B Export Cable Corridor	High	High	Yes	N/A
Offshore Wind Farm	Dogger Bank Teesside C	Pre-Application	Construction may start from 2016	31.10/8.06 km from Dogger Bank Teesside A / B (wind farm boundary 24.20 km from Dogger Bank Teesside A & B Export Cable Corridor	Low	High	Yes	N/A
Offshore Wind Farm	Dogger Bank Teesside D	Pre-Application	Construction may start from 2016	13.46 /8.08 km from Dogger Bank Teesside A / B (wind farm boundary) 20.96 km from Dogger Bank Teesside A & B Export Cable Corridor	Low	High	Yes	N/A
Offshore Wind Farm	Dogger Bank Other Developments	Potential	Not confirmed	Not confirmed	Low	Low	**No**	**Low data confidence**

Type of project	Project title	Project status	Predicted construction / development period	Distance from Dogger Bank Teesside A & B (km)	Confidence in project description	Confidence in project data	Carried forward to CIA	Rationale for not carrying into CIA
Offshore Wind Farm	Hornsea Project One	Application	Construction may start from 2015	115.81/ 98.68 km from Dogger Bank Teesside A / B (wind farm boundary) 96.80km from Dogger Bank Teesside A & B Export Cable Corridor	High	Medium	Yes	N/A
Offshore Wind Farm	Hornsea Project Two	Pre-Application	Construction may start from 2017	112.59/94.92 km from Dogger Bank Teesside A / B (wind farm boundary) 94.81km from Dogger Bank Teesside A & B Export Cable Corridor	Medium	Medium	Yes	N/A
Offshore Wind Farm	Hornsea (Other Developments)	Potential	Not confirmed	Not confirmed	Low	Low	**No**	**Low data confidence**
Offshore Wind Farm	Triton Knoll	Application	Construction may start from 2017	191.78/169.24 km from Dogger Bank Teesside A / B (wind farm boundary) 137.39 km from Dogger Bank Teesside A & B Export Cable Corridor	High	High	**No**	**Distance from Teesside A and B boundaries**
Aggregate extraction	Area 466/1	Application area	Decision expected 2012	65 / 28km from Dogger Bank Teesside A / B (wind farm boundary) 24.02km from Dogger Bank Teesside A & B Export Cable Corridor	High	Medium	Yes	N/A

Type of project	Project title	Project status	Predicted construction / development period	Distance from Dogger Bank Teesside A & B (km)	Confidence in project description	Confidence in project data	Carried forward to CIA	Rationale for not carrying into CIA
Aggregate extraction	Area 485/1	Application area	Not confirmed	90 / 63km from Dogger Bank Teesside A / B (wind farm boundary) 32.37km from Dogger Bank Teesside A & B Export Cable Corridor	High	Medium	Yes	N/A
Aggregate extraction	Area 485/2	Application area	Not confirmed	86 / 59km from Dogger Bank Teesside A / B (main site boundary) 40.43km from Dogger Bank Teesside A & B Export Cable Corridor	High	Medium	Yes	N/A





LEGEND

- Dogger Bank Zone
- Tranche boundary
- Dogger Bank Creyke Beck A
- Dogger Bank Creyke Beck B
- Dogger Bank Teesside A
- Dogger Bank Teesside B
- Dogger Bank Teesside C
- Dogger Bank Teesside D
- Dogger Bank Teesside A & B Export Cable Corridor
- Dogger Bank Teesside A & B temporary works area
- Dogger Bank Creyke Beck Export Cable Corridor
- Dogger Bank Creyke Beck temporary works area
- Dogger Bank Teesside C & D export cable corridor
- Cygnus proposed subsurface infrastructure
- Cygnus gas field development
- Aggregate application areas
- Hornsea Project Zone
- Hornsea Zone
- Triton Knoll

0 10 20 40

Kilometres

Data Source:
Oil & Gas © DECC, 2013
Energy Projects and Aggregate Areas © TCE, 2013.
Background bathymetry image derived in part from TCarta data © 2009

PROJECT TITLE

DOGGER BANK TEESSIDE A & B

DRAWING TITLE

Figure 10.1 Other plans, projects and activities for cumulative impact assessment

VER	DATE	REMARKS	Drawn	Checked
1	24/05/2013	Draft	LW	RZ
2	03/10/2013	PEI3	JE	RZ
3	07/02/2014	DCO Submission	JE	RZ

DRAWING NUMBER: **F-OFL-MA-209**

SCALE	PLOT SIZE	DATUM	PROJECTION
1:1,200,000	A3	WGS84	UTM31N

FOREWIND

10.2. Temporary disturbance to marine habitats during construction (seabed preparation, cable installation, vessel jacking-up etc.)

