FOREWIND




DOGGER BANK
TEESSIDE A & B

March
2014

# Habitats Regulations Assessment Report

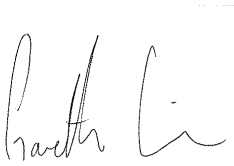
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Cover photograph: Installation of turbine foundations in the North Sea

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# 1 Introduction

## 1.1 Purpose and structure of this report

1.1.1 This document has been produced to inform the Habitat Regulations Assessment (HRA) process for Dogger Bank Teesside A & B offshore wind farm and associated export cable, onshore cable and converter station. It provides the relevant information required by the Competent Authority to undertake an appropriate assessment of the project with respect to its potential implications for European sites of nature conservation importance screened into this stage of the HRA. This step in the HRA process is further described in Section 1.3 and Section 1.4.

1.1.2 European sites are defined as Special Areas of Conservation (SACs) and Sites of Community Importance (SCIs) designated under Council Directive (92/43/EEC) on the conservation of natural habitats and of wild fauna and flora, protects habitats and species of European nature conservation importance (the 'Habitats Directive') and Special Protection Areas (SPAs) designated under Council Directive (2009/147/EC) on the conservation of wild birds (the 'Birds Directive').

1.1.3 In addition to sites designated under European nature conservation legislation, UK Government policy (Office of the Deputy Prime Minister (ODPM) Circular 06/2005) states that proposed SPAs and internationally important wetlands designated under the Ramsar Convention 1971 (Ramsar sites) are, as a matter of policy, although not law, afforded the same protection as SPAs and SACs for the purpose of considering development proposals that may affect them.

1.1.4 The European Commission's guidance on Planning for the Protection of European Sites: Appropriate Assessment (2001) identifies a four-stage process to the assessment of the effects of plans or projects on European sites. Cumulatively, these stages are referred to as the Habitat Regulations Assessment, in order to clearly distinguish the whole process from the second stage, which is referred to as the 'appropriate assessment'. The four stages are:

- Stage 1 Screening;
- Stage 2 Appropriate Assessment;
- Stage 3 Consideration of alternative solutions; and
- Stage 4 Assessment of 'Imperative Reasons of Overriding Public Interest' (IROPI).

1.1.5 This report provides information to enable the appropriate assessment stage to be undertaken. The majority of the information and assessment work presented here has been drawn from the Dogger Bank Teesside A & B Environmental Statement (ES) (Forewind 2014). The intention is that this report can be used as a stand-alone assessment of the effects of Dogger Bank Teesside A & B (both individually and combined) on the designated interest features of relevant

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European sites. However, it is important to note that much of the environmental baseline and detailed assessment work contained in the ES is not repeated in full in this Information for Appropriate Assessment Report. Reference is made to relevant sections of the ES wherever appropriate in this report and the reader is referred to the relevant ES chapters and appendices should further detail be required (see **Table 1.1**). The table also provides cross-referencing in respect of the PINS references for relevant chapters and appendices.

Table 1.1 ES chapters and appendices referenced within this report

| Chapter / Appendix | Document reference |
|---|---|
| **Chapter 5 Project Details** | F-OFL-CH-005 |
| **Chapter 9 Marine Physical Processes** | F-OFL-CH-009 |
| **Chapter 10 Marine Water and Sediment Quality** | F-OFL-CH-010 |
| **Chapter 11 Marine and Coastal Ornithology** | F-OFL-CH-011 |
| **Chapter 12 Marine and Inter-tidal Ecology** | F-OFL-CH-012 |
| **Chapter 13 Fish and Shellfish Ecology** | F-OFL-CH-013 |
| **Chapter 14 Marine Mammals** | F-OFL-CH-014 |
| **Chapter 15 Commercial Fisheries** | F-OFL-CH-015 |
| **Chapter 16 Shipping and Navigation** | F-OFL-CH-016 |
| **Appendix 5A Underwater Noise Modelling Report** | F-OFL-CH-005 App.A |
| **Appendix 9A Marine Physical Processes Assessmentof Effects Technical Report** | F-OFL-CH-009 App.A |
| **Appendix 11A Ornithology Technical Report** | F-OFL-CH-011 App.A |
| **Appendix 11B Ornithology - Extent of Displacement and Mortality Implications of Displacement of Seabirds by Offshore Wind Farms** | F-OFL-CH-011 App.B |
| **Appendix 12A Tranche B and Export Cable Corridor Benthic Survey Report** | F-OFL-CH-012 App.A |
| **Appendix 12B Tranche A Benthic Survey Report** | F-OFL-CH-012 App.B |
| **Appendix 12C Intertidal Benthic Survey Report** | F-OFL-CH-012 App.C |
| **Appendix 12D Tranche B Habitat Mapping Report** | F-OFL-CH-012 App.D |
| **Appendix 13B Tranche B Fish and Shellfish Characterisation Survey** | F -OFL-CH-013 App.B |
| **Appendix 13C Nearshore Fish and Shellfish Surveys** | F -OFL-CH-013 App.C |
| **Appendix 13D Tranche A Fish and Shellfish Characterisation Survey** | F -OFL-CH-013 App.D |
| **Appendix 13E Pelagic Fish Survey Report** | F -OFL-CH-013 App.E |
| **Appendix 13F Sandeel Survey Report** | F -OFL-CH-013 App.F |
| **Appendix 14A Dogger Bank Seal Telemetry** | F-OFL-CH-014 App.A |
| **Appendix 14B DMP Statistics Analysis Report** | F-OFL-CH-014 App.B |

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1.1.6 The following sections have been structured to facilitate an understanding of the potential effects of Dogger Bank Teesside A & B with respect to the large number of European sites and their designated features that have been screened into the appropriate assessment stage of the HRA. To facilitate the provision of information and avoid significant repetition and / or cross-referencing, information is presented at the interest feature level (e.g. Annex I habitat types and Annex II marine mammal species) and assessment outcomes are then referred to individual European sites designated for this specific interest feature. This approach also reflects the fact that, given the location of the project, there would be no direct impacts (e.g. habitat loss) on European sites designated for Annex II features. Potential effects and impacts are therefore better assessed in relation to individual species such that an understanding of impacts at the wider study area / population level can be gained before apportioning potential impacts to individual European sites. This approach is particularly relevant to seabirds, where the population of seabirds that may be present in the Dogger Bank Zone may derive from many designated SPAs.

1.1.7 After the introductory sections (Section 1 and Section 2), Section 3 provides a summary of the screening process (Step 1 in the HRA process) and details of those European sites and their features taken through into Step 2 (the appropriate assessment stage) of the HRA. Section 4 deals with Annex I habitat features and their relevant European sites, and Section 5 with Annex II features and their relevant European sites. Information on the significant number of bird species / populations and their respective SPAs screened into the appropriate assessment is provided in Section 6. Information to support the in-combination component of the appropriate assessment is provided in Section 7, and the summary and conclusions of the assessment re provided at Section 8.

## 1.2 Introduction to Dogger Bank Teesside A & B

### Background to the Dogger Bank Offshore Wind Farm proposals

1.2.1 In June 2008 The Crown Estate announced proposals for the third round (Round 3) of offshore wind farm leasing, following on from the eight Gigawatts (GW) planned from earlier United Kingdom (UK) offshore wind leasing programmes (namely, Rounds 1, 2 and later extensions). Subsequent to this announcement, a Strategic Environmental Assessment (SEA) to examine the potential for 25GW of additional UK offshore wind was carried out.

1.2.2 Under the Round 3 process, nine development ‘zones’ were identified by The Crown Estate, with a combined target energy generation capacity of 25GW. On the 8th of January 2010, following a competitive tender process, The Crown Estate announced the successful bidders for each of the zones. Forewind Limited (Forewind) was awarded the development rights for the largest zone; Dogger Bank. Forewind’s commitment is to secure all the necessary consents for the construction and development of the ‘Dogger Bank Zone’, up to the point of an investment decision.

1.2.3 Forewind has undertaken detailed assessments and calculations with respect to the Dogger Bank Zone and from these has developed its ambition to secure consent for six wind farm projects with a total target installed capacity of 7.2GW.

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## The Dogger Bank Zone

1.2.4 The Dogger Bank Zone (hereafter referred to as the 'Zone') is located in the North Sea, off the east coast of Yorkshire as shown on **Figure 1.1**. The key Zone characteristics are described in **Table 1.2**.

Table 1.2 Key Zone characteristics

| Project information | Detail |
|---|---|
| Zone size | 8,660km2 / 3,343 square miles |
| Distance from shore | 125km to 290km |
| Water depth | 18m to 63m below chart datum |
| Estimated capacity | Forewind ambition to achieve consent for up to 7.2GW of offshore wind farm projects. |

1.2.5 The Zone has many favourable attributes that make it an attractive site for offshore wind farm development. It has a good wind resource, with higher annual mean wind speeds than the other Round 3 offshore wind farm zones (>10m/s). It also has relatively shallow water depths and good ground conditions, which make it appropriate for implementation of a broad range of foundation options. Initial estimates concluded that around 4GW could be located in a water depth less than 30m, with a further 4GW between 30m and 35m water depths although this is dependent on the outcome of the necessary studies to inform the Environmental Impact Assessment (EIA) for individual projects.

1.2.6 The Zone also presents a number of different challenges to the development and delivery of projects, not least because of its considerable distance from shore.

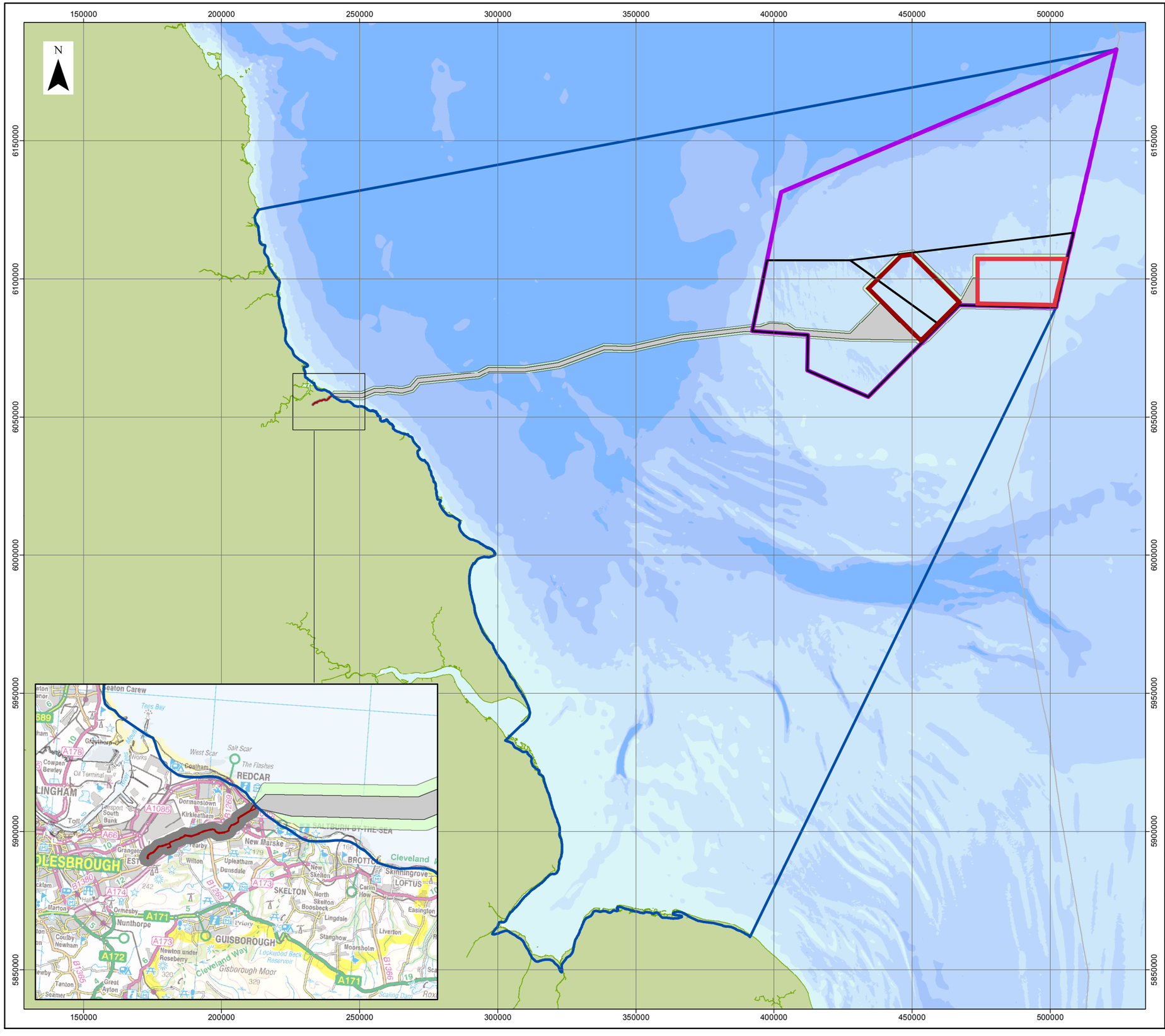
## Introduction to Forewind Limited and Project Delivery Strategy

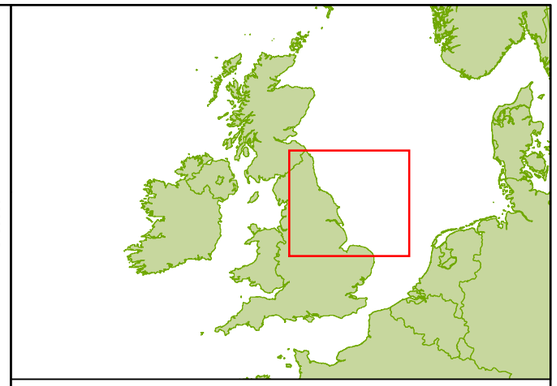
1.2.7 Forewind is a consortium comprising four leading international energy companies; SSE, RWE Innogy UK (a RWE Innogy company), Statoil and Statkraft.

1.2.8 Together these companies combine extensive experience of international offshore project delivery and renewables development, construction, asset management and operations. Through the combined experience and commitment of its owner companies, Forewind has the ability to both make a significant contribution to the future of wind energy in the UK and demonstrate commitment to the continuing development of offshore wind.

1.2.9 In order to better manage the development of the Dogger Bank Zone and to more evenly distribute the demand on Forewind's stakeholders, it was proposed that Dogger Bank should be developed in a series of Tranches. Forewind have identified four Tranches in total for which projects are achievable through a process known as Zone Appraisal and Planning (ZAP). Within each Tranche, separate projects have been identified and will be the subject of independent applications for Development Consent under the Planning Act 2008 ("the 2008 Act"). The projects will be optimised in accordance with the location, capacity and timing of grid connections, secured through the application process with National Grid.

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## LEGEND

- Zone development envelope
- Dogger Bank Zone
- Tranche boundary
- Dogger Bank Teesside A
- Dogger Bank Teesside B
- Dogger Bank Teesside A & B Export Cable Corridor
- Temporary works area
- Indicative Onshore Cable Route
- 1km onshore cable corridor

0 10 20 40

Kilometres

Data Source:
Round 3 offshore wind farm boundary © Crown Copyright, 2014
Background bathymetry image derived in part from TCarta data © 2009
Ordnance Survey data © Crown copyright and database right, 2014

PROJECT TITLE

*DOGGER BANK TEESSIDE A & B*
IfAA Report

DRAWING TITLE

**Figure 1.1 Dogger Bank Zone, the Tranches and Dogger Bank Teesside A & B**

| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 11/10/2013 | Final | GC | PT |
| 2 | 18/03/2014 | DCO Submission | GC | PT |
| | | | | |

DRAWING NUMBER:
**9Y0986/TSABHRA/01/R2**

| SCALE | PLOT SIZE | DATUM | PROJECTION |
|---|---|---|---|
| 1:1,400,000 | A3 | WGS84 | UTM31N |

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1.2.10 Tranche A was defined in 2010 with Tranche B (see **Figure 1.1**) subsequently defined in 2011. The first phase of development, Dogger Bank Creyke Beck A & B, is located in Tranche A and will make landfall on the Holderness coast and connect to the existing National Grid substation at Creyke Beck, located in the East Riding of Yorkshire. The second phase of development, Dogger Bank Teesside A & B, is located within tranches A & B and will make landfall on the Teesside coast and connect to the existing National Grid substation at Lackenby, located adjacent to the Wilton Complex in the borough of Redcar and Cleveland.

1.2.11 Dogger Bank Teesside A & B comprises two offshore wind farm development areas (Dogger Bank Teesside A and Dogger Bank Teesside B) each with a capacity of up to 1.2GW and with a combined capacity of up to 2.4GW.

## 1.3 The Habitats Regulations Assessment process

1.3.1 The Habitats Directive protects habitats and species of European nature conservation importance. Together with the Birds Directive, the Habitats Directive establishes a network of internationally important sites designated for their ecological status. SACs (including candidate SACs (cSACs)) and SCIs (including proposed SCIs (pSCIs)) are designated under the Habitats Directive for the protection of flora, fauna and habitats, and SPAs are designated under the Birds Directive for the protection of rare, vulnerable and migratory birds. These sites combine to create a Europe-wide 'Natura 2000' network of designated sites, which are hereafter referred to as European sites.

1.3.2 Terrestrial areas of the UK and territorial waters out to 12 nautical miles (nm) are designated under The Conservation of Habitats and Species Regulations 2010 as amended (herein referred to as the Habitats Regulations). The 2010 Regulations transpose the Habitats Directive into national law, and came into force on 1 April 2010. The Habitats Directive incorporated all SPAs into the definition of European sites and, consequently, the protections afforded to European sites under the Habitats Directive apply to SPAs designated under the Birds Directive.

1.3.3 Beyond 12 nautical miles and for the extent of the UK Continental Shelf, the Offshore Marine Conservation (Natural Habitats, & c.) Regulations 2007 (the Offshore Habitats Regulations) transpose the Habitats and Birds Directives into national law. This includes the Dogger Bank Zone. The Offshore Habitats Regulations came into force on 21 August 2007.

1.3.4 Regulation 61 of the Habitats Regulations defines the procedure for the assessment of the implications of plans or projects on European sites. Under this Regulation, if a proposed development is unconnected with site management and is likely to significantly affect the designated site, the competent authority must undertake an appropriate assessment (Regulation 61(1)); this process is also identified in Regulation 25(1) of the Offshore Habitats Regulations. As the terms of Regulations 25 and 61 are the same, for the purposes of this description, reference (where required) is made solely to Regulation 61.

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1.3.5 Guidance (EC 2001; Planning Inspectorate 2013) on undertaking assessment of plans or projects that may impact upon designated European sites recommends a staged approach to the process (as summarised in Section 1.4):

- **Screening (Step 1)**: The process of identifying potentially relevant European sites and the likely impacts of a project upon the designated features of a European site, either alone or in combination with other plans and projects, and considering whether the impacts are likely to be significant.
- **Appropriate Assessment (Step 2)**: Assessment of the impacts, taking into account proposed mitigation measures, on the integrity of the European site, either alone or in combination with other plans and projects, with regard to the site's structure and function and its conservation objectives. If it cannot be concluded beyond reasonable scientific doubt that the project would not adversely affect site integrity then development consent cannot be issued unless Stepss 3 and 4 are successfully concluded.
- **Assessment of Alternative Solutions (Step 3)**: Examining alternative ways of achieving the objectives of the project, to establish whether there are solutions that would avoid an adverse effect on the integrity of a European site(s).
- **Assessment of IROPI (Step 4)**: If it is shown that there are no alternative solutions then the project can receive development consent only if it can also be demonstrated that it should proceed for imperative reasons of overriding public interest (IROPI). Where IROPI can be shown then compensatory measures required to maintain the overall coherence of the site or integrity of the European site network will need to be identified and secured.

1.3.6 **Figure 1.2**, taken from Planning Inspectorate Advice Note 10 (Version 5 – Planning Inspectorate 2013), sets out the recommended steps in the process.

1.3.7 In respect of Step 2, guidance on what constitutes the integrity of a European site has been provided by the European Commission (EC 2000). In this guidance integrity is defined as:

"*the coherence of the site's ecological structure and function, across its whole area, which enables it to sustain the habitat, complex of habitats and/or populations of species for which the site has been designated*".

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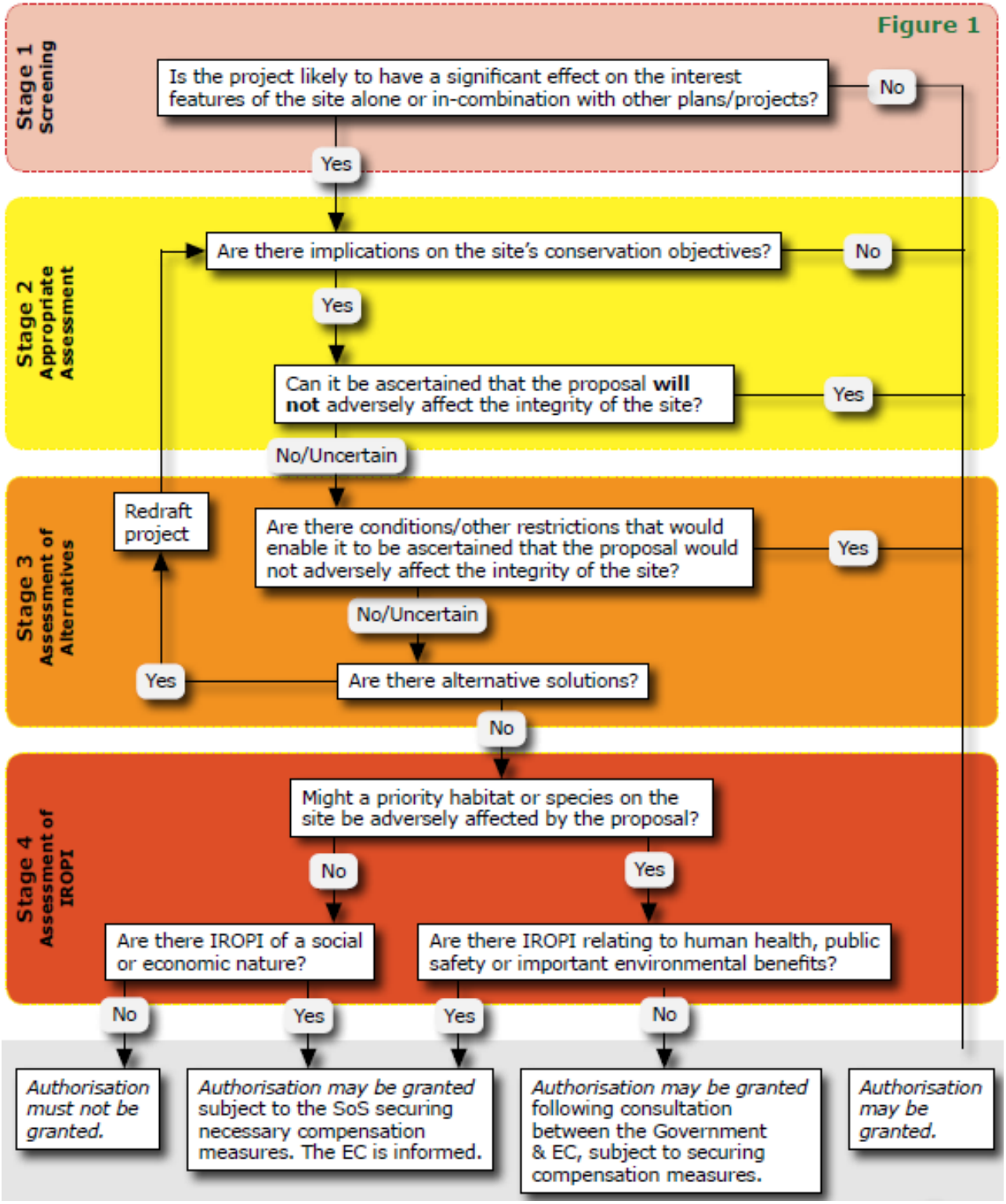



Figure 1.2 Step-by-step approach to determining whether a significant effect is likely on a European site (Figure 1 from Planning Inspectorate Advice Note 10)

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## 1.4 The requirement for a Habitats Regulations Assessment

1.4.1 As set out in Section 1.1 and Section 1.3, under the Habitats Regulations if the development is likely to have a significant effect on the notified interests of a European site, then an appropriate assessment must be made by a competent authority of its implications for the site in view of the site's conservation objectives.

1.4.2 HRA Screening for Dogger Bank Teesside A & B has been undertaken and a Screening Report submitted for comment to relevant consultees in August 2013 (see **Appendix A** of the **HRA Report**), and further consideration of screening was submitted as part of the draft HRA Report that accompanied the second stage of statutory consultation (in accordance with Sections 42, 47 and 48 of the Planning Act 2008) on the Dogger Bank Teesside A & B draft ES (Forewind 2013a). On the basis of the information available when undertaking screening it was determined that the proposed development could either, by itself, or in combination with other plans or projects, have a likely significant effect on a number of designated European sites. As the proposed development is not directly connected with or necessary to the management of the screened European sites, it was determined that an appropriate assessment of the implications of the proposed development, in respect of the conservation objectives applicable to the relevant European sites, should be undertaken. This report provides the relevant information likely to be required by the competent authority in undertake an appropriate assessment (i.e. Step 2 of the HRA process as identified in Section 1.3 and **Figure 1.2**).

## 1.5 Roles and responsibilities

1.5.1 In November 2011 the Government announced a review of the workings of the regulations implementing the Habitats and Wild Birds Directives, in England, with a view to reducing burdens on business, while maintaining the integrity of the purpose of the Directives.

1.5.2 The Review (Defra 2012) concluded that, in the large majority of cases, the implementation of the Directives is working well, allowing both development of key infrastructure and ensuring that a high level of environmental protection is maintained. However, some cases do encounter delays, although the Habitats and Wild Birds Directives may only be one contributory factor.

1.5.3 From the evidence received and analysis undertaken, the Review identified four key areas where change will improve the implementation of the Directives for the benefit of both the economy and the environment. One of the four areas related to the facilitation of nationally significant infrastructure projects (NSIPs).

1.5.4 The Government set out its ambitions to deliver a programme of major investment in infrastructure in its National Infrastructure Plan (HM Treasury & Infrastructure UK 2011), in which a 'top 40' of key areas of infrastructure investment was identified, including renewable energy.

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1.5.5 The National Infrastructure Directorate within the Planning Inspectorate (hereafter known as 'the Examining Authority') is the body responsible for examining applications for development consent under the 2008 Act. The Examining Authority will not make the final decision on Dogger Bank Teesside A & B; this decision will fall to the Competent Authority, in this case the Secretary of State for Energy and Climate Change (hereafter referred to as 'the Secretary of State').

1.5.6 This report (and any supporting documentation) produced for the Development Consent Order (DCO) application for Dogger Bank Teesside A & B will provide the information required by the Competent Authority to enable it to undertake an appropriate assessment of the implications of the project on the integrity of designated interests of relevant European sites (in accordance with Article 6(3) of the Habitats Directive) and, also, as a matter of policy with regard to the designated interests of relevant Ramsar sites.

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# 2 Dogger Bank Teesside A & B

## 2.1 Introduction

2.1.1 This section of the report provides a summary of the key components of the proposed construction, operation and decommissioning of Dogger Bank Teesside A & B.

2.1.2 Specific technologies and installation techniques have not been finalised and, therefore, the range of potential options under consideration is presented.

2.1.3 Throughout the HRA process a 'realistic worst case' approach to the assessment of the different impacts associated with Dogger Bank Teesside A & B will be followed. This approach has been validated through relevant case law, which has established an evolving custom and practice in relation to projects where the final design is not available at the consent application stage, and is referred to as the 'Rochdale Envelope approach'[1]. However, this approach depends on appropriate conditions being placed on the resulting consents to ensure that the 'worst case' likely impacts will not be exceeded by the final built development. The development should also not give rise to a likely significant effect on the environment which has not been assessed prior to construction.

2.1.4 Forewind requires flexibility during the pre-application stage and within the eventual project consents in order to allow the individual project's owner the ability to place contracts and build out the project in the most appropriate manner. This is largely driven by the fact that the supply chain offers a range of different solutions to:

- The design of the wind farm components (such as foundation type, wind turbine type and rated capacity, number of export cables and the arrangement of the onshore converter station); and
- The construction process (such as transportation methods and component installation techniques).

2.1.5 The HRA must therefore ensure that all realistic and likely worst case scenarios are adequately assessed and, if flexibility is necessary at the draft DCO stage, the project must be described in such a way that a robust assessment of the effects can be undertaken. Consequently, Forewind has given careful consideration to all potential effects that may result from Dogger Bank Teesside A & B, for each parameter, and ensured that any assessment made is reflective of the realistic worst case scenario for the specific parameter under investigation. Forewind has ensured that only 'realistic' development scenarios are considered when defining these. For example, whilst different sizes of foundation are included in the application, the largest foundations may not be

[1] As described in Chapter 5 of the Dogger Bank Teesside A & B ES 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.


