FOREWIND


DOGGER BANK
TEESSIDE A & B

March 2014

# Environmental Statement Chapter 13 Fish and Shellfish Ecology

## Application Reference: 6.13

Cover photograph: Installation of turbine foundations in the North Sea

 

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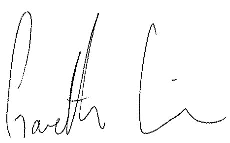
| Forewind Approval | |  | |
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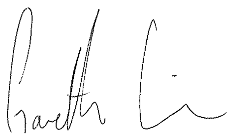
| Approved by:<br><br>Angela Lowe | Signature / Approval meeting<br><br>Gareth Lewis | Approval Date:<br><br>26 February 2014 |

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| 28 February 2014 | 4.1 | DCO Submission | BMM/TR | 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 fish and shellfish ecology and assesses the potential impacts of Dogger Bank Teesside A & B and Dogger Bank Teesside A & B Export Cable Corridor during the construction, operation and decommissioning phases. Where the potential for significant impacts is identified, mitigation measures and residual impacts are presented.

1.1.2. The description draws on original site specific and regional data collection as well as published data and grey literature. Other chapters related to this assessment include:

- **Chapter 5 Project Description**
- **Chapter 9 Marine Physical Processes**;
- **Chapter 10 Marine Water and Sediment Quality**;
- **Chapter 12 Marine and Intertidal Ecology**;
- **Chapter 14 Marine Mammals**; and
- **Chapter 15 Commercial Fisheries**.

1.1.3. The information presented in this chapter is based on a technical report authored by Brown & May Marine Limited and Precision Marine Survey Limited (PMSL) which is available in full as **Appendix 13A Fish and Shellfish Ecology Technical Report**. Brown and May Marine Ltd also undertook the impact assessment presented in Sections 6 to 11.

 

# 2. Guidance and Consultation

## 2.1. Legislation, policy and guidance

2.1.1. The assessment of potential impacts upon fish and shellfish 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
- National Policy Statement for Renewable Energy Infrastructure (EN-3), July 2011.

2.1.2. The specific assessment requirements for fish and shellfish 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 requirement | NPS reference | ES reference |
|---|---|---|
| There is the potential for the construction and decommissioning phases, including activities occurring both above and below the seabed, to interact with seabed sediments and therefore have the potential to impact fish communities, migration routes, spawning activities and nursery areas of particular species. In addition, there are potential noise impacts, which could affect fish during construction and decommissioning and to a lesser extent during operation. | Paragraph 2.6.73 | Section 6.4 – suspended sediment concentration<br>Section 6.6 – 6.8 Noise<br>Sections 7.11-7.12<br>Section 10.5 |
| The applicant should identify fish species that are the most likely receptors of impacts with respect to, feeding areas, spawning grounds, nursery grounds and migration routes. | Paragraph 2.6.74 | Section 4.2 |
| Mitigation measures should consider the reduction of electromagnetic field effects from export cables and working practices during construction to reduce the impact on fish communities. | Paragraphs 2.6.75 to 2.6.77 | Section 7.8 – 7.10 |

2.1.3. The principal guidance documents and information used to inform the assessment of potential impacts on fish and shellfish ecology are as follows:

- Centre for Environment, Fisheries and Aquaculture Science (Cefas) Guidance note for Environmental Impact Assessment in respect of Food and Environment Protection Act (FEPA) and Coast Protection Act (CPA) requirements. Version 2 – June 2004; and

- Guidelines for Data Acquisition to Support Marine Environmental Assessments of Offshore Renewable Energy Projects (Judd 2012).

## 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 (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 fish and shellfish 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 consultation and issues raised by consultees

| Consultee | Date | Comments Contents | Action taken/output | ES Reference |
|---|---|---|---|---|
| MMO (section 42 consultation on the draft ES, statutory) | 20 December 2013 | Advised that Ellis *et al*. 2012 and Coull *et al*. 1998 be used to define spawning and nursery grounds in addition to Ellis *et al.* 2010. | Ellis et *al.* 2010 is referenced in this chapter as it provides a comprehensive description of the datasets used to derive mapping layers for the distribution of eggs and larvae of fish and shellfish. Ellis *et al*. 2010 and Ellis *et al*. 2012 are considered to provide the same information on the spatial extent of spawning and nursery habitats, albeit in different formats. Coull *et al.* 1998 is referenced throughout this chapter and is also reviewed in **Appendix 13A Shellfish Ecology Technical Report**. | **Appendix 13A Fish and Shellfish Ecology Technical Report.**<br><br>Section 3.2 and 4.2 |
| | | Advised that the current ICES advice for herring in the North Sea be considered. | Current ICES advice is reviewed. | Section 6.3<br>See also:<br>**Appendix 13A Fish and Shellfish Ecology Technical Report**: Section 6.2. |
| | | Advised that the northern section of the herring spawning area should not be disturbed through the peak spawning period (mid-Aug to mid-Oct) and that it is not necessary to restrict activity during the whole spawning period. | Comments noted. | Section 4.2 |

 

| Consultee | Date | Comments Contents | Action taken/output | ES Reference |
|---|---|---|---|---|
| | | Advised that data from the International Herring Larval Survey (**IHLS**) should be considered over a series of years. | IHLS data for the ten year period 2002-2011 is presented. | **Appendix 13A Fish and Shellfish Ecology Technical Report** Figure 6.40 – Figure 6.48 |
| | | Requested the application be supported by specific sandeel surveys to cover the whole project and not just the area described by the fishery. | Additional text provided in 3.2.20 | Section 3.2 |
| | | Queried the methodology for estimating spatial extent of sandeel and herring habitat. | The approach used to estimate the spatial extent of sandeel and herring habitat is based on the approach of Jensen *et al*. 2011 and is further described in **Appendix 13G Habitats disturbance calculations report.** | Section 6.3 |
| | | Request clarification on the methodology to define the spatial extent of habitat. | Additional text added to paragraph 6.3.31. See also **Appendix 13G Habitats disturbance calculations report**. | Section 6.3 |

 

| Consultee | Date | Comments Contents | Action taken/output | ES Reference |
|---|---|---|---|---|
| | | Clarification requested to whether the impact assessment for sediment includes deposition from disposal. | Additional information provided in 6.4.14 | **Chapter 9 Marine Physical Processes** |
| | | Requested further information on piling durations. | Updated information in **Table 5.1**. | Section 5.1 |
| | | Queried whether noise impacts to sandeels during their period of dormancy were assessed. | Additional information added to 6.8.5 | Section 6.8. |
| | | Suggested a consistent naming convention with 'sandeels' used when referring to more than one species of sandeel. | Chapter updated in line with the naming convention used in the international body of literature | Amended throughout |
| | | Suggested *Nephrops* be listed as of 'regional' importance and not just 'local'. | Valuation of *Nephrops* amended to 'regional'. | Sections 3.3, 6.3 and 6.5 |

| Consultee | Date | Comments Contents | Action taken/output | ES Reference |
|---|---|---|---|---|
| | | Requested further detail on the distribution of brown crab in the western North Sea. | Update to Table 4.6. Figure 6.70 in **Appendix 13A Fish and Shellfish Ecology Technical Report** also provided to show *C. pagurus* distribution in the central North Sea. | Section 4.6 |
| | | Suggested reference to The Marine Life Information Network (MarLIN) sensitivity assessment for Nephrops be reviewed. MarLIN concluded that Nephrops have a 'high' tolerance to substrate loss. | Chapter updated. | Section 6.3 |
| | | Additional information requested regarding the effects of sediment on the nursery habitat of Nephrops. | Additional text added | Section 6.5 |
| | | Suggested ovigerous brown crab are likely to be more sensitive to re-deposition of fine sediment as they are effectively sessile whilst brooding their egg mass. | Additional text added. | Section 6.5 |
| | | Advised that the chapter be updated to recognise that brown crab is of regional importance. | Comments accepted. | Section 7.11 |

| Consultee | Date | Comments Contents | Action taken/output | ES Reference |
|---|---|---|---|---|
| | | Requested clarification on whether unbundling of cables has been considered. | Cables are to be assumed unbundled as a worst case scenario. **Table 5.2** updated and text added to clarify in this chapter. | Section 3.3 |
| JNCC/Natural England (section 42 consultation on the draft ES, statutory) | 20 December 2013 | Noted that the maximum area for physical disturbance/habitat loss during construction was inconsistent. | Amendment made. | Section 6.2 |
| | | Suggested the relative distribution of sediment should be provided for the inshore area close to landfall and the export cable. | Information on the inshore area and export cable study area is provided in Section 6.4.16 | Section 6.4 |
| | | Requested clarification on the figures quoted for the total area of preferred habitat within the Dogger Bank SA1 sandeel management area. | Methodology used to derive the estimates of sandeel habitat are provided in **Appendix 13G Habitats disturbance calculations report** | Section 6.3 |
| | | Clarification requested on the maximum sediment thickness used in modelling. | Comments noted | Section 6.5 |

 

| Consultee | Date | Comments Contents | Action taken/output | ES Reference |
|---|---|---|---|---|
| | | Requested clarification on information provided based on the reference Bone & Moore 2008 on larvae. | Clarification provided in Section 6.5.9 | Section 6.5 |
| | | Requested information on where hard structures are likely to be introduced along the export cable corridor. | Addressed in Section 7.2 and 7.3 and detailed in **Table 5.2** | Sections 7.5 and 7.6 |
| | | Raised questions regarding sensitivity of Nephrops in relation to physical disturbance to their spawning and nursery grounds, given their mobility and occupation of burrows. | Report updated with habitat preference and the spawning and nursery areas for *Nephrops* based on Coull *et al*. 1998 and Ellis *et al*. 2012. | Section 3.3<br>&<br>Section 4.2 |
| | | Suggests a review of MarLIN information for *Nephrops* sensitivity and recoverability i.e. in relation to suspended sediment on eggs, larvae and adult. | Report updated to include information from MarLIN. | Section 6.3<br>&<br>Section 6.5 |
| EPIC Regeneration Consultants LLP for Hartlepool Fishermen's Society Ltd.<br>(section 42 consultation on the draft ES, statutory) | 20 December 2013 | The inshore element of the Export Cable Corridor shows an area of the highest concentration over a known *Nephrops* habitat. | The importance of *Nephrops* in inshore areas is noted in **Table 4.6**. | Section 4.6 |

 

| Consultee | Date | Comments Contents | Action taken/output | ES Reference |
|---|---|---|---|---|
| | | Concerned that so little is understood about the impact of EMF and heating effects from HVDC cabling on commercial fish stocks and any potential for EMF to create barriers to fish stock migration. | Comments noted. A review of the EMF impacts and effects is provided. | Section 7.10- 7.12<br><br>See also **Chapter 5 Project Description** Section 3 |
| | | Request for further information on the use of bundling of cables to mitigate the effects of EMF on receptors. | Text to clarify has been added | Section 3.3 (See also Section 7.10) |
| | | Request further information on the research undertaken by Bochert and Zettler, (2004) as cited. | Comments noted. Further text has been added to clarify. | Section 7.11 |
| | | Lack of seabed samples inadequate given there are previously used spoil dumping areas in proximity. | Contaminant concentrations along the cable corridor are described in paragraph 6.6.4. | See also **Chapter 10 Marine Water and Sediment Quality**<br><br>Section 6.6 |
| MMO/Cefas (Meeting) | 10 April 2013 | Meeting to discuss the approach to methodology and impact assessment for Dogger Bank Teesside A & B.<br><br>Presentation on results of the fish and shellfish characterisation surveys in Tranche B. Cefas indicated that grey gurnard were not currently considered to be a species of interest but this position may change in the future if the species becomes increasingly commercially important.<br><br>Presentation of the sandeel survey results showing some concentration of sandeels in Dogger Bank Teesside A and very low densities of sandeels in Dogger Bank Teesside B. Cefas indicated that sandeels in Tranche B must be included for assessment.<br><br>Presentation of herring survey results showing no evidence of spawning activity on the historic | | N/A |

| Consultee | Date | Comments Contents | Action taken/output | ES Reference |
|---|---|---|---|---|
| | | spawning grounds near Tranche B. | | |
| JNCC/Natural England (written response) | 17 December 2012 | Written response from JNCC Natural England with reference to the Habitat Regulations Assessment (HRA) Screening Report. In reference to protected fish species linked to Special Protection Area (SPA) greater clarity is needed with reference to;<br><br>The impact of construction of the Dogger Bank Teesside A & B Export Cable Corridor and landfall;<br><br>The impact from the use of scour protection (rock protection);<br>Determining the thresholds of suspended sediment concentrations over which there may be an impact on the respiratory and reproductive functions of sensitive fish species;<br><br>The potential impact on habitats supporting fish species (i.e. Special Area of Conservation (SAC) sites and fish species) in relation to the export cable and potential rock protections needs to be considered; and<br><br>A consideration of the potential impact of the development on allis and twaite shad and river and sea lamprey should be included in the assessment. | This has been addressed in sections 6-8 of this chapter and in the HRA draft report **HRA Appendix B**. | Section 6 – 8 |
| MMO (written response) | 17 December 2012 | Written response from MMO to Forewind in relation to the herring spawning and sandeel report sent by Forewind and the discussions in relation to these species during the 15/08/2012 meeting with MMO/Cefas.<br><br>Specific Comments: | The results of the PSA have been included within this ES chapter.<br><br>Data on sandeel derived from 2m beam trawl sampling has also been included within | Section 6- 8 |

| Consultee | Date | Comments Contents | Action taken/output | ES Reference |
|---|---|---|---|---|
| | | The addition of PSA data has been noted;<br><br>The data with regard to sandeel is improved for Tranche A and the inclusion of the 2m beam trawl data is useful and the acknowledgment of the limitations of this data has been noted;<br><br>With regards to the sandeel data all the information must be pulled together to create a vulnerability assessment within Tranche A (this could be used to identify the higher abundance of sandeel within Tranches A & B and those sites surrounding them).<br><br>A further sandeel survey for Tranche A is not required as Forewind have reduced the boundary to exclude most of the sandeel ground to the west and the information provided does characterise the area, with the additional 2m beam trawl and PSA data;<br><br>The inclusion of herring PSA data is useful. We agree that limited spawning is likely to take place within the Dogger Bank region and the spawning ground is likely to be historic. Therefore there is no need for further surveys for Tranche A;<br><br>The southern portion of Area B (where four PSA samples have high gravel content) must be avoided for construction during the spawning season using engineering solutions. This is due to the proximity to spawning ground to the south and the historic and low level occurrence of spawning in the vicinity. This may change if there is a change in the state and use of the spawning ground; | **Appendix 13A Fish and Shellfish Ecology Technical Report**.<br><br>All available data on sandeel (fisheries, surveys and sediment type) have been integrated to inform the impact assessment on this species.<br><br>The presence of gravelly areas within Dogger Bank Teesside A & B and the wider area has been taken into account in the undertaking of the impact assessment in the former herring grounds Section 6-8 of this chapter.<br><br>The potential for construction noise to have an impact on herring spawning in the former grounds (under the assumption these are recolonized) has been included in the impact assessment Within Section 6 to 8 in this chapter. It should be noted that it is assumed that the MMO response referencing Dogger Bank Teesside B is assumed to be an error and to mean Dogger Bank Teesside A as this is the area which has four PSA samples of high gravel content and which is closest to the historic herring spawning area. | |

 

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| | | Given captured herring in the survey, they are likely to be in vicinity at spawning time – therefore impact of noise should be fully considered; and<br><br>Herring are spawning in cable corridor – therefore the impact assessment should fully consider this for laying cable – the engineering solution will not be decided until post consent, although we recommend that this is scheduled for outside the spawning period and one month lead in before to allow settlement of the spawning grounds. | Similarly, the potential use of the inshore area of the Dogger Bank Teesside A & B Export Cable Corridor for herring spawning has been included for assessment in Sections 6 to 8 of this chapter. | |
| JNCC/Natural England (written response) | 17 December 2012 | As an output from the Dogger Bank Teesside A & B Workshop of the 10th of April 2012 and the discussions held in relation to the fisheries survey results from the first years sampling, the MMO have produced the following response in consultation with our advisors Cefas.<br><br>One of the outcomes from the meeting was to discuss whether continued adult herring sampling (acoustic and trawl) was a suitable approach for the developer to collect data in order to potentially avoid a temporal piling restriction for herring. A sampling regime for sandeel was also discussed.<br><br>In addition, herring surveying and modelling parameters, liaison with pelagic fisheries and to obtain landings data, sandeel sample areas and need for PSA to aid identification of habitat were all outlined. | Production of a sandeel and herring key impacts and baseline information report to be submitted to the MMO for further discussion on key issues in relation to these species. This included the integration of PSA data, sandeel survey results, sandeel fisheries data and recent larval surveys carried out on the Dogger Bank, including the distribution of herring larvae in the area (van Damme *et al*. 2011). This report was sent to the MMO/Cefas on 13th August 2012.<br><br>Extensive consultation has been undertaken with UK and non-UK fishing fleets which operate in the Dogger Bank area. In addition, landings and VMS data | This chapter, **Chapter 15 Commercial Fisheries** and **Appendix 15A Commercial Fisheries Technical Report**. |

 

| Consultee | Date | Comments Contents | Action taken/output | ES Reference |
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| | | | were obtained to further describe UK and non-UK fishing activity in the area (See **Chapter 15 Commercial Fisheries**). The information provided in **Appendix 15A Commercial Fisheries Technical Report** has been cross-referenced in to inform the assessment on sandeel and herring within this chapter. | |
| MMO (Written response) | 12 September 2012 | Comments on the survey reports sent by Forewind to the MMO on the 09/03/2012.<br><br>The reports reviewed above provide good information on the survey methodology and species captured. We appreciate that the data has been presented in a standardised format.<br><br>For the pelagic survey previous advice suggested and we maintain the advice that the survey coverage should cover the entire site (especially if a larval survey is not carried out), not just spawning grounds identified by the Coull *et al*. (1998) spawning maps in order to highlight if herring are found across the site and potentially identify if they are in spawning state.<br><br>The fish ecology EIA methodology submitted alongside the above is appropriate.<br><br>Comments on April 10th 2012 Environmental Workshop<br>- A point was raised about whether Forewind needed to continue with the adult herring surveys. If as suggested, a herring larval | Production of a sandeel and herring key impacts and baseline information report to be submitted to the MMO for further discussion on key issues in relation to these species. This included integration of PSA data, sandeel survey results, sandeel fisheries data and recent larval surveys carried out in the Dogger Bank, including the distribution of herring larvae in the area (Van Damme *et al*. 2011). This report was sent to the MMO/Cefas on 13th August 2012. | N/A |

| Consultee | Date | Comments Contents | Action taken/output | ES Reference |
|---|---|---|---|---|
| | | survey is conducted, the need for the adult herring surveys can be reviewed. | | |
| MMO/Cefas (Meeting) | 15 August 2012 | Meeting to discuss the main concerns in relation to spawning herring and sandeel after MMO/Cefas review of the sandeel and herring key impacts and baseline information report sent for consultation by Forewind (report sent by Forewind on 13th August 2012). | Feedback provided by MMO/Cefas in a written response (12/09/2012). | N/A |
| MMO/Cefas (Meeting) | 15 August 2012 | Migratory fish such as salmon and sea trout use the study area to transit through. Consideration must be given to these when assessing the impact of the works on fish. | The ecology of migratory species such as salmonids and eels is considered within the technical report. Where available (e.g. for salmon and sea trout) Environment Agency data describing historical and contemporary patterns in the size and timing of runs in those rivers in the vicinity of the Dogger Bank Teesside A & B Export Cable Corridor has been included. Information on the North East net fishery and associated data has been included within **Appendix 15A Commercial Fisheries Technical Report.** | Sections 4.3, 6.5, 6.7 |

| Consultee | Date | Comments Contents | Action taken/output | ES Reference |
| --- | --- | --- | --- | --- |
| MMO (Meeting) | 25 July 2012 | Workshop to discuss the main concerns in relation to fish and shellfish, particularly sandeel and spawning herring.<br><br>Presentation of the preliminary results of the sandeel survey.<br><br>Presentation of current state of knowledge in relation to herring and the use of the former spawning grounds in the Dogger Bank area.<br><br>Presentation of results of preliminary noise modelling. | Feedback from the regulator provided in relation to the key areas discussed in the workshop (See MMO written response 25/07/2012 below). | N/A |
| MMO (Meeting) | 06 July 2012 | Meeting with research team to gather information on IMARES current research on the effect of piling noise on fish larvae. | IMARES feedback, information and suggested research publications have been included within this chapter and in the corresponding impact assessment Section 6 to 8. | **Appendix 13A** |
| MMO (written response to scoping) | 22nd June 2012 | As mentioned previously for Dogger Bank Creyke Beck: a short-snouted seahorse was caught in the Dogger Bank area, (Pinnegar *et al*, 2008). This is a species of conservation importance and relevant considerations should be observed. | The record of a short-snouted seahorse specimen was noted in **Appendix 13A Fish and Shellfish Ecology Technical Report** (Section 5.5). | Section 4.2, 4.3 |
| JNCC (written response to scoping) | 19th June 2012 | JNCC and Natural England defer to Cefas as the lead adviser on fish and shellfish and provide the following comments in addition. Impacts on Biodiversity Action Plan (BAP) species http://www.ukbap.org.uk/ should be considered. | Impacts on BAP species are identified and included in the assessment | Tables 4.5 and 4.6.<br><br>Section 6-7 |

| Consultee | Date | Comments Contents | Action taken/output | ES Reference |
|---|---|---|---|---|
| | | Electromagnetic Fields, identifies the proposed use of High Voltage Direct Current (HVDC) system for export cables. We highlight that this is new technology and as such there is limited expertise and existing knowledge on the electromagnetic impacts upon fish and shellfish. Therefore we agree this should be assessed in detail within the ES. We recommend that further consultation is undertaken to agree the detail and scope of that assessment. | The effect of EMF on fish and shellfish is assessed | Section 7.11 |
| | | 10.2.10 identifies the provision of artificial habitat for fish and shellfish. As outlined in our former comments on Benthic ecology the assessment should consider the potential facilitation of spread of species not previously found in the area, including non-native species. In addition, the removal of this habitat during decommissioning | The impact of the introduction of artificial reef habitat is considered. | Section 7.5 |
| Guisborough Town Council (written response to scoping) | 11th June 2012 | The Town Council would suggest that the damage to the Bank itself caused by excavation and vibration during installation and operation would be significant. Therefore it seems essential to the Town Council that before any invasive work takes place the current environmental status is established. This should cover estimates of the range and variety of fish and other flora and fauna in their various life cycles. | The assessment considers the impacts on eggs, larvae, juveniles and adults of fish and shellfish. | Section 6 -7 |
| Environment Agency (written response to scoping opinion) | 01 June 2012 | Migratory fish such as salmon and sea trout use the study area to transit through. Consideration must be given to these when assessing the impact of the works on fish. | Impacts on diadromous species (including salmon) are assessed in this chapter | Section 6 -7 |

| Consultee | Date | Comments Contents | Action taken/output | ES Reference |
|---|---|---|---|---|
| | | Whilst a desktop study has identified most of the main commercial fish species utilising the area. In the Dogger Bank Project One scoping report, (p63), the MMO highlighted that further investigation of Electromagnetic Fields (EMF) through the EIA in context of High Voltage Direct Current (HVDC) cables. However, there is no mention of elasmobranchs or consideration of EMF in the offshore PEI1. It is recommended that this is addressed and any impacts considered and mitigation measures proposed i.e. cable depth, EMF emissions etc.<br><br>Commercial finfish fishing in the area appears to have been adequately covered, but there is no mention of shellfisheries. The corridor cuts across Bridlington Bay and this area is important for crab and lobster fisheries. A full impact assessment addressing these issues should be carried out in consultation with the local fishing industry. | The potential for EMF derived from the export cable and array cables have been addressed in the Section 7 of this chapter including potential impacts on elasmobranch species.<br><br>The Dogger Bank Teesside A & B Export Cable Corridor does not pass through Bridlington Bay although it does transect grounds which record significant shellfish landings. Therefore, (in addition to finfish) a review of shellfisheries has is included within this report. Potential impacts associated with the construction, operational and decommissioning phase of Dogger Bank Teesside A & B have been assessed for both, finfish and shellfish species within Sections 6-8 in this chapter). The potential impacts of Dogger Bank Teesside A & B on commercial fishing are assessed in **Chapter 15 Commercial Fisheries.** | Sections 7.8 – 7.9 |
| IPC Scoping Report - Opinion | June 2012 | Spawning grounds and nursery areas for several fish and shellfish species are found within the Scoping Envelope. These include UK Biodiversity Action Plan protected species and commercially important fish species as identified in **Table 10.1**. Annex II diadramous fish species and features of conservation interest under the Marine Conservation Process are also located | Spawning grounds and nursery areas of commercially important fish and shellfish, diadromous/migratory species and those of conservation interest is presented in **Appendix 13A Fish and Shellfish Ecology Technical** | Section 5.4 **Appendix 13A Fish and Shellfish Ecology Technical Report** |

| Consultee | Date | Comments Contents | Action taken/output | ES Reference |
|---|---|---|---|---|
| | | within the Scoping Envelope. | **Report**. | |
| | | The Scoping Report identifies that there is a lack of evidence and scientific knowledge relating to the impact of EMF upon marine benthic community and anticipates that this potential impact assessment may not be feasible. However, the Secretary of State notes the comments in the joint response from Natural England/JNCC that there is a lack of knowledge about the effects and impacts of High Voltage Direct Current (HVDC) and therefore considers that this assessment should be scoped into the EIA | The impact of EMF on fish and shellfish is assessed. | Section 7.11 |
| | | The studies must include consideration of the impacts upon migratory fish such as salmon and sea trout. | Salmon and sea trout are assessed in this ES. | Section 6.9 and Section 7.11 |
| | | The evaluation of the impacts should interrelate with the assessment of commercial fisheries. | **Chapter 15 Commercial Fisheries** is cross-referenced in this ES. | |
| Cefas/JNCC (Workshop) | 10 April 2012 | Meeting with Dr. Henrik Mosegaard (Head of fish population dynamics and Genetics, DTU) to discuss sandeel ecology on the Dogger Bank and the most appropriate sandeel sampling methodology and timings. | The feedback obtained in relation to survey gear, timing and sandeel ecology was taken into account for definition of the sandeel specific survey methodology. | Section 3<br>Sections 6 - 8 |
| Institute for Marine Resources and Ecosystem Studies (IMARES) (Meeting) | 02 February 2012 | MMO formal response to the “Dogger Bank Fish Ecology Wind Farm Project-Fish Survey methodology submitted by Forewind to the MMO on the 18th April 2011. Response included:<br><br>Information on herring spawning, survey methods, the International Council for the | The MMO written response in relation to the herring spawning sampling methodologies could not be taken into account for the undertaking of the herring survey, as the response from the MMO was received after the survey had been completed. | Section 3 |

| Consultee | Date | Comments Contents | Action taken/output | ES Reference |
|---|---|---|---|---|
| | | Exploration of the Sea (ICES) International Herring Larval Survey (IHLS) and stock recovery;<br>The MMO and its advisors Cefas suggest that as no current larvae data for the Dogger Bank has been collected, similar methodology to the IHLS (Ichthyoplankton surveys section) could be employed to determine the present level of herring spawning at the proposed Dogger Bank wind farm site. The collection of this data, together with analysis of sediment type (see ichthyoplankton PSA analysis) would inform the advice given with regard to any potential temporal piling restrictions. Information on how ichthyoplankton surveys and particle size analysis could be valuable; and Information on sandeel and suggestions relating to survey methodology. | However in relation to the above data collected by IMARES in 2011 (van Damme *et al*. 2011) was used to inform the ichthyoplankton and herring spawning assessment (see Section 6 -- 8 in this chapter of the ES).<br><br>The advice given on the sandeel survey methodology was taken into account for survey planning. The results of the PSA derived from grab samples from the benthic survey undertaken in Tranche A together with British Geological Survey (BGS) sediment data have been integrated in to this report and the impact assessment within this chapter, in respect of both, sandeel and herring. | |
| MMO<br>(PEI1 Response) | 20 January 2012 | Presentation of fish ecology assessment methodology and planned surveys to support the EIA to Cefas.<br><br>Discussion of Cefas written responses received (email 21st July 2011) included:<br><br>-Use of 30km buffer zone around the site as sampling area of herring survey and night sampling;<br>-Need of more than one herring survey to be undertaken and discussion on the former status of the Dogger Bank spawning grounds; | The 30km buffer zone during the herring survey was used as a conservative indication of the distance at which piling noise may result in behavioural responses in herring. This is supported by the results of the noise modelling presented in Section 6.6 of this chapter (21.5km was the maximum modelled range of behavioural responses for pelagic fish). | Sections 6.6 – 6.8<br>Sections 7.11, 7.12 |

| Consultee | Date | Comments Contents | Action taken/output | ES Reference |
|---|---|---|---|---|
| | | -The need to survey wider areas than those depicted by the Danish fishing grounds in the sandeel survey and the need of substrate data to support the findings of the survey;<br>-Discussion of nearshore survey methodology;<br>-Presentation of noise modelling methodology and assumptions; and<br>-Presentation of herring spawning and sandeel survey methodologies. | The suitability for the herring survey to be carried out at night was agreed.<br><br>Information to support the current former status of the Dogger Bank herring spawning grounds is provided within Section 4 of this chapter.<br><br>During the sandeel survey, in addition to areas of high sandeel fishing activity, sampling was undertaken in the wider area (Tranche A and Tranche B). The outputs of the Particle Size Analysis (PSA) from grab samples collected during the benthic survey have been integrated in the Impact Assessment (Sections 6 to 8 of this chapter of the ES). | |
| DTU-Aqua (Meeting) | 22 November 2011 | A wide variety of species have at least part of their life cycle in the area. It would therefore be advisable to have quarterly surveys to adequately describe the seasonal variation of species. It is also important to remember that spawning ranges will vary, temporally and spatially, from one year to another. | Three fish characterisation surveys were carried out (August, October and April 2012) within Tranche A as agreed with Cefas (16/08/2012 meeting). | Section 4.2 |
| MMO (Written response) | 19 October 2011 | A short-snouted seahorse was caught in the Dogger Bank area (Pinnegard *et al*. 2008). This is a species of conservation value and relevant considerations should be observed. | The record of a short-snouted seahorse specimen was noted in **Appendix 13A Report Fish and Shellfish Ecology Technical report** (Section 5.5). This species was not recorded in the | Section 4.2, 4.3 |

| Consultee | Date | Comments Contents | Action taken/output | ES Reference |
|---|---|---|---|---|
| | | | surveys carried out in Tranche A and Tranche B and along the Dogger Bank Creyke Beck and Dogger Bank Teesside A & B Export Cable Corridors. | |
| Cefas (Meeting) | 16 August 2011 | We would recommend that separate demersal and pelagic (with acoustic support) surveys are considered. We endorse the use of gear types operated by fishermen in the area, also, we recommend, if possible, using the local fishing community and fishing methods to survey the area. | Both demersal and pelagic fish surveys were undertaken within Tranche A and Tranche B in order to appropriately characterise the fish assemblage in the area. | Section 4.2, 4.3 |
| Marine Management Organisation (MMO) (IPC Scoping Opinion)<br>MMO/Centre for Environment Fisheries and Aquaculture Science (Cefas)<br>Cefas (E-mail) | 01 November 2010<br><br>18 April 2011<br><br>21 July 2011 | The Environmental Impact Assessment (EIA) must include an assessment of the environmental effects of those species and habitats on the Oslo and Paris Conventions (OSPAR) list of Threatened and Declining species. | Species included in the OSPAR list have been included for assessment within **Appendix 13A Fish and Shellfish Ecology Technical report** Section 5.5. | Sections 6 - 9 |
| Joint Nature Conservation Committee (JNCC) (IPC Scoping Opinion) | 01 November 2010 | Dogger Bank Wind Farm Project - Fish Ecology Survey Methodology", was submitted by Forewind to the MMO and its advisors, Cefas. | The MMO provided a formal response on 19/10/2011) – see below. | Section 4.2 |
| | | Cefas preliminary feedback in relation to the proposed fish ecology survey methodology:<br><br>The overall approach to sampling appears to be well conceived and the proposed surveys are considered to provide a good characterisation and an adequate baseline of the area to inform the EIA. | A meeting was arranged with Cefas (16/08/2011) to discuss the key points raised in their email response (21/07/2011).<br><br>See **Appendix 13A Fish and Shellfish Ecology Technical report** Section 5.3 for details on survey methodology. | Section 4.2 |

| Consultee | Date | Comments Contents | Action taken/output | ES Reference |
| --- | --- | --- | --- | --- |
| | | The Dogger Bank is an area of high fishing value because there is a high diversity of species inhabiting the area, stages in their life cycle and at various times of year. For this reason we strongly recommend that quarterly surveys would be needed to fully represent this species diversity and enable an adequate impact assessment to be carried out.<br><br>Furthermore, Cefas recommend using local fishing community to gain information on fishing methods, populations and create communication channels with potentially affected fishermen.<br><br>Other recommendations:<br><br>Referential evidence is necessary to support the reason for choosing 30km buffer to account for ‘typical piling noise ranges and typical significant behavioural responses of fish’;<br><br>In relation to pelagic trawl sampling, for the method to fully work acoustic data needs to be recorded and analysed in addition to sampling data. In addition, ideally the whole area would need to be surveyed and not just the ‘Coull *et al.* 1998 ‘area. Several surveys would need to be carried out throughout the spawning season and over several years to properly address the timing and extent of peak spawning;<br><br>Explain the justification behind surveying herring at night; and<br>It is proposed the sandeel survey is carried out at night time during the beam and otter trawl survey cruises in March. | | |

| Consultee | Date | Comments Contents | Action taken/output | ES Reference |
|---|---|---|---|---|
| | | Suggest the use of International Beam Trawl Survey (IBTS) data to characterise the area. | IBTS and Dutch Beam Trawl Survey (BTS) data have been used to inform the Fish and Shellfish Technical Report. | Section 4.2 |
| Marine Management Organisation (MMO) (IPC Scoping Opinion) | 01 November 2010 | Sandeel is abundant and not necessarily adequately sampled using demersal or pelagic gear. | Sandeel was sampled using a modified scallop dredge as agreed during consultation with MMO/Cefas and Dr. Henrik Mosegaard (DTU-Aqua). | Section 4.2 |
| Joint Nature Conservation Committee (JNCC) | 01 November 2010 | Both European eel and smelt are listed as Marine Conservation Zone (MCZ) features of conservation importance and both have been known to occur within the cable corridor.  Net Gain will therefore be considering their inclusion in a possible MCZ. | The potential for diadromous species (including European eel and smelt) to transit areas relevant to the Dogger Bank Teesside A & B Export Cable Corridor has been included in Section 6 and 7.  The occurrence of smelt in the vicinity of the Dogger Bank Teesside A & B Export Cable Corridor is considered less likely than for Dogger Bank Teesside A & B, as the species is less abundant in rivers and estuaries further north such as the Tees and Esk. | Section 6 -7 |

# 3. Methodology

## 3.1. Study area

3.1.1. For the purposes of this assessment, two study areas have been defined (**Figure 3.1**). These are as follows:

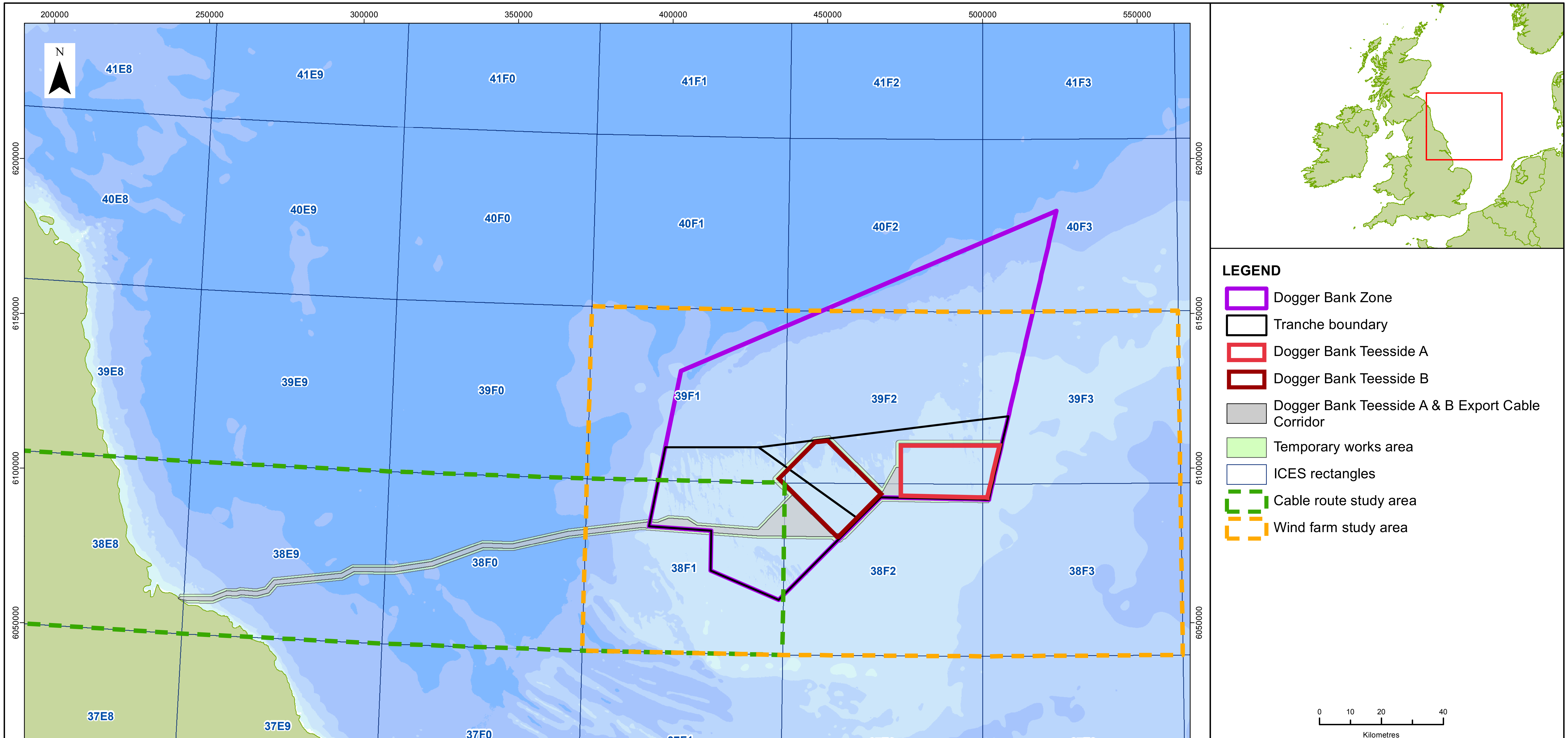
- The wind farm specific study area (Wind Farm Study Area) comprising the six International Council for the Exploration of the Sea (ICES) rectangles which tranches A and B overlap and where Dogger Bank Teesside A & B is located (38F1, 38F2, 38F3, 39F1, 39F2 and 38F3); and
- The Dogger Bank Teesside A & B Export Cable Corridor specific study area (Export Cable Corridor Study Area) which comprises the four ICES rectangles in which the Dogger Bank Teesside A & B Export Cable Corridor is located (38E8, 38E9, 38F0 and 38F1).

3.1.2. The Dogger Bank Teesside A& B Export Cable Corridor Study Area is further split into two areas:

- Dogger Bank Teesside A & B Offshore Export Cable Corridor Study Area – ICES rectangles 38F0 and 38F1; and
- Dogger Bank Teesside A &B Inshore Export Cable Corridor Study Area – ICES rectangles 38E8 and 38E9

3.1.3. The study areas defined above are aimed at providing context in terms of the location of the Dogger Bank Teesside A & B and of the Dogger Bank Teesside A & B Export Cable Corridor. Each ICES rectangle designates a standard spatial unit for referencing fisheries data. The ICES rectangle grid system provides a geographical context for the interpretation of commercial fisheries information and ICES survey data. Where required, wider areas are used for the purposes of the fish and shellfish assessment (i.e. distribution of spawning grounds, migration routes).




Data Source:
Study Areas © Brown & May Marine 2013
ICES Rectangles © ICES 2012
Background bathymetry image derived in part from TCarta data © 2009

PROJECT TITLE

DOGGER BANK TEESSIDE A & B

DRAWING TITLE

**Figure 3.1 Dogger Bank Teesside A & B and export cable corridor study areas**

| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 10/09/2013 | Draft | LW | TR |
| 2 | 07/10/2013 | PEI3 | LW | TR |
| 3 | 14/02/2014 | DCO Submission | LW | TR |

DRAWING NUMBER:

**F-OFL-MA-241**

| SCALE | PLOT SIZE | DATUM | PROJECTION |
|---|---|---|---|
| 1:1,300,000 | A3 | WGS84 | UTM31N |



FOREWIND

# 3.2. Characterisation of the existing environment – methodology

## Sources of data and information

3.2.1. The principal sources of data and information used to inform this chapter include the results of the following surveys:

- Adult and juvenile fish site specific characterisation surveys (Forewind) (**Appendix 13B, 13D**);
- Site specific pelagic fish, sandeel, epibenthic (epifaunal) and benthic surveys (Forewind) (**Appendices 13E, 13F, 12A and 12B** respectively);
- Inshore shellfish surveys (Forewind) (**Appendix 13C**);
- Inshore trammel net surveys (Forewind) (**Appendix 13C**);
- International Bottom Trawl Survey (IBTS) (2003-2012);
- International Herring Larval Survey (IHLS) (2003-2012) ; and
- Ichthyoplankton surveys undertaken in the North Sea (van Damme *et al*. 2011).

3.2.2. The site specific surveys undertaken by Forewind are described in further detail on the following pages.

3.2.3. Other sources of data include:

- MMO landings data (weight and value) by species for the period 2008 - 2012 (MMO 2013);
- **Appendix 15A.** This document includes consultation with commercial fishermen;
- Cefas publications and ICES publications;
- Distribution of spawning and nursery grounds as defined in Coull *et al*. (1998) (Fisheries Sensitivity Maps in British Waters) and in Ellis *et al*. 2010 - Mapping spawning and nursery areas of species to be considered in Marine Protected Areas (Marine Conservation Zones);
- Collaborative Offshore Wind Research into the Environment (COWRIE) (2005, 2007, 2009) reports;
- Results of monitoring programmes undertaken in operational wind farms in the UK and other European countries;
- Dogger Bank Creyke Beck ES Chapter 13 Fish and Shellfish Ecology; and
- Other relevant research publications, as identified in Section 13 (References) of this chapter.

## Distribution of spawning and nursery grounds

3.2.4. The description of spawning and nursery grounds provided in this document is primarily based on the information presented in Ellis *et al*. (2010) and Coull *et al*. (1998). These two publications are acknowledged as standards that present information on the widest potential distribution of spawning and nursery grounds of common fish and shellfish species in UK waters, and as such, they are comprehensively referenced throughout this chapter. Ellis *et al*. (2010) and Ellis *et al.* (2012) provide the same data and information albeit in different formats. The earlier version is referenced in this chapter as it provides a more comprehensive description of the datasets used to derive the layers for mapping the distribution of eggs and larvae of fish and shellfish.

3.2.5. These are useful in identifying broad spawning and nursery grounds, but not the exact definition of the boundaries of spawning and nursery grounds, particularly in the context of the relatively small footprint occupied by both Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor. In the case of Ellis *et al*. (2010, 2012) however, it should be recognised that the spawning grounds have been defined using the boundaries of the grid rectangles in which larval surveys have been undertaken and as such are unlikely to represent the actual areas of specific spawning grounds. Also, the spawning grounds given in Coull *et al.* (1998) are the result of overlaying research and literature, much of it historic, from a number of sources.

3.2.6. Similarly, the spawning times given in these publications represent the maximum duration of spawning on a species/stock basis. When considered in a localised context, the duration of the main spawning events may be considerably shorter than given in Ellis *et al*. (2010) and Coull *et al*. (1998). The spawning times of 27 populations of Atlantic herring compiled by Sinclair and Tremblay (1984), show that, while each population of herring has its own seasonally fixed spawning period, individual populations spawn for a short period of time of only a few weeks duration. In a study of a number of European herring stocks, Iles (1964) found that the duration of Stage VI (i.e. “running ripe”) lasted between one and five days. Norwegian spring spawning herring spend from one to seven days at the spawning site (Axelsen *et al*. 2000, Skaret *et al.* 2003). Therefore, Banks herring may spawn over a period that occurs between late August and October, but the duration of the spawning period itself will be limited to a few weeks or less. There is no evidence from IHLS surveys, MIK surveys, (MIK nets are specific types of net used for larval surveys), IBTs surveys or commercial landings to suggest that mature Banks herring are continually spawning over the entire period of August 1st to October 31st.

3.2.7. The relative abundance of small larvae (<10mm) in IHLS surveys conducted between 2002 and 2011 is presented in Figure 6.40 – Figure 6.48 of **Appendix 13A**.

## Landings data and knowledge gaps

3.2.8. Landings data presented in this report are based on MMO data by species and ICES rectangle. For the purposes of this document only landings by UK vessels (irrespective of port of landing) have been included. MMO data is compiled annually, 2012 data is used in this document.

3.2.9. The Dogger Bank area also supports important non-UK fisheries and, therefore, any fisheries data used in this chapter may not fully represent the overall importance of some species to non-UK fishing interests. Data on non-UK fishing activity is described in detail in **Chapter 15** and has been cross-referenced in this chapter where appropriate.

3.2.10. Landings statistics are used to provide an indication of the principal species targeted in a specific area but they cannot provide a complete picture of the relative abundance and distribution of fish and shellfish. Other factors such as market forces, environmental conditions and fisheries legislation influence the level of exploitation of a given species. In addition, knowledge of the distribution, behaviour and ecology of some fish and shellfish species is sparse at best and, in some cases, non-existent. This is particularly relevant to a number of migratory species, such as lampreys and salmonids, some of which are of conservation importance.

3.2.11. It is recognised that there are gaps in the understanding of the distribution, behaviour and ecology of certain fish and shellfish species. This is particularly evident for a number of migratory species including several species of known conservation importance (e.g. lampreys and salmonids). Knowledge gaps often relate to migration routes and use of discrete sea areas such as those within Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor.

## International Bottom Trawl Survey (IBTS)

3.2.12. IBTS data has been accessed from the DATRAS on-line database (DATRAS 2013) which contains haul information and biological data from all surveys conducted by the ICES IBTS sampling programme. Since 1997 these surveys have employed a standardised fishing method using a Grande Ouverture Verticale (GOV) trawl to sample a series of fixed stations, twice per year in the 1st and 3rd quarters (ICES 2010c). The species abundance data presented in this report refers to the average number of fish per standardised 30 minute haul during IBTS North Sea surveys 1992 to 2011.

## International Herring Larval Survey (IHLS)

3.2.13. IHLS data was accessed via the ICES Data Portal (ICES 2013a). The IHLS surveys routinely collect information on the size, abundance and distribution of herring *Clupea harengus* larvae in the North Sea. The values for larval abundance presented in this report refer to the number of herring larvae in the smallest reported size category (<10mm total length) caught per square metre at each site sampled. Sites were sampled fortnightly in the 3rd quarter in each year between 2002 and 2012.

## Site specific surveys

3.2.14. In order to inform the fish and shellfish baseline characterisation a number of surveys were undertaken in and around tranches A and B and along the Dogger Bank Teesside A & B Export Cable Corridor in 2012 and 2013. The site specific surveys are listed in **Table 3.1**. The survey methodologies adopted were devised in consultation with Cefas and the MMO.

### Table 3.1 Site specific surveys

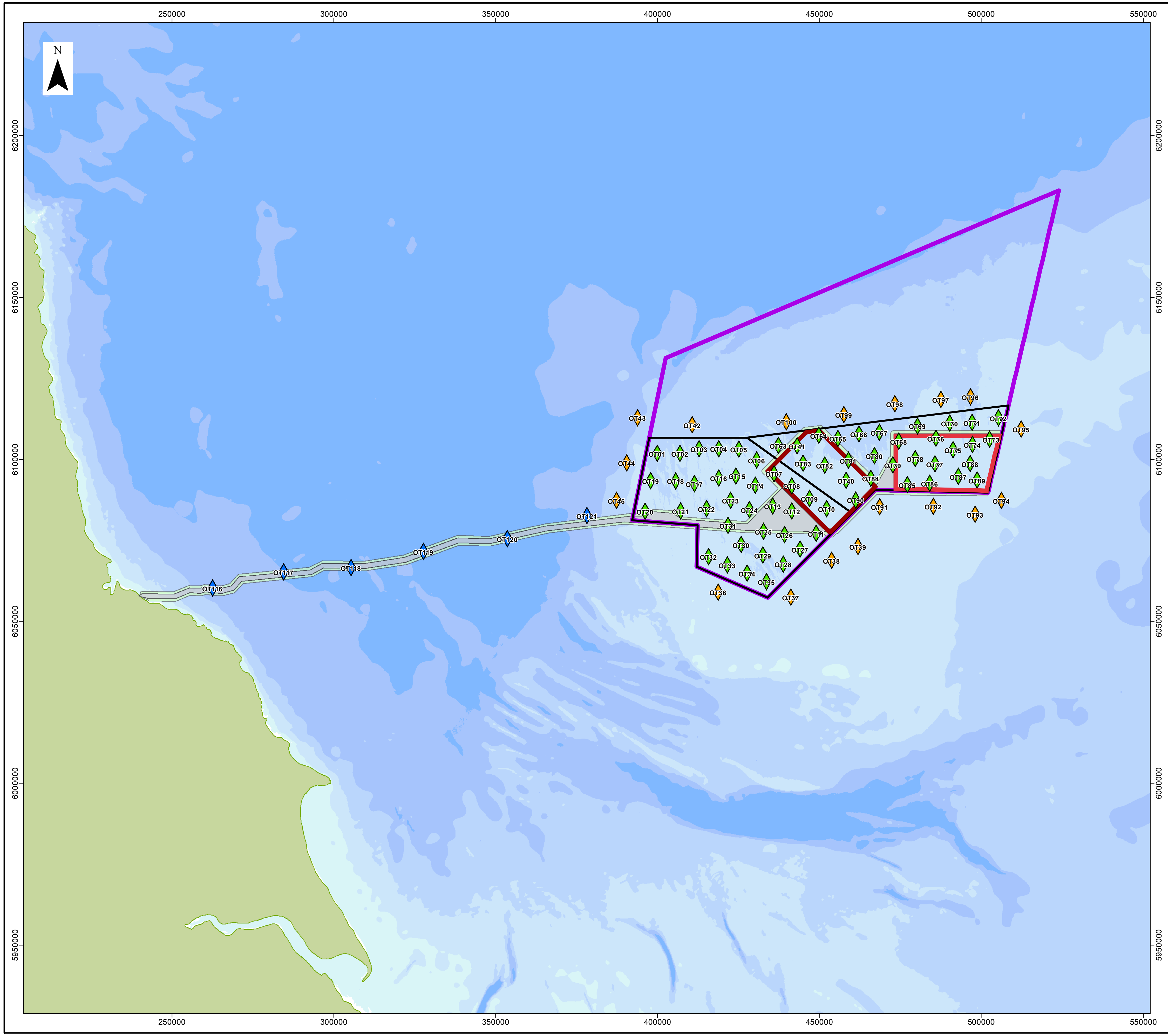
| Survey type | Gear type | Area surveyed | Survey dates | Survey report |
|---|---|---|---|---|
| Adult and juvenile Fish Characterisation Surveys (offshore) | Otter and scientific 2m beam trawl | Tranche A and adjacent control locations | August 2011<br>October 2011<br>April 2012 | **Appendix 13D Tranche A Fish & Shellfish Characterisation Survey** |
| | | Tranche B, Dogger Bank Teesside A & B Export Cable Corridor and adjacent control locations | April 2012<br>July 2012<br>October 2012 | **Appendix 13B Tranche B Fish & Shellfish Characterisation Survey** |
| Pelagic Fish Characterisation Survey (offshore) | Pelagic otter trawl | Dogger Bank former herring spawning grounds (as defined by Coull *et al.* 1998) and Dogger Bank Creyke Beck A & B Export Cable Corridor | September 2011 | **Appendix 13EPelagic Fish Survey report** |
| Sandeel Survey (offshore) | Modified scallop dredge | Tranches A and B | March/April 2012 | **Appendix 13FSandeel Survey report** |
| Shellfish (potting) survey (inshore) | Pots soaked for 68-122 hours | Inshore Dogger Bank Teesside A & B Export Cable Corridor Study Area | September 2012<br>April 2013 | **Appendix 13CNearshore Fish & Shellfish Surveys** |
| Trammel Net Surveys (inshore) | Trammel nets (five fleets) | Inshore Dogger Bank Teesside A & B Export Cable Corridor | September 2012<br>April 2013 | **Appendix 13CNearshore Fish & Shellfish Surveys** |

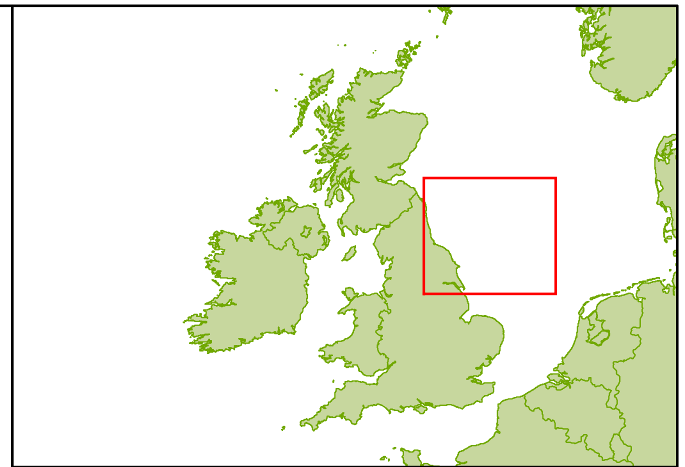
### Adult and Juvenile Fish Characterisation Surveys (Offshore Otter and Beam Trawl Survey)

3.2.15. Baseline information on the fish assemblage in and around tranches A and B was collected by a series of demersal otter trawl and scientific 2m beam trawl surveys carried out during August and October in 2011 and during April, July and October 2012. Sampling was conducted at a number of fixed stations within tranches A and B, at adjacent control locations and along Dogger Bank A & B Export Cable Corridor. The location of the stations sampled in the offshore otter trawl and beam trawl fish characterisation surveys are given in **Figure 3.2**. Due to the presence of high density static fishing gear in the inshore area of the Dogger Bank Teesside A & B Export Cable Corridor, survey work was undertaken using only the 2m scientific beam trawl, in order to avoid disturbance to normal fishing activity.

3.2.16. Catch data (individuals caught per hour) for otter and beam trawl surveys in tranches A and B is provided in **Appendix 13A**



**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

Otter and 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 3.2 Location of offshore otter and beam trawl survey sampling locations**

| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 10/09/2013 | Draft | LW | TR |
| 2 | 07/10/2013 | PEI3 | LW | TR |
| 3 | 14/02/2014 | DCO Submission | LW | TR |

DRAWING NUMBER:

**F-OFL-MA-242**

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



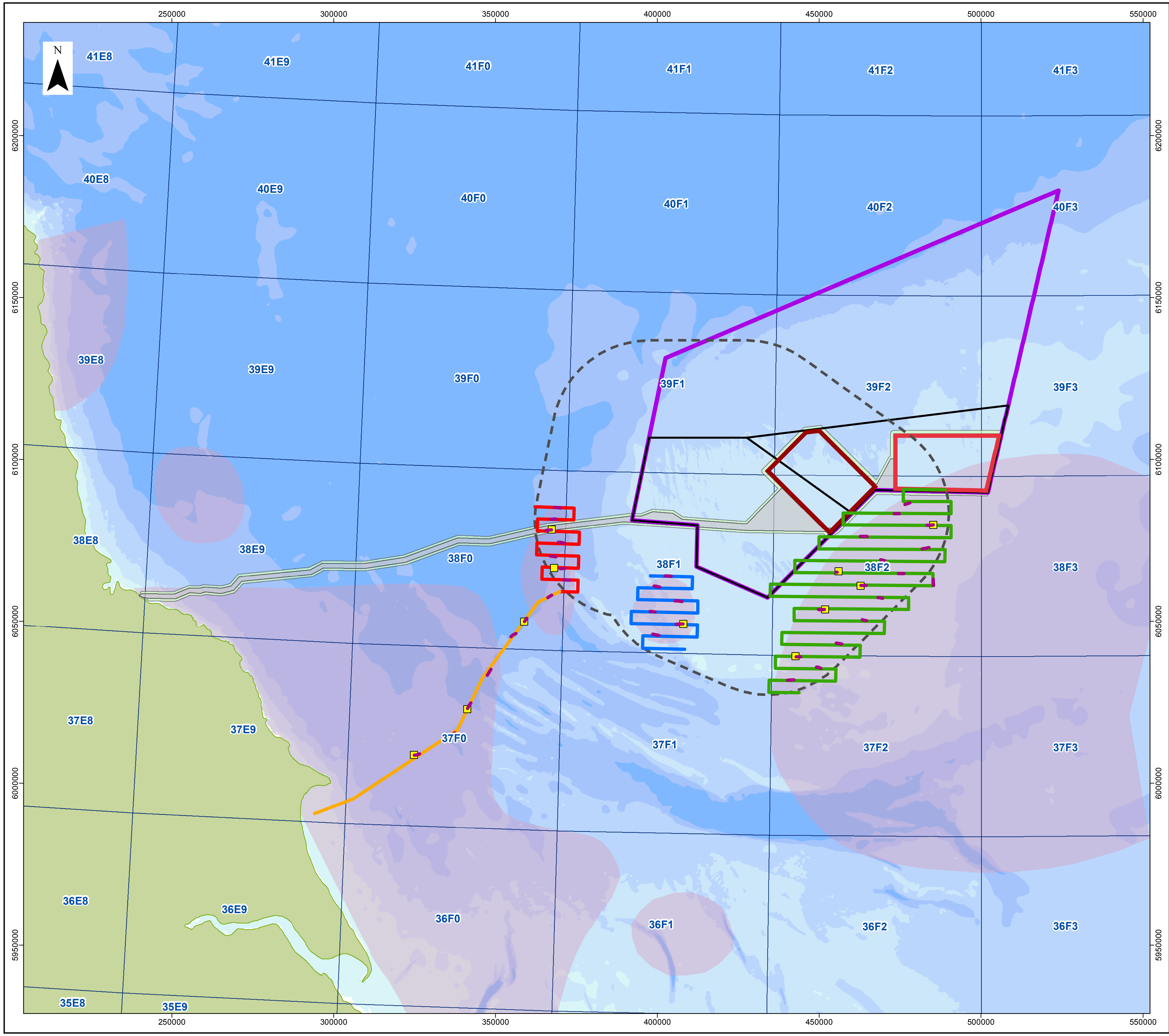
FOREWIND

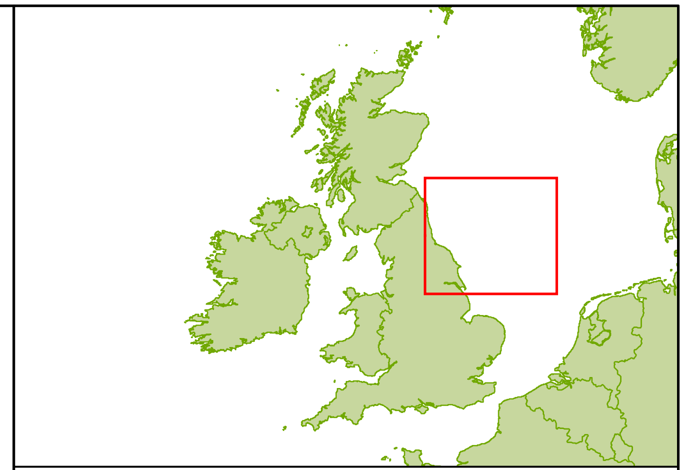
**Pelagic fish characterisation survey**

3.2.18. The pelagic fish survey targeted herring aggregations in the historic/former Dogger Bank spawning grounds with the primary aim of determining if herring were actively spawning in the area. The pelagic survey also provided information on the relative abundance and species composition of other pelagic fish species in the vicinity of the Dogger Bank Zone. Fish from each haul were counted, identified and measured. Herring were also examined and sex and maturity stage recorded. Hauls were carried out at fixed sites in three transects (A, B and C) which were located in the area of the historic herring spawning grounds (Coull *et al*. 1998). Sampling was also conducted at seven inshore sites (**Figure 3.3** Transect D). Opportunistic tows, additional to those at fixed sites, were carried out when the acoustic equipment on board the survey vessel indicated the presence of schools of pelagic fish.

3.2.19. The position of the survey transects and the trawl tow tracks of the pelagic fish survey are presented in **Figure 3.3** together with the distribution of herring spawning grounds as defined in Coull *et al*. 1998. The survey design and location of transects were agreed in consultation with Cefas as sufficient to capture potential spawning activity within the Dogger Bank Zone. Further, it was also agreed that transect locations were therefore also appropriate to Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor. As shown in **Figure 3.3** the areas sampled are those within a 30km buffer zone from Tranche A, where spawning grounds have been defined for herring. The 30km buffer area was agreed following consultation with Cefas as a conservative indication of the distance at which piling noise may result in behavioural responses in herring (see **Table 2.2**).