10.2.1. The impact assessment for Dogger Bank Teesside A & B concluded that there would be a **negligible** residual impact on all existing marine habitats within the Dogger Bank Teesside A & B area and Dogger Bank Teesside A & B Export Cable Corridor, (apart from VER C, where a **minor adverse** impact was predicted) as a result of temporary disturbance during the construction phase.

10.2.2. This conclusion was based on the fact that a maximum of 41.59km^2 of the overall area of the two sites (and Dogger Bank Teesside A & B Export Cable Corridor) would be subject to temporary disturbance, with the habitats affected having a low sensitivity to this type of effect and a high recoverability.

10.2.3. **Table 10.3** (below) lists the areas of temporary habitat disturbance loss presented in the ES's for various projects that have been included in this cumulative assessment. For Dogger Bank Teesside C & D, which are yet to be subject to EIA, it is assumed that temporary habitat loss in the construction phase will be the same as per Dogger Bank Teesside A & B, therefore, the same values are used.

Table 10.3 Temporary habitat loss from all projects considered in cumulative assessment

Type of project	Project title	Predicted amount of temporary habitat loss (via construction activities)
Offshore Wind Farm	Dogger Bank Creyke Beck A	18.61km^2
Offshore Wind Farm	Dogger Bank Creyke Beck B	18.28km^2
Offshore Wind Farm	Dogger Bank Teesside A	21.72km^2
Offshore Wind Farm	Dogger Bank Teesside B	20.83km^2
Offshore Wind Farm	Dogger Bank Teesside C	* 21.72km^2
Offshore Wind Farm	Dogger Bank Teesside D	* 21.72km^2
Offshore Wind Farm	Hornsea Project One	13.37km^2
Offshore Wind Farm	Hornsea Project Two	* 13.37km^2
Marine Aggregate	Area 466/1	**1.11km^2
Marine Aggregate	Area 485/1	**1.21km^2
Marine Aggregate	Area 485/2	**0.25km^2
TOTAL		152.19km^2

* Values of habitat loss assumed, as EIA for Teesside C & D and Hornsea Project Two not undertaken to date

** Assumed that a nominal 10% of the area of each of these is dredged at any one time, leading to temporary habitat disturbance, 10.2.2. From **Table 10.3** it can be noted that when the proposed Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D developments are combined with Hornsea Project One and Two and also marine aggregate sites in the wider region around Dogger Bank, a total of 152.19km^2 of temporary habitat disturbance is predicted. To place the extent of this temporary subtidal habitat disturbance in context with similar habitat in the wider region, the area of subtidal habitat in the southern North Sea Marine Natural Area, within which much of the Dogger Bank Teesside A & B development lies, amounts to 64,786km^2. Therefore, this temporary disturbance of 152.19km^2 represents 0.23% of similar habitat in this part of the southern North Sea alone.

10.2.3. It is also assumed that (a) the majority of this temporary habitat disturbance will arise in habitat types that are widespread across the region and as such, any permanent loss via project developments will not lead to the loss of a discrete habitat type from the southern North Sea and (b) will also exhibit a low sensitivity and high recoverability to temporary disturbance effects.

10.2.4. Therefore, in conclusion, it is predicted that there will be a **negligible cumulative impact** on benthic habitats across the wider southern North Sea region via temporary habitat disturbance from projects within the Dogger Bank Zone and other projects outside the zone.

10.3. Increased suspended sediment concentration and sediment deposition during construction phase

10.3.1. The impact assessment for Dogger Bank Teesside A & B concluded that there would be a negligible impact on benthic habitats due to increased suspended sediment concentration and sediment deposition produced during the construction phase of the project. Cumulative impacts of suspended sediment concentration and sediment deposition will only arise if there is both a spatial and temporal overlap of project construction stages and the resultant sediment plumes generated via different projects overlap to produce a cumulative impact.