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required to support the smallest wind turbine, but the largest size of foundation would be defined as the worst case scenario for assessing a range of effects, whilst smaller and more numerous foundations would define the worst case scenario for assessing other effects. In this case, the assessment seeks to identify and describe a realistic worst case for undertaking any assessment.

## 2.2 Project elements for Dogger Bank Teesside A & B

2.2.1 Development of Dogger Bank Teesside A & B is likely to comprise the following main offshore and onshore components:

- Wind turbines and associated foundations and scour protection measures;
- Offshore collector and converter stations and associated foundations, and scour protection measures;
- Offshore operations and maintenance infrastructure, such as accommodation platforms (or other appropriate accommodation arrangements), permanent moorings, and navigational buoys and scour protection measures;
- Subsea inter-array cables:
  - Between the turbines;
  - Between turbines and substations; and
  - Between substations;
- Subsea export cables, carrying power from the wind farm to the shore;
- Crossing structures at the points where project cables cross existing subsea cables and pipelines;
- Offshore meteorological masts and metocean equipment;
- Onshore transition pit;
- Cable system - from onshore transition pit to onshore converter station;
- Ancillary cable ducts – these are buried ducts running adjacent to the cable system;
- Cable system - from onshore converter station to National Grid Electricity Transmission (NGET) substation; and
- Converter substations.

2.2.2 Each of the above components, offshore and onshore, is described in detail in **Chapter 5 Project Details** of the Dogger Bank Teesside A & B ES, to which the reader is referred for more information. The following sections provide a summary of the main project components and activities in order to provide context for the potential effects assessed in subsequent sections.

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## 2.3 Offshore components and activities

2.3.1 The following list identifies the key offshore components for each individual wind farm (i.e. Dogger Bank Teesside A and Dogger Bank Teesside B) that form Dogger Bank Teesside A & B (multiply by two to get the sum total of the offshore components of the proposed development application):

- Between 120 10MW (megawatt) or 200 6MW wind turbines (ranging in diameter from 167m to 215m, with tip heights from 26m to between 267m and 315m above Highest Astronomical Tide (HAT));
- Collector substations (up to four in number);
- Converter substations (one in number);
- Met masts and metocean monitoring equipment (up to five in number);
- Accommodation platforms (up to two in number);
- Foundations for turbines, collector and converter stations, met masts, and accommodation platforms using a variety of designs including monopoles, multipoles, gravity bases, or suction caissons;
- Scour protection (if at all required and subject to foundation type);
- Inter-array (AC) cables;
- Inter-platform (HVAC) cables (up to eight);
- Export (HVDC) cables (one pair); and
- Permanent moorings (up to 10 for operation and maintenance purposes).

2.3.2 The offshore installation techniques will comprise the following activities:

- Seabed clearance, where required for turbine and other structure foundations (where gravity bases or suction caissons are proposed);
- Disposal of spoil originating from turbine installation;
- Construction of an accommodation platform, wind turbine, collector and converter substation, and met mast foundations using a variety of techniques including piling;
- Installation of scour protection (if required);
- Ploughing or trenching / jetting techniques for installation and laying of inter-array and export cables;
- Works to ensure safe and undisturbed crossing of existing cables and pipelines; and
- Installation of permanent mooring positions for operational purposes.

### Wind Turbines

2.3.3 Offshore wind turbine technology is evolving rapidly and it is anticipated that machines of between 6MW and 10MW will be considered for this project, with a resulting range of dimensions as presented in **Table 2.1**.

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Table 2.1 Indicative wind turbine parameters

| Wind turbine detail | Smallest turbine | Largest turbine |
|---|---|---|
| Generation capacity | 6MW | 10MW |
| Maximum No of wind turbines per project (up to 1.2GW) | 200 | 120 |
| Rotor diameter | 167m | 215m |
| Tip height (mHAT) | 267m | 315m |
| Hub height (mHAT) | 183.5m | 207.5m |
| Lowest tip height (mHAT) | 26m | 26m |
| Mean blade chord (m) | 3.3m | 4.2m |
| Indicative mean operational blade pitch angle (degrees) | 0-10 | 0-10 |
| Mean operational rotor speeds (rpm) | 8.84 | 6.85 |

## Foundations

2.3.4 Foundations will be required to support all offshore infrastructure (i.e. wind turbines, collector and converter stations, accommodation platforms and met masts). The type and size of foundations utilised will be influenced by a number of factors, such as availability, economics, ground conditions and environmental considerations. Consequently a range of foundation types and sizes are being considered for the project, which can be grouped into the following broad categories:

- **Monopole**: usually constructed from welded steel tubular sections (tapered or cylindrical) driven vertically into the seabed using piling hammers, and sometimes drilling rigs. Investigations are currently underway into large steel monopiles of 10m to 12m in diameter. An alternative monopile solution (suction installed bucket option) uses a steel reinforced concrete design with indicative diameter of 27m to 35m for larger turbines.
- **Multipole** (or Jacket): this describes a family of foundation options, typically consisting of three or four main legs, which are linked by a supporting matrix of cross-braces. Indicative dimensions for large multipole foundations include main tubular diameters of 4.5m to 6m, and a width of base at seabed of 51.5m to 61m. Each leg is usually secured by a pin pile, driven into the seabed and grouted or swaged into a sleeve, but this can also be achieved using other techniques, such as suction caissons as described below.
- **Tripod**: similarly to the multipole foundation options, this includes a family of foundation types. All include multiple legs (usually three) supporting a single tubular support for the turbine, and they may be asymmetrical in some cases. Indicative dimensions for large tripods are a central tubular section diameter of around 8m to 12m, supporting braces of 3m to 10m, and piles of around 3.5m to 6m diameter. The tripod is driven into the seabed in a similar manner to the multipile concepts above.
- **Gravity base structure (GBS)**: a heavy steel, concrete, or steel and concrete combination base, sometimes including additional ballast substances, which sits on the seabed to support the turbine tower. Gravity bases vary in shape and include conical, as well as cylindrical or

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hexagonal sections, with indicative base diameters up to 47m to 55m. Seabed preparation consists of removal of soft, mobile sediments and the levelling of an area. Gravity base foundations may be designed with steel skirts around the perimeter of the base, which penetrate into the soil and allow under-base grouting.

- **Suction caisson**: based on a structure comparable to an upturned bucket that is lowered to penetrate into a pre-prepared (levelled) seabed. Other than seabed surface preparation, the installation process does not result in the generation of spoil, nor does it require piling. For smaller turbine classes, caissons may be used individually with an indicative diameter of around 50m, penetrating to around 10m into the seabed. For larger turbine classes, the use of suction caisson foundations are likely to be as part of a multipile or tripod structure and thus should be considered in conjunction with the applicable dimensions above.

2.3.5 Additional foundation types that may be considered for the collector and converter stations include self-installing jack up or semi-submersible solutions that will be floated in and placed on the seabed, but this will be confirmed following detailed design work.

## Scour protection

2.3.6 Scour protection may be required around any offshore structures installed by the project. Should scour protection be required there are a number of options available, selection of which will depend on the final foundation or structural design, ground conditions, scour assessments and environmental assessment. Typical options include:

- Protective aprons;
- Mattresses;
- Flow energy dissipation (frond) devices; and
- Rock and gravel placement.

## Collector substations

2.3.7 Collector substations will receive power from the inter-array cable systems and step up the voltage for export to a HVDC converter station. The location and number of collector substations will depend on the array layout, number and capacity of wind turbines and the installed capacity of the wind farm. The export voltage will be determined by detailed studies, but is likely to be in the range of 132kV to 220kV, although recent advances in subsea cable technology has made higher voltages available (up to 400kV). The number of collector substations for the project will be determined based on detailed studies, but it is likely that, for a single project, there will be up to four collector substations for around 1.2GW of generation capacity. The largest single collector substation platform seen to date is around 600MW, and the dimensions for such a platform could typically be 75 (l) x 75 (w) x 85 (h) meters, including cranes, but the final capacity and dimensions for these substation platforms will be determined through detailed design.

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## Converter substations

2.3.8 Given the distance offshore, the likely technical solution for the project's grid connection will be Voltage Source Conversion (VSC) HVDC technology. This technology provides for significantly lower power losses over long distances than High Voltage Alternating Current (HVAC) technology. HVDC technology requires a converter station at each end of the export cable, to transform the power from AC to DC. The number of converter stations for the project will be determined based on detailed studies, but it is likely that for each project there will be one converter station for around 1GW of generation capacity, and these may be either standalone or associated with collector substations. The dimensions for a 1GW offshore converter station platform could typically be 100 (l) x 125 (w) x 105 (h) meters, including cranes, but the final capacity and dimensions for the converter station platforms will be determined through detailed design.

## Inter-array cabling and installation

2.3.9 Inter-array cabling will transmit power from the individual wind turbines to an offshore collector platform. Generation from the wind turbines will be collected, either through separate radials, ring systems, branched cable systems or a combination of these. The final design of the inter-array cable collector system will depend on the array layout, number and capacity of the wind turbines and the total installed capacity of the wind farm. Inter-array cables are typically single cables containing three cores and a fibre-optic cable to transmit data. The three cores are bundled together and protected by armouring to reduce the risk of damage to the cable during installation or from external impacts. The cables will likely have a diameter of around 250mm for 33kV (industry standard) and for higher voltages (up to 72kV).

2.3.10 The total length of inter-array cabling will depend on the actual layout and size of the wind farm, number of offshore collector substations and need for micro-routing around obstacles or constraints on the seabed, though could range between 700km - 950km.

## Export cabling

2.3.11 Export cabling will vary for different components of the project as detailed below:

- **Collector to converter export cabling**: depending on the transmission voltage and the capacity of the collector substation, there are likely to be one to four AC export cables from each of the collector substations to the converter station. The voltage will be determined by detailed studies, but is likely to be in the range of 132kV to 400kV. The export cable's conductor will comprise of copper or aluminium. The biggest diameter may be up to 300mm.
- **HVDC Export cabling to shore**: the design of the HVDC connection to shore will determine the type of export cabling required. The base case design will be a Bipolar converter system, consisting of a pair of high voltage DC cables for each converter station, one with a high positive voltage, and one with a high negative voltage relative to earth. A typical voltage for this design could be between 300kV - 550kV depending on the

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power to be transmitted. The two HVDC cables in a circuit are normally bundled together in the same trench until they approach the land fall location, where they sometimes are separated for Horizontal Directional Drilling (HDD) through to the onshore jointing pit.

2.3.12 The different export cabling types will be installed utilising the most appropriate installation technique for the location, with the likely options including jetting, ploughing, and cutting.

## Cable and pipeline crossings

2.3.13 Both inter-array and export cables may be required to cross existing pipelines or cables. The detailed methodology for the crossing of cables and pipelines by the export cables will be determined in collaboration with the owners of the infrastructure to be crossed. A number of techniques can be utilised, including:

- Pre-lay and post lay concrete mattresses;
- Pre-lay and post lay rock dumping;
- Pre-lay steel structures; or
- Pre-constructed HDPE castings or other innovative approaches.

## Meteorological masts and metocean equipment

2.3.14 The installation of a number of meteorological monitoring stations (masts) will be undertaken within the Dogger Bank Zone to provide data on the meteorological conditions in the Zone. These consist primarily of a tall tower fitted with anemometers for measuring wind data, mounted on a foundation similar to that of a smaller wind turbine. These masts may also include a wide variety of other instrumentation both mounted on the mast and deployed around it. Meteorological masts are essential to provide meteorological and oceanographic (metocean) data. The metocean data are used for designing and optimising the wind farm design prior to installation and subsequently for monitoring wind farm performance.

2.3.15 Metocean monitoring equipment will also be installed separately to the five main meteorological masts. This includes technologies such as waverider buoys (floating buoys designed to measure wave data) and AWAC units (seabed mounted equipment designed to measure wave, current, and water level data).

## Offshore installation methods

2.3.16 The offshore construction and installation process could take place over a period of several years for Dogger Bank Teesside A & B (with overlapping construction activity between projects being likely). Each project could take between three and six years to construct, with a 6 month overlap, the construction duration would be 11.5 years. Although often limited to favourable weather conditions, some activities could take place throughout the year.

2.3.17 Foundations will be installed prior to the installation of the turbines. Methods of installation vary depending upon the foundation type selected and may therefore require a range of installation vessel types.

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2.3.18 Techniques typically employed include:

- Pile driving;
- Seabed levelling (for gravity bases and suction caissons);
- Drilling;
- Connections such as grouting, swaging or bolting; and
- Pile connection activities (for multipiles and tripods).

2.3.19 Wind turbines, transition pieces (if required), converter stations, and accommodation platforms are commonly installed onto their foundation structures using one or more crane lifts from offshore barges, crane ships, or jack-up vessels. Turbines for example, have been installed pre-assembled in a single crane lift, and also erected using a series of lifts to assemble multiple tower sections, the nacelle, and blades. These large construction vessels are often supported by support craft such as tugs, crew transfer vessels, and feeder barges and may be required either to stay on site, anchoring as required, or to transit to and from base ports.

2.3.20 Subsea cables are generally installed using specialist cable installation vessels. These vessels are equipped to transport the cables, and then to install them using a variety of methods. Offshore cabling is typically installed below the seabed utilising either ploughing or trenching / jetting techniques as appropriate to the location. A detailed cable burial assessment will be carried out to identify the most suitable burial depth in each area, including consideration of operating characteristics, sediment type and risk. In some cases additional protection, similar to that used for scour protection, may be required after the installation of a cable, for instance if ground conditions result in a cable being laid too close to the seabed surface.

## Excavated seabed sediment

2.3.21 Some excavated sediment may be produced during the installation of the foundations, either through drilling or suction dredging. Where seabed preparation is anticipated (i.e. for gravity base and suction caissons) base locations may be levelled by suction dredging (or similar) to an estimated depth of 0.75m below current seabed levels. Sediment excavated during seabed preparation would be ‘side-cast’ alongside the preparation area for the turbine bases. A specific Disposal Site Characterisation Document has been produced as part of the ES to support the designation of the site as a disposal area during the construction of the project (see **Appendix 12F** of the Dogger Bank Teesside A & B ES). Currently no off-site disposal is anticipated.

## Offshore operation and maintenance

2.3.22 Once operational, Dogger Bank Teesside A & B will require regular inspections, service and maintenance throughout its lifetime. This will require a full time dedicated team of technicians and associated support staff. There are a number of approaches to the operation and maintenance (O&M) of the wind farm and the final solution will be determined following consideration of health and safety issues, transit duration, port location and facilities, weather downtime, turbine selection and the cost-benefit analysis of each option. Given the

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distance of Dogger Bank Teesside A & B from shore, it is assumed that, in addition to an onshore base at a suitable port, one or more offshore operations hubs will also be required. The offshore hub could be either a fixed platform at the site (standalone, or associated with one of the substation platforms), or medium to large vessels which are able to travel between port and the project areas. Transport to the offshore areas could be by various means, including some combination of small, medium or large vessels, jack up vessels and helicopters.

2.3.23 It is expected that as part of the O&M of the wind farms, large vessels may be used continually to support offshore activities – as offshore operations hubs, or otherwise. Therefore, it may be necessary to have a number of pre-installed permanent moorings at intervals around the project areas to allow vessels to moor while work is ongoing.

2.3.24 It is estimated that around 10 of these moorings may be required, and that they will be likely to consist of a floating buoy with appropriate mooring systems (loops, pre-fixed cables, etc), secured via chains or cables to a system of anchors on the seabed.

2.3.25 Given the range of O&M options available to Forewind these will be dealt with when and where appropriate in the relevant sections of the Dogger Bank Teesside A & B ES.

## Offshore decommissioning and replanting issues

2.3.26 The design life of most offshore wind turbine structures is around 20-25 years, whereas The Crown Estate lease for the site would be expected to be for 50 years. Therefore, it is possible that Dogger Bank Teesside A & B would be repowered during the lease period. Repowering consists of replacing some or all components with new parts, to a partly or wholly new project design. If this were to take place, then the necessary consents and licenses would need to be applied for at that time.

2.3.27 At the end of the project life, it will need to be decommissioned. At the end of The Crown Estate lease period it is a condition of the lease, as well as a statutory requirement through the provisions of the Energy Act 2004. Under the statutory process, a Decommissioning Plan is required at the request of the Secretary of State.

2.3.28 For the purposes of environmental assessment, the process of decommissioning the wind farm would be likely to be the reverse of the construction process, with some exceptions. Piled foundations would likely be removed to just below seabed with due consideration made of likely changes in seabed level. Currently there is no statutory requirement for decommissioned cables to be removed. However, the necessity to remove cables will be reviewed at the time and theenvironmental impact of the removal versus the impacts of cables left in situ determined. It is expected that decommissioning will require similar vessels to construction and will take a similar period of time.

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## 2.4 Onshore components and activities

2.4.1 Dogger Bank Teesside A & B will connect to land via HVDC export cables. The following list identifies the key onshore components for each individual wind farm (i.e. Dogger Bank Teesside A and Dogger Bank Teesside B) that form Dogger Bank Teesside A & B:

- Cable (HVDC) connection to onshore converter station (approximately 6km in length);
- Onshore converter station (covering approximately 2ha, with additional 1ha for construction, and additional 2ha for mitigation (planting and landscaping); and
- Cable (HVAC) connection to National Grid substation (approximately 2km).

2.4.2 The onshore installation techniques would comprise the following activities:

- Creation of primary and intermediate construction compounds;
- Construction of onshore joint transition bay;
- Excavation of 1.5m wide by 1.5m deep cable pit and placement of cables (working corridor of up to 36m (HVDC) and 38m (HVAC)) or use of HDD to install cables across sensitive environmental or economic infrastructure; and
- Construction of onshore converter station, covering an area of up to 5ha including mitigation land (for each project).

### Landfall location

2.4.3 The selection process for the proposed landfall location for Dogger Bank Teesside A & B followed three phases which characterised the onshore and inshore area along the Redcar and Cleveland coast and then analysed potential technical feasibility against identified constraints before selecting a preferred landfall location.

2.4.4 The landfall selection process was informed by the onshore cable route selection process to identify any significant onshore constraints that might limit the area of coastline along which a landfall and inshore assessment was to be undertaken. In addition, the process involved the assessment of a number of nearshore route options for the export cable into the landfall area that took into account proximity of the routes to European sites.

2.4.5 Taking into account environmental constraints, engineering feasibility and risks, the selection process identified a landfall site between the coastal towns of Redcar and Marske-by-the-Sea.

### Onshore transition pit

2.4.6 The transition pit is typically located close to the shoreline, to allow each offshore export cable to be jointed to an onshore cable which is then connected to the onshore converter station (the onshore cable route). The transition pit size and design will be determined through detailed design, though the working area is likely to cover an area of up to 5,000m$^2$ for both Dogger Bank Teesside A and Dogger Bank Teesside B together. The pit will be located below ground

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level and will need to be accessible throughout the lifetime of the projects and, as such, the immediate area around it will likely have restricted use.

## Cable systems from onshore transition bay to onshore converter station

2.4.7 Given the distance offshore, the likely technical solution for the project's grid connection will be HVDC technology. This technology results in significantly lower power losses over long distances than HVAC technology. HVDC technology requires a converter station at the offshore wind farm end of the export cable to transform the power from AC to DC. A second converter station is required on land to transform the DC back to AC prior to connection into the NGET system. The number of converter stations will be determined following detailed studies, but there will be one converter station at the onshore end of the export cables for around 1GW of generation capacity.

2.4.8 The onshore portion of the HVDC transmission will require buried high voltage cables between each transition pit and onshore converter station. A feasibility and route selection study has been undertaken in order to identify the optimum route for the buried cable systems to the selected landfall location.

2.4.9 The chosen cable route is approximately 6km long for the HVDC cable system. There are two cable systems, each one comprising a pair of high voltage cables and one fibre optic cable for communication purposes. Each cable system would be buried in a single trench which is likely to be around 1.5m wide and approximately 1.5m deep. The working corridor during construction is proposped to be up to 36m wide for the HVDC cable system, including two trenches, temporary haul roads, and spoil heaps. There will be three primary works compounds for each cable system situated at appropriate locations along the cable route. The larger primary compounds will form the main construction compounds in which the site based construction team will be located.

2.4.10 The primary compounds will be positioned adjacent to public highways to allow for ease of access for material deliveries and site based personnel.

2.4.11 In addition there will be smaller intermediate compounds located every 2km - 3km along the cable route to provide localised office provision, welfare facilities and material storage for each cable system.

2.4.12 Cable jointing bays may be required approximately every 700m - 1km to join lengths of cable. Following construction, the ground above the cable joint bay will be reinstated; however occasional access for maintenance purposes may be required.

2.4.13 Ancillary underground ducting may be installed adjacent to, and at the same time as, the cable system (increasing the working corridor width to accommodate the additional works) if further grid connections are offered at the Teesside substation. The ducting would facilitate retrospective pull-through of cables at a later date and minimise future cable installation works and disruption. The depth of burial of ducts will be similar to that of the cable system but separation distances and overall working corridor would be determined by detailed engineering study and agreed through discussions with the landowners.

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## Cable systems from onshore converter stations to the National Grid (NGET) substation

2.4.14 Once the transmitted power has been converted back into HVAC (400kV as stipulated by National Grid) by the onshore converter station, the power will be transmitted by cable from the onshore converter station to the existing NGET substation at Teesside. The connection will be by buried cable. This cable system will be 2km long and up to 38m wide.

## Cable installation techniques

2.4.15 A range of cable installation techniques are available for use, including cable ploughing (lower shore area), open cut trenching, coffer dam and tunnelling techniques (such as directional drilling technology). The two main techniques are described in brief below. The techniques will be discussed with consultees following the detailed design and prior to construction, together with the results of studies and assessments on a case by case basis, to determine their appropriateness for use in specific circumstances along the proposed cable routes:

- Open-cut Trenching is the default installation methodology for underground cabling in relatively unconstrained areas. For more numerous and minor physical constraints such as tracks, roads and drains, open trenching cut by an excavator can be used along with additional measures to minimise impact; and
- Horizontal Directional Drilling (HDD) is a mature tunnelling technique used for underground cable installation across significant environmental or physical features such as sea defences, rivers, roads, railways, and other utilities. A typical installation of ducts by directional drilling comprises drilling pilot holes; reaming (to make the holes bigger) and pulling the ducts through the reamed holes.

## Onshore converter stations

2.4.16 Forewind has accepted a grid connection offer made by National Grid to connect up to 2GW of the Dogger Bank Teesside A & B into the existing Lackenby substation in Teesside.

2.4.17 The converter stations will convert the DC export power to 400kV AC prior to connection to the existing National Grid substation. Two co-located converter stations will be constructed which represent the main permanent, visible, aspect of the onshore works for Dogger Bank Teesside A & B. It is envisaged that they will be proximate to the existing Lackenby NGET substation in Teesside. The design and layout of the new converter stations will be developed in parallel with the overall project development process. The final locations will be confirmed through feasibility studies, carried out during the detailed design stage, that will take into consideration land availability, environmental and technical constraints; and landowner negotiations.

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2.4.18 Initial estimates suggest that a land footprint of approximately 200m x 150m could accommodate the two converter stations of approximately 1000MW capacity each. The exact footprint will be determined through detailed design studies. The overall volume is important so a reduction in height would result in an increase in ground area, and vice versa. Typically substation buildings / apparatus may be around 15m - 35m elevation depending on land available, and will be serviced by an access road of width up to 6m. Detailed design studies will be undertaken involving a number of major suppliers, and hence these parameters could be subject to change once further information is known. In addition, a similar land area would be necessary, on a temporary basis, for construction purposes.

## NGET Lackenby (Teesside) substation

2.4.19 The requirement for any NGET substation consents necessary to undertake works associated with Dogger Bank Teesside A & B is the responsibility of National Grid. The in-combination impacts have been considered where appropriate.

## Onshore construction phase

2.4.20 The onshore construction period is estimated to be up to 36 months duration. During construction there will be a requirement for temporary construction compounds, laydown areas, spoil heaps and access tracks. Following the completion of construction, these working areas will be reinstated to their previous condition, which in many cases is likely to be agricultural farmland.

## Onshore operation and maintenance

2.4.21 During the operational phase of the wind farm, the impacts arising from the onshore components are limited. Access will be required to the converter station throughout the lifetime of the project, for monitoring and maintenance purposes, and occasional access may be needed to the cable systems for repairs as necessary.

## Onshore replanting and decommissioning

2.4.22 There is currently no statutory requirement for decommissioned cables to be removed and it is likely that removal of the cables would bring about further environmental impacts. At, and near to the landfall, the cable will be removed in order to prevent exposure of cable that may result from erosion of the coastline. The remainder of the cables will be left in-situ, though this will be reviewed over the design life of the project. The onshore site will be restored in accordance with the Decommissioning Plan, which is also a requirement of the lease.

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## 2.5 Construction of the project

2.5.1 Within the DCO the following construction options need to be maintained for Dogger Bank Teesside A and Dogger Bank Teesside B in order to provide sufficient flexibility in the programme:

- The two projects may be constructed at the same time, or at different times;
- If built at different times, either project could be built first;
- Offshore construction will commence no sooner than 18 months post consent, but must start within seven years of consent (as an anticipated condition of the development consent order). Therefore if the construction period reaches the maximum six years, the projects will have to overlap by 6 months; and
- Taking the above into account, the maximum construction period over which the construction of Dogger Bank Teesside A & B could take place is 11.5 years.

2.5.2 The flexibility allowed for in the construction programme is taken into account in the assessment of impacts during the construction phase.

## 2.6 Realistic worst case scenarios

2.6.1 The assessment of effects presented in this document has been based on the realistic worst case scenarios for Dogger Bank Teesside A & B (both projects combined and individually) in relation to the construction, operation and decommissioning phases, as shown in **Table 2.2**.