**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
- ICES rectangles
- Pelagic trawl tow
- CTD Probe deployment location
- Transect A
- Transect B
- Transect C
- Transect D
- 30km Tranche A boundary buffer
- Herring spawning ground (Coull *et al.* 1998)

0 10 20 40
Kilometres

Data Source:
Pelagic survey © Brown & May Marine, 2013
Spawning Grounds © Cefas 2012
ICES Rectangles © ICES 2012
Background bathymetry image derived in part from TCarta data © 2009

PROJECT TITLE

*DOGGER BANK TEESSIDE A & B*

DRAWING TITLE

**Figure 3.3 Pelagic survey transects and location of pelagic trawl tows**

| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 10/09/2013 | Draft | LW | TR |
| 2 | 07/10/2013 | PEI3 | LW | TR |
| 3 | 14/02/2014 | DCO Submission | LW | TR |

DRAWING NUMBER: **F-OFL-MA-243**

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



FOREWIND

### Sandeel specific survey

3.2.20. A specific survey for sandeel was undertaken in tranches A and B in March 2012 using a standard sandeel dredge, the design of which was based on consultation with the internationally recognised experts in sandeel research, Prof. Henrik Mosegaard (DTU Aqua) and Dr Peter Wright (Marine Scotland). The methodology for the survey was agreed in consultation with the MMO and the full results of the survey are provided in **Appendix 13F Sandeel Survey Report** and are summarised below.

3.2.21. A total of 110 stations were sampled, 47 of which were located in Tranche A, 20 in Tranche B and 43 at adjacent control areas. Given the patchy distribution of sandeel and the large area to be surveyed, the sampling effort was concentrated in the vicinity of known fishing grounds, since the level of commercial fishing activity is considered to reflect sandeel habitat distribution (Jensen 2001; van der Kooij *et al*. 2008; Jensen and Christensen 2008; Mosegaard, H. Pers. Comm. November 2011). Stations outside the main fishing grounds were also sampled, although less intensively. Annual ICES surveys provide the most consistently reliable indicator of the biological status of sandeel and herring stocks in the region which encompasses the development area.

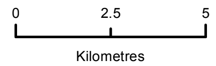
### Inshore shellfish surveys

3.2.22. The inshore shellfish survey was carried out over two four-day periods in September 2012 and April 2013, with soak periods ranging from 68 to 122 hours. The location of the stations sampled is given in **Figure 3.4**. Two fleets were positioned across the inshore cable corridor (2 and 4) and three at adjacent control locations (1, 3 and 5). A summary of the results of the survey is given in **Appendix 13A**.


**LEGEND**

- Dogger Bank Teesside A & B Export Cable Corridor
- Temporary works area
- Shellfish fleets spring 2013




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 3.4 Location of potting fleets (April 2013)

| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 24/09/2013 | Draft | LW | TR |
| 2 | 07/10/2013 | PEI3 | LW | TR |
| 3 | 14/02/2014 | DCO Submission | LW | TR |

DRAWING NUMBER: **F-OFL-MA-244**

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



FOREWIND

**Trammel net surveys**

3.2.23. Five fleets of trammel nets were deployed, with one fleet 'shot' close to the shore along each of the proposed cable routes, a second was laid along the mid-section of the inshore cable route, to account for varying depth and habitat, and two fleets 'shot' randomly within the central nearshore region, but within comparable water depths, to act as a controls. The location of the stations sampled is given in **Figure 3.5**. Two fleets were positioned across the inshore cable corridor (2 and 3) and three at adjacent control locations (1, 4 and 5). A summary of the results of the trammel net surveys is provided in **Appendix 13A**.

# 3.3. Assessment of impacts - methodology

## Assigning value to a species

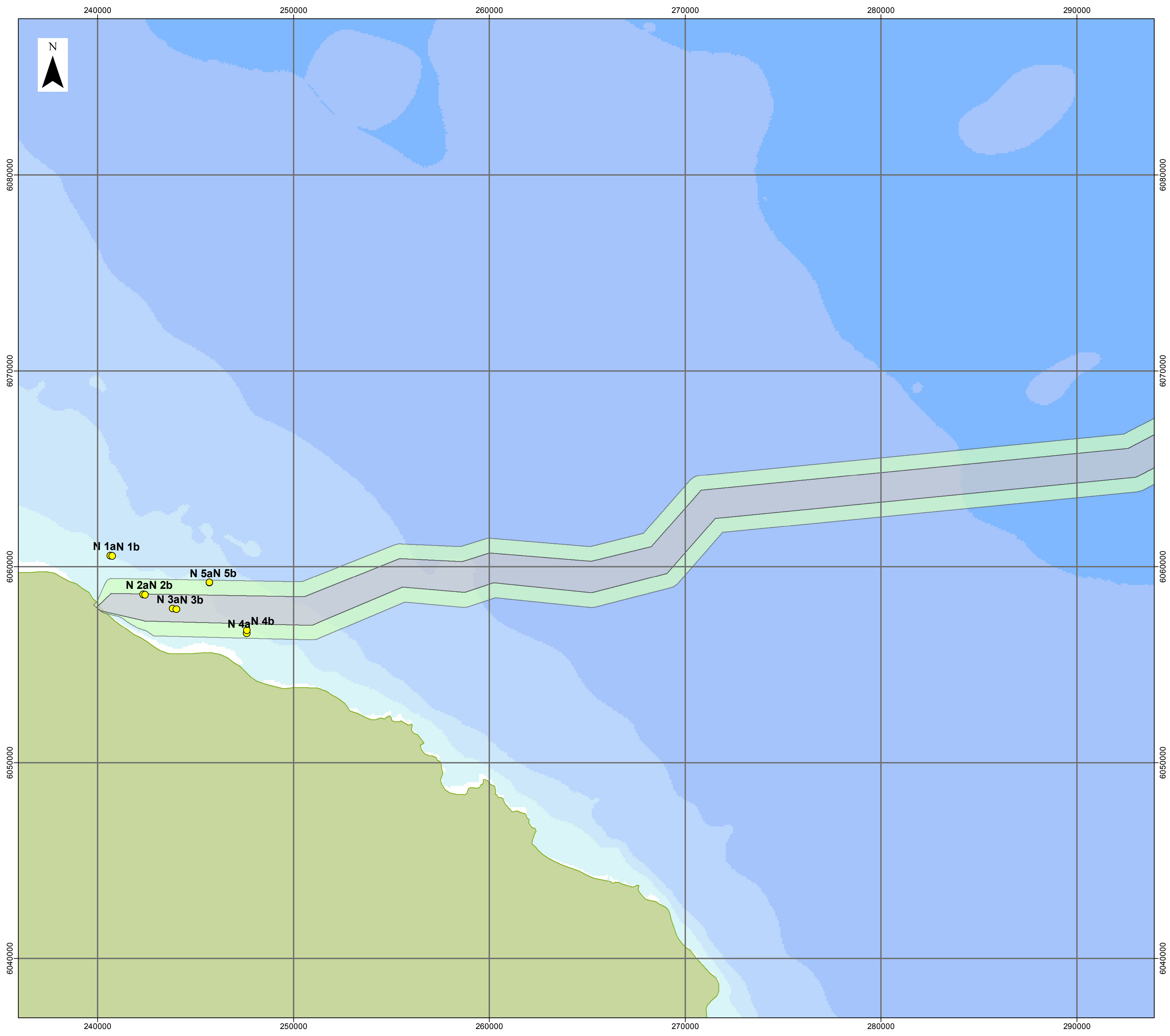
3.3.1. It is a relatively straightforward matter to assign value to species that are assigned a specific biodiversity value as a function of international or national legislation or local, regional or national conservation plans. However, only a very small proportion of marine species are afforded protection under the existing legislative or policy framework and, in the majority of cases it is necessary to devise values for species based on an alternative set of valuation criteria.

3.3.2. In assigning value to a species, it is necessary to define the geographical framework precisely and to accommodate a range of factors that may potentially influence the definition of value including species distribution, the geographical extent of spawning and nursery areas, migratory behaviour, commercial value and the size and/or conservation status of the stock or population. Furthermore, evaluation must also assess the importance of the functional role of the species. For example, some species may not have a specific conservation value in themselves, but may be functionally linked to a feature of high conservation value (e.g., prey species for protected bird or marine mammal species).

## Identifying Valued Ecological Receptors (VERs)

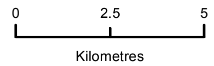
3.3.3. The following table shows the criteria used to classify valued ecological receptors (VERs) within the geographic frame of reference applicable to the Dogger Bank Teesside A & B project area (**Table 3.2**).




**LEGEND**

- Dogger Bank Teesside A & B Export Cable Corridor
- Temporary works area
- Gillnetting sites (spring 2013)




Data Source:
Survey Locations © PMSL, 2013
Background bathymetry image derived in part from TCarta data © 2009

PROJECT TITLE

*DOGGER BANK TEESSIDE A & B*

DRAWING TITLE

**Figure 3.5 Location of April 2013 gillnetting stations**

| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 08/10/2013 | PEI3 | LW | TR |
| 2 | 14/02/2014 | DCO Submission | LW | TR |

DRAWING NUMBER:

**F-OFL-MA-266**

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



FOREWIND

## Table 3.2 Geographic frame of reference

| Value of the VER | Criteria used to assign VER value |
|---|---|
| International | • Receptors protected under international law. |
| National | • Receptors protected under national law;<br>• UK BAP priority species (including grouped action plans) and Nationally Important Marine Species that have nationally important populations within the Export Cable Corridor Study area and wind farm study area, particularly in the context of species that may be rare or threatened in the UK; and<br>• Receptors with nationally important spawning/nursery/feeding/overwintering grounds and/or migratory routes in the area of the development. |
| Regional | • UK BAP priority species (including grouped action plans) or Nationally Important Marine Species that have regionally important populations and are locally widespread and/or abundant within the area of development;.<br>• Receptors listed as conservation priorities in regional plans;<br>• Receptors that are of commercial value to the fisheries of the central North Sea;<br>• Receptors that form an important prey item for other species of conservation or commercial value and that are key components of the fish assemblages within the fish and shellfish study area; and<br>• Receptors with regionally important spawning/ nursery/ feeding/ overwintering grounds and/or migratory routes in the area of the development. |
| Local | • Species which are not protected under conservation legislation but are of commercial importance forming a key component of the fish assemblages within the study area;<br>• Receptors with no defined spawning/ nursery/ feeding/ overwintering grounds and/or migratory routes in the area of the development; and<br>• The species is common throughout the UK and forms a component of the fish assemblages in the fish and shellfish study area. |

3.3.4. A number of Valued Ecological Receptors (VERs) have been identified within the Wind Farm Study Area and Dogger Bank Teesside A & B Export Cable Corridor Study Area using information provided by the fish and shellfish characterisation surveys as detailed in **Appendix 13A**. **Table 3.3** presents a description of these VERs and their valuation.

## Table 3.3 VERs identified in the study area and their valuation

| VER | Valuation | Importance within the fish and shellfish study area and justification |
|---|---|---|
| **Demersal fish species** | | |
| Sandeel[1] *Ammodytes spp* | Regional | • UK BAP species and a nationally important marine feature;<br>• Commercially important species;<br>• Occurs throughout the study area and high abundance recorded in the western sector of Tranche A;<br>• High intensity spawning areas occurs within study area;<br>• Low intensity nursery areas occurs within study area; and<br>• Key prey species for fish, birds and marine mammals. |
| Plaice *Pleuronectes platessa* | Regional | • UK BAP species;<br>• Commercially important species;<br>• Highly abundant throughout the study area;<br>• Low/High intensity spawning areas in vicinity of study area; and<br>• Low intensity nursery areas in vicinity of study area. |
| Dab *Limanda limanda* | Regional | • Abundant throughout the study area; and<br>• Common by-catch species in commercial fisheries. |
| Whiting *Merlangius merlangus* | Regional | • Commercially important species;<br>• Moderate/high abundance in the study area; and<br>• Low intensity spawning areas in vicinity of study area. |
| Cod *Gadus morhua* | Regional | • UK BAP species, listed by OSPAR as threatened and/or declining and listed as vulnerable on the IUCN Red List;<br>• Commercially important species;<br>• Low abundance throughout the study area;<br>• Low intensity spawning areas in vicinity of study area; and<br>• Low/high intensity nursery areas in vicinity of study area. |
| Lemon Sole *Microstomus kitt* | Local | • Commercially fished;<br>• Moderately abundant throughout the study area;<br>• Spawning areas (undefined intensity) in the vicinity of the study area; and<br>• Nursery areas (undefined intensity) in the vicinity of the study area. |
| Sole *Solea solea* | Local | • UK BAP species;<br>• Commercially important species;<br>• Recorded in low numbers in Tranche B; and<br>• Low intensity nursery grounds in the vicinity of the study area. |
| Other demersal species | Local | • Includes grey gurnard *Eutrigla gurnardus* and *solenette Buglossidium gluteum* (key characterising species of the fish assemblage) and small demersal species;<br>• No information on spawning or nursery habitats;<br>• Little or no commercial importance;<br>• Not listed under nature conservation legislation; and |

[1] Sandeel is a bentho-pelagic species but are included with demersal species here. For the purposes of this assessment the term "lesser sandeel" refers to *Ammodytes marinus* while the family name "Ammodytidae" (as used by ICES in the context of SA1 sandeel stock assessments) refers to the five species of sandeel that occur in the North Sea i.e lesser sandeel *Ammodytes marinus* Raitt, sandeel *Ammodytes tobianus*, smooth sandeel *Gymnammodytes semisquamatus*, greater sandeel *Hyperoplus lanceolatus* and Corbin's sandeel *Hyperoplus immaculatus*.

| VER | Valuation | Importance within the fish and shellfish study area and justification |
|---|---|---|
| | | • Likely prey items for fish, bird and marine mammal species. |
| Elasmobranchs | Local | • Species include thornback ray *Raja clavata*, spurdog *Squalus acanthius*, starry smoothhound *Mustelas asterias* and lesser spotted dogfish *Scyliorhinus canicula*. Many elasmobranch species listed as UK BAP species or listed by OSPAR as threatened and/or declining;<br>• All recorded as occurring in study area in low numbers;<br>• Study area situated within low intensity nursery area for spurdog, otherwise no defined elasmobranch spawning or nursery areas in the vicinity; and<br>• Low commercial value. |
| **Pelagic fish species** | | |
| Herring<br>*Clupea harengus* | Regional | • UK BAP species and nationally important marine species;<br>• Commercially important species;<br>• Low/moderate abundance in the vicinity of the study area;<br>• Active and historic spawning areas within the vicinity of the study area;<br>• Low/high intensity nursery habitats within the study area; and<br>• Key prey species for birds and marine mammals. |
| Sprat<br>*Sprattus sprattus* | Regional | • Commercially important species.  Low abundance recorded in the study area;<br>• Important prey species for bird and marine mammal species;<br>• Spawning areas (undefined intensity) present within vicinity of the study area; and<br>• Nursery areas (undefined intensity) present within the vicinity of the study area. |
| Mackerel<br>*Scomber scombrus* | Local | • UK BAP species and nationally important marine feature.<br>• Commercially important species;<br>• Seasonal distribution, with moderate abundance; recorded in study area during summer;<br>• Spawning grounds (undefined intensity) within the vicinity of the study area; and<br>• Nursery area (low intensity) within the vicinity of the study area. |
| Other Pelagic Species | Local | • Species include horse mackerel *Trachurus trachurus* and bass *Dicentrarchus labrax* which were recorded at low abundances; and<br>• Not considered to be commercially important in the study area. |
| **Migratory fish species** | | |
| River and Sea Lamprey<br>*Lampetra fluviatilis*<br>*Petromyzon marinus* | International | • UK BAP priority species; and<br>• Sea lamprey listed by OSPAR as declining and/or threatened. |
| Other Migratory Fish Species | Regional to National | • Atlantic salmon *Salmo salar*, sea trout *Salmo trutta*, European eel *Anguilla anguilla* and European smelt *Osmerus eperlanus* may transit the study area; |

| VER | Valuation | Importance within the fish and shellfish study area and justification |
|---|---|---|
| | | • Atlantic salmon commercially fished in inshore area in the vicinity of the Export Cable Corridor Study Area;<br>• Atlantic salmon listed as Annex II species; and<br>• Sea trout, European eel and European smelt are all listed as UK BAP priority species and European eel is listed as critically endangered on the IUCN Red List. |
| **Shellfish species** | | |
| *Nephrops* | Local | • Most valuable of all commercial shellfish species in the study area;<br>• Spawning and nursery areas in vicinity of the study area: and<br>• Distribution is substrate specific and determined by presence of soft muds/sand. |
| Brown (Edible) crab *Cancer pagurus* | Regional | • Abundant shellfish species in the vicinity of the Export Cable Corridor Study Area;<br>• Important commercial species; and<br>• Likely to overwinter within the study area and potential nursery habitat in inshore areas. |
| Lobster *Homarus gammarus* | Local | • High commercial value; and<br>• Possible nursery habitat in inshore areas. |

## Impact pathways

3.3.5. For each potential effect, the impact assessment identifies key receptors and implements a systematic approach to understand the impact pathways and the level of impacts on given receptors. The process considers the following:

- The sensitivity of a receptor to an effect; and
- The magnitude of the effect.

## Sensitivity of a receptor

3.3.6. Sensitivity relates to the capacity of a VER to accommodate change and the ability to recover if affected (**Table 3.2**). Sensitivity is a function is of the following factors (see **Chapter 4 EIA Process**):

- Vulnerability - is the probability that a VER will be exposed to a stressor to which it is sensitive (*sensu* Tyler-Walters and Jackson 1999);
- Recoverability - The likely recoverability of a VER from disturbance or damage is dependent on its ability to regenerate, regrow, recruit or recolonize, depending on the extent of damage incurred and hence its intolerance; and
- Value - (see Section 3.3.1) for a description of the approach used to assign value to receptors).

3.3.7. For the purposes of assessments in this chapter, value is assigned to the majority of fish and shellfish receptors, according to their relative worth at the stock/population level, hence the sensitivity of a receptor is generally considered in terms of capacity of the stock or population of a given species to adapt, tolerate and recover from anticipated impacts, as discussed further in Sections 6, 7 and 8.

3.3.8. **Table 3.4** below presents the parameters for the various levels of sensitivity shown when value is taken into account. In this way, value is applied inherently within the definition of sensitivity assigned to a species for a particular impact throughout the impact assessment. Defined examples presented in the table may not be appropriate for all receptors and therefore, this is applied throughout the impact assessment on a species by species basis, using the information presented in the existing environment and based on expert judgement.

Table 3.4 Sensitivity of a receptor

| Sensitivity | Definition<br>Note: Receptor in this instance refers to the stock/population of a species of fish or shellfish, rather than the individual, and sensitivity to the stocks ability to recover from anticipated impacts. |
|---|---|
| Negligible | • Locally important receptors with low vulnerability and medium to high recoverability.<br>• Receptor is not vulnerable to impacts regardless of value/importance. |
| Low | • Nationally and internationally important receptors with low vulnerability and high recoverability.<br>• Regionally important receptors with low vulnerability and medium to high recoverability.<br>• Locally important receptors with medium to high vulnerability and low recoverability. |
| Medium | • Nationally and internationally important receptors with medium vulnerability and medium recoverability.<br>• Regionally important receptors with medium to high vulnerability and low recoverability.<br>• Locally important receptors with high vulnerability and no ability for recovery. |
| High | • Nationally and internationally important receptors with high vulnerability and no/low recoverability.<br>• Regionally important receptors with high vulnerability and no recoverability. |

## Magnitude of effect

3.3.9. The magnitude of the effect is a function of the spatial extent, duration and timing (seasonality and/or frequency of occurrence) of the anticipated effect. Expert judgement was employed to consider and evaluate the likely effect on the species, population and habitat identified as a VER (**Table 3.3**).

3.3.10. The magnitude levels presented below are indicative of combinations of the four factors noted above which could lead to the magnitude presented. Other options could fall within each level of magnitude and this is applied throughout the assessment based on expert judgement. **Table 3.5** is intended to provide indicative scenarios which might lead to the magnitudes presented.

Table 3.5 Magnitude of effect

| Magnitude | Definition<br>Note: Baseline levels refer to the defined stock/population of the species |
|---|---|
| Negligible | • Very localised effects;<br>• Very short term duration;<br>• Low or high frequency; and<br>• Resulting in small or medium changes to environmental and ecological baselines. |
| Low | • Localised effects;<br>• Short or long term duration;<br>• Low or high frequency; and<br>• Resulting in small changes relative to baseline levels.<br>or<br>• Effects occurring over larger areas;<br>• Short term;<br>• Low frequency; and<br>• Resulting in small or medium changes to environmental and ecological baseline levels. |
| Medium | • Effects occurring over large areas;<br>• Short term and high frequency; and<br>• Resulting in medium changes to environmental and ecological baseline levels. |
| High | • Effects occurring over large areas;<br>• Long term and high frequency; and<br>• Resulting in medium to high changes to environmental and ecological baseline levels. |

## Overall impact

3.3.11. The significance of an effect upon a VER is a function of the magnitude of the effect and the sensitivity of the receptor where the sensitivity of the receptor is also linked to the value of the VER. The impact assessment matrix combining levels of magnitude and sensitivity is given below (**Table 3.6**). Potential impacts identified within the assessment as "major" or "moderate" can be regarded as significant in terms of the EIA regulations and are, where possible, avoided or reduced through mitigation

Table 3.6 Overall impact resulting from each combination of receptor sensitivity and the magnitude of effect on it

| Receptor sensitivity | Magnitude of effect | | | |
|---|---|---|---|---|
| | **High** | **Medium** | **Low** | **Negligible** |
| **High** | Major | Major | Moderate | Minor |
| **Medium** | Major | Moderate | Minor | Minor |
| **Low** | Moderate | Minor | Minor | Negligible |
| **Negligible** | Minor | Minor | Negligible | Negligible |

## Embedded mitigation

3.3.12. In addition to the mitigation measures identified throughout the impact assessment sections of this chapter, the following embedded mitigation has also been considered in deriving the level of residual impacts.

3.3.13. Cables will be buried where feasible, or protected, thereby reducing the potential effects of EMF on sensitive fish and shellfish receptors (see **Chapter 5** for further details on EMF).

3.3.14. During construction, 24 hour working practices may be employed. This could reduce the overall construction time and the total duration over which impacts on fish and shellfish from construction activities could occur.

# 4. Existing Environment

## 4.1. Regional context

### Finfish

4.1.1. The distribution of fish communities in the North Sea is broadly related to changes in water depth and temperature (Daan *et al*. 1990). In shallow waters (50-100m depth) in the central and northern North Sea (ICES Divisions IVa and IVb) the fish assemblages are dominated by haddock *Melanogrammus aeglefinus*, whiting, herring, dab and plaice. At greater depths (100-200m), Norway pout *Trisopterus esmarkii* dominate (ICES 2005).

4.1.2. The southern North Sea (ICES Division IVc) is generally shallower with dominant fish species more characteristic of inshore waters (<50m depth) such as plaice, sole *Solea solea*, dab, whiting, and non-commercial species such as lesser weever *Echiichthys vipera*, grey gurnard and solenette. In addition, species poorly sampled by trawls, such as sandeel and sand gobies are also abundant (ICES 2005c).

4.1.3. Based on catches of the fifty most abundant fish species found in English groundfish surveys (1982-1986), Harding *et al*. (1986) divided the fish assemblage of the North Sea into three community groups: the shelf edge community, the North Central community, and the Southeastern community. The spatial distribution of these communities is illustrated in **Figure 4.1**, together with ICES Divisions.

4.1.4. Dogger Bank Teesside A & B falls within the Southeastern community, being immediately adjacent to the boundary of North Central community defined in Harding *et al*. 1986. The Dogger Bank Teesside A & B Export Cable Corridor falls partly in the Southeastern fish community with the longest section traversing the North Central community.

4.1.5. The principal fish species associated with the North Central and Southeastern communities provided in **Table 4.1**. Haddock, whiting, cod *Gadus morhua*, Norway pout, saithe *Pollachius virens* and dab are the principal species of the North Central community; whilst dab, whiting, grey gurnard, horse mackerel *Trachurus trachurus*, plaice and cod are the principal species in the Southeastern community.

4.1.6. Research on benthic fish assemblages on the Dogger Bank from a survey undertaken in 2006 (Sell *et al*. 2007) found grey gurnard, dab and, to a lesser extent, plaice, to be the dominant species in GOV otter trawl samples. In 2m beam trawl samples, solenette, scaldfish *Arnoglossus laterna*, dab, sand goby and snake pipefish *Entelurus aequoreus* were the five most abundant species, with dab, solenette, lemon sole *Microstomus kitt*, scaldfish and plaice being the dominant species in terms of weight.

Table 4.1 Species composition of the North Central and South-eastern North Sea fish communities (after Harding *et al*. 1986)

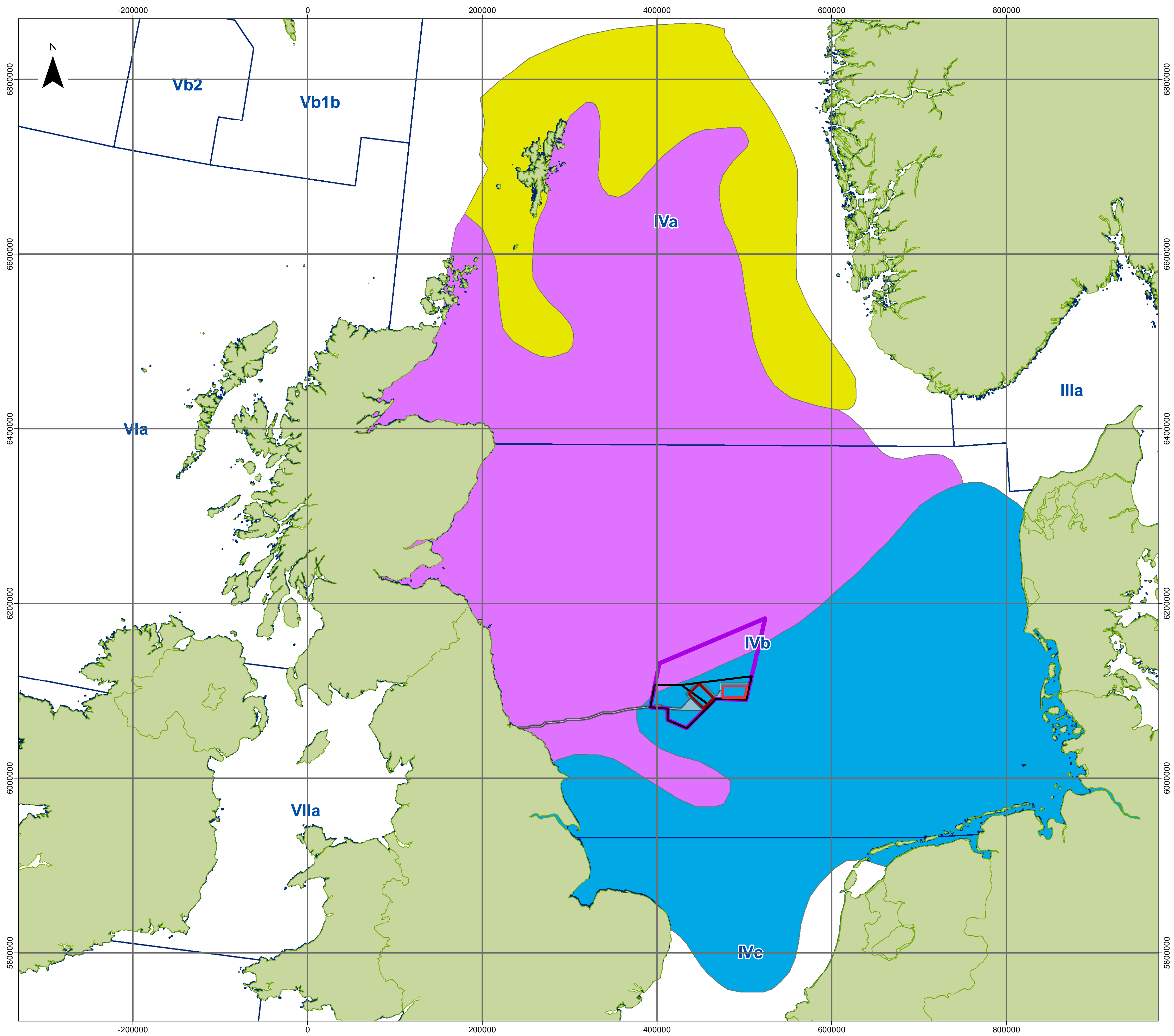
| North Central Community | | Southeastern Community | |
|---|---|---|---|
| **Species** | **Percentage by weight** | **Species** | **Percentage by weight** |
| Haddock | 42.4 | Dab | 21.8 |
| Whiting | 13.9 | Whiting | 21.6 |
| Cod | 9.2 | Grey Gurnard | 12.8 |
| Norway pout | 4.7 | Horse Mackerel | 10.1 |
| Saithe | 4.5 | Plaice | 6.3 |
| Dab | 3.7 | Cod | 5.5 |
| Remainder | 21.6 | Remainder | 21.9 |

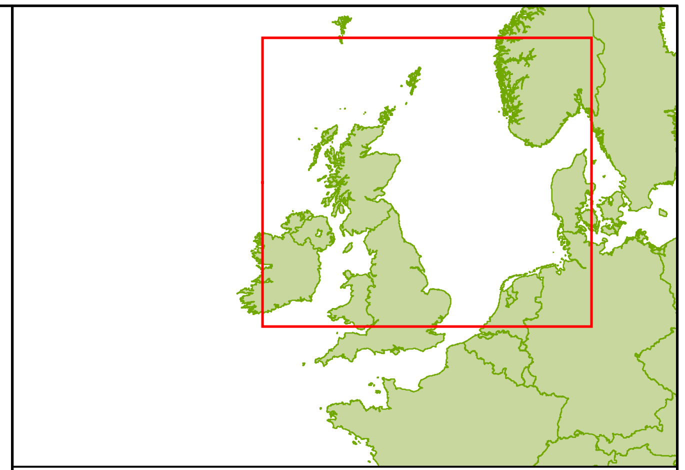
4.1.7. The fish assemblage within Dogger Bank Teesside A & B is, therefore, expected to be similar to that described above in Harding *et al*. (1986) for the North Central and Southeastern fish communities and in Sell *et al.* (2007) for the Dogger Bank.

## Shellfish Distribution

4.1.8. The North Sea supports important stocks of several commercially exploited shellfish species including Nephrops, *Nephrops norvegicus*, king scallop *Pecten maximus*, European lobster *Homarus gammarus*, edible crab *Cancer pagurus*, velvet crab *Necora puber,* common whelk *Buccinium undatum*, brown shrimp *Crangon crangon* and pink shrimp *Pandalus montagui*. The majority of these species are distributed throughout all three North Sea areas and it is therefore not possible to classify distributions in the same manner as for fish communities (e.g. after Harding *et al*.1986; see above). General distribution of key shellfish species in the North Sea is described in **Appendix 13A** Section 5.2. The ecology of key species common to Dogger Bank Teesside A & B and Dogger Bank Teesside A & B Export Cable Corridor is summarised in **Table 4.2**.



**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
- ICES sea area

North Sea fish communities (ICES 2005)

- North central community
- Shelf edge community
- Southeastern community

0 25 50 100
Kilometres

Data Source:
Fish Communities © Brown & May Marine 2013
ICES Rectangles © ICES 2012
Background bathymetry image derived in part from TCarta data © 2009

PROJECT TITLE

*DOGGER BANK TEESSIDE A & B*

DRAWING TITLE

**Figure 4.1 Distribution of three fish communities of the North Sea based on the English Groundfish Survey 1982-1986 (adapted from ICES 2005)**

| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 10/09/2013 | Draft | LW | TR |
| 2 | 07/10/2013 | PEI3 | LW | TR |
| 3 | 14/02/2014 | DCO Submission | LW | TR |

DRAWING NUMBER: **F-OFL-MA-245**

| SCALE | PLOT SIZE | DATUM | PROJECTION |
|---|---|---|---|
| 1:4,500,000 | A3 | WGS84 | UTM31N |



FOREWIND

## 4.2. Overview of findings from site specific surveys

### Adult and juvenile fish characterisation surveys (Offshore otter and beam trawl survey)

4.2.1. Grey gurnard, dab, plaice and whiting had the highest catch rates in all otter trawl surveys in tranches A and B while other species were caught in comparatively low numbers.

4.2.2. In beam trawl surveys, the most abundant species in Tranche A was solenette, dab, lesser sandeel and sand goby whereas in Tranche B solenette, dab and sand goby dominated the catch. Lesser sandeel was considerably less abundant in Tranche B than recorded in Tranche A.

### Pelagic fish characterisation survey (pelagic otter trawl)

4.2.3. Five pelagic species were recorded during the survey: sprat *Sprattus sprattus*, herring, mackerel *Scomber scombrus*, anchovy *Engraulis encrasicolus* and garfish *Belone belone* in addition to several demersal fish species. The number of individuals caught and catch rates by species and transect are shown in **Appendix 13A** Table 5.7. The full results of the pelagic fish survey are provided in **Appendix 13E** and **Appendix 13A** Table 5.7. Sprat was the species caught in greatest numbers, particularly in Transect C (32,047 individuals).

4.2.4. Herring were found in two of the four transects sampled, with 11,673 individual herring recorded in Transect C whereas only one individual was recorded in Transect B. The majority of the herring caught were 'virgin' juvenile fish. As described in **Appendix 13E** the pelagic survey was undertaken during the spawning season of the Banks herring stock (August-October). The pelagic survey was specifically designed to sample herring from those areas in the vicinity of the development designated as spawning grounds by Coull *et al.* (1998) and Ellis *et al.* (2010). The pelagic survey was conducted during September in order to maximize the likelihood of capturing individuals in peak spawning condition, however only young, immature herring were recorded in survey samples. The temperatures and salinities recorded during the survey correspond with those when large herring spawning aggregations are expected to occur. No herring in spawning condition or recovering from spawning was found over the historic herring grounds of the Dogger Bank. This suggests that there was no herring spawning activity in this area either during the time of the survey, or during the period immediately prior to the commencement of the survey.

4.2.5. Mackerel was recorded in all four transects, occurring in the highest numbers in transects A and B. Other fish species caught during the pelagic survey were all demersal species and caught in relatively small numbers with the exception of whiting. Large numbers of whiting (2,482 fish) were caught along the inshore corridor (Transect D).

## Sandeel specific survey

4.2.6. Three species of sandeel were recorded: lesser sandeel, greater sandeel *Hyperoplus lanceolatus* and smooth sandeel *Gymnammodytes semisquamatus*. Of these, lesser sandeel was the dominant species in the majority of stations and accounted for 98.2% of the total sandeel catch.

4.2.7. Sandeel was found in highest numbers in stations located along the western boundary of Tranche A. This species was also relatively abundant within Tranche A at stations to the west of Dogger Bank Teesside B. Fewer sandeel were present in Tranche B and were mainly concentrated in the central sector and at two sites along the eastern boundary of Dogger Bank Teesside A (**Figure 4.2**).

## Inshore shellfish (potting) survey

4.2.8. Edible crab was the most numerous of all species recorded. Moderate numbers of lobster and velvet crab were caught at both inshore cable and control stations. The hermit crab *Pagurus bernhardus* did not appear in autumn samples but was present in reasonably large numbers in samples from April 2013.

## Trammel net survey

4.2.9. Edible crab was the most abundant species in samples, followed by dab and cod. Lesser spotted dogfish *Scyliorhinus canicula* was caught in both sampling periods but was more numerous in the spring survey compared to that undertaken during autumn.

4.2.10. Single specimens of thornback ray *Raja clavata* were recorded in both sampling periods at sites along the cable route and one spotted ray *Raja montagui* was caught in the inshore area in April 2013.

4.2.11. One lesser sandeel was caught in the inshore area in April 2013.

## Landings data - commercial fish and shellfish species

4.2.12. The principal commercial fish and shellfish species caught in the Wind Farm and Dogger Bank Teesside A & B Export Cable Corridor Study Areas by UK registered vessels is provided in **Appendix 13A**, Section 5.4. This information has been used to provide an indication of the main species of commercial importance found within the development, although without the inclusion of non-UK landings data from the Dogger Bank area the weights and values provided in **Appendix 13B** and **13D** may underestimate the degree of exploitation.

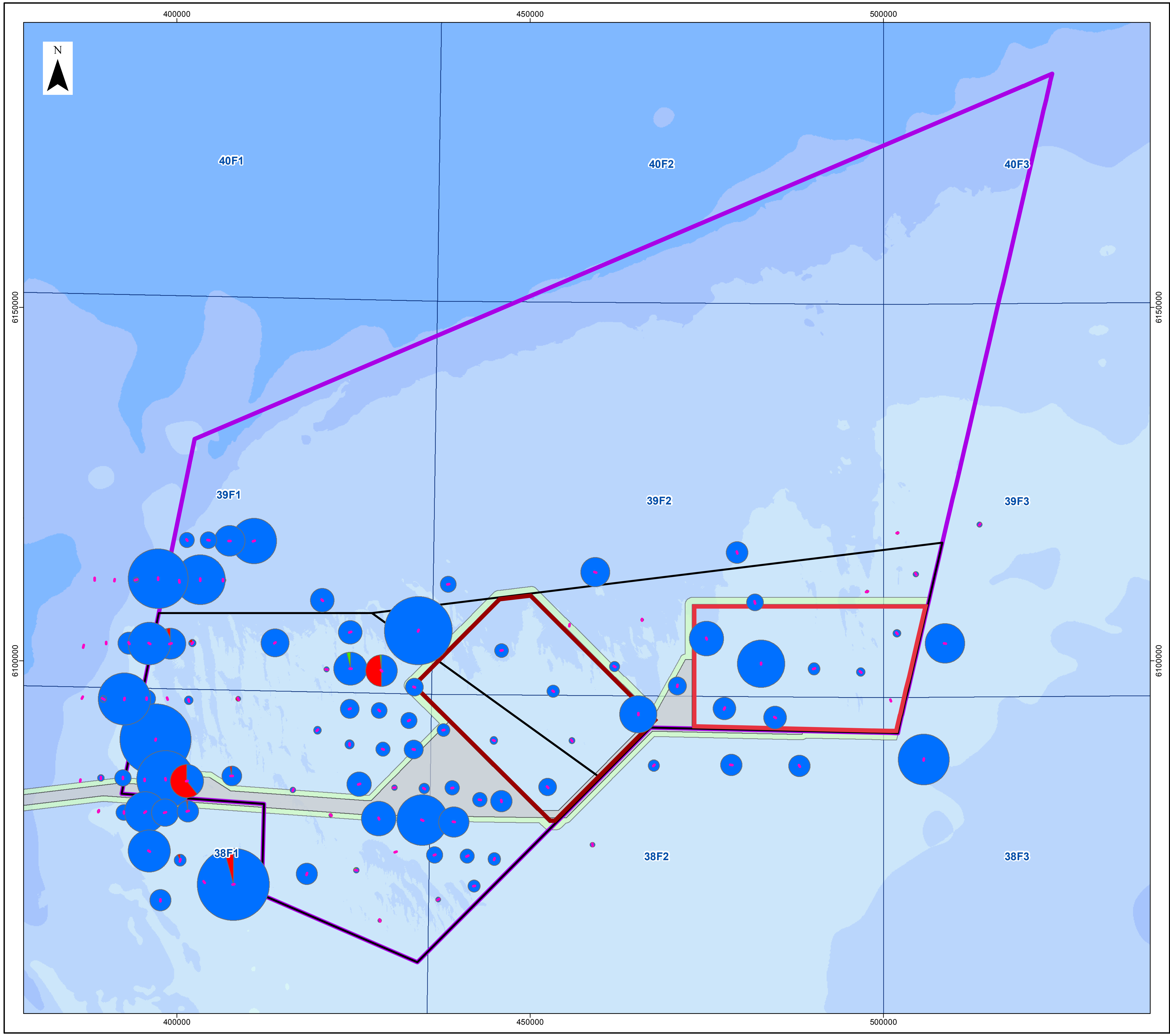
### Wind Farm Study Area

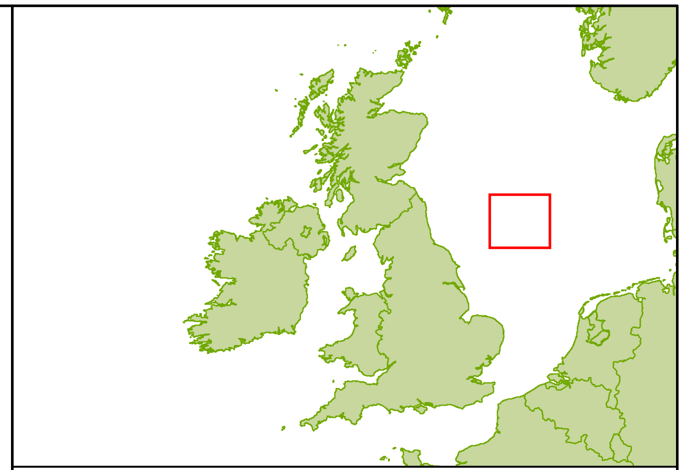
4.2.13. Plaice ranked highest in terms of both landed weight and value followed by sandeel and dab. Turbot *Scophthalmus maximus* and lemon sole are amongst the principal species landed by value. The highest landings are recorded in ICES rectangle 39F3 along the eastern boundary of Tranche B.

4.2.14. In addition, other species, including sprat, haddock, cod, gurnard, sole, whiting, brill *Scophthalmus rhombus*, monkfish *Lophius spp*. and hake *Merluccius merluccius* are of commercial importance in the Wind Farm Study Area. These species are among the top 20 species landed by weight and value. Landings of elasmobranch and shellfish are comparatively low. In the Wind Farm Study Area spurdog *Squalus acanthias* was the most abundant elasmobranch landed. Shellfish landings were dominated by *Nephrops* and whelk.



**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
- ICES rectangles
- Sandeel dredge location

Relative catch rate by species

*Total*: 10, 100, 500, 1,000, 10,000

- Raitt's Sandeel
- Smooth Sandeel
- Greater Sandeel

0 5 10 20 Kilometres

Data Source:
Relative catch rate © Brown & May Marine 2013
ICES Rectangles © ICES 2012
Background bathymetry image derived in part from TCarta data © 2009

PROJECT TITLE

DOGGER BANK TEESSIDE A & B

DRAWING TITLE

**Figure 4.2 Relative abundance of sandeel by station and species (individuals caught per hour) in tranches A and B**

| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 10/09/2013 | Draft | LW | TR |
| 2 | 11/10/2013 | PEI3 | LW | TR |
| 3 | 14/02/2014 | DCO Submission | LW | TR |

DRAWING NUMBER: **F-OFL-MA-246**

| SCALE | PLOT SIZE | DATUM | PROJECTION |
|---|---|---|---|
| 1:550,000 | A3 | WGS84 | UTM31N |



FOREWIND

### Export Cable Corridor Study Area

4.2.16. Whiting, *Nephrops* and haddock are the three main species landed by weight from the Export Cable Corridor Study Area. However, catch composition varies considerably between ICES rectangles. For example, herring accounts for a relatively high percentage of the landings by weight in ICES rectangle 38F0 while landings of plaice dominate catches from ICES rectangle 38F1. Landings by weight for cod and sprat caught in rectangles 38E9 and 39F0 are also comparatively high. The most valuable species caught in the Export Cable Corridor Study Area are *Nephrops* and lobster. Whiting, cod, haddock and plaice are the four most valuable fish species. Whiting is also targeted in this area by French registered vessels (see **Appendix 15A**).

## Species with defined spawning and nursery grounds

4.2.17. A number of fish species have defined spawning and nursery grounds within and in the vicinity of Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor. These are listed in **Table 4.2**, based on information provided in Ellis *et al.* (2012) and Coull *et al*. (1998).

4.2.18. In addition to the species listed below, other fish and shellfish species may spawn or use Dogger Bank Teesside A & B and/or the Dogger Bank Teesside A & B Export Cable Corridor as a nursery ground. The ecology of the principal fish and shellfish species identified in the Wind Farm and Export Cable Corridor Study Areas, including spawning, is described in further detail below.

## Table 4.2 Species with defined spawning and nursery grounds within or in the vicinity of Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor (based on Coull *et al*. 1998 and Ellis *et al*. 2012)

| Species | Spawning Grounds | | | Spawning Season (Month) | | | | | | | | | | | | Nursery Grounds | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Dogger Bank Teesside A | Dogger Bank Teesside B | Dogger Bank Teesside A & B Export Cable Corridor | J | F | M | A | M | J | J | A | S | O | N | D | Dogger Bank Teesside A | Dogger Bank Teesside B | Dogger Bank Teesside A & B Export Cable |
| Herring - Banks stock | * | * | | | | | | | | | | * | * | | | | | |
| Cod | | | | | * | * | | | | | | | | | | | | |
| Plaice | | | | * | * | | | | | | | | | | | * | * | |
| Whiting | | | | | | | | | | | | | | | | | | |
| Sole | | * | | | | | * | | | | | | | | | | | |
| Lemon sole | N/A | | | | | | | | | | | | | | | N/A | | |
| Sandeel | | | | | | | | | | | | | | | | | | |
| Mackerel | | | | | | | | * | * | * | | | | | | | | |
| Sprat | | | | | | | | * | * | | | | | | | | | |
| *Nephrops* | | | | | | | | * | * | * | | | | | | | | |
| Hake | N/A | | | | | | | | | | | | | | | | | |
| Blue Whiting | N/A | | | | | | | | | | | | | | | | | |
| Anglerfish | N/A | | | | | | | | | | | | | | | | | |
| Ling | N/A | | | | | | | | | | | | | | | | | |
| Spurdog | N/A | | | | | | | | | | | | | | | | | |
| Tope | N/A | | | | | | | | | | | | | | | | N/A | |

**Key**

| Key | |
|---|---|
| (blue) | High Intensity |
| (yellow) | Low Intensity |
| (grey) | Undefined Intensity |
| (green) | Spawning Period |
| * | Peak Spawning Period |
| (orange) | Former/Historic Grounds |
| * | Grounds in the vicinity but not within the Project |
| N/A | Insufficient information available |

## Species of conservation interest

### Diadromous migratory species

4.2.19. A number of diadromous species of conservation importance may transit the Wind Farm and Export Cable Corridor Study Areas as part of their migration or foraging activity (see **Table 4.3**).

Table 4.3 Principal diadromous migratory species relevant to Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor

| Common Name | Scientific name | Conservation Status | | | | |
|---|---|---|---|---|---|---|
| | | UK BAP | OSPAR | IUCN Red list | Bern Convention | Habitats Directive |
| European eel | *Anguilla anguilla* | ✓ | ✓ | Critically endangered | - | - |
| Allis shad | *Alosa alosa* | ✓ | ✓ | Least concern | ✓ | ✓ |
| Twaite shad | *Alosa fallax* | ✓ | - | Least concern | ✓ | ✓ |
| Sea lamprey | *Petromyzon marinus* | ✓ | ✓ | Least concern | ✓ | ✓ |
| River lamprey | *Lampetra fluviatilis* | ✓ | - | Least concern | ✓ | ✓ |
| Salmon | *Salmo salar* | ✓ | ✓ | Lower risk/least concern | ✓ | ✓ |
| Sea trout | *Salmo trutta* | ✓ | - | Least concern | - | - |
| Smelt | *Osmerus esperlanus* | ✓ | - | Least concern | - | - |

4.2.20. The diadromous species listed are expected to transit Dogger Bank Teesside A & B on an occasional basis. Some may regularly cross the Dogger Bank Teesside A & B Export Cable Corridor as part of their migration and/or transit adjacent areas as part of their foraging activity.

### Elasmobranchs

4.2.21. Sharks and rays have slow growth rates and low reproductive output compared to other species groups (Camhi *et al.* 1998). This results in slow rates of stock increase and low resilience to fishing mortality (Holden 1974). Directed fisheries have caused stock collapse for many species (Musick 2005), although at present, mortality in mixed-species and by-catch fisheries appears to be a more significant threat (Bonfil 1994). As a result the stocks of most elasmobranch species are currently at low levels and spatial management measures have been introduced to protect the remaining stocks (ICES 2008a).

4.2.22. A summary of the principal species with conservation status and/or declining stocks potentially using the Dogger Bank Teesside A&B Wind Farm and Dogger Bank Teesside A&B Export Cable Corridor Study Areas is given in **Table 4.4**.

Table 4.4 Principal elasmobranch species of conservation interest potentially present in the Wind Farm and Export Cable Corridor Study Areas

| Common Name | Scientific Name | Present in Dogger Bank Teesside fish characterisation surveys | Conservation Status | | |
|---|---|---|---|---|---|
| | | | UK BAP | OSPAR | IUCN Red List |
| Basking shark | *Cetorhinus maximus* | x | ✓ | ✓ | Vulnerable |
| Smooth-hounds | *Mustelus asterias/M. mustelus* | ✓ | - | - | Least concern/ Vulnerable |
| Spurdog | *Squalus acanthias* | ✓ | ✓ | ✓ | Vulnerable |
| Thresher shark | *Alopias vulpinus* | x | - | - | Vulnerable |
| Tope | *Galeorhinus galeus* | x | ✓ | - | Vulnerable |
| Blonde ray | *Raja brachyura* | ✓ | - | - | Near Threatened |
| Cuckoo ray | *Leucoraja naevus* | x | - | - | Least concern |
| Common Skate Complex | *Dipturus intermedia/* | x | ✓ | ✓ | Critically endangered |
| Dipturus flossada | *Dipturus flossada* | x | - | ✓ | Least concern |
| Spotted ray | *Raja montagui* | ✓ | - | ✓ | Near Threatened |
| Thornback ray | Raja clavata | x | ✓ | - | Endangered |

## Other Species of Conservation Interest

4.2.23. A number of species commercially exploited in the North Sea and expected to be found in the Wind Farm and Export Cable Corridor Study Areas are of conservation interest, being listed as UK BAP priority species. These are shown in **Table 4.5**. Where applicable, other conservation designations' status (OSPAR and IUCN) are also given.

### Table 4.5 Commercial fish species of conservation interest potentially present in the Wind Farm and Export Cable Corridor Study Areas

| Common name | Scientific Name | Present in Dogger Bank Teesside A & B fish characterisation surveys | Conservation status | | |
|---|---|---|---|---|---|
| | | | UK BAP | OSPAR | IUCN Red list |
| Lesser sandeel | *Ammodytes marinus* Raitt | ✓ | ✓ | - | - |
| Herring | *Clupea harengus* | ✓ | ✓ | - | Least concern |
| Cod | *Gadus morhua* | ✓ | ✓ | ✓ | Vulnerable |
| Whiting | *Merlangius merlangus* | ✓ | ✓ | - | - |
| Plaice | *Pleuronectes platessa* | ✓ | ✓ | - | Least concern |
| Mackerel | *Scomber scombrus* | ✓ | ✓ | - | Least concern |
| Sole | *Solea solea* | ✓ | ✓ | - | - |
| Horse mackerel | *Trachurus trachurus* | ✓ | ✓ | - | - |
| Anglerfish | *Lophius piscatorius* | ✓ | ✓ | - | - |
| Ling | *Molva molva* | ✓ | ✓ | - | - |
| Hake | *Merluccius merluccius* | ✓ | ✓ | - | - |

4.2.24. Non-commercial fish species of conservation interest, such as sand gobies, are also found in the Dogger Bank Teesside A & B Wind Farm and Dogger Bank Teesside A & B Export Cable Corridor Study Areas. This species is protected under the Bern Convention, Appendix III, and was recorded in relatively high numbers in the fish characterisation 2m beam trawl surveys carried out in tranches A and B (**Appendix 13A** Table 5.5 and Table 5.6).

4.2.25. It should also be noted that a short-snouted seahorse *Hippocampus hippocampus* was captured in 2006 as part of a Cefas research survey on the Dogger Bank (Pinnegar *et al.* 2008). This species is of conservation importance, being protected under the Wildlife and Countryside Act (1981) since 2008 (Natural England 2012). The record of this specimen was, however, made at considerable distance from Dogger Bank Teesside A and B, being found in ICES rectangle 37F1, approximately 30km south of the Dogger Bank Teesside A & B Export Cable Corridor (at its closest point). No evidence of the presence of this species was found in Dogger Bank Teesside A or Dogger Bank Teesside

B or along the Dogger Bank Teesside A & B Export Cable Corridor in any survey work.

### Key species in the food web

4.2.26. Fish that occur in the Wind Farm and Export Cable Corridor Study Areas such as sandeel, herring and sprat are key species linking trophic levels in the North Sea (Furness 2002). They are both major predators of zooplankton and also the principal prey of many top predators such as birds, marine mammals and piscivorous fish.

4.2.27. Sandeel is most vulnerable to predation when in transit to, or feeding in the water column (Hobson 1986; Furness 2002; van der Kooij *et al.* 2008) and it is also during this free-swimming period that they are targeted by commercial pelagic trawlers (van der Kooij *et al.* 2008). Sandeel constitute an important prey species for a number of fish predators such as herring, salmon, sea trout, cod, haddock, whiting, grey gurnard, saithe, mackerel, horse mackerel and starry ray as well as squid (Collins & Pierce 1996; Mills *et al*. 2003; Greenstreet *et al*. 1998; Wright & Kennedy 1999; ICES 2005c; ICES 2006; ICES 2008a; ICES 2009b; ICES 2010b; Walters 2010; Walters 2011). Salmon post smolts are known to largely feed on small fish such as 0-group sandeel (Haugland *et al.* 2006). Marine mammals such as common seals (ICES 2006; Thompson *et al.* 2003), grey seals (McConnell *et al*. 1999), harbour porpoise (Santos *et al*. 2005; Thompson *et al*. 2007) and minke whale (Olsen & Holst 2001; Pierce *et al*. 2004) also feed on sandeel.

4.2.28. Sandeel is a key component of the diet of many birds, such as kittiwake, razorbill, puffin, common tern, arctic tern, European shag, great skua and common guillemot, all of which are known to rely on sandeel consumption during the breeding season (Wright and Bailey 1993; Furness 1999; Wanless *et al*. 1998; Wanless *et al*. 1999; Wanless 2005).

4.2.29. Herring is an important prey species for fish such as whiting, cod, mackerel and horse mackerel (ICES 2008b; ICES 2005b; ICES 2005c). Predation mortality of one year old herring in the North Sea is mainly as a result of consumption by cod, whiting, saithe and seabirds, Younger herring (0-group individuals) are largely preyed upon by horse mackerel (ICES 2008b). Herring egg mats are also known to attract a number of predators such as spurdog, haddock, mackerel, lemon sole and other herring (de Groot 1980; Mills *et al.* 2003; Haugland *et al*. 2006; Skaret *et al*. 2002; Richardson *et al*. 2011).

4.2.30. Similarly, sprat is important as prey to other fish species including cod, grey gurnard, herring, sandeel, spurdog, horse mackerel, mackerel, sea trout *Salmo trutta* and whiting (ICES 2005b; ICES 2009) and many seabirds (Wanless *et al*. 2005). In addition, as described for sandeel, both herring and sprat are also known to be important in the diet of marine mammals such as seals and harbour porpoise (Santos & Pierce 2003; Wood 2001; Santos *et al*. 2004).

## 4.3. Principal fish and shellfish species identified

4.3.1. A full review of the ecology of the principal fish and shellfish species identified in the area of Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B

Export Cable Corridor on the basis of their commercial importance, relative abundance in the area, role in the ecosystem and conservation status provided in **Appendix 13A**, Section 6. The following table (**Table 4.6**) summarises the key information provided in **Appendix 13A** which is considered to be relevant to the impact assessment.