10.3.2. Based on the marine physical processes cumulative impact assessment undertaken as part of this EIA, the following conclusions can be reached with respect to potential spatial and temporal overlap of sediment plumes (and resultant deposition) from Dogger Bank Teesside A & B and other developments in the Dogger Bank Zone and wider region.

10.3.3. Assuming that a similar construction sequence is adopted for foundation installation and cable laying in all other projects at the same time as Dogger Bank Teesside B and Dogger Bank Creyke Beck B, potential exists for some of the respective plumes to interact, creating a larger overall plume, with higher suspended sediment concentrations and, potentially, a greater depositional footprint on the seabed. However, given that the numerical modelling undertaken for the individual projects (Dogger Bank Teesside B and Dogger Bank Creyke Beck B) has identified that the maximum thickness of sediment that would remain deposited on the seabed at the end of the 30-day simulation periods would be less than 0.1mm (for both conical GBS and 12m pile foundation scenarios), it is considered, using expert judgment, that the potential for thick sequences of sediment persistently accumulating on the seabed due to plume interaction from all six projects is low, even if the construction programmes coincide.

10.3.4. Cumulative effects of Dogger Bank Teesside A, B, C & D and Dogger Bank Creyke Beck A & B with other offshore wind farms and aggregate license areas have also been considered with respect to sediment plume interaction. It is unlikely that the construction plumes of other wind farms (in particular Hornsea Project One) will interact with the Dogger Bank plumes. Plumes from adjacent aggregate dredging areas would also be small and short-lived in comparison to the Dogger Bank plumes, therefore**,** no cumulative effects are anticipated via increased suspended sediment plumes and the residual impact remains as **negligible**.

10.4. Permanent loss of marine habitats via installation of project infrastructure associated with offshore wind farm development and other activities

10.4.1. A cumulative effect of permanent loss of habitats due to the construction of foundations and associated project infrastructure, such as scour and cable protection and vessel mooring is predicted via additional projects in the Dogger Bank Zone and other activities / development outside the zone, including further offshore wind developments such as Hornsea Project One and Project Two.

10.4.2. **Table 10.4** lists the areas of permanent habitat loss presented in the ES's for various projects that have been included in this cumulative assessment. For Dogger Bank Teesside C & D, which is yet to be subject to the EIA process, it is assumed that permanent habitat loss will be the same as per Dogger Bank Teesside A & B, therefore, the same values are used.

Table 10.4 Permanent habitat loss from all projects considered in cumulative assessment

Type of project	Project title	Predicted amount of permanent habitat loss (via foundations, cable protection etc. in operational phase)
Offshore Wind Farm	Dogger Bank Creyke Beck A	4.98km^2
Offshore Wind Farm	Dogger Bank Creyke Beck B	4.88km^2
Offshore Wind Farm	Dogger Bank Teesside A	6.40km^2
Offshore Wind Farm	Dogger Bank Teesside B	6.13km^2
Offshore Wind Farm	Dogger Bank Teesside C	* 6.40km^2
Offshore Wind Farm	Dogger Bank Teesside D	* 6.40km^2
Offshore Wind Farm	Hornsea Project One	13.37km^2
Offshore Wind Farm	Hornsea Project Two	* 13.37km^2
TOTAL		**61.93km^2**

* Values of habitat loss assumed, as EIA for Teesside C and D and Hornsea Project Two not undertaken to date

10.4.3. From **Table 10.4** it can be noted that the proposed Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D developments are combined with Hornsea Project One and Two, a total of 61.93km^2 of permanent habitat loss is predicted. To place the extent of this permanent habitat loss in context with similar habitat in the wider region, the area of subtidal habitat in the southern North Sea Marine Natural Area, within which much of the Dogger Bank Teesside A & B development lies, amounts to 64,786km^2. Therefore, this permanent loss of 61.93km^2 represents 0.09% of similar habitat in this part of the southern North Sea alone.

10.4.4. It is also assumed that (a) the majority of this permanent habitat loss will arise in habitat types that are widespread across the region and as such, any permanent loss via project developments will not lead to the loss of a discrete habitat type from the southern North Sea and (b) that permanent loss of any particularly sensitive benthic habitats (e.g. Annex I reef) has been avoided by the project-specific EIA processes, which should have identified any such habitats and proposed appropriate mitigation measures (micro-siting) to avoid damage to these habitats.