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Table 2.2 Realistic worst case scenario for the assessment of impacts on European sites and their features

| Impact | Realistic worst case scenario | Rationale |
|---|---|---|
| **Construction phase** | | |
| Increase in suspended sediment concentrations due to installation of foundations and cables (modelling parameters) | The worst case installation process for effects on suspended sediment concentrations and sediment deposition that was modelled is 24 12m-diameter drilled monopole foundations, a set of inter-array cables connecting them and one export cable (within and outside the Dogger Bank Zone) installed together over a 30-day period. The worst case installation sequencing is:<br>• Foundations installed on a daily basis;<br>• After each daily installation of the first eight foundations, the drill arisings are dispersed by typical wave and tidal current conditions;<br>• After installation of the eighth foundation, a one-year storm event takes place and equilibrium scour is reached at each foundation releasing the full sediment load through scour;<br>• At day 25, no more foundations are installed;<br>• Each foundation is connected to an adjacent foundation by an inter-array cable after all 24 foundations have been installed; and<br>• Excavation of the export cable is assumed continuous over the 30-day period and takes place simultaneously with the installation of the 24 foundations.<br>The worst-case scenario assumes that all sediment with a particle size less than 0.18mm is suspended in a plume | An installation process was developed that is realistic, but that is also very conservative in terms of numbers of foundations and installation over a relatively short period. |
| | The worst case location for the 24 drilled monopole foundations is in the western corner of Dogger Bank Teesside B. | Sandeels are considered the most sensitive species to suspended sediment concentrations, and the highest densities (proxy data from Danish satellite vessel monitoring system) occur in the western corner of Dogger Bank Teesside B and outside and adjacent to its northern and western boundaries. |


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| Impact | Realistic worst case scenario | Rationale |
|---|---|---|
| Increase in suspended sediment concentrations due to installation of foundations and cables (modelling parameters) - *continued from above* | A worst case drill arisings volume of 6,220m$^3$ is applied for the installation of a 12m piled foundation, the widest diameter needed to support a 12m-diameter monopole to hold a 10MW wind turbine. | Forewind calculated this volume based on a pile diameter of 12m and an average drill penetration depth of 55m. |
| | The worst case scenario is for 12m-diameter drilled monopole foundations and assumes that all sediment with a particle size greater than 0.18mm falls to the seabed and does not enter the plume. | An installation process was developed that is realistic in terms of particle size distribution released into the water column. |
| | The export cable will produce 971,000m$^3$ of sediment over its 216km length or approximately 4,500m$^3$ per km or 1,344m$^3$ for every hour of trenching. | The export cable volume released is based on a cable that will be placed in a trench 1.5m wide with a maximum depth of 3m (in an approximate 'U' shape) over a length that can be excavated of 216km (the assumed cable length from landfall to wind farm). An excavation rate of 298.6m/hour was used (total time to complete excavation would be 30 days). |
| | The inter-array cables will release approximately 3,750m$^3$ of sediment per km length excavated. | The inter-array cable volume released is based on cables that are excavated up to 3m deep and 1.5m wide in an approximate 'U' shape. |


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| Impact | Realistic worst case scenario | Rationale |
|---|---|---|
| Increase in suspended sediment concentrations due to installation of foundations and cables (modelling parameters) – *continued from above* | The worst case equilibrium scour volume for 12m monopole foundations is estimated to range from 365m$^3$ to 756m$^3$ depending on applied wave climate and water depth. | The scour volumes for the monopole foundation were predicted using empirical methods from literature and existing knowledge using the following criteria (details can be found in Appendix E of Appendix 9A in **Chapter 9 Marine Physical Processes** of the Dogger Bank Teesside A & B ES):<br>• The equilibrium scour volumes for sand were derived in various water depths defined by the location of the foundations;<br>• They were calculated for the combined action of waves and tidal currents during a one-year storm event; and<br>• They conservatively assume maximum equilibrium scour depths because there is the potential for any one set of 24 foundations to be located where the sand thickness is greater than the equilibrium scour depth. |


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| Impact | Realistic worst case scenario | Rationale |
|---|---|---|
| Increased suspended sediment concentrations and sediment deposition (model results) | The predicted release of sediments into water column (and subsequent re-deposition) resulting from the activities and modelling parameters above, provided the following modelled outputs:<br>**Suspended sediment concentrations (bottom layer) - Tranche B**<br>• Maximum predicted suspended sediment concentration of greater than 200mg/l occurring within the confines of the 24 foundations and along the in-Zone cable route and between approximately 1km and 11km either side of the route;<br>• Maximum distance from the centre of the foundations to where background concentration of 2mg/l is reached is up to 40km to the south and north;<br>• Average suspended sediment concentration between 50mg/l and 100mg/l occurring within the confines of the 24 foundations and within a band approximately 9km either side of the in-Zone cable route;<br>• Average suspended sediment concentration reduces to 2mg/l approximately 18km (south) to 32km (north) from the in-Zone cable route; and<br>• 2mg/l (baseline) is exceeded >90% of the 30-day simulation period for 15km southwest of the centre of the foundations along the in-Zone cable route.<br>**Sediment deposition**<br>• Small patch within the confines of the foundation layout where the maximum deposition reaches 10mm-50mm;<br>• Predicted maximum deposition reduces to 0.5mm up to approximately 35km north of the in-Zone cable route;<br>• Average deposition of 1-5mm occurs within and 10km to the north of the foundations; and<br>• At the end of the 30-day simulation, the predicted thickness of sediment resting on the seabed is less than 0.1mm. | Increases in suspended sediment concentrations modelled based on the installation of 24 x 12m diameter monopole foundations installed via drilling, a set of inter-array cables and one export cable within a 30-day period. A conservative representation of the construction process was considered to be phasing of these elements over this time period.<br><br>The northern and western boundaries of Dogger Bank Teesside B are the closest to sensitive ecological habitats and were therefore selected as the location for the modelling of the 24 foundations. |


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| Impact | Realistic worst case scenario | Rationale |
|---|---|---|
| Physical disturbance to habitat and species and temporary habitat loss | The maximum footprint of temporary disturbance (Dogger Bank Teesside A & B and Dogger Bank Teesside A & B Export Cable Corridor) during construction is **21.77km$^2$** for Dogger Bank Teesside A and **20.79km$^2$** for Dogger Bank Teesside B. This footprint is based on the following aspects of construction that would result in seabed disturbance for each wind farm (noting any differentiation between either wind farm):<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 arising (0.657km$^2$);<br>• Seabed prepared area for 5 x meteorological masts (0.019km$^2$);<br>• Seabed prepared area for 4 x collector stations (0.032km$^2$);<br>• Seabed prepared area for 1 x converter station (0.016km$^2$);<br>• Seabed prepared area for 2 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 (0.093km$^2$);<br>• Installation of up to 320km 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 573km (Dogger Bank Teesside A) and 484km (Dogger Bank Teesside B) of export cables (with worst-case disturbance width (via jetting) of 10m (5.82km$^2$ for Dogger Bank Teesside A and 4.84km$^2$ for Dogger Bank Teesside B);<br>• Anchor footprint for installation of export cables (0.176km$^2$); and<br>• Construction buoys (0.0034km$^2$).<br>The area of disturbance based on the breakdown above that occurs within the Dogger Bank cSAC is **18.29km$^2$** for Dogger Bank Teesside A (15.81km$^2$ for the wind farm and 2.48km$^2$ for the export cable corridor), and **17.41km$^2$** for Dogger Bank Teesside B (15.81km$^2$ for the wind farm and 1.60km$^2$ for the export cable corridor). Total area of disturbance within the Dogger Bank cSAC for Dogger Bank Teesside A & B is **35.70km$^2$** (31.62km$^2$ for the wind farm and 4.08km$^2$ for the export cable corridor). | The worst case scenario for temporary physical disturbance to benthic habitats during the construction phase was established by defining the maximum amount (spatial extent) of habitat disturbance produced by the various elements of construction (as detailed left).<br><br>Assumes export cable installation via anchor spread barge only required from KP0 (landfall) to KP80 (80km offshore).<br><br>The permanent loss of habitat due to the presence of foundations and cable/scour protection is discussed in the operation phase section. |


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| Impact | Realistic worst case scenario | Rationale |
|---|---|---|
| Risk of collision resulting in physical damage and loss to marine mammal populations<br>Physical disturbance due to underwater noise from vessel noise<br>Disturbance to birds due to vessel movements. | Large and medium crane vessels, floating and dynamic positioning and jack up type, logistics, transportation and feeder vessels, tugs and anchor handling vessels, hotel and accommodation vessels, personnel transfer craft, dredging, seabed preparation and aggregate handling craft, diving support vessels, guard ships, general offshore and subsea construction vessels, cable installation and maintenance vessels, survey vessels.<br>Indicative number of vessels movements: 5,150 round trips to port, averaging 1,717 each year of a three year construction phase, or 859 each year for a six year construction phase for each wind farm (Dogger Bank Teesside A and Dogger Bank Teesside B).<br>Indicative number of materials transport (to construction site) vessel movements: 660 (for the full construction period) for each wind farm (Dogger Bank Teesside A or Dogger Bank Teesside B).<br>Maximum of 66 vessels on site at any one time during construction for each wind farm (Dogger Bank Teesside A or Dogger Bank Teesside B).<br>**Cumulative**: 396 vessels for six concurrent wind farms (Dogger Bank Teesside A and Dogger Bank Teesside B, and Dogger Bank Creyke Beck A and Dogger Bank Creyke Beck B, and Dogger Bank Teesside C and Dogger Bank Teesside D). | The worst case reflects the estimated maximum number of vessels that will be offshore during this phase. |
| Physical disturbance due to presence of construction vessels (export cable corridor wind farm) | Dogger Bank Teesside A - length of export cable is 261km.<br>Dogger Bank Teesside B – length of export cable is 220km.<br>Maximum of 6 vessels each year.<br>Dogger Bank Teesside A - duration of export cable corridor works is 696 days.<br>Dogger Bank Teesside B - duration of export cable corridor works is 595 days.<br>Rate of progress is 100m/hour over 60% of total duration.<br>4 campaigns with 30 days between each campaign. | The worst case scenario for construction represents the greatest number of vessels present at one time and the duration of construction. |
| Physical, visual and noise disturbance during construction of the export cable landfall | **For each wind farm (Dogger Bank Teesside A and Dogger Bank Teesside B):**<br>Maximum width of beach open trenching to bury cables: 10m.<br>Cofferdam size = 2 x 10m wide x 10m long x 3m deep.<br>Distance from shore to transition pit = 1km.<br>Construction area – one wind farm = 2,500m$^2$.<br>8 week construction duration for intertidal and shallow sub-tidal works.<br>**Cumulative (Dogger Bank Teesside A and Dogger Bank Teesside B)**:<br>Maximum width of beach open trenching to bury cables: 20m.<br>Construction area – both wind farms (Dogger Bank Teesside A & B) = 5,000m$^2$.<br>14 week construction duration for intertidal and shallow sub-tidal works. | The worst case scenario for construction represents the largest extent of potential disturbance. |


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<table>
<tr><th>Impact</th><th>Realistic worst case scenario</th><th>Rationale</th></tr>
<tr><td>Physical disturbance due to underwater noise from pile driving (per pile – single impact)</td><td>Maximum pile size<br>Method 100% pile driving – monopoles:<br>• Maximum number of piles: 120 x 10+MW turbines;<br>• Pile diameter: 12m;<br>• Maximum penetration:55m;<br>• Hammer capacity:3000kJ;<br>• Maximum blow force: 3000kJ;<br>• Soft-start duration: 0.5h;<br>• Soft-start hammer energy: 300kJ;<br>• Total pile driving duration: 5 hours 30 minutes (full force time per pile is five hours, with soft-start duration of 30 minutes).</td><td>The worst case scenario for a single hammer blow represents the largest impact footprint and potential for injury to marine mammals.<br>Five hours is considered the worst case for the amount of time required to pile one foundation (plus 30 minutes soft-start).</td></tr>
<tr><td>Physical disturbance due to underwater noise from pile driving for each wind farm</td><td>Maximum number of piles for each wind farm (Dogger Bank Teesside A and Dogger Bank Teesside B):<br>(Method assuming 100% pile driving multileg piles (6MW)):
<table>
<tr><th>Element</th><th>Number</th><th>Number piles per device</th><th>Total number piles</th><th>pile diam. (m)</th><th>Pene-tration (m)</th><th>Max blow force (kJ)</th><th>time per pile excl. soft-start (hrs)</th><th>Soft-start blow force (kJ)</th></tr>
<tr><td>WTG (6MW)</td><td>200</td><td>6</td><td>1200</td><td>3.5</td><td>55</td><td>2300</td><td>3</td><td>230</td></tr>
<tr><td>met mast</td><td>5</td><td>4</td><td>20</td><td>3.5</td><td>52</td><td>1900</td><td>3</td><td>190</td></tr>
<tr><td>OCP</td><td>4</td><td>24</td><td>96</td><td>2.75</td><td>60</td><td>1900</td><td>3</td><td>190</td></tr>
<tr><td>OSP</td><td>1</td><td>24</td><td>24</td><td>2.75</td><td>70</td><td>1900</td><td>3</td><td>190</td></tr>
<tr><td>Accom. platform</td><td>2</td><td>24</td><td>48</td><td>2.75</td><td>70</td><td>1900</td><td>3</td><td>190</td></tr>
</table>
Total pile driving duration (active piling time for each wind farm): 4,164 hours (with 694 hours of soft-start piling) for each wind farm (Dogger Bank Teesside A or Dogger Bank Teesside B).<br>Maximum construction period six years, minimum three years for each wind farm (Dogger Bank Teesside A or Dogger Bank Teesside B).<br>Maximum of 600 piling operations per year for wind turbines plus 188 for other structures for each wind farm (Dogger Bank Teesside A or Dogger Bank Teesside B).<br>Maximum of two simultaneous piling operations for each wind farm (Dogger Bank Teesside A or Dogger Bank Teesside B).<br>Both concurrent and sequential phasing are included in the worst case scenario.<br>Cumulative – a maximum of six wind farms in simultaneous construction (with two piling operations per wind farm), a total of 12 piling rigs.</td><td>The worst case scenario for construction of the offshore wind farm represents the longest temporal duration of impact, which equates to the maximum number of pile driving events.<br>Five hours is considered the worst case for the amount of time required to pile one foundation (plus 30 minutes soft-start). However, this is only expected to be required for a very small number of foundations, if at all and hence a conservative worst case average is applied of three hours per pile across a whole wind farm.</td></tr>
</table>


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| Impact | Realistic worst case scenario | Rationale |
|---|---|---|
| **Operation phase** | | |
| Change in waves and tidal currents (hydrodynamics) and inter-related effects on benthos (modelling parameters) | Conical gravity base is the worst case foundation for effects on tidal currents. | This was quantified using a tidal current model which predicts the reduction in tidal flow around each foundation. The characteristics of the worst case conical gravity base foundation were selected from a range of six alternative conical gravity base designs which were interrogated using the tidal current model. |
| | Conical gravity base is the worst case foundation for effects on waves. | This was quantified using the WAMIT model which calculates reflection factors for different wave periods which are then integrated with the average wave spectrum to predict the overall wave reflection ('blockage') induced by each foundation. The characteristics of the worst case conical gravity base foundation were selected from a range of six alternative conical gravity base designs which were interrogated using the WAMIT model. |


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| Impact | Realistic worst case scenario | Rationale |
|---|---|---|
| Change in waves and tidal currents (hydrodynamics) and inter-related effects on benthos (modelling parameters) – *continued from above* | Maximum change in tidal currents and waves during the operation phase produced by installation scenario of 400 x 6MW GBS#1 foundations across Dogger Bank Teesside A & B (200 x 6MW each wind farm), spaced 750m apart around the perimeter with wider internal spacing.<br>**Cumulative (Dogger Bank Teesside A & B, and Dogger Bank Creyke Beck A & B, and Dogger Bank Teesside C & D)**: six wind farms at 200 x 6MW GBS#1 foundations at 750m spacing for each wind farm. | The worst case scenario layout is considered to be a grid of foundations that fills each wind farm, with the minimum spacing around the perimeter, providing the maximum potential for interaction of tidal current and wave processes between foundations in areas of sensitive habitat. Two scenarios were tested to reach this conclusion:<br>• grid of 6MW foundations across Teesside A & B; and<br>• grid of 10MW foundations across Teesside A & B. |
| Change in waves and tidal currents (hydrodynamics) and inter-related effects on benthos (model results) | Maximum change in current velocity is less than 2% along narrow (up to 3km wide) bands restricted to the Dogger Bank Teesside A and Dogger Bank Teesside B boundaries. | For the purpose of predicting effects on waves and tidal currents, the worst case scenario is considered to be a perimeter of foundations at their minimum spacing with a wider spaced grid of foundations across the bulk of each wind farm (Dogger Bank Teesside A and Dogger Bank Teesside B). |


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| Impact | Realistic worst case scenario | Rationale |
|---|---|---|
| Increase in suspended sediment concentrations due to scour associated with foundations (modelling parameters) | An array of 200 6MW conical gravity base foundations across each wind farm (400 x 6MW for Dogger Bank Teesside A & B combined) is the worst case operational foundation layout for effects on sediment transport.<br>The worst case layout comprises a perimeter of foundations at their minimum spacing (750m) with a wider spaced grid of foundations across the bulk of each wind farm (Dogger Bank Teesside A or Dogger Bank Teesside B).<br>The foundations would be installed over a (minimum) two year construction period for each wind farm (Dogger Bank Teesside A or Dogger Bank Teesside B).<br>After one year of installation, a one-year storm takes place and equilibrium scour is reached at 200 foundations (half of the total number of foundations to be installed). The storm releases the full sediment load through scour.<br>At the end of year two, after all 400 foundations have been installed, both wind farms are subject to a 50-year storm and the storm releases the full sediment load through scour. | The worst case scenario layout is considered to be a grid of foundations that fills each wind farm providing the maximum potential for creation of high concentration suspended sediment plumes:<br>• A 'perimeter plus grid' layout is considered to be a realistic potential wind farm layout;<br>• A closer spaced perimeter would increase the intensity of the sediment dispersion close to the most sensitive habitat, relative to an equally spaced grid throughout each wind farm; and<br>• The perimeter encompasses the full area available to each wind farm and the central grid fills this perimeter, ensuring the sediment dispersion is maximised over the widest possible area. |


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| Impact | Realistic worst case scenario | Rationale |
|---|---|---|
| Increase in suspended sediment concentrations due to scour associated with foundations (modelling parameters) - *continued from above* | The worst case operational scour volumes for the conical gravity base foundations are:<br>• 0 - 21m$^3$ for typical conditions;<br>• 0 - 709m$^3$ for a one-year storm; and<br>• 0 - 2,843m$^3$ for a 50-year storm<br>The worst case operational scour plan areas (including the base plate area itself) for the conical gravity base foundations are:<br>• 1,964m$^3$ - 2,073m$^2$ for typical conditions;<br>• 1,964m$^3$ - 2,625m$^2$ for a one-year storm; and<br>• 1,964m$^3$ - 3,350m$^2$ for a 50-year storm<br>The worst case operational scour depths for the conical gravity base foundations are:<br>• 0 - 0.39m for typical conditions;<br>• 0 - 2.2m for a one-year storm; and<br>• 0 - 4.3m for a 50-year storm. | The worst case scour volumes, plan areas and depths were estimated using a combination of empirical methods in three stages:<br>• Stage 1: predict scour volumes, areas and depths using various empirical formulae devised for granular sand under waves and tidal currents;<br>• Stage 2: take account of the strength of the sub-seabed Holocene sediments and their ability to resist scour; and<br>• Stage 3: take account of the scour-resistant clay layer that directly underlies the sand at various depths across Dogger Bank Teesside A & B. |


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| Impact | Realistic worst case scenario | Rationale |
|---|---|---|
| Increase in suspended sediment concentrations due to scour associated with foundations (modelled results - continued from above) | Release of sediments into water column and subsequent increase in suspended sediment concentrations resulting from the activities and modelling parameters above, resulted in the following modelled outputs:<br>**After Two-Years Operation (50yr storm scenario):**<br>• Maximum suspended sediment concentrations predicted by the model at any time over the 30-day simulation period of >200mg/l. These concentrations occur as 20km long, 6km wide patches along the north and south perimeters of Dogger Bank Teesside A and also the southwest perimeter of Dogger Bank Teesside B.<br>• Maximum suspended sediment concentrations are >20mg/l across all of Dogger Bank Teesside A & B, gradually reducing with distance from the foundations until they are 2mg/l approximately 40km - 54km south of the Dogger Bank Teesside A & B boundaries and 20km - 37km north of the Dogger Bank Teesside A & B boundaries.<br>• The average suspended sediment concentrations in the bottom layer are between 10mg/l and 50mg/l across both wind farms (Dogger Bank Teesside A and Dogger Bank Teesside B). These concentrations extend up to approximately 19km to the south of the Dogger Bank Teesside A & B boundaries. Average suspended sediment concentrations reduce to 2mg/l up to approximately 36km south of the Dogger Bank Teesside A & B southern boundaries and up to 26km north of the Dogger Bank Teesside A northern boundary.<br>• 2mg/l is exceeded > 90% of the 30-day simulation period in two patches, one to the south of Dogger Bank Teesside B and one within and to the south of Dogger Bank Teesside B, up to 15km south of their southern boundaries. Exceedance is generally greater 70% across both Dogger Bank Teesside A & B. | Maximum and average changes in suspended sediment concentrations in the bottom layer and sediment thickness deposited from the plume based on 30-day model run after two years (all the 400 x foundations are struck by a 50-year storm). |
| | Release of sediments into water column and their subsequent re-deposition resulting from the activities and modelling parameters above, resulted in the following modelled outputs:<br>**After Two-Years Operation (50yr storm scenario):**<br>• Predicted maximum thickness over the simulation period is 5mm with the majority of Dogger Bank Teesside A & B subject to maximum deposition between 0.5mm and 5mm.<br>• Thicknesses reduce to below 0.1mm approximately 16km - 30km from the southern boundaries of Dogger Bank Teesside A & B and 13km - 35km from the northern boundaries.<br>• Average deposition is predicted to be between 0.5mm and 5mm in a 32km long, 14km wide area located between the two wind farms (Dogger Bank Teesside A and Dogger Bank Teesside B).<br>• Elsewhere the maximum average deposition is less than 0.5mm reducing to less than 0.1mm approximately 23km south-west of Dogger Bank Teesside B and 19km north of Dogger Bank Teesside A.<br>• Maximum sediment thickness is 1.7mm at R5. | Maximum and average changes in suspended sediment concentrations in the bottom layer and sediment thickness deposited from the plume based on 30-day model run after two years (all the 400 x foundations are struck by a 50-year storm). |


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| Impact | Realistic worst case scenario | Rationale |
|---|---|---|
| Temporary impact on benthos due to physical disturbance caused by maintenance activities | Maximum footprint of temporary habitat disturbance due to jacking-up activities required during the operation phase for each wind farm = 0.904km$^2$, 1.808km$^2$ for Dogger Bank Teesside A & B. | Direct impact on benthos due to physical disturbance caused by maintenance activities. |
| Introduction of new habitat from colonisation of the foundation structures | The introduction of new hard structures with a maximum surface area provided by the following infrastructure for each wind farm (Dogger Bank Teesside A or Dogger Bank Teesside B):<br>• 200 x GBS #1 foundations;<br>• GBS foundations for 5 x meteorological masts;<br>• GBS foundations for 4 x collector stations;<br>• GBS foundation for 1 x converter station;<br>• GBS foundation for 2 x offshore accommodation platforms;<br>• Footprint of vessel moorings and buoy chains;<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. | The exact surface area (km$^2$) available for colonisation cannot be calculated but it will be greater than the figure presented for “footprint” of impact as the former is a 3-D metric, whilst the latter is 2-D. |


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| Impact | Realistic worst case scenario | Rationale |
|---|---|---|
| Permanent loss of habitat via placement of infrastructure (foundations, cable protection, scour protection, vessel moorings etc.) | Maximum footprint of permanent habitat loss assessed as **5.999km$^2$** for Dogger Bank Teesside A and **5.719km$^2$** for Dogger Bank Teesside B, based on the following:<br>• 200 x gravity base structures (GBS) #1[1] foundations (1.005km$^2$);<br>• GBS foundations for 5 x meteorological masts (0.023km$^2$);<br>• GBS foundations for 4 x collector stations (0.036km$^2$);<br>• GBS foundation for 1 x converter station (0.017km$^2$);<br>• GBS foundation for 2 x accommodation blocks (0.035km$^2$);<br>• Footprint of vessel moorings and buoy chains (0.047km$^2$);<br>• Inter-array cable protection (incl. cable ends) (1.00km$^2$);<br>• Inter-platform cable protection (1.000km$^2$);<br>• Inter-platform cable crossings (0.147km$^2$);<br>• Export cable protection - 2.57km$^2$ (Dogger Bank Teesside A) and 2.31km$^2$ (Dogger Bank Teesside B); and<br>• Export cable crossings (0.098km$^2$).<br><br>The area above that occurs within the Dogger Bank cSAC is **4.88km$^2$** for Dogger Bank Teesside A (3.73km$^2$ for structure footprint and 1.15km$^2$ for cable protection and crossings), and **4.52km$^2$** for Dogger Bank Teesside B (3.73km$^2$ for structure footprint and 0.79km$^2$ for cable protection and crossings). Total area within the Dogger Bank cSAC for Dogger Bank Teesside A & B is **9.40km$^2$** (7.46km$^2$ for structure footprint and 1.94km$^2$ for cable protection and crossings). | The scenario described gives rise to the greatest area of permanent seabed habitat loss.<br><br>Any other development scenario or installation technique considered would result in no greater or less habitat loss. |
| Risk of collision resulting in physical damage and loss to marine mammals populations<br>Physical disturbance due to underwater noise from vessel noise<br>Disturbance to birds due to vessel movements. | Indicative number of vessels movements for each wind farm (Dogger Bank Teesside A or Dogger Bank Teesside B) per year for 6MW wind turbines: 730 round trips to port each year (including 3 large Operation and Maintenance (O&M) vessels (40 movements); 11 small O&M vessels (430 movements), 2 lift vessels (40 movements), 2 cable maintenance vessels (10 movements), 8 auxiliary vessels (210 movements)).<br>Maximum of 26 vessels on site at any one time each wind farm (Dogger Bank Teesside A or Dogger Bank Teesside B) during the operation phase.<br>**Cumulative (Dogger Bank Teesside A and Dogger Bank Teesside B)**: 1,460 round trips per year, with a maximum of 52 vessels on site at any one time. | The worst case reflects the maximum number of vessels on site, and the number of round trips to port. |


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| Impact | Realistic worst case scenario | Rationale |
|---|---|---|
| Collision risk – wind turbines | **For each wind farm (Dogger Bank Teesside A and Dogger Bank Teesside B):**<br>200 x 6MW wind turbines.<br>Tip height = 26m to 267m above HAT.<br>Rotor diameter = 167m<br>Rotor speed = 8.84rpm.<br>Turbine operation time = average of 94.5% of the year.<br>Maximum blade width = 5.5m.<br>Pitch = 10 degrees. | The worst case scenario is based on modelled collision risk for a range of seabird species. |
| Physical disturbance due to underwater noise from wind turbines operation | A maximum of 200 operating 6MW wind turbines for each wind farm (Dogger Bank Teesside A or Dogger Bank Teesside B).<br>**Cumulative (Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D)**: 1,200 operating 6MW turbines. | The worst case is the maximum number of turbines. |
| Indirect physical disturbance due to presence of physical barriers (marine mammals) | Approximately 196km from Dogger Bank Teesside A to coast.<br>Approximately 165km from Dogger Bank Teesside B to coast.<br>Minimum turbine spacing 750m (6MW) for each wind farm (Dogger Bank Teesside A and Dogger Bank Teesside B). | The minimum turbine spacing and distance to shore of the array represents the worst case, which could present a physical barrier to movement. |
| Indirect physical disturbance due to presence of physical barriers (ornithology) | Shortest east-west migratory route for Dogger Bank Teesside A is 575km.<br>Shortest east-west migratory route for Dogger Bank Teesside B is 575km.<br>Minimum turbine spacing 750m (6MW) for each wind farm (Dogger Bank Teesside A and Dogger Bank Teesside B). | The shortest migratory route represents the worst case as a physical barrier to migratory birds as the additional distance travelled (10km diversion for Dogger Bank Teesside A, 20km for Dogger Bank Teesside B, and 25km for Dogger Bank Teesside A & B) represent the greatest percentage increase in distance travelled across the migratory route. |


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| Impact | Realistic worst case scenario | Rationale |
|---|---|---|
| Presence of electro-magnetic-fields (EMF) | 950km of 33kV to 72.5kV inter-array HVAC cable (if buried, target burial 0.7m where feasible) for each wind farm (Dogger Bank Teesside A and Dogger Bank Teesside B).<br>320km of 132kV to 400kV inter platform HVAC cable (if buried, target burial 0.7m where feasible) for each wind farm (Dogger Bank Teesside A and Dogger Bank Teesside B).<br>573km (Dogger Bank Teesside A) or 378km (Dogger Bank Teesside B) of High Voltage Direct Current (HVDC) export cables (up to 550kV). Cables will be buried or use industry standard shielding.<br>Length of unburied cable is 170.2km (Dogger Bank Teesside A) and 151.3km (Dogger Bank Teesside B). | The worst case is the maximum cable lengths, and minimum burial depths. |
| **Decommissioning phase** | | |
| Increased suspended sediment concentrations and sediment deposition | Removal of foundations, export and inter-array cables and cable protection. As per details (above) for increased suspended sediment concentrations and sediment deposition during construction (although predicted to be much less in reality – see comment under rationale). | Any effects produced during decommissioning will be less than those described during the construction phase due to absence of seabed preparation or pile drilling, which are the main sources of increased suspended sediment concentrations during the construction phase. |
| Loss of species colonising hard structures | As per details (above) for loss of permanent habitat during the operation phase. | Assumed that all infrastructure above seabed level will be removed during decommissioning. |
| Temporary disturbance to habitats via removal of cables | • Removal of up to 950km of inter array-cables for each wind farm (Dogger Bank Teesside A or Dogger Bank Teesside B).<br>• Removal of up to 320km of inter-platform cables for each wind farm (Dogger Bank Teesside A or Dogger Bank Teesside B).<br>• Removal of up to 573km (Dogger Bank Teesside A) and 484km (Dogger Bank Teesside B) of export cables. | Assumed that all cables will be removed during decommissioning. |


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| Impact | Realistic worst case scenario | Rationale |
|---|---|---|
| Risk of collision resulting in physical damage and loss to marine mammals populations | Level of vessel activity may be similar to construction.<br>Indicative number of vessel movements for 6MW wind turbines: 5,150 (for the full decommissioning period) for each wind farm (Dogger Bank Teesside A or Dogger Bank Teesside B).<br>Indicative number of materials transport vessel movements: 660 (during three year decommissioning period) for each wind farm (Dogger Bank Teesside A or Dogger Bank Teesside B).<br>Decommissioning could extend for up to six years. | The worst case considers the same maximum number of vessels as construction. |
| Physical disturbance due to underwater noise from vessel noise | | |
| Physical disturbance due to underwater noise from cutting of piles | Cutting of foundations below sea level and removal of debris. | The worst case is the nosiest approach to removal or turbines and debris. |

[1] All footprints for foundations inclusive of scour protection.


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# 3 Findings of the Screening Stage

## 3.1 Introduction

3.1.1 As set out above, an HRA Screening Report for Dogger Bank Teesside A & B (see **Appendix A** of the **HRA Report**) was prepared and circulated for consultation in August 2013. The HRA Screening Report set out the steps taken to determine the possible designated SPAs, SACs, SCIs, and Ramsar sites that could be affected by the proposed wind farm development. Subsequently, the draft HRA Report submitted as part of the PEI3 statutory consultation further expanded on the screening stage, and the findings within this section build on the findings of the draft HRA Report and consultation comments received.

3.1.2 As set out in the introductory chapters to the Dogger Bank Teesside A & B ES, Dogger Bank Teesside A & B represents the second phase of development proposed within the Dogger Bank Zone. A target installed capacity of 7.2GW has been identified as achievable for the Zone, of which Dogger Bank Teesside A & B would represent 2.4GW. At an early stage in the project development process it was recognised that sequential wind farm development of the Dogger Bank Zone would lead to potential cumulative impacts on a range of receptors, including habitats and species of designated European sites. Therefore, in order to facilitate the HRA process, screening was undertaken at both the Zone level (i.e. the entirety of the Dogger Bank Zone Round 3 development) and for Dogger Bank Teesside A & B alone. Consideration of potential effects on European sites at the zone level provides for the potential 'cumulative' view of the development of a number of projects within the Zone. The HRA Screening Report concluded whether development, either at the Zone level or within Dogger Bank Teesside A & B would have a likely significant effect (LSE) with respect to each of the European sites screened into the HRA process.