## Table 4.6 Ecology distribution and commercial importance of key fish and shellfish in all study areas

| Species and conservation status | Distribution | Ecology | Exploitation | Management | Local distribution |
|---|---|---|---|---|---|
| **Demersal Species** | | | | | |
| Sandeel *Ammodytes marinus*<br><br>UK BAP priority species | Abundant and widespread but patchy throughout the North Sea, Mainly *Ammodytes marinus* (Lesser sandeel). Site specific demersal spawners found on the edge of sandbanks in medium coarse sand sediments (particle size >0.25mm - <2mm). | Bentho-pelagic or semi pelagic. Important prey species for piscivorous fish, seabirds and marine mammals. Abundance related to population dynamics of predatory finfish. Diurnal and seasonal movements between seabed and water column. Buried at night and feed during daylight in spring and summer but buried all winter except for spawning (Nov-Feb). Eggs demersal, larvae pelagic (1-3 months duration). | Dogger Bank contributes 65% to entire North Sea catch during 2003-2009 (ICES 2010). Fishing from March to June with a peak in May and coincides with feeding season. Fishing grounds represent the main population distribution (van der Kooij *et al*. 2008). Fishing is concentrated on the western boundary of the zone (Tranche A). | Resilient population recovers once fishery is closed (Greenstreet *et al.* 2000). Seven subpopulations defined by ICES. Dogger Bank Teesside A & B and Dogger Bank Teesside A & B Export Cable Corridor fall within SA1 area (ICES 2010). Recruitment thought to be low generally therefore catch recommended at no more than 23,000 tonnes. | See **Appendix 13A Fish and Shellfish Ecology Technical Report** Figure 6.6 for distribution within Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor<br><br>Areas within Dogger Bank Teesside A & B suitable for sandeel settlement Through Particle Size Analysis (PSA) of grab samples (**Appendix 13A Fish and Shellfish Ecology Technical Report** Figure 6.7). |
| Plaice *Pleuronectes platessa*<br><br>UK BAP priority species<br>IUCM red list status 'Least concerned'. | Widely distributed in the North Sea, sandy substrates at depths between 10-50m. Seasonal migrations from winter spawning areas south of Dogger Bank Zone to | Spawning widespread in southern North Sea in winter. Egg production around the Dogger Bank is diffuse. | Principal commercial species caught mainly by Dutch beam trawlers also Danish seines and gillnets. Caught within Wind Farm Study Area and | Two stage multiannual plan for plaice (and sole) adopted by EU Council in 2007. Stock considered to be in good condition. | Dogger Bank Teesside A & B and Dogger Bank Teesside A & B Export Cable Corridor fall within spawning grounds of low intensity (Ellis *et al.* 2012). Western edge of Dogger Bank Teesside A overlaps high intensity spawning area. Common in survey catches in tranches A and B and |

| Species and conservation status | Distribution | Ecology | Exploitation | Management | Local distribution |
|---|---|---|---|---|---|
| | summer feeding grounds 250km to the north (Hunter *et al.* 2003). Coastal and inshore waters important juvenile nursery areas. Juveniles move offshore after the age of one year. | | Dogger Bank Teesside A & B Export Cable Corridor Study Area. | | Dogger Bank Teesside A & B Export Cable Corridor. |
| Dab<br>*Limanda limanda* | Wide distribution in North Sea depths 20-40m. Abundant off the Danish coast and south of Dogger Bank Teesside A & B development. | Seasonal migration of adults inshore in summer. Spawning occurs between April and June. Food generally bottom-living invertebrates e.g. crustaceans, polychaetes and molluscs (Wheeler 1978; Ruiz 2008d). | High landings by value and weight recorded in the Wind Farm Study Area. | ICES advice for catches not to increase for 2012 and 2013 (ICES 2012). | Survey data show higher numbers in Tranche A than B. Lower numbers in the Wind Farm Study Area and the Dogger Bank Teesside A & B Offshore Export Cable Corridor Study Area. |
| Sole<br>*Solea solea*<br><br>UK BAP priority species | Widely distributed in shallow southern North Sea, on sandy and muddy substrate between 1-70m depths. | Feed on small crustacean, molluscs, polychaetes and echinoderms (ICES 2005). Spawning usually inshore from March to June with a peak in April. | Low landings by weight from the Wind Farm Study Area. | ICES advice that the landings should not exceed 14,000 tonnes. | Not caught in Wind Farm Study Area. No overlap in spawning areas except the southern boundary of Dogger Bank Teesside A and the Inshore Dogger Bank Teesside A & B Export Cable Corridor Study Area overlap a low intensity spawning area. |
| Lemon sole<br>*Microstomas kitt* | Frequently found on offshore Banks between 40 to 200m on sand and gravelly substrates. | Feed on benthic prey including polychaetes, crustacean and molluscs and echinoderms (Wheeler 1978; Rogers and Stocks 2001). Widespread spawning between April and September (Coull *et al.* 1998 Wheeler 1978). | Forms part of a mixed flat fish fishery using beam and otter trawling. Commercially important in the Dogger Bank Teesside A & B Export Cable Corridor Study Area | ICES advice is that catch should not increase although no formal assessment of sole in EU waters is undertaken. | Inshore Export Cable Corridor Study Area overlaps with spawning and nursery grounds. |

| Species and conservation status | Distribution | Ecology | Exploitation | Management | Local distribution |
|---|---|---|---|---|---|
| | | | and northern areas of the Wind farm Study Area. | | |
| Grey gurnard *Eutrigla gurnardus* | Found at depths to 140m associated with offshore area such as the Dogger Bank. Commonly found between 20-50m. Abundant at sites to the north and east of the Wind Farm Study Area. | Food includes benthic crustacea, brown and pink shrimp, small crab and fish such as gobies and dragonet. Migrate from the central western North Sea to southern areas to spawn and form semi pelagic aggregations to northwest of Dogger Bank in winter. | Mainly taken as by-catch in demersal fisheries from Wind Farm Study Area and Export Cable Corridor Study Area. | No formal management for EU populations. | Very few individuals were captured at sites within Tranche A or Tranche B, where Dogger Bank Teesside A & B are located. Large numbers of grey gurnard were also found at sites in the vicinity of the Offshore Dogger Bank Teesside A & B Export Cable Corridor Study Area. |
| Whiting *Merlangius merlangus*<br><br>UK BAP Priority species | Bentho-pelagic species found in shallow water 30-100m on mud and gravel but also sandy rocky substrate. Wide distribution throughout the North Sea. Whiting tend to be present in relatively high numbers to the east and south of the Dogger Bank Zone and in the vicinity of the Dogger Bank Teesside A & B Export Cable Corridor. Relatively few whiting were recorded within tranches A and B. | Feed entirely on fish, such as Norway pout, sprat sandeel, and juvenile herring cod and haddock. Immature stages feed on euphausiids, mysids and carngonid shrimp (Hislop *et al*. 1991; ICES 2005; Wheeler 1978). During the night they primarily feed on bottom-dwelling prey, whilst feeding on pelagic prey during daylight (ICES 2005). Spawning takes place from February to June (Coull *et al*. 1998) but mostly in spring, in shallow water (Wheeler 1978). | Generally considered to be of secondary commercial importance. Caught in large numbers throughout the entire North Sea; however, large quantities of the catch tend to be discarded (ICES 2005). | Reference points for whiting are not defined but ICES is currently developing and evaluating a management plan for this stock. ICES advice is for landings not to exceed 26,000 tonnes. | Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor fall within defined spawning and nursery grounds for whiting, which is one of the main species landed within the Dogger Bank Teesside A & B Export Cable Corridor Study Area. |

| Species and conservation status | Distribution | Ecology | Exploitation | Management | Local distribution |
|---|---|---|---|---|---|
| Cod<br>*Gadus morhua*<br><br>UK BAP Priority species<br><br>OSPAR list of threatened and/or declining species<br><br>IUCN defines the status of the species as “Vulnerable”. | Cod is widely distributed in the North Sea (Heessen 1993), being found mainly from shallow coastal waters to the shelf edge (200m depth), South of the Dogger Bank, adult cod migrate southward for spawning during autumn and north again to feeding grounds in the spring (ICES 2005). | Food is mainly copepods for young stages and fish species when adults (Wilding and Heard 2004; Wheeler 1978; Arnett and Whelan 2001). | Cod is, in general terms, of secondary commercial importance in the Wind Farm Study Area. | ICES has advised that landings of cod in the North Sea, Eastern Channel and Skagerrak should not exceed 25,441 tonnes in 2013. | Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor are located at considerable distance from areas of high cod egg production. |
| Turbot<br>*Scophthalmus maximus* | Found on sandy, gravel or shell gravel and occasionally muddy substrates or areas of mixed sand and rocks (Walters 2008) from 20m to 800m. Found throughout the North Sea and within the Dogger Bank Zone Project. | Visual feeders on other benthic fishes and small pelagic species (ICES 2011a) including sandeel, sprat, herring, whiting, pouting, occasionally flatfish species, dragonets and gobies (Wheeler 1987). Migrations recorded from the nursery grounds in the south-eastern part to more northerly areas. Adult turbot are more tolerant of the colder conditions in the northern areas of the North Sea than juveniles (ICES 2011a). | A valuable by-catch in the fishery for flatfish and demersal species (ICES 2011a). The highest landings for this species are recorded in rectangle 38F2 where Dogger Bank Teesside A & B are located. | ICES have advised for 2012 and 2013 on the basis of precautionary consideration that catches should not increase. | Found in low numbers in the otter trawl surveys carried out in tranches A and B. They are of commercial importance in the Wind Farm Study Area where they record the second highest landings by value after plaice. |
| **Other demersal species**<br>**Appendix 13A Fish and Shellfish Ecology Technical Report** describes the ecology of haddock, angler fish, ling, blue whiting, and hake. These species are either found in low numbers, are not of great commercial importance or were not recorded in large numbers in the fish and shellfish surveys. | | | | | |

| Species and conservation status | Distribution | Ecology | Exploitation | Management | Local distribution |
|---|---|---|---|---|---|
| **Non-commercial species.** Scaldfish, lesser weever, pogge *Agonus cataphractus* and common dragonet *Callionymus lyra* were found in small numbers in the fish surveys. Solenette and species of goby also form an important component of the fish assemblage although they are not of commercial importance. Solonette were found in both Dogger Bank Teesside A & B but this varied seasonally and sand goby was one of the most abundant species caught in the surveys in the Dogger Bank Teesside A & B Export Cable Corridor Study Area. | | | | | |
| **Pelagic species** | | | | | |
| Herring<br>*Clupea harengus*<br><br>UK BAP priority species | Herring are widely distributed throughout the Northwest and Northeast Atlantic. Herring occur throughout the North Sea but 1-group herring are generally restricted to within the 100m depth contour. Adult fish are found mostly on the continental shelf to depths of 200m. The distribution of herring from IBTS surveys is shown in **Appendix 13A Fish and Shellfish Ecology Technical Report** Figure 6.34. | Mainly feed on calanid copepods during their early juvenile life, and also consume euphausids, hyperiid amphipods, juvenile sandeel, sea-squirts (*Oikopleura* spp.) and fish eggs. Larger herring predominantly consume copepods in conjunction with small fish, arrow worms and ctenophores (ICES 2005). Herring move to the central and northern North Sea to feed in spring (Corten 2001). Herring is an important prey species for piscivorous fish, marine mammals and seabirds. | One of the most important pelagic species in the North Sea and has been intensively exploited for centuries. | | The distribution of herring spawning and nursery grounds in relation to the location of Dogger Bank Teesside A & B and the Export Cable Corridor is shown in **Appendix 13A Fish and Shellfish Ecology Technical Report** Figure 6.35 as defined by Coull *et al.* 1998 and Ellis *et al.* (2012). Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor fall within broad low intensity herring nursery grounds. The Dogger Bank Teesside A & B Export Cable Corridor falls within the defined Flamborough coastal herring spawning grounds. Herring grounds have been defined in the vicinity of Dogger Bank Teesside A & B. |
| Sprat<br>*Sprattus sprattus* | Abundant in shallow waters. Widely distributed in the North Sea, being most abundant south of the Dogger Bank and in the Kattegat (ICES 2005). | Main prey items include copepods, cladocerans, sea-squirts, bivalve larvae, mysids and euphausids (Maes and Ollevier 2002, ICES 2005). Sprat is an important food resource for a number of commercially | As suggested by fisheries statistics, the Wind Farm and the Dogger Bank Teesside A & B Export Cable Corridor Study Areas do not support | No specific management measures for this species. | Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor fall within the broad spawning and nursery grounds defined for sprat. Caught in greatest numbers in the pelagic survey particularly along Transect C. |

| Species and conservation status | Distribution | Ecology | Exploitation | Management | Local distribution |
|---|---|---|---|---|---|
| | Generally remain within the 50m depth contours and are more common in inshore waters. | important predatory fish and sea birds.<br>Spawning in the North Sea is thought to primarily occur from May to August, peaking between May and June (Coull *et al.* 1998) in both coastal waters and up to 100km offshore, in deep basins (Whitehead 1986, Nissling *et al.* 2003).<br>Females spawn repeatedly in batches throughout the spawning season (Milligan 1986). Eggs and larvae are pelagic and so subject to larval drift, moving into coastal nursery areas as juvenile (Hinrichsen *et al*. 2005, Nissling *et al*. 2003). | important sprat fisheries. | | |
| Mackerel<br>*Scomber scombrus*<br><br>UK BAP priority species<br><br>IUCN Red List of Threatened Species, Least concern' | Widespread in the North Sea overwintering in deep water on the edge of the continental shelf. Migration is south in spring to the central North Sea after which they mix with fish from the western stock on the feeding grounds in the southern Norwegian Sea and the northern North Sea, before returning to over- | Mackerel feed on large quantities of pelagic crustaceans and also prey on schools of smaller fish, particularly sprat, herring and sandeel (Wheeler 1978). They are important as a food resource for larger pelagic predators, including sharks and marine mammals and a variety of seabirds (ICES 2005). | Landings data does not suggest this species to be of particular commercial importance in the Wind Farm and Export Cable Corridor Study Areas. **Chapter 15 Commercial Fisheries**, however, indicates that mackerel is targeted by French trawlers over certain sections | ICES advice for 2013 suggests that the existing measures to protect North Sea spawning mackerel should remain in place. On the basis of the Norway, Faroe Islands, and EU management plan ICES suggest that the catches in 2013 be between 497,000 and | Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor fall within the broad spawning and nursery grounds defined for this species. |

| Species and conservation status | Distribution | Ecology | Exploitation | Management | Local distribution |
|---|---|---|---|---|---|
| | wintering areas (ICES 2005). | | of the Dogger Bank Teesside A & B Export Cable Corridor Study Area. | 542,000 tonnes (ICES 2012a). | |
| Horse mackerel *Trachurus trachurus*<br><br>UK BAP Priority species | Southern species with a northerly limit in the northern North Sea. | Food for juveniles is planktonic larvae, adults feed on fish species such as juvenile herring, cod and whiting. | Not of particular importance. | No formal management advice. | Low numbers caught in otter trawls in tranches A and B. |
| **Elasmobranchs** | | | | | |
| Thornback ray *Raja clavata*<br><br>OSPAR list of threatened and/or declining species<br><br>IUCN Red List of Threatened Species 'Near Threatened' | Most abundant in the south-western North Sea, particularly in the Outer Thames Estuary and The Wash (ICES 2005, ICES 2008b). | No information. | Thornback ray is commercially important in the North Sea being the dominant ray species in commercial landings (ICES 2005). Landings of this species in both the Wind Farm and Dogger Bank Teesside A & B Export Cable Corridor Study Areas are, however, comparatively low (see values for grouped category "skates and rays". | | A single thornback ray was recorded in two of the three otter trawl surveys carried out in Tranche B and within the Dogger Bank Teesside A & B Export Cable Corridor Study Area. In addition, a thornback ray was found in the trammel net surveys carried out in the Inshore Dogger Bank Teesside A & B Export Cable Corridor Study Area. |

| Species and conservation status | Distribution | Ecology | Exploitation | Management | Local distribution |
|---|---|---|---|---|---|
| Spotted ray<br>*Raja montagui*<br><br>OSPAR list of threatened and/or declining species<br><br>IUCN Red List of Threatened Species "Least Concern" | Spotted ray is most commonly found in moderately deep water, mainly between 60m and 120m and on sandy substrates (Wheeler 1978). Species is poorly represented in the area of the Dogger Bank and therefore it is not expected to be found in high numbers within the Dogger Bank Teesside A & B Export Cable Corridor Study Area and the Wind Farm Study Areas. | No information. | Considered of secondary importance in UK landings in comparison to thornback ray. Usually landed together with thornback ray and blonde ray by the Dutch beam trawl fleet (ICES 2007). | No formal management measures. | Found in the otter trawl surveys of tranches A and B and the Dogger Bank Teesside A & B Export Cable Corridor Study Area as well as in the trammel net surveys in low numbers. |
| Blonde ray<br>*Raja brachyura*<br><br>IUCN Red List of Threatened Species 'Near Threatened' | Common in inshore waters (14m to 146m) off southern and western England less frequent in the North Sea and Celtic Sea (Ellis *et al.* 2005). | Food is a wide range of crustaceans, worms and fish, particularly herring, sprat, pouting, sandeel and sole (Wheeler 1978). | Considered of secondary importance in UK landings data in comparison to thornback ray and is also landed, together with thornback ray and spotted ray, by the Dutch beam trawl fleet (ICES 2007). | No formal management measures. | Not caught within any Study Area and not recorded in either the inshore trammel net or the offshore trawl surveys. |
| **Other ray species**<br>Starry ray, cuckoo ray (IUCN Red List as Least Concern), undulate ray (UK BAP priority species and IUCN Red List as Endangered) – were all either recorded in very low numbers or not at all in the fishing surveys. For further details see **Appendix 13A Fish and Shellfish Ecology Technical Report** Section 6.3. | | | | | |

| Species and conservation status | Distribution | Ecology | Exploitation | Management | Local distribution |
|---|---|---|---|---|---|
| Lesser spotted dogfish *Scyliorhinus canicula* | Widespread and abundant along the southern and western seaboards of the British Isles at depths of 6m to 308m, showing a patchy distribution in the North Sea (Ellis *et al.* 2005). | Generally found in the shallow sublittoral on muddy and sandy substrates to depths up to 100m (Pizzolla 2008). | | | They were found in very low numbers in the otter trawl surveys undertaken within tranches A and B, and were also present at stations sampled along the Dogger Bank Teesside A & B Export Cable Corridor Study Area. This species was, however, found in relatively high numbers in the trammel net survey carried out in the inshore area. |
| Smoothhound *Mustelus spp.*<br><br>IUCN Red List of Threatened Species 'Least Concern' | Widely distributed around the British Isles in waters of 10m to 200m depth. They are, however, more abundant along the southern and western coast of the UK with high catch rates recorded in the outer Thames Estuary and Bristol Channel (Ellis *et al*. 2005). Smoothhound are found less frequently than starry smoothhounds and have been rarely recorded in the North Sea (Ellis *et al.* 2005). | They feed primarily on crustaceans, including hermit crabs, edible crabs, shore crabs, small lobsters and squat crabs (Wheeler 1978). | | | Their average abundance in IBTS survey catches is shown in **Appendix 13A Fish and Shellfish Ecology Technical Report** Figure 6.58.<br><br>Smoothhound was found at otter trawl sites in Tranche B and within the Dogger Bank Teesside A & B Export Cable Corridor Study Area. This species was also found in inshore trammel net surveys (see **Appendix 13A Fish and Shellfish Ecology Technical Report** Table 5.9). |
| Spurdog *Squalus acanthias*<br><br>IUCN Red List of | Now most abundant in the western North Sea and off the isles of Orkney and | Opportunistic feeders that take a wide range of predominantly pelagic prey. Important fish prey includes | Exploitation reduced substantially in recent years due to decreasing quota | In 2010, the TAC for spurdog was set to zero, landings were | Spurdog is the principal elasmobranch species recorded in commercial landings from the Wind Farm Study Area and the Dogger Bank Teesside A |

| Species and conservation status | Distribution | Ecology | Exploitation | Management | Local distribution |
|---|---|---|---|---|---|
| Threatened Species, 'Vulnerable' | Shetland (ICES 2005). Present at depths between 15m and 528m (Ellis *et al.* 2005) near the sea bed on soft substrates but also near the surface (Wheeler 1978). | herring, sprat, small gadoids, sandeel, and mackerel; however, crustaceans (swimming crabs, hermit crabs and euphausids), squid and ctenophores also represent important prey to this species (ICES 2005). | allocations (Ellis *et al.* 2009). | however still permitted under a by-catch TAC, provided certain conditions were met (ICES 2011b). In 2011, the TAC for spurdog was retained at zero and no landings (including by-catch) were permitted (ICES 2011b). | & B Export Cable Corridor Study Area. They are located within defined low intensity nursery grounds.<br><br>Recorded in otter trawl surveys undertaken in tranches A and B. |
| Tope<br>*Galeorhinus galeus*<br><br>UK BAP priority species<br><br>IUCN Red List of Threatened Species "Vulnerable" | Regularly recorded around the British Isles (Ellis *et al*. 2005). They are generally found in shallow waters down to 200m living in small schools close to the sea bed, although when actively feeding they can be found in mid-water (Wheeler 1978). | They eat a variety of fish, including pilchards, herring, anchovies, smelt, hake, cod sole, mackerel and gobies. They also consume invertebrates such as squid, octopus, crabs and marine snails (Shark Trust 2010).<br><br>The location and temporal stability of specific parturition grounds are not well established for this viviparous species (Ellis *et al*. 2012). | - | - | Tope were not recorded in any of the fish characterisation surveys carried out in tranches A and B. Low intensity nursery grounds, have, however been defined for this species to the south of the Dogger Bank Zone overlapping with the southern section of the Wind Farm Study Area (Figure 6.60). |
| Basking shark<br>*Cetorhinus maximus*<br><br>UK BAP priority species<br>OSPAR list of threatened and/or | Basking sharks migrate from the western English Channel in spring to western Scottish waters, where they spend the summer | - | - | Basking shark is of conservation importance being protected under the Wildlife and Countryside Act, 1981. | Sightings of this species in coastal waters in the Wind Farm and Dogger Bank Teesside A & B Export Cable Corridor Study Areas are generally rare (Bloomfield and Soland 2006). High sightings density areas are found off the west coast of Scotland, around |

| Species and conservation status | Distribution | Ecology | Exploitation | Management | Local distribution |
|---|---|---|---|---|---|
| declining species.<br><br>IUCN Red List of Threatened Species “Vulnerable”. | and early autumn before moving offshore between November and March (Evans *et al*. 2011). Whilst they are rare off the east coast of England they may occasionally transit the Dogger Bank Teesside A & B Wind Farm and Dogger Bank Teesside A & B Export Cable Corridor Study Areas. | | | | the Isle of Man, all around the south west of England, and along the middle of the western half of the English Channel (Bloomfield and Soland 2006). Three sightings were however recorded during aerial surveys conducted in September 2010 (Lat 55.066809 Long 2.498298), September (Lat 55.741304 Long 3.220443) and November 2011 (Lat 55.069800 Long 1.742822) indicating that the species may occasionally transit the Dogger Bank Teesside A &B Wind Farm and Dogger Bank Teesside A & B Export Cable Corridor Study Areas. |
| **Migratory diadromous species** | | | | | |
| European eel *Anguilla anguilla*<br><br>UK BAP species and assessed as<br><br>IUCN Red List of Threatened Species “Critically Endangered”<br><br>Listed in Appendix II of the Convention for International Trade in Endangered Species of Wild Fauna and | Present in nearly all rivers throughout England, although numbers have declined dramatically in recent years. The main fisheries for eels are based in lowland areas in southern and eastern England. Eels are present in both the River Esk and River Tees (situated north and south of the Dogger Bank | Catadromous migratory species. Spawning is thought to occur in the Sargasso Sea, with the newly hatched larvae being transported back towards the European coast by prevailing currents. They metamorphose into glass eels as they arrive on the continental shelf, and subsequently become pigmented ‘elvers’ (Aarestrup *et al.* 2009; Potter and Dare 2003). Adults are thought to migrate to sea | Levels of commercial exploitation are generally low in the North Eastern Environment Agency Region with a total catch of 160kgs of adult eels reported from 8 commercial licenses issued in 2010 (Environment Agency 2010). There is at least one commercial fyke netter targeting eels in the tidal section of | Protected species. Recruitment of juvenile eels of the European stock is currently very low, with the decline in the eel stock being internationally recognised as a conservation priority. ICES indicate that the stock continues in decline (ICES 2011c). | It is likely that eels occasionally transit the area of Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor. This is likely to be of increased relevance to the Dogger Bank Teesside A & B Export Cable Corridor given the position of the Esk and Tees relative to the cable landfall. |

| Species and conservation status | Distribution | Ecology | Exploitation | Management | Local distribution |
|---|---|---|---|---|---|
| Flora (CITES) | Teesside A & B Export Cable Landfall, respectively). Currently only targeted commercially in the Tees. | from August to December. Glass eels arrive at coastal waters from February to March and migrate upstream as elvers from May until September (Environment Agency 2011b). Little known about the sea phase. | the River Tees (Walmsey and Pawson 2007). | | |
| Sea and River lamprey<br><br>*Petromyzon marinus* and *Lampetra fluviatilis*<br><br>UK BAP Priority List.<br><br>Annexes II and V of the EU Habitats Directive Appendix III of the Bern Convention<br><br>IUCN Red List of Threatened Species "Least Concern" | Distribution is largely dictated by the host (Waldman *et al*. 2008). At sea, Sea lamprey feed on a variety of marine mammals and fish, including, shad, herring, Pollack *Pollachius pollachius*, salmon, cod, haddock and basking sharks (Kelly and King 2001; ter Hofstede *et al*. 2008). The rarity of capture in coastal and estuarine waters suggests that sea lampreys are solitary feeders and widely dispersed at sea. It is possible that sea lamprey often feed in deeper offshore waters as they have been caught at considerable depths | Both species are parasitic anadromous migratory species, both spawn in fresh water in spring or early summer, followed by a larval phase (ammocoetes) spent in suitable silt beds in streams and rivers (Laughton and Burns 2003). All individuals die after spawning (Maitland 2003a). Ammocoetes can spend several years in these silt beds, feeding on organic detritus and eventually transforming into adults from late summer onwards (Laughton and Burns 2003). After transformation, river and sea lampreys migrate to sea, where they use their suckers to attach to other fish (Maitland 2003a). After several years in the marine environment the adults return to fresh water to spawn (Laughton and Burns 2003). | Not exploited. | Protected species. | Both species are recorded in the River Tees (situated north of the Dogger Bank Teesside A & B Export Cable landfall). Although not recorded in the River Esk it is likely that even if they do not spawn in-river both species are present occasionally as the river has a run of salmon and sea trout which are a common host/prey type. There is, therefore, potential for sea and river lamprey to occasionally transit the Dogger Bank Teesside A & B Export Cable Corridor and/or Dogger Bank Teesside A & B as part of their foraging or migratory behaviour. |

| Species and conservation status | Distribution | Ecology | Exploitation | Management | Local distribution |
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| | (4100m water depth) (Moore *et al*. 2003). | | | | |
| Atlantic salmon and sea trout<br>*Salmo salar*<br>*Salmo trutta*<br><br>UK BAP priority species<br>Annex ll of the EU Habitats Directive | Of the 80 rivers in which salmon are recorded, 64 are 'designated principal salmon rivers'. The performance of salmon stocks in these rivers is assessed against conservation limits (CL) which are identified by a target number of eggs deposited during spawning to ensure the status of the population remains favourable (Environment Agency & Cefas, 2012). A number of the remaining rivers such as the Severn and Yorkshire Ouse support salmon populations in the early stages of recovery but are not currently designated as principal salmon rivers. Those rivers | Anadromous migratory species which utilises both freshwater and marine habitats during its life cycle Spawning occurs in the upper reaches of rivers during late autumn and winter when females cut nests (Redds). Larvae hatch in spring, go through the fry to parr stage by the first summer. After one to five years in freshwater they go through smoltification and as smolts (March to June) migrate down the river to the sea. Adults return to natal rivers to spawn. | Declared rod and line catches of both salmon and sea trout have increased almost continually since the mid-1990s and numbers of recorded salmon were an order of magnitude greater in 2011 than during the 1980s to mid- 1990s. Salmon and sea trout from the Esk and Tees are exploited by the North East drift net fishery which operates along the coast of Yorkshire and Northumberland. This fishery is the most significant extant commercial salmon and sea trout fishery in England and Wales (see **Appendix 15A Commercial Fisheries Technical Report**). The | As per conservation status. | The Dogger Bank Teesside A & B Export Cable Corridor landfall is situated between two designated 'principal salmon rivers'; the Yorkshire Esk to the South and the Tees immediately to the north. |

| Species and conservation status | Distribution | Ecology | Exploitation | Management | Local distribution |
|---|---|---|---|---|---|
| | which are suitable for salmon will in most, if not all, cases also support stocks of sea trout. | | majority of salmon from this fishery result from the Northumbrian area, which accounts for 74% to 96% of the total. | | |
| Allis and Twaite shad<br>*Alosa alosa*<br>*Alosa fallax*<br><br>UK BAP priority fish species<br>Annex ll of the EU Habitats Directive | Occurring mainly in shallow coastal waters and estuaries, with a preference for water 10m to 20m deep. There are no known spawning sites for allis shad in Britain, though both sub-adults and sexually mature adults are still regularly found around the British coast (Maitland and Lyle 1995). Spawning stocks of the twaite shad are only found in a few rivers in and around the southern Welsh border (JNCC 2007). | Anadromous migratory species, Migration into fresh water occurs during late spring (April to June) along the coast to higher, middle watercourses of rivers to spawn from mid-May to mid-July (Maitland and Hatton-Ellis 2003; Acolas *et al.* 2004; Patberg *et al*. 2005). The majority of Allis shad die after spawning. | Not exploited. | As per protected species. | Species have not been recorded in any river in the vicinity of the Dogger Bank Teesside A & B Export Cable Corridor. Given the offshore location of Dogger Bank Teesside A & B, it is not expected that these two species will be present in the sites. They may, however, occasionally transit the inshore area of the Dogger Bank Teesside A & B Export Cable Corridor. |
| Smelt<br>*Osmerus eperlanus*<br><br><br>UK BAP Priority Species | Little is known about the distribution and likely spawning potential of smelts within English estuaries. Maitland (2003b) reports the | Anadromous species which congregate in estuaries during the winter, entering rivers from February to April to spawn. After spawning the adults return to sea whilst the juveniles remain in | | Despite being widely distributed throughout the North Atlantic and European waters, they are considered to be | Not expected that the species will be to be present in Dogger Bank Teesside A or Dogger Bank Teesside B due to the rarity of smelt in rivers e.g. Tees and Esk and due to their restricted marine migration. For the same reasons smelt are not expected to regularly transit the |

 

| Species and conservation status | Distribution | Ecology | Exploitation | Management | Local distribution |
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| | occurrence of smelt in Yorkshire rivers within the Humber River Basin District. Species is believed to have been extirpated from the Tees as early as the 1930s (Maitland 2003b). | the estuary for the remainder of the summer (Barnes 2008f). During their marine phase they are most commonly found next to river mouths and in estuaries (Wheeler 1978). | | threatened in UK waters. | Dogger Bank Teesside A & B Export Cable Corridor. |
| **Shellfish** | | | | | |
| Edible crab *Cancer pagurus* | The results of suture tagging experiments carried out off the Norfolk coast (Edwards 1979) suggest a northerly long-distance movement of mature females. | Found on bedrock including under boulders, mixed coarse grounds and offshore in muddy sand (Neal and Wilson 2008).<br>The movement of female crabs is related to their reproductive cycle. After pairing and mating (July-September) and subsequent spawning (October-December), egg bearing ("berried") females move to offshore over-wintering grounds to hatch their eggs. However despite overwintering in hollows of sand and gravel, they are not necessarily confined to such areas, and eggs may be hatched over a wide variety of sediment types from fine sands to pebbles.<br>A chart showing the relative | Commercially important in the Dogger Bank Teesside A & B Inshore Export Cable Corridor Study Area (ICES rectangles 38E8 and 38E9), where they support important commercial fisheries (see **Chapter 15 Commercial Fisheries**). | | Most abundant species found during the shellfish (potting) survey carried out in the Dogger Bank Teesside A & B Inshore Export Cable Corridor Study Area. Also recorded in the epibenthic (epifaunal) survey and at otter trawl survey sites in Tranche A, Tranche B and the Dogger Bank Teesside A & B Export Cable Corridor<br>The highest larval densities occurred offshore to the south west of Dogger Bank Teesside A & B. Larvae were also recorded in the Inshore Export Cable Corridor Study Area and in the northern section of Tranche A, although at comparatively low densities. |

 

| Species and conservation status | Distribution | Ecology | Exploitation | Management | Local distribution |
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| | | distribution of *C.pagurus* in the Central North Sea based on IBTS survey data is provided in **Appendix 13A Fish and Shellfish Ecology Technical Report**. | | | |
| Velvet crab *Necora puber* | Primarily found on rock and stone substrates inter-tidally and in shallow waters (Wilson 2008). | | Gained in commercial importance in recent years and landings are recorded from the Dogger Bank Teesside A & B Inshore Export Cable Corridor Study Area, particularly in rectangles 38E8 and 38E9. | | Generally caught in relatively moderate numbers in the shellfish (potting) survey carried out in the Dogger Bank Teesside A & B Inshore Export Cable Corridor Study Area. In Tranche A they were found in relatively high numbers during the epibenthic (epifaunal) survey, with a total of 193 individuals recorded in stations sampled (**Appendix 12B Tranche A Benthic Survey Report**). In Tranche B catch rates were low (**Appendix 12A Tranche B and Export Cable Corridor Benthic Survey Report**). |
| Lobster *Hommarus gammarus* | Widely distributed along the Eastern Atlantic coasts of Europe and are found in most areas of the British Isles, particularly off rocky coastlines (Bennett *et al*. 2006). Most abundant in crevices in which to shelter or hide. Also found in sandy areas with rocky outcrops under which they can burrow (Beard and | Not known to undertake extensive alongshore or on/offshore migrations but more localised movements driven by local competition for food or the need to move to a different habitat as their size increases (Pawson *et al*. 1995). Tagging experiments carried out in the south coast of England (Smith *et al*. 2001) found that 95% of recaptured lobsters moved less than 3.8km from their original position over periods of 862 days. Berried | High commercial importance in the Dogger Bank Teesside A & B Export Cable Corridor Study Area and are the second most valuable species landed. | | A total of 163 lobsters were caught during the inshore potting survey (**Appendix 13A Fish and Shellfish Ecology Technical Report** Table 5.8) but were not recorded offshore in the otter trawl surveys. |

 

| Species and conservation status | Distribution | Ecology | Exploitation | Management | Local distribution |
|---|---|---|---|---|---|
| | McGregor 1991). | females generally appear from September to December in areas where lobsters are normally present. Little is known about the distribution and abundance of lobster larvae. | | | |
| **Other shellfish species** | | | | | |
| Whelks *Buccinum undatum* | The distribution of juvenile whelks tends to be limited to areas close to the adult stock (Lockwood 2005). Juveniles hatch from demersal egg cases as developed individuals (Hancock 1967). | Commonly found around the British coasts on soft substrates in sub-tidal areas and occasionally in intertidal fringes (Ager *et al.* 2008). | Of commercial importance in the UK. Landings data suggest that they are of secondary commercial importance in Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor. The highest landings for this species are recorded in the Wind Farm Study Area, particularly in rectangle 39F3. | | Caught in relatively small numbers in Tranche B. No whelks were recorded in the potting survey carried out in the Dogger Bank Teesside A & B Inshore Export Cable Corridor Study Area (see **Appendix 13B Tranche B Fish and Shellfish Characterisation Survey**). |
| Scallops *Pectinidae spp* | Both species are found on a variety of substrate types, from rocks and stones to fine silty mud, although they are most abundant in areas with rocky | King scallops are generally sedentary and usually found recessed in the sediment with the upper (left) valve level with the substrate, whilst queen scallops lay on top of the substratum and are considered to be a more | Landings of King scallop from the Export Cable Corridor Study Area are of moderate importance in terms of weight and value scallop dredgers | | Queen scallops are also expected to occur in the Dogger Bank Teesside A & B Wind Farm and Dogger Bank Teesside A & B Export Cable Corridor Study Areas. They were recorded in relatively low numbers as part of otter trawl surveys in tranches A and B. |

 

| Species and conservation status | Distribution | Ecology | Exploitation | Management | Local distribution |
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| | outcrops or boulders on silty sand mixed with shell substrates (Pawson 1995; Franklin *et al.* 1980, Brand 2006). They, however, differ in their propensity and ability to swim. | mobile species (Jenkins *et al*. 2003). | have been recorded in low numbers in inshore grounds to the south of the Dogger Bank Teesside A & B Export Cable Corridor (see **Appendix 15A Commercial Fisheries Technical Report**). | | |
| *Nephrops* | The distribution of *Nephrops* is limited by the extent of cohesive muddy sediment suitable for burrow construction. Sediment type also appears to affect the structure of *Nephrops* populations, with areas of fine sediment being characterised by the presence of large-bodied individuals and low population densities, and areas of sandier mud showing higher population densities and *Nephrops* smaller in size (Howard 1989). | *Nephrops* are opportunistic predators feeding on crustaceans, molluscs, polychaetes and echinoderms (Parslow-Williams *et al*. 2002). | *Nephrops* are of commercial importance particularly north and west of the Dogger Bank in the Central North Sea, along the northeast coast of England, the eastern coast of Scotland, and on the Fladen ground in the northern North Sea (Rogers and Stocks 2001). As shown by landings data (Section 5.4). | | *Nephrops* is of only moderate importance in the Wind Farm Study Area (**Appendix 13A Fish and Shellfish Ecology Technical Report** Table 5.13 and Table 5.14). In the Export Cable Corridor Study Area, however, landings of *Nephrops* are considerably higher and this species is ranked first by value and in terms of landed weight (**Appendix 13A Fish and Shellfish Ecology Technical Report** Table 5.15 and Table 5.16). |

| Species and conservation status | Distribution | Ecology | Exploitation | Management | Local distribution |
|---|---|---|---|---|---|
| Shrimp<br>Brown shrimp<br>Common shrimp<br>Pink shrimp<br><br>*Palaemon spp.*<br>*Crangon crangon*<br>*Palaemon serratus*<br>*Pandalus montagui* | Pink shrimp is common in the North Sea at depths between 20 to100m (Ruiz 2008a). The species is typically associated hard substrates and *Sabellaria spinulosa* reef (Warren and Sheldon 1967) but may also occur over sand, mud and gravel substrates. | Brown shrimp has very high productivity and is an important food source for many birds, fish and crustaceans and is commercially exploited for human consumption (Neal 2008).<br><br>Pink shrimp diet consists principally of small polycheates, hydroids, copepods and other small invertebrates (Ruiz 2008d). Migration to deeper offshore waters for spawning occurs during October and November (Ruiz, 2008d). Recorded during benthic (epifaunal) surveys not in high numbers (**Appendix 12A Tranche B and Export Cable Corridor Benthic Survey Report** and **Appendix 12B Tranche A Benthic Survey Report**). | MMO landings data records no significant landings of shrimp species either in the Dogger Bank Teesside A & B Wind Farm or Dogger Bank Teesside A & B Export Cable Corridor Study Areas.<br><br>. | | Brown shrimp and the common shrimp were found in relatively high numbers in the benthic (epifaunal) surveys (**Appendix 12A Tranche B and Export Cable Corridor Benthic Survey Report** and **Appendix 12B Tranche A Benthic Survey Report**). |

# 5. Assessment of Impacts – Worst case Definitions

## 5.1. General

5.1.1. This section establishes a realistic worst case scenario for each category of impact as the basis for the subsequent impact assessment. This involves both a consideration of the relative timing of construction and operation of Dogger Bank Teesside A & B, as well as the particular design parameters of each project that define the Rochdale Envelope[2] for this particular assessment.

5.1.2. Full details of the range of development options being considered by Forewind are provided within **Chapter 5**. For the purpose of the fish and shellfish ecology impact assessment, the type of construction, operation and decommissioning activities that may result in potential effects on fish and shellfish receptors are outlined in **Table 5.1**. The key design parameters that form the realistic worst case scenarios for each category of impact are listed in **Table 5.2**. Only those design parameters with the potential to influence the level of impact are identified.

5.1.3. The realistic worst case scenarios identified here also apply to the cumulative impact assessment. 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 Section 11) and summarised in **Chapter 33 Cumulative Impact Assessment**.

## 5.2. Realistic worst case scenarios

5.2.1. The key design parameters that form the realistic worst case scenarios for each category of impact are set out in **Table 5.2**.

[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.

## Table 5.1 Types of impacts per project area and their potential effects on fish and shellfish

| Impact type | Potential Impact | Potential effects on fish and shellfish |
|---|---|---|
| **Construction** | | |
| Installation of cables and foundations | Temporary physical disturbance to seabed habitat and temporary habitat loss. | • Lethal effects on eggs and larvae;<br>• Physical disturbance to fish and shellfish; and<br>• Direct mortality of sessile and burrowing species. |
| | Increased suspended sediment concentrations and increased levels of sediment re-deposition. | • Temporary disturbance to biologically sensitive areas such as foraging, nursery or spawning grounds caused by deposition of fine particulates;<br>• Potential smothering of gills/eggs/larvae of sensitive fish and shellfish within the plume;<br>• Temporary reduction in availability of phytoplankton for planktivorous species; and<br>• Temporary increase in turbidity resulting in a reduction in the foraging ability of sight-dependent predators. |
| Piling activity | Construction noise. | • Lethal/traumatic damage to sensitive fish and shellfish receptors; and<br>• Disturbance to foraging and spawning behaviour. |
| **Operation** | | |
| Presence of foundations, cables and scour/cable protection | Permanent net reduction of existing seabed habitat due to the construction footprint. | • Permanent net reduction in foraging/spawning/nursery areas for fish and shellfish habitat. |
| | Changes in fishing activity. | • As described in **Chapter 15 Commercial Fisheries**. |
| | Operational noise. | • Disturbance to foraging and spawning behaviour. |
| Presence of inter-array and export cables | EMF and heat emissions from sub-sea cables. | • Behavioural changes - elasmobranchs, diadromous species, other fish species (e.g. cod and plaice) and shellfish. |
| Introduction of hard substrate | Increase in available habitat due to the introduction of artificial structures. | • Permanent habitat and community changes for sensitive fish and shellfish; and<br>• Potential net increase in abundance and biodiversity resulting from the creation of artificial reef habitat. |

| Decommissioning | | |
|---|---|---|
| Removal of cable and foundations | • Noise and vibration;<br>• Physical disturbance to seabed;<br>• Increased suspended sediment concentrations and sediment deposition; and<br>• Removal of artificial habitat. | • Similar effects to those described for construction. |

Table 5.2 Key design parameters forming the realistic worst case scenarios for the assessment of impacts on fish and shellfish ecology per wind farm project area (Source Dogger Bank Teesside A & B CPD –Issue 3)

| Potential effect | Design parameters for the worst case scenario | Rationale |
|---|---|---|
| **Construction** | | |
| Physical disturbance and temporary habitat loss (for each project). | Maximum footprint of permanent habitat loss assessed as 21.72km$^2$ which represents 3.28% of the overall area of Dogger Bank Teesside A (main site and Export Cable Corridor) and 20.83km$^2$ which represents 3.01% of Dogger Bank Teesside B (main site and Export Cable Corridor).<br><br>• Seabed prepared area for 200 (6MW) x GBS foundations (0.845km$^2$);<br>• Residual mounds of sediment left in situ following seabed preparation/disposal of drill arisings (0.657km$^2$);<br>• Seabed prepared areas for five x met-masts (0.019km$^2$);<br>• Seabed prepared area for four x collector stations (0.032km$^2$);<br>• Seabed prepared area for one x converter station (0.016km$^2$);<br>• Seabed prepared area for two x accommodation platforms (0.032km$^2$);<br>• Jack up barge seabed footprint for 200 turbines (1.008km$^2$);<br>• Anchor footprint from foundation installation (0.372km$^2$);<br>• Anchor footprint from WTG and topside installation of up to 950 km of inter array cables (with worst-case disturbance width via jetting of 10m) (0.093km$^2$);<br>• Installation of up to 320 km of inter platform cables (with worst-case disturbance width via jetting of 10m) (3.20km$^2$);<br>• Installation of up to 950km of inter-array cables (with worst-case disturbance width via jetting of 10m) (9.50km$^2$);<br>• Installation of up to 573 km (Teesside A) and 484 km (Teesside B) of export cables (with worst-case disturbance width via jetting of 10m (Teesside A 5.73km$^2$) (Teesside B 4.84km$^2$); and<br>• Anchor footprint from export cable installation (0.176km$^2$)<br>• Construction buoys (0.034 km$^2$). | All values shown here are for Teesside A alone. For Teesside A and Teesside B combined, values should be doubled apart from export cable disturbances where different cable lengths for Teesside A and Teesside B = different impact footprints.<br><br>Export cables are assumed to be unbundled.<br><br>Greatest footprint of temporary habitat disturbance via seabed preparation for Gravity Base Structure (GBS) foundations. |
| Release of contaminants from disturbed sediment | As above | As above |
| Underwater noise –piling events | • Maximum construction period six years, minimum three years.<br>• Total duration of construction noise: maximum of 4056 hours.<br>• Maximum of 600 piling operations per year for wind turbine, plus up to 188 for other structures. | Installation of multi-leg pin piles will result in the greatest associated noise impact ranges, however, given the significantly |

| Potential effect | Design parameters for the worst case scenario | | Rationale |
|---|---|---|---|
| | • Maximum of two simultaneous piling operations.<br>• Both concurrent and sequential phasing are included in the worst case scenario<br>• Cumulative – a maximum of six projects in simultaneous construction (with two piling operations per project), a total of 12 rigs. | | higher number of piling events associated with installation of jackets/multipole foundations (up to six piling events per foundation) in comparison to monopoles ( one piling event per foundation) this option has been considered worst case.<br>The worst case scenario considers that temporal disturbance (i.e. maximum duration) from construction noise has a greater effect on fish and shellfish than the maximum noise range disturbance (i.e. maximum spatial effects). |
| | Multi-leg pin piles | • No. of installations per project: 200;<br>• No. piles per installation: six;<br>• Maximum no. impact driven piles: 1200;<br>• Pile diameter: 3.5m;<br>• Indicative penetration depth: 60m;<br>• Time per pile (excluding soft-starts): three hrs;<br>• Maximum hammer blow energy: 2300kJ; and<br>• Total duration: 3600 hrs. | |
| | Met masts | • No. of installations per project: five;<br>• Maximum number impact-driven piles per foundation: four;<br>• Total no piles: 20;<br>• Pile diameter: 3.5m;<br>• Max penetration: 52m;<br>• Time per pile (excluding soft-starts): three hrs;<br>• Maximum hammer blow energy: 1900kJ; and<br>• Total duration: 60 hrs. | |
| | Offshore collector platforms | • No. of installations per project: four;<br>• Max impact-driven piles per foundation: 24;<br>• Total no piles: 96;<br>• Pile diameter: 2.75m;<br>• Max penetration: 60m;<br>• Time per pile (excluding soft-starts): three hrs;<br>• Hammer blow energy: 1900kJ; and<br>• Total duration: 288 hours. | |
| | Offshore converter | • No. of installations per project: one;<br>• Max impact-driven piles per foundation: 12;<br>• Total no piles: 12;<br>• Pile diameter: 2.75m;<br>• Max penetration: 70m;<br>• Time per pile (excluding soft-starts): three hrs; | |

| Potential effect | Design parameters for the worst case scenario | | Rationale |
|---|---|---|---|
| | | • Hammer blow energy: 1900 kJ; and<br>• Total duration: 36 hrs. | |
| | Offshore accommodation platform | • No. installations per project: two;<br>• Max impact-driven piles per foundation: 12;<br>• Total no. piles: 24;<br>• Pile diameter: 2.75m;<br>• Time per pile (excluding soft-starts): three hrs;<br>• Max penetration: 70m;<br>• Hammer blow energy: 1900 kJ; and<br>• Total duration: 72 hrs. | |
| Suspended sediment | Drill arisings from drilling monopoles | • All sediment arising from seabed preparation is assumed to be side cast; and<br>• Releases 553,000m$^3$ of sediment over the entire construction period. | As described in **Chapter 9 Marine Physical Processes** the worst case scenario is for the installation of 12m monopoles with conical GBS foundations (with the largest base plate of 55m) since these require the largest area of seabed preparation. |
| | Cable trenching | • Maximum trench dimensions 1.5m wide x 3m deep; and<br>• Releases 972,000m$^3$ of sediment over the entire construction period. | Worst case scenario assumes that the whole volume of sediment from the excavated trench is released for dispersion, regardless of excavation method. |
| Sediment deposition | Conical GBS foundation | Number of foundations 120 x 10MW WTGs. | As described in **Chapter 9 Marine Physical Processes**. |

<table>
<tr><th>Potential effect</th><th colspan="2">Design parameters for the worst case scenario</th><th>Rationale</th></tr>
<tr><th colspan="4">Operation</th></tr>
<tr><td>Introduction of hard substrate</td><td colspan="2">The introduction of new hard structures with a maximum surface area provided by the following project infrastructure:<br>• 200 x GBS foundations;<br>• GBS foundations for five x met-masts;<br>• GBS foundations for four x collector stations;<br>• GBS foundation for one x converter station;<br>• GBS foundation for two x accommodation blocks;<br>• Inter-array cable protection (incl. cable ends);<br>• Inter-platform cable protection;<br>• Inter-platform cable crossings;<br>• Export cable protection; and<br>• Export cable crossings.</td><td>Permanent habitat and community changes for sensitive fish and shellfish.<br><br>The maximum volume of introduced hard substrate results from the installation of conical GBS foundations and maximum rock berm protection footprint.<br><br>Total net volume of introduced hard substrate (rock berm) per project: maximum 7,495,928m3.</td></tr>
<tr><td rowspan="4">EMF</td><td>Inter-Array cable<br>HVAC cable</td><td>950km of 33k to 72.5kV (minimum burial of 0m).</td><td rowspan="4">The HVAC scenario provides the maximum EMF output for each project.<br><br>Maximum of 400kV HVAC cable.<br><br>Minimal burial depth of 0m.<br><br>Worst case estimate for length of unburied cable is 168.5km for Dogger Bank Teesside A and 150.9km for Dogger Bank Teesside B.<br><br>Worst case estimate for length of unburied inter-array and platform cables =20%.</td></tr>
<tr><td>Inter-Platform cable<br>HVAC cable</td><td>Maximum of eight cables with a total length of 320km of 132-400kV (minimum burial of 0m)</td></tr>
<tr><td>HVAC cable</td><td>Maximum of cables with a total length of 320km of 132-400kV (minimum burial of 0m).</td></tr>
<tr><td>Export cable<br>HVDC cable</td><td>• Dogger Bank Teesside Project A max total length: 573km.<br>• Dogger Bank Teesside Project B max total length: 484km.<br>• Unbundled cables.</td></tr>
</table>

| Potential effect | Design parameters for the worst case scenario | | Rationale |
|---|---|---|---|
| **Operation** | | | |
| Suspended sediment and sediment re-deposition | Conical GBS foundation | 200 x 6MW turbines with minimum spacing. | As described in **Chapter 9 Marine Physical Processes** the worst case scenario layout is a grid of foundations that fills each project area providing maximum potential for creation of high suspended sediment plumes. |
| | Scour | • Typical operational scour volume: 3-29$m^3$ per foundation.<br>• Typical operational scour plan area: 26-85$m^2$. | Worst case operational scour volumes for the conical GBS foundations. |
| Operational noise | WTG | 200 x 6MW turbines with minimum spacing (750m). | This was deemed to represent worst case due to the increased number of wind turbines, and the closer spacing, resulting in greater summation of the noise. |
| | Operation and Maintenance vessels | Maximum of 26 vessels per project per year. | |
| Permanent loss of seabed habitat resulting from installation of artificial structures (including foundations, cable protection, scour protection and vessel moorings) | Maximum footprint of permanent habitat loss assessed as 6.407.509km2 which represents 0.97% of the overall area of Dogger Bank Teesside A (main site and Dogger Bank Teesside A & B Export Cable Corridor) and 6.13$km^2$ which represents 0.89% of Dogger Bank Teesside B.<br><br>• GBS foundations * for 200 10MW WTGs (1.005$km^2$);<br>• GBS foundations for five x met-masts (0.023$km^2$);<br>• GBS foundations for four x collector stations (0.036$km^2$);<br>• GBS foundation for one x converter station (0.017$km^2$);<br>• GBS foundation for two x accommodation blocks (0.035$km^2$);<br>• Footprint of 10 x vessel moorings and buoy chains (0.470$km^2$);<br>• Inter-array cable protection (incl. cable ends) (1.000$km^2$);<br>• Inter-platform cable protection (1.000$km^2$);<br>• Inter-platform cable crossings (0.147$km^2$);<br>• Export cable protection 2.570$km^2$ (Dogger Bank Teesside A) /2.300$km^2$ (Dogger Bank Teesside B); and<br>• Export cable crossings (0.098$km^2$). | | The worst case scenario for loss of seabed habitat assumes the maximum seabed footprint and maximum area of permanent habitat loss. Maximum footprint incorporates the foundation type with the largest foundation footprint and jetting as the cable burial technique which causes the largest area of seabed disturbance. |

| Potential effect | Design parameters for the worst case scenario | Rationale |
|---|---|---|
| **Operation** | | |
| | * all footprints for foundations inclusive of scour protection. | |
| Changes in fishing activity | As described in **Chapter 15 Commercial Fisheries**. | |
| **Decommissioning** | | |
| Noise | Similar to construction. | |
| Loss of species | As per details (above) for loss of permanent habitat during operation. | Assume that all project infrastructure above seabed level will be removed during decommissioning. |
| Increased suspended sediment concentration and sediment deposition | As per details (above) for increased suspended sediment concentration and sediment. | 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. |
| Temporary disturbance to habitats via removal of cables | • Removal of up to 950km of inter array cables;<br>• Removal of up to 320km of inter platform cables; and<br>• Removal of up to 573km of export cables. | Assume that all cables will be removed during decommissioning. |

## 5.3. Construction scenarios

5.3.1. The specific timing of the construction of Dogger Bank Teesside A & B will be determined post consent and, therefore, a Rochdale Envelope approach has been undertaken for the EIA. There are a number of key principles relating to how the two 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 time, either project could be built first;
- If built at different times with the first project taking six years, then second project taking six years, with a six month overlap gives 11 years and six months duration of continuous construction;
- Offshore construction will commence no sooner than 18 months post consent, but must start within seven years and finish within thirteen years of consent (as an anticipated condition of the development consent order); and
- Assuming a maximum construction period of six years for each project, and taking the above into account, the maximum construction period over which the offshore construction of Dogger Bank Teesside A & B could take place is eleven and a half years.

5.3.2. 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.

5.3.3. 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 scenarios. The three construction scenarios for Dogger Bank Teesside A & B that have been considered within the fish and shellfish ecology assessment are therefore:

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

5.3.4. For each potential impact only the worst case construction scenario for two Dogger Bank Teesside A & B projects is presented. In the case of the fish and shellfish ecology assessment, it has been assumed that sequential rather than concurrent construction of the two projects constitutes the worst case scenario. This would result in fish and shellfish receptors being disturbed for up to 11 years and six months as opposed to up to six years if concurrent construction was undertaken. Given the proximity of Dogger Bank Teesside A & B and their relative homogeneity in terms of the fish and shellfish assemblage, this scenario would potentially affect the largest number of year classes and spawning events of relevant species. On this basis, this scenario is considered to have the greatest potential to result in detrimental impact on fish and shellfish receptors.

5.3.5. As such, the construction scenarios presented within the impact assessment sections of this chapter (Section 6) are:

- Single project – either Dogger Bank Teesside A or Dogger Bank Teesside B being built in isolation; and
- Two projects – sequential Dogger Bank Teesside A or Dogger Bank Teesside B being built then a gap and the construction of the other commencing.

5.3.6. Each potential impact listed above, has been assessed separately for Dogger Bank Teesside A, Dogger Bank Teesside B, Dogger Bank Teesside A & B combined. Where relevant, potential effects have also been described separately for the Dogger Bank Teesside A & B Export Cable Corridor. It should be noted that given the relative homogeneity of Dogger Bank Teesside A & B and to a lesser extent, the Dogger Bank Teesside A & B Export Cable Corridor in terms of the presence of key fish and shellfish receptors, where relevant, it has been assumed that the assessment carried out for Dogger Bank Teesside A also applies to Dogger Bank Teesside B, Dogger Bank Teesside A & B, and in some instances the Dogger Bank Teesside A & B Export Cable Corridor.

## 5.4. Operation scenarios

5.4.1. **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.

5.4.2. As set out under the construction scenarios above, where relevant, it has been assumed that the assessment carried out for Dogger Bank Teesside A also applies to Dogger Bank Teesside B, Dogger Bank Teesside A & B and in some instances the Dogger Bank Teesside A & B Export Cable Corridor.

## 5.5. Decommissioning scenarios

5.5.1. **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 DECC 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.

# 6. Impacts during Construction

## 6.1. General

6.1.1. The following potential impacts associated with the construction phase are assessed below:

- Direct effects of temporary disturbance to the seabed potentially resulting in displacement and physiological damage to fish and shellfish;
- Indirect effects of increased suspended sediment concentrations and sediment re-deposition resulting from temporary seabed disturbance; and
- Indirect effects of underwater noise caused by installation activities.

6.1.2. It is recognised that, in addition to the potential impacts identified above, a progressive loss of seabed habitat will occur as construction works advance and wind farm related infrastructure is progressively installed. Since it is expected that the full impacts of the introduction of hard substrate will be most apparent during the operation phase rather than during construction, the introduction of hard substrate is assessed with other operational impacts in Section 7 of this chapter.

6.1.3. It should also be noted that the assessment of impacts during construction takes account of any relevant embedded mitigation as identified in Section 3.3.

## 6.2. Temporary physical disturbance/loss of seabed habitat – direct effects

6.2.1. Physical disturbance resulting from cable installation and seabed preparation for foundations (for example, the placement and deployment of jack up vessel legs) will potentially affect fish and shellfish, particularly species of limited mobility. However, during this activity, habitat disturbance/loss will be temporary, localised and potentially reversible.

6.2.2. A maximum area 21.7 $km^2$ of seabed habitat within Dogger Bank Teesside A and 20.87$km^2$ of seabed habitat within Dogger Bank Teesside B will be temporarily disturbed or lost during the construction phase of each project (see **Table 5.2**). During the construction period, potential disturbance is expected to be localised and of relatively short duration. Considering the relatively small area directly affected and the intermittent and reversible nature of the effect, the magnitude of temporary seabed disturbance during construction activities for Dogger Bank Teesside A, Dogger Bank Teesside B and Dogger Bank Teesside A & B is considered to be low.

6.2.3. The deployment of jetting or ploughing techniques provides the worst case scenario for the installation of the unbundled cables in the Dogger Bank Teesside A & B Export Cable Corridor. These methods would potentially disturb a total area of 5.73 km2 of seabed habitat for Dogger Bank Teesside A and 4.84 $km^2$ for Dogger Bank Teesside B (see **Table 5.2**). Given that the area of seabed disturbance is relatively small and the disturbance is temporary, reversible as well as localised in extent, the magnitude of temporary habitat disturbance due to installation of the cable corridor is considered to be low.

6.2.4. The potential impacts of the construction phase on the benthos have been considered for assessment in **Chapter 12**.

# 6.3. Temporary physical disturbance/loss of seabed habitat – impacts on fish and shellfish

## Direct impacts on eggs and larvae

6.3.1. Since, by definition, pelagic organisms are resident in the water column, it is not anticipated that there will be an effect-receptor interaction between pelagic fish eggs, pelagic fish or pelagic shellfish larval receptors and the effect of temporary physical disturbance /loss of seabed habitat. Since there is no apparent impact pathway for temporary physical disturbance/ loss of seabed habitat to impact on pelagic eggs and larvae they are scoped out of the assessment.

6.3.2. Lesser sandeel spawn on the seabed in the vicinity of their burrows between December and January. The benthic eggs are adhesive and attach themselves to grains of sand. Currents often cover the eggs with sand to a depth of a few centimetres, but laboratory experiments have shown that the eggs are still capable of developing normally and they hatch as soon as the current uncovers them again (Winslade, 1971). Buried eggs experience reduced current flow and lower oxygen tension which may result in delaying the hatching period but this is considered to be a necessary adaptation to their continued survival in a dynamic environment (Hassel *et al.* 2004). Eggs hatch in February and March (Wright and Bailey 1996) and the larvae are planktonic. Juvenile sandeel adopt a demersal habit after two to five months (Conway *et al*. 1997). Construction activities resulting in disturbance or loss of the preferred habitat for sandeel has the potential to impact on the stock of the Dogger Bank SA1 sandeel stock (see **Appendix 13A** for a description of North Sea sandeel stocks and the ICES stock management designations for sandeel).

6.3.3. The Banks herring stock spawns in the North Sea between August and October. The demersal eggs are deposited over coarse sand and gravel and adhere to the substrate, forming dense mats several centimetres thick. In parts the spawn may be very dense and Bowers (1969) has reported it to be up to nine eggs deep in the thickest parts. Both Bowers (1969) and Parrish *et al.* (1959) have noted that the eggs in the bottom layers of such patches are less advanced in development than those in the surface layers, although there appears to be little difference in mortality between layers. Thus although the eggs may not be buried in the substrate they may be just as effectively 'buried' under other eggs where they are likely to experience lower oxygen concentrations and flow rates of water. The spawn of Blackwater herring may be uncovered for up to 1.5 hours at extreme low water springs and normal hatching can occur after exposure of the eggs to the atmosphere for seven hours (Winslade 1971). This suggests that the observed ability of the eggs to withstand low oxygen concentrations by retardation of development may be related to the conditions they experience during development. Winslade (1971) proposes that, where the eggs are several layers deep, the slower development of those in the bottom layers would ensure that they did not hatch until after those in the surface layers. Eggs typically hatch into pelagic larvae within seven to ten days, depending on the water temperature. It is anticipated that disturbance or loss of herring spawning habitat, particularly in the inshore Flamborough spawning grounds, has the potential to affect herring eggs and larvae. This is further discussed in section 6.3.24 and the current ICES advice for herring in the North Sea is described in section 6.2.1 of **Appendix 13A**.

6.3.4. The eggs of the principal shellfish species in the Dogger Bank Zone, such as edible crab, lobster, and *Nephrops* remain attached to the abdomen of ovigerous females until hatching. Egg-bearing edible crabs and *Nephrops* typically remain buried in sediment for periods ranging from four to nine months, depending on the species. There is evidence to suggest that trawling for *Nephrops* can result in substantial egg loss through abrasion (Chapman and Ballantyne 1980) while the rate of egg loss is increased for berried velvet crabs that sustain physical damage during capture (Norman and Jones 1993). However, shellfish have adopted a reproductive strategy of high egg production to compensate for losses during egg extrusion and the extended incubation period (McQuaid *et al.* 2009).

6.3.5. Depending on the temporal and spatial extent of construction activities the resultant temporary physical disturbance of the seabed may affect eggs laid on the seabed by benthic spawning fish as well as the egg masses of shellfish such as *Nephrops*, lobsters and edible crab.

### Dogger Bank Teesside A

6.3.6. The total area of Dogger Bank Teesside A is 662.07km$^2$ (including the 1km temporary works buffer). Up to 15.33km$^2$ (2.32%) of temporary seabed habitat loss/disturbance is predicted to occur during the construction period (**Table 5.2**), representing a comparatively small area of the extensive fish spawning and nursery areas of the majority of benthic species potentially affected by construction activities, therefore the scale of the potential effect-receptor interaction is anticipated to be small.

6.3.7. With the exception of sandeel and herring, the majority of benthic fish egg receptors are deemed to be of low vulnerability, high recoverability and of local or regional importance within the study area. The sensitivity of these receptors is, therefore, deemed to be low. The magnitude of the effect is considered to be low, therefore the effect on benthic fish egg receptors is considered to result in a **minor adverse** impact.

6.3.8. Sandeel is a demersal spawner and the results of fish and shellfish characterisation surveys show that they are patchily distributed in tranches A and B. According to generalised maps of Coull *et al*. (1998) and Ellis *et al*. (2010), Dogger Bank Teesside A & B fall within a high intensity spawning grounds for sandeel. However the results of the sandeel specific survey showed that the distribution of lesser sandeel was patchy within the project boundary, and the abundance of this species was lower in Tranche B compared to that found in Tranche A (see **Appendix 13A**). The spatial extent of sandeel habitat can also be inferred from the distribution of Danish VMS data (Jensen *et* *al.* 2011) and although the fishing grounds are believed to represent the major areas of sandeel distribution in the North Sea it is reasonable to expect that smaller patches of additional suitable habitat exist (Bergstad *et al.* 2001). Danish VMS data as a proxy for sandeel distribution indicates that there are no areas of preferred sandeel habitat within Dogger Bank Teesside A and that only 71km$^2$ of suitable habitat is present within Dogger Bank Teesside B (see **Appendix 13G**). Although the sandeel specific survey recorded the presence of lesser sandeel at sites within Dogger Bank Teesside A & B, the Danish VMS data suggests that their distribution is sufficiently patchy that commercial sandeel fishing is not presently viable within Tranche B. Sandeel eggs are considered to be receptors of medium vulnerability, medium recoverability and of regional importance the sensitivity of sandeel eggs is considered to be medium. As previously mentioned, the magnitude of the effect is low, resulting in an assessment of **minor adverse** impact.

6.3.9. An estimated area of 168.46km$^2$ of the south eastern sector of Dogger Bank Teesside A overlaps with the historic herring spawning ground (**Appendix 13G**). No active herring spawning has been recorded in this area since the late1970s. The total area of the historic ground as defined by Coull *et al*. (1998) is estimated as 14,858 km$^2$ therefore the maximum area of the historic grounds potentially affected by physical disturbance/habitat loss is equivalent to 1.13% of the total historic spawning area of the Banks herring stock. Physical disturbance of benthic herring egg mats during construction activities may potentially result in decreased egg survival. The spatial and temporal extent of the effect is proportionally small and the level of effect-receptor interaction is considered to be negligible and the magnitude is anticipated to be low.

6.3.10. Given that there is currently no spawning occurring in the historic spawning grounds (but allowing for the possibility that recolonisation may potentially occur at some future date) herring eggs are deemed to be of low vulnerability, medium recoverability and of regional importance, therefore the sensitivity of these receptors is considered to be low. When their sensitivity is considered in context of the low magnitude of the effect, the impact of temporary physical disturbance, loss of seabed habitat on herring eggs is assessed as **minor adverse**.

6.3.11. Shellfish have limited mobility and may not be capable of escaping construction activities causing physical disturbance to the seabed. In particular, the egg masses of ovigerous (egg-bearing) species would be potentially vulnerable to physical damage from construction activities. Considering that any potential physical disturbance is of a relatively short duration and the impact occurs in an offshore area where shellfish densities are low, the level of effect-receptor interaction is expected to be small. Shellfish eggs are considered to be receptors of low vulnerability, high recoverability and of regional importance within the study area. The sensitivity of these receptors is therefore considered to be low. As previously stated, the magnitude of the effect is low; therefore the resulting impact is assessed as **minor adverse**.