10.4.5. Therefore, in conclusion, it is predicted that there will be a **minor adverse** cumulative impact on benthic habitats in the wider region such as those that represent VERs A, B and C within the Dogger Bank Teesside A & B project boundaries, and a **negligible** cumulative impact on all other benthic habitats across the wider southern North Sea region via permanent habitat loss from projects within the Dogger Bank Zone and other projects outside, specifically Hornsea Project One and Project Two.

10.5. Increased suspended sediment concentration and sediment deposition during operational phase.

10.5.1. In terms of suspended sediment plumes and deposition created by all six Dogger Bank projects operating concurrently, after two years, the maximum concentration was predicted to increase to greater than 200mg/l in areas up to 22km long and 7km wide along the boundaries of the projects. Across all projects, suspended sediment concentrations are generally greater than 50mg/l, reducing to the background of 2mg/l up to approximately 55km from the project boundaries. Average suspended sediment concentrations are 50-100mg/l across the boundaries of Dogger Bank Creyke Beck A & B, reducing to the background of 2mg/l up to approximately 39km from the project boundaries.

10.5.2. After two years, maximum sediment deposition of 5mm occurs across all project areas with deposition reducing to less than 0.1mm up to 43km from the boundaries. Average deposition is predicted to be 0.1-0.5mm reducing to 0.1mm close to the southern boundaries and up to approximately 32km north of the northern boundaries. Time series of bed thickness show that it in places it may exceed 3mm continuously for up to 10.17 days. Over most of the deposit footprint the thickness only exceeds 1mm for several days continuously. The predicted bed thickness at the end of the 30-day simulation period was less than 0.1mm across the depositional area.

10.5.3. Therefore, a **minor adverse** cumulative impact is predicted due to the interaction of operational phase plumes from Dogger Bank Creyke Beck A & B, Dogger Bank Teesside A & B and Dogger Bank Teesside C & D as the benthic fauna exposed to the cumulative interaction of these plumes will be adapted to temporary high suspended sediment loads and sediment deposition.

10.6. Direct impact via vessel activity (jacking-up and anchoring in operational phase)

10.6.1. For Dogger Bank Teesside A & B built (and operated) together, the worst-case impact scenario for temporary disturbance over the lifetime of the project (within the main site boundaries due to maintenance vessels) was a disturbance footprint of 1.81km^2 over a combined project area of 1153.90km^2 (0.16% of overall project areas).

10.6.2. **Table 10.5** lists the areas of temporary habitat disturbance via jacking-up in the operational phase for various projects that have been included in this cumulative assessment. For Dogger Bank Teesside C & D, which are yet to be subject to EIA, it is assumed that temporary habitat disturbance will be the same as per Dogger Bank Teesside A & B, therefore, the same values are used.

Table 10.5 Temporary habitat loss from all projects considered in cumulative assessment

Type of project	Project title	Predicted amount of temporary habitat loss (via jacking-up in operational phase)
Offshore Wind Farm	Dogger Bank Creyke Beck A	0.90km^2
Offshore Wind Farm	Dogger Bank Creyke Beck B	0.90km^2
Offshore Wind Farm	Dogger Bank Teesside A	0.90km^2
Offshore Wind Farm	Dogger Bank Teesside B	0.90km^2
Offshore Wind Farm	Dogger Bank Teesside C	* 0.90km^2
Offshore Wind Farm	Dogger Bank Teesside D	* 0.90km^2
Offshore Wind Farm	Hornsea Project One	0.71km^2
Offshore Wind Farm	Hornsea Project Two	* 0.71km^2
TOTAL		**6.82km^2**

* Values of habitat loss assumed, as EIA for Teesside C & D and Hornsea Project Two not undertaken to date

10.6.3. Whilst these individual amounts of disturbance do represent a cumulative impact on benthic habitats across the wider region, when considered together, this impact is predicted to be **negligible.**

10.6.4. This conclusion is reached by noting the same factors as outlined above for permanent habitat loss, such as the widespread nature of much of these habitats throughout the southern North Sea, but also noting the fact that the majority of habitats that will be subject to this particular effect will have a low sensitivity to disturbance and a high recoverability.