3.1.3 It should also be noted that the HRA Screening Report (see **Appendix A** of the **HRA Report**) identified that the project was not directly connected with or necessary to the management of the European sites for which a LSE was identified and screened into the appropriate assessment phase.

3.1.4 Given the large spatial scale and nature of the wind energy development proposals for the Dogger Bank Zone and the large number of European sites that potentially could be affected, an initial screening stage was undertaken. This stage essentially represented a site-identification / selection process, which, while it formed part of the overall LSE determination stage, was separated out to ensure a focussed and detailed consideration of LSE across the possible sites and features that could be influenced by wind farm development within the Dogger Bank Zone and Dogger Bank Teesside A & B.

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3.1.5 The site identification process was based on an examination of the capacity of the likely effects of development within the Dogger Bank Zone and Dogger Bank Teesside A & B to influence physical, chemical and biological processes that may affect the ecological features for which the European sites encompassed in the search area are designated (i.e. SAC / SCIs, SPAs, and Ramsar Sites). This pre-screening / site selection was based on:

- A wide North Sea search area, which reflected the potential for designated sites supporting mobile designated populations (e.g. migratory birds) to interact with the potential effects of wind farm development in the central North Sea;
- The identification of impact pathways linked to the potential effects of the construction, operation and decommissioning of wind farm proposals within the Dogger Bank Zone. This stage in the pre-screening exercise took into account potential environmental sensitivities linked to the likely effects of development;
- Preliminary assessment of the sites that could be affected based upon location and the types of identified effects – exclusion of sites / features for which no impact pathway would be likely to arise and / or for which the impact of potential effects were considered to be insignificant; and
- Further assessment of sites in respect of the potential for interest features that could be affected.

3.1.6 For those sites and designated features identified as having the potential to be affected by wind farm development (at the Zone and Dogger Bank Teesside A & B level) further screening to determine LSE was then undertaken.

3.1.7 Specific information on the areas of Dogger Bank Teesside A & B was limited at the time of production of the HRA Screening Report and therefore, to allow for this, a precautionary approach to the determination of LSE was taken. Where sufficient information or evidence from other relevant studies was available to enable determination of no, or, likely significant effect this was presented in respect of relevant European designated interest features considered in the assessment process.

3.1.8 It was stated in the HRA Screening Report (see **Appendix A** of the **HRA Report**) that as the assessment work for Dogger Bank Teesside A & B progressed, initial conclusions on LSE may be refined and any changes to the sites and features to which LSE may apply would be reported in the information for appropriate assessment report. This approach has been adopted, but with modification in order to facilitate a clear assessment process. That is, the additional environmental information produced subsequent to screening has enabled the screening decisions previously reached to be refined. However, in undertaking the assessment work to determine LSE (or not) essentially the same data analysis is required as for the appropriate assessment stage of the HRA (i.e. determination of adverse effect on integrity). Further consideration of LSE has, therefore, effectively been subsumed into the overall assessment of effects and impacts presented in the report sections herein.

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3.1.9 For those designated sites and features where it was apparent during screening that information was insufficient to enable a firm decision on LSE to be made, a sequential determination is presented in this report. If, on assessment of the relevant information, it is apparent that the effects of Dogger Bank Teesside A & B would not constitute LSE with respect to designated features / sites then this is stated and no further assessment undertaken. If, on the other hand, the assessment indicates that LSE would arise and / or there is still uncertainty regarding the evidence base, then the assessment process required to determine whether an adverse effect on site integrity could arise is followed and a conclusion in respect of this provided.

3.1.10 In respect of the above, points of clarification or requests for further information raised in consultation responses to the LSE decisions set out in the HRA Screening Report are either dealt with in the appropriate assessment sections of this report (Sections 4 to 6) or in Section 3.2 below, which provides a summary of the outcomes of the screening process.

## 3.2 Summary of the findings of the Screening Stage

3.2.1 This section provides a summary of the screening results, incorporating the findings from the initial screening exercise and responses received during consultation on the HRA Screening Report and on the draft HRA Report submitted as part of the PEI3 statutory consultation (see **Appendix C** of the **HRA Report** for tabulated comments received on the HRA Screening Report and the draft HRA Report). A description of the findings is set out in subsequent paragraphs under broad habitats / species groups for which designated features and sites have been classified.

3.2.2 The full list of European sites (and features) that were identified at the pre-screening stage and which were then assessed to determine whether a LSE could arise is provided in Table 6.1 (UK sites) and Table 6.2 (transboundary sites) in the HRA Screening Report (see **Appendix A** of the **HRA Report**). The information included in Tables 6.1 and 6.2 of the HRA Screening Report provides a summary of the reasoning, at the time of the production of the HRA Screening Report, behind the determination of LSE for individual features and sites, including those sites and features for which no LSE was determined. Given the comments received (see **Appendix C** of the **HRA Report**) during consultation on the HRA Screening Report and draft HRA Report (see Section 3.4) and additional environmental assessment work and data produced subsequent to the initial screening exercise, re-assessment of LSE was undertaken with respect to those European sites initially screened into the process and additional sites identified via consultation and further assessment work. The complete list of European sites and their designated features for which screening of LSE has been undertaken and the final conclusions are presented in **Appendix D** of the **HRA Report**.

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3.2.3 **Figure 3.1** shows the locations of the European sites for which LSE has been determined in respect of Annex I habitats; **Figure 3.2** (see **Table 3.1** for reference list) shows the locations of the European sites for which LSE has been determined in respect of their Annex II grey seal populations, and **Figure 3.3** (see **Table 3.2** for reference list) shows the locations of the European sites for which LSE has been determined in respect of their Annex II harbour porpoise populations. **Figure 3.2** and **Figure 3.3** show the 'study area' which was used to identify possible sites for which grey seal and harbour porpoise are relevant features for consideration in the screening exercise.

3.2.4 A summary of the potential impact pathways through which features and sites could be affected is also provided in **Table 3.3** and further detailed in Section 3.3, where summary information on the screening (in respect of LSE) of potential effects of wind farm development within the Dogger Bank Zone is provided.

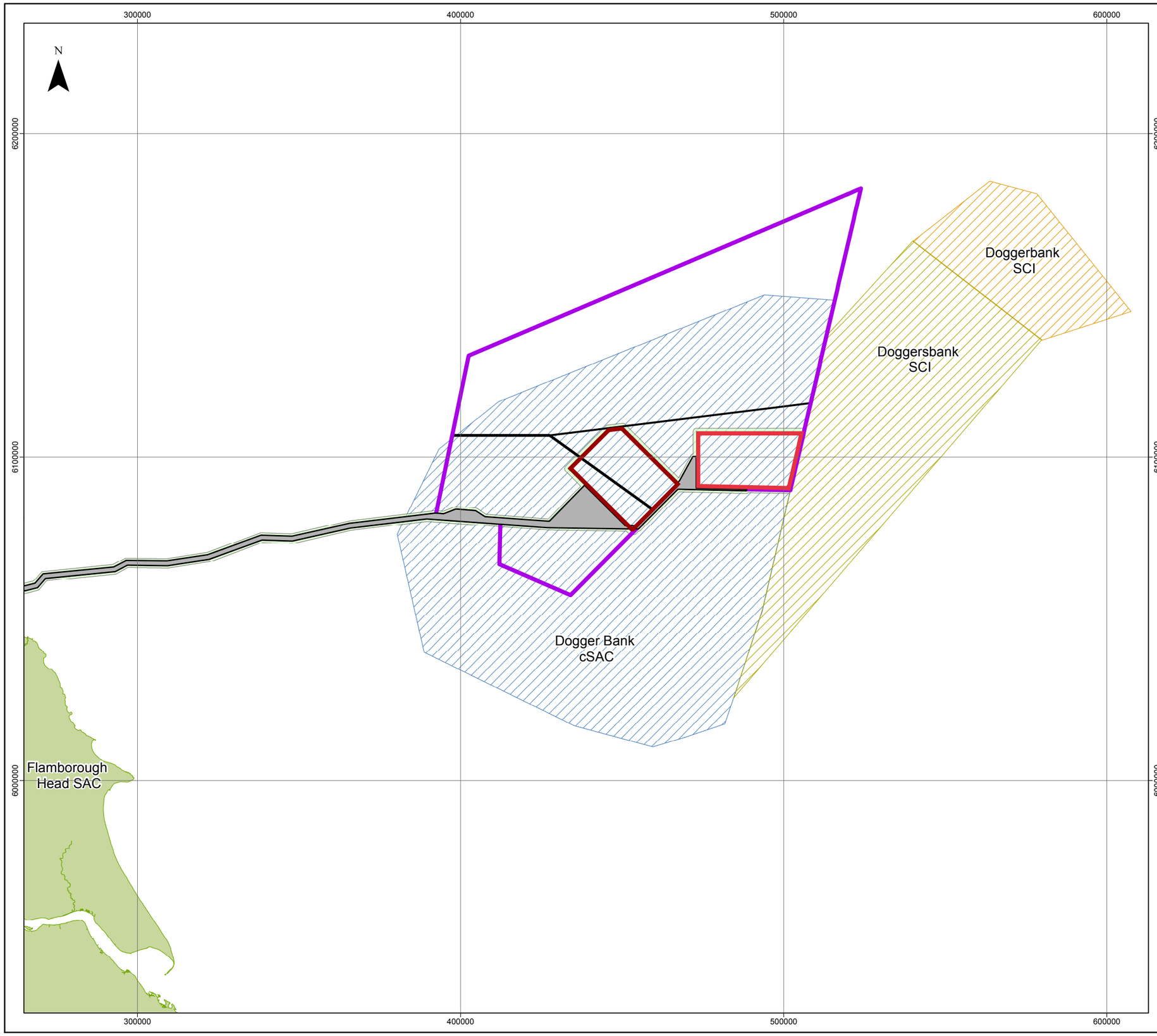
## Terrestrial designated sites / species populations

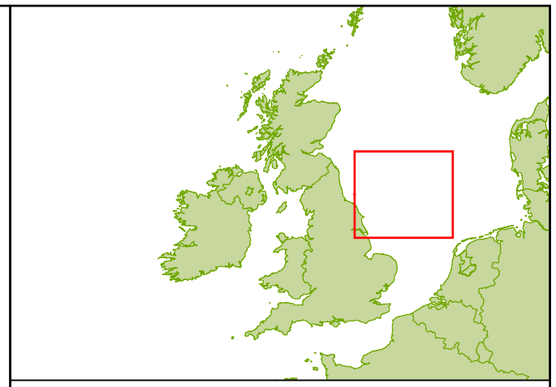
3.2.5 As set out in the HRA Screening Report, there are no terrestrial SACs or SPAs / Ramsar sites that would be directly affected by the proposed works within the export cable route from the landfall location or at the proposed substation location (see Figure 5.1 in **Appendix A** of the **HRA Report**).

3.2.6 The nearest designated terrestrial site is the North York Moors SAC and SPA, which is located 7km to the south of the landward cable corridor and onshore converter station. There are no identified impact pathways through which habitats of the North York Moors SAC or the designated bird populations of the North York Moors SPA would be affected by the works within the onshore cable corridor or onshore converter station (see Section 2.4 and **Appendix A** of the **HRA Report**). Therefore, these sites were not screened into the appropriate assessment stage.

3.2.7 The Teesmouth and Cleveland Coast SPA and Ramsar site lies approximately 2km to the north-west of the export cable landfall within the intertidal zone. Given the proximity to the Dogger Bank Teesside A & B Export Cable Corridor, there is a potential for indirect effects to occur on the supporting habitats (i.e. sand and shingle, intertidal sandflat and mudflat, rocky shore, and saltmarsh) of the SPA and Ramsar site, particularly during construction and decommissioning (disturbance being unlikely during operation as all cable infrastructure would be buried under the surface of the intertidal zone) of the Dogger Bank Teesside A & B Export Cable Corridor. Indirect effects on the supporting habitats could impact on the foraging behaviour and resource of the features for which the Teesmouth and Cleveland Coast SPA and Ramsar site is designated. Furthermore, potential disturbance works within the intertidal zone during the project phases could disturb bird species which are a feature of the European site, species include breeding little tern and sandwich tern, wintering knot, and passage redshank and ringed plover. Consequently, these sites have been screened into the appropriate assessment stage.

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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

Special Area of Conservation (SAC)/ Sites of Community Importance (SCI)

- Germany
- Netherlands
- UK

0 10 20 40
Kilometres

Data Source:
Environmental Designations © JNCC, 2014 and European Environment Agency, 2014
Round 3 offshore wind farm boundary © Crown Copyright, 2014

PROJECT TITLE

*Dogger Bank Teesside A & B*
IfAA Report

DRAWING TITLE

**Figure 3.1 Annex I Habitats Directive sites for which LSE has been determined**

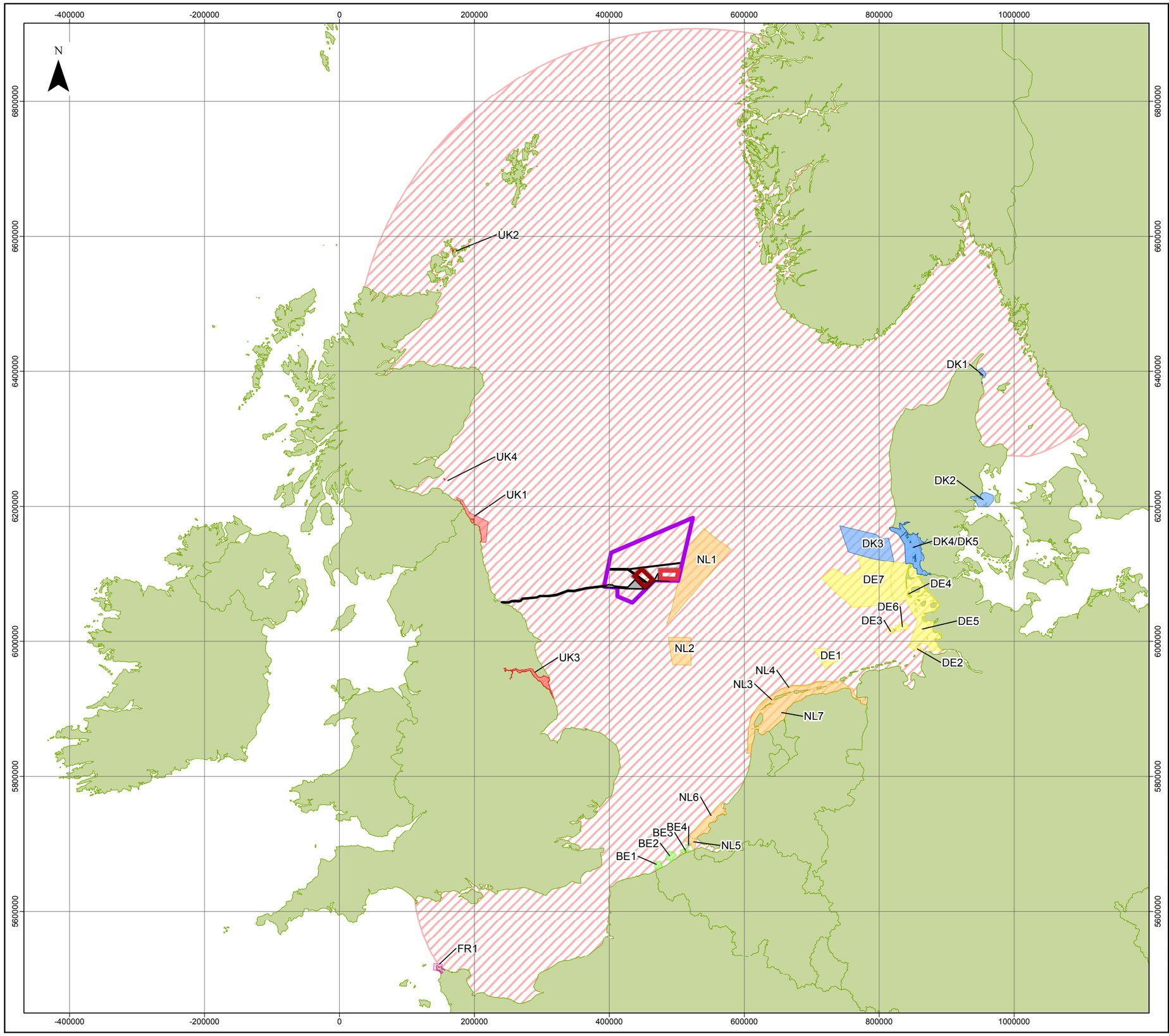
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|---|---|---|---|---|
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| 2 | 18/03/2014 | DCO Submission | GC | PT |
| | | | | |

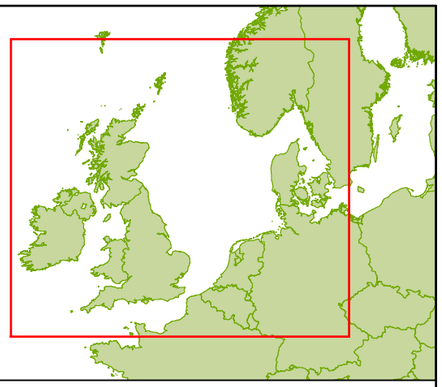
DRAWING NUMBER:
**9Y0986/TSABHRA/02/R2**

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|---|---|---|---|---|---|---|---|

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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
- Study area

Transboundary SAC/SCI

- Belgium
- France
- Germany
- Denmark
- Netherlands
- UK

0 25 50 100
Kilometres

Data Source:
Environmental Designations © JNCC, 2014 and European Environment Agency, 2014
Round 3 offshore wind farm boundary © Crown Copyright, 2014

PROJECT TITLE

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IfAA Report

DRAWING TITLE

**Figure 3.2 Habitats Directive sites with Annex II grey seal feature for which LSE has been determined (see Table 3.1 for site reference list)**

| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 10/10/2013 | PEI3 | JE | PT |
| 2 | 18/03/2014 | DCO Submission | JE | PT |
| | | | | |

DRAWING NUMBER:

**9Y0986/TSABHRA/03/R2**

| SCALE | PLOT SIZE | DATUM | PROJECTION |
|---|---|---|---|
| 1:5,750,000 | A3 | WGS84 | UTM31N |

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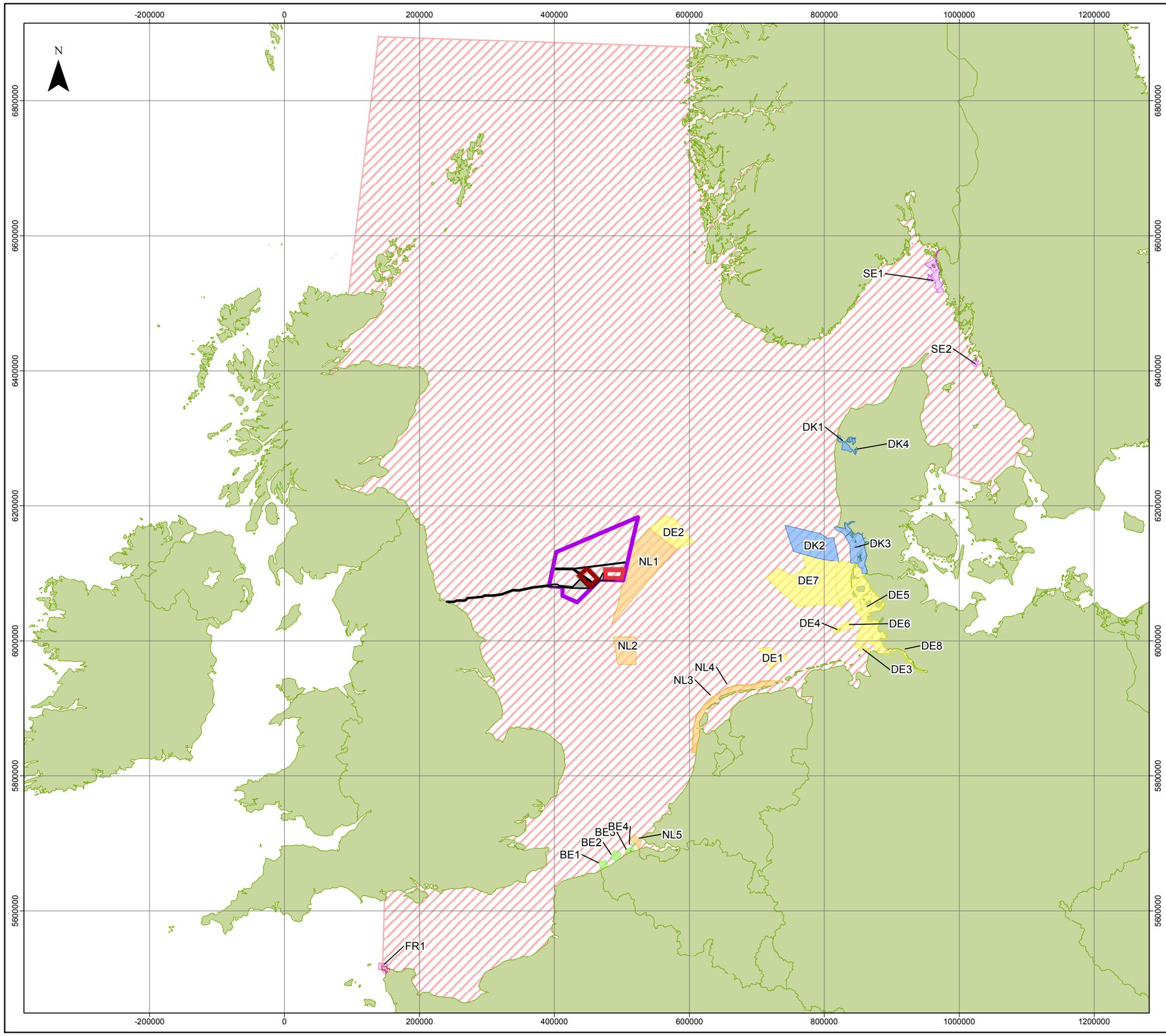
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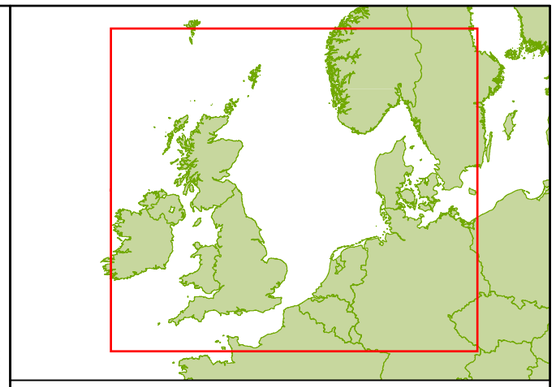
## Table 3.1 Site reference list for Figure 3.2

| Reference | Site name |
|---|---|
| **UK** | |
| UK1 | Berwickshire and North Northumberland Coast SAC |
| UK2 | Faray and Holm of Faray SAC |
| UK3 | Humber Estuary SAC and Ramsar site |
| UK4 | Isle of May SAC |
| **Belgium** | |
| BE1 | SBZ1 pSCI |
| BE2 | SBZ2 pSCI |
| BE3 | SBZ3 pSCI |
| BE4 | Vlakte van de Raan SCI |
| **Denmark** | |
| DK1 | Hirsholmene, havet vest herfor og Ellinge Å's udløb SCI / SAC |
| DK2 | Horsens Fjord, havet øst for og Endelave SCI / SAC |
| DK3 | Sydlige Nordsø SCI / SAC |
| DK4 | Vadehavet med Ribe Å, Tved Å og Varde Å vest for Varde SCI / SAC |
| DK5 | Vadehavet Ramsar |
| **France** | |
| FR1 | Récifs et landes de la Hague SCI |
| **Germany** | |
| DE1 | Borkum-Riffgrund (Borkum Reef Ground) SCI |
| DE2 | Hamburgisches Wattenmeer Ramsar |
| DE3 | Helgoland mit Helgoländer Felssockel SCI |
| DE4 | Küsten- und Dünenlandschaften Amrums SCI |
| DE5 | NTP S-H Wattenmeer und angrenzende Kustengebiete SCI |
| DE6 | Steingrund SCI |
| DE7 | Sylter Außenriff (Sylt Outer Reef) SCI |
| **Netherlands** | |
| NL1 | Doggersbank SCI |
| NL2 | Klaverbank SCI |
| NL3 | Noordzeekustzone SCI |
| NL4 | Noordzeekustzone II pSCI |
| NL5 | Vlakte Van der Raan SCI / SAC |
| NL6 | Voordelta SCI |
| NL7 | Waddenzee SCI / SAC |
| **Norway** | |
| NO1 | Rott-Hastein Kjor Ramsar |

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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
- Study area

Transboundary SAC/SCI

- Belgium
- France
- Germany
- Denmark
- Netherlands
- Sweden

0 50 100 200
Kilometres

Data Source:
Environmental Designations © JNCC, 2014 and European Environment Agency, 2014
Round 3 offshore wind farm boundary © Crown Copyright, 2014

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*Dogger Bank Teesside A & B*
IfAA Report

DRAWING TITLE

**Figure 3.3 Habitats Directive sites with Annex II harbour porpoise feature for which LSE has been determined (see Table 3.2 for site reference list)**

| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 11/10/2013 | PEI3 | JE | PT |
| 2 | 18/03/2014 | DCO Submission | GC | PT |
| | | | | |

DRAWING NUMBER:

**9Y0986/TSABHRA/04/R2**

| SCALE | PLOT SIZE | DATUM | PROJECTION |
|---|---|---|---|
| 1:5,750,000 | A3 | WGS84 | UTM31N |

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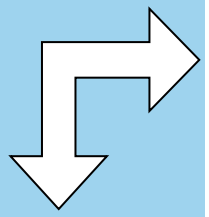
Table 3.2 Site reference list for Figure 3.3

| Reference | Site name |
|---|---|
| **Belgium** | |
| BE1 | SBZ1 pSCI |
| BE2 | SBZ2 pSCI |
| BE3 | SBZ3 pSCI |
| BE4 | Vlakte van de Raan SCI |
| **Denmark** | |
| DK1 | Agger Tange, Nissum Bredning, Skibsted Fjord og Agerø SCI / SAC |
| DK2 | Sydlige Nordsø SCI / SAC |
| DK3 | Vadehavet med Ribe Å, Tved Å og Varde Å vest for Varde SCI / SAC |
| DK4 | Venø, Venø Sund SCI / SAC |
| **France** | |
| FR1 | Récifs et landes de la Hague SCI |
| **Germany** | |
| DE1 | Borkum-Riffgrund (Borkum Reef Ground) SCI |
| DE2 | Doggerbank SCI |
| DE3 | Hamburgisches Wattenmeer SCI |
| DE4 | Helgoland mit Helgoländer Felssockel SCI |
| DE5 | NTP S-H Wattenmeer und angrenzende Kustengebiete SCI |
| DE6 | Steingrund SCI |
| DE7 | Sylter Außenriff (Sylt Outer Reef) SCI |
| DE8 | Unterelbe SCI |
| **Netherlands** | |
| NL1 | Doggersbank SCI |
| NL2 | Klaverbank SCI |
| NL3 | Noordzeekustzone SCI |
| NL4 | Noordzeekustzone II pSCI |
| NL5 | Vlakte Van De Raan SCI / SAC |
| **Sweden** | |
| SE1 | Kosterfjorden-Väderöfjorden SCI / SAC |
| SE2 | Vrangoskargarden SCI / SAC |

3.2.8 Potential effects on designated terrestrial SAC bat populations were also screened out. All of the UK bat species (namely, greater horseshoe, lesser horseshoe, Bechstein's and barbastelle) for which SACs have been designated are effectively sedentary (within the UK) and non-migratory, therefore, they would not be affected by wind farm development within the North Sea. There are no SACs designated for these species within 250km of the onshore cable corridor and onshore converter station, the nearest SAC (Paston Great Barn) designated for Annex II bat species (barbastelle) being located in North Norfolk.