**Dogger Bank Teesside B**

6.3.12. The total area of Dogger Bank Teesside B is 692.97km$^2$ (including the 1km temporary works buffer). Temporary seabed habitat loss/disturbance predicted to occur during the construction period represents a comparatively small area of the extensive fish spawning and nursery areas of the majority of benthic species potentially affected by construction activities, therefore the scale of the potential effect-receptor interaction is anticipated to be small (**Table 5.2**).

6.3.13. Benthic fish egg receptors, with the exclusion of herring and sandeel, are deemed to be of low vulnerability, high recoverability and of local to regional importance within the study area and therefore their sensitivity is deemed to be low. The magnitude of the effect is considered to be low, therefore the effect of temporary loss of seabed habitat on benthic fish eggs is considered to result in a **minor adverse** impact.

6.3.14. Sandeel is a demersal spawner and the results of fish and shellfish characterisation surveys show that they are patchily distributed in tranches A and B. Dogger Bank Teesside B falls within a high intensity spawning habitat for sandeel. However, the proportion of spawning habitat for sandeel potentially affected by temporary physical disturbance/habitat loss is 0.56% of the estimated total area of preferred habitat for the Dogger Bank sandeel stock in the central North Sea SA1 management area (see **Appendix 13A**). Given the proportionally small area involved, the scale of the effect-receptor interaction at the stock/population level is small and the magnitude of the effect is judged to be low.

6.3.15. Sandeel eggs are receptors of medium vulnerability, medium recoverability and of regional importance therefore the sensitivity of sandeel eggs is considered to be medium. As previously mentioned, the magnitude of the effect is low, and the impact is anticipated to be **minor adverse**.

6.3.16. Dogger Bank Teesside B does not overlap with the historic herring spawning grounds and therefore **no impact** is expected to occur as a result of Dogger Bank Teesside B construction.

**Dogger Bank Teesside A & B**

6.3.17. As described above for Dogger Bank Teesside A and Dogger Bank Teesside B.

**Dogger Bank Teesside A & B Export Cable Corridor**

6.3.18. Up to 10.57km$^2$ of temporary physical disturbance/ seabed habitat loss is predicted to result from installation of the Dogger Bank Teesside A & B Export Cable Corridor (**Table 5.2**). It is expected that only a relatively small proportion of the extensive fish spawning and nursery areas of the majority of demersal fish species in the regional area will be affected and the scale of the effect-receptor interaction is anticipated to be small. The magnitude of the effect is considered to be low.

6.3.19. With the exception of sandeel and herring, the majority of benthic fish egg receptors are deemed to be of low vulnerability, high recoverability and of local or regional importance within the study area. The sensitivity of these receptors is therefore considered to be low and the effect of temporary loss of seabed habitat on benthic fish eggs is considered to result in a **minor adverse** impact.

6.3.20. Sandeel spawn in the areas where they reside and fish and shellfish characterisation surveys found that adult sandeels are present in the area of the

Dogger Bank Teesside A & B Export Cable Corridor. Trenching of the Dogger Bank Teesside A & B Export Cable Corridor will potentially traverse through 22.6km of sandeel preferred habitat, resulting in temporary physical disturbance/ habitat loss of 59km$^2$ or 0.47% of the total available sandeel spawning habitat of the Dogger Bank SA1 sandeel stock (**Appendix 13A** Figure 6.7 and Figure 6.8). Since the level of disturbance at the stock/population level is proportionally negligible, the level of effect-receptor interaction is anticipated to be negligible and the magnitude judged to be low. Sandeel eggs are receptors of medium vulnerability, medium recoverability and of regional importance therefore the sensitivity of sandeel eggs is considered to be medium. As previously mentioned, the magnitude of the effect is low, resulting in an assessment of **minor adverse** impact.

6.3.21. The Dogger Bank Teesside A & B Export Cable Corridor traverses a length of 27km through the inshore Flamborough herring spawning area as defined by Coull *et al*. (1998). Assuming trenching as a worst case scenario, the cable corridor will potentially impact an area of 0.84km$^2$, equivalent to less than 0.01% of the total area of the inshore Flamborough spawning grounds. It is anticipated that the level of effect-receptor interaction will be negligible given the small proportion of herring spawning habitat potentially affected by construction activities (**Figure 6.4** and **Figure 6.5**).

6.3.22. ICES (2013) advises that the North Sea stock of autumn spawning herring is currently in a low productivity phase as the survival ratio between newly hatched larvae and recruits have been lower than during the years prior to 2001.

6.3.23. ICES stock advice (ICES 2013) considers that herring spawning and nursery areas can be sensitive and vulnerable to certain anthropogenic influences such as marine aggregate dredging.

6.3.24. The Dogger Bank Teesside A & B Export Cable will impact an estimated area equivalent of 0.01% of the total area of the Flamborough spawning grounds. Furthermore the duration of the effect will be short term and it is not expected that cable burial will materially alter the substrate composition. Therefore unlike aggregate dredging, there will not be a significant loss of spawning area. As a result, herring eggs are deemed to be receptors of low vulnerability, medium recoverability and of regional importance, therefore their sensitivity is considered to be low. Combined with the low magnitude of the effect, the impact of temporary physical disturbance/loss on herring eggs is considered to be **minor adverse**.

6.3.25. The Dogger Bank Teesside A & B Inshore Export Cable Corridor Study Area traverses a coastal area where shellfish such as *Nephrops*, edible crab, lobsters and velvet crab support valuable commercial fisheries. As outlined in Section 6.3.4, temporary physical disturbance to the seabed habitat may adversely impact on the egg masses of ovigerous/over-wintering females. Shellfish eggs are considered to be receptors of medium vulnerability, high recoverability and of regional importance within the study area. The sensitivity of these receptors is therefore considered to be low. As previously stated, the magnitude of the effect is low, therefore the resulting impact is **minor adverse**.

## Adult and juvenile fish and shellfish

6.3.26. Potential direct impacts on adult and juvenile fish and shellfish can take the form of physical disturbance to foraging and over-wintering habitats and lethal damage or physical trauma caused by contact with construction gear.

6.3.27. In general, mobile fish (such as herring) are expected to be able to avoid temporary disturbance. Sandeel, however, is a relatively sedentary species, remaining in burrows during the winter months. Due to their preference for sand habitats with a weight fraction of silt and clay less than 2%, their distribution is patchy but widespread throughout the North Sea. Van Deurs *et al.* (2008) found no evidence for anthropogenic disturbance of sandeel habitats by offshore beam trawling. In addition a reduction in the silt and clay fraction of sediment following the construction of the Horns Rev Offshore Wind Farm resulted in a short term increase in the density of juvenile and adult sandeel (Van Deurs *et al*. 2012). However, ICES has advised that sandeel is vulnerable to localised depletion and while some evidence suggests that they can recolonise rapidly in some areas (Greenstreet *et al.* 2010), particular banks may take years to recover (ICES 2010).

6.3.28. During the consultation process, the MMO responded that "…*there may be some degree of adverse impact on resident sandeel during the construction phase, particularly if construction takes place during and for a period after spawning*" and further "*but given the relatively lower numbers of sandeel seemingly present, coupled with the comparatively small geographically area in question, the overall impact on sandeel distribution in the long term is likely to be minimal. Thus, no further mitigation is required at this time*" (11/06/2013, case reference: REN329).

6.3.29. Since most shellfish species are less mobile than fish species this makes them potentially vulnerable to the effects of construction activities. It should however, be considered that commercially targeted decapods such as crab, lobster and *Nephrops* are mobile, active predator/scavengers with relatively large body sizes. For example, the Marine Life Information Network (MarLIN) reports sensitivity scores for some shellfish species[3] which reflect their tolerance of habitat disturbance (see **Table 6.3**). Edible crab are rated as having a low sensitivity score for physical disturbance due to their tolerance to displacement and their high population recoverability rates. Ovigerous over-wintering females are vulnerable to physical disruption due to their habit of remaining buried and relatively immobile during the brooding period. However those that escape physical impacts will quickly recolonise the remaining habitat (Bennett 1995). Similarly, *Nephrops* is assigned a low MarLIN sensitivity score to physical disturbance as a consequence of its high recovery rate. The impact on *Nephrops* of temporary loss/ physical disturbance is assessed in 6.3.33 and 6.3.39. *Nephrops* have a high level of tolerance to disturbance and generally demonstrate a rapid recovery following displacement. *Nephrops* will re-establish burrows within two days provided they do not sustain physical damage (Marrs *et al*. 1998). A significant proportion of burrows on a given ground are likely to be unoccupied as *Nephrops* are known to move between these sites (Chapman

[3] Note that MarLIN only provides sensitivity scores for VER's of crab and *Nephrops*

and Rice 1971). Experimental research in the Bay of Biscay on *Nephrops* has shown a relatively high discard survival rate, demonstrating that 62% of individuals classified as 'moribund' returned to 'healthy' within three days of re-submersion in the field. That these samples could have been in the in the cod end of the trawl for potentially up to one hr 55 minutes and on deck (out of the water) from 12 minutes to  hours 10 minutes, suggests that *Nephrops* is relatively robust to physical disturbance. In this study it was also found that females had a higher survival rate than males (Mehault, *et al.* 2011). Given that the main *Nephrops* fishery is to the north of the Dogger Bank Teesside A & B Export Cable Corridor, it is anticipated that the proportion of *Nephrops* habitat affected is likely to be small in the context of the wider availability of suitable habitat in the central North Sea.

**Dogger Bank Teesside A**

6.3.30. Most mobile fish species are expected to avoid areas of physical disturbance and move to adjacent areas where there is no physical disturbance or temporary loss of seabed habitat. The potential level of interaction between the effect and the receptor is anticipated to be small. With the exception of sandeel and shellfish, most juvenile and adult fish receptors in the study area are deemed to be of low vulnerability, high recoverability and of local to international importance. The sensitivity of these receptors to physical disturbance/temporary loss of seabed habitat is low. As previously described, the magnitude of the effect is low and the impact is assessed to be **minor adverse**.

6.3.31. Sandeel is patchily distributed in the vicinity of Dogger Bank Teesside A. The highest densities occur along the western boundary of Tranche A, outside the footprint of the foundation layout of Dogger Bank Teesside A & B. The distribution of sandeel fishing effort indicates that there is widespread availability of preferred habitat adjacent to areas which may sustain temporary loss of seabed habitat. Their foraging habitat is widespread, covering approximately 5% of the total area of the North Sea and there is evidence to suggest that there is considerable mixing within fishing grounds at scales less than 28km (Jensen *et al*. 2011). The total area of preferred sandeel habitat within the Dogger Bank SA1 sandeel management area is estimated to be approximately 12,675km$^2$ (see **Appendix13G**). Evidence from Particle Size Analysis of grab samples from Dogger Bank Teesside A indicates the presence of preferred sandeel habitat (see **Appendix 13A**) and lesser sandeel were present in characterisation surveys. However, the low level of commercial fishing activity in this area suggests that the relative abundance of sandeel is low and their distribution is patchy. Note that all estimates of the spatial extent of preferred sandeel habitat presented above are based on the approach of Jensen *et al*. (2011) and are further discussed in **Appendix 13G**. The limitations of this methodology are acknowledged by Jensen *et al*. (2011) and apply to the estimates of preferred sandeel habitat presented in this assessment.

6.3.32. Considering the relatively low abundance of sandeel in Dogger Bank Teesside A, the degree of effect-receptor interaction is anticipated to be small. Juvenile and adult sandeel is considered to be a receptor of medium vulnerability, high recoverability and of regional importance therefore the sensitivity is considered to be medium. When considered in terms of the low magnitude of effect which has been assigned to temporary physical disturbance/loss of seabed habitat, the impact on sandeel is considered to be **minor adverse**.

6.3.33. The principal shellfish species potentially present in Dogger Bank Teesside A include edible crab, lobster, velvet crab, whelk, King scallops *Pecten maximus* and *Nephrops*. In all cases, these species are typically more abundant in the vicinity of the inshore section of the Dogger Bank Teesside A & B Export Cable Corridor. As described previously, *Nephrops*, lobster and crab are of particular commercial importance in this area. While shellfish have limited mobility to avoid the direct effects of construction activities, they have a high level of tolerance to disturbance and they generally demonstrate a rapid recovery following displacement (see **Table 6.3**). In this case, shellfish are considered to be receptors of moderate vulnerability, high recoverability and of local to regional importance within the study area. The sensitivity of shellfish receptors is deemed to be low. Since the magnitude of the effect is low, the impact of the temporary physical disturbance/loss of seabed habitat on shellfish is predicted to be **minor adverse**.

**Dogger Bank Teesside B**

6.3.34. As described above for Dogger Bank Teesside A.

**Dogger Bank Teesside A & B**

6.3.35. As described above for Dogger Bank Teesside A and Dogger Bank Teesside B.

**Dogger Bank Teesside A & B Export Cable Corridor**

6.3.36. As described above for Dogger Bank Teesside A for adult and juvenile fish with the exception of sandeel and shellfish which are discussed below.

6.3.37. As described in **Appendix 13F**, the total area of preferred sandeel habitat within the Dogger Bank SA1 sandeel management area is estimated to be approximately 12,675km$^2$ and the estimated area affected by trenching of the Dogger Bank Teesside A & B Export Cable Corridor is 59km$^2$, equivalent to 0.47% of the total estimated area of preferred sandeel habitat within SA1. It is anticipated that temporary physical disturbance/ seabed habitat loss will affect a negligible proportion of the total SA1 sandeel population.

6.3.38. Considering the relatively low abundance of sandeel in the vicinity of the Dogger Bank Teesside A & B Export Cable Corridor, the degree of effect-receptor interaction is anticipated to be small. Juvenile and adult sandeel are considered to be receptors of low vulnerability, high recoverability and of regional importance therefore their sensitivity is considered to be low. When considered in terms of the low magnitude of impact assigned to temporary physical disturbance/loss of seabed habitat, the impact on sandeel is assessed to be **minor adverse**.

6.3.39. Shellfish support a number of important commercial fisheries in the vicinity of the Dogger Bank Teesside A & B Export Cable Corridor (see **Appendix 15A)**. The relative area of temporary physical disturbance/seabed habitat loss is small, compared to the wide distribution of these shellfish species in inshore areas in the region therefore the level of effect-receptor interaction is expected to be small. Shellfish are considered to be receptors of moderate vulnerability, high recoverability and of regional importance within the study area. The sensitivity of shellfish receptors is therefore considered to be low. When considered in terms of the low magnitude of the effect, the overall impact is assessed as **minor adverse**.

## 6.4. Suspended sediment concentrations

**Drilling and trenching**

6.4.1. The physical disturbance of the seabed associated with construction works, particularly seabed preparation and/or drilling to facilitate foundation installation in addition to cable installation methods such as jetting or ploughing will cause increased concentrations of suspended sediment and subsequent sediment re-deposition.

6.4.2. Suspended sediment concentrations and re-deposition thicknesses associated with seabed preparation for installation of conical GBS foundations and drilling to facilitate 12m monopole foundation installation are modelled in **Chapter 9. Chapter 9** shows drill arisings resulting from the installation of 12m monopoles with GBS foundations to be the worst case scenario for increased suspended sediment concentrations and sediment deposition from the plume.

6.4.3. For the purposes of plume modelling it is assumed that drill arisings for monopole installation will contain the following proportions of sediment size: 55% of the drilling volume will comprise sands (100% of which will disaggregate) and 28.7% will comprise silt and clay (70% of which will disaggregate). The remaining 16.3% of sediment will not disaggregate into its constituent particles and so will settle rapidly to the seabed without entering the sediment plume.

6.4.4. For export cable trench excavation, different techniques including jetting, ploughing, trenching, cutting, mass flow excavation and pre-sweeping (dredging) may be used. For the purposes of modelling, a conservative approach regardless of technique used is taken, where it is assumed that the whole volume of sediment from the trench dimension is released for dispersion.

6.4.5. The predicted worst case spatial extent and levels of increased suspended sediment concentrations and sediment re-deposition for drilling of 12m monopoles and installation export cable by trenching are summarised below.

### Suspended sediment concentrations from drilling and trenching

6.4.6. The background level of suspended sediment concentrations in the study area is typically 2mg/l (see **Chapter 9**). The results of coastal processes modelling, as described in **Chapter 9**, predict that maximum concentrations of suspended sediment in the bottom layer, greater than 200mg/l, will occur within the foundation layout and within a band approximately 1km and 11km on either side of the cable route. Maximum suspended sediment concentrations, measured outwards from the foundation layout, reduce to background levels of 2mg/l at distances of 40 km to the north and 40km to the south.

6.4.7. Maximum suspended sediment concentrations of 100-200 mg/l occur at two localised positions along the Dogger Bank Teesside A & B Export Cable

Corridor, near the coast and 50km offshore. Average suspended sediment concentrations are typically less than 100mg/l along the majority of the route of the Dogger Bank Teesside A & B Export Cable Corridor and maximum concentrations gradually reduce with distance from the Dogger Bank Teesside A & B Export Cable Corridor, until they are predicted to be 2mg/l (background level), up to 32km to the north and up to 18km south of the corridor.

6.4.8. Over a 30 day simulation period, a predicted sediment concentration of 50-100mg/l extended from the modelled layout along a 20km long, 9km wide band, adjacent to and north of the in-Zone cable route. Relatively small changes in average suspended sediment concentrations of up to 10mg/l are predicted along the Dogger Bank Teesside A & B Export Cable Corridor.

6.4.9. Suspended sediment concentrations of 2mg/l (i.e. background levels) are exceeded more than 90% of the simulation period time at distances up to 15km southwest of the centre of the foundations.

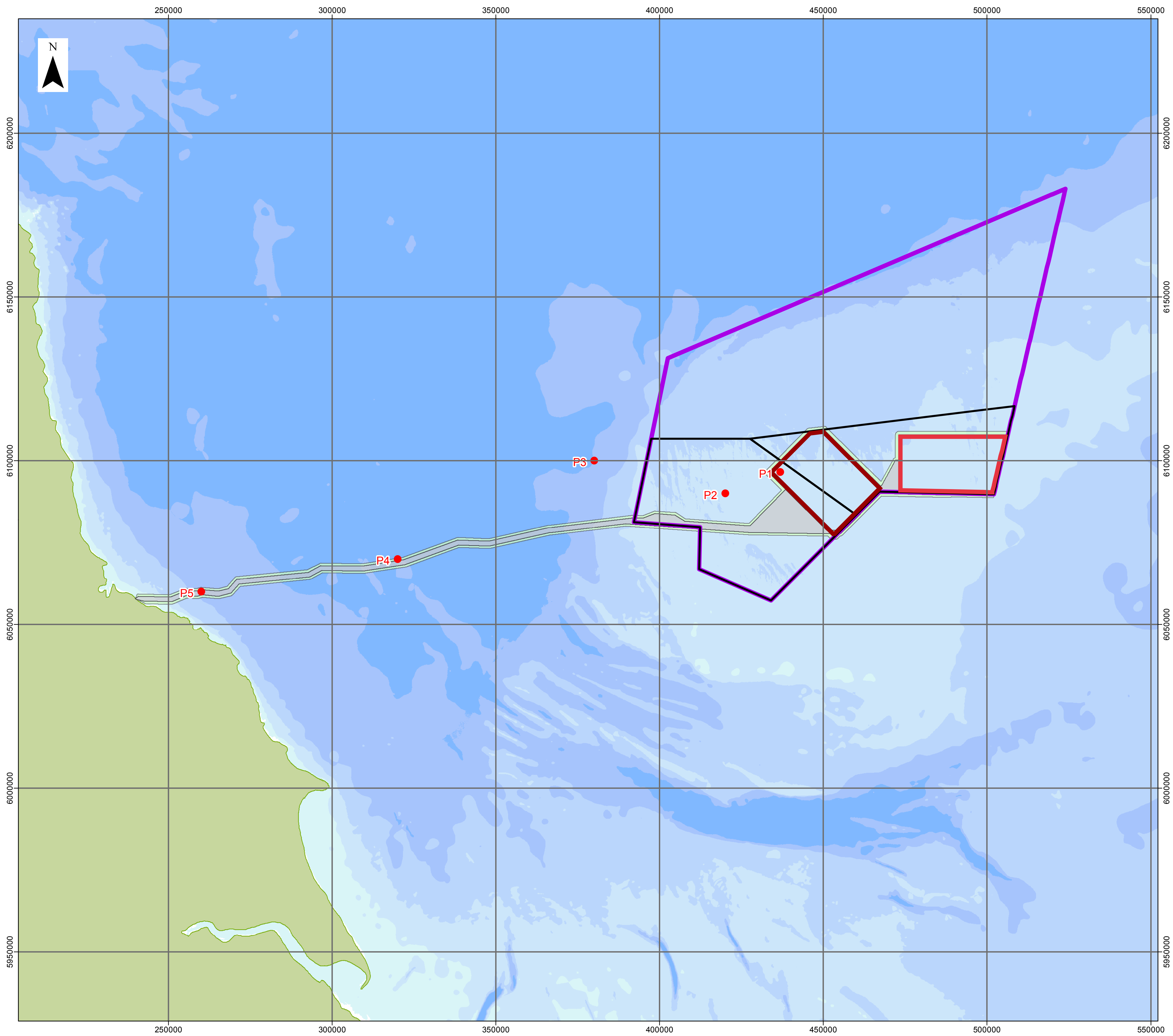
## Sediment re-deposition from drilling and trenching

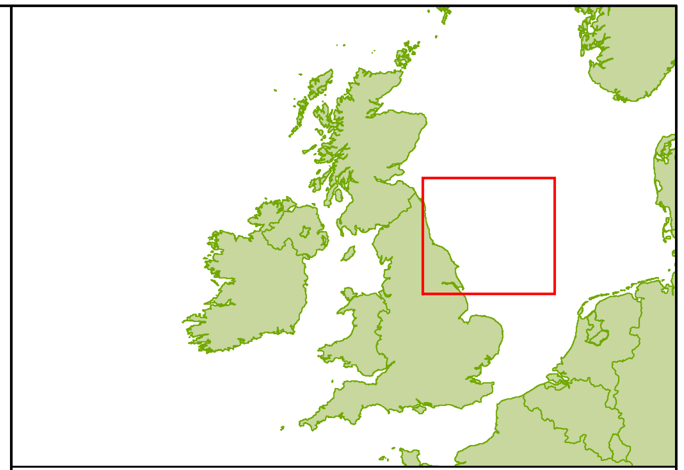
6.4.10. The maximum change in deposition of 5-50mm is predicted within the confines of the foundation layout reducing to less than 5mm along the Dogger Bank Teesside A & B Export Cable Corridor. Away from the centre of the foundations and along the export corridor, predicted maximum deposition reduces to 0.5mm up to 25km north of the corridor and outside the Zone.

6.4.11. Average deposition between 1mm and 5mm would occur within the confines of the foundations and up to 14km north of the centre of the layout, decreasing to less than 0.5mm at distances greater than 15km from the centre of the layout in the same direction.

6.4.12. The maximum length of time that sediment maintains thicknesses greater than 10mm, 7mm, 3mm and 1mm, based on time series of the plume over 30 days from points modelled at five selected points in the western section of Dogger Bank Teesside B are given in **Table 6.1**.



**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
- Sediment thickness time series analysis point

0 10 20 40
Kilometres

Data Source:
Modelling © Danish Hydraulic Institute, 2012
Background bathymetry image derived in part from TCarta data © 2009

PROJECT TITLE

*DOGGER BANK TEESSIDE A & B*

DRAWING TITLE

## Figure 6.1 Location of sediment deposition modelling studies

| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 20/09/2013 | Draft | LW | TR |
| 2 | 07/10/2013 | PEI3 | LW | TR |
| 3 | 14/02/2014 | DCO Submission | LW | TR |

DRAWING NUMBER:

**F-OFL-MA-247**

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



FOREWIND

Table 6.1 Maximum persistence of sediment thickness over the 30-day simulation period for installation of conical GBS #1 foundations

| Point | Maximum thickness (mm) | Maximum continuous time of sediment thickness (days) | | | | Thickness at end of simulation (mm) |
|---|---|---|---|---|---|---|
| | | >10mm | >7mm | >3mm | >1mm | |
| **P1** | 13.26 | 0.75 | 1.50 | 4.25 | 7.33 | <0.1 |
| **P2** | 3.11 | 0 | 0 | 0.25 | 0.92 | <0.1 |
| **P3** | 1.35 | 0 | 0 | 0 | 0.25 | <0.1 |
| **P4** | 1.26 | 0 | 0 | 0 | 0.08 | <0.1 |
| **P5** | 1.00 | 0 | 0 | 0 | 0.08 | <0.1 |

6.4.13. Within the foundation layout (Point P1), sediment thicknesses greater than 1mm persist for 7.33 days while thicknesses greater than 7mm and 10mm occur continuously for a maximum of 1.50 and 0.75 days, respectively. At Point P2, approximately 20km west-southwest of the foundation layout, the longest period for predicted sediment thicknesses to exceed 1mm is 0.92 days. Deposition thicknesses, during the simulation period, exceed 1mm for 0.25 days at Point P3, located outside the western boundary of the Dogger Bank Zone, in an area characterised by high sandeel concentrations. At Point P4 (located mid-way along Dogger Bank Teesside A & B Export Cable Corridor) and at Point P5 (approximately 20km from the coast), deposition thicknesses never exceed 1mm. At the end of the 30 day simulation period, predicted deposition thicknesses at all sites is less than 0.1mm.

6.4.14. The fate of side cast sediment resulting from seabed preparation is described in **Appendix 9A**. For installation of a conical GBS, on average about 62% of the sediment (2,279$m^3$) less than 0.18mm is suspended in the plume model and 38% greater than 0.18mm remains (1,396$m^3$) at the source position as a residual side cast mound. The non-suspended sediment will be distributed over the wider area of the seabed in the form of a sand wave with similar characteristics to existing natural sand waves. The mud fraction and the fraction of sand less than 0.18mm are assumed to disperse in the plume but the 0.18-0.25mm component will deposit at the source position. 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. The median particle size distribution of the sediment deposited at the source position (i.e. > 0.18mm) will not be significantly different from the existing surrounding seabed sediments and will remain within the fine sand classification.

6.4.15. Considering that maximum suspended sediment concentrations are broadly confined within the foundation layout and significant sediment thicknesses (i.e. 7-10mm) persist for only short periods of time (0.75-1.50 days), the magnitude of increased suspended sediment concentrations and sediment re-deposition for Dogger Bank Teesside A, Dogger Bank Teesside B and Dogger Bank Teesside A & B is considered to be low.

6.4.16. Coastal processes modelling indicates that the maximum suspended sediment level along the entire length of the Dogger Bank Teesside A & B Export Cable Corridor will not exceed background levels, with the exception of the bottom layer (<2m above the seabed) within the first 2.5 km of the landfall site (maximum suspended sediment levels of ≤150mg/l) as well as the bottom layer (<10m above the seabed) at the point where the cable connection meets the western edge of Tranche A (maximum suspended sediment levels >200mg/l). Taking into account the small overall increases in suspended sediment concentrations, the small areas affected by sediment re-deposition and the short persistence of such thicknesses within the Dogger Bank Teesside A & B Export Cable Corridor, the magnitude of the effect of increased suspended sediment concentrations and sediment re-deposition is considered to be low.

## 6.5. The effect of increased suspended sediment concentration and sediment re-deposition.

### Impact on eggs and larvae

6.5.1. Eggs and larvae are considered to be less tolerant to increased suspended sediment concentrations than later life stages and larvae are generally considered to be more sensitive than eggs (Appleby and Scarratt 1989). Most of the fish species identified as having spawning habitats within the study area are pelagic spawners, producing pelagic eggs that remain within the water column. After hatching, the larvae undergo a planktonic phase of variable duration, ranging from weeks to months depending on the species, during which time they can be transported vast distances before metamorphosing into adults. It is anticipated that the eggs and larvae of pelagic spawners and the pelagic larvae of demersal spawners will be more vulnerable to the effects of increased suspended sediment concentrations compared to the effects of sediment redeposition.

6.5.2. It is anticipated that the eggs of demersal spawning species, such as herring and sandeel, will be more vulnerable to the effects of sediment deposition and smothering compared to the eggs of pelagic spawners, such as cod, whiting, plaice, sole and sprat.

6.5.3. A laboratory study by Kiørboe *et al.* (1981) established that herring eggs suffered no adverse effects from continuous exposure to suspended sediment concentrations as high as 300 mg/l and they could tolerate short term exposure at levels up to 500 mg/l. The study concluded that herring eggs suffered no harmful effects from suspended sediment concentrations far in excess of the maximum levels expected from mining, dredging and similar operations. Studies carried out on eggs of freshwater and estuarine herring eggs hatching at suspended sediment concentrations as high as 7000mg/l (Griffin *et al*. 2009) suggested that the attachment of sediment particles on herring eggs may lead to retarded development and reduced larval survival rates at sediment concentrations as low as 250 mg/l.

6.5.4. The burial of herring eggs under a thin layer of sediment has been reported to result in substantial egg mortality (Messieh *et al*. 1981). Herring are substrate specific spawners and deposition of sediment on the seabed could potentially result in a temporary loss of spawning grounds, in the event that sediment deposition resulted in significant changes to the characteristics of the substrate. This could affect herring stocks assuming they were unable to locate their normal grounds and deposited their eggs on sub-optimal sites instead (De Groot 1980).

6.5.5. Sandeel eggs have an adhesive surface and small sediment particles released as a result of construction activities may stick to eggs, reducing the diffusion of oxygen and potentially resulting in increased egg mortality (Engel-Sørensen and Skyt 2001). However, Winslade (1971) showed that sandeel eggs are typically buried to a depth of a few centimetres and they are adapted to survive in conditions of reduced current flow and decreased oxygen levels by delaying the hatching period until they are subsequently uncovered by the current.

6.5.6. Berried crustaceans (e.g., brown crab, lobster and *Nephrops*) are likely to be more vulnerable to smothering as the eggs carried by these species require regular aeration. However, as females of all three species are ovigerous the potential for eggs to be impacted by increased suspended sediment concentrations/sediment deposition will be partially influenced by the response/tolerance of the adult to these impacts. Marine Life Information Network (MarLIN) sensitivity scores to increased suspended sediment concentrations and smothering are assessed as low for both Nephrops and edible crab (see **Table 6.5**), which is in part due to their mobile nature. The MarLIN benchmark for *Nephrops* assumes that this species is tolerant to smothering to a depth of 5cm for a period of 30 days. The results of coastal processes modelling (see **Chapter 9**) indicates that *Nephrops* nursery and spawning areas will not be subject to sediment levels of this depth or persistence.

6.5.7. Increased levels of turbidity may potentially result in fine silt particles adhering to the gills of larvae causing suffocation (de Groot 1980). Rönnbäck and Westerberg (1996) found that the mortality of cod eggs increased at suspended sediment concentrations above 100 mg/l.

6.5.8. Many species of larvae use their sight to locate prey. If increasing turbidity results in a loss of visual acuity, there is potential for increased suspended sediment concentrations to have a detrimental effect on larval foraging success. Johnston and Wildish (1981) investigated the effect of increased levels of suspended sediment on the feeding rate of different size classes of larval herring. Larval herring consumed significantly fewer food items at concentrations of 20 mg/l and smaller larvae were more affected by increased levels of suspended sediment than were larger larvae. Boehlert and Morgan (1985), in a study which exposed Pacific herring *Clupea harengus pallasi* larvae to suspensions of estuarine sediment and volcanic ash at concentrations ranging from 0 to 8000 mg/l, found that maximum feeding incidence and intensity occurred at levels of suspension of either 500mg/l for sediment or 1000mg/l for volcanic ash and that feeding decreased at greater concentrations.

6.5.9. Larvae of species such as herring, plaice, sole, turbot, and cod are thought to sight their prey at a distance of only a few millimetres (Bone and Moore 2008). There is evidence to suggest that suspended sediment may enhance feeding by providing a visual contrast to prey items on the small perceptive scale used by the larvae. In addition larval residence in turbid environments such as estuaries may serve to reduce predation from larger visual planktivores, while searching ability in the small larval perceptive field is not decreased (Bone and Moore 2008).

6.5.10. In a feeding study of larval assemblages in the southern North Sea, Pérez-Domínguez and Vogel (2010) found that the presence of larval sandeel was correlated with high levels of suspended particulate matter, including silt. The absence of silt in their stomach contents indicated that sandeel larvae were able to successfully target prey items in turbid environments.

**Dogger Bank Teesside A**

6.5.11. A number of pelagic and demersal fish species are expected to use the area of Dogger Bank Teesside A as a spawning and/or nursery ground. Eggs and larvae of the majority of fish species present in the area are distributed over large areas in comparison to those areas where high suspended sediment concentrations may potentially occur.

6.5.12. Results of modelling presented in **Chapter 9** predict that, within an average water depth of 34m, the maximum levels of suspended sediment are confined to a base layer confined within 10m of the seabed and within 4m of the surface. The model predicts that the suspended sediment concentration will not exceed 15mg/l in a stratified mid-layer comprising approximately 58% of a 34m deep cross-section of the water column.

6.5.13. As a result, assuming uniform vertical distribution of fish eggs and larvae, the model predicts that the sediment plume could potentially affect ~50% the fish egg and larvae receptors present in the water column. Realistically, the level of temporal and spatial interaction between the effect of elevated suspended sediment concentrations and fish egg and larval receptors will depend on the extent of diurnal vertical migration, larval behaviour and the presence of stable retention zones in the study area. However, this interaction is anticipated to be localised and temporary.

6.5.14. The effect of sediment re-deposition has the potential to affect species such as herring and sandeel which deposit benthic eggs on or in the substrate. As described in the **Appendix 13A**, the defined herring spawning grounds in the area of Dogger Bank Teesside A are not currently active but they may be potentially re-colonised in the future. Given the outputs of physical processes modelling (**Chapter 9**), there is potential for some sediment deposition to occur within discrete areas of the historic grounds (**Figure 6.4** and **Figure 6.5**). The survival and development of herring eggs has been reported to be unaffected by suspended sediment concentrations considerably higher than the maximum levels anticipated for Dogger Bank Teesside A. Conversely, smothering is likely to be detrimental in the short term (Birklund & Wijsman 2005). Considering that only a small proportion of the total area of historic spawning grounds will potentially be affected by increased levels of sediment redeposition, the degree of effect-receptor interaction is considered to be low.

6.5.15. Assuming that the historic spawning ground is re-colonized, herring eggs are deemed to be receptors of low vulnerability, medium recoverability and of regional importance, therefore the sensitivity of these receptors is considered to be low. As previously described the magnitude of the effect is considered to be low, therefore the impact is assessed as **minor adverse**.

6.5.16. Dogger Bank Teesside A is situated within an area designated as a high intensity sandeel spawning and nursery ground. During construction, maximum sediment deposition thickness is not expected to exceed 5mm and this will reduce to negligible levels within 30 days. It is not anticipated that sediment deposition during the construction phase will result in changes to the substrate characteristics in the study area. Less than 1% of high density, sandeel spawning habitat is anticipated to be affected by increased suspended sediment concentrations and sediment re-deposition (**Figure 6.6** and **Figure 6.7**). It is considered that the effect will be intermittent, short-term and will temporarily affect a proportionally small percentage of the eggs and larvae of the of Dogger Bank SA1 sandeel population.

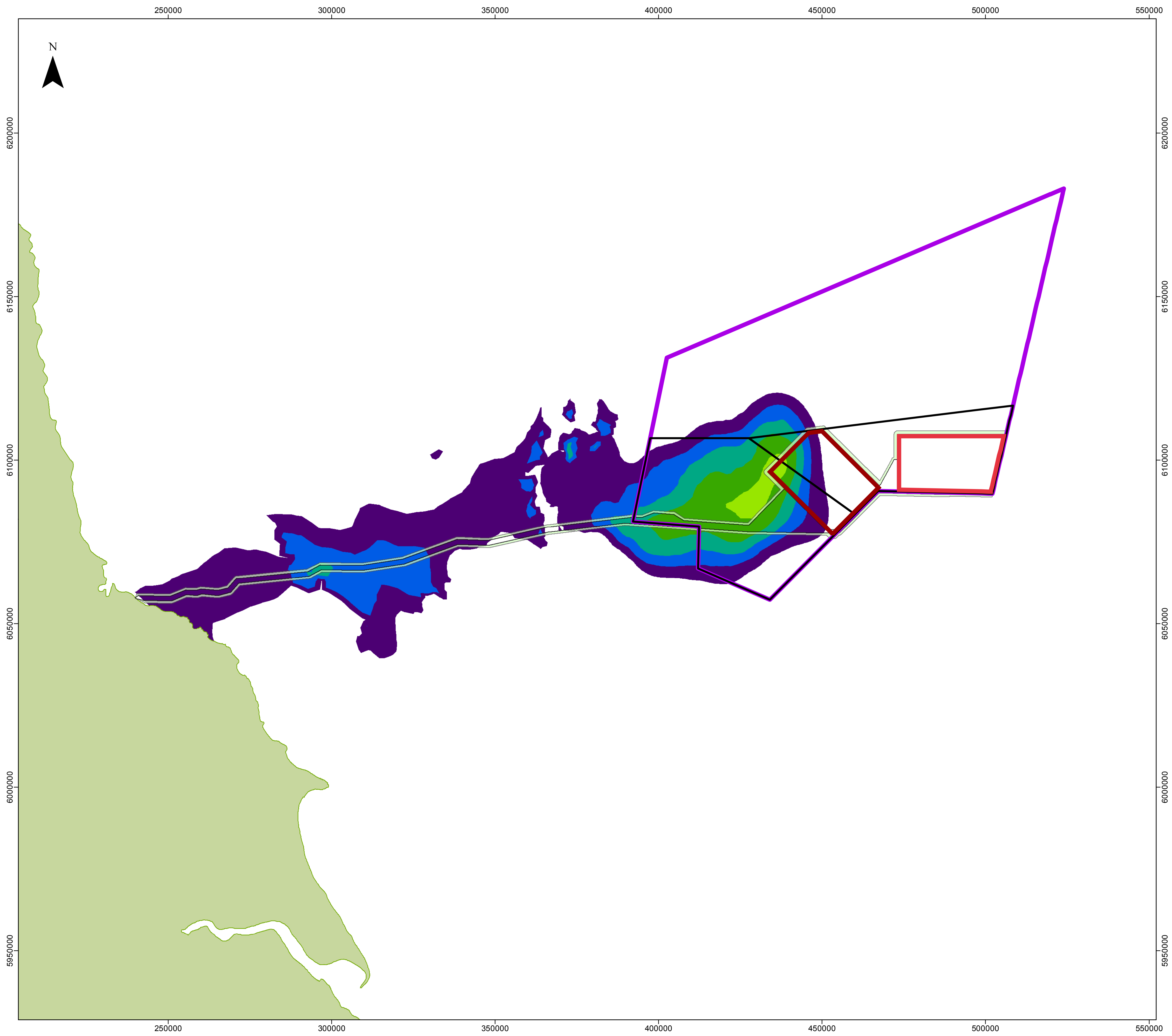
6.5.17. Considering the limits of the spatial and temporal extent of the effect of suspended sediment concentrations in areas where sandeel eggs are expected to occur, the level of effect-receptor interaction is anticipated to be small. Sandeel eggs are deemed to be receptors of low vulnerability, medium recoverability and of regional importance therefore the sensitivity of sandeel eggs is considered to be low. As previously described the magnitude of the effect is considered to be low therefore the impact is assessed as **minor adverse**.

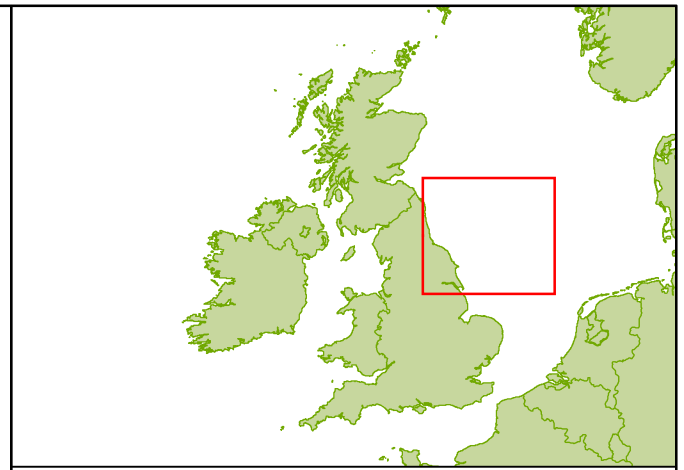
**Dogger Bank Teesside B**

6.5.18. As per Dogger Bank Teesside A with the exception of herring (see below).

6.5.19. Modelling studies on the potential effects of construction on sediment processes (see **Chapter 9)** show that there is little potential for herring eggs in the former spawning grounds to be affected by sediment re-deposition (**Figure 6.4** and **Figure 6.5**). The degree of interaction between sediment deposition and herring eggs is considered to be small. Assuming that the historic ground is re-colonised, herring eggs are deemed to be receptors of low vulnerability, medium recoverability and of regional importance, therefore the sensitivity of these receptors is considered to be low. As previously described, the magnitude of the effect is considered to be low therefore the impact is assessed as **minor adverse**.



**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

Suspended sediment concentration kg/m³

- Above 0.200
- 0.100 - 0.200
- 0.050 - 0.100
- 0.020 - 0.050
- 0.010 - 0.020
- 0.005 - 0.010
- 0.002 - 0.005
- Below 0.002

0 10 20 40
Kilometres

Data Source:
Modelling © Danish Hydraulic Institute, 2013
Background bathymetry image derived in part from TCarta data © 2009

PROJECT TITLE

*DOGGER BANK TEESSIDE A & B*

DRAWING TITLE

**Figure 6.2 Average modelled suspended sediment concentration over the simulation period of 30 days**

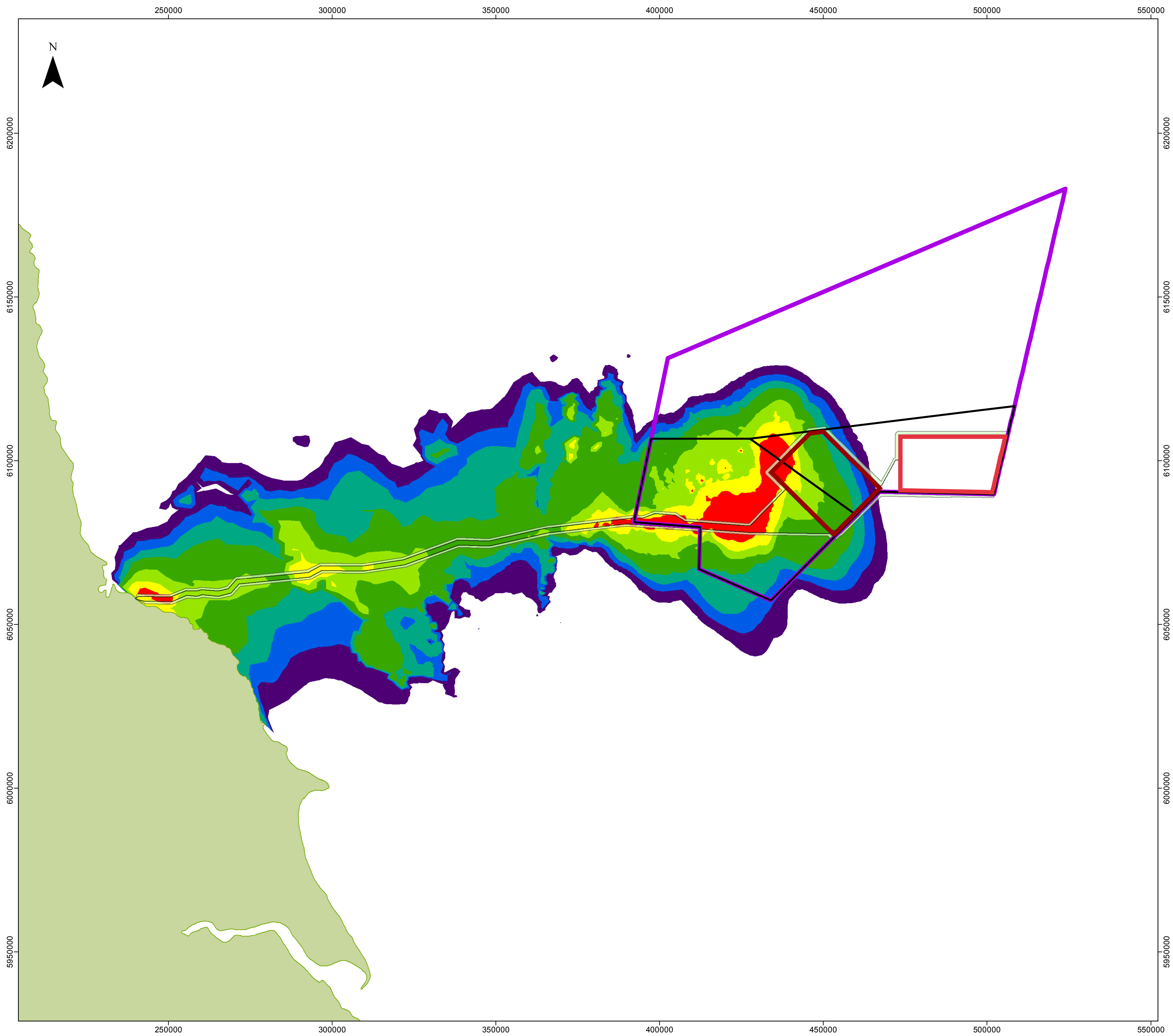
| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 08/10/2013 | PEI3 | LW | TR |
| 2 | 14/02/2014 | DCO Submission | LW | TR |
| | | | | |

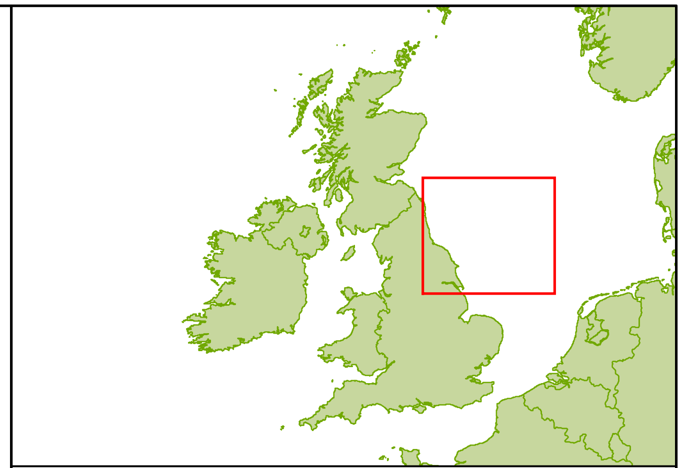
DRAWING NUMBER: **F-OFL-MA-248**

| SCALE | 1:1,200,000 | 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

Suspended sediment concentration kg/m³

- Above 0.200
- 0.100 - 0.200
- 0.050 - 0.100
- 0.020 - 0.050
- 0.010 - 0.020
- 0.005 - 0.010
- 0.002 - 0.005
- Below 0.002

0 10 20 40
Kilometres

Data Source:
Modelling © Danish Hydraulic Institute, 2013
Background bathymetry image derived in part from TCarta data © 2009

PROJECT TITLE

*DOGGER BANK TEESSIDE A & B*

DRAWING TITLE

**Figure 6.3 Maximum modelled suspended sediment concentration over the simulation period of 30 days**

| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 08/10/2013 | PEI3 | LW | TR |
| 2 | 14/02/2014 | DCO Submission | LW | TR |
| | | | | |

DRAWING NUMBER: **F-OFL-MA-249**

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



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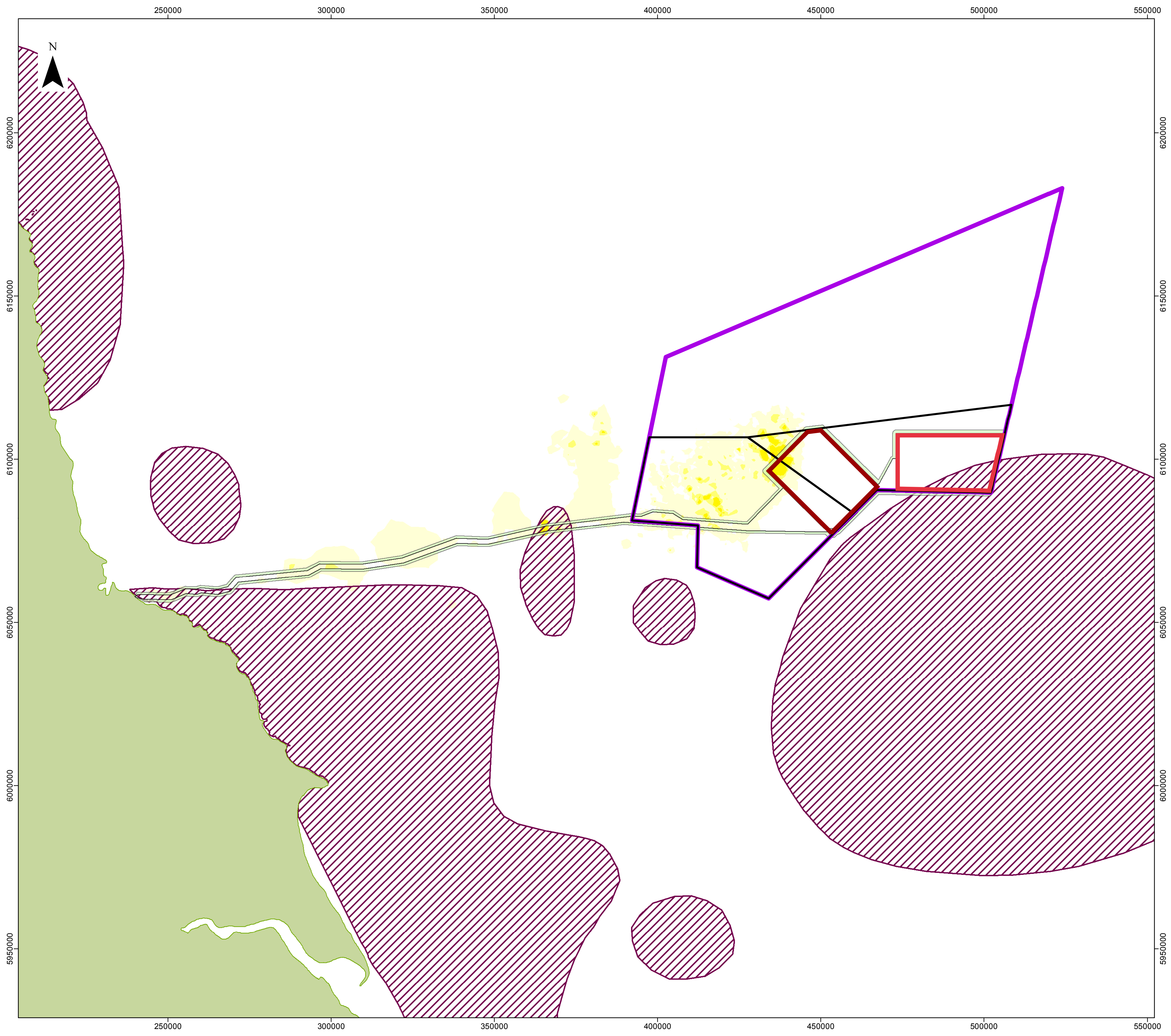
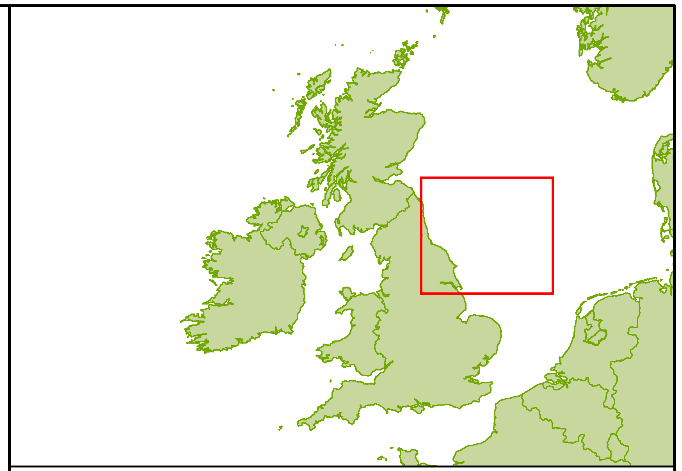


**LEGEND**

- Dogger Bank Zone
- Tranche boundary
- Dogger Bank Teesside A
- Dogger Bank Teesside B
- Dogger Bank Teesside A & B Export Cable Corridor
- Temporary works area
- Herring spawning ground (Coull *et al.* 1998)

Sediment thickness (m)

- Above 0.1000
- 0.0500 - 0.1000
- 0.0100 - 0.0500
- 0.0050 - 0.0100
- 0.0010 - 0.0050
- 0.0005 - 0.0010
- 0.0001 - 0.0005
- Below 0.0001

0 10 20 40
Kilometres

Data Source:
Modelling © Danish Hydraulic Institute, 2013
Spawning Grounds © Cefas, 2012
Background bathymetry image derived in part from TCarta data © 2009

PROJECT TITLE

*DOGGER BANK TEESSIDE A & B*

DRAWING TITLE

**Figure 6.4 Herring spawning grounds and average sediment deposition thickness over the 30 day simulation period**

| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 08/10/2013 | PEI3 | LW | TR |
| 2 | 14/02/2014 | DCO Submission | LW | TR |

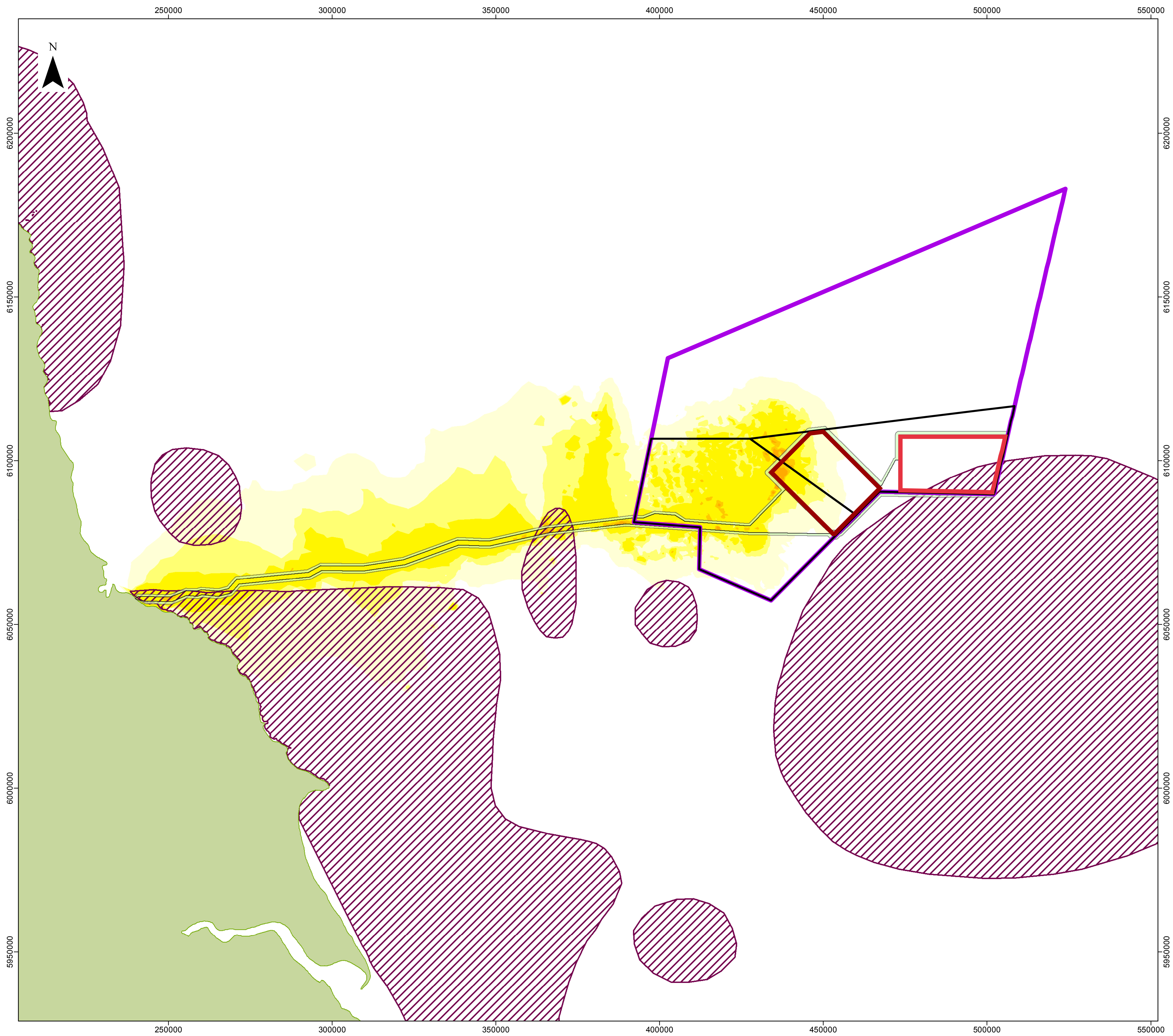
DRAWING NUMBER:

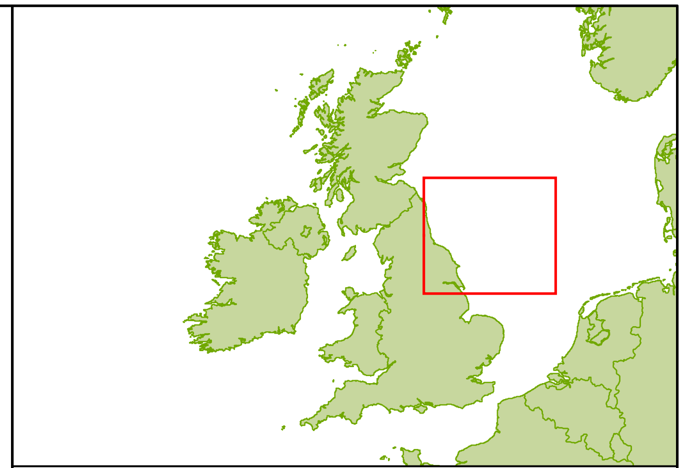
**F-OFL-MA-250**

| SCALE | 1:1,200,000 | 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
- Herring spawning ground (Coull *et al.* 1998)

Sediment thickness (m)

- Above 0.1000
- 0.0500 - 0.1000
- 0.0100 - 0.0500
- 0.0050 - 0.0100
- 0.0010 - 0.0050
- 0.0005 - 0.0010
- 0.0001 - 0.0005
- Below 0.0001

0 10 20 40
Kilometres

Data Source:
Modelling © Danish Hydraulic Institute, 2013
Spawning Grounds © Cefas, 2012
Background bathymetry image derived in part from TCarta data © 2009

PROJECT TITLE

*DOGGER BANK TEESSIDE A & B*

DRAWING TITLE

**Figure 6.5 Herring spawning grounds and maximum sediment deposition thickness over the 30 day simulation period**

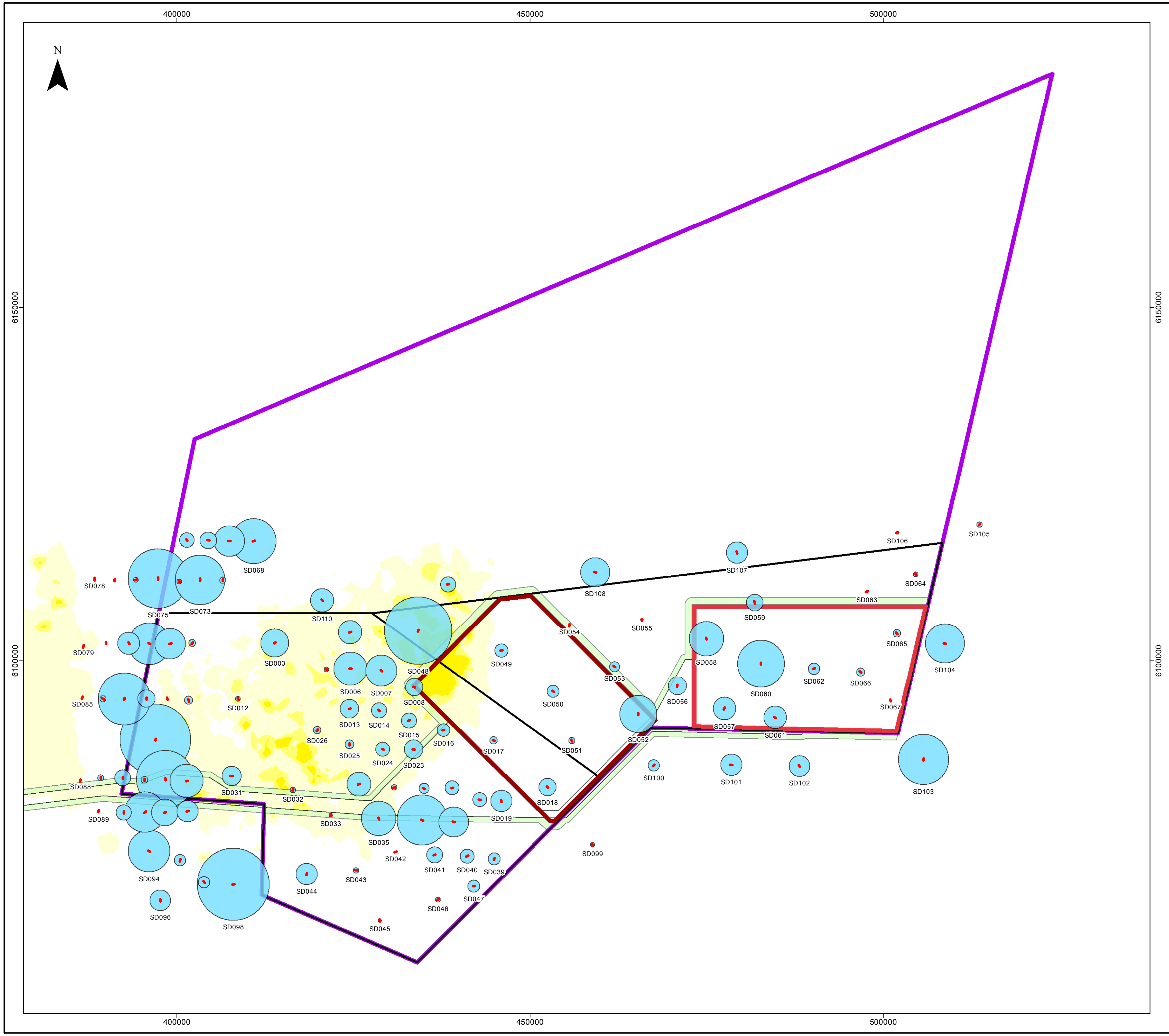
| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 08/10/2013 | PEI3 | LW | TR |
| 2 | 14/02/2014 | DCO Submission | LW | TR |