10.7. Cumulative impact of introduction of hard substrates in form or foundations / scour & cable protection into a mainly sedimentary environment (southern North Sea)

10.7.1. Colonisation of hard substrates (introduced in form of foundations and scour/cable protection) will occur on all projects within the Dogger Bank Zone and also other wind farm development projects outside the zone. The amount of hard substrate introduced to the wider region via these developments will be broadly similar as a proportion (%) of the existing sedimentary environment as that discussed above with regard to the cumulative impact of permanent habitat loss.

10.7.2. Of the two types of effect described in the earlier impact assessment section for Dogger Bank Teesside A & B, namely "reef" effects and potential "stepping-stones" for colonisation by invasive species, these are both predicted to arise at each individual site. However there are already areas of hard substrate within the area in the form of ship wrecks, therefore, it is likely that species colonising the foundations and scour/cable protection will not be new species to the area.

10.7.3. However, if these effects do actually arise in reality (which is uncertain), whilst there may be some degree of connectivity between different projects, the spatial scale of them will be very localised and, in the main, due to the distance between the various structures associated with the projects identified in this cumulative impact assessment, it is not predicted that there will be any form of cumulative impact between different projects.

10.8. Impact on the Dogger Bank cSAC via cumulative impacts

10.8.1. Scope exists for cumulative impacts on the Dogger Bank cSAC via construction and operation of Dogger Bank Teesside A & B with other Dogger Bank projects (Dogger Bank Creyke Beck A & B; Dogger Bank Teesside C & D) and also marine aggregate sites located within the boundary of the cSAC.

10.8.2. Potential cumulative impacts will include all those listed in the preceding cumulative assessment section, namely temporary habitat disturbance, increased suspended sediment concentrations and sediment deposition, permanent habitat loss and colonisation of hard substrate.

10.8.3. Construction phase impacts on these habitats via temporary habitat disturbance and increased suspended sediments and deposition associated with Dogger Bank Teesside A & B have been assessed in preceding sections. Therefore, this cumulative assessment aims to describe and quantify these potential construction phase impacts, along with similar construction phase impacts for other projects located within the boundary of the Dogger Bank cSAC, in the context of this designated site.

10.8.4. The following assessment should be read in conjunction with the **HRA Report** for Dogger Bank Teesside A & B.

10.8.5. Based on the SAC Selection Assessment Document (JNCC, Version 9.0, August 2011), the overall area of the Dogger Bank cSAC is 12,331km^2. With respect to potential sources of cumulative impact on the cSAC, this assessment has considered construction phase impacts from six wind farm projects within the Dogger Bank Round 3 Zone as well as habitat disturbance from the three marine aggregate licence areas that also lie within the cSAC boundary and which may become active at or around the same time as construction of any of the Dogger Bank wind farm sites.

Table 10.6 Temporary habitat loss from all projects within Dogger Bank cSAC

Project	Footprint of construction phase effects (temporary disturbance) within cSAC boundary (via works in main site and Dogger Bank Teesside A & B Export Cable Corridors*)	Construction phase effect footprint as % of overall cSAC
Dogger Bank Creyke Beck A & B	33.54km^2	0.27%
Dogger Bank Teesside A & B	35.70km^2	0.29%
Dogger Bank Teesside C & D	** 35.70km^2	0.29%
Area 466/1	*** 1.11km^2	0.01%
Area 485/1	**1.21km^2	0.01%
Area 485/2	**0.25km^2	0.002%
TOTAL	**107.51km^2**	**0.87%**

* Only the footprint of effect within the parts of the Dogger Bank Teesside A & B Export Cable Corridor that lie within the cSAC boundary are listed here. The cable corridor "within the cSAC boundary" includes all of the export cable within the main zone and the small section outside the main zone but still within the SAC boundary.
** Values of habitat loss assumed, as EIA for Dogger Bank Teesside C & D and Hornsea Project Two not undertaken to date.
*** Assumed that a nominal 10% of the area of each of these is dredged at any one time, leading to temporary habitat disturbance

10.8.6. From **Table 10.6** it can be noted that 0.87% of the cSAC could be affected by direct temporary habitat disturbance created by the projects listed, all of which are located within the boundaries of the cSAC.

10.8.7. Whilst noting the very small proportion of the overall cSAC that would be affected by temporary disturbance during construction of all these projects, it is also important to note that the majority of habitats that would be affected within the cSAC boundary also have a low sensitivity to temporary disturbance, with only **negligible** and **minor adverse** impacts predicted on these habitats via earlier impact assessments.