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Table 3.3 Activities and effects screened into the appropriate assessment stage

| Activity | Effect | Direct / Indirect | Potential impact | Site / feature screened in | Where assessed |
|---|---|---|---|---|---|
| **Construction phase** | | | | | |
| Installation of foundations, cables and ancillary structures and the placement of jack-up vessel legs | Disturbance to substrate (seabed) | Direct | Physical damage to benthic habitats | Dogger Bank cSAC – subtidal sandbanks | Sections 4.6, 4.9, and 7.3 |
| | Progressive alteration to hydrodynamic processes (tidal currents and flows) | Indirect | Physical damage to benthic habitats | Dogger Bank cSAC – subtidal sandbanks<br>Northumbria Coast SPA and Ramsar site - supporting habitats<br>Teesmouth and Cleveland Coast SPA and Ramsar site - supporting habitats<br>Doggersbank SCI (Netherlands) - subtidal sandbanks<br>Doggerbank SCI (Germany) – subtidal sandbanks | Sections 4.6, 4.9, 4.10, 7.3, and 7.4 |
| | Increase in suspended sediment concentrations in the water column  | Indirect | Physical damage to sensitive benthic species (e.g. filter feeders, algae) | Dogger Bank cSAC – subtidal sandbanks<br>Northumbria Coast SPA and Ramsar site - supporting habitats<br>Teesmouth and Cleveland Coast SPA and Ramsar site - supporting habitats<br>Doggersbank SCI (Netherlands) - subtidal sandbanks<br>Doggerbank SCI (Germany) – subtidal sandbanks | Sections 4.6, 4.9, 4.10, 7.3, 7.4, and 7.5 |
| | | | Alteration to prey species (fish) distribution, density or quality | All sites supporting grey seal and/or harbour porpoise (see **Tables 3.1** and **3.2**) as a qualifying feature | Sections 5.6, 5.10, 5.10, 5.16, 5.20, 7.6, and 7.7 |
| | | | | All SPA and Ramsar sites (see **Table 3.4**) supporting seabird species that forage within Dogger Bank Teesside A & B or along the Dogger Bank Teesside A & B Export Cable Corridor | Sections 6.5, 6.8, and 7.8 |


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| Activity | Effect | Direct / Indirect | Potential impact | Site / feature screened in | Where assessed |
|---|---|---|---|---|---|
| Installation of foundations, cables and ancillary structures and the placement of jack-up vessel legs (continued) | Re-deposition of sediment from the water column | Indirect | Physical loss or damage (smothering) of sensitive benthic species | Dogger Bank cSAC – subtidal sandbanks<br>Northumbria Coast SPA and Ramsar site - supporting habitats<br>Teesmouth and Cleveland Coast SPA and Ramsar site - supporting habitats<br>Doggersbank SCI (Netherlands) - subtidal sandbanks<br>Doggerbank SCI (Germany) – subtidal sandbanks | Sections 4.6, 4.9, 4.10, 7.3, 7.4, and 7.5 |
| | | | Alteration to prey species (fish) distribution, density or quality | All sites supporting grey seal and/or harbour porpoise (see **Tables 3.1** and **3.2**) as a qualifying feature | Sections 5.6, 5.10, 5.10, 5.16, 5.20, 7.6, and 7.7 |
| | | | | All SPA and Ramsar sites (see **Table 3.4**) supporting seabird species that forage within Dogger Bank Teesside A & B or along the Dogger Bank Teesside A & B Export Cable Corridor | Sections 6.5, 6.8, and 7.8 |
| Pile driving and vessel movements | Underwater noise | Direct | Physical damage (mortality) to marine mammals | All sites supporting grey seal and/or harbour porpoise as a qualifying feature (see **Tables 3.1** and **3.2**) | Sections 5.6, 5.10, 5.10, 5.16, 5.20, 7.6, and 7.7 |
| | | | Alteration to prey species (fish) distribution, density or quality | All sites supporting grey seal and/or harbour porpoise as a qualifying feature (see **Tables 3.1** and **3.2**) | Sections 5.6, 5.10, 5.10, 5.16, 5.20, 7.6, and 7.7 |
| | | | | All SPA and Ramsar sites supporting seabird species that forage within Dogger Bank Teesside A & B (see **Table 3.4**) | Sections 6.5, 6.8, and 7.8 |
| Vessel movements | Collision | Direct | Physical damage (mortality) to marine mammals | All sites supporting grey seal and/or harbour porpoise as a qualifying feature (see **Tables 3.1** and **3.2**) | Sections 5.6, 5.10, 5.10, 5.16, 5.20, 7.6, and 7.7 |


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| Activity | Effect | Direct / Indirect | Potential impact | Site / feature screened in | Where assessed |
|---|---|---|---|---|---|
| **Operation phase** | | | | | |
| Footprint / presence of structures (i.e. accommodation platforms, turbines, collector and converter substations, met mast foundations, scour protection, non-buried cables, and permanent moorings) | Obstruction of the seabed causing a physical loss of habitat | Direct | Reduction in area of habitat and associated benthic species | Dogger Bank cSAC – subtidal sandbanks | Sections 4.7, 4.9, and 7.3 |
| | | Indirect | Alteration to prey species (fish) distribution, density or quality | All sites supporting grey seal and/or harbour porpoise (see **Tables 3.1** and **3.2**) as a qualifying feature | Sections 5.7, 5.10, 5.10, 5.17, 5.20, 7.6, and 7.7 |
| | | | | All SPA and Ramsar sites (see **Table 3.4**) supporting seabird species that forage within Dogger Bank Teesside A & B or along the Dogger Bank Teesside A & B Export Cable Corridor | Sections 6.6, 6.7, and 7.8 |
| | Alteration to hydrodynamic processes (tidal currents and flows) | Indirect | Physical damage to benthic habitats and species | Dogger Bank cSAC – subtidal sandbanks<br>Northumbria Coast SPA and Ramsar site - supporting habitats<br>Teesmouth and Cleveland Coast SPA and Ramsar site - supporting habitats<br>Doggersbank SCI (Netherlands) - subtidal sandbanks<br>Doggerbank SCI (Germany) – subtidal sandbanks | Sections 4.7, 4.9, 4.10, 7.3, 7.4, and 7.5 |
| | Scour induced increase in suspended sediment concentrations in the water column. Confined to the wind farm development as cable will be buried | Indirect | Physical damage to sensitive benthic species (e.g. filter feeders) | Dogger Bank cSAC – subtidal sandbanks<br>Northumbria Coast SPA and Ramsar site - supporting habitats<br>Teesmouth and Cleveland Coast SPA and Ramsar site - supporting habitats<br>Doggersbank SCI (Netherlands) - subtidal sandbanks<br>Doggerbank SCI (Germany) – subtidal sandbanks | Sections 4.7, 4.9, 4.10, 7.3, 7.4, and 7.5 |
| | | | Alteration to prey species (fish) distribution, density or quality | All sites supporting grey seal and/or harbour porpoise (see **Tables 3.1** and **3.2**) as a qualifying feature | Sections 5.7, 5.10, 5.10, 5.17, 5.20, 7.6, and 7.7 |
| | | | | All SPA and Ramsar sites (see **Table 3.4**) supporting seabird species that forage within Dogger Bank Teesside A & B | Sections 6.6, 6.7, 6.8, and 7.8 |


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| Activity | Effect | Direct / Indirect | Potential impact | Site / feature screened in | Where assessed |
|---|---|---|---|---|---|
| Continued from above | Re-deposition of sediment from the water column (resulting from scour) | Indirect | Physical loss or damage (smothering) of sensitive benthic species | Dogger Bank cSAC – subtidal sandbanks<br>Northumbria Coast SPA and Ramsar site - supporting habitats<br>Teesmouth and Cleveland Coast SPA and Ramsar site - supporting habitats<br>Doggersbank SCI (Netherlands) - subtidal sandbanks<br>Doggerbank SCI (Germany) – subtidal sandbanks | Sections 4.7, 4.9, 4.10, 7.3, 7.4, and 7.5 |
| | Physical barrier to marine mammal movements | Direct | Displacement from and reduction in available feeding area | All sites supporting grey seal and/or harbour porpoise (see **Tables 3-1** and **3.2**) as a qualifying feature | Sections 5.7, 5.10, 5.10, 5.17, 5.20, 7.6, and 7.7 |
| Presence of jack-up vessels during maintenance | Disturbance to substrate (seabed) | Direct | Physical damage to benthic habitats | Dogger Bank cSAC – subtidal sandbanks | Sections 4.7, 4.9, and 7.3 |
| Operation of wind turbines | Increase in underwater noise levels | Direct | Behavioural influence on marine mammals | All sites supporting grey seal and/or harbour porpoise (see **Tables 3.1** and **3.2**) as a qualifying feature | Sections 5.7, 5.10, 5.10, 5.17, 5.20, 7.6, and 7.7 |
| | Collision of birds with turbines | Direct | Mortality potentially leading to a reduction in population levels | All SPA and Ramsar sites (see **Table 3.4**) supporting seabird species that forage within Dogger Bank Teesside A & B and migratory bird species that pass through the wind farm area | Sections 6.6, 6.7, 6.8, and 7.8 |
| | Displacement of birds from wind farm area | Indirect | Effective loss of foraging habitat for seabirds and potential mortality leading to a reduction in breeding colony population levels | All SPA and Ramsar sites (see **Table 3.4**) supporting seabird species that forage within Dogger Bank Teesside A & B | Sections 6.6, 6.7, 6.8, and 7.8 |
| | Barrier to bird movements | Indirect | Increase in energetic cost of foraging / migration | All SPA and Ramsar sites (see **Table 3.4**) supporting seabird species that forage within Dogger Bank Teesside A & B and migratory bird species that pass through the wind farm area | Sections 6.6, 6.7, 6.8, and 7.8 |


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| Activity | Effect | Direct / Indirect | Potential impact | Site / feature screened in | Where assessed |
|---|---|---|---|---|---|
| Vessel movements | Collision with vessels undertaking maintenance | Direct | Physical damage (mortality) to marine mammals | All sites supporting grey seal and/or harbour porpoise (see **Tables 3.1** and **3.2**) as a qualifying feature | Sections 5.7, 5.10, 5.10, 5.17, 5.20, 7.6, and 7.7 |
| **Decommissioning phase** | | | | | |
| Placement of jack-up vessel legs and removal of structures (i.e. accommodation platforms, turbines, collector and converter substations, met mast foundations, scour protection, cables, and permanent moorings) | Disturbance to substrate (seabed) | Direct | Physical damage to benthic habitats | Dogger Bank cSAC – subtidal sandbanks | Sections 4.8, 4.9, and 7.3 |
| | Increase in suspended sediment concentrations in the water column | Indirect | Physical damage to sensitive benthic species (e.g. filter feeders, algae) | Dogger Bank cSAC – subtidal sandbanks<br>Northumbria Coast SPA and Ramsar site - supporting habitats<br>Teesmouth and Cleveland Coast SPA and Ramsar site - supporting habitats<br>Doggersbank SCI (Netherlands) - subtidal sandbanks<br>Doggerbank SCI (Germany) – subtidal sandbanks | Sections 4.8, 4.9, 4.10, 7.3, 7.4, and 7.5 |
| | | | Alteration to prey species (fish) distribution, density or quality | All SPA and Ramsar sites (see **Table 3.4**) supporting seabird species that forage within Dogger Bank Teesside A & B or along the Dogger Bank Teesside A & B Export Cable Corridor | Sections 6.5, 6.8, and 7.8 |
| | | | | All sites supporting grey seal and/or harbour porpoise (see **Tables 3.1** and **3.2**) as a qualifying feature | Sections 5.8, 5.10, 5.10, 5.18, 5.20, 7.6, and 7.7 |
| | Re-deposition of sediment from the water column | Indirect | Physical loss or damage (smothering) of sensitive benthic species | Dogger Bank cSAC – subtidal sandbanks<br>Northumbria Coast SPA and Ramsar site - supporting habitats<br>Teesmouth and Cleveland Coast SPA and Ramsar site - supporting habitats<br>Doggersbank SCI (Netherlands) - subtidal sandbanks<br>Doggerbank SCI (Germany) – subtidal sandbanks | Sections 4.8, 4.9, 4.10, 7.3, 7.4, and 7.5 |


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| Activity | Effect | Direct / Indirect | Potential impact | Site / feature screened in | Where assessed |
|---|---|---|---|---|---|
| Continued from above | | | Alteration to prey species (fish) distribution, density or quality | All SPA and Ramsar sites (see **Table 3.4**) supporting seabird species that forage within Dogger Bank Teesside A & B or along the Dogger Bank Teesside A & B Export Cable Corridor | Sections 6.5, 6.8, and 7.8 |
| | | | | All sites supporting grey seal and/or harbour porpoise (see **Tables 3.1** and **3.2**) as a qualifying feature | Sections 5.8, 5.10, 5.10, 5.18, 5.20, 7.6, and 7.7 |
| Vessel movements | Collision with marine mammals | Direct | Physical damage (mortality) to marine mammals | All sites supporting grey seal and/or harbour porpoise (see **Tables 3.1** and **3.2**) as a qualifying feature | Sections 5.8, 5.10, 5.10, 5.18, 5.20, 7.6, and 7.7 |
| Pile cutting and vessel movements | Underwater noise | Direct | Physical damage (mortality) to marine mammals | All sites supporting grey seal and/or harbour porpoise (see **Tables 3.1** and **3.2**) as a qualifying feature | Sections 5.8, 5.10, 5.10, 5.18, 5.20, 7.6, and 7.7 |
| | | | Alteration to prey species (fish) distribution, density or quality | All sites supporting grey seal and/or harbour porpoise (see **Tables 3.1** and **3.2**) as a qualifying feature | Sections 5.8, 5.10, 5.10, 5.18, 5.20, 7.6, and 7.7 |
| | | | | All SPA and Ramsar sites supporting seabird species (see **Tables 3.1** and **3.2**) that forage within Dogger Bank Teesside A & B | Sections 6.5, 6.8, and 7.8 |


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## Coastal and marine designated habitats

### Direct effect on habitats

3.2.9 The pre-screening exercise identified that the only designated site where direct effects would manifest is the Dogger Bank cSAC, as Dogger Bank Teesside A & B overlaps with the boundary of this site (see **Figure 3.1**). Direct and indirect effects could arise on the habitats and benthic communities of the subtidal sandbanks feature as well as the hydrodynamic regime and morphology of this feature. Consequently, direct effects on the habitats and supporting habitats within the boundary of all other SACs, SPAs and Ramsar sites were screened out (no LSE concluded).

3.2.10 Within the overlap area between the Dogger Bank cSAC and the Dogger Bank Zone (including Dogger Bank Teesside A & B) direct habitat loss from the subtidal sandbanks feature would occur from within the cSAC as a result of the installation of foundations, cables and ancillary structures and the placement of jack-up vessel legs (see Section 3.3 and **Table 3.3**). Development within the Dogger Bank Zone outside of the boundary of the cSAC would not result in any direct loss. The direct loss of habitat would lead to a reduction in the extent of the designated area that potentially could compromise the favourable condition of the affected feature.

### Indirect effect on habitats

3.2.11 Within the wind farm development area, any hydrodynamic influences from the placement of structures on the seabed would be highly localised around individual turbines and parts of the inter-array and export cable where protection is used. Potentially, disturbance of surface sediments during construction may release fine sediment that could be transported up to maximum of 50km (see paragraph 6.2.6 in **Chapter 9** of the Dogger Bank Teesside A & B ES) from the installation sites. Indirect effects on designated habitats as a result of increased suspended sediment concentrations and sediment deposition (e.g. smothering of benthos through sediment re-deposition) due to scour during the operation phase could result in effects extending a maximum of 54km away (see paragraph 7.4.5 in **Chapter 9** of the Dogger Bank Teesside A & B ES). Indirect effects on designated habitats as a result of the modification of current velocities and waves during the operation phase could also result in effects extending a maximum of 8km for tidal currents and 75km for waves from the wind farm boundary (see paragraphs 7.2.4 and 7.3.5 in **Chapter 9** of the Dogger Bank Teesside A & B ES). Consequently, any indirect effects described above can be expected to be confined to within these ranges, which encompass the following sites:

- Dogger Bank cSAC (within zone of suspended sediment increase and hydrodynamic change);
- Northumbria Coast SPA and Ramsar site - distance 20km from export cable corridor (within zone of suspended sediment increase);
- Teesmouth and Cleveland Coast SPA and Ramsar site (within zone of suspended sediment increase and hydrodynamic change);

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- Doggerbank SCI (Germany) - distance 43km from nearest wind farm project (within zone of suspended sediment increase and hydrodynamic change); and
- Doggersbank SCI (Netherlands) - adjacent to the nearest wind farm project (within zone of suspended sediment increase and hydrodynamic change).

3.2.12 It is also predicted that some temporary interruption of sediment transport over the upper intertidal area at the landfall location could occur as a result of the installation of cofferdams to facilitate cable laying. The cofferdams would be relatively small-scale structures and, given their proposed temporary (<14 weeks) presence (see **Table 2.2**), no long-term significant influence on the rate of sediment transport or volume of sediment transported along the frontage would be expected (see Section 7.5 in **Chapter 9** of the Dogger Bank Teesside A & B ES). HDD will be used to pass the export cable under the cliff at the landfall location and the permanent footprint of the cable would be buried under the intertidal zone, therefore, no effects on coastal processes would occur during the operational phase. Given this, sediment supply to depositional areas downdrift and updrift of the landfall location would be maintained throughout the lifetime of the project and intertidal and subtidal habitats that are reliant, to a degree, on the feed of sediment along the coast would not be affected.

3.2.13 In the subtidal area, there is a possibility that the cables would be on the surface and protected by rock armour (or some other form of remedial protection), which potentially could create a partial barrier to sediment transport.

3.2.14 The main reason that the cables may be surface laid is the absence of surface sand and the proximity of bedrock to the seabed. Cable protection, if required in the subtidal zone, is anticipated to be up to approximately 15m wide and stand up to approximately 1.5m above the surrounding seabed, with armour slopes of 1 in 3 (18 degrees). The presence of these structures could result in a barrier to water flow and sediment transport on or immediately above the seabed. Potentially, this could:

- Stop or slow down the bedload transport of sediment across the seabed by acting as a partial physical barrier; and
- Induce local turbulence in the flow field which could cause unwanted secondary scour in a ‘down-flow’ direction.

3.2.15 With regard to effects on bedload sediment transport, the key factors in determining the magnitude of the potential effect are the type and extent of bed transport. The two main drivers of transport in the subtidal and nearshore zone are the flood (north to south) and ebb currents (south to north).

3.2.16 Given the proposed shallow sloping nature of the armour, any entrapment of bedload sediment would be negligible in scale and no blockage effect would occur (see paragraph 7.5.8 in **Chapter 9** of the Dogger Bank Teesside A & B ES). The scour induced by turbulence is also predicted to be negligible in scale and both localised and temporary. Overall, therefore, no net sediment transport effects are likely given the localised, temporary and intermittent slow down predicted at the location of any cable extents that are protected by armour. Given this, no sediment transport effects are considered herein for or in relation

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to the supporting habitats (or habitats that are features) of European sites within the study area. In respect of this potential effect, no LSE on the supporting habitats of the Teesmouth and Cleveland Coast SPA and Ramsar site and Northumbria Coast SPA and Ramsar site is concluded.

## Coastal and marine designated species populations

### Migratory fish

3.2.17 All designated sites around the North Sea supporting Annex II populations of diadromous fish (Atlantic salmon, twaite shad, allis shad, and sea lamprey) were screened into the assessment process in the pre-screening exercise due to the potential for works in the marine environment to have an adverse effect upon the migratory behaviour of these species. Sites supporting designated populations of river lamprey were screened out of the assessment process as this species is confined to freshwater and estuarine habitats (Maitland 2003) and no impact pathways that could adversely affect populations of this species were identified.

3.2.18 Based on further consideration of the distribution and likely behaviour of the relevant migratory fish species in relation to the location of the Dogger Bank Zone and the likely effects of development, it was concluded that the works would not have a LSE with respect to SACs around the North Sea designated for their Annex II migratory fish populations. The key reasons for this conclusion were as follows:

- There are no designated riverine/estuarine SACs for twaite shad or allis shad in UK North Sea waters, both species exhibiting a western seaboard distribution in the UK (Maitland & Hatton-Ellis 2003). While some continental European SACs with estuarine links to the North Sea have been designated for twaite shad, available information indicates that migratory adults would be likely to use the coastal waters of the southern North Sea. The Dogger Bank Zone is located in the central North Sea and therefore outside of coastal waters in which twaite shad and allis shad are likely to be present during the marine phase of their life-cycle (Maitland & Hatton-Ellis 2003). Consequently, migratory behaviour would not be influenced by wind farm development (including cable installation) for Dogger Bank Teesside A & B or within the Dogger Bank Zone;
- There have been increasing numbers of Atlantic salmon in the rivers discharging along the north east coast, including rivers such as the Coquet, the Tyne, the Wear, the Tees, the Yorkshire Esk, the Trent, the Ouse and the Humber, though Scottish rivers are considered a particular stronghold for Atlantic salmon. Available evidence indicates that the majority of Atlantic salmon return to rivers on the east coast of Scotland and North East England from winter feeding grounds in the North Atlantic, including the Faroes and West Greenland areas. It is unlikely that salmon returning to these rivers would migrate south beyond their river of origin, and hence they are unlikely to migrate through the Dogger Bank Zone. However, it is possible that post-smolts and adults may transit across the Dogger Bank Teesside A & B Export Cable Corridor as part of foraging (e.g. in the southern North Sea) and / or migratory activity (e.g. to rivers in southern

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England); though the numbers are likely to be very low. Overall, the exposure risk for European populations in Scottish and English rivers to effects that potentially could influence migratory behaviour (e.g. turbine installation, cable-laying) is considered to be extremely low, as evidenced in the low numbers caught south of the Northumbrian coast (see **Chapter 13 Fish and Shellfish Ecology** of the Dogger Bank Teesside A & B ES);

- Given that the migratory distribution of Atlantic salmon and both shad species would appear to preclude any significant presence within the Dogger Bank Zone or the Dogger Bank Teesside A & B Export Cable Corridor, and given the extent of foraging area with respect to the North Sea, it is considered highly unlikely that construction or operational effects associated with wind farm development would have any significant influence such that an adverse effect on the designated migratory populations of specific European sites would arise; and
- Sea lamprey is a solitary, dispersive species. Individuals from designated populations could be present within the Dogger Bank Zone and could therefore be affected by some aspects of the works, notably disturbance and displacement associated with increased underwater noise levels. However, mortality effects are considered unlikely, particularly as host species are predicted to be largely unaffected by the development. There is no evidence to indicate that adults undertake migration from offshore waters along specific routes. Works in the marine environment, therefore, would be unlikely to disrupt the migratory behaviour of fish along specific routes to and from designated rivers for this species.

3.2.19 Subsequent to the production of the HRA Screening Report, analysis and assessment of the potential effects of wind farm construction and operation on fish species / populations determined that impacts on diadromous fish species would be negligible (see **Chapter 13** of the Dogger Bank Teesside A & B ES). This conclusion is built upon both the known distribution and likely abundance of diadromous species within the zone of influence of the project and analysis of the potential effects, particularly in respect of the generation of underwater noise.

3.2.20 Construction related activities, such as impact pile driving, rock placement for scour protection and dredging associated with seabed preparation for installation of gravity bases and cable laying related activities, would all generate underwater noise. Impact pile driving is the activity with potential to result in the most detrimental impact on fish.

3.2.21 The impact of underwater noise on fish was modelled for fish in mid-water (pelagic fish) and fish that dwell near or on the seabed (demersal fish). This modelling work reveals that the potential instantaneous injury impact ranges for fish, based on the onset of auditory tissue damage, are relatively small. These ranges would be less than 200m (at the onset of soft-start piling at hammer energies of 300kJ) to less than 600m (see Table 6.7 and 6.8 in **Chapter 13** of the Dogger Bank Teesside A & B ES). The intermittent and short term nature of pile driving activity and the small area in which lethal/injury impacts could occur, indicates that potential impacts at the population level for any species would be

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highly unlikely to occur. As a measure to avoid any lethal/injury impacts in the vicinity of piling works, soft-start piling would be used, which would enable fish to flee the immediate vicinity of the piling activity prior to the highest noise levels being reached.

3.2.22 In terms of behavioural impacts the underwater noise modelling shows that startle responses or C-turn reactions (which indicate a very strong dislike to the sound) are unlikely to occur at ranges beyond 500m from a pile for 1,900kJ hammer energies (see Tables 6.7 and 6.8 in **Chapter 13** of the Dogger Bank Teesside A & B ES). At the onset of a soft-start (300kJ) this range is likely to 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) would be larger. At the onset of a soft-start these ranges are estimated to between 3.8km to 8.5km (taking minimum and maximum ranges for demersal and pelagic fish, respectively).

3.2.23 As discussed, diadromous migratory species would be unlikely to occur with any regularity or in large numbers within Dogger Bank Teesside A & B. Any construction related disturbance effects within Dogger Bank Teesside A & B would be intermittent and there would remain substantial areas within the Dogger Bank Zone in which noise levels would not lead to adverse behavioural reactions, enabling migratory fish, if present, to relocate and continue migratory movements. Given the distance between Dogger Bank Teesside A & B and the coast (in excess of 165km), the calculation of potential zones of disturbance indicates that these species would not be disturbed immediately prior to river entry nor immediately after leaving rivers.

3.2.24 As set out above, significant noise-related mortality of fish species that may act as prey for sea lamprey would not be expected during construction of the wind farm. Even if prey species were displaced from an area affected by increased noise levels, sea lamprey would either be displaced with these fish or relocate to areas where suitable prey were present.

3.2.25 During the operation phase there is no evidence to indicate that the low frequency noise generated by wind turbines produces serious damage to fish hearing organs or that strong avoidance reactions are produced (Wahlberg & Westerberg, 2005).

3.2.26 In the case of the export cable, 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, would generate underwater noise (Nedwell & Howell 2004). The levels of noise associated with these activities are, however, negligible in comparison to pile driving (see **Appendix 13G** of the Dogger Bank Teesside A & B ES) and no mortality / injury type effects would be expected. Although there may be potential for behavioural responses such as avoidance reactions to occur, these would only take place in close proximity to those construction activities occurring at a given time. The progressive and localised nature of cable-laying installation works also means that substantial areas of offshore and nearshore waters would remain undisturbed. The nearest river / estuary supporting designated migratory fish populations to the Dogger Bank Teesside A & B Export Cable Corridor is the

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Humber Estuary and the Tweed Estuary. These sites are located 96km to the south and 107km to the north, respectively, of the Dogger Bank Teesside A & B Export Cable Corridor and, hence, are well outside of any potential zone in which noise levels might lead to disruption to migration. Movements of sea lamprey and river lamprey into and out of the Humber Estuary and Tweed Estuary would not, therefore, be compromised by works undertaken for the export cable.

3.2.27 Localised and temporary increases in suspended sediment concentrations would arise during cable-laying activities. Such increases would be within the existing range of suspended sediment concentrations. Only temporary changes in average suspended sediment concentration along the export cable route are predicted (see **Chapter 9** of the Dogger Bank Teesside A & B ES). Migratory fish, if present, would be able to either avoid or move quickly through any localised area subject to increased suspended sediment. Given this and the short-lived nature of any increase, no impact on migratory fish populations would be expected.

3.2.28 Benthic habitat loss along the export cable route would occur in areas where rock is used to protect and bury the cable(s). The total area that would be lost (where the worst case has been determined as 4.9km$^2$, assuming all cable protection occurs on rock habitat) is considered to be negligible within the context of the existing benthic habitat available as a resource to fish. In the case of diadromous migratory species, it should be noted that twaite shad, allis shad and Atlantic salmon are pelagic, water column feeders and sea lamprey is parasitic upon a range of larger fish species. Consequently, benthic habitat loss is unlikely to be of critical importance to the feeding ecology of these species, particularly so as, if present, they would be transiting rapidly through the narrow export cable corridor.

3.2.29 There is evidence that species such as Atlantic salmon, European eel, river lamprey, and sea lamprey respond to electromagnetic fields (EMF), namely electric (E) and magnetic (B) fields (Gill *et al*. 2005). Life functions supported by a magnetic sense may include orientation, homing and navigation, to assist with long or short-range migrations or movements as well as detection of prey and predator avoidance (Gill *et al*. 2005; Normandeau *et al*. 2011). Consequently, the EMF emitted by subsea cables may interfere with these functions in areas where the cable EMF levels are detectable by the individual organism. The possibility of interference would be minimised due to the burial of cables and armouring of exposed cables or cable crossings. The strength of the magnetic fields generated by AC and DC cabling decreases exponentially with distance from source, limiting the potential area of influence to several meters in either direction. In addition, studies at existing wind farms and information with respect to cables indicate that no measurable influence has been identified on migratory fish species::

- Atlantic salmon - migration of Atlantic salmon in the Baltic Sea appears unaffected despite the presence of a number of electrical cables in the path of their migration route (Walker 2001);

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- European eel - no correlation between eel catch data and power production were detected at the Nysted wind farm, furthermore, mark and recapture experiments showed that eels did cross the export cable (Hvidt *et al*. 2005). Whilst research by Westerberg (1999) on HVDC cables and eel migration found that some effects associated with the magnetic disturbance were likely to occur, the consequences appeared to be small, and no evidence was found that the cable constituted a permanent obstacle to migration, either for adult eels or for elvers; and
- Lampreys - 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. However, lampreys spawn in freshwater, therefore, they would only be exposed to EMF if migration routes to freshwater spawning sites cross areas with EMF influence. Given that the cables are only present in the marine environment and notable distances from rivers, the degree of interaction between lampreys and EMF would be very small and not expected to disrupt migration routes.

3.2.30 For all designated Annex II diadromous fish species / populations that may be present in the nearshore and offshore area it is therefore concluded that effects associated with construction and operation of the wind farm would not disrupt migratory behaviour and give rise to any population level impacts. For all sites screened into the HRA process for their designated Annex II migratory fish populations, no LSE is concluded.