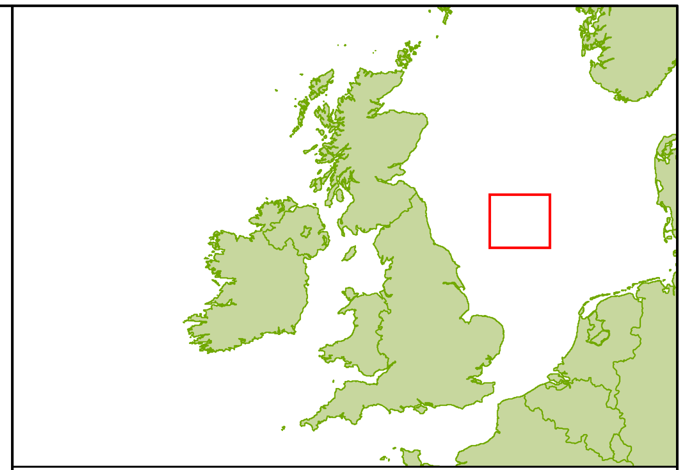
DRAWING NUMBER: **F-OFL-MA-251**

| SCALE | PLOT SIZE | DATUM | PROJECTION |
|---|---|---|---|
| 1:1,200,000 | 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
- Sandeel dredge location

Relative catch rate by species

- 10
- 100
- 500
- 1,000
- 10,000

Sediment thickness (m)

- Above 0.1000
- 0.0500 - 0.1000
- 0.0100 - 0.0500
- 0.0050 - 0.0100
- 0.0010 - 0.0050
- 0.0005 - 0.0010
- 0.0001 - 0.0005
- Below 0.0001

0 5 10 20
Kilometres

Data Source:
Modelling © Danish Hydraulic Institute, 2013
Catch rate © Brown & May Marine, 2013
Background bathymetry image derived in part from TCarta data © 2009

PROJECT TITLE

*DOGGER BANK TEESSIDE A & B*

DRAWING TITLE

**Figure 6.6 Sandeel specific survey results and average sediment deposition thickness over the 30 day simulation period**

| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 11/10/2013 | PEI3 | LW | TR |
| 2 | 14/02/2014 | DCO Submission | LW | TR |

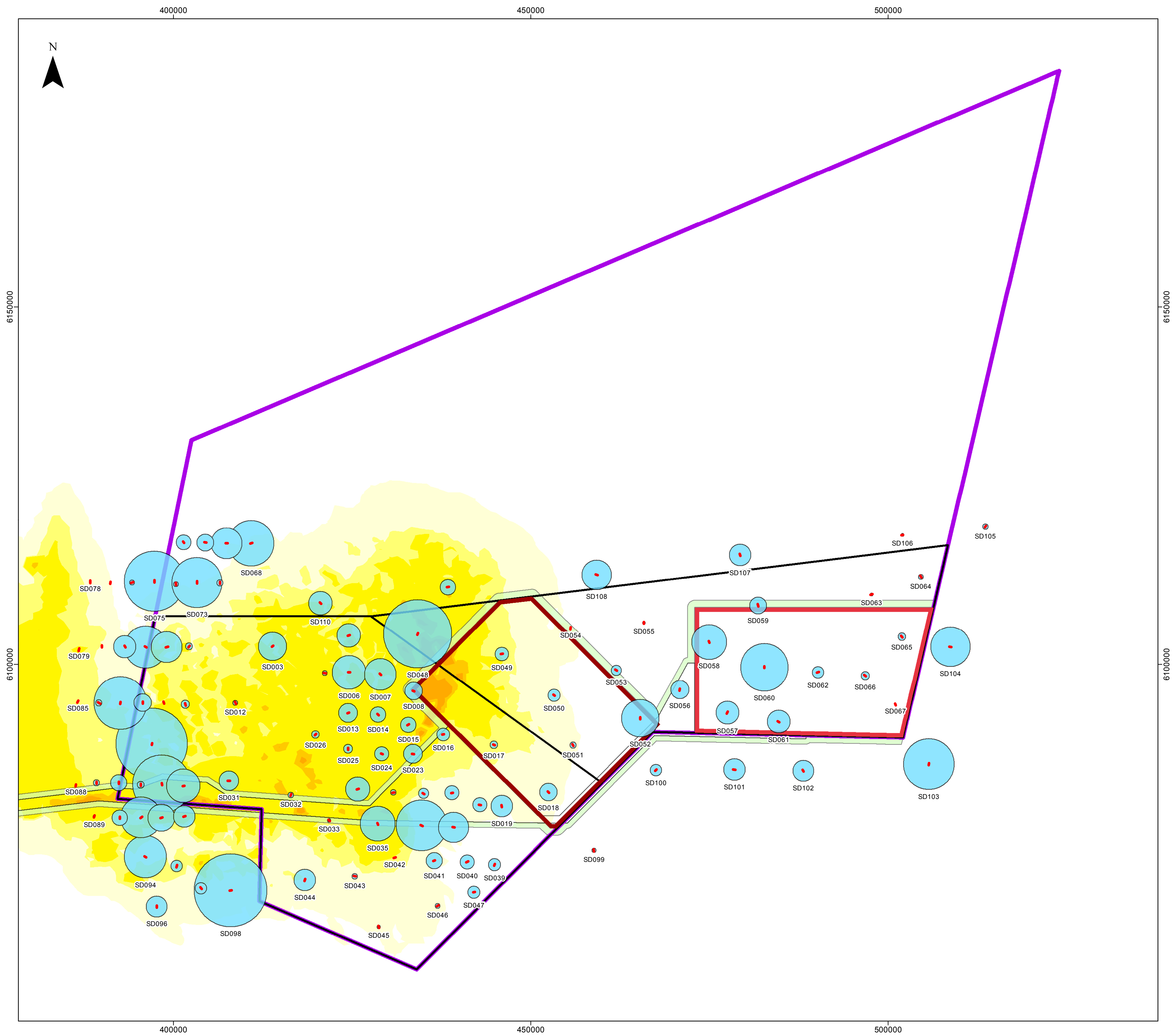
DRAWING NUMBER:

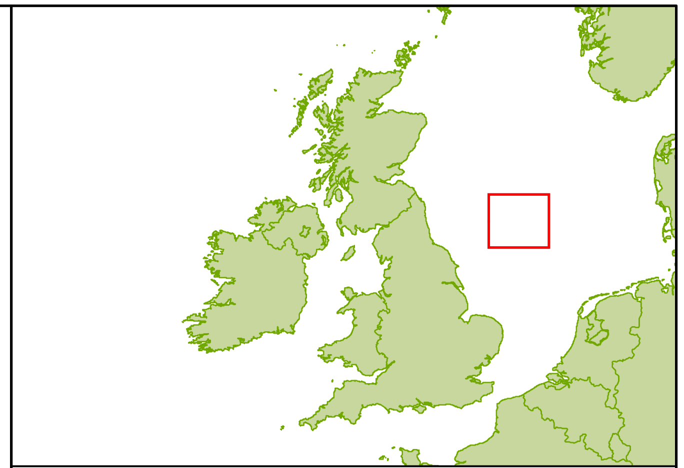
**F-OFL-MA-252**

| SCALE | 1:550,000 | 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
- Sandeel dredge location

Relative catch rate by species

- 10
- 100
- 500
- 1,000
- 10,000

Sediment thickness (m)

- Above 0.1000
- 0.0500 - 0.1000
- 0.0100 - 0.0500
- 0.0050 - 0.0100
- 0.0010 - 0.0050
- 0.0005 - 0.0010
- 0.0001 - 0.0005
- Below 0.0001

0 5 10 20
Kilometres

Data Source:
Modelling © Danish Hydraulic Institute, 2013
Catch rate © Brown & May Marine, 2013
Background bathymetry image derived in part from TCarta data © 2009

PROJECT TITLE

*DOGGER BANK TEESSIDE A & B*

DRAWING TITLE

**Figure 6.7 Sandeel specific survey results and maximum sediment deposition thickness over the 30 day simulation period**

| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 11/10/2013 | PEI3 | LW | TR |
| 2 | 14/02/2014 | DCO Submission | LW | TR |

DRAWING NUMBER:

**F-OFL-MA-253**

| SCALE | 1:550,000 | PLOT SIZE | A3 | DATUM | WGS84 | PROJECTION | UTM31N |
|---|---|---|---|---|---|---|---|



FOREWIND

### Dogger Bank Teesside A & B

6.5.20. As for Dogger Bank Teesside A.

### Dogger Bank Teesside A & B Export Cable Corridor

6.5.21. Eggs and larvae are distributed over large sea areas in comparison to regions where high suspended sediment concentrations may potentially result from construction activities. In addition, most of the fish species expected in the area have pelagic eggs and larvae which drift with the currents. As a result, fish eggs and larvae would only be exposed to the highest concentrations of suspended sediment on a short term, temporary basis. In addition, only a small proportion of the eggs and larvae of a given species would be expected to interact with the sediment plume (**Figure 6.2** and **Figure 6.3**). In light of the small degree of interaction, eggs and larvae are, in general terms, considered to be receptors of low vulnerability, medium recoverability and regional importance; therefore they are deemed to be of low sensitivity. The magnitude of the effect is considered to be low therefore effect of suspended sediment concentrations is considered to result in a **minor adverse** impact.

6.5.22. The Dogger Bank Teesside A & B Offshore Export Cable Corridor Study Area traverses an area of both high and low intensity sandeel spawning and nursery habitat. There are no defined sandeel spawning or nursery habitats in the vicinity of the Dogger Bank Teesside A & B Inshore Export Cable Corridor Study Area. Maximum sediment deposition thickness in the immediate area of the cable route is not expected to exceed 5-10 mm with an average deposition thickness up to 1mm in localised areas. Interaction between sediment deposition and sandeel eggs is therefore only expected to occur over the relatively small areas depicted in **Figure 6.6** and **Figure 6.7**. Sandeel eggs in the vicinity of the Dogger Bank Teesside A & B Offshore Export Cable Corridor Study Area are considered to be receptors of low vulnerability, medium recoverability and of regional importance therefore the sensitivity of these receptors is deemed to be low. Given that the magnitude of the effect is low, the effect of sediment re-deposition is considered to result in a **minor adverse** impact.

6.5.23. The Dogger Bank Teesside A & B Inshore Export Cable Corridor Study Area is located within currently active herring spawning grounds. There is, therefore, potential for sediment re-deposition to occur in areas where herring eggs have been, or are to be laid. In this context, the availability of suitable spawning substrate in the wider area, together with the small areas expected to be affected within the Dogger Bank Teesside A & B Export Cable Corridor Study Area should be taken in to account. The spatial extent of the inshore spawning area as defined by Coull *et al.* (1998) is 10,512 km$^2$, of which 0.003% will be affected by export cable installation. The potential degree of spatial and temporal effect-receptor interaction is anticipated to be low (**Figure 6.4** and **Figure 6.5**). Taking this low level of spatial overlap into account, the effect-receptor interaction is considered to be negligible. Herring eggs are deemed to be receptors of low vulnerability, medium recoverability and of regional importance, therefore their sensitivity is considered to be low. With the low magnitude of the effect, the impact of sediment re-deposition on herring eggs is **minor adverse.**

6.5.24. Increased suspended sediment concentrations within the Dogger Bank Teesside A & B Export Cable Corridor (a potential spawning habitat for brown crab and lobster) will only affect a small area at any one time and will be temporary in nature. Increased suspended sediment concentrations are anticipated to affect only a small area of the *Nephrops* nursery habitat as defined by Coull *et al,* 1998 (see **Appendix 15A**) in the vicinity of Dogger Bank Teesside A & B, therefore the level of effect-receptor interaction is anticipated to be low. Shellfish eggs and larvae are considered to be receptors of low vulnerability, high recoverability and of local or regional importance in the study area. Taking the above into account, the sensitivity of eggs and larvae to increased suspended sediment concentrations is considered to be low. Given that the magnitude of the effect is also considered to be low, the impact is assessed as **minor adverse**.

## Impacts on adult and juvenile fish

6.5.25. Sandeel is expected to have some tolerance to periodic sediment deposition since the species habitat is subject to naturally occurring sediment re-suspension and deposition in the high energy environment of the Dogger Bank Zone (Macer 1966; Wright *et al.* 2000).

6.5.26. The effect of increased suspended sediment concentrations on juvenile and adult fish varies depending on anatomical parameters such as gill dimensions and on the size and shape of sediment particles. Potential effects of suspended sediment on fish include clogging of gills, abrasion of the body surface, reduced sight avoidance and/or death (Engell- Sørensen & Skyt 2001; Appleby & Scarratt 1989).

6.5.27. In general terms, concentrations of suspended sediment have to be on the scale of milligram per litre (mg/l) to cause avoidance reactions in juvenile and adult fish. For lethal effects to occur, concentrations of suspended sediment have to be on the scale of grams per litre (g/l) (Engell- Sørensen and Skyt 2001). It should be noted, however, that effects of increased suspended sediment concentrations on marine organisms not only relate to the level of suspended sediment concentration to which an individual is exposed but also the duration of the exposure time to a given concentration (Newcombe and Jensen 1996).

### Dogger Bank Teesside A

6.5.28. The principal fish species identified in the existing baseline report (**Appendix 13A**) are mobile and are expected to be able to move away from areas where high increased suspended sediment concentrations may occur. Suspended sediment concentrations are, therefore, considered to only have potential to result in short term disturbance to juvenile and adult fish (including migratory species). In addition, as suggested for eggs and larvae, the distribution ranges of juvenile and adult fish are very wide in the context of the small areas expected to be affected by high increased suspended sediment concentrations (**Figure 6.2** and **Figure 6.3**). As a result, the degree of interaction between juvenile and adult fish and increased suspended sediment concentrations is considered to be low. Adult and juvenile fish are therefore considered receptors of low sensitivity. The magnitude of the effect is assessed as low and the impact is anticipated to be **minor adverse**.

6.5.29. In the particular case of sandeel, in addition to increased suspended sediment concentration related impacts, there might be potential for sediment re-deposition to have an effect on buried sandeel, potentially resulting in suffocation and/or behavioural impacts (i.e. whether they leave the sediment due to reduced oxygen levels). As mentioned above for sandeel eggs, however, taking the location of Dogger Bank Teesside A relative to areas where high sandeel densities are known to occur, the potential for sediment re-deposition to take place over high density sandeel areas is unlikely (**Figure 6.6** and **Figure 6.7**). In light of the above interaction the sandeel is considered to be a receptor of low vulnerability, medium recovery and regional importance, therefore they are considered to be of low sensitivity. The magnitude of the effect is considered to be low resulting in a **minor adverse** impact.

**Dogger Bank Teesside B**

6.5.30. The assessment of the impact of increased suspended sediment concentrations on adult and juvenile fish given above for Dogger Bank Teesside A also applies to Dogger Bank Teesside B. Adult and juvenile fish are considered to be receptors of low sensitivity and, coupled with low magnitude; the effect of increased suspended sediment concentration is assessed to result in a **minor adverse** impact.

6.5.31. As for Dogger Bank Teesside A, in addition to increased suspended sediment concentrations, there may be potential for sediment re-deposition to have an effect on buried sandeel. It should be noted that the western boundary of Dogger Bank Teesside B is located approximately 10km distance from high density sandeel grounds. There is, therefore, potential for a higher degree of effect-receptor interaction than that described above for Dogger Bank Teesside A in relation to sediment re-deposition and buried sandeel (**Figure 6.6** and **Figure 6.7**).

6.5.32. Research by Behrens *et al*. (2007) on the oxygenation in the burrows of sandeel *Ammodytes tobianus* found that the oxygen penetration depth at the sediment interface was only a few millimetres. Sandeel was, however typically buried in anoxic sediments at depths of 1-4 cm. In order to respire, buried sandeel appear to induce an advective transport through the permeable interstice and form an inverted cone of porewater with 93% oxygen saturation in front of the mouth. Behrens *et al*. (2007) found that when sandeel were exposed to decreasing oxygen tensions they gradually approached the sediment surface. This research suggests that if the re-deposited sediment is sufficiently coarse, buried sandeel may continue to respire while remaining buried in the sediment. In the worst case scenario that the sediment re-deposited is fine and of sufficient thickness to prevent respiration, sandeel would be expected to move closer to the surface and/or emerge into the water column making them more easily vulnerable to predation.

6.5.33. Furthermore, once they are in the water column they may be unable to bury in adjacent areas if the substrate is unsuitable. The area of high density grounds where fine sediment may be re-deposited would, however, be comparatively small in the context of the overall distribution of high density sandeel areas on and around the Dogger Bank (Dogger Bank SA1). Modelling (see **Chapter 9**) carried out in high density sandeel areas in the vicinity of the western boundary of Dogger Bank Teesside B, predicts very small deposition thicknesses to occur in that area (max. thickness of 1.0 mm) and it is anticipated that there is little potential for such small levels of fine sediment thickness to prevent respiration in buried sandeel.

6.5.34. Juvenile and adult sandeel are considered to be receptors of medium vulnerability, medium recoverability and of regional importance therefore their sensitivity is considered to be medium. When considered in terms of the low magnitude of effect assigned to suspended sediment concentration and deposition, the impact on sandeel is assessed to be **minor adverse**.

**Dogger Bank Teesside A & B**

6.5.35. As for Dogger Bank Teesside B.

**Dogger Bank Teesside A & B Export Cable Corridor**

6.5.36. The areas where a greater increase in suspended sediment concentrations and re-deposition is expected to occur along the Dogger Bank Teesside A & B Export Cable Corridor will be very small in relation to the wide distribution ranges of the fish species present in the area. Adult and juvenile fish are mobile and will be able to temporarily use undisturbed adjacent areas (**Figure 6.2** and **Figure 6.3**). They are considered receptors of low vulnerability, high recoverability and of local to regional importance resulting in low sensitivity. The magnitude of the effect is considered to be low and the impact of increased suspended sediment concentrations and sediment re-deposition is assessed as **minor adverse**.

6.5.37. Sandeel is not particularly abundant within the Dogger Bank Teesside A & B Export Cable Corridor Study Area and therefore the potential degree of effect-receptor interaction will be very small. On this basis sandeel is considered to be of low vulnerability, high recoverability and of regional importance. Sandeel is deemed to be a receptor of low sensitivity and considering that the magnitude of the effect is low, the impact is assessed as **minor adverse**.

## Shellfish

6.5.38. The principal shellfish species potentially present in Dogger Bank Teesside A, Dogger Bank Teesside B and the Dogger Bank Teesside A & B Export Cable Corridor include *Nephrops*, edible crab, lobster, velvet crab and scallops. Although these species (with the exception of scallops) are mobile scavenger/predators, they may have a reduced capacity to avoid the areas of highest suspended sediment concentrations when compared with fish species. The effect of smothering on ovigerous brown crab is included as part of the assessment of the effect of sediment redeposition on shellfish eggs in section 6.5.23. It should be noted in this context, that the principal shellfish identified are expected to be more abundant in areas relevant to the Dogger Bank Teesside A & B Export Cable Corridor Study Area (where they support important fisheries) rather than in the Wind Farm Study Area.

6.5.39. The ability of filter feeders such as scallops to feed may be affected by increased suspended sediment concentrations. Experiments carried out in New Zealand with the scallop *Pecten novaezelandiae* found that, for a period of time less than a week, this species coped with suspended sediment concentrations below 250mg/l, whilst for periods greater than a week suspended sediment concentrations above 50 mg/l may have led to decreased growth (Nicholls *et al*. 2003). Studies undertaken by Navarro and Widdows (1997) found a significant negative relationship between the clearance rate of cockle *Cerastoderma edule* and suspended sediment concentrations. Filtration rates increased until 300mg/l, at which level, filtration rates abruptly declined to very low values at 570 mg/l.

6.5.40. It should be noted that the largest single cause of mortality in invertebrates associated with sediments is generally attributable to the effects of sediment deposition, and not from suspended sediment concentration *per se*. The most obvious impact of deposited sediments is that of smothering in non-motile species (Appleby and Scarratt 1989).

### Dogger Bank Teesside A

6.5.41. Examples of the degree of sensitivity to smothering and increased suspended sediment concentration for the principal shellfish species identified in the **Appendix 13A**, for which the Marine Life Information Network (MarLIN) provides species specific information are given in **Table 6.2** (MarLIN 2012).

Table 6.2 Sensitivity to smothering, increased suspended sediment concentrations and displacement of shellfish species (Source: MarLIN 2012)

| Receptor | | Sensitivity to smothering | Sensitivity to increased suspended sediment concentrations | Sensitivity to displacement |
|---|---|---|---|---|
| **Common Name** | **Latin name** | | | |
| *Nephrops* | *Nephrops norvegicus* | Not sensitive (high confidence) | Not sensitive (low confidence) | Very low (high confidence) |
| Edible Crab | *Cancer pagurus* | Very low (high confidence) | Low (very low confidence) | Not sensitive (moderate confidence) |
| King scallop | *Pecten maximus* | Low (low confidence) | Low (moderate confidence) | Not sensitive (not relevant) |

(Associated level of confidence for each sensitivity assessment shown in brackets)

6.5.42. The MarLIN sensitivity scores for the principal shellfish species potentially present in Dogger Bank Teesside A indicate that tolerance and recoverability from the effects of smothering, displacement and increased suspended sediment concentrations varies considerably between species. However, many of these MarLIN scores are associated with low levels of confidence and therefore must be treated with caution.

6.5.43. Given that construction activities will be localised and of relatively short duration the level of effect-receptor interaction is small. Given that shellfish generally demonstrate reasonable tolerance to suspended sediment and sediment deposition they are considered to be receptors of low vulnerability, high recoverability and of local or regional importance. The sensitivity of shellfish is deemed to be low. The magnitude of the effect of increased suspended sediment concentrations and sediment re-deposition is considered to be low, therefore the impact is assessed as **minor adverse**.

**Dogger Bank Teesside B**

6.5.44. As described above for Dogger Bank Teesside A.

**Dogger Bank Teesside A & B**

6.5.45. As described above for Dogger Bank Teesside A and Dogger Bank Teesside B.

**Dogger Bank Teesside A & B Export Cable Corridor**

6.5.46. The principal shellfish species identified in the existing environment baseline are, in general terms, expected to be relatively abundant within and/or in the vicinity of the Dogger Bank Teesside A & B Export Cable Corridor. The inshore section particularly supports important commercial fisheries (*Nephrops*, crab and lobster). As shown in **Table 6.2** shellfish species have reasonable tolerance and recoverability to effects of smothering and increased suspended sediment concentrations, although confidence in these data are low

6.5.47. Taking into account the small areas potentially affected by increased suspended sediment concentrations and sediment re-deposition resulting from cable installation activities, the degree of spatial and temporal interaction between shellfish species and increased suspended sediment concentration and sediment re-deposition will be very small. In light of this but also recognising that information is limited, shellfish species are considered as receptors of medium vulnerability, high recoverability and of local or regional importance, therefore their sensitivity is deemed to be low. Since the magnitude of increased suspended sediment concentration and sediment re-deposition is considered to be low the impact is anticipated to be **minor adverse**.

## 6.6. Release of sediment contaminants through seabed disturbance-effects

6.6.1. Any such events therefore will have varying levels of effect dependent on the species present and pollutants involved.

6.6.2. The description of contaminant levels within the main Dogger Bank Teesside A & B wind farm sites and the export cable corridor is presented in **Chapter 12**. The results of site-specific surveys indicate that the levels of contaminants in the offshore wind farm areas where sediment re-suspension concentrations are predicted to be the largest due to cable and foundation 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.

6.6.3. Within the wind farm area, PCBS and organotins are below their respective limits of detection. All hydrocarbons (with the exception of naphthalene at three stations) and all metals (with the exception of CR, Cu and Ni at three stations and Mn at four stations) are all below published threshold levels, where available. In general, contaminants can be considered to be at background levels for the area.

6.6.4. Sediment concentrations of the organotin Tributyltin (TBT) is below the limit of detection at all sampled stations and PCB concentrations were representative of the wider area. Concentrations of hydrocarbons and metals display considerable variation along the cable corridor route. Highest total hydrocarbons are recorded at stations closest inshore while lower concentrations were generally observed at stations further offshore. A similar trend is evident for metals with several metals, including Cr, Cu and Ni recording relatively high concentrations above comparison threshold levels.

6.6.5. Based on the assessment in **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.

6.6.6. This method of foundation installation will result in a worst case volume of 6,220m$^3$ of drill arisings being released at the sea surface, of which 37% (2,301m$^3$) is expected to be deposited in the immediate vicinity of the release points without entering any sediment plume. The release of contaminants such as naphthalene and metals from the relatively small proportion of fines in the sediments is expected to disperse rapidly with the tide and/or currents and therefore increased bio-availability resulting in adverse toxological effects to fish and shellfish receptors is not expected.

## 6.7. Release of sediment contaminants through seabed disturbance-impacts

### Dogger Bank Teesside A

6.7.1. There is the potential for fish and shellfish receptors to be adversely affected by the release of contaminants in the sediments through preparation works for the installation of foundations and cable laying operations.

6.7.2. The sensitivity of fish and shellfish receptors to sediment contaminants will vary depending on a range of factors including species and life stage. Pollutants may result in a range of potentially lethal and sub-lethal effects on sensitive fish eggs and larvae (Westerhagen 1988) including delayed hatching, reduced hatching success and abnormal development (Bunn *et al*. 2000).

6.7.3. Adult fish are less likely to be affected by marine pollution due to their increased mobility. Recent research indicates that variation in some physico-chemical factors (salinity, temperature, pH) or variables that co-vary with these factors (e.g. wave activity or grain size) have a much greater influence on fish assemblages than anthropogenic stressors such as contamination (McKinley *et al.* 2011).

6.7.4. The effect of potential contaminant re-mobilisation is predicted to be of local spatial extent, short term duration and intermittent. The magnitude is considered to be negligible 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.

6.7.5. The fish and shellfish receptors are deemed to be of low to medium vulnerability, high recoverability and local to international importance in the study area. The sensitivity of the receptors is therefore, considered to be low to medium. The impact on fish and shellfish receptors will therefore be of **negligible** or **minor adverse** significance.

**Dogger Bank Teesside B**

6.7.6. As described above for Dogger Bank Teesside A.

**Dogger Bank Teesside A & B**

6.7.7. As described above for Dogger Bank Teesside A and Dogger Bank Teesside B.

**Dogger Bank Teesside A & B Export Cable Corridor**

6.7.8. In contrast to the high energy offshore environments, those fish and shellfish species which are dependent on intertidal habitats may be more susceptible to release of sediment bound contaminants due to the lower dispersion rates within these areas. Resuspension of contaminated sediments may have the potential to affect juvenile fish species and shellfish (e.g., intertidal crustaceans and cockles), although the extent of this impact is expected to be limited.

6.7.9. Modelling outputs predict that the maximum suspended sediment concentration of 100-200mg/l occurs in two discrete areas along the cable corridor, one near the coast and the other about 50km offshore. Values remain above background levels up to a distance of 50km to the north and 45km to the south of the corridor. Average values along the export cable corridor only increase up to 10mg/l above background along the entire length of the route

6.7.10. The effect of potential contaminant re-mobilisation along the export cable corridor is predicted to be of local spatial extent, short term duration and intermittent. Although contaminant levels are higher in the nearshore cable area compared to the offshore wind farm sites (see paragraph 6.6.4), the magnitude of any potential contaminant re-mobilisation effect is anticipated to be low due to the potentially lower levels of sediment resulting from cable installation activities.

6.7.11. The fish and shellfish receptors are deemed to be of low to medium vulnerability, high recoverability and local to international importance in the study area. The sensitivity of the receptors is therefore, considered to be low to medium and the effect on fish and shellfish receptors will therefore be **minor adverse**.

6.7.12. A summary of the impact assessment for seabed disturbance is given in **Table 6.3** and **Table 6.4** below.

## Table 6.3 Seabed disturbance impact assessment summary

| Potential Effect | Magnitude* | Receptor | Sensitivity | | | | Impact | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Dogger Bank Teesside A | Dogger Bank Teesside B | Dogger Bank Teesside A & B | Dogger Bank Teesside A & B Export Cable Corridor | Dogger Bank Teesside A | Dogger Bank Teesside B | Dogger Bank Teesside A & B | Dogger Bank Teesside A & B Export Cable Corridor |
| Temporary physical disturbance/ loss of seabed habitat | Low | Eggs and larvae of pelagic fish spawners | Negligible | Negligible | Negligible | Negligible | Negligible | Negligible | Negligible | Negligible |
| | | Eggs and larvae of demersal fish spawners | Low | Low | Low | Low | Minor adverse | Minor adverse | Minor adverse | Minor adverse |
| | | Eggs and larvae of sandeel | Medium | Medium | Medium | Medium | Minor adverse | Minor adverse | Minor adverse | Minor adverse |
| | | Eggs and larvae of herring | Low | Low | Low | Low | Minor adverse | Minor adverse | Minor adverse | Minor adverse |
| | | Eggs and larvae of shellfish | Low | Low | Low | Low | Minor adverse | Minor adverse | Minor adverse | Minor adverse |

| Potential Effect | Magnitude* | Receptor | Sensitivity: Dogger Bank Teesside A | Sensitivity: Dogger Bank Teesside B | Sensitivity: Dogger Bank Teesside A & B | Sensitivity: Dogger Bank Teesside A & B Export Cable Corridor | Impact: Dogger Bank Teesside A | Impact: Dogger Bank Teesside B | Impact: Dogger Bank Teesside A & B | Impact: Dogger Bank Teesside A & B Export Cable Corridor |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Adult and juvenile fish | Low | Low | Low | Low | Minor adverse | Minor adverse | Minor adverse | Minor adverse |
| | | Sandeel | Medium | Medium | Medium | Low | Minor adverse | Minor adverse | Minor adverse | Minor adverse |
| | | Shellfish | Low | Low | Low | Low | Minor adverse | Minor adverse | Minor adverse | Minor adverse |
| Release of sediment contaminants through seabed disturbance | Negligible | Fish and Shellfish | Low/ Medium | Low/ Medium | Low/ Medium | - | Negligible/Minor adverse | Negligible/ Minor adverse | Negligible/ Minor adverse | Negligible/ Minor adverse |
| | Low | Fish and Shellfish | - | - | - | Low/ Medium | Minor adverse | Minor adverse | Minor adverse | Minor adverse |

*Applies to Dogger Bank Teesside A, Dogger Bank Teesside B, Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor

Table 6.4 Increased suspended sediment concentration and deposition impact assessment summary

| Potential Effect | Magnitude* | Receptor | Sensitivity | | | | Impact | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Dogger Bank Teesside A | Dogger Bank Teesside B | Dogger Bank Teesside A & B | Dogger Bank Teesside A & B Export Cable Corridor | Dogger Bank Teesside A | Dogger Bank Teesside B | Dogger Bank Teesside A & B | Dogger Bank Teesside A & B Export Cable Corridor |
| Increased suspended sediment concentrations and sediment re-deposition | Low | Fish Eggs and larvae (general) | Low | Low | Low | Low | Minor adverse | Minor adverse | Minor adverse | Minor adverse |
| | | Herring eggs | Medium | Medium | Medium | Low | Minor adverse | Minor adverse | Minor adverse | Minor adverse |
| | | Sandeel eggs | Low | Low | Low | Low | Minor adverse | Minor adverse | Minor adverse | Minor adverse |
| | | Adult and juvenile fish (general) | Low | Low | Low | Low | Minor adverse | Minor adverse | Minor adverse | Minor adverse |
| | | Sandeel | Medium | Medium | Medium | Low | Minor adverse | Minor adverse | Minor adverse | Minor adverse |
| | | Shellfish | Low | Low | Low | Low | Minor adverse | Minor adverse | Minor adverse | Minor adverse |

*Applies to Dogger Bank Teesside A, Dogger Bank Teesside B, Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor

## 6.8. Construction noise - effects

6.8.1. Noise can affect fish in a number of ways ranging from lethal injury and hearing impairment to behavioural reactions and auditory masking (Nedwell *et al*. 2007). Construction related activities including; impact pile driving for installation of pin piles and monopoles; rock placement for scour protection; dredging associated with seabed preparation for installation of gravity bases; and cable laying related activities, will all generate underwater noise. Of these, impact pile driving generates the most noise for the longest period of time thereby potentially resulting in the most detrimental impact on fish and shellfish. For this reason, the impact assessment presented below focuses on pile driving as the worst case scenario for noise based on the noise modelling undertaken by the National Physical Laboratory (NPL) provided in **Appendix 5A Underwater Noise Technical Report**.

6.8.2. Different fish species have different hearing capabilities due to their diversity in hearing structures. For classification purposes, the terms hearing specialist and hearing generalist are commonly used. This classification is independent of taxonomic grouping being based on a species' hearing capability. Hearing specialists possess a physiological coupling between the swim bladder and the inner ear resulting in high sound pressure sensitivity and low hearing thresholds. Hearing generalists typically demonstrate poor hearing sensitivity. Hearing generalists can be further categorised as species lacking gas-filled structures and species possessing a swim bladder but lacking specialised coupling mechanisms (Thomsen *et al.* 2006).

6.8.3. Hearing specialists present in Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor include species such as herring and sprat. The majority of the species present in these areas, however, are hearing generalists, including commercially important species, such as plaice, sole, and sandeel. This categorisation can also be extended to most species of conservation interest encountered within the study areas (see Section 3.1). In diadromous species such as Atlantic salmon, sea trout and European eel the swim bladder has no direct connection to the ear and is not thought to play a significant role in the hearing of these species (Hawkins & Johnstone 1978; Popper & Fay 2003). Other species lacking a swim bladder, such as diadromous lampreys and elasmobranchs are also considered to be hearing generalists (Gill *et al*. 2010).

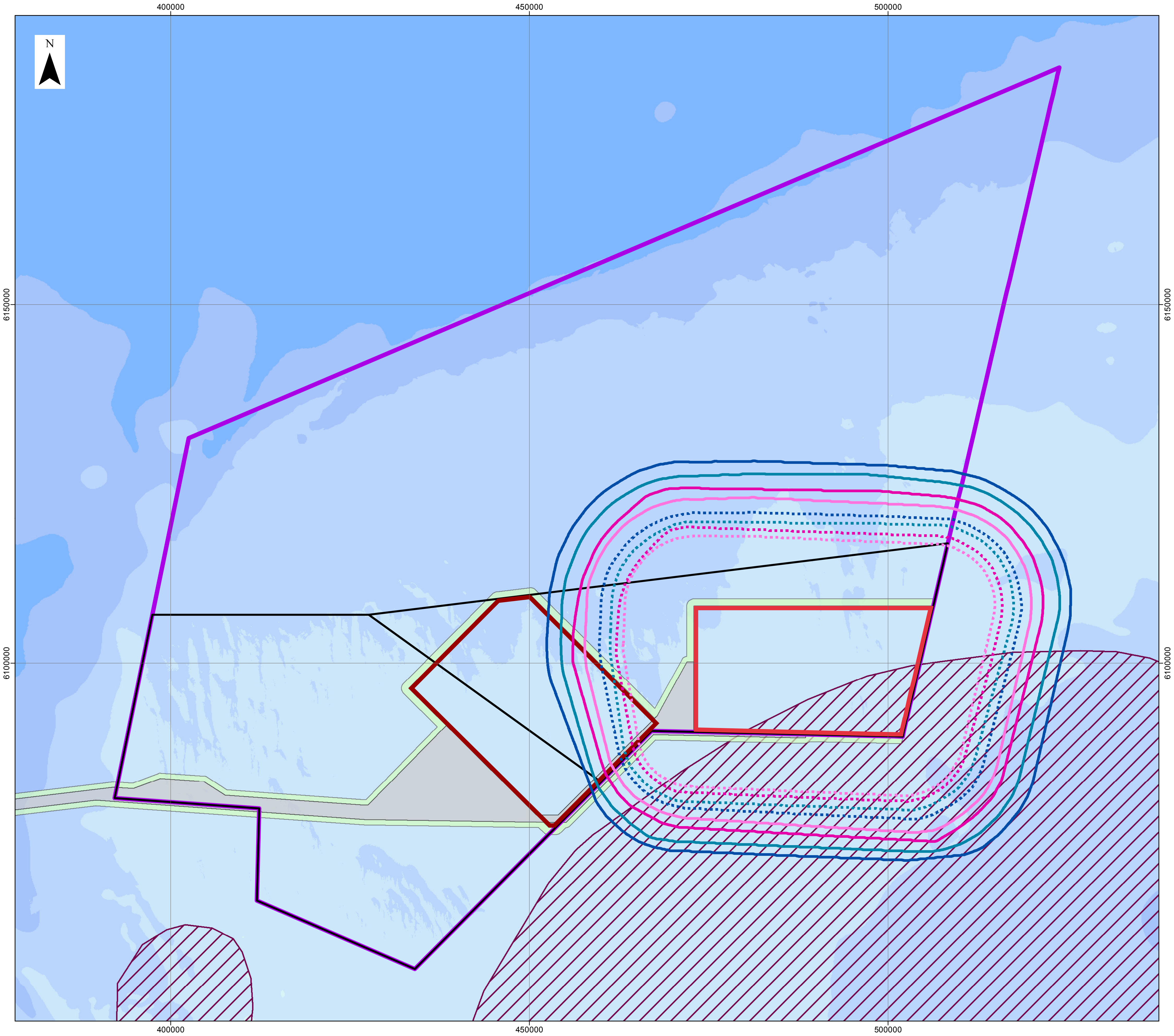
6.8.4. The undertaking of noise related impact assessments on a species specific basis is complicated because fish hearing capabilities have been documented for a limited number of species (Hastings & Popper 2005; Nedwell *et al*. 2004). As a result, extrapolation of hearing capabilities between different species, particularly those which are taxonomically distant should be undertaken with the greatest caution (Hastings & Popper 2005). Therefore, given the current lack of knowledge on species specific hearing abilities generic (non-species specific) criteria were used to model the ranges at which injury and behavioural responses are expected to occur in fish. The criteria used to describe the impact ranges of injury and behavioural effects in fish are shown in **Figure 6.8** and **Table 6.5**.

6.8.5. Sandeel is assumed to be resident in the sediment during noise events. Behrens *et al.* (2007) have demonstrated that dormant sandeel move from their burrows in response to low levels of oxygen saturation. A study on the effect of seismic events on sandeel has shown that sandeel density is not influenced by high sound pressure levels (Hassel *et al*. 2004).

6.8.6. Any assessment on the effect of the displacement of dormant sandeels by noise would have to assume a worst case that a significant proportion were either eaten by predators or else have used up so much of their stored energy reserves that they all starved before their spring foraging period, although there is a lack of information on the bioenergetics costs or likelihood of predation in the literature. Their sensitivity would be rated as medium (i.e. Regionally important receptors with medium to high vulnerability and low recoverability), the magnitude is low so the significance is considered to be **minor adverse**.




**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
- Herring spawning ground (Coull *et al.* 1998)

**Palegic**

Dogger Bank Teesside A 2300kJ footprint (level)

- 168
- 173

Dogger Bank Teesside A 3000kJ footprint (level)

- 168
- 173

**Demersal**

Dogger Bank Teesside A 2300kJ footprint (level)

- 168
- 173

Dogger Bank Teesside A 3000kJ footprint (level)

- 168
- 173

0 5 10 20
Kilometres

Data Source:
Modelling © NPL Management, 2013
Spawning Grounds © Cefas, 2012
Background bathymetry image derived in part from TCarta data © 2009

PROJECT TITLE

*DOGGER BANK TEESSIDE A & B*

DRAWING TITLE

**Figure 6.8 Comparative indication of the extent of behavioural impact ranges on pelagic fish assuming 2300 kilojoule (kJ) and 3000kJ hammer energies**

| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 07/10/2013 | PEI3 | LW | TR |
| 2 | 20/02/2014 | DCO Submission | LW | TR |

DRAWING NUMBER:

**F-OFL-MA-254**

| SCALE | 1:550,000 | PLOT SIZE | A3 | DATUM | WGS84 | PROJECTION | UTM31N |
|---|---|---|---|---|---|---|---|



FOREWIND

## Table 6.5 Summary of injury criteria used for fish

| Species | Dual injury criteria (PTS) | |
|---|---|---|
| | Peak SPL**(dB re 1 µPa)[4] | SEL*** (dB re 1 µPa² s)[5] |
| Fish* (Popper *et al*. 2006 and Carlson *et al*. 2007) | 206 | 187 |

* Applicable to all fish species with a mass of over 2g.
** Sound Pressure Level
*** Sound Exposure Level

6.8.8. The impact ranges estimated for possible moderate to strong avoidance are stated as an impact range spread. Possible moderate to strong avoidance reactions (**Table 6.6**) occur within a specific noise range (i.e. 168-173 Peak SPL (dB re 1 µPa). Fish are expected to exhibit changes in swimming and schooling behaviour within this range. This impact range also reflects the inherent uncertainty in the response due to differences in species, sex, age and condition, as well as the influence of stressors to which the fish is or has been exposed. The response of the fish may also depend on the reasons and drivers for the fish being in the area (i.e. feeding, spawning). For example, in a study of the reaction by spawning herring to a survey vessel (Skaret *et al.* 2005), it was found that the impetus to engage in reproductive activity at the spawning site overruled avoidance reactions in herring.

## Table 6.6 Summary of behavioural criteria for generic fish species

| Potential Response | Behavioural response criteria for generic fish species |
|---|---|
| | Peak SPL (dB re 1 µPa) |
| Possible moderate to strong avoidance (McCauley *et al*. 2000) | 168-173* |
| Startle response or C-turn reaction (Pearson *et al*. 1992) | 200 |

*These levels have been established from seismic airgun and should therefore only be applied for impulsive sound sources for fish that are sensitive to sound below around 500Hz

6.8.9. Whilst species specific modelling was not undertaken, the behavioural impact on fish was modelled in terms of fish in mid-water (pelagic fish) and fish that dwell near or on the seabed (demersal fish). Sound pressures near the seabed are generally lower and result in smaller impact ranges than in mid-water (see **Appendix 5A**).

6.8.10. Modelling was undertaken at a number of locations within Dogger Bank Teesside A & B. The outputs of the noise modelling carried out are given in **Table 6.7** and **Table 6.8** for Teesside A & Teesside B, respectively. These show impact ranges in terms of both injury and behavioural effects for pelagic

[4] SPL: Sound Pressure Level, measure of the received acoustic energy at the receptor. Unit: dB re 1 µPa2•s
[5] SEL: Sound Exposure Level: Sound Exposure Level, a measure of the received acoustic energy at the receptor. Unit: dB re 1 µPa2•s

and demersal fish using different hammer energies (300kJ, 1900kJ, 2300kJ and 3000kJ).

6.8.11. As defined in **Table 5.2**, for the purposes of defining the worst case scenario for Dogger Bank Teesside A and Dogger Bank Teesside B, it has been considered that the installation of the maximum number of turbines (200 x 6MW) in each project and the use of jacket foundations on pin piles (needing up to six piles per foundation) requiring a hammer blow energy of 2300kJ constitutes the worst case. This contrasts with the noise range of 3000kJ hammer blow energy required to install a single foundation for 12m monopoles which affects a slightly wider area but requires only a single piling event per foundation. The spatial extent of the noise impact range from multi-leg pin piling is slightly less than monopiling but extends over a considerably longer period of time, given the need to install six piles for each foundation.

6.8.12. Furthermore, and as shown in **Table 6.6** above, the difference in the spatial extent of the impact ranges between 2300kJ and 3000kJ blow energies is relatively small. This is further illustrated in **Figure 6.8** which shows the worst case total area (footprint) impacted by noise during the whole construction phase of Dogger Bank Teesside A at levels at which behavioural impacts are expected in pelagic fish. As shown, the total noise footprint of the construction phase will be only marginally greater if 3000kJ hammer blow energy is deployed to install 12m monopole foundations.

6.8.13. It should be noted, that in addition to the turbines, up to four offshore collector platforms and one offshore converter platform will be installed in each Dogger Bank Teesside A & B wind farm project and pile driving may also be required to install these structures depending on the foundation type. The maximum hammer blow energy required for installing offshore structure foundations is 1900kJ. Further to the offshore collector and offshore platforms, up to five meteorological data masts may also be installed in each Dogger Bank Teesside A & B wind farm project. The highest hammer energy required for installation of these would be 1900kJ, if monopile foundations are used.

## Table 6.7 Estimated impact ranges for pelagic and demersal fish in Dogger Bank Teesside A

| Impact criterion | Estimated impact ranges for fish in Dogger Bank Teesside A | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Fish in midwater (Pelagic) | | | | Fish in near or on the seabed (Demersal) | | | |
| | 300kJ | 1900kJ | 2300kJ | 3,000kJ | 300kJ | 1900kJ | 2300kJ | 3,000kJ |
| Instantaneous injury/PTS (peak pressure level 206 dB re 1 µPa) | <100m | <200m | <200m | <200m | <100m | <200m | <200m | <200m |
| Startle response (peak pressure level 200 dB re 1 µPa) | <100m | <500m | <500m | <600m | <100m | <500m | <500m | <600m |
| Possible avoidance of area*(peak pressure level 168 -173 dB re 1 µPa) | 3.8 – 8.5km | 8.0-17.5km | 10.0-19.0km | 10.0-21.0km | 3.0 – 6.6km | 6.5-14.0km | 7.0-15.5km | 7.5-17.0km |

## Table 6.8 Estimated impact ranges for pelagic and demersal fish in Dogger Bank Teesside B

| Impact criterion | Estimated impact ranges for fish in Dogger Bank Teesside B | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Fish in midwater (Pelagic) | | | | Fish in near or on the seabed (Demersal) | | | |
| | 300kJ | 1900kJ | 2300kJ | 3,000kJ | 300kJ | 1900kJ | 2300kJ | 3,000kJ |
| Instantaneous injury/PTS (peak pressure level 206 dB re 1 µPa) | <100m | <200m | <200m | <250m | <100m | <200m | <200m | <250m |
| Startle response (peak pressure level 200 dB re 1 µPa) | <200m | ~400m or less | <500m | <600m | <200m | <400m | <500m | <600m |
| Possible avoidance of area*(peak pressure level 168 -173 dB re 1 µPa) | 4.0 – 8.0km | 8.5-18.5km | 9.5-19.5km | 10.0 – 21.0km | 3.2– 7km | 11.0-26.5 km | 7.5-15.5km | 8.0 – 17.5km |

*Some particularly insensitive species of fish might only exhibit avoidance behaviour at lesser ranges

6.8.14. The assessment of construction noise related effects given below also takes account of the possibility of two simultaneous pile driving activities taking place in each Dogger Bank Teesside A & B wind farm project (see **Table 5.1**) (for fish receptors the worst case is considered to be when the two simultaneous piling operations are separated by the maximum distance possible within a project). As described in **Appendix 5A** the instantaneous sound pressure level from two pile driving events is highly unlikely to increase the peak noise level. The size of the impacted area where simultaneous pile driving takes place would, therefore, only be dependent on the separation between installation vessels. Where simultaneous pile driving takes place in adjacent locations, the small increase in the spatial extent of the effect would largely be compensated by the resulting reduction in the duration of the effect.

6.8.15. As shown in **Table 6.7** and **Table 6.8** above, potential instantaneous injury impact ranges for fish, based on the onset of auditory tissue damage, are relatively small. These ranges would only be of the order of tens (at the onset of soft-start piling at hammer energies of 300kJ) to a few hundred metres. Assuming 2,300kJ hammer energies, ranges are predicted to be less than 150m at Dogger Bank Teesside A and Dogger Bank Teesside B. Taking the intermittent and short term nature of pile driving activity and the small areas where lethal/injury impacts could occur, the magnitude of injury/lethal construction noise related effects is considered to be negligible for Dogger Bank Teesside A, Dogger Bank Teesside B and Dogger Bank Teesside A & B. It should be noted that, as stated in **Chapter 5** and Section 3.3 above soft-start piling will be used allowing marine organisms to flee the immediate vicinity of the piles before the highest noise levels are reached.

6.8.16. In terms of behavioural impacts the underwater noise modelling shows that startle responses or C-turn reactions (which indicate a very strong avoidance reaction to sound) are unlikely to occur at ranges beyond 450m from the pile for 1900kJ hammer energies (**Table 6.7** and **Table 6.8**). At the onset of a soft-start (300kJ) this range would likely be less than 100m. The impact ranges for disturbance or avoidance where moderate to strong avoidance may occur (i.e. changes in swimming and schooling behaviour) are considerably larger. For 2300kJ hammer energies the ranges are predicted to be 9km to 16.5km for Dogger Bank Teesside A and 9km to 19km for Dogger Bank Teesside B for fish in mid-water and 7km to 13.5km for Dogger Bank Teesside A and 9km to 19km for Dogger Bank Teesside B for hearing species dwelling near or on the seabed. At the onset of a soft-start these ranges are estimated to be 3km to 7.5km for Dogger Bank Teesside A and 4km and 9km for Dogger Bank Teesside B (taking minimum and maximum ranges for demersal and pelagic fish, respectively).

6.8.17. Taking the relatively small range at which behavioural responses are expected in fish), particularly in the case of startle responses, together with the short term and intermittent nature of pile driving across the construction period, the magnitude of behavioural effects on fish is considered to be low. This is considered to be the case for Dogger Bank Teesside A, Dogger Bank Teesside B and Dogger Bank Teesside A & B.

6.8.18. In the case of the Dogger Bank Teesside A & B Export Cable Corridor, pile driving will not be required. However, a number of cable installation related activities, such as, vessel movement, dredging, trenching and rock dumping for cable protection, will generate underwater noise (Nedwell & Howell 2004). The levels of noise associated with these are, however, negligible in comparison to pile driving (**Appendix 5A**). Although there may be potential for behavioural responses such as avoidance reactions to occur, these would only take place in close proximity to where construction operations are taking place at a given time. The magnitude of construction noise related effects associated with export cable installation works is, therefore, considered to be **negligible**.

## 6.9. Construction noise - impacts

### Lethal/Injury Effects - Impacts on adult and juvenile fish

6.9.1. Fish mortality would only be likely to occur in immediate proximity to the pile. It should be noted, however, that adult and juvenile fish are mobile and hence able to flee the localised areas where lethal and injury effects may occur. Furthermore, the use of a soft-start will allow fish to move away from the pile before the highest noise levels are reached, further reducing the potential for lethal/injury impacts to occur.

**Dogger Bank Teesside A**

6.9.2. Juvenile and adult fish are expected to avoid the localised areas where the highest noise levels will be reached during piling activity in the area of Dogger Bank Teesside A. The potential for juvenile and adult fish to be exposed to lethal levels of noise is considered to be small and the effect-receptor interaction is correspondingly small. Juvenile and adult fish are receptors of low vulnerability, medium recoverability and of local to regional importance; they are considered to have low sensitivity to the effects of underwater noise. The magnitude of the effect is considered to be negligible and impact is assessed to be **negligible.**

**Dogger Bank Teesside B**

6.9.3. As assessed above for Dogger Bank Teesside A.

**Dogger Bank Teesside A & B**

6.9.4. As described above for Dogger Bank Teesside A.

**Dogger Bank Teesside A & B Export Cable Corridor**

6.9.5. There is little potential for noise associated with Dogger Bank Teesside A & B Export Cable Corridor installation *per se* to result in lethal/injury effects on fish. Due to small overlap of habitat and noise produced during construction, the effect-receptor interaction is likely to be small. As a result, the majority of adult and juvenile fish species in the cable corridor are considered as receptors of low vulnerability, medium recoverability and of local to regional importance. Their sensitivity to lethal/injury noise related effects is expected to be low and when considered together with the negligible magnitude of the effect, the impact is assessed to be **negligible**.

6.9.6. Diadromous species migrating either to or from the river Tees and Esk (and to a lesser extent other rivers) have an increased potential to be impacted by noise generated during export cable installation. Due to the position of the Dogger Bank Teesside A & B Export Cable Corridor in relation to the Esk and Tees migration is likely to be affected in inshore areas. Diadromous species are assessed to be receptors of medium vulnerability, medium recoverability and of national importance. Their sensitivity is deemed to be medium. However, cable installation is of relatively short duration and levels of associated noise are considerably less than those generated during piling. The magnitude of the effect is considered to be negligible and the impact **minor adverse**.

## Lethal/Injury Effects - Impacts on larvae

6.9.7. Early life stages, such as non-swimming larvae, will not be able to flee the vicinity of the foundations during pile driving and hence are more likely to be exposed to higher noise levels than the mobile juvenile and adult life stages.

6.9.8. Consultation was undertaken with IMARES which is currently involved in a number of research projects to improve the knowledge of the effects of pile driving noise on fish, with a particular focus on fish larvae (**Table 2.2**).

6.9.9. Research on sole larvae (Bolle *et al*. 2011) did not find significant effects at a cumulative SEL of 206 dB and suggested that the assumption of 100% mortality within a radius of 1000m around a piling site (used in the Appropriate Assessment of Dutch offshore wind farms (Prins *et al*. 2009) was too precautionary for this species. It was stated that the results should not be extrapolated to fish larvae in general, as inter-specific differences in vulnerability to sound exposure may occur. It is also recognised that this study was focused on the potential lethal effects of sound exposure and not on any physiological, behavioural or morphological effects or on determining the likelihood of survival in the long term. The results do, however, suggest that previous assumptions in relation to the lethal impact of noise on larvae are likely to be over-precautionary and should be revised. Taking the relatively small areas around each pile driving operation where larval mortality may potentially occur and the short term and intermittent nature of pile driving, the magnitude of the effect is considered to be **negligible**.

6.9.10. The distribution of larvae of a given species extends over wide areas at a given time. These are comparatively large in comparison to areas where lethal effects could occur in larvae. In addition, risk of mortality due to prolonged noise exposure would be reduced as a result of larval drift, (as larvae will for the most not be exposed to the highest noise levels for extended periods of time). Taking the above into account, and the limited research available on the implications of the effect of piling noise on larval stages, they therefore are considered to be receptors of high vulnerability, low recoverability and of regional importance, resulting in medium sensitivity. The magnitude of the effect is considered to be negligible; therefore, lethal/injury noise related effects are assessed to result in a **minor adverse** impact.

### Dogger Bank Teesside B

6.9.11. As assessed above for Dogger Bank Teesside A.

### Dogger Bank Teesside A & B

6.9.12. As assessed above for Dogger Bank Teesside A.

### Dogger Bank Teesside A & B Export Cable Corridor

6.9.13. Pile driving will not be required for cable installation and it is not expected that noise associated with cable installation activities has the potential to result in lethal effects on larvae. Larvae are deemed to be receptors of low vulnerability, medium recoverability and of regional importance. Therefore the sensitivity of larvae is low and considered in terms of the negligible magnitude of the effect, injury/lethal effects associated with export cable installation noise are considered to result in a **negligible** impact.

## Behavioural effects - Disturbance to spawning fish and nursery grounds

6.9.14. Spawning and nursery grounds have been defined for a number of both pelagic and demersal species within and in the vicinity of Dogger Bank Teesside A, Dogger Bank Teesside B and the Dogger Bank Teesside A & B Export Cable Corridor (see **Appendix 13A**). There is, therefore, potential for juveniles and spawning fish to be disturbed by noise generated during the construction phase.

### Dogger Bank Teesside A

6.9.15. The majority of the fish species for which spawning and nursery grounds have been defined within and in the vicinity of Dogger Bank Teesside A are pelagic spawners able to use large sea areas for spawning. Although these areas vary depending on the species under consideration they are very large in relation to the ranges at which behavioural effects are expected to occur. The degree of interaction between juveniles, spawning fish and noise levels at which behavioural effects associated with pile driving noise may occur will, therefore, be small. Taking this into account, fish species with defined spawning and nursery grounds within and in the vicinity of Dogger Bank Teesside A are considered as receptors of low vulnerability, medium recoverability and regional importance; with low sensitivity. Together with the low magnitude of the effect, the effect of construction noise in terms of disturbance to spawning and nursery grounds considered to result in a **minor adverse** impact on these species.

6.9.16. Exceptions to this are the species which spawn on specific substrates, namely, herring and sandeel. Herring spawn in areas of coarse sand and gravel while sandeel distribution is dependent on suitable substrate for burrowing and the adult distribution typically corresponds with their spawning habitat.

6.9.17. In the particular case of herring, given the small areas where startle responses in pelagic fish are predicted (<450m) and the distance from Dogger Bank Teesside A to the inshore spawning grounds, there is little potential for noise levels at which strong behavioural reactions would occur to disturb the active herring spawning grounds. Possible avoidance of the area may, however, occur at greater ranges and potentially overlap with the historic grounds to the south of Dogger Bank Teesside A (**Figure 6.9**). As shown, however, these noise levels would only overlap a proportionally small section of these historic spawning grounds. In light of this and the uncertainties in relation to the potential for the spawning grounds to be re-colonised in the future, spawning herring are considered to be receptors of medium vulnerability, medium recoverability and regional importance resulting in medium sensitivity. The magnitude of the effect is low, therefore, it is anticipated that construction noise will result in a **minor adverse** impact on spawning herring.

6.9.18. It is anticipated that the effect-receptor interaction for sandeel will be small. There is little potential for a significant overlap between high density sandeel areas and areas where possible noise avoidance may occur (peak pressure level 168-173 dB re 1 µPa) (see **Figure 6.10**). Furthermore, field experiments (Hessel *et al*. 2003; 2004), in which sandeel was exposed to seismic shooting for a period of 2.5 days, found no difference in the abundance of sandeel and only moderate behavioural reactions were detected. Taking the above into account, sandeel is considered to be a receptor of low vulnerability, high recoverability and regional importance. The low sensitivity of this species combined with the low magnitude of the effect of results in a **minor adverse** impact for construction noise.

**Dogger Bank Teesside B**

6.9.19. In general terms, the assessment provided above for Dogger Bank Teesside A also applies to Dogger Bank Teesside B. Therefore the effect of construction noise in terms of disturbance to spawning and nursery grounds is considered to result in a **minor adverse** impact.

6.9.20. In the particular case of herring, as shown in **Figure 6.11** below, noise levels triggering avoidance reactions by pelagic fish will not impact on the active inshore spawning area but noise may potentially affect a small proportion of the total area of the historic herring spawning grounds. In view of this small interaction and acknowledging that the spawning grounds may be recolonised at some future date, herring are considered receptors of low vulnerability, medium recoverability and regional importance resulting in medium sensitivity. The magnitude of the effect is considered to be low and therefore the impact is **minor adverse**.

6.9.21. In the case of sandeel, as shown in **Figure 6.12** noise levels at which possible avoidance is predicted to occur in pelagic fish may reach a small high density sandeel area in close vicinity to Dogger Bank Teesside B. It should be noted, however, that only localised areas will be affected at a given time and that the high density sandeel area on the western Dogger Bank Zone boundary will remain unaffected. Sandeel may tolerate exceptional levels of noise such as seismic shooting. As described above sandeel were exposed to seismic shooting for a period of 2.5 days and only moderate behavioural reactions were detected Hessel *et al.* (2003, 2004). Sandeel is therefore considered to be a receptor of medium vulnerability, high recoverability and regional importance. The medium sensitivity of this species considered in terms of the low magnitude of the effect of results in a **minor adverse** impact.