10.8.8. With respect to effects of suspended sediment concentration and sedimentation, the spatial extent of this effect footprint is greater than that for direct physical disturbance but will still be a relatively small proportion of the overall cSAC area. As outlined in earlier impact assessments, the habitats present within the Dogger Bank cSAC (VERs A, B and C) also exhibit a low sensitivity to suspended sediment concentrations and sediment deposition.

10.8.9. In terms of permanent habitat loss, Table 10.7 lists the permanent habitat loss from projects within the cSAC boundary (the proposed Dogger Bank Teesside

A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D developments), amount to 27.43km^2, which equates to 0.22% of the overall cSAC.

Table 10.7 Permanent habitat loss from all projects within Dogger Bank cSAC

Project	Footprint of operational phase effects (permanent habitat loss) within cSAC boundary (via works in main site and Dogger Bank Teesside A & B Export Cable Corridors*)	Operational phase effect footprint as % of overall cSAC
Dogger Bank Creyke Beck A	3.94km^2	0.03%
Dogger Bank Creyke Beck B	3.69km^2	0.02%
Dogger Bank Teesside A	4.88km^2	0.03%
Dogger Bank Teesside B	4.52km^2	0.03%
Dogger Bank Teesside C	4.88km^2	0.03%
Dogger Bank Teesside D	4.52km^2	0.03%
TOTAL	**27.43km^2**	**0.22%**

* Only the footprint of effect within the parts of the Dogger Bank Creyke Beck A & B, Dogger Bank Teesside A & B and Dogger Bank Teesside C & D Export Cable Corridors that lie within the cSAC boundary are listed here. The cable corridor “within the cSAC boundary” includes all of the export cable within the main zone and the small section outside the main zone but still within the SAC boundary.
** Values of habitat loss assumed, as EIA for Dogger Bank Teesside C & D not undertaken to date.

11. Transboundary Effects

11.1.1. This section of the chapter considers the potential for transboundary effects (effects across international boundaries) to occur on benthic and epibenthic resources as a result of the construction, operation or decommissioning of Dogger Bank Teesside A & B projects. For the purpose of this assessment, two types of transboundary effects are defined:

- i) those that might arise within the Exclusive Economic Zone (EEZ) of other European Community states; and
- ii) those that may arise on the interests of other European Community states, e.g. a non UK fishing vessel operating legitimately within UK waters.

11.1.2. With respect to the first type of potential transboundary effect, all impacts on the benthos during the construction, operation and decommissioning phases of all the projects (whether built in isolation or together), will be limited to direct habitat loss or disturbance caused by the placement of project infrastructure such as cables, foundations and scour protection and/or activity of vessels involved in the construction and operational phases (via jacking-up and anchoring) and indirect impacts due to the effect of increased suspended sediment concentration and sediment deposition.

11.1.3. Increased suspended sediment concentration created during the construction phase (due to cable and foundation installation) and operational phase (via sediment liberated as a result of scour effects) are noted to occur outside the site boundary. However the physical process modelling done on the worst-case scenario indicates that increased suspended sediment concentrations and sediment deposition do not impact non-UK waters. The areas that are affected outside the boundaries of Dogger Bank Teesside A & B are still located within UK territorial waters, albeit outside the main Dogger Bank Zone.

11.1.4. Therefore, there is no scope for direct or indirect transboundary impacts of type (i) listed above, i.e. impacts within the EEZ of other European Community states.

11.1.5. There is also no scope for transboundary impacts of type (ii) listed above, e.g. a non UK fishing vessel operating legitimately within UK waters. The impacts on benthic ecology within UK waters predicted as a result of this development (Dogger Bank Teesside A or Dogger Bank Teesside B in isolation or both built together) will not result in any wider impacts on activities, such as commercial fishing, that are undertaken by non UK vessels, in UK-waters.

11.1.6. A summary of the likely transboundary effects of Dogger Bank Teesside A & B can be found in **Chapter 32 Transboundary Effects**.

12. Summary

12.1.1. This chapter of the ES has provided a characterisation of the existing environment for marine and intertidal ecology based on both existing and site specific survey data, which has established that there will be some **negligible** and **minor adverse** residual impacts on marine ecology during construction, operation and decommissioning phases of Dogger Bank Teesside A & B.