**Marine mammals**

3.2.31 Survey work has revealed that harbour porpoise are frequently present in Dogger Bank Teesside A & B and the Dogger Bank Zone and that the area is also used by grey seal and small numbers of harbour seal. The Dogger Bank cSAC is not designated for supporting any Annex II marine mammal populations.

3.2.32 Surveys of the entire Dogger Bank Zone, using Hi-Def video cameras, between November 2009 and July 2012 show harbour porpoise to be very abundant, occurring mostly in May and June (see paragraph 4.2.26 in **Chapter 14 Marine Mammals** of the Dogger Bank Teesside A & B ES). The highest number of individuals identified in a month was 930, in May 2011. Modelled estimates of harbour porpoise absolute density, calculated from the raw and fitted data, ranged from 0 to 1.5 (1.2 to 2.5) porpoise per $km^2$ in 2009 (upper and lower 95% confidence interval provided in brackets), from 0 to 2 (1.2 to 2.5) porpoise per $km^2$ in 2010, from 0 to 4 (2.5 to 7) porpoise per $km^2$ in 2011, and from 0 to 5 (3 to 7) porpoise per $km^2$ in 2012 (see paragraph 4.2.29 in **Chapter 14** of the Dogger Bank Teesside A & B ES). Density estimates appear to be increasing with the highest in 2012. Using the aerial survey data, an average absolute density of 0.64 individuals per $km^2$ was calculated across the survey area, with an estimated absolute abundance of 8,358 individuals (see paragraph 4.2.30 in **Chapter 14** of the Dogger Bank Teesside A & B ES).

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3.2.33 Dogger Bank Teesside A & B is at the furthermost foraging range of both harbour seal and grey seal. Grey seal are known to forage up to 145km from their haul outs (Thompson *et al*. 1996), whilst harbour seals forage up to 60km from their haul outs (Thompson & Miller 1990; Dietz *et al*. 2003). Telemetry data indicates that grey seal from the east coast of the UK and continental Europe may forage within or transit through Dogger Bank. Occasional use of the area is also indicated by tagged harbour seal from colonies in The Wash.

3.2.34 Boat-based surveys recorded low numbers (typically below 15) of grey seal in the Dogger Bank Zone throughout the year whilst, during December 2010 to March 2011, numbers were slightly higher, with up to 18 being observed. No grey seal were recorded during boat-based surveys undertaken in August, September or October 2010 (see paragraph 4.3.15 in **Chapter 14** of the Dogger Bank Teesside A & B ES). Aerial surveys detected even fewer grey seals, with a maximum of four seals for each month of January to April 2011 (see paragraph 4.3.16 in **Chapter 14** of the Dogger Bank Teesside A & B ES). Most winter surveys encountered no grey seal, with other monthly surveys identifying one or two individuals.

3.2.35 One harbour seal was recorded in the Dogger Bank Zone on surveys in March 2008 (Cork Ecology 2009), while the more recent boat-based surveys recorded seven harbour seals in the area in February 2011, one harbour seal in March 2011, October 2011 and November 2011, and two in December 2011. There were no other sightings throughout the entire survey period (see paragraph 4.3.39 in **Chapter 14** of the Dogger Bank Teesside A & B ES). Aerial surveys detected harbour seal in five of the 31 survey months (see paragraph 4.3.40 in **Chapter 14** of the Dogger Bank Teesside A & B ES), representing nine individuals throughout the year. Of the 24 harbour seals tagged in The Wash by the Sea Mammal Research Unit (SMRU), none entered the Dogger Bank Teesside A boundary and one harbour seal track reached the western boundary of Dogger Bank Teesside B (see paragraph 4.3.38 and Figure 4.38 in **Chapter 14** of the Dogger Bank Teesside A & B ES). This low usage is confirmed by Jones *et al*. (2013), which shows harbour seal density at Dogger Bank Teesside A & B to be zero (see Figure 4.38 in **Chapter 14** of the Dogger Bank Teesside A & B ES).

3.2.36 Screening identified that the main effects on marine mammals resulting from development for Dogger Bank Teesside A & B would relate to potential disturbance and displacement as a result of increased noise levels generated during construction work, reduction in prey availability (again due to disturbance and displacement of fish during construction), and increased collision risk with vessels during construction and operation. Of these effects, an increase in underwater noise levels during construction, specifically linked to piling works, is considered to possess the greatest potential for impact at the population level. Modelling of underwater noise levels has been undertaken to inform the assessment of potential behavioural responses of marine mammals during the construction phase for the wind farm (see **Chapter 14** of the Dogger Bank Teesside A & B ES for further information).

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3.2.37 While there is the potential for collision of mammals with vessels operating within and transiting to/from the development area, the overall risk of such collision is considered to be low. Guidance on the risk of pinniped mortality linked to the use of vessels with ducted propellers (Statutory Nature Conservation Agencies (SNCAs 2012) suggests that, for seals, the risk is low at distances over 30nm from breeding colonies; with Dogger Bank Teesside A & B and Dogger Bank Teesside A & B Export Cable Corridor located 54nm or more from the nearest colonies.

3.2.38 On the basis of the very low numbers of harbour seal observed within the Dogger Bank Zone (see paragraph 3.2.33 above), data from available tagging studies showing a very limited use of the area and the low risk of collision related mortality, it is concluded that wind farm development within Dogger Bank Teesside A & B and the Dogger Bank Zone would not have any implications for designated sites supporting harbour seal populations. No LSE was therefore concluded for SACs / SCIs for which harbour seal is a designated feature.

3.2.39 Given the greater observed usage of the Dogger Bank Zone by grey seal and tagging data which demonstrates that individuals appear to make active use of the Dogger Bank Zone for foraging (or transit between colonies), there is an increased potential (in comparison to that for harbour seal) for development effects to impact upon grey seal populations.

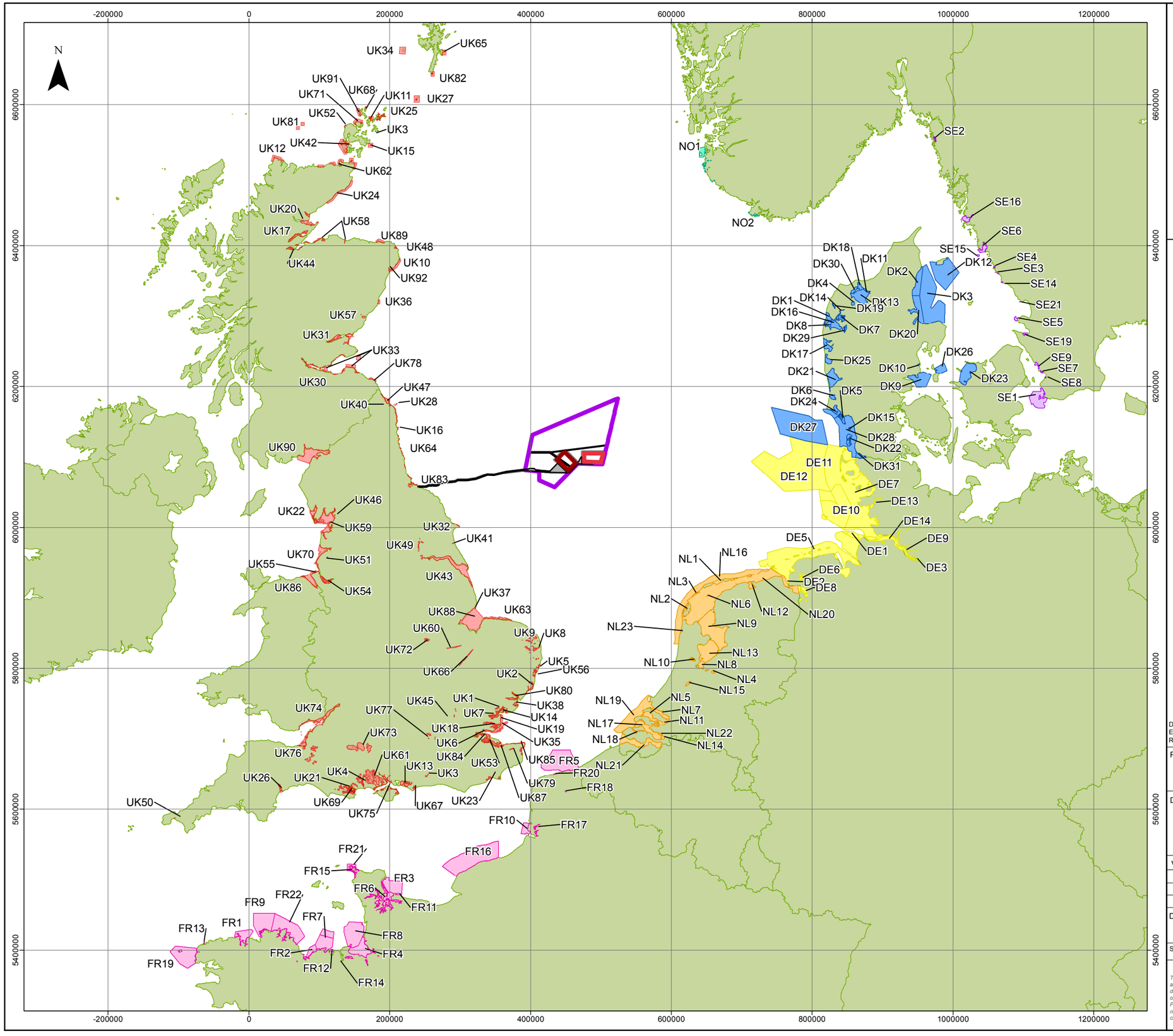
3.2.40 It is highly likely that harbour porpoise observed within Dogger Bank Teesside A & B form part of the overall mobile southern North Sea population. The effects of wind farm development, particularly increased underwater noise levels during construction, are known to have potential adverse effects on individual cetaceans and, therefore, development within Dogger Bank Teesside A & B and the wider Dogger Bank Zone could have implications for the status of this species within European sites which are designated for this feature.

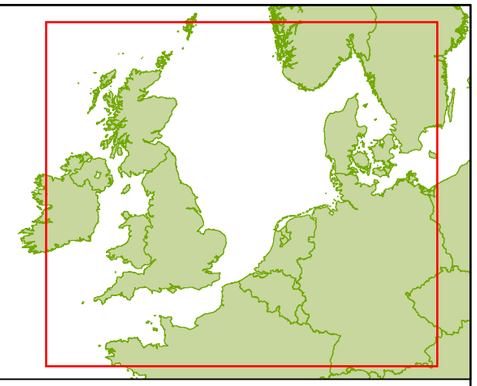
3.2.41 For the reasons set out, during screening it was not possible to discount the potential for LSE to arise with regard to European sites designated for their grey seal and harbour porpoise populations (see **Figure 3.2** and **Figure 3.3** respectively). All sites considered at the pre-screening stage that support designated Annex II grey seal and harbour porpoise mammal populations were, therefore, considered at risk of LSE and further information and assessment is provided in this report to determine whether an adverse effect on these species could occur.

**Birds**

3.2.42 Survey data and previous studies show that the Dogger Bank Zone may at times support nationally and internationally important numbers of seabirds (at all times of the year). Potentially, the Dogger Bank Zone and Dogger Bank Teesside A & B project area are also on the flyway of a significant number of migratory birds moving to and from breeding and wintering grounds. As such, wind farm development within the Dogger Bank Zone and Dogger Bank Teesside A & B may have significant implications for a large number of designated SPAs and Ramsar sites around the North Sea and potentially further afield (see **Figure 3.4** and **Table 3.4**).

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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
- Denmark Special Protection Area (SPA)/Ramsar site
- France Special Protection Area (SPA)
- Germany Special Protection Area (SPA)/Ramsar site
- Netherlands Special Protection Area (SPA)/Ramsar site
- Norway Ramsar site
- Sweden Special Protection Area (SPA)
- UK Special Protection Area (SPA)/Ramsar site selection

0 50 100 200

Kilometres

Data Source:
Environmental Designations © JNCC, 2014 and European Environment Agency, 2014
Round 3 offshore wind farm boundary © Crown Copyright, 2014

PROJECT TITLE

*Dogger Bank Teesside A & B*
IfAA Report

DRAWING TITLE

**Figure 3.4 Birds Directive sites screened in and assessed within this report (see Table 3.3 for site reference list)**

| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 11/10/2013 | PEI3 | JE | PT |
| 2 | 18/03/2014 | DCO Submission | GC | PT |
| | | | | |

DRAWING NUMBER:

**9Y0986/TSABHRA/05/R2**

| SCALE | PLOT SIZE | DATUM | PROJECTION |
|---|---|---|---|
| 1:5,500,000 | A3 | WGS84 | UTM31N |

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## Table 3.4 Site reference list for Figure 3.4

| Site name |
|---|
| **UK** |
| Abberton Reservoir SPA / Ramsar (UK1) |
| Alde–Ore Estuary SPA / Ramsar (UK2) |
| Arun Valley SPA / Ramsar (UK3) |
| Avon Valley SPA / Ramsar (UK4) |
| Benacre to Easton Bavents SPA (UK5) |
| Benfleet and Southend Marshes SPA / Ramsar (UK6) |
| Blackwater Estuary SPA / Ramsar (UK7) |
| Breydon Water SPA / Ramsar (UK8) |
| Broadland SPA / Ramsar (UK9) |
| Buchan Ness to Collieston Coast SPA (UK10) |
| Calf of Eday SPA (UK11) |
| Cape Wrath SPA (UK12) |
| Chichester and Langstone Harbours SPA / Ramsar (UK13) |
| Colne Estuary SPA / Ramsar (UK14) |
| Copinsay SPA (UK15) |
| Coquet Island SPA (UK16) |
| Cromarty Firth SPA / Ramsar (UK17) |
| Crouch and Roach Estuaries (Mid-Essex Coast Phase 3) Ramsar (UK18) |
| Dengie (Mid-Essex Coast Phase 1) SPA / Ramsar (UK19) |
| Dornoch Firth and Loch Fleet SPA / Ramsar (UK20) |
| Dorset Heathlands SPA (UK21) |
| Duddon Estuary SPA / Ramsar (UK22) |
| Dungeness to Pett Level SPA / Ramsar (UK23) |
| East Caithness Cliffs SPA (UK24) |
| East Sanday Coast SPA / Ramsar (UK25) |
| Exe Estuary SPA / Ramsar (UK26) |
| Fair Isle SPA (UK27) |
| Farne Islands SPA (UK28) |
| Fetlar SPA (UK29) |
| Firth of Forth SPA / Ramsar (UK30) |
| Firth of Tay and Eden Estuary SPA / Ramsar (UK31) |
| Flamborough and Filey Coast pSPA (UK32) |
| Forth Islands SPA (UK33) |
| Foula SPA (UK34) |
| Foulness (Mid-Essex Coast Phase 5) SPA / Ramsar (UK35) |
| Fowlsheugh SPA (UK36) |
| Gibraltar Point SPA / Ramsar (UK37) |
| Hamford Water SPA / Ramsar (UK38) |
| Hermaness, Saxa Vord and Valla Field SPA (UK39) |
| Holburn Lake and Moss Ramsar (UK40) |
| Hornsea Mere SPA (UK41) |
| Hoy SPA (UK42) |
| Humber Flats, Marshes and Coast SPA / (Humber Estuary) Ramsar (UK43) |
| Inner Moray Firth SPA / Ramsar (UK44) |
| Lee Valley SPA / Ramsar (UK45) |
| Leighton Moss SPA / Ramsar (UK46) |

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| Site name |
|---|
| Lindisfarne SPA / Ramsar (UK47) |
| Loch of Strathbeg SPA / Ramsar (UK48) |
| Lower Derwent Valley SPA / Ramsar (UK49) |
| Marazion Marsh SPA (UK50) |
| Martin Mere SPA / Ramsar (UK51) |
| Marwick Head SPA (UK52) |
| Medway Estuary and Marshes SPA / Ramsar (UK53) |
| Mersey Estuary SPA / Ramsar (UK54) |
| Mersey Narrows amd North Wirral Foreshore SPA / pRamsar (UK55) |
| Minsmere-Walberswick SPA / Ramsar (UK56) |
| Montrose Basin SPA / Ramsar (UK57) |
| Moray and Nairn Coast SPA / Ramsar (UK58) |
| Morecambe Bay SPA / Ramsar (UK59) |
| Nene Washes SPA / Ramsar (UK60) |
| New Forest SPA (UK61) |
| North Caithness Cliffs SPA (UK62) |
| North Norfolk Coast SPA / Ramsar (UK63) |
| Northumbria Coast SPA (UK64) |
| Noss SPA (UK65) |
| Ouse Washes SPA / Ramsar (UK66) |
| Pagham Harbour SPA / Ramsar (UK67) |
| Papa Westray (North Hill and Holm) SPA (UK68) |
| Poole Harbour SPA / Ramsar (UK69) |
| Ribble and Alt Estuaries SPA / Ramsar (UK70) |
| Rousay SPA (UK71) |
| Rutland Water SPA / Ramsar (UK72) |
| Salisbury Plain SPA (UK73) |
| Severn Estuary SPA / Ramsar (UK74) |
| Solent and Southampton Water SPA / Ramsar (UK76) |
| Somerset Levels and Moors SPA / Ramsar (UK77) |
| South West London Waterbodies SPA / Ramsar (UK77) |
| St Abb's Head to Fast Castle SPA (UK78) |
| Stodmarsh SPA / Ramsar (UK79) |
| Stour and Orwell Estuaries SPA / Ramsar (UK80) |
| Sule Skerry and Sule Stack SPA (UK81) |
| Sumburgh Head SPA (UK82) |
| Teesmouth and Cleveland Coast SPA / Ramsar (UK83) |
| Thames Estuary and Marshes SPA / Ramsar (UK84) |
| Thanet Coast and Sandwich Bay SPA / Ramsar (UK85) |
| The Dee Estuary SPA / Ramsar (UK86) |
| The Swale SPA / Ramsar (UK87) |
| The Wash SPA / Ramsar (UK88) |
| Troup, Pennan and Lion's Heads SPA (UK89) |
| Upper Solway Flats and Marshes SPA / Ramsar (UK90) |
| West Westray SPA (UK91) |
| Ythan Estuary, Sands of Forvie and Meikle Loch SPA / (Ythan Estuary and Meikle Loch) Ramsar (UK92) |


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| Site name |
| --- |
| **Denmark** |
| Agger Tange SPA (DK1) |
| Alborg Bugt, nordlige del SPA (DK2) |
| Ålborg Bugt, østlige del SPA (DK3) |
| Draby Vig SPA (DK4) |
| Fano SPA (DK5) |
| Filso SPA / Ramsar (DK6) |
| Glomstrup Vig, Agero, Munkholm og Katholm Odde, Lindholm og Rotholme SPA (DK7) |
| Harboøre Tange, Plet Enge og Gjeller Sø SPA (DK8) |
| Horsens Fjord og Endelave SPA / Ramsar (DK9) |
| Kysing Fjorde SPA (DK10) |
| Kysten fra Aggersund til Bygholm Vejle SPA (DK11) |
| Laeso, sydlige del SPA (DK12) |
| Logstor Bredning, Livo, Feggesund og Skarrehage SPA (DK13) |
| Magerodde og Karby Odde SPA (DK14) |
| Mando SPA (DK15) |
| Nissum Bredning SPA / (Nissum Bredning with Harboore & Agger Tange) Ramsar (DK16) |
| Nissum Fjord SPA / Ramsar (DK17) |
| Ostlige Vejler SPA (DK18) |
| Oveso SPA (DK19) |
| Randers og Mariager Fjorde og Alborg Bugt, sydlige del SPA (DK20) |
| Ringkøbing Fjord SPA / Ramsar (DK21) |
| Romo SPA (DK22) |
| Sejro Bug(t) tog Nekselo SPA / (Sejrø Bugt, Nekselø Bugt and Saltbaek Vig) Ramsar (DK23) |
| Skallingen og Langli SPA (DK24) |
| Stadil Fjord og Vest Stadil Fjord SPA / (Stadil & Veststadil Fjords) Ramsar (DK25) |
| Stavns Fjord SPA / (Stavns Fjord and adjacent waters) Ramsar (DK26) |
| Sydlige Nordsø SPA (DK27) |
| Vadehavet SPA / Ramsar (DK28) |
| Venø, Venø Sund SPA (DK29) |
| Vestlige Vejler, Arup Holm og Hovsor Ron SPA (DK30) |
| Vida(e)n, Tondermarsken og Saltvandssoen SPA (DK31) |
| **France** |
| Baie de Morlaix SPA (FR1) |
| Baie de Saint-Brieuc-Est SPA (FR2) |
| Baie de Seine occidentale SPA (FR3) |
| Baie du Mont Saint Michel SPA (FR4) |
| Bancs des Flandres SPA (FR5) |
| Basses Vallées du Cotentin et Baie des Veys SPA (FR6) |
| Cap d'Erquy-Cap Frehel SPA (FR7) |
| Chausey SPA (FR8) |
| Cote de Granit Rose-Sept Iles SPA (FR9) |
| Estuaires picards : Baie de Somme et d'Authie SPA (FR10) |
| Falaise du Bessin Occidental SPA (FR11) |
| Iles de la Colombière, de la Nellière et des Haches SPA (FR12) |
| Ilot du Trevors SPA (FR13) |
| Ilots Notre-Dame et Chevret SPA (FR14) |
| Landes et dunes de la Hague SPA (FR15) |

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| Site name |
|---|
| Littoral Seino-Marin SPA (FR16) |
| Marais arriere-littoraux Picards SPA (FR17) |
| Marais Audomarois SPA (FR18) |
| Ouessant-Molene SPA (FR19) |
| Platier d'Oye SPA (FR20) |
| Recifs et lands de la Hague SPA (FR21) |
| Tregor Goelo SPA (FR22) |
| **Germany** |
| Hamburgisches Wattenmeer SPA / Ramsar (DE1) |
| Hund und Paapsand SPA (DE2) |
| Muhlenberger Loch SPA / Ramsar (DE3) |
| Niederelbe, Barnkrug-Otterndorf Ramsar (DE4) ***Not shown on figure due to GIS licensing issues***. |
| Niedersächsisches Wattenmeer und angrenzendes Küstenmeer Ramsar (DE5) |
| Ostfriesische Meere SPA (DE6) |
| Ramsar Gebiet S-H Wattenmeer und angrenzende Küstengebiete SPA (DE7) |
| Rheiderland SPA (DE8) |
| Schleswig Holstein Wadden Sea and adjacent areas Ramsar (DE9) |
| Seevogelschutzgebiet Helgoland SPA (DE10) |
| SPA Östliche Deutsche Bucht SPA (DE11) |
| Sylter Außenriff SPA (DE12) |
| Untereider SPA (DE13) |
| Unterelbe SPA (DE14) |
| Wattenmeer, Elbe-Weser-Dreieck Ramsar (DE15) ***Not shown on figure due to GIS licensing issues***. |
| Wattenmeer, Jadebusen & Westliche Wesermundung Ramsar (DE16) N ***Not shown on figure due to GIS licensing issues***. |
| Wattenmeer, Ostfriesisches Wattenmeer & Dollart Ramsar (DE17) ***Not shown on figure due to GIS licensing issues***. |
| **Netherlands** |
| Boschplaat Ramsar (NL1) |
| Duinen en Lage Land Texel SPA (NL2) |
| Duinen Vlieland SPA (NL3) |
| Eemeer & Gooimeer Zuidover SPA (NL4) |
| Grevelingen SPA / Ramsar (NL5) |
| Griend Ramsar (NL6) |
| Haringvliet SPA (NL7) |
| Ijmeer Ramsar (NL8) |
| Ijsselmeer SPA / Ramsar (NL9) |
| Ilperveld, Varkensland en Twiske SPA (NL10) |
| Krammer Volkerak SPA / Ramsar (NL11) |
| Lauwersmeer SPA / Ramsar (NL12) |
| Markemeer en Ijmeer SPA / (Markemeer) Ramsar (NL13) |
| Markiezaat SPA (NL14) |
| Nieuwkoopse Plassen SPA (NL15) |
| Noordzeekustzone SPA / (Waddeneilanden, Noordzeekustzone, Breebaart) Ramsar (NL16) |
| Oosterschelde SPA / (Oosterschelde & Markiezaatmeer) Ramsar (NL17) |
| Veerse Meer SPA / Ramsar (NL18) |
| Voordelta SPA / Ramsar (NL19) |
| Waddenzee SPA / Ramsar (NL20) |

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| Site name |
|---|
| Westerschelde en Saeftinge SPA / Westerschelde en Verdronken Land van Saeftinge Ramsar (NL21) |
| Zoommeer SPA (NL22) |
| Zwanenwater SPA / Ramsar (NL23) |
| **Norway** |
| Jaeren Wetland System Ramsar (NO1) |
| Lista Wetlands System Ramsar (NO2) |
| Rott-Hastein Kjor Ramsar (NO3) |
| **Sweden** |
| Fasterbo-Foteviken SPA (SE1) |
| Galto lera-Alga lera SPA (SE2) |
| Gamla Kopstad SPA (SE3) |
| Getterons fagelreservat SPA (SE4) |
| Hallands Vadero SPA (SE5) |
| Kungsbackfjorden SPA (SE6) |
| Loddeans mynning SPA (SE7) |
| Lommaomradet SPA (SE8) |
| Lundakrabuten SPA (SE9) |
| Morups Tange SPA (SE14) |
| Nidingen SPA (SE15) |
| Nordre Als Esturarium SPA (SE16) |
| Skalderviken SPA (SE19) |
| Tylon SPA (SE21) |

3.2.43 The pre-screening exercise and HRA Screening Report (see **Appendix A** in the **HRA Report**) identified that the following designated sites and species populations should be included in the assessment process:

- SPAs and Ramsar sites designated for breeding seabird populations of the following species: northern fulmar, northern gannet, great skua, Arctic skua, black-legged kittiwake, lesser black-backed gull, great black-backed gull, common guillemot, razorbill, and Atlantic puffin. Unless specific tracking data was available, mean maximum foraging ranges were used to determine the sites from which birds observed within Dogger Bank Teesside A & B during the breeding season could derive. However, seabirds present within the development area and Dogger Bank Zone at other times of the year (e.g. wintering / passage) could also derive from these breeding sites as birds would not be constrained to their colonies post-breeding and, therefore, it is not possible to screen sites out solely on the use of foraging range during the breeding season;
- SPAs and Ramsar sites designated for wintering / passage seabird populations for the above seabird species, also including little gull, across the North Sea and the east coast of the UK; and
- SPAs and Ramsar sites that support designated populations of migratory species (including species that may form part of internationally important assemblages of waterbirds) that could pass through Dogger Bank Teesside A & B and the Dogger Bank Zone.

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3.2.44 While a reasoned argument to discount potential LSE for designated SPAs supporting breeding seabird populations located at distances greater than appropriate foraging ranges of the species populations could be made, it was noted that seabirds from sites at a distance greater than these foraging ranges could pass through or overwinter within the Dogger Bank Zone. Consequently, it was determined that, for all sites around the greater North Sea that support the key seabird species, the potential for LSE could arise as a result of wind farm development within the Dogger Bank Zone, including Dogger Bank Teesside A & B.

3.2.45 A number of seabird species were screened out with respect to LSE (see **Appendix A** of the **HRA Report**) on the basis of very low numbers present within the Dogger Bank Zone (both during the breeding and non-breeding seasons) and the fact the development site lies well outside of the foraging range of the majority of breeding seabirds. Species falling into this category include: great cormorant, European shag, pomarine skua, European storm petrel, and Leach's storm-petrel.

3.2.46 With regard to herring gull, this species was screened out with respect to LSE (see paragraphs 6.3.73 and 6.3.74 in **Appendix A** of the **HRA Report**) due to the very low numbers present (also see **Table 6.9**) and the proposed development area being significantly outside the mean maximum foraging range for the herring gull populations at any European sites around the North Sea.

3.2.47 Arctic tern and common ternwere screened out with respect to LSE (see paragraphs 6.3.75 to 6.3.82 in **Appendix A** of the **HRA Report**) due to the very low numbers present within the Dogger Bank Zone as a whole (see **Table 6.9**) and the fact that their key migration routes being predominantly coastal, in the context of the projects significant distance offshore.

3.2.48 The HRA Screening Report (see **Appendix A** of the **HRA Report**), concluded that, due to the numerous migratory populations that could be at risk from wind farm development, a LSE could arise with respect to all SPAs / Ramsar sites around the greater North Sea that support migratory species that pass through the Dogger Bank Zone and Dogger Bank Teesside A & B.

## 3.3 Project activities and effects screened in / out of this assessment

3.3.1 The project activities and effects considered in this report are those related to the construction, operation and decommissioning of Dogger Bank Teesside A & B, comprising the landfall for the export cable, the export cable route, and the offshore wind farm, as detailed in Section 2. As explained in the introduction to this section, the activities considered are those that could generate effects that have the potential to lead to a LSE in respect of the European sites and features identified as part of the screening process.

3.3.2 The HRA Screening Report (see **Appendix A** of the **HRA Report**) assessed the potential of all of the key effects that could be generated by project activities to impact upon designated European sites and their features. As stated previously, screening was conducted with reference to information available at

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the time and a precautionary approach was adopted to determine the potential characteristics, magnitude and extent of effects likely to arise from project activities.