**Dogger Bank Teesside A & B Export Cable Corridor**

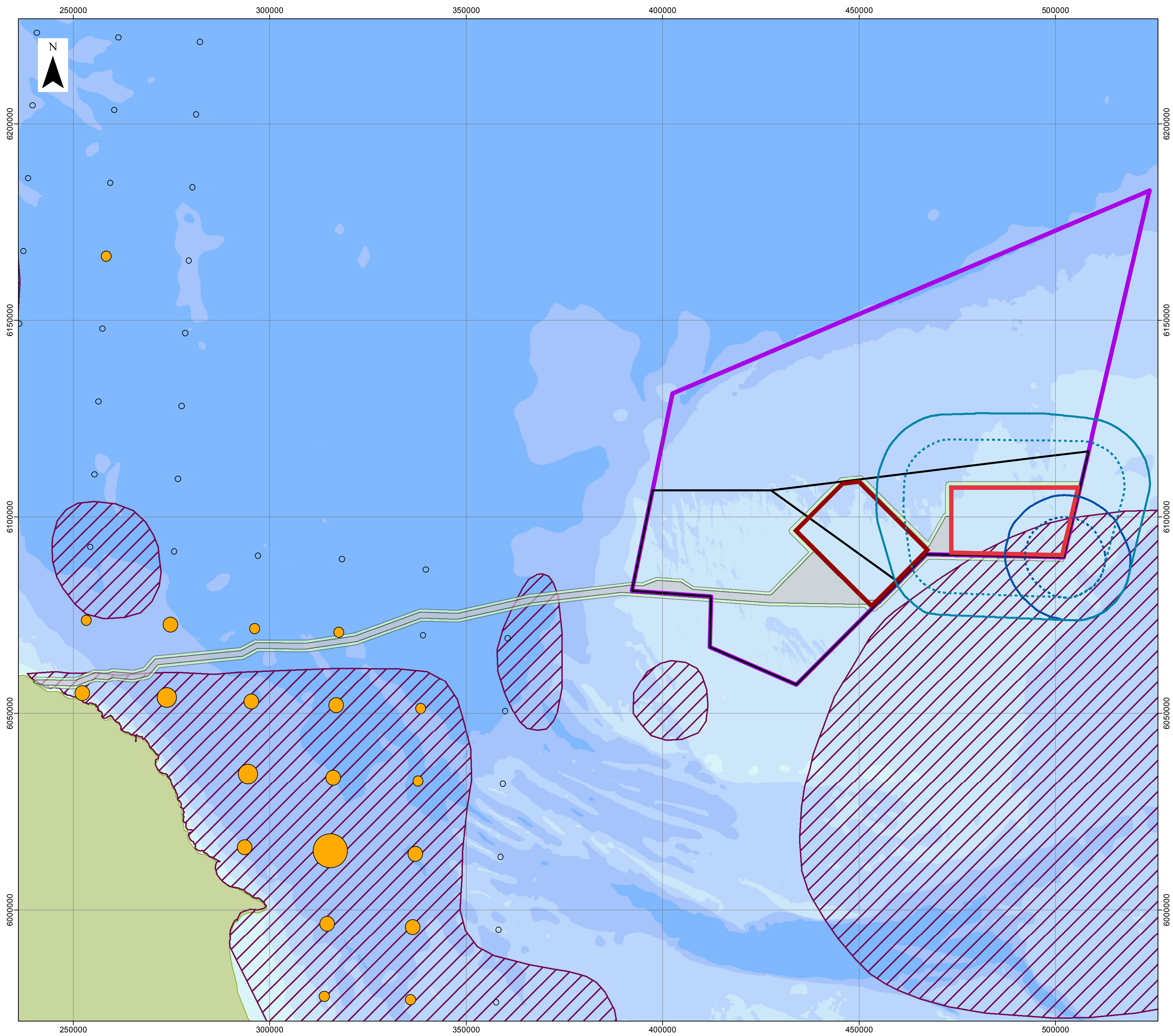
6.9.22. As previously mentioned, the noise levels associated with the Dogger Bank Teesside A & B Export Cable Corridor installation will be negligible in comparison to noise generated by pile driving. There is, however, potential for noise associated with cable installation to result in avoidance of the area immediately adjacent to where works are taking place. The spawning and nursery grounds of fish species are comparatively wide in this context and, therefore, fish species with spawning and nursery grounds in the area of the export cable are considered to have low vulnerability, medium recoverability and local or regional importance such that they are receptors of low sensitivity. With the magnitude of effect considered to be negligible the impact of cable installation related noise is assessed to be **negligible**.

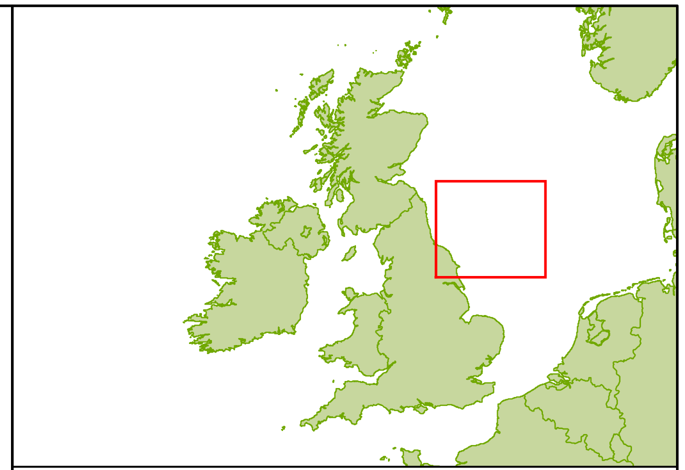
6.9.23. The Dogger Bank Teesside A & B Export Cable Corridor traverses the northern boundary of an inshore area of active herring spawning grounds. The area of the Flamborough inshore grounds as defined by Coull *et al*. (1998) is estimated as 10,512km$^2$. The cable corridor affects an estimated 0.003% of the total area of the spawning grounds therefore the effect-receptor interaction is expected to be negligible. However, herring are substrate specific spawners and therefore are limited by the availability of a suitable substrate in which to spawn. It is anticipated that underwater noise may potentially interrupt herring aggregation behaviour and some spawning herring may be deterred from depositing their eggs over suitable substrate. For these reasons, spawning herring are deemed to be receptors of low vulnerability, medium recoverability and regional importance. Taking the above into account, they are considered to be receptors of low sensitivity. The magnitude of the effect is considered to be low and the impact of cable installation related noise is assessed to be **minor adverse**.

## Behavioural effects - disturbance to migration

6.9.24. There are a number of species which may transit the area of Dogger Bank Teesside A, Dogger Bank Teesside B and the Dogger Bank Teesside A & B Export Cable Corridor during migration. This includes diadromous migratory species such as eel, salmon and sea trout, but also includes elasmobranchs and demersal and pelagic fish species which undertake smaller scale seasonal migrations to feeding and spawning grounds.



## 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
- Herring spawning ground (Coull *et al.* 1998)

Dogger Bank Teesside A 2300kJ palegic footprint (level)

- 168
- 173

Dogger Bank Teesside A 2300kJ palegic pile (level)

- 168
- 173

Herring larvae - 2011

- 0
- 1 - 100
- 101 - 1000
- 1001 - 2500
- 2501 - 5000
- 5001 - 7500
- > 7500

0 5 10 20
Kilometres

Data Source:
Modelling © NPL Management, 2013
Herring Larvae © IHLS, 2013
Spawning Grounds © Cefas, 2012
Background bathymetry image derived in part from TCarta data © 2009

PROJECT TITLE

*DOGGER BANK TEESSIDE A & B*

DRAWING TITLE

**Figure 6.9 Dogger BankTeesside A noise ranges for a single pile construction (hammer energy 2300kJ) in relation to herring spawning grounds**

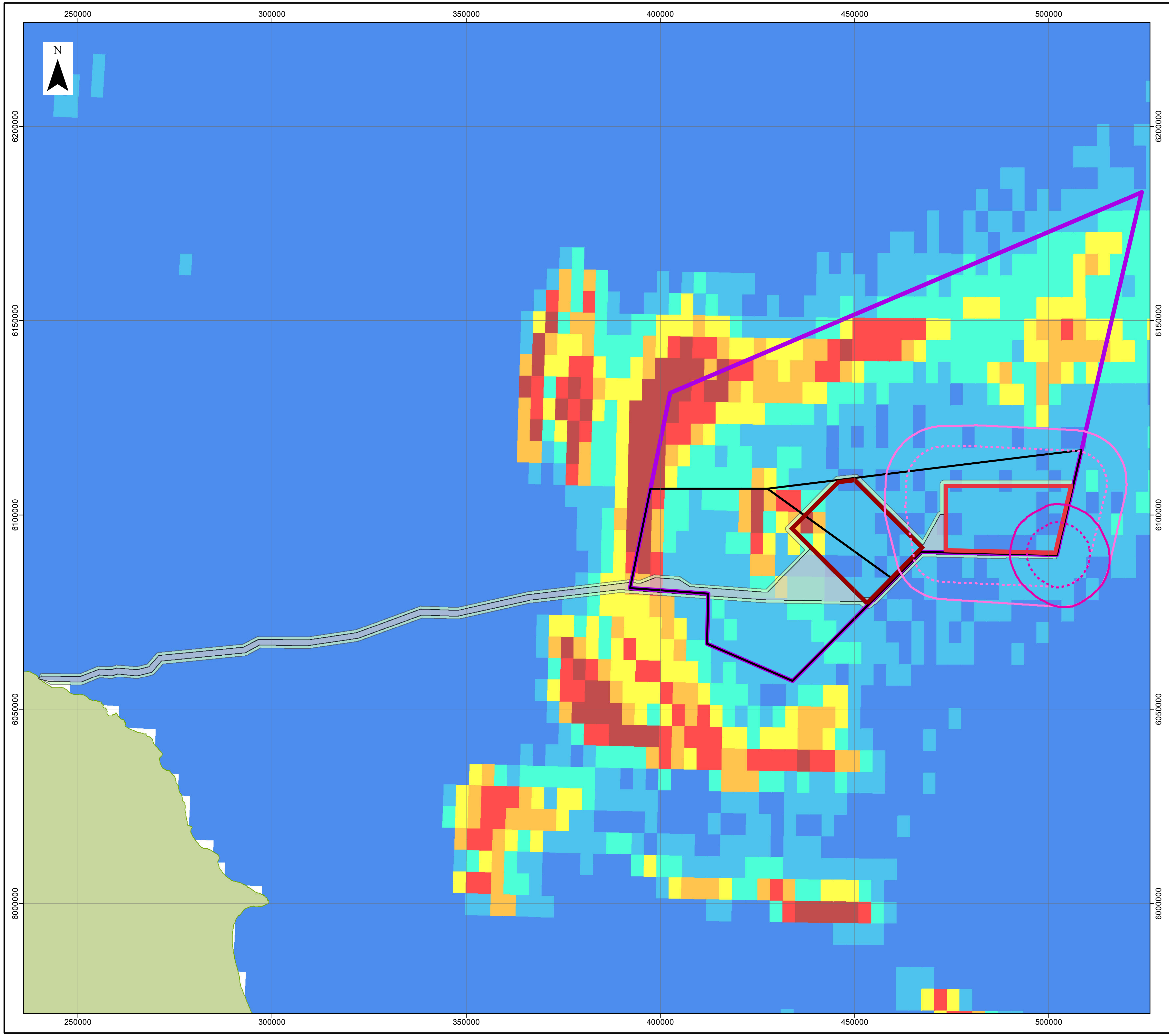
| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 07/10/2013 | PEI3 | LW | TR |
| 2 | 20/02/2014 | DCO Submission | LW | TR |

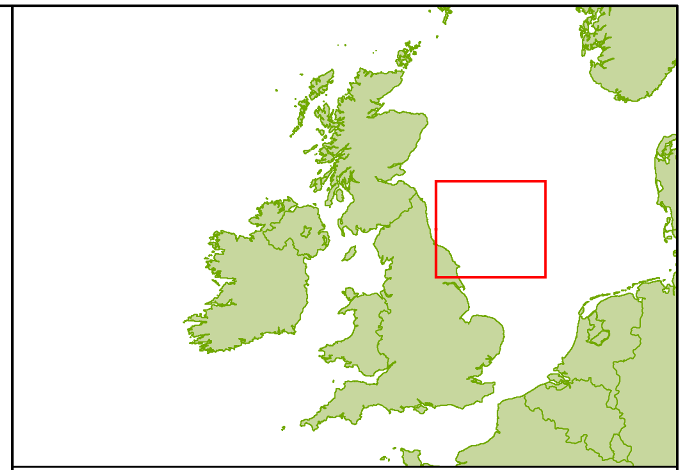
DRAWING NUMBER: **F-OFL-MA-255**

| 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

Danish sandeel satellite (VMS) density

0 to 2
3 to 5
6 to 10
11 to 20
21 to 40
41 to 80
Over 80

Dogger Bank Teesside A 2300kJ demersal footprint (level)

168
173

Dogger Bank Teesside A 2300kJ demersal pile (level)

168
173

0 5 10 20
Kilometres

Data Source:
Modelling © NPL Management, 2013
VMS © Ministeriet for Fødevarer, Landbrug og Fiskeri, 2014

PROJECT TITLE

*DOGGER BANK TEESSIDE A & B*

DRAWING TITLE

**Figure 6.10 Dogger BankTeesside A noise ranges for a single pile construction (hammer energy 2300kJ), in relation to Danish VMS (2008-2012)**

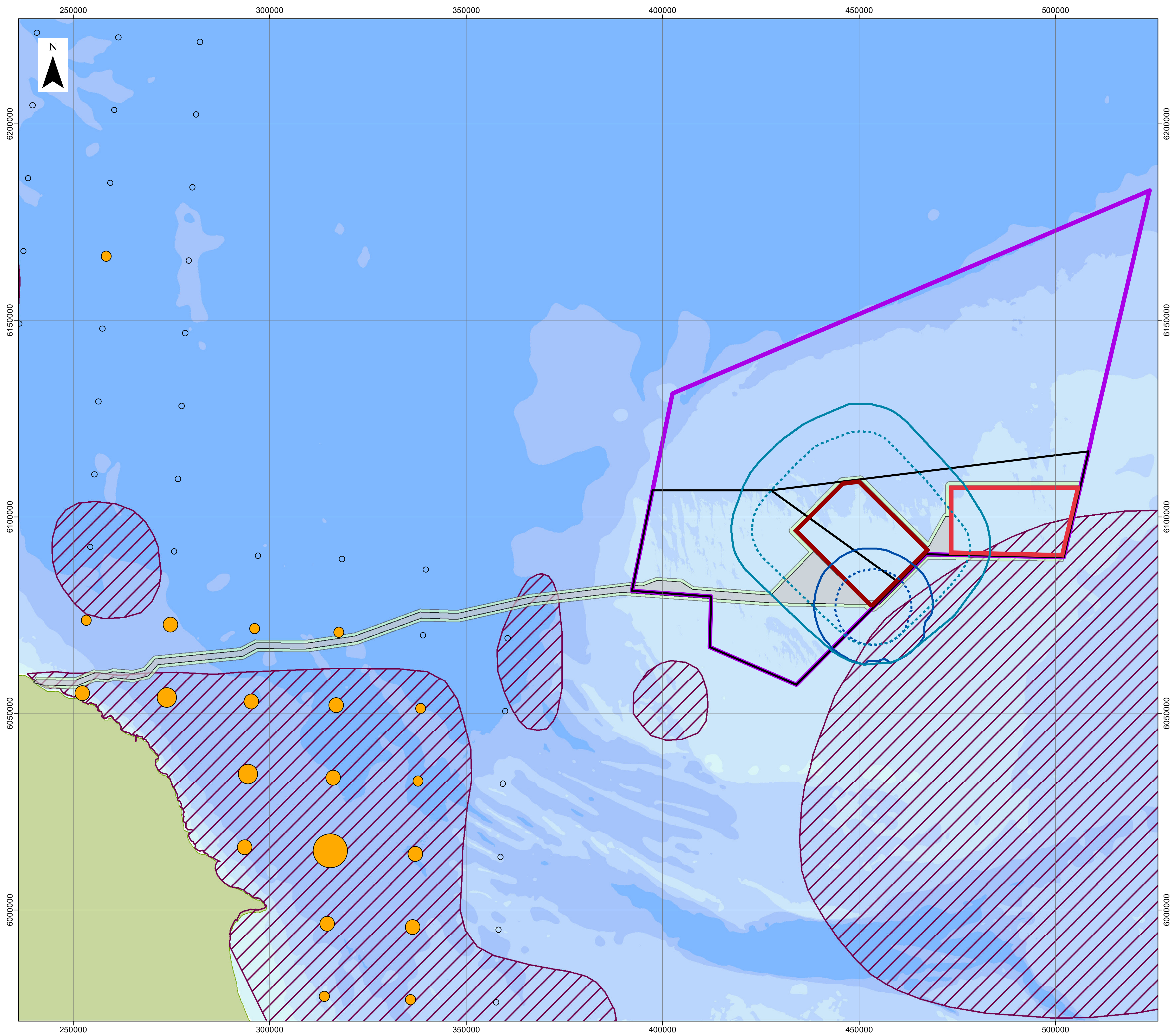
| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 07/10/2013 | PEI3 | LW | TR |
| 2 | 20/02/2014 | DCO Submission | LW | TR |

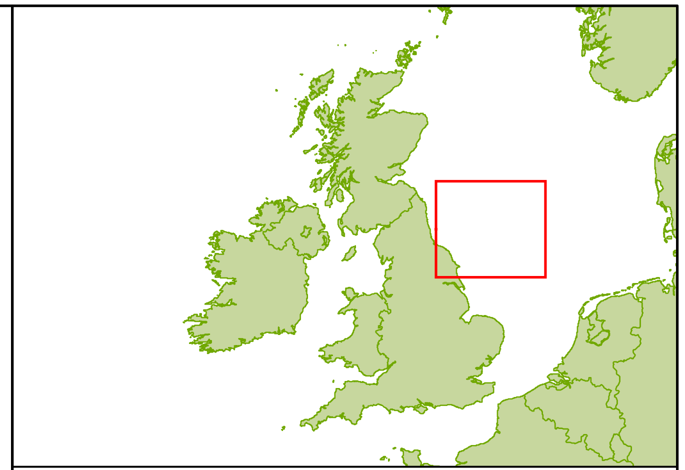
DRAWING NUMBER: **F-OFL-MA-256**

| 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
- Herring spawning ground (Coull *et al.* 1998)

Dogger Bank Teesside B 2300kJ palegic footprint (level)

- 168
- 173

Dogger Bank Teesside B 2300kJ palegic pile (level)

- 168
- 173

Herring larvae - 2011

- 0
- 1 - 100
- 101 - 1000
- 1001 - 2500
- 2501 - 5000
- 5001 - 7500
- > 7500

0 5 10 20
Kilometres

Data Source:
Modelling © NPL Management, 2013
Herring larvae © IHLS, 2013
Spawning Grounds © Cefas, 2012
Background bathymetry image derived in part from TCarta data © 2009

PROJECT TITLE

*DOGGER BANK TEESSIDE A & B*

DRAWING TITLE

**Figure 6.11 Dogger Bank Teesside B noise ranges for a single pile construction (hammer energy 2300kJ) in relation to herring spawning grounds**

| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 07/10/2013 | PEI3 | LW | TR |
| 2 | 20/02/2014 | DCO Submission | LW | TR |

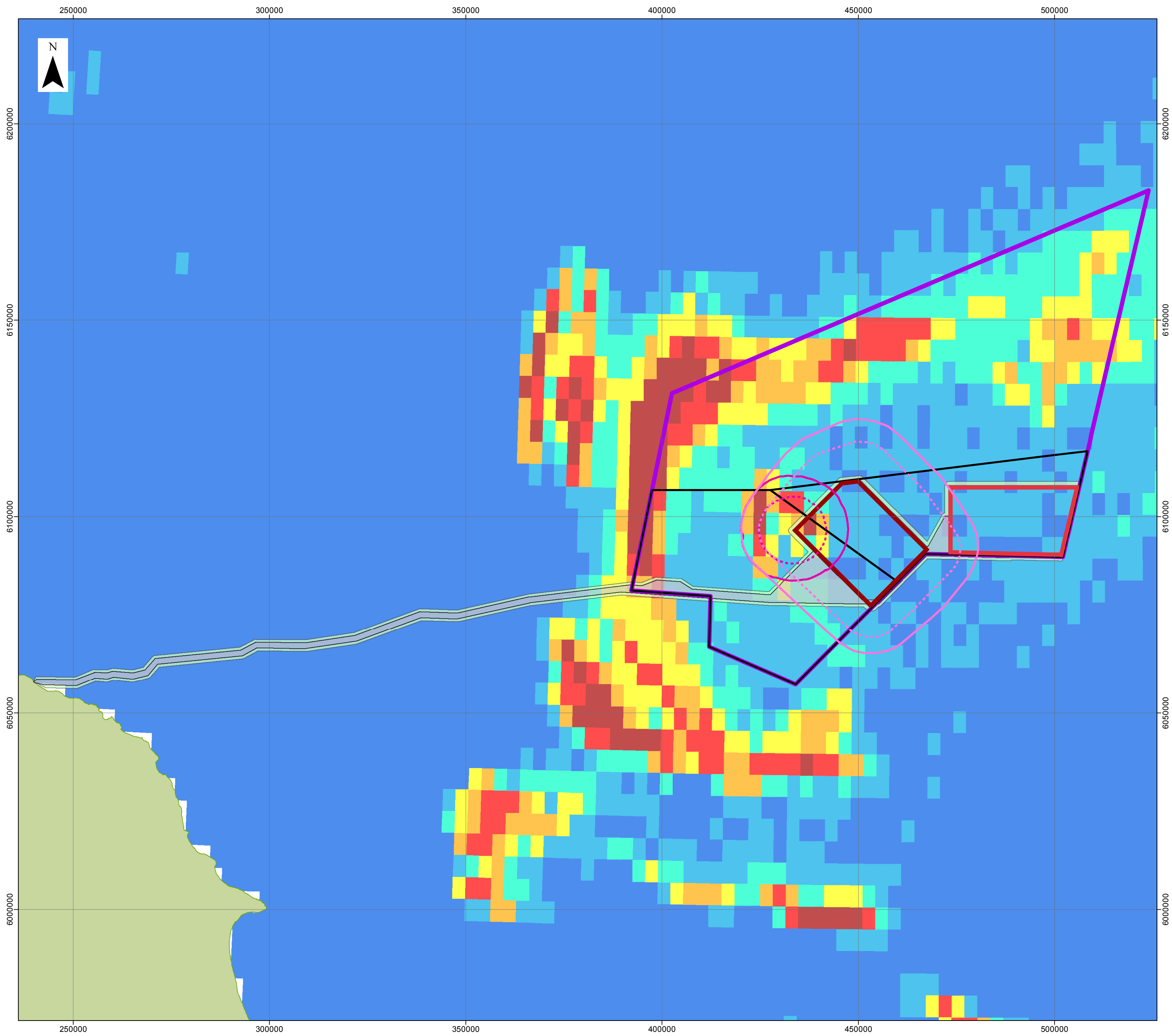
DRAWING NUMBER:

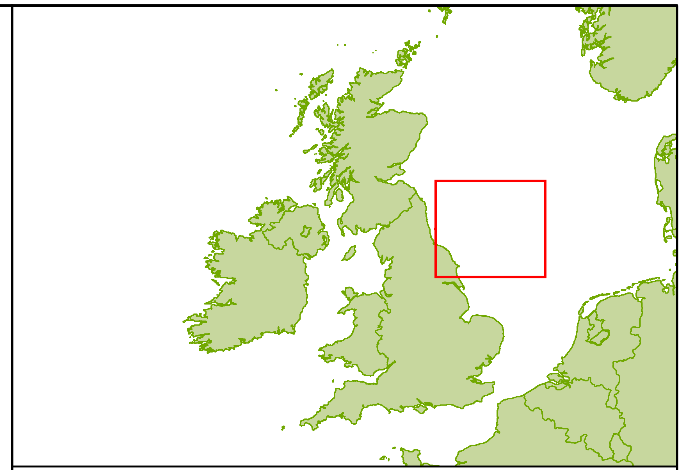
**F-OFL-MA-257**

| 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

Danish sandeel satellite (VMS) density

- 0 to 2
- 3 to 5
- 6 to 10
- 11 to 20
- 21 to 40
- 41 to 80
- Over 80

Dogger Bank Teesside B 2300kJ demersal footprint (level)

- 168
- 173

Dogger Bank Teesside B 2300kJ demersal pile (level)

- 168
- 173

0 5 10 20
Kilometres

Data Source:
Modelling © NPL Management, 2013
VMS © Ministeriet for Fødevarer, Landbrug og Fiskeri, 2014

PROJECT TITLE

*DOGGER BANK TEESSIDE A & B*

DRAWING TITLE

**Figure 6.12 Dogger Bank Teesside B noise ranges for a single pile construction (hammer energy 2300kJ), in relation to Danish VMS (2008-2012)**

| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 07/10/2013 | PEI3 | LW | TR |
| 2 | 20/02/2014 | DCO Submission | LW | TR |

DRAWING NUMBER: **F-OFL-MA-258**

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



FOREWIND

### Dogger Bank Teesside A

6.9.25. As described in **Appendix 13A**, diadromous species are only expected to be found occasionally in the area of Dogger Bank Teesside A. Given the distance between Dogger Bank Teesside A and the coast, these species will not be disturbed by construction noise immediately prior to entering, nor immediately after leaving natal rivers.

6.9.26. Assuming that diadromous species and other migratory species occasionally transit Dogger Bank Teesside A then there is a potential for short term, localised, disturbance to migration if fish encounter noise levels that induce avoidance reactions. Given the relatively constricted ranges at which these reactions occur, it is expected that in the event of such disturbance fish would be able to utilise the wider area for migration.

6.9.27. In light of these considerations, the degree of effect-receptor interaction is considered to be small. Diadromous and other fish species potentially migrating through Dogger Bank Teesside A are therefore assigned a receptor sensitivity of low based on their low vulnerability, high recoverability and national/international importance. Given the low magnitude assigned to construction noise, behavioural effects on diadromous species and elasmobranchs are assessed to result in a **minor adverse** impact.

### Dogger Bank Teesside B

6.9.28. As assessed above for Dogger Bank Teesside A.

### Dogger Bank Teesside A & B

6.9.29. As described above for Dogger Bank Teesside A.

### Dogger Bank Teesside A & B Export Cable Corridor

6.9.30. Due to the position of the Dogger Bank Teesside A & B Export Cable Corridor relative to rivers such as the Tees and Esk there is an increased potential for diadromous species, such as salmon, sea trout and eel to be affected by noise associated with installation of the Dogger Bank Teesside A & B Export Cable Corridor. This is due to the position of the cable landfall relative to the mouths of these rivers and the tendency for migration close to the coast during some stages of the life history of these species. For these reasons diadromous species are assigned a receptor sensitivity of medium based on their medium vulnerability, medium recoverability and national/international importance. With the magnitude of the effect considered to be low the impact is considered to be **minor adverse**.

## Behavioural effects of noise on prey species/feeding

6.9.31. The principal fish and shellfish species found in Dogger Bank Teesside A, Dogger Bank Teesside B and the Dogger Bank Teesside A & B Export Cable Corridor feed on a combination of invertebrate and fish prey. They may, therefore, be affected if construction results in decreased feeding opportunities (e.g. if the availability of prey is reduced due to behavioural responses of prey species to noise).

### Dogger Bank Teesside A

6.9.32. The fish assemblages and the benthic communities are relatively homogenous across Dogger Bank Teesside A and adjacent areas. If prey is temporarily displaced as a result of piling noise, fish will be able to find suitable prey in adjacent areas. In addition, as indicated in **Chapter 12**, significant adverse effects (above minor) on benthic ecology are not predicted to occur as a result of the construction phase of Dogger Bank Teesside A, Dogger Bank Teesside B and the Dogger Bank Teesside A & B Export Cable Corridor.

6.9.33. Taking the above into account, prey species are considered to be of low vulnerability, medium recoverability and local to regional importance. Their sensitivity is low and considered in terms of the low magnitude of the effect of construction noise on prey species and feeding behaviour in the Dogger Bank Teesside A area, the impact is assessed to be **minor adverse**.

### Dogger Bank Teesside B

6.9.34. As assessed above for Dogger Bank Teesside A.

### Dogger Bank Teesside A & B

6.9.35. As assessed above for Dogger Bank Teesside A.

## Behavioural effect of noise on shellfish

6.9.36. Shellfish are generally of limited mobility and, when in close proximity to construction activities, they may be exposed to potentially significant noise levels.

6.9.37. The principal shellfish VERs present in Dogger Bank Teesside A, Dogger Bank Teesside B and the Dogger Bank Teesside A & B Export Cable Corridor include *Nephrops*, edible crab and lobster. Other species such as whelks, scallops, brown shrimp and other brown shrimp species such as *Crangon almanni* which occur in the study area were not assigned VER status but are they are referred to in the following section.

6.9.38. The hearing mechanism of invertebrate species is currently not well understood, however, they are generally assumed to be less sensitive to noise than fish, due to the lack of a swim bladder. Research on the effect of noise on species such as the common prawn *Palaemon serratus* and the longfin squid *Loligo pealeii*, however, found these species to be sensitive to acoustic stimuli and it has been suggested that they may be able to detect sound similarly to most fish, via their statocysts (Lovell *et al*. 2005; Mooney *et al*. 2010).

6.9.39. Given the limited information currently available on shellfish hearing mechanisms, a conservative approach has been taken which assumes that the noise modelling carried out for fish, also applies to shellfish species. The limitations of the current available information in relation to the hearing ability of shellfish species, particularly in the case of molluscs such as whelks and scallops (both commercial species found in the area), which may be considerably less sensitive to noise than crustaceans, are however fully recognised.

**Dogger Bank Teesside A**

6.9.40. The principal shellfish species found in Dogger Bank Teesside A have wide distribution ranges. The areas where lethal and behavioural impacts associated with pile driving may occur are comparatively small and the effect-receptor interaction is also considered to be small. Shellfish species are considered to be receptors of low vulnerability, high recoverability and of local to regional value. The sensitivity of the receptor is considered to be low and in conjunction with the associated low magnitude, the effect of construction noise is considered to result in a **minor adverse** impact.

**Dogger Bank Teesside B**

6.9.41. As assessed above for Dogger Bank Teesside A.

**Dogger Bank Teesside A & B**

6.9.42. As assessed above for Dogger Bank Teesside A.

**Dogger Bank Teesside A & B Export Cable Corridor**

6.9.43. *Nephrops*, crab and lobster are targeted by the commercial fishery in the inshore area. There is potential for shellfish larvae to be present within and/or in the vicinity of the Dogger Bank Teesside A & B Export Cable Corridor. The noise associated with installation of the Dogger Bank Teesside A & B Export Cable Corridor potentially may result in behavioural reactions in fish and shellfish. However, it is anticipated that behavioural responses would be limited to the area close proximity to any construction activity. These areas are proportionally very small in the context of the wide distribution of shellfish larvae in the region. The effect-receptor interaction is expected to be small. Shellfish are deemed to be receptors of low vulnerability, high recoverability and of local to regional value. The sensitivity of the receptor is considered to be low and in conjunction with the associated low magnitude, the effect of construction noise is considered to result in a **minor adverse** impact.

## 6.10. Construction noise impact assessment summary

6.10.1. A summary of the construction noise impact assessment is given in **Table 6.9** below.

## Table 6.9 Construction noise impact assessment summary

| Potential Effect | Magnitude* Dogger Bank Teesside A, Dogger Bank Teesside B and Dogger Bank Teesside A & B | Magnitude* Dogger Bank Teesside A & B Export Cable Corridor | Receptor | | Sensitivity Dogger Bank Teesside A | Sensitivity Dogger Bank Teesside B | Sensitivity Dogger Bank Teesside A & B | Sensitivity Dogger Bank Teesside A & B Export Cable Corridor | Impact Dogger Bank Teesside A | Impact Dogger Bank Teesside B | Impact Dogger Bank Teesside A & B | Impact Dogger Bank Teesside A & B Export Cable Corridor |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Construction noise** | | | | | | | | | | | | |
| | Negligible | Negligible | Fish | Adult and juvenile fish | Low | Low | Low | Low | Negligible | Negligible | Negligible | Negligible |
| | | | | Larvae | Medium | Medium | Medium | Low | Minor adverse | Minor adverse | Minor adverse | Negligible |
| Behavioural | Low | | | Adult and juvenile fish | Low | Low | Low | Low | Minor adverse | Minor adverse | Minor adverse | Negligible |
| | | | | Herring | Medium | Medium | Medium | Medium | Minor adverse | Minor adverse | Minor adverse | Minor adverse |
| | | | | Sandeel | Low | Medium | Medium | Low | Minor adverse | Minor adverse | Minor adverse | Minor adverse |
| | | | | Diadromous species | Low | Low | Low | Medium | Minor adverse | Minor adverse | Minor adverse | Minor adverse |
| | | | | Other fish species | Low | Low | Low | Medium | Minor adverse | Minor adverse | Minor adverse | Minor adverse |
| Prey species/ Prey species feeding | | | | Fish in general | Low | Low | Low | Low | Minor adverse | Minor adverse | Minor adverse | Negligible |
| General | | | Shellfish | | Low | Low | Low | Low | Minor adverse | Minor adverse | Minor adverse | Negligible |

# 7. Impacts during Operation

## 7.1. General

7.1.1. The following potential impacts associated with the operational phase are assessed below:

- Loss of habitat;
- Introduction of hard substrate;
- EMF;
- Operational noise; and
- Changes to fishing activity.

7.1.2. In the Dogger Bank Teesside A & B Export Cable Corridor only EMF and loss of habitat related effects are considered relevant during the operational phase.

7.1.3. It should also be noted that the assessment of impacts during operation takes account of any relevant embedded mitigation as identified in Section 3.3.

## 7.2. Permanent loss of habitat - effects

7.2.1. The introduction of foundations and, where required, scour protection will result in a permanent loss of seabed habitat for the duration of the operational phase. As described in **Chapter 12** the greatest net loss of seabed would result from the introduction of 200 GBS foundations in each Dogger Bank Teesside A & B wind farm project.

7.2.2. In addition to turbine foundations, further loss of habitat will result from the footprint of the foundations of up to five met masts, four collector substations, one converter substation, two accommodation blocks per Dogger Bank Teesside A & B wind farm project, cable protection of array and inter-platform cables where required, cable crossings and vessel moorings. The worst case net loss of seabed is anticipated to be 3.77km$^2$ per Dogger Bank Teesside A & B wind farm project (**Table 5.2**).

7.2.3. In the particular case of the export cable the loss of seabed habitat may occur during the operational phase as a result of cable protection measures and crossings. This is estimated to cover a worst case area of 2.67km$^2$.

7.2.4. The worst case scenario for total permanent loss of seabed habitat is 6.44 km$^2$, equivalent to a maximum of 1.15% of the total area of each Dogger Bank Teesside A & B wind farm project (**Table 5.2**).

7.2.5. The loss of seabed described above (all footprints for foundations are inclusive of scour protection) and any associated loss of habitat will be constant and last for the duration of the operational phase. Given its small spatial extent, however, it is considered to result in an effect of low magnitude. This is considered to be the case for Dogger Bank Teesside A, Dogger Bank Teesside

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

## 7.3. Permanent loss of habitat - impacts

**Dogger Bank Teesside A**

7.3.1. The installation of turbine foundations, scour protection and cable protection has the potential to result in the permanent removal of fish and shellfish habitat. The majority of fish and shellfish species present in Dogger Bank Teesside A have wide distribution ranges and comparatively large spawning, nursery and feeding areas within the region. They are, therefore, expected to remain unaffected by the small predicted loss of seabed and the effect-receptor interaction is anticipated to be small. Most fish and shellfish receptors in the study area are deemed to be of low vulnerability, high recoverability and of local or regional importance therefore they are considered to be of low sensitivity. The effect of loss of habitat on fish and shellfish species is therefore expected to result in a **minor adverse** impact.

7.3.2. Sandeel is substrate specific, requiring the presence of an adequate sandy substrate in which to burrow. As suggested by fisheries data and the results of the sandeel survey carried out in tranches A and B, they are present within Dogger Bank Teesside A. This area however supports very small numbers of sandeel in the context of the Dogger Bank SA1. The degree of interaction between loss of habitat associated with Dogger Bank Teesside A and sandeel is therefore considered to be very small. Taking this into account sandeel is considered to be a receptor of medium vulnerability, medium recoverability and regional value, therefore a receptor of medium sensitivity. Together with the low magnitude of the effect, the loss of habitat is considered to result in a **minor adverse** impact.

7.3.3. It should be noted that specific post-construction monitoring for sandeel undertaken at Horns Rev Offshore Wind Farm has not found evidence of a long term effect on the sandeel population seven years after construction (Stenberg *et al*. 2011).

7.3.4. In the case of herring, Dogger Bank Teesside A overlaps a small area of former herring spawning grounds (as defined by Coull *et al*. 1998). As suggested by the distribution of sediment types within the study area, there is potential for discrete areas of suitable herring spawning substrate to occur within Dogger Bank Teesside A. If re-colonisation of the former herring spawning grounds occurs, there may be potential for these coarse sediment and gravelly areas to be lost. The potential loss of spawning grounds, however, is proportionally small in the context of the extent of available gravelly areas in the vicinity of Dogger Bank Teesside A. It should also be noted that the presence of coarse sediment in a given area does not necessarily constitute a preferred herring spawning ground.

7.3.5. Taking the potential extent of interaction described above into account, herring are considered receptors of medium vulnerability, medium recoverability and regional value, therefore they are deemed to be receptors of medium sensitivity.

The magnitude of the effect is considered to be low therefore the impact of loss of habitat is considered to be **minor adverse**.

**Dogger Bank Teesside B**

7.3.6. As described above for Dogger Bank Teesside A, the fish and shellfish species present in Dogger Bank Teesside B have wide distribution ranges, being able to use comparatively large areas for spawning, nursery and feeding. They are, therefore, expected to remain unaffected by the small predicted loss of seabed and are considered to be receptors of low vulnerability, medium recoverability and of regional value, therefore they are deemed to be receptors of low sensitivity. The impact of loss of habitat on fish and shellfish species is therefore expected to be **minor adverse.**

7.3.7. Fisheries data and the results of the sandeel survey carried out in tranches A and B show that sandeel are expected to be found within Dogger Bank Teesside B. This area is, however, very small in the context of the distribution of sandeel in the wider Dogger Bank SA1. Forewind have taken the presence of sandeel into account when defining the western boundary of tranche A (Section 3.3). In this respect, sandeel species are, therefore, considered receptors of medium vulnerability, medium recoverability and regional importance, therefore they are deemed to be receptors of medium sensitivity and the effect of loss of habitat is considered to result in a **minor adverse** impact. As previously mentioned for Dogger Bank Teesside A, the wide distribution of high density sandeel areas outside Dogger Bank Teesside B should be noted in this context (see **Appendix 13A**).

7.3.8. In the case of herring, Dogger Bank Teesside B does not fall within the defined former herring spawning grounds or their immediate vicinity (Coull *et al*. 1998). It is recognised, however, that there is potential for discrete suitable herring spawning substrate to be found within Dogger Bank Teesside B as suggested by the distribution of sediment types within Dogger Bank Teesside B (see **Appendix 13A**). As described above for Dogger Bank Teesside A, the potential loss of spawning grounds associated with this is very small in the context of the extent of available gravelly areas on the Dogger Bank and the extent of the former spawning grounds (see **Appendix 13A**). Furthermore the presence of adequate coarse sediment does not necessarily imply that herring will use a given area for spawning.

7.3.9. Taking the above into account together with the distance from Dogger Bank Teesside B to the defined former herring spawning grounds (Coull *et al*. 1998), herring are considered receptors of low vulnerability, medium recoverability and regional value, therefore sensitivity is deemed to be low. The impact of the loss of spawning habitat is considered to result in a **minor adverse** impact.

**Dogger Bank Teesside A & B**

7.3.10. As assessed above for Dogger Bank Teesside A and Dogger Bank Teesside B.

**Dogger Bank Teesside A & B Export Cable Corridor**

7.3.11. The loss of seabed habitat associated with the Dogger Bank Teesside A & B Export Cable Corridor during the operational phase is very small in the context of the distribution of fish and shellfish species present in the area of the export cable, including areas used for spawning, as nursery, feeding or overwintering grounds. With respect to this small interaction, fish and shellfish are therefore considered receptors of low vulnerability, medium recoverability and local to international importance, therefore they are receptors of medium sensitivity. Since the magnitude of effect is low the loss of habitat is considered to result in a **minor adverse** impact.

7.3.12. In the particular case of spawning herring, as previously mentioned, they are substrate specific spawners, needing the presence of an adequate substrate on which to lay their eggs. The Dogger Bank Teesside A & B Inshore Export Cable Corridor Study Area falls within known active herring spawning grounds and, therefore, there may be potential for a loss of spawning grounds to occur associated with the Dogger Bank Teesside A & B Export Cable Corridor. However the small spatial extent of the Dogger Bank Teesside A & B Export Cable Corridor it is considered to result in an effect of low magnitude. As shown in **Appendix 13A** the extent of the defined grounds, and of coarse sediment and gravelly areas within those grounds, is very wide in comparison to the potential loss of habitat associated with export cable protection during the operation phase. Taking the above into account it is considered that there will be a low degree of interaction between the active herring spawning grounds and areas where the export cable may be protected during the operational phase. Herring are therefore considered receptors of medium vulnerability, medium recoverability and regional importance and therefore of medium sensitivity. The effect of loss of spawning habitat on herring is considered to result in a **minor adverse** impact.

7.3.13. Sandeel is present in the vicinity of the Dogger Bank Teesside A & B Export Cable Corridor. The proportional loss of sandeel habitat to the introduction of hard substrate is small compared to the extensive area occupied by the Dogger Bank SA1 sandeel population in the North Sea. However displaced sandeel may be vulnerable to increased levels of predation or unable to relocate successfully. The level of interaction is considered to be medium and given the small spatial extent of the Dogger Bank Teesside A & B Export Cable Corridor an effect of low magnitude is assigned. Sandeel is considered to be a receptor of medium vulnerability, medium recoverability and regional importance. The species is deemed to be a receptor of medium sensitivity and the effect of the loss of spawning habitat is anticipated to result in a **minor adverse** impact.

## 7.4. Permanent loss of habitat impact assessment summary

7.4.1. The loss of habitat impact assessment on fish and shellfish species is summarised in **Table 7.1** below.

Table 7.1 Permanent loss of habitat impact assessment summary

| Potential effect | Magnitude of effect | Receptor | Receptor sensitivity | | | | Impact |
|---|---|---|---|---|---|---|---|
| | Dogger Bank Teesside A, B and Dogger Bank Teesside A & B | | Dogger Bank Teesside A | Dogger Bank Teesside B | Dogger Bank Teesside A & B | Dogger Bank Teesside A & B Export Cable Corridor | All areas |
| Permanent loss of habitat | Low | Fish and Shellfish in general | Low | Low | Low | Low | Minor adverse |
| | | Sandeel | Medium | Medium | Medium | Medium | |
| | | Herring | Medium | Medium | Medium | Medium | |

## 7.5. Introduction of hard substrate-effects

7.5.1. Dogger Bank Teesside A and Dogger Bank Teesside B are located in a predominantly soft seabed environment. The sub-surface sections of turbine towers, the foundations and where required, the placement of scour and cable protection material will result in the introduction of hard substrate in areas previously characterised by the presence of soft sediment.

7.5.2. The introduced hard substrate is expected to be colonised by a number of organisms, including a range of encrusting and attaching species such as ascidians, bryozoans and bivalve molluscs (**Chapter 12**). This is likely to increase local species diversity as well as the abundance and biomass of epifaunal organisms.

7.5.3. The increase in diversity and productivity of seabed communities may have an effect on fish, resulting in either attraction or increased productivity (Hoffman *et al*. 2000). The potential for marine structures, whether man-made or natural, to attract and concentrate fish is well documented (Sayer *et al*. 2005; Bohnsack, 1989; Bohnsack and Sutherland 1985). Whether these structures act only to attract and aggregate fish or actually increase biomass is, however, currently unclear.

7.5.4. During post-construction monitoring work at Horns Rev Offshore Wind Farm, it was estimated that the introduction of hard substrate resulted in 60 times increased food availability for fish and other organisms in the wind farm area compared to the native infaunal biomass (Leonhard and Pedersen 2005). A succession in the number of fish species was observed when comparing the results of surveys undertaken in March and in September. It was suggested that this could be a result of seasonal migrations of fish species to the turbine site for foraging. Bib *Trisopterus luscus* and schools of cod were observed, presumably partly feeding on crustaceans on the scour protection. Other species such as rock gunnel *Pholis gunnellus* and dragonet were commonly found inhabiting caves and crevices between the stones. In addition, pelagic and semi-pelagic fish such as sprat, mackerel and lesser sandeel seemed to be more frequently recorded than previously (Leonhard & Pedersen 2005).

7.5.5. Andersson *et al*. (2009) compared the epibenthic colonisation of concrete and steel experimental pillars with natural areas and sampled fish assemblages. The study found overall higher abundance and species numbers on the pillars (with no difference between steel and concrete pillars) compared to the surrounding soft bottom habitats. A reef effect was detected in species such as two-spotted goby *Gobiusculus flavescens* and goldsinny wrasse *Ctenolabrus rupestris*. This preference was, however, not observed on bottom-dwelling species such as gobies.

7.5.6. Studies carried out in operational wind farms in Sweden (Wilhelmsson *et al*. 2006) found greater fish abundances in the vicinity of the wind turbines than in surrounding areas and no evidence of associated effects in terms of diversity. On the monopiles of the wind turbines, however, the structure of the fish community found was different, with the total fish abundance being greater and diversity lower than in the surrounding seabed.

7.5.7. The Horns Rev Offshore Wind Farm monitoring follow-up report recently published (Stenberg *et al*. 2011) examined the changes in the fish community seven years after construction. This report suggests that the introduction of hard substrate has resulted in minor changes in the fish community and species diversity. Fish community changes were observed due to changes in densities of the most commonly occurring fish, whiting and dab. However, this reflected the general trend of these fish populations in the North Sea.

7.5.8. The introduction of hard substrate was, however, found to result in higher species diversity close to each turbine with a clear (horizontal) distribution, which was most pronounced in the autumn, when most species occurred. New reef habitat fish such as goldsinny wrasse, viviparous eelpout *Zoarces viviparous* and lumpsucker *Cyclopterus lumpus* were found to establish themselves on the introduced reef area. In the particular case of sandeel, it should be noted that sandeel specific monitoring carried out in Horns Rev Offshore Wind Farm suggests that the construction of the wind farm has not resulted in a detrimental long-term effect on the overall occurrence of sandeel in the area (Stenberg *et al*. 2011).

7.5.9. A review of the short term ecological effects of the offshore wind farm Egmond aan Zee (OWEZ) in the Netherlands, based on two year post-construction monitoring (Lindeboom *et al*. 2011) found minor effects upon fish assemblages, especially near the monopiles, and it was suggested that species such as cod may find shelter within the wind farm. At OWEZ, a study of the residence time and behaviour of sole and cod was also undertaken (Winter *et al*. 2010). Some sole were found in the wind farm area for periods of up to several weeks during the growing season, suggesting there was no large scale avoidance of the wind turbines. Evidence of sole being attracted to monopile habitats was, however, not found. For cod, it was found that at least part of the juvenile population, spend long periods within the wind farm. Near-turbine fish observations carried out at OWEZ (Couperus *et al*. 2010) using high resolution sonar suggest that fish around the monopiles exhibit relatively stationary behaviour and occur in loose aggregations rather than dense schools. The aggregations found in the study area consisted primarily of horse mackerel and cod.

7.5.10. Similarly, the results of fish monitoring programmes carried out in operational wind farms in the UK do not suggest that major changes in fish species composition, abundance or distribution have occurred. At North Hoyle, a change in the diversity of organisms or the species composition of the benthic and demersal community was not found. The annual post-construction beam trawl surveys indicated that most of the fish species considered were broadly comparable to previous years and within the long-term range. Some species showed recent increases and decreases, but broadly mirrored regional trends (Cefas 2009). At Barrow offshore wind farm, pre and post-construction otter trawl survey results from the wind farm area showed similar patterns of abundance, with the most frequently caught fish being dab, plaice, whiting and lesser spotted dogfish. Results from control locations showed a similar pattern, and found no significant differences between the catches of the two most abundant species (dab and plaice) before and after installation of the wind farm. No differences were found between the numbers caught at control locations and within the wind farm area after the wind farm was constructed (Cefas 2009).

7.5.11. Langhamer and Wilhelmsson (2009) carried out a field experiment to study the potential for fish and crabs to colonise wave energy foundations and the effects of manufactured holes. This study recorded a significantly higher abundance of fish and crabs on the foundations compared to the surrounding soft substrate.

7.5.12. It is likely that the greatest potential for positive effects exists for crustacean species, such as crab and lobster, due to expansion of their natural habitats (Linley *et al*. 2007) and the creation of additional refuge areas. Where foundations and scour protection are placed within areas of sandy and coarse sediments, this will represent novel habitat and new potential sources of food in these areas and could potentially extend the habitat range of some shellfish species. Post-construction monitoring surveys at the Horns Rev Offshore Wind Farm noted that the hard substrates were used as a hatchery or nursery grounds for several species, and was particularly successful for brown crab.

7.5.13. Linley *et al*. (2007) suggest that the introduction of wind farm related structures could extend the distribution of some shellfish mobile species such as crabs and lobsters, as a result of increased habitat opportunities. At Horns Rev Offshore Wind Farm, for example, it was found during post construction monitoring that the wind farm site was being used as a nursery area by juvenile edible crabs (Leonhard and Pedersen 2005). Colonisation of structures by commercial shellfish species has also been reported at the artificial reef constructed in Poole Bay in 1989, where attraction and fidelity was demonstrated for lobster and edible crabs within three weeks of construction (Collins *et al*. 1992; Jensen *et al*. 1994). In addition, evidence of reproductive activity for a number of shellfish species such as spider crabs, velvet crabs and presence of berried female lobster was also found (Jensen *et al*. 1992).

7.5.14. Based on the experience at Horns Rev Offshore Wind Farm and Poole Bay, Linley *et al*. (2007) suggested that edible crab may be among the early colonisers of operational wind farms. Experiments to study the potential for fish and crabs to colonise wave energy foundations and the effects of manufactured holes (Langhamer & Wilhelmsson 2009) recorded a significantly higher abundance of fish and crabs on the foundations compared to the surrounding soft substrate.

7.5.15. The colonisation of the new habitats may potentially lead to the introduction of non-native and invasive species. With respect to fish and shellfish populations, this may have indirect adverse effects on shellfish populations as a result of competition. However, no non-native species were identified as present in the area during the site-specific surveys. Some of the more common non-native species that are now found in the waters of the UK such as the slipper limpet *Crepidula fornicata* and the Chinese mitten crab *Eriocheir sinensis* prefer more estuarine conditions and more sheltered, lower energy environments. There is little evidence of adverse effects resulting from colonisation of other offshore wind farms by non-native species; the post construction monitoring report for the Barrow offshore wind farm demonstrated no evidence of invasive or alien species on or around the monopiles (EMU 2008a), and a similar study of the Kentish Flats monopiles only identified slipper limpet (EMU 2008b). A more recent survey of wrecks on the Dogger Bank showed that the predominant species found were typical of a North Sea rocky reef in moderate to strong currents (Envision 2011). The main species found included the coral (dead mans fingers) *Alcyonium digitatum*, plumose anemone *Metridium senile*, cod, lobster, edible crab, tube worm *Spirobranchus sp*. and various ascidians.

## 7.6. Introduction of hard substrate-impacts

7.6.1. The impact of the introduction of hard substrate is predicted to be of local spatial extent, long term duration (for the life-time of Dogger Bank Teesside A & B), continuous and irreversible (during the lifetime of Dogger Bank Teesside A & B). The impact is expected to have direct and indirect effects on fish and shellfish receptors. The magnitude of effect is considered to be low for Dogger Bank Teesside A, Dogger Bank Teesside B and Dogger Bank Teesside A & B.

7.6.2. It is anticipated that any hard substrate associated with cable protection in the Dogger Bank Teesside A & B Export Cable Corridor will only be introduced in discrete areas and will not be continuous along large lengths of the Dogger Bank Teesside A & B Export Cable Corridor. The magnitude of effect of the introduction of hard substrate in this case is therefore considered to be **negligible.**

### Dogger Bank Teesside A

7.6.3. As suggested by the findings of the above monitoring studies, there may be potential for Dogger Bank Teesside A & B to be used as nursery and spawning area and/or provide shelter and increased feeding opportunities to some fish and shellfish species.

7.6.4. The dominant natural substrate character of the construction area, (e.g., soft sediment or hard rocky seabed), will determine the number of new species found on the introduced vertical hard surface and associated scour protection. When placed on an area of seabed which is already characterised by rocky substrates, few species will be added to the area, but the increase in total hard substrate could sustain higher abundance (Andersson & Öhman 2010). Conversely, when placed on a soft seabed, most of the colonising fish will be from rocky (or other hard bottom) habitats, thus the overall diversity of the area will increase (Andersson *et al*. 2009).

7.6.5. The introduction of hard substrate has the potential to result in minor effects on fish and shellfish; typically on an individual species basis rather than on the fish and shellfish assemblage as a whole. Fish and shellfish are therefore considered to be receptors of medium vulnerability, medium recoverability and of local to international value. The sensitivity of the receptors is deemed to be medium. Considering the low magnitude of the effect of the introduction of hard substrate on fish and shellfish species, the impact is assessed as **minor**. Whether this impact is beneficial or adverse will depend on the particular species in question.

7.6.6. In the event that there is a requirement for the seabed to be returned to its original condition prior to the installation of Dogger Bank Teesside A & B infrastructure, any beneficial effects arising from the introduction of hard substrate will be removed during the decommissioning phase.

**Dogger Bank Teesside B**

7.6.7. As assessed above for Dogger Bank Teesside A.

**Dogger Bank Teesside A & B**

7.6.8. As assessed above for Dogger Bank Teesside A.

**Dogger Bank Teesside A & B Export Cable Corridor**

7.6.9. Cable protection may be required in discrete areas along the Dogger Bank Teesside A & B Export Cable Corridor. The introduction of hard substrate is not expected to be spatially continuous and will have little potential to result in aggregation effects and/or changes to the fish and shellfish assemblage of the area. Fish and shellfish are therefore considered as receptors of low vulnerability, medium recoverability and of local to regional value. The sensitivity of the receptors is therefore deemed to be low. When considered in terms of the negligible effect, the impact of the introduction of hard substrate associated with the Dogger Bank Teesside A & B Export Cable Corridor and the impact is assessed to be **negligible**.

7.6.10. In terms of hard substrate resulting in a loss of suitable substrate for herring spawning, the worst case proportional loss of spawning area (assuming that the total length of the cable corridor is protected) is anticipated to be 0.81km$^2$, equivalent to 0.008% of the total area of the inshore Flamborough herring spawning grounds.

7.6.11. The introduction of hard substrate has the potential to result in a loss 1.67km$^2$ of habitat and spawning area for sandeel, equivalent to 0.006% of the total area of suitable habitat within the SA1 management area.

7.6.12. Fish and shellfish (including herring and sandeel) are therefore considered as receptors of low vulnerability, medium recoverability, and of local to regional importance and therefore their sensitivity to the introduction of hard substrate associated with the Dogger Bank Teesside A & B Export Cable Corridor is deemed to be low. As the magnitude of the effect is negligible, and the impact is assessed to be **negligible**.

## 7.7. Introduction of hard substrate impact assessment summary

7.7.1. A summary of the introduction of hard substrate impact assessment is given in **Table 7.2**.

Table 7.2 Introduction of hard substrate impact assessment summary

| Potential effect | Magnitude of effect | | Receptor | Receptor sensitivity | | Impact | |
|---|---|---|---|---|---|---|---|
| | Dogger Bank Teesside A, B and Dogger Bank Teesside A & B | Dogger Bank Teesside A & B Export Cable Corridor | | Dogger Bank Teesside A, B and Dogger Bank Teesside A & B | Dogger Bank Teesside A & B Export Cable Corridor | Dogger Bank Teesside A, B and Dogger Bank Teesside A & B | Dogger Bank Teesside A & B Export Cable Corridor |
| Introduction of hard substrate | Low | Negligible | Fish and shellfish (general) | Medium | Low | Minor adverse | Negligible |

## 7.8. Increases in suspended sediment concentration and sediment re-deposition due to scour associated with foundations - effects

7.8.1. Over the period of operation, there is the potential for creation of sediment plumes caused by seabed scour around non-scour protected wind turbine foundations after they have been installed. No potential operational effects are considered for the export and inter-array cables since they will be buried or surface-layed and protected where cable burial is not feasible and protrude (with armouring) only a small distance above the seabed.

7.8.2. In **Chapter 9** the effect of scour on sediment transport was modelled using a worst case scenario with a gridded layout of 6MW conical GBS#1 foundations at their minimum 750m spacing with a wider spaced grid of foundations across the rest of each Dogger Bank Teesside A & B wind farm project, including platforms, meteorological masts and vessel moorings. Two scenarios were tested as the worst case for plume dispersion using a minimum construction period of two years. These are a scenario after one year when 200 foundations are operational subject to a 30-day simulation including a one-year storm, and a scenario after two years when all 400 foundations are operational and subject to a 30-day simulation including a larger 50-year storm. 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 and Dogger Bank Teesside B respectively).

7.8.3. The results show that the maximum suspended sediment concentration after one year of operation at any time throughout the 30-day simulation period was predicted to be 50-100mg/l above natural background levels (2mg/l). Maximum concentrations reduce to background levels up to approximately 37km from the project boundaries. The highest average suspended sediment concentration was 10-20mg/l reducing to background levels up to approximately 28km from the project boundaries.

7.8.4. After two years, the maximum concentration was predicted to increase to greater than 200mg/l in areas up to 20km long and 6km wide along the boundaries of the projects. Across the whole of both projects, maximum suspended sediment concentrations were greater than 20mg/l reducing to background levels (2mg/l) up to approximately 54km from the project boundaries. The highest average concentrations after two years were 10-50mg/l within the projects and up to 19km outside their boundaries. Average concentrations reduce to background levels (2mg/l) up to approximately 36km from the project boundaries.

7.8.5. After one year, maximum sediment deposition of 0.1-0.5mm occurs within both projects during the 30-day simulation period, reducing to 0.1mm up to approximately 30km outside the project boundaries. Average deposition was predicted to be mainly less than 0.1mm. Time series of bed thickness show that throughout the footprint the maximum within the foundation layout doesn't exceed 0.7mm. The predicted bed thickness at the end of the 30-day simulation period was effectively zero across much of the depositional area.

7.8.6. After two years, maximum deposition of 0.5-5mm occurs across each project with deposition reducing to less than 0.1mm up to 35km from the boundaries. Average deposition is predicted to be 0.5-5mm between the projects reducing to less than 0.1mm up to approximately 23km outside the project boundaries.. Time series of bed thickness show that the thickness within the foundation layout may exceed 1mm continuously for up to 3.00 days. The predicted bed thickness at the end of the 30-day simulation period was less than 0.1mm across much of the depositional area.

7.8.7. A comparison of operational scour volumes with naturally occurring release of sediment during a one-year storm shows that predicted scour volumes are five times less than half the volume that would be suspended without the foundations in place. For a 50-year storm, scour volumes are six times less than the volumes that would be suspended without the foundations in place during a storm of the same magnitude.

## 7.9. Increases in suspended sediment concentration and sediment re-deposition due to scour associated with foundations - impacts

### Dogger Bank Teesside A

7.9.1. The modelled outputs from **Chapter 9** predict that concentrations of suspended sediment and levels of sediment re-deposition during the operational phase (**Table 7.3**) will be less than the potential effects of suspended sediment concentrations and sediment re-deposition described for the construction phase (see **Table 6.4**). The magnitude of the effect is judged to be low.

7.9.2. The sensitivity of fish and shellfish receptors to suspended sediment and sediment deposition are described previously in Section 6.5. Any such events will have varying levels of effect dependent on the species and life history stage of the species. The sensitivity of fish and shellfish receptors is considered to be low to medium. The significance of the impact is assessed to be **minor adverse**.

**Dogger Bank Teesside B**

7.9.3. As described above for Dogger Bank Teesside A (see **Table 7.3**).

**Dogger Bank Teesside A & B**

7.9.4. As described above for Dogger Bank Teesside A and Dogger Bank Teesside B (see **Table 7.3**).

Table 7.3 Increases in suspended sediment concentration and sediment re-deposition due to scour associated with foundations impact assessment summary

| **Potential effect** | **Magnitude of effect** | | **Receptor** | **Receptor sensitivity** | | **Impact** | |
|---|---|---|---|---|---|---|---|
| | **Dogger Bank Teesside A, B and Dogger Bank Teesside A & B** | **Dogger Bank Teesside A & B Export Cable Corridor** | | **Dogger Bank Teesside A, B and Dogger Bank Teesside A & B** | **Dogger Bank Teesside A & B Export Cable Corridor** | **Dogger Bank Teesside A, B and Dogger Bank Teesside A & B** | **Dogger Bank Teesside A & B Export Cable Corridor** |
| Increases in suspended sediment concentration and sediment re-deposition due to scour associated with foundations | Low | - | Fish and shellfish (general) | Low/ Medium | - | Minor adverse | - |

## 7.10. Electromagnetic fields (EMF) - effects

7.10.1. Molluscs, crustaceans, elasmobranch fish and teleost fish are able to detect applied or modified magnetic fields. Species for which there is evidence of a response to E and B fields include elasmobranches (sharks, skates and rays), river lamprey, sea lamprey, cod (E field only), European eel, plaice and Atlantic salmon (Gill *et al*. 2005). Data on the use that marine species make of these capabilities is limited, although it can be inferred that the life functions supported by an electric sense may include detection of prey, predators or conspecifics to assist with feeding, predator avoidance, and social or reproductive behaviours. Life functions supported by a magnetic sense may include orientation, homing, and navigation to assist with long or short-range migrations or movements (Gill *et al*. 2005; Normandeau *et al*. 2011). Therefore, the EMF emitted by subsea cables may interfere with these functions in areas where the cable EMF levels are detectable by the organism. This may cause an expenditure of energy in moving to areas which may not be suitable for finding either prey species or members of the same species, or in moving away from areas where predators are mistakenly located.