12.1.2. The marine subtidal and intertidal habitats recorded across the main Dogger Bank Teesside A & B sites and Dogger Bank Teesside A & B Export Cable Corridors are typical for the central North Sea, with a range of biotopes recorded which have been grouped into nine VER's based on the sensitivity of the various biotopes.

12.1.3. Some of the subtidal benthic habitats correspond to the Annex I habitat "sandbanks slightly covered by seawater at all times" and lie within the boundary of the Dogger Bank cSAC. The sensitivity of the habitats identified within the study area to the impacts predicted via construction, operation and decommissioning of Dogger Bank Teesside A & B range from low to high, with the magnitude of effects generally negligible to low due to the small spatial extent of effect compared to the wider distribution of similar habitats.

12.1.4. This has resulted in the majority of impacts being assessed as **negligible** to **minor adverse**.

12.1.5. The impact assessment has also considered the potential for impacts on subtidal habitats that correspond to the boundary of the SAC (VERs A, B and C) to adversely affect the integrity of the Dogger Bank cSAC. Based on the assessment no such adverse effects are predicted. More details on the cSAC are provided in the **HRA Report**.

12.1.6. Due to the lack of significant impacts on marine subtidal or intertidal habitats, no specific mitigation is proposed and the monitoring proposals are typical of those for existing UK offshore wind farm projects, with a formal pre-construction baseline survey to be carried out in the future followed by a number of annual post-construction surveys. The design of these surveys will take account of the impact predictions made in the ES in order that the monitoring data can test the predictions of the ES.

12.1.7. **Table 12.1** provides a summary of the potential impacts on marine and intertidal ecology arising from the realistic worst case scenarios set out in **Table 5.1** earlier in the chapter.

Table 12.1 Summary of predicted impacts of Dogger Bank Teesside A & B on marine and intertidal ecology

Impacts	Mitigation	Residual impact
Construction		
Physical disturbance to habitats and species and temporary habitat loss	None	**Negligible** impact on all VER apart from VER C **Minor adverse** impact on VER C
Increased suspended sediment concentration and sediment deposition	None	**Negligible** impact on all VER apart from VER C **Minor adverse** impact on VER C
Release of sediment contaminants resulting in potential effects on benthic ecology	None	**Negligible** impact on VERs A, B and C in wind farm sites (and furthest offshore part of the cable corridor) **Minor adverse** impact on VERs D to I (cable corridor VERs)
Increased suspended sediment concentration leading to impacts on plankton and primary productivity	None	**Negligible** impact
Physical disturbance to intertidal habitats and species during landfall works	None	**Negligible** impact (VERs H and I)
Potential construction phase impacts on Dogger Bank cSAC	None	**Negligible** impact (VER A and B) **Minor adverse** impact (VER C)
Operation		
Permanent loss of habitat via placement of project infrastructure (foundations, cable protection, scour protection)	None	**Negligible** impact on VERs D, E, F, G, H and I **Minor adverse** impact on VERs A, B and C
Temporary impact on benthos due to physical disturbance caused by maintenance activities	None	**Negligible** impact
Change in hydrodynamics and inter-related effects on benthos	None	**Negligible** impact
Increase in suspended sediment concentration due to scour associated with foundations	None	**Negligible** impact for all VERs apart from VER C **Minor adverse** impact for VER C
Increase in sediment deposition following increase in suspended sediment concentration due to scour associated with foundations	None	**Negligible** impact
Introduction of new habitat in the form of foundation structures, leading to potential colonisation	None	**Negligible** impact
Effect of EMF on benthic communities	Where feasible cables will be buried to at least 1m	**Negligible** impact on all VERs
Potential operational phase impacts on Dogger Bank cSAC	None	**Negligible** impact (VER A and B) **Minor adverse** impact (VER C)

Impacts	Mitigation	Residual impact
Decommissioning		
Increased suspended sediment concentration and sediment deposition	None	**Negligible** impact
Loss of species colonising hard structures	None	**Negligible** impact
Temporary disturbance to habitats via removal of cables	None	**Negligible** impact on all VER apart from VER C **Minor adverse** impact on VER C
Potential decommissioning phase impacts on the Dogger Bank cSAC	None	**Negligible** impact (VER A and B) **Minor adverse** impact (VER C)

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