3.3.3 Information reported within the Dogger Bank Teesside A & B ES provides much greater detail on the baseline environment and the nature of effects that could occur as a result of project development. This additional information has enabled the screening process to be refined with respect to the potential for impacts to occur on the designated features of European sites as a result of project activities.

3.3.4 Consequently, in order to focus the appropriate assessment stage on those activities with the potential to generate effects that may give rise to a LSE on European sites and their interest features, a review of the effects assessed and reported within the Dogger Bank Teesside A & B ES has been undertaken (see **Appendix A** of the **HRA Report** and summary in **Table 3.3**). This review has 'screened in' or 'screened out' activities and their associated effects.

3.3.5 Direct effects are those that lead to an impact on an environmental receptor as a direct result of the activity itself. In this instance the project activity would have to take place within a designated European site (e.g. habitat loss / disturbance) or modify species populations (e.g. through direct mortality). The direct effects that could arise from the project are detailed in Section 5.2 of **Appendix A** of the **HRA Report**.

3.3.6 Indirect effects are considered through a determination of the source of the effect (i.e. the activity), the presence of a pathway, and the presence of a receptor (interest feature or species) on which an impact could arise. These are secondary effects that arise as a consequence of the direct effect(s) of the project itself. If there is no pathway from the source of the effect to a European site or interest feature(s) then the activities in question can be screened out from further assessment. The indirect effects that could arise from the project are detailed in Section 5.2 of **Appendix A** of the **HRA Report**.

3.3.7 It should be reiterated at this stage that the HRA Screening Report (see **Appendix A** of the **HRA Report**) identified that LSE with respect to designated terrestrial habitats and species would not arise as a result of onshore development for Dogger Bank Teesside A & B; consequently, onshore activities and associated effects are not considered further herein.

3.3.8 A summary effects map (set out in **Table 3.3**) has been developed from this screening exercise using the processes and effects that are linked to the sensitivity of the various features of the European sites screened into the assessment (i.e. for which LSE has been determined). The effects map presents all the project activities that could give rise to effects with the potential to affect European sites and features, showing those activities and effects that are assessed further in this report.

3.3.9 Based on the information contained in relevant Dogger Bank Teesside A & B ES chapters, the following activities and effects have been screened out of the assessment process and are not, therefore, included in **Table 3.3**.

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## Water quality effects that may result from incidental or accidental spillages and leaks

3.3.10 Whilst there is no intention to discharge toxic contaminants into the aquatic environment as a result of project activities in any phase of the development of Dogger Bank Teesside A & B, there is a potential for incidental or accidental discharges of synthetic or non-synthetic substances (e.g. lubricants, diesel, screenwash, coolants, grey and black water, sewage, and concrete / cement based grout). Given that it is impossible to determine with any certainty the potential nature, scale and effect of potential incidental or accidental discharges on the environment, no specific assessment of the potential impacts on designated European sites and their interest features has been undertaken. However, the potential for such events to occur and their adverse environmental consequences are fully recognised.

3.3.11 The risk of these events and their likelihood of occurrence can be managed and minimised through the use of good practice measures. These measures will be set out in an Environmental Management Plan (EMP) covering the identified risks for each phase of the project. The EMP will be developed post-consent when specific details of the final scheme proposal are confirmed, and subject to the requirements that arise during the examination relevant to the Dogger Bank Teesside A & B development consent application. The EMP will set out the measures to be utilised to reduce the risk of any incident or accident to a very low level of probability. Furthermore, measures will also be identified within the EMP which are intended to minimise the effect of any accidental or incidental spillage. That is, it will identify a range of measures to manage (e.g. clean-up) any incidental or accidental spillage, should an incident occur, principally through containment.

## Water quality effects from the re-suspension of contaminated sediments

3.3.12 Twenty three sediment samples from across the Tranche A and B areas within and adjacent to Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor were analysed for metals, Polychlorinated biphenyls (PCBs), Dibutyltin (DBT), and Polycyclic aromatic hydrocarbons (PAHs). The results of the analyses are presented in Tables 4.1 and 4.2 in **Chapter 10 Marine Water and Sediment Quality** of the Dogger Bank Teesside A & B ES.

3.3.13 The survey data (summarised in **Table 3.5** and shown in Tables 4.1 and 4.3 in **Chapter 10** of the Dogger Bank Teesside A & B ES) indicates that whilst some sites along the Dogger Bank Teesside A & B Export Cable Corridor exceed either the Cefas Action Level 1 concentrations or the Canadian Sediment Quality Guidance threshold effect levels (TELs) for metal contaminants (such as arsenic, chromium, copper, lead or nickel) only one site exceeded the higher Cefas Action Level 2 (for nickel) and 6 sites exceeded the Canadian probable effect levels (PELs) for chromium and four for copper.

3.3.14 Within the area for tranches A & B (see Tables 4.2 and 4.4 in **Chapter 10** of the Dogger Bank Teesside A & B ES, and summarised in **Table 3.5**), only one site exceeded the Cefas Action Level 1 concentrations (for chromium, copper, and nickel) and the Canadian Sediment Quality Guidance TEL (for chromium), though one site also exceeded the Canadian probable effect levels (PELs) for

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copper. Furthermore, only two sites exceeded the Canadian TEL for Napthalene. All other PAHs, and all PCB and DBT concentrations were below the exceedance levels for any relevant criteria at the sampled locations in tranches A & B.

Table 3.5 Number of sediment samples out of 23 taken for the Dogger Bank Teesside A & B Export Cable Corridor and tranches A & B showing metal concentrations exceeding Cefas and Canadian guideline ranges

| Metal | Cefas Action Levels (AL) | | | Canadian Sediment Quality Guidelines | | | |
|---|---|---|---|---|---|---|---|
| | AL 1 | | AL 2 | TEL | | PEL | |
| | Export cable corridor | Wind farm | Export cable corridor | Export cable corridor | Wind farm | Export cable corridor | Wind farm |
| Arsenic | 1 | 0 | 0 | 8 | 0 | 0 | 0 |
| Cadmium | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Chromium | 9 | 1 | 0 | 3 | 1 | 6 | 0 |
| Copper | 9 | 1 | 0 | 5 | 0 | 4 | 1 |
| Mercury | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lead | 4 | 0 | 0 | 5 | 0 | 0 | 0 |
| Nickel | 8 | 1 | 1 | n/a | n/a | n/a | n/a |
| Zinc | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total hydrocarbons | 0 | 0 | 0 | 7[1] | 2[1] | 0 | 0 |

1 Individual hydrocarbon exceedances identified for Canadian Sediment Quality Guideline TELs.

3.3.15 Given that the significant majority of disturbance would arise within the offshore wind farm area for Dogger Bank Teesside A & B (i.e. within tranches A & B), and elevated levels of sediment contaminant concentrations with the potential to result in impacts on marine fauna and communities have not been recorded within tranches A & B, it is concluded that an adverse effect on site integrity would not arise. Whilst indicative contaminant levels are noted for some metals at some sampling sites for the Dogger Bank Teesside A & B Export Cable Corridor, the negligible and localised disturbance proposed, and the predominantly sandy nature of the material present, significantly reduces the potential for re-suspension and transport of contaminants. Consequently, contaminant effects resulting from the re-suspension of sediment are not assessed further as a significant effect is not expected.

## Direct non-physical disturbance (EMF) effects on cetaceans and pinnipeds (specifically European site features - grey seal and harbour porpoise)

3.3.16 There is no evidence available to indicate that benthic communities or marine mammals are affected (either through altered behaviour or any other effects) by the electromagnetic fields (EMF) associated with electric cables (Normandeau *et al*. 2011). The high voltage direct current (HVDC) system proposed to be deployed is considered to have significantly lower EMF emissions than alternating current (AC) systems that have been used to date (OSPAR 2009) and is, therefore, unlikely to give rise to any noticeable or measurable impacts.

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Consequently, given the low sensitivity of marine mammals to EMF, the fact that cables would be mainly buried or covered over, the depth of water above the cables (such that any EMF reduces with distance), and that the cables will be shielded to meet industry standards, the effect of EMF on marine mammals is not considered further in this assessment.

### Physical barrier effects on European site features (specifically grey seal and harbour porpoise)

3.3.17 The minimum spacing between 6MW turbines would be 750m. This means that animals can be expected to move between structures and through the operational wind farm irrespective of layout. Evidence from the Egmond aan Zee offshore wind farm (Lindeboom *et al*. 2011) suggests that marine mammals may be attracted to the site for foraging and, as such, this indicates that the wind farm would not act as a barrier to the movement of individuals or populations in the area.

## 3.4 Summary of all European designated sites screened into this Information for Appropriate Assessment Report

3.4.1 **Table 3.6** presents the list of all sites considered during the screening process for Dogger Bank Teesside A & B, and identifies whether each site has been screened in or out of this assessment. As identified earlier, the final LSE conclusions for all sites and their relevant features are detailed in **Appendix D** of the **HRA Report**.

## 3.5 Summary of the HRA Screening Report consultation responses

3.5.1 The comments received from the Joint Nature Conservation Committee (JNCC), Natural England, and the Marine Management Organisation (MMO) with respect to the HRA Screening Report are tabulated in **Appendix C** of the **HRA Report**. Where comments identified European sites or their associated features that should be screened in or out of the appropriate assessment stage, these have been considered and relevant inclusions or exclusions incorporated within this section. The key comments received from the JNCC and Natural England are summarised in **Appendix C** of the **HRA Report**, along with an indication of how they have been addressed in this document or elsewhere in the Dogger Bank Teesside A & B ES.

3.5.2 Responses to the technical comments received from the JNCC, Natural England and the Royal Society for the Protection of Birds (RSPB) on the ornithology EIA methodologies (geographical and ecological assumptions papers) are presented in Appendix 3 of **Appendix 11A** of the Dogger Bank Teesside A & B ES.

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## Table 3.6 Summary of all UK and transboundary European sites screened in or out of the Dogger Bank Teesside A & B HRA process

| Site and designation | Screened In |
|---|---|
| Abberton Reservoir SPA | Yes |
| Abberton Reservoir Ramsar | Yes |
| Alde–Ore Estuary SPA | Yes |
| Alde–Ore Estuary Ramsar | Yes |
| Arun Valley SPA | Yes |
| Arun Valley Ramsar | Yes |
| Auskerry SPA | No |
| Avon Valley SPA | Yes |
| Avon Valley Ramsar | Yes |
| Beast Cliff-Whitby (Robin Hood's Bay) SAC | No |
| Benacre to Easton Bavents SPA | Yes |
| Benfleet and Southend Marshes SPA | Yes |
| Benfleet and Southend Marshes Ramsar | Yes |
| Berriedale and Langwell Waters SAC | No |
| Berwickshire and North Northumberland Coast SAC | Yes |
| Blackwater Estuary (Mid-Essex Coast Phase 4) SPA | Yes |
| Blackwater Estuary (Mid-Essex Coast Phase 4) Ramsar | Yes |
| Breydon Water SPA | Yes |
| Breydon Water Ramsar | Yes |
| Broadland SPA | Yes |
| Broadland Ramsar | Yes |
| Buchan Ness To Collieston Coast SPA | Yes |
| Caithness and Sutherland Peatlands SPA | No |
| Caithness and Sutherland Peatlands Ramsar | No |
| Caithness Lochs SPA | No |
| Caithness Lochs Ramsar | No |
| Calf of Eday SPA | Yes |
| Cape Wrath SPA | Yes |
| Chesil Beach and the Fleet SPA | No |
| Chesil Beach and the Fleet Ramsar | No |
| Chichester and Langstone Harbours SPA | Yes |
| Chichester and Langstone Harbours Ramsar | Yes |
| Colne Estuary (Mid-Essex Coast Phase 2) SPA | Yes |
| Colne Estuary (Mid-Essex Coast Phase 2) Ramsar | Yes |
| Copinsay SPA | Yes |
| Coquet Island SPA | Yes |
| Cromarty Firth SPA | Yes |
| Cromarty Firth Ramsar | Yes |
| Crouch and Roach Estuaries (Mid-Essex Coast Phase 3) SPA | No |
| Crouch and Roach Estuaries (Mid-Essex Coast Phase 3) Ramsar | Yes |
| Deben Estuary SPA | No |
| Deben Estuary Ramsar | No |
| Dengie SPA | Yes |
| Dengie (Mid-Essex Coast Phase 1) Ramsar | Yes |
| Dogger Bank cSAC | Yes |
| Dornoch Firth and Loch Fleet SPA | Yes |

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| Site and designation | Screened In |
|---|---|
| Dornoch Firth and Loch Fleet Ramsar | Yes |
| Dorset Heathlands SPA | Yes |
| Dorset Heathlands Ramsar | No |
| Duddon Estuary SPA | Yes |
| Duddon Estuary Ramsar | Yes |
| Dungeness to Pett Level SPA | Yes |
| Dungeness to Pett Level proposed Ramsar | Yes |
| East Caithness Cliffs SPA | Yes |
| East Sanday Coast SPA | Yes |
| East Sanday Coast Ramsar | Yes |
| Exe Estuary SPA | Yes |
| Exe Estuary Ramsar | Yes |
| Fair Isle SPA | Yes |
| Faray and Holm of Faray SAC | Yes |
| Farne Islands SPA | Yes |
| Fetlar SPA | Yes |
| Firth of Forth SPA | Yes |
| Firth of Forth Ramsar | Yes |
| Firth of Tay and Eden Estuary SPA | Yes |
| Firth of Tay and Eden Estuary Ramsar | Yes |
| Flamborough and Filey Coast pSPA | Yes |
| Flamborough Head SAC | No |
| Forth Islands SPA | Yes |
| Foula SPA | Yes |
| Foulness (Mid-Essex Coast Phase 5) SPA | Yes |
| Foulness (Mid-Essex Coast Phase 5) Ramsar | Yes |
| Fowlsheugh SPA | Yes |
| Gibraltar Point SPA | Yes |
| Gibraltar Point Ramsar | Yes |
| Great Yarmouth North Denes SPA | No |
| Haisborough, Hammond and Winterton cSAC | No |
| Hamford Water SPA | Yes |
| Hamford Water Ramsar | Yes |
| Hermaness, Saxa Vord and Valla Field SPA | Yes |
| Holburn Lake and Moss SPA | No |
| Holburn Lake and Moss Ramsar | Yes |
| Hornsea Mere SPA | Yes |
| Hoy SPA | Yes |
| Humber Estuary SAC | Yes |
| Humber Estuary Ramsar | Yes |
| Humber Flats, Marshes and Coast SPA | Yes |
| Inner Dowsing, Race Bank and North Ridge cSAC | No |
| Inner Moray Firth SPA | Yes |
| Inner Moray Firth Ramsar | Yes |
| Isle of May SAC | Yes |
| Lee Valley SPA | Yes |
| Lee Valley Ramsar | Yes |
| Leighton Moss SPA | Yes |


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| Site and designation | Screened In |
|---|---|
| Leighton Moss Ramsar | Yes |
| Lindisfarne SPA | Yes |
| Lindisfarne Ramsar | Yes |
| Loch of Strathbeg SPA | Yes |
| Loch of Strathbeg Ramsar | Yes |
| Lower Derwent Valley SPA | Yes |
| Lower Derwent Valley Ramsar | Yes |
| Marazion Marsh SPA | Yes |
| Martin Mere SPA | Yes |
| Martin Mere Ramsar | Yes |
| Marwick Head SPA | Yes |
| Medway Estuary and Marshes SPA | Yes |
| Medway Estuary and Marshes Ramsar | Yes |
| Mersey Estuary SPA | Yes |
| Mersey Estuary Ramsar | Yes |
| Mersey Narrows and North Wirral Foreshore SPA | Yes |
| Mersey Narrows and North Wirral Foreshore Ramsar | Yes |
| Minsmere-Walberswick SPA | Yes |
| Minsmere-Walberswick Ramsar | Yes |
| Montrose Basin SPA | Yes |
| Montrose Basin Ramsar | Yes |
| Moray and Nairn Coast SPA | Yes |
| Moray and Nairn Coast Ramsar | Yes |
| Morecambe Bay SPA | Yes |
| Morecambe Bay Ramsar | Yes |
| Mousa SPA | No |
| Nene Washes SPA | Yes |
| Nene Washes Ramsar | Yes |
| New Forest SPA | Yes |
| North Caithness Cliffs SPA | Yes |
| North Norfolk Coast SAC | No |
| North Norfolk Coast SPA | Yes |
| North Norfolk Coast Ramsar | Yes |
| North Norfolk Sandbanks and Saturn Reef cSAC | No |
| Northumbria Coast SPA | Yes |
| Northumbria Coast Ramsar | Yes |
| Noss SPA | Yes |
| Orkney Mainland Moors SPA | No |
| Otterswick and Graveland SPA | No |
| Ouse Washes SPA | Yes |
| Ouse Washes Ramsar | Yes |
| Outer Thames Estuary SPA | No |
| Pagham Harbour SPA | Yes |
| Pagham Harbour Ramsar | Yes |
| Papa Stour SPA | No |
| Papa Westray (North Hill and Holm) SPA | Yes |
| Pentland Firth Islands SPA | No |
| Poole Harbour SPA | Yes |

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| Site and designation | Screened In |
|---|---|
| Poole Harbour Ramsar | Yes |
| Ramna Stacks and Gruney SPA | No |
| Ribble and Alt Estuaries SPA | Yes |
| Ribble and Alt Estuaries Ramsar | Yes |
| River Derwent SAC | No |
| River Oykel SAC | No |
| River South Esk SAC | No |
| River Spey SAC | No |
| River Tay SAC | No |
| River Teith SAC | No |
| River Thurso SAC | No |
| River Tweed SAC | No |
| Ronas Hill – North Roe and Tingon SPA | No |
| Ronas Hill – North Roe and Tingon Ramsar | No |
| Rousay SPA | Yes |
| Rutland Water SPA | Yes |
| Rutland Water Ramsar | Yes |
| Salisbury Plain SPA | Yes |
| Saltfleetby-Theddlethorpe Dunes & Gibraltar Point SAC | No |
| Severn Estuary SPA | Yes |
| Severn Estuary Ramsar | Yes |
| Solent and Southampton Water SPA | Yes |
| Solent and Southampton Water Ramsar | Yes |
| Somerset Levels and Moors SPA | Yes |
| Somerset Levels and Moors Ramsar | Yes |
| South West London Waterbodies SPA | Yes |
| South West London Waterbodies Ramsar | Yes |
| St Abb's Head to Fast Castle SPA | Yes |
| Stodmarsh SPA | Yes |
| Stodmarsh Ramsar | Yes |
| Stour and Orwell Estuaries SPA | Yes |
| Stour and Orwell Estuaries Ramsar | Yes |
| Sule Skerry and Sule Stack SPA | Yes |
| Sumburgh Head SPA | Yes |
| Switha SPA | No |
| Teesmouth and Cleveland Coast SPA | Yes |
| Teesmouth and Cleveland Coast Ramsar | Yes |
| Thames Estuary and Marshes SPA | Yes |
| Thames Estuary and Marshes Ramsar | Yes |
| Thanet Coast and Sandwich Bay SPA | Yes |
| Thanet Coast and Sandwich Bay Ramsar | Yes |
| The Dee Estuary SPA | Yes |
| The Dee Estuary Ramsar | Yes |
| The River Dee SAC | No |
| The Swale SPA | Yes |
| The Swale Ramsar | Yes |
| The Wash SPA | Yes |
| The Wash Ramsar | Yes |


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| Site and designation | Screened In |
|---|---|
| The Wash and North Norfolk Coast SAC | No |
| Troup, Pennan And Lion's Heads SPA | Yes |
| Tweed Estuary SAC | No |
| Upper Solway Flats and Marshes SPA | Yes |
| Upper Solway Flats and Marshes Ramsar | Yes |
| West Westray SPA | Yes |
| Ythan Estuary and Meikle Loch Ramsar | Yes |
| Ythan Estuary, Sands of Forvie and Meikle Loch SPA | Yes |
| **Belgium** | |
| Het Zwin SPA | Yes |
| Kustbroedvogels te Zeebrugge-Heist SPA | No |
| SBZ 1 pSCI | Yes |
| SBZ 2 pSCI | Yes |
| SBZ 3 pSCI | Yes |
| Uitbreeding Trapegeer-Stroombank SCI (Vlaamse Bank SCI) | Yes |
| Vlakte van de Raan SCI | Yes |
| ZPS 1 SPA | Yes |
| ZPS 2 SPA | Yes |
| ZPS 3 SPA | Yes |
| **Denmark** | |
| Agger Tange SPA | Yes |
| Agger Tange, Nissum Bredning, Skibsted Fjord og Agerø SCI / SAC | Yes |
| Alborg Bugt, nordlige del SPA | Yes |
| Ålborg Bugt, østlige del SPA | Yes |
| Draby Vig SCI | No |
| Draby Vig SPA | Yes |
| Fano SPA | Yes |
| Filso Ramsar | Yes |
| Filso SPA | Yes |
| Glomstrup Vig, Agero, Munkholm og Katholm Odde, Lindholm og Rotholme SPA | Yes |
| Harboøre Tange, Plet Enge og Gjeller Sø SPA | Yes |
| Hirsholmene SPA | No |
| Hirsholmene Ramsar | No |
| Hirsholmene, havet vest herfor og Ellinge Å's udløb SCI / SAC | Yes |
| Horsens Fjord, havet øst for og Endelave SCI / SAC | Yes |
| Horsens Fjord og Endelave SPA | Yes |
| Horsens Fjord og Endelave Ramsar | Yes |
| Kallesmærsk Hede og Grærup Langsø SPA | No |
| Kallesmærsk Hede, Grærup Langsø, Fiilsø og Kærgård Klitplantage SCI / SAC | No |
| Kysing Fjorde SPA | Yes |
| Kysten fra Aggersund til Bygholm Vejle SPA | Yes |
| Laeso, sydlige del SPA | Yes |
| Løgstør Bredning, Livø, Feggesund og Skarrehage SPA | Yes |
| Magerodde og Karby Odde SCI / SAC | No |
| Magerodde og Karby Odde SPA | Yes |
| Mandø SPA | Yes |
| Nissum Bredning SPA | Yes |

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| Site and designation | Screened In |
|---|---|
| Nissum Bredning with Harboore and Agger Tange Ramsar | Yes |
| Nissum Fjord SCI / SAC | No |
| Nissum Fjord SPA | Yes |
| Nissum Fjord Ramsar | Yes |
| Nordre Rønner SPA | No |
| Nordre Rønner Ramsar | No |
| Østlige Vejler SPA | Yes |
| Ovesø SPA | Yes |
| Randers og Mariager Fjorde og Alborg Bugt, sydlige del SPA | Yes |
| Ringkøbing Fjord SPA | Yes |
| Ringkøbing Fjord Ramsar | Yes |
| Rømø SPA | Yes |
| Sejrø Bugt og Nekselø SPA | Yes |
| Sejrø Bugt, Nekselø Bugt and Saltbaek Vig Ramsar | Yes |
| Skallingen og Langli SPA | Yes |
| Stadil and Veststadil Fjords Ramsar | Yes |
| Stadil Fjord og Vest Stadil Fjord SCI / SAC | No |
| Stadil Fjord og Vest Stadil Fjord SPA | Yes |
| Stavns Fjord SPA | Yes |
| Stavns Fjord and adjacent waters Ramsar | Yes |
| Stavns Fjord, Samsø Østerflak og Nordby Hede SCI / SAC | No |
| Sydlige Nordsø SCI / SAC | Yes |
| Sydlige Nordsø SPA | Yes |
| Vadehavet SPA | Yes |
| Vadehavet Ramsar | Yes |
| Vadehavet med Ribe Å, Tved Å og Varde Å vest for Varde SCI / SAC | Yes |
| Venø, Venø Sund SCI / SAC | Yes |
| Venø, Venø Sund SPA | Yes |
| Vestlige Vejler, Arup Holm og Hovsør Røn SPA | Yes |
| Vidaen, Tøndermarsken og Saltvandssøen SPA | Yes |
| **France** | |
| Baie de Morlaix SPA | Yes |
| Baie de Saint-Brieuc-Est SPA | Yes |
| Baie de Seine occidentale SPA | Yes |
| Baie du Mont Saint Michel SPA | Yes |
| Bancs des Flandres SPA | Yes |
| Basses Vallees du Contentin et Baie des Veys SPA | Yes |
| Cap d'Erquy-Cap Frehel SPA | Yes |
| Chausey SPA | Yes |
| Cote de Granit Rose-Sept Iles SPA | Yes |
| Estuaires picards: Baie de Somme et d'Authie SPA | Yes |
| Falaise du Bessin Occidental SPA | Yes |
| Iles de la Colombiere, de la Nelliere et des Haches SPA | Yes |
| Ilot du Trevors SPA | Yes |
| Ilots Notre-Dame et Chevret SPA | Yes |
| Landes et dunes de la Hague SPA | Yes |
| Littoral Seino-Marin SPA | Yes |
| Marais arriere-littoraux Picards SPA | Yes |

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| Site and designation | Screened In |
|---|---|
| Marais Audomarois SPA | Yes |
| Ouessant-Molene SPA | Yes |
| Platier d'Oye SPA | Yes |
| Récifs et landes de la Hague SCI | Yes |
| Tregor Goelo SPA | Yes |
| **Germany** | |
| Borkum-Riffgrund (Borkum Reef Ground) SCI | Yes |
| Doggerbank SCI | Yes |
| Hamburgisches Wattenmeer SCI | Yes |
| Hamburgisches Wattenmeer SPA | Yes |
| Hamburgisches Wattenmeer Ramsar | Yes |
| Helgoland mit Helgoländer Felssockel SCI | Yes |
| Hund und Paapsand SCI | No |
| Hund und Paapsand SPA | Yes |
| Küsten- und Dünenlandschaften Amrums SCI | Yes |
| Muhlenberger Loch SPA | Yes |
| Muhlenberger Loch Ramsar | Yes |
| Nationalpark Niedersächsisches Wattenmeer SCI | No |
| Niederelbe, Barnkrug-Otterndorf Ramsar | Yes |
| Niedersächsisches Wattenmeer und angrenzendes Küstenmeer SPA | Yes |
| NSG Rantumbecken SCI | Yes |
| NTP S-H Wattenmeer und angrenzende Kustengebiete SCI | Yes |
| Ostfriesische Meere SPA | Yes |
| Ramsar Gebiet S-H Wattenmeer und angrenzende Küstengebiete SPA | Yes |
| Rheiderland SPA | Yes |
| Schleswig Holstein Wadden Sea and adjacent areas Ramsar | Yes |
| Schleswig-Holsteinisches Elbästuar und angrenzende Flächenupdate SCI | No |
| Seevogelschutzgebiet Helgoland SPA | Yes |
| SPA Östliche Deutsche Bucht SPA | Yes |
| Steingrund SCI | Yes |
| Sylter Außenriff (Sylt Outer Reef) SCI | Yes |
| Sylter Außenriff SPA | Yes |
| Unterems und Außenems pSCI | No |
| Untereider SPA | Yes |
| Unterelbe SCI | Yes |
| Unterelbe SPA | Yes |
| Wattenmeer, Elbe-Weser-Dreieck Ramsar | Yes |
| Wattenmeer, Jadebusen & Westliche Wesermundung Ramsar | Yes |
| Wattenmeer, Ostfriesisches Wattenmeer & Dollart Ramsar | Yes |
| **Netherlands** | |
| Boschplaat Ramsar | Yes |
| Doggersbank SCI | Yes |
| Duinen en Lage Land Texel SPA | Yes |
| Duinen Terschelling SPA | No |
| Duinen Vlieland SPA | Yes |
| Eemeer & Gooimeer Zuidover SPA | Yes |
| Eems-Dollard SCI | No |

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| Site and designation | Screened In |
|---|---|
| Grevelingen SPA | Yes |
| Grevelingen Ramsar | Yes |
| Griend Ramsar | Yes |
| Haringvliet SCI | No |
| Haringvliet SPA | Yes |
| Ijmeer Ramsar | Yes |
| Ijsselmeer SPA | Yes |
| Ijsselmeer Ramsar | Yes |
| Ilperveld, Varkensland en Twiske SPA | Yes |
| Klaverbank SCI | Yes |
| Krammer Volkerak SPA | Yes |
| Krammer Volkerak Ramsar | Yes |
| Lauwersmeer SPA | Yes |
| Lauwersmeer Ramsar | Yes |
| Markemeer Ramsar | Yes |
| Markemeer en Ijmeer SPA | Yes |
| Markiezaat SPA | Yes |
| Nieuwkoopse Plassen SPA | Yes |
| Noordzeekustzone SCI | Yes |
| Noordzeekustzone SPA | Yes |
| Noordzeekustzone II pSCI | Yes |
| Oosterschelde SCI | No |
| Oosterschelde SPA | Yes |
| Oosterschelde & Markiezaatmeer Ramsar | Yes |
| Veerse Meer SPA | Yes |
| Veerse Meer Ramsar | Yes |
| Vlakte Van der Raan SCI / SAC | Yes |
| Voordelta SCI | Yes |
| Voordelta SPA | Yes |
| Voordelta Ramsar | Yes |
| Voornes Duin SPA | No |
| Voornes Duin Ramsar | No |
| Waddeneilanden, Noordzeekustzone, Breebaart Ramsar | Yes |
| Waddenzee SCI / SAC | Yes |
| Waddenzee SPA | Yes |
| Waddenzee Ramsar | Yes |
| Westerschelde en Saeftinghe SCI | No |
| Westerschelde en Saeftinge SPA | Yes |
| Westerschelde en Verdronken Land van Saeftinge Ramsar | Yes |
| Zoommeer SPA | Yes |
| Zwanenwater SPA | Yes |
| Zwanenwater Ramsar | Yes |

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| Site and designation | Screened In |
|---|---|
| **Norway** | |
| Jaeren Wetland System Ramsar | Yes |
| Lista Wetlands System Ramsar | Yes |
| Rott-Hastein Kjor Ramsar | Yes |
| **Sweden** | |
| Angelholms kronopark SCI / SAC | No |
| Balgo SCI | No |
| Balgo SPA | No |
| Batafjorden SPA | No |
| Bjarekusten SCI / SAC | No |
| Falsterbo-Foteviken SPA | Yes |
| Galtaback-Lynga strandanger SPA | No |
| Galto lera-Algo lera SPA | Yes |
| Gamla Kopstad SPA | Yes |
| Getterons fagelreservat SCI | No |
| Getterons fagelreservat SPA | Yes |
| Grimsholmen SCI / SAC | No |
| Hallands Vadero SCI / SAC | No |
| Hallands Vadero SPA | Yes |
| Haron SCI / SAC | No |
| Koster SCI / SAC | No |
| Kosterfjorden-Väderöfjorden SCI / SAC | Yes |
| Kungsbackafjorden SCI / SAC | No |
| Kungsbackafjorden SPA | Yes |
| Loddeans mynning SPA | Yes |
| Lommaomradet SPA | Yes |
| Lundakrabukten SPA | Yes |
| Morups tange SCI / SAC | No |
| Morups tange SPA | Yes |
| Nidingen SCI / SAC | No |
| Nidingen SPA | Yes |
| Nordre alvs Estuarium SCI / SAC | No |
| Nordre alvs Estuarium SPA | Yes |
| Pater Noster-skargarden SCI / SAC | No |
| Salofjorden SCI / SAC | No |
| Salofjorden SPA | No |
| Skalderviken SPA | Yes |
| Tanumskusten SCI / SAC | No |
| Tylon SPA | Yes |
| Ven SCI / SAC | No |
| Vrangoskargarden SCI / SAC | Yes |
| Vrangoskargarden SPA | No |


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## 3.6 Screening of other plans and projects for the assessment of in-combination effects

3.6.1 Regulation 61 of the Habitats Regulations requires the Competent Authority to make an appropriate assessment of any plan or project which is likely to have a significant effect on a European site, either alone or in-combination with other plans or projects. For the in-combination assessment, the scope for "other plans or projects" is considered to be:

- approved but uncompleted projects;
- on-going activities (e.g. aggregate extraction, discharge consents);
- plans or projects for which an application has been made and are under consideration by the consenting authorities; and
- plans and projects which are reasonably foreseeable, i.e. projects for which an application has not yet been submitted, but which are likely to progress before completion of the development and for which sufficient information is available to assess the likelihood of cumulative and in-combination effects; noting in this context that a positive appropriate assessment can only be made if the conclusion can be reached beyond reasonable scientific doubt.