7.10.2. As previously mentioned the potential effects associated with EMF will be mitigated through the use of armoured array and export cables. In addition, cables will be buried where feasible, further mitigating potential EMF associated impacts on fish and shellfish receptors. In instances where adequate burial cannot be achieved, alternative protection measures, as described in **Chapter 5**, will be used.

7.10.3. A number of different cabling options are included in the project description for array and export cables. For the purposes of defining the worst case scenario the highest rating option for each type of cable and the maximum cabling length are considered to constitute the worst case, as this is expected to result in the strongest associated fields and total area affected. A summary of the parameters used in the assessment for each cable type is given below.

**Array cables per project**

***Inter-Array cables***

- Alternating Current (AC) three core cable of maximum voltage 72.5kV;
- Maximum length of cabling: 950km; and
- Protected with concrete mattresses, pipes, half pipes or cable clips where burial is not feasible.

***Inter-Platform cables***

- High Voltage Alternating Current (HVAC) cables of maximum voltage 400kV;
- Maximum number of cables: eight;
- Maximum length of cabling: 320km; and
- Protected with rock placement, concrete mattresses, steel bridging or concrete bridging where burial is not feasible.

7.10.4. AC cables generate an electric field (E) and a magnetic field (B). The total E field cancels itself out to a large extent and the remaining E is shielded by the metallic sheath and cable armour. The B fields generated by AC cables are, however, constantly changing. The varying B produce associated induced electric fields (iE), therefore both B and iE will be generated by inter array cables during the operational phase of Dogger Bank Teesside A & B.

7.10.5. Export cables per project:

- HVDC of maximum voltage of 550kV;
- Maximum number of cables: one pair (two cables per circuit);
- Maximum length of export cable Dogger Bank Teesside A: 573km
- Maximum length of export cable Dogger Bank Teesside B: 484km
- Protected with rock burial, concrete mattresses, pipes, half-pipes, or cable clips where burial is not feasible.

7.10.6. Unlike AC cables, iE fields will not be produced directly by Direct Current (DC) cables. In the marine environment, however, organisms and tidal streams will pass through the static B field and this will indirectly result in the production of an iE field. As a result, both B and iE fields will also be produced during the operational life of the export cables. It should be noted, that in the particular case of DC cables, if these are bundled, the strength of the B field will be significantly reduced.

7.10.7. The strength of the B fields generated by both AC and DC cables decreases exponentially, horizontally and vertically, with distance from the source. An indication of this is given for AC and DC cables in **Table 7.4** and **Table 7.5** respectively. These show averaged predicted magnetic fields at intervals above and horizontally along the seabed for a number of AC and DC projects, as provided in Normandeau *et al*. (2011). Since the strength of the magnetic field decreases with distance from the source, the potential effect of EMF on fish and shellfish will likely be influenced by the position of particular species in the water column and water depth.

Table 7.4 Averaged magnetic field strength values from AC cables

| Distance (m) above seabed | Magnetic field strength (µT) | | |
|---|---|---|---|
| | Horizontal distance (m) from cable | | |
| | 0 | 4 | 10 |
| 0 | 7.85 | 1.47 | 0.22 |
| 5 | 0.35 | 0.29 | 0.14 |
| 10 | 0.13 | 0.12 | 0.08 |

Table 7.5 Averaged magnetic field strength values from DC cables above and horizontally along the seabed assuming 1m burial (Normandeau *et al*. 2011)

| Distance (m) above seabed | Magnetic field strength (μT) | | |
|---|---|---|---|
| | Horizontal distance (m) from cable | | |
| | 0 | 4 | 10 |
| 0 | 78.27 | 5.97 | 1.02 |
| 5 | 2.73 | 1.92 | 0.75 |
| 10 | 0.83 | 0.74 | 0.46 |

7.10.8. Although cable burial does not completely mitigate B or iE fields, it reduces exposure of electromagnetically sensitive species to the strongest EMF that exist at the 'skin' of the cable, owing to the physical barrier of the substratum (OSPAR 2008). In instances where adequate burial cannot be achieved, it is anticipated that alternative protection, as described in **Chapter 5**, will be used. Fish and shellfish species will, therefore, not be directly exposed to the strongest EMF as a result of the physical barrier provided by either cable burial or cable protection.

7.10.9. Given the EMF related effects may potentially occur in a relatively small area, limited to the immediate vicinity of the cables, the magnitude of the effect of EMF is considered to be low for Dogger Bank Teesside A, Dogger Bank Teesside B, Dogger Bank Teesside A & B and for the Dogger Bank Teesside A & B Export Cable Corridor.

7.10.10. A summary of species for which there is evidence of a response to E and B fields is provided in **Table 7.6** and **Table 7.7** as provided in Gill *et al*. (2005)

Table 7.6 Species found in UK coastal waters for which there is evidence of a response to E fields. Gill *et al*. (2005)

| Species / species groups | Latin name |
|---|---|
| **Elasmobranchs** | |
| Lesser Spotted Dogfish | *Scyliorhinus canicula* |
| Blue shark | *Prionace glauca* |
| Thornback ray | *Raja clavata* |
| Round ray | *Rajella fyllae* |
| **Agnatha** | |
| River lamprey | *Lampetra fluviatilis* |
| Sea lamprey | *Petromyzon marinus* |
| **Teleosts** | |
| European eel | *Anguilla anguilla* |
| Cod | *Gadus morhua* |
| Plaice | *Pleuronectes platessa* |
| Atlantic salmon | *Salmo salar* |

Table 7.7 Species found in UK waters for which there is evidence of a response to B fields.

| Species / species groups | Latin name |
|---|---|
| **Elasmobranchs** | |
| All elasmobranchs possess the ability to detect magnetic fields | |
| **Agnatha** | |
| River lamprey | *Lampetra fluviatilis* |
| Sea lamprey | *Petromyzon marinus* |
| **Teleosts** | |
| European eel | *Anguilla anguilla* |
| Plaice | *Pleuronectes platessa* |
| Atlantic salmon | *Salmo salar* |
| Sea trout | *Salmo trutta* |
| Yellowfin tuna | *Thunnus albacares* |
| **Crustaceans** | |
| Lobster, crabs, shrimps and prawns | Specific cases non-UK<br>Decapoda: *Crangon crangon*<br>Isopoda: *Idotea baltica*<br>Amphipoda: *Talorchestia martensii* ,*Talitrus saltator* |
| **Molluscs** | |
| Snails, bivalves and squid | Specific case non-UK<br><br>Nudibranch: *Tritonia diomedea* (Willows 1999) |

## 7.11. Electromagnetic fields (EMF) - Impacts

7.11.1. The principal species groups potentially present in Dogger Bank Teesside A, Dogger Bank Teesside B and the Dogger Bank Teesside A & B Export Cable Corridor for which there is evidence of a response to EMF are as follows:

- Elasmobranchs;
- Diadromous migratory species: European eel, river and sea lamprey and salmon and sea trout;
- Other fish species: cod and plaice; and
- Shellfish species.

### *Elasmobranchs*

7.11.2. Elasmobranchs are the major group of organisms known to be electrosensitive. They possess specialised electroreceptors called Ampullae of Lorenzini. These species naturally detect bioelectric emissions from prey, conspecifics and potential predators/competitors (Gill *et al*. 2005). They are also known to either detect magnetic fields using their electronsensory systems or through a yet-to-be described magnetite receptor system (Normandeau *et al*. 2011). Magnetic field detection is thought to be used as a means of orientation in elasmobranches, however, evidence for magnetic orientation by sharks and rays is limited to date (Meyer *et al*. 2005) and there is currently debate on the actual mechanisms used (Johnsen and Lohmann 2005).

7.11.3. Elasmobranchs may be confused by anthropogenic E field sources that lie within similar ranges to natural bioelectric fields. Both attraction and repulsion reactions have been observed associated with E-fields in elasmobranch species. Gill and Taylor (2001) found limited laboratory based evidence that the lesser spotted dogfish avoids DC E-fields at emission intensities similar to those predicted from offshore wind farm AC cables. The same fish were attracted to DC emissions at levels predicted to emanate from their prey. Laboratory studies have found both AC and DC artificial electric fields stimulated feeding responses in elasmobranchs (Kalmijn 1982; Tricas and Sisneros 2004; Kimber *et al*. 2011). Research by Gill *et al*. (2009) found that lesser spotted dogfish were more likely to be found within the zone of EMF emissions, and some thornback ray showed increased movement around the cable when the cable was switched on. Responses were, however, unpredictable and did not always occur, appearing to be species dependent and individual specific. Recent research on lesser spotted dogfish (Kimber *et al*. 2011) suggests that although they possess the ability to distinguish certain artificial E fields, sharks are either unable to distinguish, or showed no preference between similar strength, anthropogenic (dipole) and natural (live crab) DC E fields.

7.11.4. Information gathered as part of the monitoring programme undertaken at Burbo Bank suggest that certain elasmobranch species (sharks, skates and rays) do feed inside the wind farm and demonstrated that they are not excluded during periods of low power generation (Cefas 2009). Monitoring at Kentish Flats found an increase in thornback ray, smooth hound and other elasmobranchs during post construction surveys in comparison to surveys before construction. It appeared, however, that there was no discernible difference between the data for the wind farm site and reference areas, including population structure changes. It was therefore concluded that the population increase observed was unlikely to be related to the operation of the wind farm (Cefas 2009).

**Dogger Bank Teesside A**

7.11.5. Few sharks and rays were captured in fish characterisation surveys and their relative abundance in the vicinity of Dogger Bank Teesside A is considered to be low. However, elasmobranchs typically have wide distribution ranges and defined nursery grounds for spurdog and tope overlap with both Dogger Bank Teesside A and Dogger Bank Teesside B. Therefore, there is considerable potential for these species to transit Dogger Bank Teesside A.

7.11.6. EMF produced by the array cables is expected to result in temporary behavioural reactions, rather than long term impacts on feeding, migration or confusion in elasmobranch species. A medium level of interaction between elasmobranchs and EMF is therefore expected. Elasmobranch species are considered as receptors of medium vulnerability, medium recoverability and local value, therefore they are receptors of medium sensitivity. As previously defined, the magnitude of the effect is considered to be low. EMF related effects are therefore assessed to result in a **minor adverse** impact.

**Dogger Bank Teesside B**

7.11.7. As described for Dogger Bank Teesside A.

**Dogger Bank Teesside A & B**

7.11.8. The assessment for both Dogger Bank Teesside A and Dogger Bank Teesside B individually also applies to Dogger Bank Teesside A & B combined.

7.11.9. As described in detail in **Appendix 13A**, a number of elasmobranch species are expected to be found along the Dogger Bank Teesside A & B Export Cable Corridor. Starry smoothhound, lesser spotted dogfish, spotted ray and thornback ray were all recorded in the Dogger Bank Teesside A & B Inshore Export Cable Corridor Study Area in trammel net surveys. In addition, the Dogger Bank Teesside A & B Export Cable Corridor falls within the wide nursery grounds defined for spurdog.

7.11.10. Elasmobranchs are expected to make limited use of the Dogger Bank Teesside A & B Export Cable Corridor Study Area in the context of their wide distribution ranges. In addition, EMF associated with export cables are only expected to result in temporary behavioural reactions, rather than long term impacts on feeding, migration or confusion. In light of this, elasmobranchs are considered to be receptors of medium vulnerability, medium recoverability and local value; therefore they are receptors of medium sensitivity. The magnitude of the effect is assessed as low and EMF is anticipated to result in a **minor adverse** impact.

***Diadromous migratory species***

7.11.11. European eel possess magnetic material of biogenic origin of a size suitable for magnetoreception (Hanson *et al*. 1984; Hanson and Walker 1987; Moore and Riley 2009) and are thought to use the geomagnetic field for orientation (Karlsson 1985). In addition, their lateral line has been found to be slightly sensitive to electric current (Berge 1979; Vriens and Bretschneider 1979). Research carried out on salmon and sea trout also indicates that these species are able to respond to magnetic fields (Formicki *et al*. 2004; Tanski *et al*. 2005; Sadowski *et al*. 2007; Formicki and Winnicki 2009). The presence of magnetic material suitable for magnetoreception has been found in Atlantic salmon (Moore *et al*. 1990), as has the ability of this species to respond to electric fields (Rommel and McLeave 1973).

7.11.12. Lampreys possess ampullary electroreceptors that are sensitive to weak, low-frequency electric fields (Bodznick and Northcutt 1981; Bodznick and Preston 1983); however, information on the use that they make of the electric sense is limited. It is likely however that they use it in a similar way as elasmobranchs to detect prey, predators or conspecifics and potentially for orientation or navigation (Normandeau *et al*. 2011).

**Dogger Bank Teesside A**

7.11.13. Dogger Bank Teesside A is located 196km offshore, therefore it is expected that diadromous migratory species will not be subject to EMF associated with array cables prior to river entry or immediately after leaving rivers. They may, however, occasionally transit Dogger Bank Teesside A, and there is, therefore, potential for EMF associated with the array to affect these species during migration and/or feeding activity.

7.11.14. As previously mentioned, the strength of E and B fields decreases quickly with distance to the source, hence potential effects on movement and behaviour in salmonids, likewise in other pelagic species, would be closely linked to the proximity of the fish to the source of EMF. Gill and Bartlett (2010) suggest that any potential EMF associated effect on the migration of salmon and sea trout is dependent on the depth of water and the proximity of natal rivers to development sites. The migration of Atlantic salmon in the Baltic Sea for example seems to continue unaffected, despite the presence of a number of operating HVDC cables in the path of the migration route (Walker 2001). The level of effect-receptor interaction between EMF associated with the array cables and salmon and sea trout is considered to be small. These species are considered to be receptors of medium vulnerability, medium recoverability and regional to national importance therefore they are deemed to be of medium sensitivity. The magnitude of the effect is considered to be low therefore the effect of EMF on salmonids is assessed to result in a **minor adverse** impact.

7.11.15. As suggested above for salmonids, European eel may also occasionally transit Dogger Bank Teesside A as part of their migration. A number of studies have been carried out in relation to the migration of eels and the effects of EMF derived from offshore wind farm cables. Experiments undertaken at the operational wind farm of Nysted detected barrier effects. However, correlation analysis between catch data and data on power production showed no indication that the observed effects were attributable to EMF. Furthermore, mark and recapture experiments showed that eels did cross the export cable (Hvidt *et al*. 2005). Similarly research by Westerberg (1999) on HVDC cables and eel migration found some effects associated with the magnetic disturbance were likely to occur although the consequences appeared to be small. In addition, no indication was found that the cable constituted a permanent obstacle to migration, either for adult eels or for elvers.

7.11.16. Further research, where 60 migrating silver eels were tagged with ultrasonic tags and released north of a 130 kV AC cable, found swimming speeds were significantly lower around the cable than in areas to the north and south (Westerberg and Lagenfelt 2008). It was noted that no details on the behaviour during passage over the cable were recorded and possible physiological mechanisms explaining the phenomenon were unknown. Based on the results of Westerberg and Lagenfelt (2008) before publication, Öhman *et al*. (2007) suggested that even if an effect on migration was demonstrated, the effect was small, and on average the delay caused by the passage was approximately 30 minutes. Based on the above, a medium degree of interaction between EMF and European eel is expected to occur. European eel are therefore considered to be receptors of medium vulnerability, medium recoverability and national importance, therefore they are deemed to be of medium sensitivity. The magnitude of the effect is considered to be low thus EMF related effects are assessed to result in a **minor adverse** impact.

7.11.17. The information available to date on the response lamprey have to E fields is limited. Chung-Davidson (2008) found that weak electric fields may play a role in their reproduction and it was suggested that electrical stimuli provoke different behaviour in feeding-stage and spawning-stage sea lampreys. Lampreys spawn in freshwater therefore will only be exposed to EMF if migration routes to freshwater spawning sites cross areas with EMF influence. The degree of interaction between lampreys and EMF is anticipated to be very small. Lampreys are considered of low vulnerability, medium recoverability and international importance, therefore they are deemed to be of low sensitivity and effects associated with EMF are assessed to result in a **minor adverse** impact.

**Dogger Bank Teesside B**

7.11.18. As assessed above for Dogger Bank Teesside A.

**Dogger Bank Teesside A & B**

7.11.19. As assessed above for Dogger Bank Teesside A.

**Dogger Bank Teesside A & B Export Cable Corridor**

7.11.20. Diadromous species are more likely to cross export cables than array cables, particularly in the Inshore Dogger Bank Teesside A & B Export Cable Corridor Study Area. The Dogger Bank Teesside A & B Export Cable Corridor landfall is situated between two designated ‘principal salmon rivers’; the Yorkshire Esk to the south and the Tees immediately to the north. Both of these rivers support populations of salmonids. However, given the distance between the landfall site and the mouths of the Esk and the Tees, it is not expected that diadromous species will be subject to the effect of EMF prior to or immediately after leaving the rivers.

7.11.21. The effect-receptor interaction for diadromous species is anticipated to be low. Salmon and sea trout are considered to be receptors of low vulnerability, medium recoverability and national importance, therefore they are deemed to be receptors of low sensitivity. The magnitude of the effect is low and the effect of EMF on salmonids is, therefore, assessed to result in a **minor adverse** impact.

7.11.22. European eel is considered as a receptor of low vulnerability, medium recoverability and national value, therefore European eel is deemed to be a receptor of low sensitivity. The magnitude of the effect is low and the impact associated with EMF is considered to be **minor adverse.**

7.11.23. Lampreys are considered as receptors of low vulnerability, medium recoverability and international value, therefore they are deemed to be receptors of low sensitivity. The magnitude of the effect is low and the impact associated with EMF is considered to be **minor adverse**.

***Other Fish Species***

7.11.24. Further to the species described above, as shown in **Table 7.6** and **Table 7.7** there is some evidence of a response to EMF in other fish species, such as cod and plaice VERs (Gill *et al*. 2005).

### Dogger Bank Dogger Bank Teesside A

7.11.25. The results of post-construction monitoring carried out in operational wind farms do not suggest that EMF have resulted in significant detrimental impacts on these species. Lindeboom *et al*. (2011) suggests that the presence of the foundations and scour protection and potential changes in the fisheries related to offshore wind farm development would have the most impact upon fish species. Similarly, Leonhard and Pedersen (2006) indicate that noise from the wind turbines and EMF from cabling do not seem to have a major impact on fish and other mobile organisms attracted to the hard bottom substrates for foraging, shelter and protection. In line with this, research carried out at the Nysted offshore wind farm (Denmark), focused on detecting and assessing possible effects of EMF on fish during power transmission, and found no differences in the fish community composition after the wind farm was operational (Hvidt *et al*. 2005). Whilst effects on the distribution and migration of four species were observed (European eel, flounder, cod and Baltic herring), it was recognised that the results were likely to be valid on a very local scale, and only on the individual level, and that an impact on a population or community level was likely to be very limited.

7.11.26. Taking the above into account, it is expected that EMF will only result in short term, temporary behavioural effects on these species. All other fish and shellfish receptors are deemed to be of low vulnerability and are of local to regional importance in the fish and shellfish study area. The sensitivity of these receptors is therefore, considered to be low. Magnitude is deemed to be low therefore the impact is assessed as **minor adverse**.

### Dogger Bank Teesside B

7.11.27. As assessed above for Dogger Bank Teesside A.

### Dogger Bank Teesside A & B

7.11.28. As assessed above for Dogger Bank Teesside A.

### Dogger Bank Teesside A & B Export Cable Corridor

7.11.29. There is some evidence of a response to EMF in teleost species such as cod and plaice. The results of monitoring programmes carried out in operational wind farms do not suggest that EMF have resulted in a detrimental impact on these species. Leonhard and Pedersen (2006) indicate that EMF from cabling do not seem to have a major impact on fish and other mobile organisms attracted to the hard bottom substrates for foraging, shelter and protection.

7.11.30. It is therefore expected that EMF will at worst, result in short term, temporary behavioural effects on these species. The “other fish species” receptor group are deemed to be of low vulnerability and are of local to regional importance in the study area. The sensitivity of these receptors is therefore, considered to be low. Magnitude is deemed to be low therefore the impact is assessed as **minor adverse**.

#### *Shellfish*

7.11.31. Research on the ability of marine invertebrates to detect EMF has been limited. Although there is no direct evidence of effects to invertebrates from undersea cable EMF (Normandeau *et al*. 2011), the ability to detect magnetic fields has been studied for some species and there is evidence in some of a response to magnetic fields, including molluscs and crustaceans (**Table 7.6**).

7.11.32. Crustacea, including lobster and crabs, have been shown to demonstrate a response to B fields, with the spiny lobster *Panulirus argus* shown to use a magnetic map for navigation (Boles and Lohmann; 2003). However, it is uncertain if other crustaceans including commercially important brown crab and European lobster are able to respond to magnetic fields in this way. Limited research undertaken with the European lobster found no neurological response to magnetic field strengths considerably higher than those expected directly over an average buried power cable (Normandeau *et al*. 2011; Ueno *et al*. 1986). Indirect evidence from post construction monitoring programmes undertaken in operational wind farms do not suggest that the distribution of potentially magnetically sensitive species of crustaceans or molluscs have been affected by the presence of submarine power cables and associated magnetic fields.

**Dogger Bank Teesside A**

7.11.33. The principal shellfish species identified in **Appendix 13A** appear to be more abundant in areas closer to shore, making them more relevant to the Dogger Bank Teesside A & B Export Cable Corridor than within the boundaries of Dogger Bank Teesside A. Species such as brown shrimp and velvet crab have, however, been found within Tranche A in relatively high numbers. Other species such as edible crab and queen scallop have also been found occasionally during survey work within Tranche A.

7.11.34. Research undertaken by Bochert and Zettler (2004), where a number of species, including the brown shrimp and mussels *Mytilus edulis* both found in UK waters, were exposed to a static magnetic field of 3.7mT for several weeks, found no differences in survival between experimental and control animals. The effect of EMF on shellfish is, therefore, expected to be limited to behavioural responses.

7.11.35. The role of the magnetic sense in invertebrates has been hypothesised to function in relation to orientation, navigation and homing, using geomagnetic cues (Cain *et al*. 2005; Lohmann *et al*. 2007). Research undertaken on the Caribbean spiny lobster *Panulirus argus* (Boles and Lohmann 2003) suggests that this species derives positional information from the Earth's magnetic field which is used during long distance migration. *Nephrops* and European lobster belong to the same taxonomic family (Nephropidae) and neither are known to undertake significant long distance migrations. Indeed limited research undertaken with the European lobster found no neurological response to magnetic field strengths considerably higher than those expected directly over an average buried power cable (Ueno *et al*. 1986; Normandeau *et al*. 2011).

7.11.36. Indirect evidence from monitoring programmes undertaken in operational wind farms do not suggest that the distribution of potentially magnetically sensitive species of crustaceans or molluscs have been affected by the presence of submarine power cables and associated magnetic fields. In this context, however, the lack of shellfish specific EMF monitoring programmes should be recognised. As a result of the information provided above shellfish species are considered receptors of low vulnerability, medium recoverability and local regional importance. Their sensitivity is low, the magnitude is low and EMF related effects are assessed to result in a **minor adverse** impact.

**Dogger Bank Teesside B**

7.11.37. As assessed above for Dogger Bank Teesside A.

**Dogger Bank Teesside A & B**

7.11.38. As assessed above for Dogger Bank Teesside A.

**Dogger Bank Teesside A & B Export Cable Corridor**

7.11.39. The degree of interaction between shellfish species and B fields associated with the Dogger Bank Teesside A & B Export Cable Corridor is expected to be very small. Whilst some species may use the earth's magnetic field for orientation, there is no evidence to date to suggest that EMF associated with offshore wind farms have potential to result in significant effects on shellfish species. Indirect evidence from monitoring programmes undertaken in operational wind farms do not suggest that the distribution of potentially magnetically sensitive species of crustaceans or molluscs have been affected by the presence of submarine power cables and associated B fields. Research undertaken by Bochert and Zettler (2004), where a number of commercially important shellfish species such as brown shrimp and mussels were exposed to a static magnetic field of 3.7 mT for several weeks. This field strength was chosen to represent a maximum value which could be emitted by cables associated with offshore wind farms and is considerably higher than the averaged values outlined in **Table 7.4** and **Table 7.5** (Normandeau *et al*. 2011). The experiment tested both long term survival and fitness (measured by condition and gonosomatic indices) in experimental and control animals and found no significant differences between treatments. The functional role of the magnetic sense in invertebrates is hypothesized to be for orientation, navigation and homing using geomagnetic cues (Cain *et al*. 2005; Lohmann *et al*. 2007). As a result of research undertaken by Bochert and Zettler (2004), in addition to that of Normandeau *et al.* (2011) and Ueno *et al.* 1986, it is assumed that *Nephrops* will not be impacted by EMF.

7.11.40. There is a general lack of information and research on the potential changes in water/sediment temperature as a result of the installation of sub-sea power cables. When electric energy is transported, increased temperature of the cable surface can sometimes lead to subsequent warming of the surrounding environment. The two main types of offshore cable used in the offshore wind sector are HVAC and HVDC. In general, thermal radiation can be expected to be greater for HVAC cables than for HVDC cables at equal transmission rates (OSPAR commission; 2009). This is because transmission losses for HVDC cables are significantly lower than for HVAC cables. Field measurements carried out to assess thermal radiation from wind farm cables at the Nysted wind farm (Denmark) showed an average variation of 0.8K directly above (25cm) an installed 132kV HVAC cable relative to a control site. Less deviation was found in lateral locations (30cm to the side) indicating attenuation was rapid within the sediment (Meibner *et al*. 2007). Measurements at the sediment surface however were the same as ambient conditions suggesting little heating effect on the overlying water column. Therefore, it is not expected that temperature radiation as a result of EMF will impact shellfish species in the area.

7.11.41. Taking the degree of interaction between shellfish receptors and the effect of EMF, and the fact that shellfish are receptors of low vulnerability, medium recoverability and local importance. Their sensitivity is low, the magnitude is low and the impact is therefore anticipated to be **minor adverse**.

## 7.12. EMF impact assessment summary

7.12.1. A summary of the EMF impact assessment is given in **Table 7.8**.

Table 7.8 EMF impact assessment summary

| **Potential effect** | **Effect magnitude** | **Receptor** | | **Receptor sensitivity** | | **Impact** |
|---|---|---|---|---|---|---|
| | **Dogger Bank Teesside A, B Dogger Bank Teesside A & B Dogger Bank Teesside A & B Export Cable Corridor** | | | **Dogger Bank Teesside A, B Dogger Bank Teesside A & B** | **Dogger Bank Teesside A & B Export Cable Corridor** | **All areas** |
| EMF | Low | Elasmobranchs | | Medium | | Minor adverse |
| | | Diadromous migratory species | Salmon and sea trout | Medium | Medium | |
| | | | European sea eel | Medium | Medium | |
| | | | Lamprey | Low | Low | |

## 7.13. Operational noise-effects

7.13.1. The main source of noise during operation originates from the wind turbines gearbox and generator. In addition, noise would also result from surface vessels servicing the wind farm. The radiated levels from the wind turbines are low and the spatial extent of the potential effect on marine receptors is generally considered to be small and unlikely to result in injury. Measurements of operational noise at a series of UK wind farm sites (Nedwell *et al*. 2007) found that in general, the noise levels generated were very low, being only marginally above ambient noise levels.

7.13.2. In this context a major contribution to the ambient noise would result from sea-state, which would be expected to increase as the wind turbine rotational speed increases with wind speed. Increased ambient noise may, therefore, exceed wind turbine noise (Tougaard and Henriksen 2009). Furthermore, considering the operational noise of the wind farm and any associated service vessels, the ambient noise levels within Dogger Bank Teesside A and Dogger Bank

Teesside B would be expected to be lower than those present in the vicinity of the shipping lanes to the north and south.

7.13.3. Given the low noise levels predicted, any risk of significant behavioural disturbance on fish would be limited to the area immediately surrounding the wind turbine, which represents a very small proportion of the area of Dogger Bank Teesside A & B. Similarly, the combined area affected taking account of Dogger Bank Teesside A & B would be small.

7.13.4. Taking the above into account, the magnitude of the effect of operational noise on fish and shellfish receptors is considered to be low for Dogger Bank Teesside A, Dogger Bank Teesside B and Dogger Bank Teesside A & B.

## 7.14. Operational noise- impacts

### Dogger Bank Teesside A

7.14.1. Research by Wahlberg and Westerberg (2005) found that operational noise did not have any destructive effect upon the hearing ability of fish, even within distances of a few meters. It was estimated that fish would only be consistently scared away from wind turbines at ranges shorter than 4m and only at high wind speeds (higher than 13 m/s).

7.14.2. Post-construction monitoring of hard substrate communities at Horns Rev Offshore Wind Farm (Leonhard and Pedersen 2005) found, based on comparisons with fish fauna on shipwrecks in other parts of the North Sea, that there was great similarity in the species observed, including benthic species. The authors note that there was no indication that noise or vibrations from the wind turbines had any impacts on the fish community. This is in line with the findings of post construction monitoring carried out in other wind farms described in the 'Introduction of Hard Substrate' section above (i.e. Winter *et al*. 2010; Stenberg *et al*. 2011; Lindeboom *et al*. 2011; Couperus *et al*. 2010).

7.14.3. Taking the above into account it is reasonable to assume that the effect of operational noise on fish and shellfish will be limited and the level of interaction is low. Fish and shellfish receptors are therefore, considered to be of low vulnerability, high recoverability and of local to international value. The sensitivity of these receptors is deemed to be low and in the context of the low magnitude of the operational noise, the effect is assessed to result in a **minor adverse** impact.

### Dogger Bank Teesside B

7.14.4. As assessed above for Dogger Bank Teesside A.

### Dogger Bank Teesside A & B

7.14.5. As assessed above for Dogger Bank Teesside A.

## 7.15. Operational noise impact assessment summary

7.15.1. A summary of the operational noise impact assessment on fish and shellfish receptors is given below in **Table 7.9**

Table 7.9 Operational noise impact assessment summary

| Potential effect | Magnitude<br>Dogger Bank Teesside A, B and Dogger Bank Teesside A & B | Receptor | Sensitivity<br>Dogger Bank Teesside A, B and Dogger Bank Teesside A & B | Impact<br>Dogger Bank Teesside A, B and Dogger Bank Teesside A & B |
|---|---|---|---|---|
| Operational noise | Low | Fish and shellfish (general) | Low | Minor adverse |

## 7.16. Changes to fishing activity

7.16.1. Changes to fishing activity as a result of the installation of Dogger Bank Teesside A and Dogger Bank Teesside B could potentially affect fish and shellfish species. Primarily this would be species commercially targeted and/or caught as by-catch, although a wider range of organisms may also be affected due to changes in seabed communities associated with seabed disturbance. Physical disturbance of habitat arising from the passage of fishing gear over the seabed occurs in a number of ways (Kaiser *et al*. 2003):

- Disturbance to upper layers of seabed causing short-term re-suspension of sediment, re-mineralisation of nutrients and contaminants, and re-sorting of sediment particles;
- Direct removal, damage, displacement or death of a proportion of the animals and plants living in or on the seabed;
- A short term attraction of carrion consumers into the path of fishing gear; and
- The alteration of habitat structure.

7.16.2. A reduction in fishing activity in Dogger Bank Teesside A & B may benefit seabed communities, this could in turn have a positive effect on fish and shellfish species, provided the productivity of the area increases. In addition, target and by-catch species would be positively affected through a direct decrease in fishing mortality on a site specific basis. The potential displacement of fishing into other sensitive areas should, however, be recognised.

7.16.3. As indicated in **Chapter 15** there may be potential for some decrease in fishing effort within Dogger Bank Teesside A and Dogger Bank Teesside B during the operational phase. In the case of the Dogger Bank Teesside A & B Export Cable Corridor it is expected that fishing activities will continue at levels similar to those prior to cable installation (see **Chapter 15,** paragraph 8.2.35). Taking the relatively small levels of change expected in fishing activity during the operational phase, the magnitude of the effect is considered to be low. This is considered to be the case for Dogger Bank Teesside A, Dogger Bank Teesside B and Dogger Bank Teesside A & B Export Cable Corridor.

7.16.4. The sensitivity of fish and shellfish species to changes in fishing activity will vary depending on the species under consideration and where fishing effort is displaced to. It is not possible however to undertake a detailed assessment at this early stage. It is considered that if there is a small to medium degree of interaction between fish and shellfish receptors then the effect may occur. Fish and shellfish receptors are therefore expected to, at worst, be of medium vulnerability, medium recoverability and regional importance, therefore they are deemed to be of medium sensitivity. The magnitude is considered to be low as a result the effect associated with changes to fishing activity is not anticipated to result in an impact above **minor adverse**.

## 7.17. Changes to fishing activity impact assessment summary

7.17.1. A summary of the changes to fishing activity impact assessment is given in **Table 7.10**.

Table 7.10 Changes to fishing activity impact assessment summary

| **Potential effect** | **Magnitude of effect** | **Receptor** | **Receptor sensitivity** | **Impact** |
|---|---|---|---|---|
| | **Dogger Bank Teesside A, B and Dogger Bank Teesside A & B** | | **Dogger Bank Teesside A, B and Dogger Bank Teesside A & B** | **Dogger Bank Teesside A, B and Dogger Bank Teesside A & B** |
| Changes to fishing activity | Low | Fish and shellfish (general) | Medium | Minor adverse |

# 8. Impacts during Decommissioning

8.1.1. The principal potential effects on fish and shellfish species associated with decommissioning are as follows:

- Physical disturbance of seabed habitat;
- Increased suspended sediment concentrations and increased sediment deposition;
- Noise; and
- Loss of artificial habitat/colonising structures.

8.1.2. For the purposes of this assessment and in the absence of detailed information on decommissioning schedules and methodologies at this early stage, it is assumed that any impacts derived from the decommissioning phase will at worst be of no greater impact than those during the construction. Impacts during construction are not anticipated to be greater than **minor adverse**.

8.1.3. As indicated in **Chapter 5** it is currently envisaged that piled foundations would be cut below seabed level with the protruding section being removed. In the case of GBS foundations it may be preferable to leave the structures on the seabed to preserve the marine habitat that has been established there during the operational phase, subject to discussion with key stakeholders and regulators. This may also be the case in terms of removal of scour protection.

8.1.4. Foundation cutting or dredging and seabed disturbance resulting from removal of cables and cable protection may cause short-term increases in suspended sediment concentrations, however since there will be no need for seabed preparation or pile drilling, and considering the possibility that cables will be left in situ, any increase in suspended sediment concentration will be less than that described for the construction phase.

8.1.5. It should be noted that pile driving is not expected to be required during decommissioning. As a result, noise related effects associated with this phase are expected to be considerably below those previously assessed for the construction phase.

# 9. Inter-relationships

9.1.1. The assessment of the impacts arising from construction, operation and decommissioning of Dogger Bank Teesside A, Dogger Bank Teesside B and the Dogger Bank Teesside A & B Export Cable Corridor given above, indicates that impacts on receptors addressed in other ES chapters may potentially further contribute to the impacts assessed on fish and shellfish species and vice versa. The objective of this section 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. The principal linkages identified are summarised in **Table 9.1** below. No inter-relationships have been identified where an accumulation of residual impacts on fish and shellfish ecology gives rise to a need for additional mitigation.

Table 9.1 Fish and shellfish ecology inter-relationships

| Inter-relationship | Relevant sections | Linked chapters |
|---|---|---|
| Impacts on seabed habitats | Impact assessment sections 6 - 8 | **Chapter 9 Marine Physical Processes** |
| | | **Chapter 12 Marine and Intertidal Ecology** |
| Impacts on commercial species | Commercial species have been taken into account across the whole of this chapter. | **Chapter 15 Commercial Fisheries** |
| Impacts on fish species due to pollutants from sediment and accidental spillage as well as an increase in turbidity | Impact assessment Section 6.2 and throughout **Chapter 10 Marine Water and Sediment Quality** | **Chapter 10 Marine Water and Sediment Quality** |
| Effects on key prey species | Key prey species have been taken in to account across both **Appendix 13A**: **Fish and Shellfish Technical Report** and throughout this chapter. | **Chapter 14 Marine Mammals** |
| | | **Chapter 11 Marine and Coastal Ornithology** |
| | | **Chapter 12 Marine and Intertidal Ecology** |

# 10. Cumulative Impacts

## 10.1. CIA Strategy and screening

10.1.1. This section describes the cumulative impact assessment for fish ecology, taking into consideration other plans, projects and activities. A summary of the cumulative assessment is presented in **Chapter 33**

10.1.2. Forewind has developed a strategy (the 'CIA Strategy') for the assessment of cumulative impacts in consultation with a number of statutory stakeholders, including the MMO. Further details of the approach to CIA that has been 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. In this manner, the assessment considers (where relevant) the potential for cumulative impacts in the following sequence:

- The cumulative impacts associated with Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor and Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D including their respective Export Cable Corridors;
- The cumulative effects of Dogger Bank Teesside A & B, Dogger Bank Creyke Beck and Dogger Bank Teesside C & D with other planned, consented or under construction wind farm developments outside of the Dogger Bank Zone; and
- The cumulative effects of Dogger Bank Teesside A & B, Dogger Bank Creyke Beck and Dogger Bank Teesside C & D with other planned, consented or under construction wind farm developments outside the Dogger Bank Zone and other future installations, regulated activities such as aggregate dredging and possible marine conservation areas which may exclude or restrict commercial fishing activities.

10.1.5. 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' we can have in the data and information available.

10.1.6. In order to identify the activities, projects and plans to take forward in the detailed assessment that follows, a two-step screening process is undertaken:

- Impact screening (**Table 10.1**): consideration of the potential for each impact, as assessed for Dogger Bank Teesside A & B in isolation, to contribute to a cumulative impact both within and outwith the Dogger Bank Zone. This step also involves an appraisal of the confidence in the information available to inform the screening decision (following the methodology set out in **Chapter 4**); and
- Project screening (**Table 10.2**): the identification of the actual individual plans, projects and activities that may result in cumulative impacts for inclusion in the CIA. 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.

10.1.7. Installed infrastructure including wind farms, oil and gas installations and sub-sea cables are considered to form part of the existing environment and are not considered in the following assessment. Similarly, military activities are also considered to be part of the existing environment to which fish and shellfish are currently exposed, and therefore have not been included in the current assessment.

10.1.8. In addition to the above, the potential impact of Dogger Bank Teesside A & B with possible marine conservation areas (which may exclude or restrict commercial fishing activities) is discussed separately at the end of this section.

10.1.9. The potential impacts considered for cumulative assessment are those associated with the construction phase:

- Temporary disturbance of seabed; and
- Construction noise.

10.1.10. Cumulative effects derived from the operational phase (loss of habitat, introduction of hard substrate, operational noise and EMF), have not been considered for assessment of cumulative impacts with other developments/activities, given the limited and site specific nature of the predicted impacts as demonstrated in the Dogger Bank Creyke Beck specific impact assessment given above (see Section 6).

10.1.11. In the particular case of impacts associated with the decommissioning phase, given the limitations in relation to final decommissioning methodologies, not only in relation to Dogger Bank Teesside A & B, but other projects included in this assessment, potential effects associated with this phase have not been considered for the purposes of the cumulative impact assessment.

10.1.13. Furthermore, the evaluation of magnitude of effects and sensitivities of receptors carried out in this assessment are, to a large extent, of a subjective nature. This is a result of the lack of detailed information on the existing environment descriptions and impact assessments for the various other developments and measures being considered in this assessment, with the exception of Dogger Bank Teesside A & B. As such, impact significance has only been applied to the cumulative assessment to wind farm projects within the Dogger Bank Zone.

Table 10.1 Potential cumulative impacts (impact screening)

| Impact | Potential cumulative impact in the Zone & Dogger Bank Teesside A & B Export Cable Corridor | Potential cumulative impact outside the Zone | Data confidence (Zone and Dogger Bank Teesside A & B Export Cable Corridor) | Data confidence (outside the Zone) |
|---|---|---|---|---|
| Temporary physical disturbance/loss of seabed habitat | Yes | Yes | Medium | Medium |
| Construction noise | Yes | Yes | Medium | Medium |
| Permanent loss of habitat | Yes | Yes | Medium | Medium |
| Introduction of hard substrate | Yes | Yes | Medium | Medium |
| Operational noise | Yes | Yes | Medium | Medium |
| EMF | No | No | N/A | N/A |

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

10.1.15. 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;
- 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;
- Military exercises and firing ranges are also considered to be part of the existing environment to which fishermen have adapted and have, therefore, also not been assessed; and
- With the exception of Dogger Bank Teesside A & B and Dogger Bank Creyke Beck, detailed existing baseline descriptions, impact assessments and measures being considered are not available for every development included in the CIA project list.

10.1.16. Forewind is intending to develop four other projects within the Dogger Bank Zone in addition to Dogger Bank Teesside A & B. Project information and boundaries are available for Dogger Bank Creyke Beck and Dogger Bank Teesside C & D, which are shown in **Figure 10.1.**

10.1.17. Dogger Bank Teesside A & B comprise two wind farms, each with a generating capacity of up to 1.2GW, which will connect into the national grid at Lackenby substation. Dogger Bank Teesside A & B will have a total generating capacity of up to 2.4GW. Dogger Bank Teesside C & D will comprise two wind farms, each with a generating capacity of up to 1.2GW, which will connect into the national grid just south of the Tees Estuary. Dogger Bank Teesside C & D will have a total generating capacity of up to 2.4GW.

10.1.18. Dogger Bank Creyke Beck will comprise two wind farms (Creyke Beck A and Creyke Beck B), each with a generating capacity of up to 1.2GW, and will connect to the existing National Grid substation at Creyke Beck, in the East Riding of Yorkshire. Dogger Bank Creyke Beck A & B will have a total generating capacity of up to 2.4GW. As suggested in **Chapter 9**, the worst case scenario in terms of increased suspended sediments would be for all six projects to be constructed at the same time over a six-year period.

## Table 10.2 Cumulative Impact Assessment screening for fish ecology (project screening)

| Type of project | Project title | Project status | Predicted construction/ development period | Distance from Dogger Bank Dogger Bank Teesside (km) | Confidence in project details | Confidence in project data | Carried forward to cumulative impact assessment? | Rationale for where no cumulative impact is expected |
|---|---|---|---|---|---|---|---|---|
| Offshore wind farm | Dogger Bank Creyke Beck | Pre-Application | Construction may start from 2016 | Dogger Bank Teesside A approximately 35.<br><br>Dogger Bank Teesside B approx. 5 | High | High | Yes | N/A |
| Offshore wind farm | Dogger Bank Teesside C & D | Potential | Not confirmed | Dogger Bank Teesside A approximately 27.<br><br>Dogger Bank Teesside B approx. 8 | High | High | Yes | N/A |
| Offshore wind farm | Hornsea Project One | Pre-consent | Project One may start construction 2015 | Approx. 64 to the south of Dogger Bank Teesside A | Medium | Medium | Yes | N/A |
| Offshore wind farm | Hornsea Project Two | Potential | Not confirmed | Approx. 59 to the south of Dogger Bank Teesside A | Medium | Medium | Yes | N/A |
| Offshore wind farm | Hornsea Zone – other future development | Potential | Not confirmed | Not confirmed | Low | Low | No | Low confidence in project details and data |

| Type of project | Project title | Project status | Predicted construction/ development period | Distance from Dogger Bank Dogger Bank Teesside (km) | Confidence in project details | Confidence in project data | Carried forward to cumulative impact assessment? | Rationale for where no cumulative impact is expected |
|---|---|---|---|---|---|---|---|---|
| Offshore wind farm | Westernmost Rough | Consented | 2012-2014 | Approx. 25 to the south of the export cable | High | Medium | Yes | N/A |
| Offshore wind farm | H2-20 | Pre-consent | Not confirmed | Approx. 150 to the north-east of Dogger Bank Teesside A and Dogger Bank Teesside B | Medium | Medium | No | Distance (see Section 10.3.4) |
| Offshore wind farm | Firth of Forth | Pre-Application | Not confirmed | Approx. 211 to the north-west of Dogger Bank Teesside B | Medium | Low | Yes | N/A |
| Offshore wind farm | East Anglia One | Pre-consent | 2015-2017 | Approx. 250 to the south of the export cable and Dogger Bank Teesside A. | Medium | Medium | Yes | N/A |
| Offshore wind farm | East Anglia Zone- other future developments | Potential | Not confirmed | Not confirmed | Low | Low | No | Low confidence in project details and data |
| Offshore wind farm | Triton Knoll | Consented | Construction may start from 2017 | Approx. 145 to the south of Dogger Bank Teesside A | Yes | Medium | Yes | N/A |

| Type of project | Project title | Project status | Predicted construction/ development period | Distance from Dogger Bank Dogger Bank Teesside (km) | Confidence in project details | Confidence in project data | Carried forward to cumulative impact assessment? | Rationale for where no cumulative impact is expected |
|---|---|---|---|---|---|---|---|---|
| Aggregate extraction | Area 466 | Application area | Awaiting decision | Approx. 3 to the north of Dogger Bank Teesside B | Medium | Medium | Yes | N/A |
| Aggregate extraction | Area 485 | Application area | Not confirmed | Approx. 5 to the south-west of the Dogger Bank Teesside A and 20 south of the export cable | Medium | Medium | Yes | N/A |
| Aggregate extraction | Area 448 | Application area | Not confirmed | Approx. 50 to the south-west of the export cable | Medium | Medium | No | Distance & subsequent low likelihood of interaction (see Section 10.4) |
| Aggregate extraction | Area 449 | Application area | Not confirmed | Approx. 50 to the south-west of the export cable | Medium | Medium | No | As above |
| SACs with Marine Components | Dogger Bank | Potential cSAC | In consultation | 0 | Medium | Medium | Yes | N/A |
| SACs with Marine Components | North Norfolk Sandbanks & Saturn Reef | Potential cSAC | In consultation | 104 | Medium | Medium | Yes | N/A |

| Type of project | Project title | Project status | Predicted construction/ development period | Distance from Dogger Bank Dogger Bank Teesside (km) | Confidence in project details | Confidence in project data | Carried forward to cumulative impact assessment? | Rationale for where no cumulative impact is expected |
|---|---|---|---|---|---|---|---|---|
| Nature Conservation | NG 12, Compass Rose | Potential Netgain rMCZ | In consultation | 80 | Medium | High | Yes | N/A |
| Nature Conservation | RA 10, Compass Rose RA | Potential Netgain rRA | In consultation | 90 | Medium | High | Yes | N/A |
| Nature Conservation | NG 11, Runswick Bay | Potential Netgain rMCZ | In consultation | 139 | Medium | High | Yes | N/A |
| Nature Conservation | NG 9, Holderness Offshore | Potential Netgain rMCZ | In consultation | 117 | Medium | High | Yes | N/A |
| Nature Conservation | NG 8, Holderness Inshore | Potential Netgain rMCZ | In consultation | 141 | Medium | High | Yes | N/A |
| Nature Conservation | Doggersbank pSCI | Potential SCI designation | Not known | 47 | Medium | Medium | Yes | N/A |

| Type of project | Project title | Project status | Predicted construction/ development period | Distance from Dogger Bank Dogger Bank Teesside (km) | Confidence in project details | Confidence in project data | Carried forward to cumulative impact assessment? | Rationale for where no cumulative impact is expected |
|---|---|---|---|---|---|---|---|---|
| Nature Conservation | NG 7, Markham's Triangle | Potential Netgain rMCZ | In consultation | 84 | Medium | High | Yes | N/A |
| Nature Conservation | Klaverbank pSCI | Potential SCI designation | Unknown | 74 | High | Medium | Yes | N/A |
| Nature Conservation | NG 6, Silver Pit | Potential Netgain rMCZ | In consultation | 136 | Medium | High | Yes | N/A |
| Nature Conservation | NG 5, Lincs Belt | Potential Netgain rMCZ | In consultation | 162 | Medium | High | Yes | N/A |
| Nature Conservation | RA 6, Dogs Head Sandbanks | Potential Netgain rRA | In consultation | 204 | Medium | High | Yes | N/A |
| Nature Conservation | NG 2, Cromer Shoal Chalk Beds | Potential Netgain rMCZ | In consultation | 188 | Medium | High | Yes | N/A |

| Type of project | Project title | Project status | Predicted construction/ development period | Distance from Dogger Bank Dogger Bank Teesside (km) | Confidence in project details | Confidence in project data | Carried forward to cumulative impact assessment? | Rationale for where no cumulative impact is expected |
|---|---|---|---|---|---|---|---|---|
| Nature Conservation | RA 1, North Norfolk Blue Mussel Beds | Potential Netgain rRA | In consultation | 196 | Medium | High | Yes | N/A |
| Nature Conservation | NG 1b, Orford Inshore | Potential Netgain rMCZ | In consultation | 280 | Medium | High | Yes | N/A |
| Nature Conservation | Outer Banks/Zeeuwse Banken | Potential Dutch MPA's | In consultation | 327 | Low | High | Yes | N/A |
| Nature Conservation | Coastal Sea/Kustzee | Potential Dutch MPA's | In consultation | 280 | Low | High | Yes | N/A |
| Nature Conservation | Brown Ridge | Potential Dutch MPA's | In consultation | 212 | Low | High | Yes | N/A |
| Nature Conservation | RA 7, Seahenge Peat and Clay | Potential Netgain rRA | In consultation | 210 | Medium | High | Yes | N/A |

| Type of project | Project title | Project status | Predicted construction/ development period | Distance from Dogger Bank Dogger Bank Teesside (km) | Confidence in project details | Confidence in project data | Carried forward to cumulative impact assessment? | Rationale for where no cumulative impact is expected |
|---|---|---|---|---|---|---|---|---|
| Nature Conservation | RA 5, Blakeney Seagrass | Potential Netgain rRA | In consultation | 198 | Medium | High | Yes | N/A |
| Nature Conservation | Frisian Front | Potential Dutch MPA's | In consultation | 171 | Medium | High | Yes | N/A |
| Nature Conservation | Borkham Reef | Potential Dutch MPA's | In consultation | 266 | Low | High | Yes | N/A |
| Nature Conservation | Central Oyster Grounds | Potential Dutch MPA's | In consultation | 112 | Low | High | Yes | N/A |
| Nature Conservation | Gas Leaks | Potential Dutch MPA's | In consultation | 157 | Low | High | Yes | N/A |
| Nature Conservation | NG 10, Castle Ground | Potential Netgain rMCZ | In consultation | 134 | Medium | High | Yes | N/A |

| Type of project | Project title | Project status | Predicted construction/ development period | Distance from Dogger Bank Dogger Bank Teesside (km) | Confidence in project details | Confidence in project data | Carried forward to cumulative impact assessment? | Rationale for where no cumulative impact is expected |
|---|---|---|---|---|---|---|---|---|
| Nature Conservation | NG 16, Swallow Sand | Potential Netgain rMCZ | Put forward for designation in 2013 | 49 | Medium | High | Yes | N/A |
| Nature Conservation | NG 13, Coquet to St Mary's | Potential Netgain rMCZ | In consultation | 181 | Medium | High | Yes | N/A |
| Nature Conservation | NG 14, Farnes East | Potential Netgain rMCZ | In consultation | 169 | Medium | High | Yes | N/A |
| Nature Conservation | RA 12, Farnes Clay | Potential Netgain rRA | In consultation | 178 | Medium | High | Yes | N/A |
| Nature Conservation | NG 15, Rock Unique | Potential Netgain rMCZ | Put forward for designation in 2013 | 139 | Medium | High | Yes | N/A |
| Nature Conservation | RA 13, Rock Unique RA | Potential Netgain rRA | In consultation | 149 | Medium | High | Yes | N/A |

| Type of project | Project title | Project status | Predicted construction/ development period | Distance from Dogger Bank Dogger Bank Teesside (km) | Confidence in project details | Confidence in project data | Carried forward to cumulative impact assessment? | Rationale for where no cumulative impact is expected |
|---|---|---|---|---|---|---|---|---|
| Nature Conservation | NG 17, Fulmar | Potential Netgain rMCZ | In consultation | 110 | Medium | High | Yes | N/A |
| Nature Conservation | Scottish MCZ project A | MCZ recommendation for site designations | In consultation | 205 | Medium | Low | Yes | N/A |
| Nature Conservation | Scottish MCZ project B | MCZ recommendation for site designations | In consultation | 325 | Medium | Low | Yes | N/A |
| Nature Conservation | Scottish MCZ project C | MCZ recommendation for site designations | In consultation | 535 | Medium | Low | Yes | N/A |
| Nature Conservation | Scottish MCZ project D | MCZ recommendation for site designations | In consultation | 594 | Medium | Low | Yes | N/A |
| Nature Conservation | RA 6, Dogs Head Sandbanks | Potential Netgain rRA | In consultation | 178 | Medium | High | Yes | N/A |

| Type of project | Project title | Project status | Predicted construction/ development period | Distance from Dogger Bank Dogger Bank Teesside (km) | Confidence in project details | Confidence in project data | Carried forward to cumulative impact assessment? | Rationale for where no cumulative impact is expected |
|---|---|---|---|---|---|---|---|---|
| Nature Conservation | Western Fladen (WFL) | Proposed Nature Conservation MPA | In consultation | 435 | Medium | High | Yes | N/A |
| Nature Conservation | South-east Fladen (SEF) | Proposed Nature Conservation MPA | In consultation | 372 | Medium | High | Yes | N/A |
| Nature Conservation | North-east Faroe Shetland Channel (NEF) | Proposed Nature Conservation MPA | In consultation | 845 | Medium | High | Yes | N/A |
| Nature Conservation | Faroe-Shetland sponge belt (FSS) | Proposed Nature Conservation MPA | In consultation | 719 | Medium | High | Yes | N/A |
| Nature Conservation | Norwegian boundary sediment plain (NSP) | Proposed Nature Conservation MPA | In consultation | 342 | Medium | High | Yes | N/A |
| Nature Conservation | Turbot Bank (TBB) | Proposed Nature Conservation MPA | In consultation | 338 | Medium | High | Yes | N/A |

| Type of project | Project title | Project status | Predicted construction/ development period | Distance from Dogger Bank Dogger Bank Teesside (km) | Confidence in project details | Confidence in project data | Carried forward to cumulative impact assessment? | Rationale for where no cumulative impact is expected |
|---|---|---|---|---|---|---|---|---|
| Nature Conservation | East of Gannet and Montrose Fields (EGM) | Proposed Nature Conservation MPA | In consultation | 258 | Medium | High | Yes | N/A |
| Nature Conservation | Firth of Forth Banks Complex (FOF) | Proposed Nature Conservation MPA | In consultation | 301 | Medium | High | Yes | N/A |
| Nature Conservation | Southern Trench (STR) | MPA search location | In consultation | 413 | Medium | High | Yes | N/A |
| Nature Conservation | Bancs des Flandres | Potential SCI designation | In consultation | 428 | Medium | High | Yes | N/A |
| Nature Conservation | Pobie Bank Reef | Candidate SAC | In consultation | 636 | Medium | High | Yes | N/A |

## 10.2. Cumulative impact of Dogger Bank Teesside A & B, Dogger Bank Creyke Beck and Dogger Bank Teesside C & D.

10.2.1. The CIA adopts an additive approach whereby the cumulative effects of the following interactions are progressively assessed:

- The cumulative impacts associated with Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor and Dogger Bank Creyke Beck and Dogger Bank Teesside C & D, including their respective Export Cable Corridors;
- The cumulative effects of Dogger Bank Teesside A & B and Dogger Bank Teesside C & D with other planned, consented or under construction wind farm developments outside of the Dogger Bank Zone; and
- The cumulative effects of Dogger Bank Teesside A & B, Dogger Bank Creyke Beck and Dogger Bank Teesside C & D with other planned, consented or under construction wind farm developments outside the Dogger Bank Zone and other future installations, regulated activities such as aggregate dredging and possible marine conservation areas which may exclude or restrict commercial fishing activities.

## 10.3. Temporary physical disturbance/loss of seabed habitat

10.3.1. There is potential for cumulative temporary habitat loss to occur as a result of construction operations within the Dogger Bank Teesside A & B, Dogger Bank Creyke Beck and Dogger Bank Teesside C & D sites. The worst case scenario is for construction activities occurring within all six project areas simultaneously. The proportional area of temporary disturbance/habitat loss within all sites is expected to be of a similar magnitude. The cumulative effect will be highly localised, with only a relatively small proportion of habitat disturbance /loss occurring at any one time.

10.3.2. The cumulative effect of temporary physical disturbance/habitat loss will be of medium duration, intermittent and reversible and the magnitude is considered to be low.

10.3.3. Most fish species are predicted to have a relatively low level of vulnerability to temporary habitat loss, though sandeel and other demersal spawning species and shellfish species, both of which have specific habitat resource requirements are deemed to be more sensitive to this type of disturbance.

10.3.4. In the context of sandeel spawning habitat, the cumulative habitat loss may potentially result in a loss of up to 0.52% of the available preferred sandeel habitat within the Dogger Bank SA1 management area.

10.3.5. Temporary disturbance/habitat loss within the inshore Flamborough herring spawning grounds resulting from the installation of export cables has the potential to affect a maximum area equivalent to 0.02% of the total Flamborough inshore spawning grounds. The methodology used to derive estimates of the spatial extent of the overlap of the development site with herring spawning areas) is described in **Appendix 13G**. Estimates of the area of herring spawning grounds in the vicinity of the development site are based on the mapping layers presented in Coull *et al.* (1998). The limitations of the data sets used to provide these mapping layers are acknowledged by Coull *et al.* (1998) and, by extension, these limitations apply to the overlap estimates presented in this assessment.

10.3.6. Cumulative effects of temporary disturbance/habitat loss may potentially affect brown crab and lobster populations in the inshore areas but it is anticipated that these effects will be limited in their spatial and temporal extent and the proportion of the available habitat affected is predicted to be small.

10.3.7. Most fish and shellfish receptors in the fish and shellfish study area are deemed to be of low vulnerability, high recoverability and of local to international importance within the fish and shellfish study area. The sensitivity of these receptors is therefore considered to be low and the impact is assessed as **minor adverse**.

10.3.8. Sandeel and herring are deemed to be of medium vulnerability, medium recoverability and of regional importance within the fish and shellfish study area. The sensitivity of these receptors is therefore considered to be medium and the impact is assessed as **minor adverse**.

10.3.9. Edible crab and European lobster are deemed to be of low vulnerability, high recoverability and of regional importance within the fish and shellfish study area. The sensitivity of these receptors is therefore considered to be low and the impact is assessed as **minor adverse**.

## 10.4. Suspended sediment and sediment re-deposition

10.4.1. Cumulative effects, in terms of seabed disturbance, will be restricted to interaction of sediment plumes and sediment deposition on the seabed. Given the potential worst case construction programme, cumulative effects may arise if the construction of foundations in different projects is synchronous and the plumes that are created by the construction overlap spatially. If a similar construction sequence is adopted for sets of foundations in the other Dogger Bank projects at the same time as Dogger Bank Teesside B, then the respective plumes may potentially interact, to create a larger overall plume, with higher suspended sediment concentration and, potentially, a greater depositional footprint on the seabed.

10.4.2. Given that the maximum thickness of sediment that remained deposited on the seabed at the end of the 30-day simulation period for Dogger Bank Teesside A & B was less than 0.1mm (for conical GBS, 12m monopole and 10m monopole scenarios), the potential for accumulating persistently thick sequences of sediment due to plume interaction is low. This assumes that the worst case methodology used for Dogger Bank Teesside B, is duplicated for Dogger Bank Teesside A, Dogger Bank Creyke Beck and Dogger Bank Teesside C & D.

10.4.3. Taking the above into account the magnitude of the effect of increased suspended sediment concentrations resulting from simultaneous construction of Dogger Bank Teesside A and Dogger Bank Teesside B, Dogger Bank Creyke

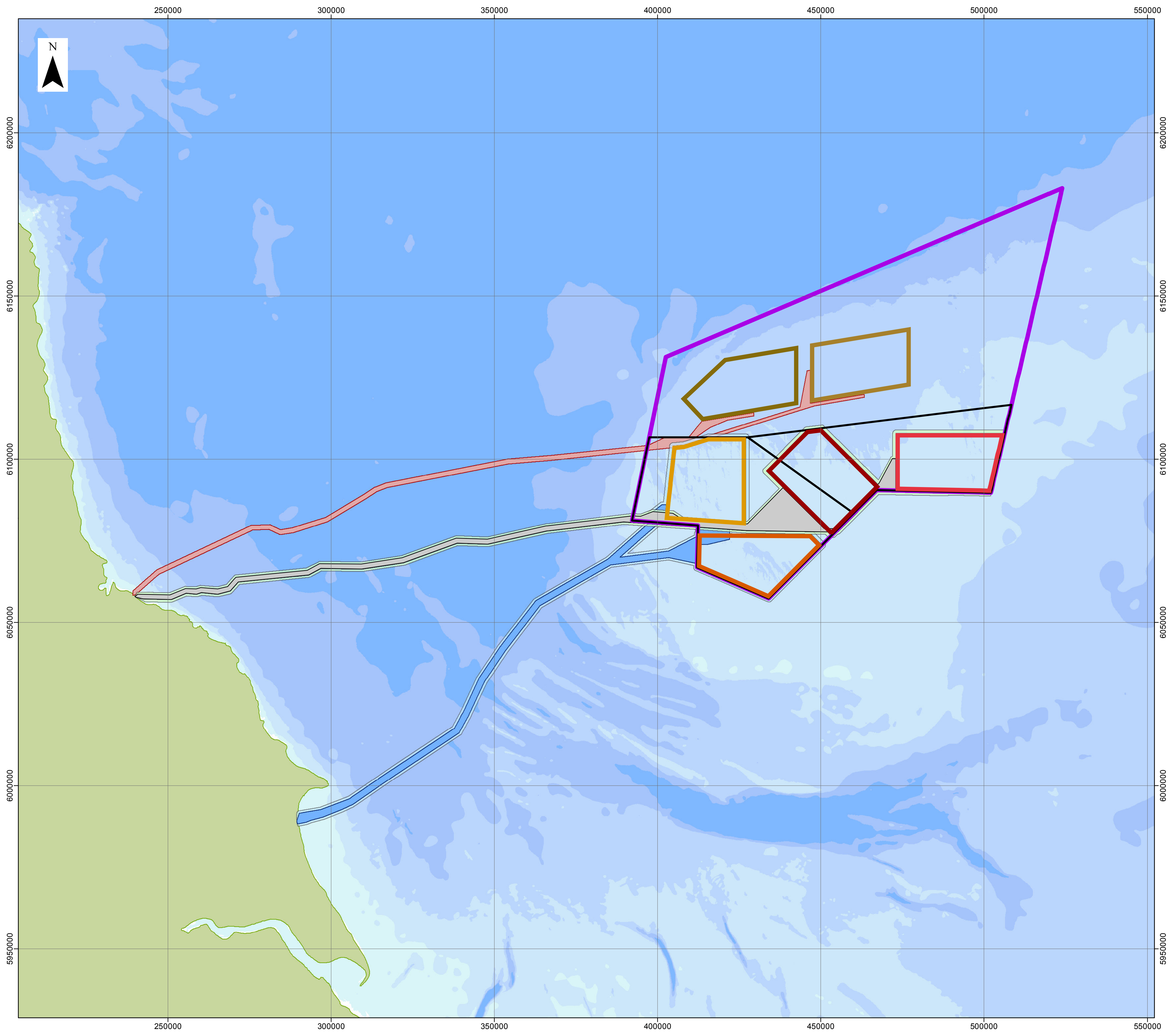
Beck and Dogger Bank Teesside C and D, is considered to be low, as previously assessed for Dogger Bank Teesside A & B (Section 5.1) .

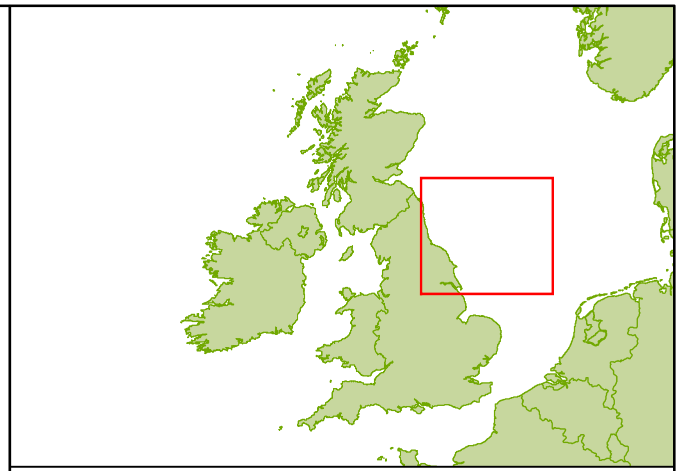
10.4.4. Given the wide distribution ranges of fish and shellfish and eggs and larvae in comparison to the areas potentially affected and, in the particular case of adult and juvenile fish, their ability to avoid areas of elevated suspended sediment concentrations, the interaction between the effect and receptors will be small. In this respect they are considered to be receptors of low vulnerability, medium recoverability and local to regional value therefore they are deemed to be receptors of low sensitivity (**Table 6.5**). Any potential cumulative impact is therefore assessed to be **minor adverse**.

10.4.5. Sandeel and herring are considered of higher sensitivity given their dependence on the presence of an adequate substrate in which to deposit their eggs. An indication of the distribution of high density areas for sandeel is given in **Figure 10.2** based on Danish sandeel fishing density satellite (VMS) data (average 2007-2011). As shown, Dogger Bank Teesside A and Dogger Bank Teesside B are located at considerable distance from high sandeel density areas but there is potential for construction activities in Dogger Bank Teesside C and D to have a greater impact on preferred habitat areas for sandeel. However, in the context of the large area of preferred habitat for sandeel available within the Dogger Bank SA1 sandeel management area, the degree of effect-receptor interaction is not expected to vary substantially from that presented in Section 6 for Dogger Bank Teesside A and Dogger Bank Teesside B. Sandeel is therefore considered of medium vulnerability, medium recoverability and regional importance, therefore their sensitivity is deemed to be medium. As a result of the low magnitude, seabed disturbance related effects are assessed to result in a **minor adverse** impact.

10.4.6. In the particular case of herring, Dogger Bank Teesside A & B is located in the immediate vicinity of the historic spawning grounds (**Figure 10.3**). Assuming those grounds are re-colonised by the time that construction activity is taking place, there may be potential for disturbance via sediment re-deposition to occur on herring eggs. The large areas available for spawning which are undisturbed in relation to the areas potentially affected by elevated suspended sediment concentrations and sediment deposition should be noted in this context. Taking the potential interaction into account herring are considered of medium vulnerability, medium recoverability and regional importance therefore their sensitivity is deemed to be medium. The cumulative impact of temporary seabed disturbance on spawning herring is assessed to be **minor adverse**.



**LEGEND**

- Dogger Bank Zone
- Tranche boundary
- Dogger Bank Creyke Beck A
- Dogger Bank Creyke Beck B
- Dogger Bank Teesside
- 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

0 10 20 40
Kilometres

Data Source:
Background bathymetry image derived in part from TCarta data © 2009

PROJECT TITLE

*DOGGER BANK TEESSIDE A & B*

DRAWING TITLE

**Figure 10.1 Dogger Bank Teesside A & B, Dogger Bank Teesside C & D, Dogger Bank Creyke Beck A & B and export cable corridors**

| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 20/09/2013 | Draft | LW | TR |
| 2 | 07/10/2013 | PEI3 | LW | TR |
| 3 | 14/02/2014 | DCO Submission | LW | TR |

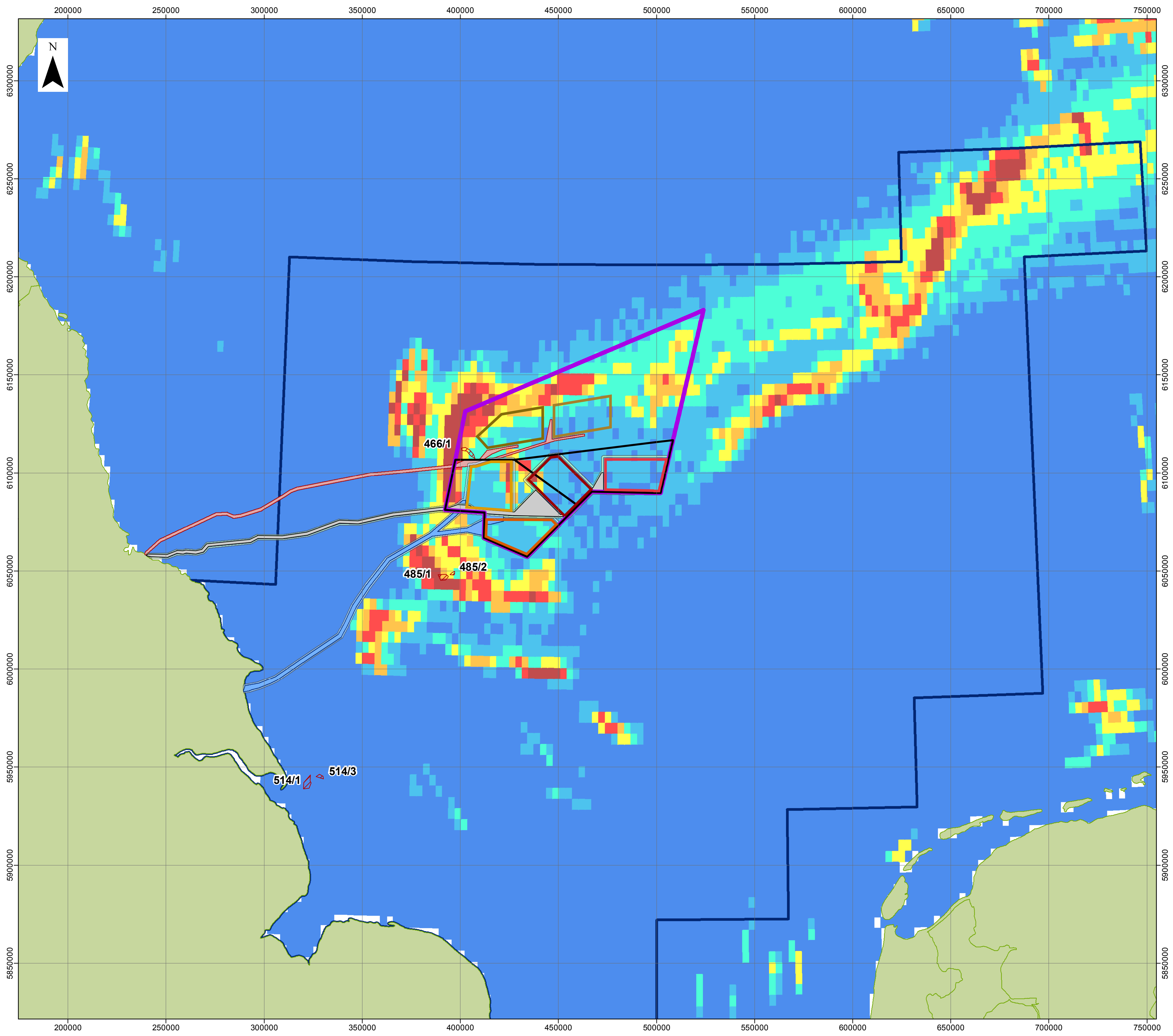
DRAWING NUMBER:

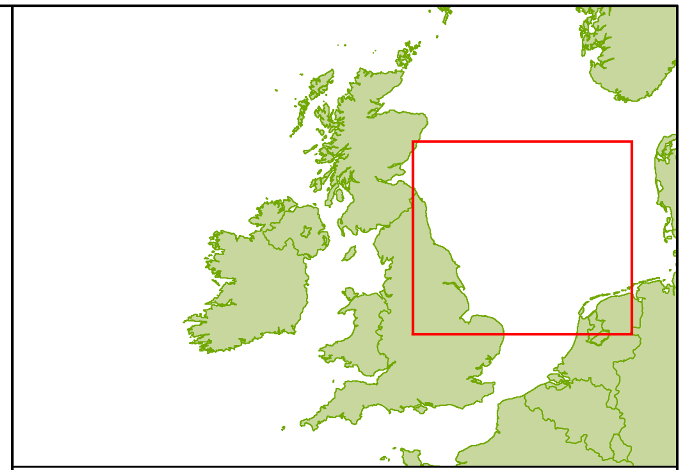
**F-OFL-MA-259**

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



FOREWIND



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
- ICES sandeel area
- Aggregate application area

Danish sandeel satellite (VMS) density

- 0 to 2
- 3 to 5
- 6 to 10
- 11 to 20
- 21 to 40
- 41 to 80
- Over 80

0 10 20 40
Kilometres

Data Source:
Aggregate Areas © The Crown Estate, 2013
VMS © Ministeriet for Fødevarer, Landbrug og Fiskeri, 2014

PROJECT TITLE

*DOGGER BANK TEESSIDE A & B*

DRAWING TITLE

**Figure 10.2 Danish sandeel fishing, satellite VMS density (average 2008-2012)**

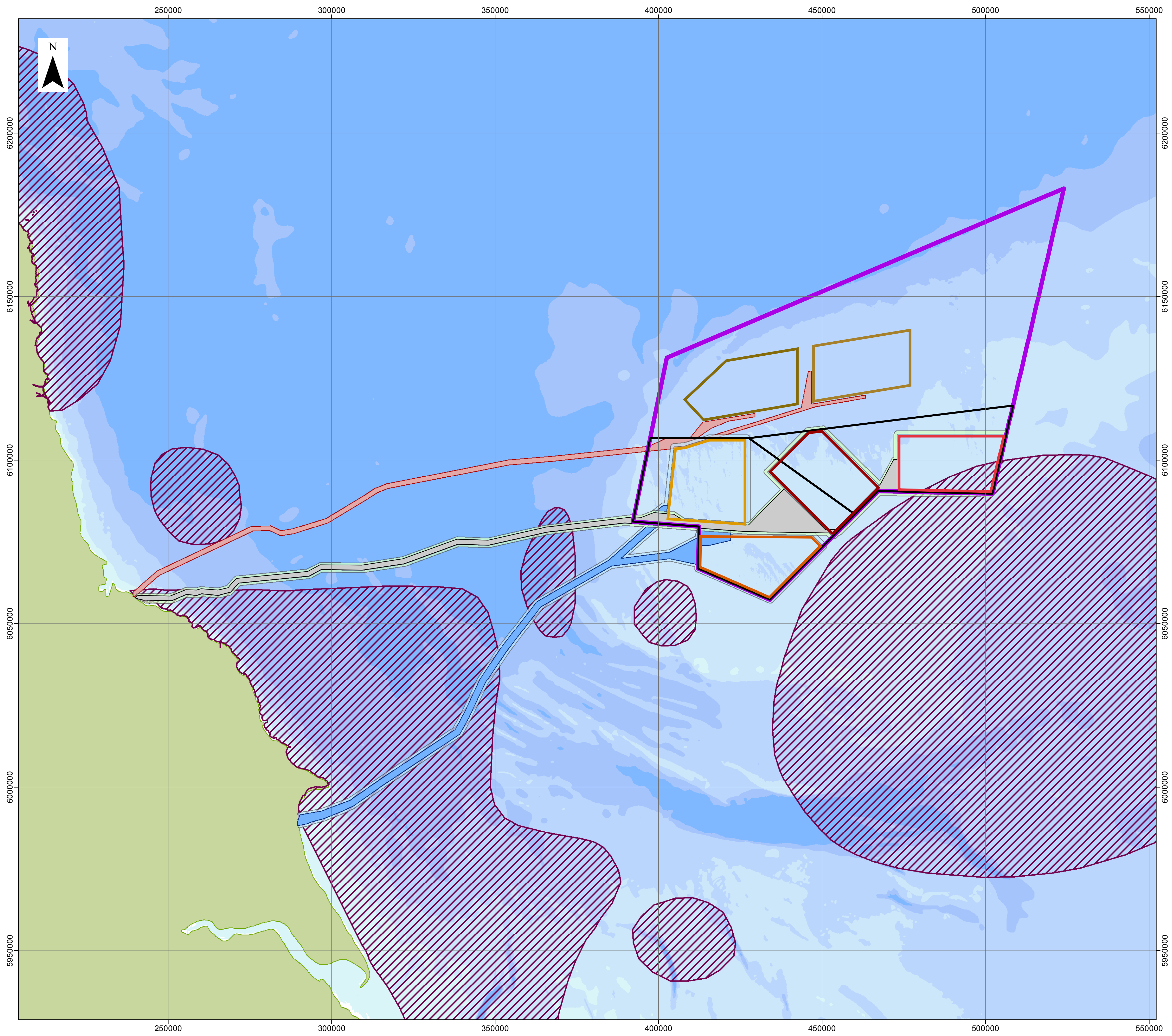
| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 07/10/2013 | PEI3 | LW | TR |
| 2 | 14/02/2014 | Pre-DCO Submission | LW | TR |

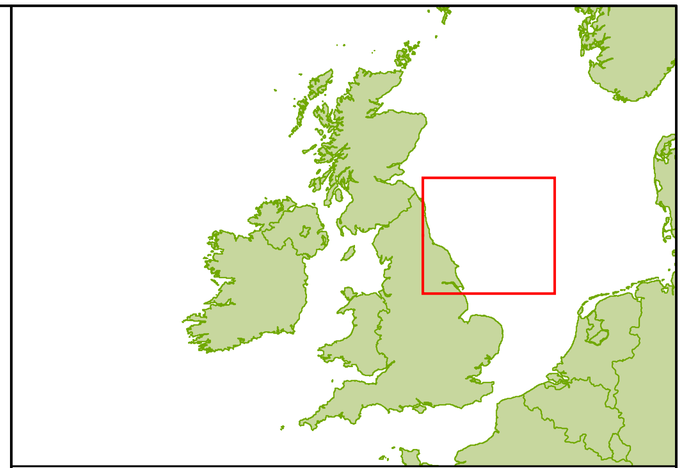
DRAWING NUMBER: **F-OFL-MA-260**

| SCALE | 1:2,000,000 | PLOT SIZE | A3 | DATUM | WGS84 | PROJECTION | UTM31N |
|---|---|---|---|---|---|---|---|



FOREWIND



**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
- Herring spawning ground (Coull *et al.* 1998)

0 10 20 40
Kilometres

Data Source:
Spawning Grounds © Cefas, 2012
Background bathymetry image derived in part from TCarta data © 2009

PROJECT TITLE

*DOGGER BANK TEESSIDE A & B*

DRAWING TITLE

## Figure 10.3 Herring spawning grounds

| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 20/09/2013 | Draft | LW | TR |
| 2 | 07/10/2013 | PEI3 | LW | TR |
| 3 | 14/02/2014 | DCO Submission | LW | TR |

DRAWING NUMBER: **F-OFL-MA-261**

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



FOREWIND

## 10.5. Construction noise

10.5.1. Impact piling during construction is the activity with the potential to result in the most detrimental impact on fish and shellfish species. Sequential construction of Dogger Bank Teesside A, Dogger Bank Teesside B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D, has been considered the worst case scenario in relation to fish and shellfish receptors. This would result in the construction phase taking place for up to 11 years and six months. As presented in Section 6 injury or lethal effects associated with piling noise would only occur at very small ranges and are therefore not considered further in the cumulative assessment. The assessment below is therefore focused on the potential for cumulative impacts at the behavioural level to occur.

10.5.2. The worst case spatial range of disturbance resulting from two pile driving operations per project taking place at Dogger Bank Teesside A, Dogger Bank Teesside B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D is shown in **Figure 10.4** (based on a larger 2300kJ hammer being used as this is the worst case for 10+MW jacket foundations and hence provides the biggest spatial range). It should be noted that piling can occur on a maximum of two piles at any one time per project and that a maximum of 12 piling rigs can be in use across the Dogger Bank Zone at any one time (**Chapter 5**). This means that for Dogger Bank Teesside A & B, Dogger Bank Teesside C & D and Dogger Bank Creyke Beck A & B construction could occur concurrently with two piling vessels active in each project.

10.5.3. In order to assess the worst case scenario (maximum spatial range and longest duration) it is assumed that construction of the first of Dogger Bank Teesside A & B's projects commences within 18 months of consent (as soon as possible) and lasts for a duration of six years (the longest possible duration). It is further assumed that another Dogger Bank Teesside project starts seven years post consent (as late as possible) and lasts for as long as possible (six years, as construction must be completed 13 years post consent). Another assumption is that concurrent construction of the Dogger Bank Creyke Beck A & B, Dogger Bank Teesside A & B and Dogger Bank Teesside C & D projects being considered will take six years (maximum construction period) and will be constructed in a way which ensures constant piling in the Zone through the simultaneous construction of Dogger Bank Teesside A & B, Dogger Bank Teesside C & D and Dogger Bank Creyke Beck A & B.

10.5.4. Taking the relatively small ranges of behavioural response impact associated with concurrent pile driving operations, and the intermittent and short term nature of pile driving activity, the magnitude of the effect is considered to be low.

10.5.5. As described for Dogger Bank Teesside A & B, the distribution of most fish and shellfish species (including spawning, nursery and feeding areas) is wide in relation to the areas where behavioural reactions may be triggered by piling noise at a given time. The potential interaction between the effects of noise and fish and shellfish receptors is small due to their wide spatial distribution. Fish and shellfish (with the exception of sandeel and herring) are considered to be receptors of low vulnerability, medium recoverability and of local to regional importance; they are considered to have low sensitivity to the effects of underwater noise. The magnitude is anticipated to be low therefore the cumulative impact is assessed to be **minor adverse**.

10.5.6. In the particular case of herring, assuming the former grounds are re-colonised by the time that construction activity is taking place, as assessed for Dogger Bank Teesside A & B above (Section 6) avoidance of small sections of the former grounds resulting from pile driving activity at Dogger Bank Teesside A & B may occur. This would however only be the case during installation of foundations in the vicinity of the grounds. In addition, impact ranges at which behavioural responses would be expected will only overlap with a small section of the defined former grounds. Taking the medium degree of interaction as described above into account, spawning herring are considered receptors of medium vulnerability, medium recoverability and regional value. They are deemed to be receptors of medium sensitivity. The effect of construction noise on spawning herring is therefore assessed to result in a minor adverse impact. This should, however, be taken in the context of the extent of suitable substrate for herring spawning in other areas and on the relatively wide extension of the former spawning grounds.

10.5.7. With respect to sandeel, Dogger Bank Teesside C & D is located in areas which may potentially support higher densities of sandeel than either Dogger Bank Creyke Beck A & B or Dogger Bank Teesside A & B. However, given the spatial extent of preferred habitat available within the SA1 management area, the area affected by construction noise is proportionally small. The assessment carried out for Dogger Bank Teesside A (Section 6) is considered to apply in cumulative terms. Sandeel is therefore considered of medium sensitivity and the cumulative impact is assessed to be **minor adverse**.

## 10.6. Permanent habitat loss

10.6.1. Cumulative long term habitat loss is predicted to occur as a result of the presence of all offshore wind farm structures (i.e., foundations, scour protection and cable protection). The maximum adverse scenario for permanent habitat loss assumes the minimum amount of cable burial (although it is unlikely that the maximum amount of cable protection will be required) and the maximum foundation footprint i.e. GBS foundations inclusive of scour protection.

10.6.2. In assessment terms, it is difficult to quantify the cumulative effect of permanent habitat loss of seabed habitat. However, as described in **Chapter 12**, comparable seabed habitats are relatively widespread throughout the central North Sea and the loss is not anticipated to impact on ecosystem function. The magnitude of the impact is considered to be low.

10.6.3. Sensitivities of fish and shellfish receptors in the fish and shellfish study area to long term habitat loss are summarised in Section 7. Most fish and shellfish receptors in the fish and shellfish study area are deemed to be of low vulnerability, high recoverability and of local to international importance within the fish and shellfish study area. The sensitivity of these receptors is therefore considered to be low. The impact is assessed as **minor adverse**.

10.6.4. The fish and shellfish species considered to be most vulnerable to habitat loss are demersal spawning species such as sandeel and herring which have specific spawning habitat requirements. In addition, sandeel have specific habitat resource requirements with a preference for sediment with high sand low silt content. In relation to the potential impact on sandeel habitats the project boundaries intentionally avoid the area of high density sandeel in the western section of Tranche A in order to minimise the potential impact of the Dogger Bank Zone. This will minimise the potential effects on the sandeel, the sandeel fishery and also on predators such as seabirds, marine mammals and other fish which exploit sandeel as a key prey species (see **Chapter 6 Site Selection and Alternatives**).

10.6.5. The Flamborough herring spawning ground is not expected to be affected by long term habitat loss since the proportion of seabed affected is negligible compared to the total area designated as herring spawning habitat by Coull *et al*. 1998.

10.6.6. Cumulative effects on sandeel are also likely to be small given that the relative area of sandeel habitat lost represents such a small proportion of the total area of available sandeel habitat within the SA1 management area.

10.6.7. Sandeel and herring are deemed to be receptors of medium vulnerability, medium recoverability and of regional importance, therefore their sensitivity is deemed to be medium. The impact is assessed as **minor adverse**.

10.6.8. Cumulative effects on shellfish species as a result of permanent habitat loss are not anticipated to have a negative effect. There is the potential for the introduction of hard substrate and the formation of artificial reefs to result in positive effects for edible crab and lobster. Shellfish receptors are deemed to be of medium vulnerability, high recoverability and of regional importance within the fish and shellfish study area. The sensitivity of these receptors is therefore considered to be medium. The impact is assessed as **minor adverse**.

## 10.7. Summary

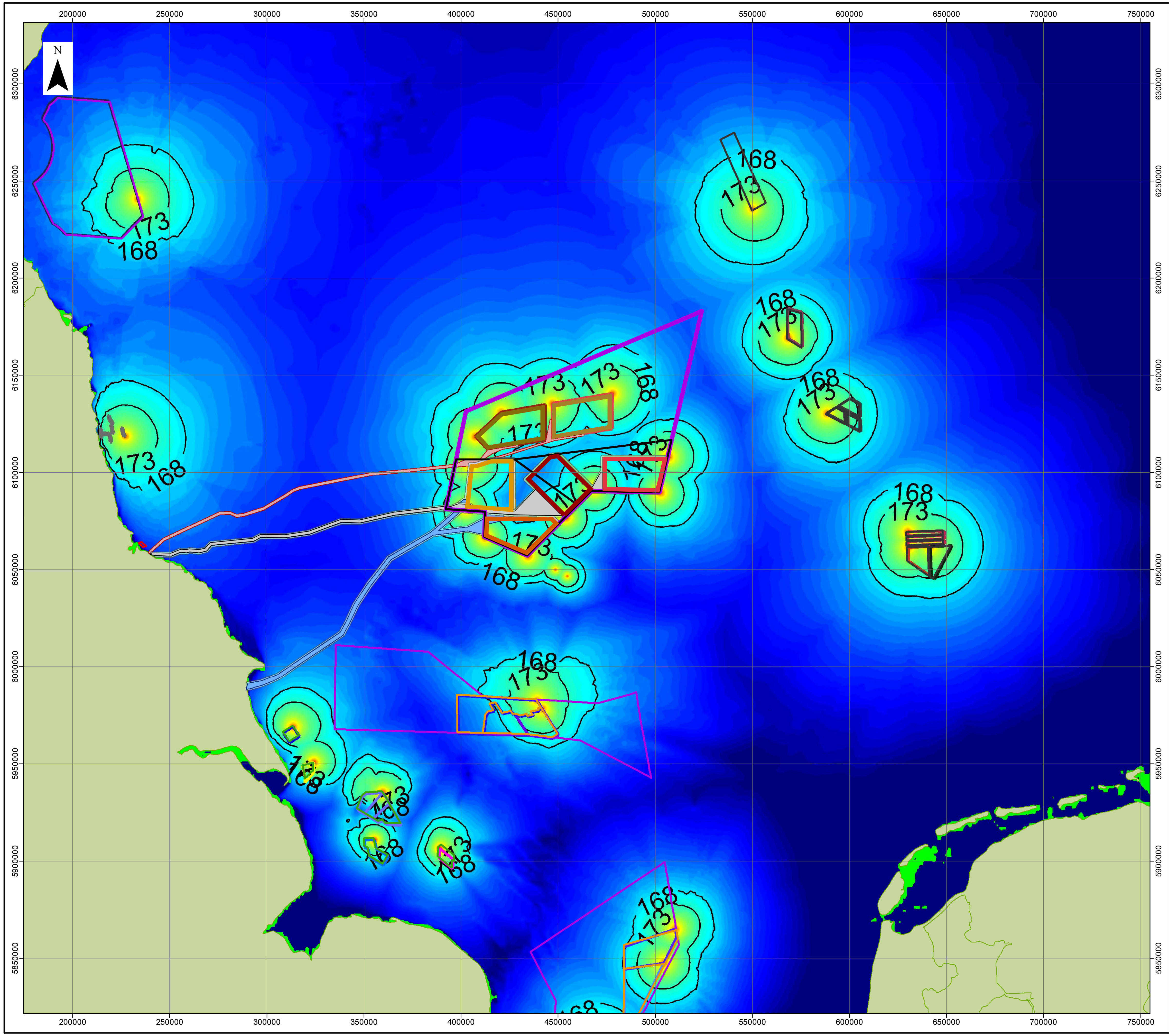
10.7.1. The cumulative impact assessment described above for Dogger Bank Teesside A & B, Dogger Bank Teesside C & D and Dogger Bank Creyke Beck A & B is summarised in **Table 10.3** below.

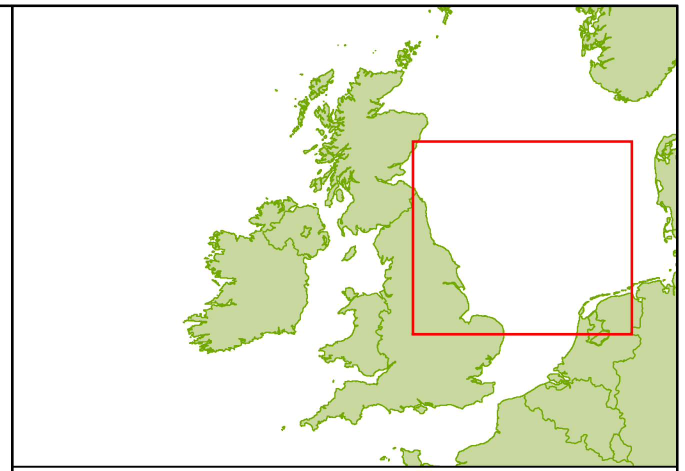
Table 10.3 Cumulative impact assessment summary

| Potential effect | Effect magnitude | Receptor | Receptor sensitivity | Cumulative impact |
|---|---|---|---|---|
| Temporary physical disturbance/loss of seabed habitat | Low | Fish and shellfish in general | Low | Minor adverse |
| | | Herring | Medium | Minor adverse |
| | | Sandeel | Medium | Minor adverse |
| | | Shellfish | Low | Minor adverse |

| Potential effect | Effect magnitude | Receptor | Receptor sensitivity | Cumulative impact |
|---|---|---|---|---|
| Suspended sediment and sediment re-deposition | Low | Fish and shellfish in general | Low | Minor adverse |
| | | Herring | Medium | Minor adverse |
| | | Sandeel | Medium | Minor adverse |
| Construction noise | Low | Fish and shellfish in general | Low | Minor adverse |
| | | Herring | Medium | Minor adverse |
| | | Sandeel | Medium | Minor adverse |
| Permanent loss of seabed habitat | Low | Fish and shellfish in general | Low | Minor adverse |
| | | Herring | Medium | Minor adverse |
| | | Sandeel | Medium | Minor adverse |
| | | Shellfish | Medium | Minor adverse |



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

Wind energy project

- Round 1
- Round 2
- Round 3
- Round 3 zone
- Non-UK wind farm development

Peak Pressure Level (dB re 1 μPa): 150, 160, 170, 180, 190, 200, 210

Data Source:
UK offshore wind farms © The Crown Estate, 2014
Non-UK offshore wind farms © Marine Find, 2013
Modelling © NPL Management, 2013

0 10 20 40 Kilometres

PROJECT TITLE

*DOGGER BANK TEESSIDE A & B*

DRAWING TITLE

**Figure 10.4 Noise generation from pile driving at other projects in relative proximity to Dogger Bank Teesside A & B**

| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 07/10/2013 | PEI3 | LW | TR |
| 2 | 14/02/2014 | DCO Submission | LW | TR |

DRAWING NUMBER: **F-OFL-MA-262**

| SCALE 1:2,000,000 | PLOT SIZE A3 | DATUM WGS84 | PROJECTION UTM31N |
|---|---|---|---|



FOREWIND

# 10.8. The cumulative impact of Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B, Dogger Bank Teesside C & D and other projects outside the Dogger Bank Zone

## Seabed disturbance due to sediment deposition

10.8.1. As indicated in **Chapter 9** the following proposed wind farm projects have been taken into account for cumulative assessment in terms of temporary disturbance of the seabed during construction:

- Project One Hornsea Offshore Wind Farm;
- Westermost Rough; and
- H2-20 offshore wind farm (German sector of the North Sea).

10.8.2. As stated in **Chapter 9** it is unlikely that the construction plumes of Project One Hornsea Wind Farm would interact with the construction plumes of Dogger Bank Teesside A & B, Dogger Bank Teesside C & D and Dogger Bank Creyke Beck A & B. There is therefore little potential for cumulative impacts on fish and shellfish receptors to occur.

10.8.3. Sediment plumes associated with installation of the Dogger Bank Teesside A & B, Dogger Bank Teesside C & D and Dogger Bank Creyke Beck A & B Export Cable Corridors may potentially interact with construction plumes of Westermost Rough if both are synchronous. As stated in **Chapter 9**, however, this potential interaction is not expected to result in significant effect. It is, therefore, considered that there is little potential for cumulative impacts on fish and shellfish receptors to occur.

10.8.4. In the particular case of the H2-20 offshore wind farm, given its distance to Dogger Bank Teesside A & B (approx.150km east-northeast of Dogger Bank Teesside A & B), **Chapter 9** concluded that there is not potential for cumulative effects in relation to seabed disturbance during construction to occur. As a result cumulative impacts associated with this are not expected on fish and shellfish receptors.

10.8.5. There may be potential for aggregate dredging taking place in the vicinity of Dogger Bank Teesside A & B, Dogger Bank Teesside C & D and Dogger Bank Creyke Beck A & B to result in a cumulative impact on fish and shellfish receptors resulting from the effects of seabed disturbance.

10.8.6. The following dredging areas have been included for assessment of cumulative impacts:

- Aggregates Area 466: Located at the northern boundary of Dogger Bank Teesside B;
- Aggregates Dredging Area 485: Located approximately 25km south west of Dogger Bank Teesside A and 20km south of the Dogger Bank Teesside A & B Export Cable Corridor; and

- Aggregate Dredging Areas 448 and 449: Located at the entrance of the Humber Estuary, approximately 50km to the south-southwest of the Dogger Bank Teesside A & B Export Cable Corridor.

10.8.7. The location of these areas are shown in relation to the distribution of herring and spawning grounds and high density areas for sandeel is given in **Figure 10.5** and **Figure 10.6**.

10.8.8. Areas 466 and 485 are located in known high density areas for sandeel (**Figure 10.6**). Area 485 also falls within a discrete section of the former herring spawning grounds, whilst Areas 448 and 449 are both located within the currently active inshore herring spawning grounds (**Figure 10.5**).

10.8.9. As indicated in **Chapter 9** analysis of time series of sediment deposition from the Dogger Bank Teesside A & B worst case construction plume at the southern corner of Area 466 shows that sediment thickness at any time is generally less than 1mm. Occasionally, sediment is thicker than 1mm and can be continuously greater than 1mm for a maximum period of 42 hours. Sediment deposition out of the Dogger Bank Teesside A & B construction plume would have little effect on the characteristics of the seabed sediment in Area 466. With regards to Area 485, it was assumed that the dredging process and sequencing is similar to that at Area 466.

10.8.10. In the particular case of dredging areas 448 and 449, as suggested in **Chapter 9** it is unlikely that any interaction with the sediment plume associated with the Dogger Bank Teesside A & B, Dogger Bank Teesside C & D and Dogger Bank Creyke Beck A & B cable installation will occur, given the small size of the plume generated by the cable and the low likelihood that the cable will be excavated on the same day as the aggregate extraction is being undertaken.

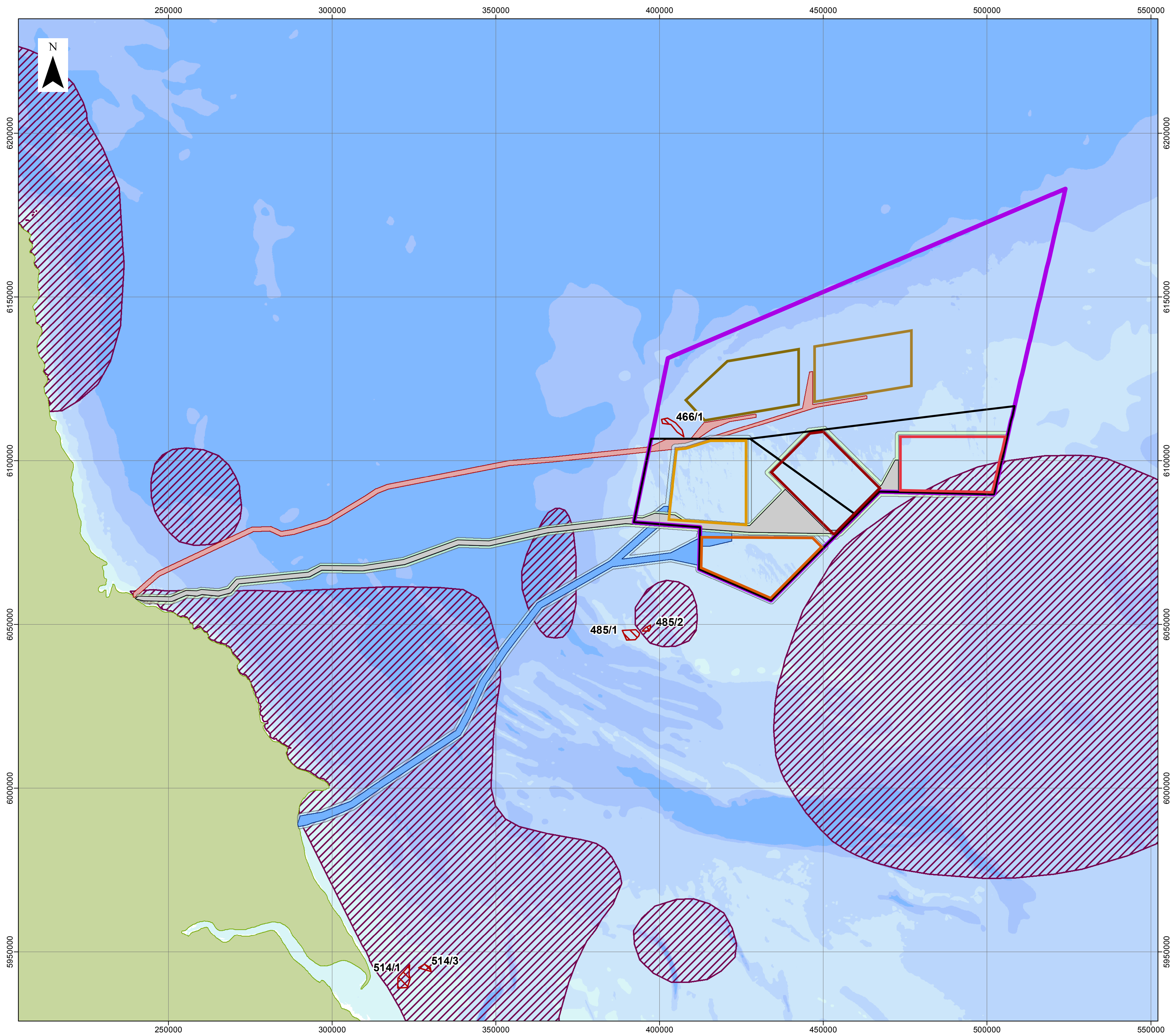
10.8.11. Taking the above into account it is not considered that dredging activities will contribute significantly to the cumulative impact effect on fish and shellfish in general, nor in the particular case of spawning herring and sandeel. Therefore **no cumulative impact** is anticipated.

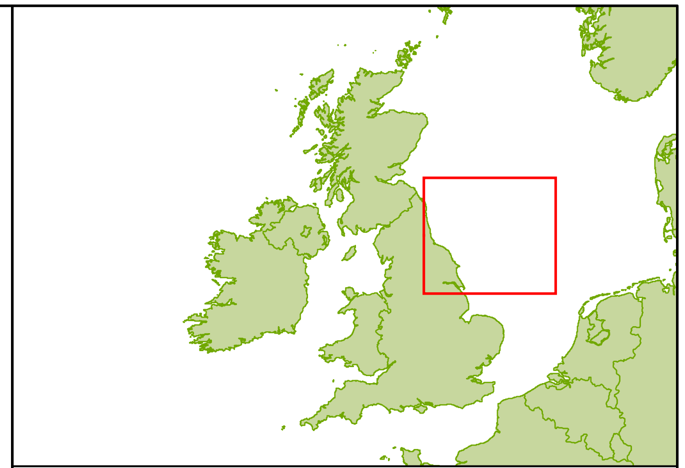
## Noise

10.8.12. As presented in **Appendix 5A**, the spatial range of potential behavioural effects associated with pile driving noise on fish were modelled for the following wind farms located in the proximity of the Dogger Bank Teesside A & B, Dogger Bank Teesside C & D and Dogger Bank Creyke Beck A & B:

- Firth of Forth;
- East Anglia;
- Hornsea; and
- Triton Knoll.



**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
- Herring spawning ground (Coull *et al.* 1998)
- 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
- Aggregate application area

0 10 20 40
Kilometres

Data Source:
Spawning Grounds © Cefas, 2012
Aggregate Areas © The Crown Estate, 2013
Background bathymetry image derived in part from TCarta data © 2009

PROJECT TITLE

*DOGGER BANK TEESSIDE A & B*

DRAWING TITLE

**Figure 10.5 Dredging areas in the vicinity of Dogger Bank Teesside A & B and herring spawning grounds**

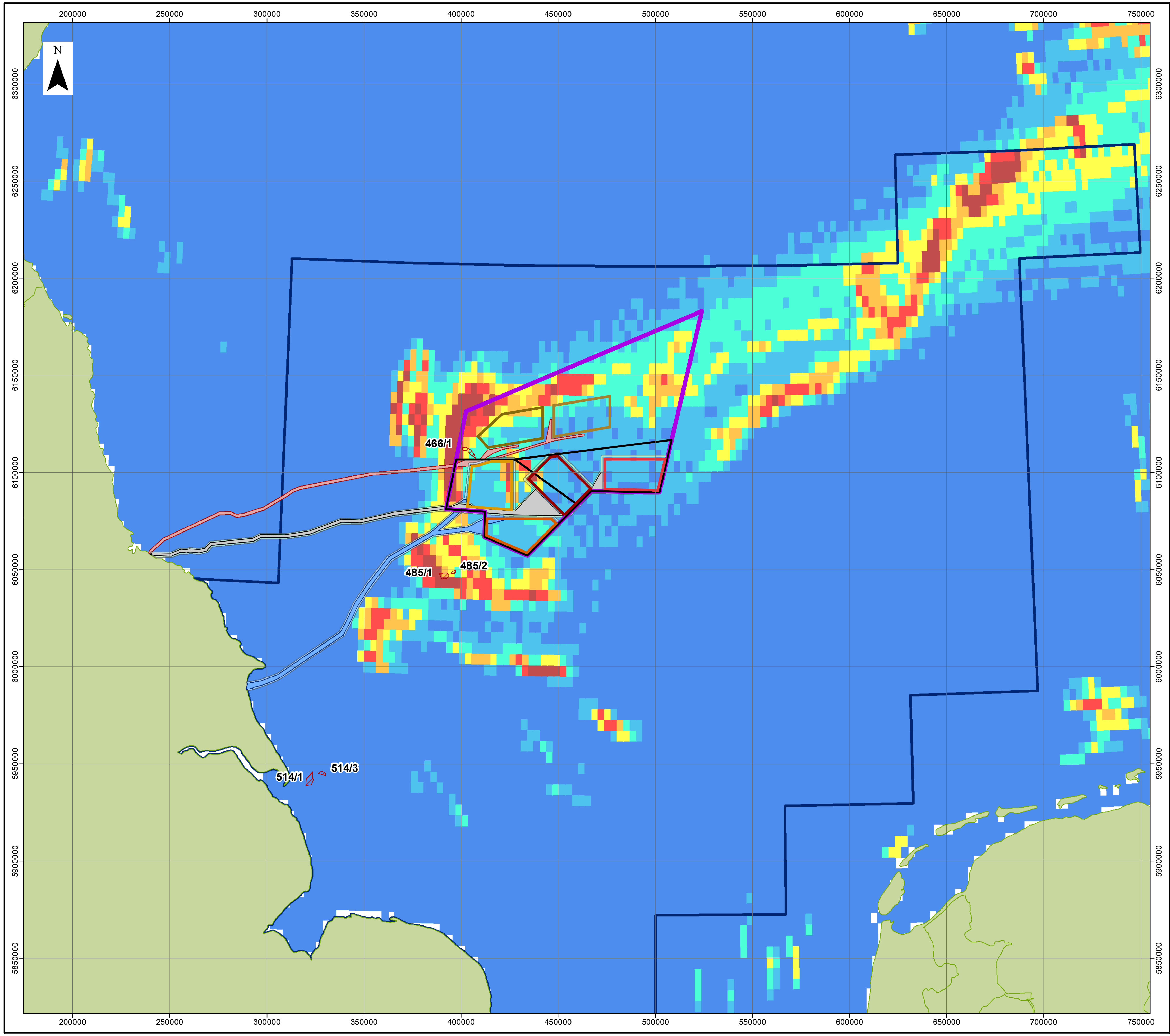
| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 20/09/2013 | Draft | LW | TR |
| 2 | 07/10/2013 | PEI3 | LW | TR |
| 3 | 14/02/2014 | DCO Submission | LW | TR |

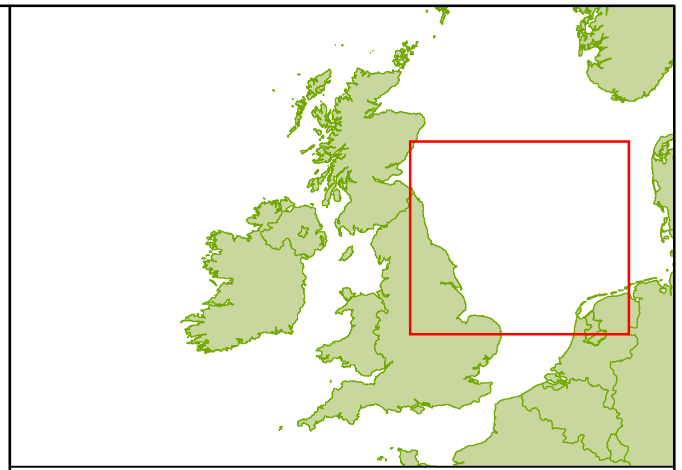
DRAWING NUMBER: **F-OFL-MA-263**

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



FOREWIND



**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
- ICES sandeel area
- Aggregate application area

Danish sandeel satellite (VMS) density

- 0 to 2
- 3 to 5
- 6 to 10
- 11 to 20
- 21 to 40
- 41 to 80
- Over 80

0 10 20 40
Kilometres

Data Source:
Aggregate Areas © The Crown Estate, 2013
VMS © Ministeriet for Fødevarer, Landbrug og Fiskeri, 2014

PROJECT TITLE

*DOGGER BANK TEESSIDE A & B*

DRAWING TITLE

**Figure 10.6 Dredging areas in the vicinity of Dogger BankTeesside A & B and density of Danish fishing (satellite VMS average 2008-2012)**

| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 07/10/2013 | PEI3 | LW | TR |
| 2 | 14/02/2014 | Pre-DCO Submission | LW | TR |

DRAWING NUMBER:

**F-OFL-MA-264**

| SCALE | PLOT SIZE | DATUM | PROJECTION |
|---|---|---|---|
| 1:2,000,000 | A3 | WGS84 | UTM31N |



FOREWIND

10.8.13. The outputs of the noise modelling undertaken for these developments, is given in **Figure 10.4**. This illustrates the extent of behavioural disturbance for fish in mid water.

10.8.14. As shown, assuming simultaneous piling at the closest locations from other wind farm developments to Dogger Bank Teesside A & B, Dogger Bank Teesside C & D and Dogger Bank Creyke Beck A & B there will not be spatial overlap of noise levels at which behavioural reactions may occur in pelagic fish. In the unlikely event that simultaneous piling was happening at all of the locations modelled above, the total area affected at behavioural levels would still be relatively small in the context of the wide distribution ranges (including spawning, nursery grounds and feeding grounds) of fish and shellfish receptors and any simultaneous disturbance would be temporary and very short term.

10.8.15. As described in **Appendix 5A** and summarised below, in addition to pile driving associated with wind farm installation, shipping, oil and gas related activities and dredging may further contribute to wind farm related noise.

10.8.16. Shipping density local to Dogger Bank Teesside A & B, Dogger Bank Teesside C & D and Dogger Bank Creyke Beck A & B is generally lower than closer inshore or in some of the surrounding areas, including areas to the south. Commercial shipping, fishing and dredging all radiate substantially lower noise levels compared to impact piling and are unlikely to increase the risk of physiological damage to marine fauna compared to the construction of Dogger Bank Teesside A & B, Dogger Bank Teesside C & D and Dogger Bank Creyke Beck A & B and other wind farms alone. In general, noise generated by transiting surface vessels will result in a very small contribution to the overall noise level resulting from impact pile driving activities.

10.8.17. It is therefore not considered that additional noise associated with other activities has potential to significantly contribute to the cumulative impact of noise on fish and shellfish species associated with the Dogger Bank Teesside A & B, Dogger Bank Teesside C & D and Dogger Bank Creyke Beck A & B and other wind farm developments.

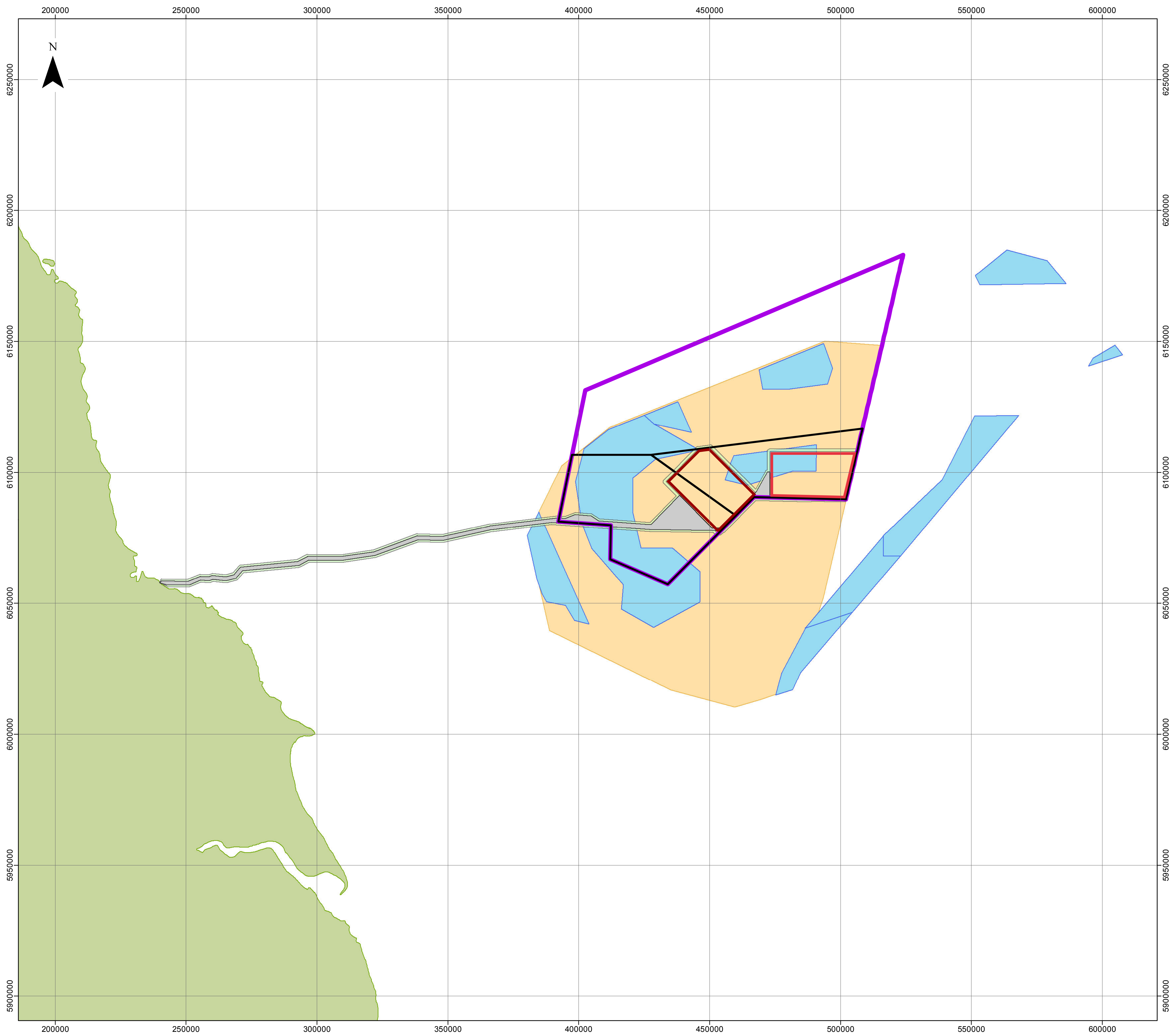
## 10.9. Dogger Bank Teesside A & B, Dogger Bank Creyke Beck, Dogger Bank Teesside C & D and marine conservation areas

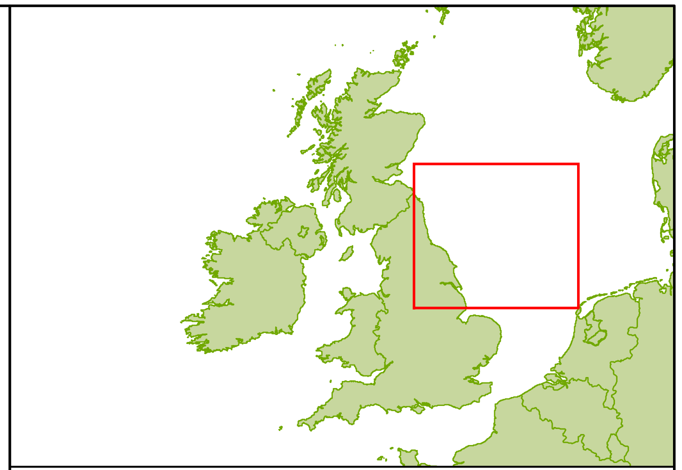
10.9.1. Dogger Bank Teesside A & B, Dogger Bank Teesside C & D and Dogger Bank Creyke Beck A & B fall within an area currently outlined as the Dogger Bank candidate Special Area of Conservation (cSAC). Conservation measures associated with the introduction of marine conservation areas may result in a beneficial cumulative impact on fish and shellfish receptors on a site specific area, particularly if fishing activity in the area changes substantially from measures which may be implemented. However, the potential for fishing effort to be displaced into sensitive areas should be noted in this context.

10.9.3. **Figure 10.7** shows a chart reproduced from a paper prepared on behalf of the Danish, Dutch, English and German fishermen organisations titled “Fisheries Spatial Management Measures for the Dogger Bank SAC: Fishing Industry Amendment Proposal”. The sections marked in purple are those proposed by the fishing industry to be under fisheries management within which towed bottom gears are prohibited from operating. The potential for a likely beneficial impact on target species and benthic habitats associated with the exclusion of towed gear should be noted. As described in **Chapter 15** although the proposed sectors overlap the majority of Dogger Bank Creyke Beck A & B, and small sections of Dogger Bank Teesside A & B and Dogger Bank Teesside C & D the areas proposed by the fishing industry may not be adopted. Furthermore, the proposed sectors align with the areas which the UK, Danish and German VMS and UK surveillance suggest sustain low levels of fishing activity.



**LEGEND**

- Dogger Bank Zone
- Tranche boundary
- Dogger Bank Teesside
- Dogger Bank Teesside B
- Dogger Bank Teesside A & B Export Cable Corridor
- Temporary works area
- cSAC proposed no trawl zones
- Dogger Bank cSAC

0 10 20 40
Kilometres

Data Source:
Management Sectors © NFFO 2012
Background bathymetry image derived in part from TCarta data © 2009

PROJECT TITLE

*DOGGER BANK TEESSIDE A & B*

DRAWING TITLE

**Figure 10.7 Proposed fisheries management sectors within Dogger Bank cSAC**

| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 20/09/2013 | Draft | LW | TR |
| 2 | 07/10/2013 | PEI3 | LW | TR |
| 3 | 14/02/2014 | DCO Submission | LW | TR |

DRAWING NUMBER:

**F-OFL-MA-265**

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



FOREWIND

# 11. Transboundary Issues

## 11.1. General

11.1.1. The distribution of fish and shellfish species is independent of national geographical boundaries. The impact assessment presented in this section has therefore been undertaken taking account of the distribution of fish stocks and populations irrespective of political limits. As a result it is considered that the assessment of transboundary effects is already integrated in the assessment given above.

11.1.2. The location of Dogger Bank Teesside A & B is an important consideration with respect to potential transboundary effects. Although Dogger Bank Teesside A & B does not lie in international waters the eastern boundary of the Dogger Bank Zone is synonymous with the international boundary bordering Dutch and German waters. Also of note is that the eastern boundary of Dogger Bank Teesside A is in close proximity to an international boundary with The Netherlands.

11.1.3. With regard to the effects of noise (namely from percussive piling, Section 6.6), the assessment has shown that behavioural impacts (including spawning behaviour) are not anticipated beyond 13.5km and 19km from the noise source. With regard to the potential effects of increased suspended sediment concentrations and deposition of sediment on the seabed (Section 6.4), the assessment indicates that any transboundary effects would be negligible. All other potential impacts, such as loss of habitat, will be contained within or in close proximity to the project boundaries, and no significant transboundary effects are anticipated.

# 12. Summary

12.1.1. This chapter of the ES has provided a characterisation of the existing fish and shellfish environment based on both existing and site specific survey data. As discussed in Sections 6, 7 and 8 of this chapter fish and shellfish may be affected as a result of temporary physical disturbance during construction, and permanent loss of habitat during operation of Dogger Bank Teesside A & B. All residual impacts identified for fish and shellfish ecology are minor adverse or negligible, with no significant residual impacts. **Table 12.1** provides a summary of the potential impacts on fish and shellfish arising from the realistic worst case scenarios set out in **Table 5.2** earlier in the chapter.

Table 12.1 Summary of potential impacts on fish and shellfish ecology

| Description of impact | Receptor | Residual impact | | | |
|---|---|---|---|---|---|
| | | Dogger Bank Teesside A | Dogger Bank Teesside B | Dogger Bank Teesside A & B | Dogger Bank Teesside A & B Export Cable Corridor |
| **Construction / decommissioning phase** | | | | | |
| Temporary physical disturbance/ loss of seabed habitat | Eggs and larvae of pelagic fish spawners | Negligible | Negligible | Negligible | Negligible |
| | Eggs and larvae of demersal fish spawners | Minor adverse | Minor adverse | Minor adverse | Minor adverse |
| | Eggs and larvae of sandeel | Minor adverse | Minor adverse | Minor adverse | Minor adverse |
| | Eggs and larvae of herring | Minor adverse | Minor adverse | Minor adverse | Minor adverse |
| | Eggs and larvae of shellfish | Minor adverse | Minor adverse | Minor adverse | Minor adverse |
| | Adult and juvenile fish | Minor adverse | Minor adverse | Minor adverse | Minor adverse |

| Description of impact | Receptor | Residual impact | | | |
|---|---|---|---|---|---|
| | | Dogger Bank Teesside A | Dogger Bank Teesside B | Dogger Bank Teesside A & B | Dogger Bank Teesside A & B Export Cable Corridor |
| | Sandeel | Minor adverse | Minor adverse | Minor adverse | Minor adverse |
| | Shellfish | Minor adverse | Minor adverse | Minor adverse | Minor adverse |
| Increased suspended sediment concentrations and sediment re-deposition | Eggs and larvae (general) | Minor adverse | Minor adverse | Minor adverse | Minor adverse |
| | Herring eggs | Minor adverse | Minor adverse | Minor adverse | Minor adverse |
| | Sandeel eggs | Minor adverse | Minor adverse | Minor adverse | Minor adverse |
| | Adult and juvenile fish (general) | Minor adverse | Minor adverse | Minor adverse | Minor adverse |
| | Sandeel | Minor adverse | Minor adverse | Minor adverse | Minor adverse |
| | Shellfish | Minor adverse | Minor adverse | Minor adverse | Minor adverse |
| Construction noise | Adult and juvenile fish | Negligible | Negligible | Negligible | Negligible |
| | Larvae | Minor adverse | Minor adverse | Minor adverse | Negligible |
| | Fish in general | Minor adverse | Minor adverse | Minor adverse | Negligible |
| | Herring | Minor adverse | Minor adverse | Minor adverse | Minor adverse |
| | Sandeel | Minor adverse | Minor adverse | Minor adverse | Minor adverse |
| | Diadromous species | Minor adverse | Minor adverse | Minor adverse | Minor adverse |
| | Other fish species | Minor adverse | Minor adverse | Minor adverse | Minor adverse |
| | Fish in general | Minor adverse | Minor adverse | Minor adverse | Negligible |
| | Shellfish | Minor adverse | Minor adverse | Minor adverse | Negligible |

| Description of impact | Receptor | Residual impact | | | |
|---|---|---|---|---|---|
| | | Dogger Bank Teesside A | Dogger Bank Teesside B | Dogger Bank Teesside A & B | Dogger Bank Teesside A & B Export Cable Corridor |
| **Operational Phase** | | | | | |
| Loss of habitat | Fish and shellfish in general | Minor adverse | | | |
| | Sandeel | | | | |
| | Herring | | | | |
| Introduction of hard substrate | Fish and shellfish (general) | Minor adverse | Minor adverse | Minor adverse | Negligible |
| EMF | Elasmobranchs | Minor adverse | | | |
| | Salmon and sea trout | | | | |
| | European eel | | | | |
| | Lamprey | | | | |
| | Other fish | | | | |
| | Shellfish | | | | |
| Operational noise | Fish and shellfish (general) | Minor adverse | | | N/A |
| Changes to fishing activity | Fish and shellfish (general) | Minor adverse | | | N/A |

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