3.6.2 The process adopted for selecting projects for the assessment of in-combination effects is reported below. Following this, the approach to the in-combination assessment undertaken herein is then described.

3.6.3 The starting point for the identification of other relevant plans and projects was to identify a list of those other plans, projects and activities of potential relevance to Dogger Bank Teesside A & B which fall into the criteria set out above. The full list is reported in **Chapter 33 Cumulative Impact Assessment** of the Dogger Bank Teesside A & B ES. The study area on which the list was based was made as wide as possible to ensure that all projects with the potential for cumulative effect were included. This included the identification of projects by activity type (e.g. aggregate extraction) for each country with a North Sea border from Belgium and the Thames Estuary in the southern North Sea to the Shetland Isles and Norway in the north. Pre-screening was then undertaken, taking into consideration both plan, project and activity information (i.e. information available on the nature of the project and the works involved, timings and location) and EIA data (i.e. quality and quantity of available data and judgements on which to base an assessment) in order to rule out plans and projects that clearly would not act in-combination with the proposed development, so that greater focus could be made on screening for the remaining plans and projects.

3.6.4 The next stage of screening of other plans, projects and activities was to determine potential environmental parameters (receptors) on which the spatial and temporal influence of different plans, projects and activities might combine to have an effect. This process was informed by various chapters in the Dogger Bank Teesside A & B ES. Specific details and tables were presented in those chapters and referred to later in this document where relevant. At this stage,

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broad criteria were considered for each relevant project and activity, notably whether they have the potential to directly or indirectly impinge on the features of the European sites considered in this document.

3.6.5 The final list of plans, projects and activities that have been screened in for consideration in the in-combination assessment within this information for appropriate assessment is presented in **Table 3.7**. The list is extracted from the relevant ES chapters (i.e. **Chapter 9**, **Chapter 10**, **Chapter 12 Marine and Intertidal Ecology**, **Chapter 13**, **Chapter 14**, and **Appendix 11A Ornithology Technical Report** of the Dogger Bank Teesside A & B ES) for the relevant source (project and activity) and receptor (designated site feature). For the projects and activities listed in **Table 3.7**, an indication is provided as to which receptors (designated site feature) have been assessed in combination with Dogger Bank Teesside A & B following the approach described below. Further consideration of specific data available for these projects has also resulted in some projects being screened out of the in-combination assessment, as detailed in Section 7.

Table 3.7 Projects and activities considered within the in-combination assessment for European sites and their relevant features

| Type of project | Title | Topic | | | |
|---|---|---|---|---|---|
| | | Marine and coastal ornithology | Marine and intertidal ecology | Fish and shellfish ecology | Marine mammals |
| Aggregate extraction | Area 400 | No | No | No | Yes |
| | Area 439 | No | No | No | Yes |
| | Area 448 (now 514/1) | No | No | No | Yes |
| | Area 449 (now 514/3) | No | No | No | Yes |
| | Area 454 (now Area 512) | No | No | No | Yes |
| | Area 466/1 | Yes | Yes | Yes | Yes |
| | Area 483 | No | No | No | Yes |
| | Area 484 | No | No | No | Yes |
| | Area 485/1 | Yes | Yes | Yes | Yes |
| | Area 485/2 | Yes | Yes | Yes | Yes |
| | Area 492 | No | No | No | Yes |
| | Area 493 | No | No | No | Yes |
| | Area 494 | No | No | No | Yes |
| | Area 495/1 | No | No | No | Yes |
| | Area 495/2 | No | No | No | Yes |
| | Area 506 | No | No | No | Yes |
| Cables and pipelines | Breagh Pipeline | No | No | No | Yes |

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| Type of project | Title | Topic | | | |
|---|---|---|---|---|---|
| | | Marine and coastal ornithology | Marine and intertidal ecology | Fish and shellfish ecology | Marine mammals |
| Offshore Wind Farms | Beatrice | Yes | No | No | Yes |
| | Blyth Demonstration Site | Yes | No | No | Yes |
| | Breeveertien II | Yes | No | No | No |
| | Dogger Bank Creyke Beck A & B | Yes | Yes | Yes | Yes |
| | Dogger Bank Teesside C & D | Yes | Yes | Yes | Yes |
| | Dudgeon | Yes | No | No | Yes |
| | East Anglia ONE | Yes | No | Yes | Yes |
| | East Anglia THREE | No | No | No | Yes |
| | East Anglia FOUR | No | No | No | Yes |
| | European Offshore Wind Development Centre / Aberdeen Offshore Wind Farm | Yes | No | No | No |
| | Firth of Forth Alpha | Yes | No | Yes | Yes |
| | Firth of Forth Bravo | Yes | No | Yes | Yes |
| | Galloper | Yes | No | No | Yes |
| | Greater Gabbard | Yes | No | No | No |
| | Hornsea Project One | Yes | Yes | Yes | Yes |
| | Hornsea Project Two | No | Yes | Yes | Yes |
| | Humber Gateway | Yes | No | No | Yes |
| | Inch Cape | Yes | No | No | Yes |
| | Kentish Flats | No | No | No | Yes |
| | Lincs | Yes | No | No | Yes |
| | London Array II | Yes | No | No | Yes |
| | Moray Firth - Telford, Stevenson and MacColl | Yes | No | No | Yes |
| | Neart Na Gaoithe | Yes | No | No | Yes |
| | Offshore- Bürger-windpark Butendiek (Germany) | No | No | No | Yes |
| | Race Bank | Yes | No | No | Yes |
| | Sheringham Shoal | Yes | No | No | No |
| | Teesside Offshore Wind Farm | Yes | No | No | Yes |
| | Thanet | Yes | No | No | No |
| | Triton Knoll | Yes | No | Yes | Yes |
| | Westermost Rough | Yes | No | Yes | Yes |

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| Type of project | Title | Topic | | | |
|---|---|---|---|---|---|
| | | Marine and coastal ornithology | Marine and intertidal ecology | Fish and shellfish ecology | Marine mammals |
| Oil and gas extraction | Cygnus gas field development (Alpha and Bravo) | Yes | No | No | Yes |
| | Ensign | No | No | No | Yes |
| | Rochelle | No | No | No | Yes |
| Tidal energy generation | Cantick Head | No | No | No | Yes |
| | Westray South | No | No | No | Yes |
| Wave energy generation | Brough Head (Aquamarine Power) | No | No | No | Yes |
| | Costa Head | No | No | No | Yes |
| | Inner Sound | No | No | No | Yes |

3.6.6 Subsequent to the plan, project and activity screening and selection process detailed in the relevant chapters of the Dogger Bank Teesside A & B ES, further screening was undertaken and reported (in Section 7) for each European site feature, based on the information provided and impacts reported with respect to the other plans, projects and activities in order to ascertain whether there was sufficient and robust assessment information in order to inform the further screening. Additional explanation of the plan, project and activity screening process is provided in subsequent sections dealing with the specific designated feature types. Available information was used to consider the potential spatial and temporal overlap of the predicted effects of these plans, projects and activities with Dogger Bank Teesside A & B on the European site features (i.e. such that an in-combination effect may arise). For these identified interactions the likelihood and nature of any increase (or possible decrease) in the level of impact identified for the relevant environmental parameter has been determined and is described herein.

3.6.7 Once the assessment of any interaction of effects that may occur was undertaken, using the reported quantitative assessments for the other relevant plans, projects and activities, re-assessment of the relevant effects was carried out with respect to each European site feature (in Section 7 of this report) in order to determine whether a significant in-combination impact would be likely to arise. Subsequently, consideration was given to whether the determined in-combination impact could have the potential to prevent the achievement of favourable condition in line with the conservation objectives applicable to each European site in order to allow an assessment of the potential effect on integrity to be made. The process takes full account of any proposed mitigation measures designed to reduce specific impacts identified during the assessment.

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# 4 SAC Annex I Designated Habitats and supporting habitats of SPAs

## 4.1 Introduction

4.1.1 This section provides the information required to undertake appropriate assessment of the effects of Dogger Bank Teesside A & B on the Annex I habitat types (and supporting processes) of the European sites listed in **Table 4.1**. Consideration and assessment is also provided in this section with respect to those supporting habitats of designated SPA and Ramsar sites that may be affected by the proposed development. Following the methodology set out in Section 1.1, for each habitat type, the relevant European site is identified and the sensitivity, vulnerability and conservation objectives for the habitat type for that site are presented. Following this, the baseline environment relevant to the habitat feature under consideration is described with reference to specific Chapters within the Dogger Bank Teesside A & B ES.

4.1.2 For each habitat type, a list is provided of the development activities and likely impacts associated with the construction, operation and decommissioning of Dogger Bank Teesside A & B. Subsequent to this, the effects of the project and impacts on designated features are described and assessed in detail.

4.1.3 Assessment of the identified impacts against the defined conservation objectives of the relevant European sites and for the relevant feature(s) is provided and a view on whether the proposed development would have an adverse effect on the integrity of the relevant feature(s) and, subsequently, the individual European site(s) as a whole is given.

Table 4.1 Annex I designated sites / features and supporting habitat features to be assessed

| Feature | European sites |
|---|---|
| Dogger Bank cSAC | Sandbanks which are slightly covered by sea water all the time |
| Northumbria Coast SPA and Ramsar site | Sandy beaches |
| | Shallow inshore waters |
| | Rocky shores with associated boulder and cobble communities |
| | High tide artificial roost sites |
| Teesmouth and Cleveland Coast SPA and Ramsar site | Sand and shingle |
| | Intertidal mudflat and sandflat |
| | Rocky shore |
| | Saltmarsh |
| Doggersbank SCI (Netherlands) | Sandbanks which are slightly covered by sea water all the time |
| Doggerbank SCI (Germany) | Sandbanks which are slightly covered by sea water all the time |

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## 4.2 Sites and conservation objectives

### Dogger Bank cSAC

#### Site features

4.2.1 The Dogger Bank cSAC is an extensive sublittoral sandbank formed by glacial processes and submergence through sea-level rise, with large parts covered by water seldom deeper than 20m below chart datum (see **Figure 3.1**). The site supports the Annex I '*sandbanks which are slightly covered by seawater all the time*' feature. The site is not designated for any other features. Dogger Bank is unvegetated and comprises moderately mobile, clean sandy sediments. Although it is likely that the fauna of the Dogger Bank has been impacted by bottom-trawling, the gross physical structure of the bank is intact, and the biology is likely to be representative of the habitat.

#### Conservation objectives

4.2.2 The Conservation Objectives (JNCC 2012a) for the Dogger Bank cSAC '*sandbanks which are slightly covered by seawater all the time*' are, subject to natural change, restore the sandbanks to favourable condition, such that:

- The natural environmental quality is restored;
- The natural environmental processes and the extent are maintained; and
- The physical structure, diversity, community structure and typical species, representative of sandbanks which are slightly covered by seawater all the time, in the Southern North Sea, are restored.

4.2.3 With regard to the above objectives the following definitions are presented in the Conservation Objectives and Advice on Operations (JNCC 2012a):

- **Restore** - natural recovery to favourable condition through the reduction or removal of adverse impacts;
- **Natural environmental quality** - chemical quality parameters of water, suspended sediment levels, and radionuclide levels etc., should not deviate from baseline levels at designation (if data is available) or from reference conditions;
- **Natural environmental processes** - circulation, sediment deposition and erosion etc., that should not deviate from baseline levels at designation (if data is available) or from reference conditions;
- **Extent** – the area covered by habitat and communities;
- **Physical structure** – the shape, form and composition of the habitat and its substrata;
- **Diversity** - the number of different biological communities or number of species within a given community; and
- **Community structure** - e.g. age classes, sex ratios, distribution of species, abundance, biomass, reproductive capacity, recruitment, range and mobility.

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### Subtidal sandbanks feature vulnerabilities

4.2.4 The Dogger Bank sandbank is currently moderately or highly vulnerable to the following pressures (JNCC 2012a):

- Physical loss by obstruction (installation of petroleum and renewable energy industry infrastructure and cables);
- Physical damage by physical disturbance or abrasion (demersal trawling); and
- Biological disturbance by selective extraction of species (demersal trawling).

4.2.5 The Dogger Bank sandbank is of low vulnerability to non-toxic contamination through changes in turbidity; for example, from cable laying (JNCC 2012a).

4.2.6 In addition, the feature is sensitive to the following pressures:

- Toxic contamination by introduction of synthetic and/or non-synthetic compounds (pollution from oil and gas industry); and
- Non-toxic contamination by changes in nutrient loading (sewage from oil and gas rigs).

4.2.7 However, exposure to contamination is unknown at this time and without further information it is impossible to quantify vulnerability in this context.

### Subtidal sandbanks feature sensitivities

4.2.8 The interest features and associated biological communities of the Dogger Bank cSAC are sensitive to the following (JNCC 2012a):

- Physical loss through removal (moderate level), obstruction (high level) and smothering (low level);
- Physical damage through changes in suspended sediment (low level) and physical disturbance or abrasion (moderate level);
- Toxic contamination through the introduction of synthetic (moderate level) and non-synthetic compounds (moderate level);
- Non-toxic contamination through changes in nutrient loading (moderate level), thermal regime (low level), turbidity (low level) and salinity (moderate level); and
- Biological disturbance through the selective extraction of species (moderate level).

## Northumbria Coast SPA

### Site features

4.2.9 The Northumbria Coast SPA is designated for its national and internationally important populations of breeding little tern, and overwintering purple sandpiper and turnstone.

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4.2.10 The supporting habitats for the SPA interest features are (English Nature 2000a):

- Sandy beaches - the nesting area for little terns are the sandy beaches adjacent to the Long Nanny at Low Newton;
- Shallow inshore waters - little tern forage in shallow waters for surface dwelling marine fish, crustaceans and invertebrates, particularly in the waters of the Long Nanny, as well as offshore areas outside the European site boundary;
- Rocky shores with associated boulder and cobble beaches - purple sandpiper are almost entirely restricted to foraging on rocky shore habitats, where they feed on a variety of marine invertebrates, with preference for mussels, winkles, and dog whelks; they sometimes forage on banks of rotting seaweed on the strandline where they eat the larvae, pupae and adults of the kelp fly. The diet of turnstones mainly comprises winkles, shrimps and barnacles, as well as on the seaweed covered rocks; and
- High tide artificial roost sites - the man made structures at River Tyne South Pier and Seaham Harbour Pier are used as high tide roosts, and through the tidal cycle, with birds roosting on the pier sides below high tide.

**Conservation objectives**

4.2.11 The Conservation Objectives (Natural England, downloaded 2013) for the Northumbria Coast SPA are:

"*Avoid the deterioration of the habitats of the qualifying features, and the significant disturbance of the qualifying features, ensuring the integrity of the site is maintained and the site makes a full contribution to achieving the aims of the Birds Directive*" such that "*subject to natural change, to maintain or restore*":

- The extent and distribution of the habitats of the qualifying features;
- The structure and function of the habitats of the qualifying features;
- The supporting processes on which the habitats of the qualifying features rely;
- The populations of the qualifying features; and
- The distribution of the qualifying features within the site.

**Supporting habitat sub-feature vulnerabilities**

4.2.12 The features (and supporting sub-features) of the Northumbria Coast SPA are vulnerable to the following pressures (Natural England 2000a):

- Physical loss - little terns are moderately vulnerable to the loss of beach and inshore water supporting habitats due to removal or smothering, and purple sandpiper and turnstone are moderately vulnerable to the loss of rocky shore supporting habitat due to removal or smothering which would result in loss of food resource;
- Physical damage - little terns are moderately vulnerable to loss or change in the nature of the substrate of the sandy beach supporting habitats.

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Purple sandpiper and turnstone are moderately vulnerable to loss of rocky shore supporting habitat due to abrasion, extraction, and siltation which would result in loss of or change to their food resource;

- Non-physical disturbance - all bird species for which the site is designated are moderately vulnerable to both visual and noise disturbance, which can displace them from breeding and feeding in the areas of supporting habitats;
- Toxic contamination - all bird species for which the site is designated are moderately vulnerable to contamination with synthetic and non-synthetic compounds, as this may affect them indirectly by affecting the abundance of food items and could cause sub-lethal or mortality due to bioaccumulation. Currently there is no information to show that this is a problem within the site;
- Non-toxic contamination - little terns are moderately vulnerable to changes in water temperature, salinity, nutrient and organic loading due to the indirect effect on prey species, and organic and nutrient enrichment and changes in turbidity can reduce water clarity and reduce the visibility of prey items. Currently there is no evidence to show that this is a problem within the site. The rocky shore supporting habitat is moderately vulnerable to nutrient and organic loading which can change the quantity and diversity of prey availability for feeding birds; and
- Biological disturbance - little terns are moderately vulnerable to over-exploitation of fisheries and the introduction of microbial pathogens, whilst rocky shores and the birds that forage on its communities are moderately vulnerable to selective extraction of prey species. Currently there is no evidence to show that this is a problem within the site.

**Supporting habitat sub-feature sensitivities**

4.2.13 The supporting habitats (sub-features) of the Northumbria Coast SPA are sensitive to the following pressures (Natural England, 2000a):

- Physical loss - all supporting habitats and the bird species that exploit them (for breeding and foraging) are highly sensitive to physical loss through removal or smothering;
- Physical damage (siltation) - the sandy beaches, shallow inshore waters, and rocky shore supporting habitats and the bird species that exploit them display low sensitivity to siltation, no sensitivity is displayed by artificial roosts;
- Physical damage (abrasion) - the rocky shore supporting habitats and the bird species that exploit them display moderate sensitivity to abrasion, whilst the shallow inshore waters supporting habitat display low sensitivity to abrasion, and the sandy beaches and artificial roosts display no sensitivity to abrasion;
- Physical damage (selective extraction) - the sandy beaches and rocky shore supporting habitats and the bird species that exploit them display moderate sensitivity to selective extraction, whilst the shallow inshore

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waters display low sensitivity to selective extraction, and no sensitivity is displayed by artificial roosts;

- Non-physical disturbance (noise) - the sandy beaches, rocky shore, and artificial roost supporting habitats and the bird species that exploit them display moderate sensitivity to noise disturbance, whilst shallow inshore waters display low sensitivity to noise disturbance;
- Non-physical disturbance (visual) - the sandy beaches, rocky shore, and artificial roost supporting habitats and the bird species that exploit them display moderate sensitivity to visual disturbance, whilst shallow inshore waters display low sensitivity to visual disturbance;
- Toxic contamination - all bird supporting habitats and the bird species that exploit them display moderate sensitivity to contamination with synthetic and non-synthetic compounds;
- Non-toxic contamination (nutrient loading) - the shallow inshore waters and rocky shore supporting habitats and the bird species that exploit them display moderate sensitivity to changes in nutrient loading, whilst sandy beaches display low sensitivity to nutrient loading;
- Non-toxic contamination (organic loading) - the shallow inshore waters and rocky shore supporting habitats and the bird species that exploit them display moderate sensitivity to changes in organic loading, whilst sandy beaches display low sensitivity to organic loading;
- Non-toxic contamination (thermal regime) - the shallow inshore waters supporting habitat and the bird species that exploit it display moderate sensitivity to changes in thermal regime, no sensitivity is displayed in relation to the other supporting habitats;
- Non-toxic contamination (salinity) - the shallow inshore waters supporting habitat and the bird species that exploit it display moderate sensitivity to changes in salinity, no sensitivity is displayed in relation to the other supporting habitats;
- Non-toxic contamination (turbidity) - the shallow inshore waters supporting habitat and the bird species that exploit it display moderate sensitivity to increased turbidity, no sensitivity is displayed in relation to the other supporting habitats; and
- Biological disturbance - the shallow inshore waters supporting habitat and the bird species that exploit it display moderate sensitivity to the introduction of microbial pathogens, whilst rocky shore habitats display moderate sensitivity to the introduction of non-native species, and shallow inshore waters and rocky shore supporting habitats and the bird species that exploit them display moderate sensitivity to selective extraction of species. No or low sensitivity is displayed by the habitats not identified.

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## Northumbria Coast Ramsar

### Site features

4.2.14 The Northumbria Coast Ramsar is designated due to the achievement of Ramsar criterion 6, in that it supports internationally important populations of breeding little tern and wintering purple sandpiper and ruddy turnstone. The supporting habitat features are considered to be the same as those for the Northumbria Coast SPA (see paragraph 4.2.10 above) due to the designated area being concurrent and because the same species are present.

### Conservation objectives

4.2.15 The objectives (see paragraph 4.2.11 above) described for the Northumbria Coast SPA features that fall within criterion 6 for the Northumbria Coast Ramsar have been used in this assessment.

### Supporting habitat sub-feature vulnerabilities

4.2.16 The vulnerabilities (see paragraph 4.2.12 above) identified for the Northumbria Coast SPA features that fall within criterion 6 of the Northumbria Coast Ramsar are considered to apply within this site.

### Supporting habitat sub-feature sensitivities

4.2.17 The sensitivities (see paragraph 4.2.13 above) identified for the Northumbria Coast SPA features that fall within criterion 6 of the Northumbria Coast Ramsar are considered to apply within this site.

## Teesmouth and Cleveland Coast SPA

### Site features

4.2.18 The Teesmouth and Cleveland Coast SPA is designated for its national and internationally important populations of breeding little tern, overwintering knot, and on passage redshank, ringed plover and sandwich tern. In addition, the site regularly supports over 21,000 wintering waterfowl, including species such as cormorant, lapwing, sanderling, and shelduck.

4.2.19 The supporting habitats for the SPA interest features are (English Nature 2000b):

- Sand and shingle areas - sparsely vegetated shingle/sand areas fronting sand dune systems which are important nesting area for little terns, located at Hart Warren Dunes, South Gare and Coatham Sands, and Seaton Dunes;
- Intertidal sandflat and mudflat - provide roosting and loafing sites for sandwich terns prior to autumn migration, and for little tern in summer. Key sites are North Gare Sands, Seal Sands, Bran Sands, and Coatham Sands;
- Shallow coastal water - comprise the main feeding areas for little tern and sandwich tern, which feed almost exclusively on fish (particularly sprats and sandeels);


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- Rocky shores - these provide vital food resources for the wintering knot population (particularly mussel spat), a small proportion of the redshank population, and other species and are also used by knot as high water roosting sites. Present around Hartlepool Headland / North Sands, South Gare, Coatham and Redcar Rocks, and Seaton Snook;
- Intertidal sandflat and mudflat - these support high densities of invertebrates which are important as a winter food resource for knot, redshank, shelduck and sanderling with key food source species being mudsnails, cockles, marine worms such as ragworms, crustaceans, and small polychaetes and oligochaetes. Areas of prime importance for knot are Seal Sands and Hartlepool North Sands, and prime areas for redshank are Seal Sands, North Tees Mudflat, and Greatham Creek. Knot also roost at higher tidal levels at North Gare Sands, Bran Sands, and Hartlepool North Sands;
- Saltmarsh - the small area of saltmarsh at Greatham Creek and within the Seal Sand Peninsula enclosures provides roosting opportunities for redshank, and provide significant foraging and roosting habitat for many waterbird species including shelduck and teal; and
- Grazing marsh - a small proportion of the redshank population and a high proportion of other waterbird species utilise grazing marsh habitats outside the European site.

**Conservation objectives**

4.2.20 The Conservation Objectives (Natural England, downloaded 2013) for the Teesmouth and Cleveland Coast SPA are:

"*Avoid the deterioration of the habitats of the qualifying features, and the significant disturbance of the qualifying features, ensuring the integrity of the site is maintained and the site makes a full contribution to achieving the aims of the Birds Directive*" such that "*subject to natural change, to maintain or restore*":

- The extent and distribution of the habitats of the qualifying features;
- The structure and function of the habitats of the qualifying features;
- The supporting processes on which the habitats of the qualifying features rely;
- The populations of the qualifying features; and
- The distribution of the qualifying features within the site.

**Supporting habitat sub-feature vulnerabilities**

4.2.21 The features (and supporting sub-features) of the Teesmouth and Cleveland Coast SPA are vulnerable to the following pressures (Natural England 2000b):

- Physical loss - little terns are moderately vulnerable to activities or operations which result in the loss of beach habitat or which affect the function of the beach habitat;
- Non-physical disturbance - all bird species for which the site is designated are moderately vulnerable to both visual and noise disturbance, which can

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displace them from breeding and feeding in the areas of supporting habitats;

- Toxic contamination - all bird species for which the site is designated are highly vulnerable to contamination from synthetic and non-synthetic compounds, as this may affect them indirectly by affecting the abundance of food items (such as benthic invertebrates) and could cause sub-lethal or mortality due to bioaccumulation. At present there is no evidence of direct toxic contamination of the bird species within the site;
- Non-toxic contamination - all birds that feed within the intertidal supporting habitats are highly vulnerable to nutrient and organic enrichment due to the indirect effect on prey species (particularly mud-dwelling invertebrates which can be smothered by algal mats) due to a range of factors including sediment change, declines in turbidity and associated increases in light penetration, elevated levels of TBT, and climate change (milder winters);
- Biological disturbance - the selective extraction of prey species by bait collection within the intertidal areas provides cause for concern. There is no evidence that commercial or recreational fisheries are causing an increase in vulnerability to the site's features.

**Supporting habitat sub-feature sensitivities**

4.2.22 The supporting habitats (sub-features) of the Teesmouth and Cleveland Coast SPA are sensitive to the following pressures (Natural England 2000b):

- Physical loss - all species are highly sensitive to physical loss through removal of all of the supporting habitats. All species are moderately sensitive to physical loss through smothering of all of the supporting habitats with the exception of coastal waters and the species that exploit this habitat, which exhibit low sensitivity to smothering;
- Physical damage (siltation) - the coastal waters, rocky shore, intertidal sandflat and mudflat, and saltmarsh supporting habitats and the bird species that exploit them exhibit low sensitivity to siltation, no sensitivity is exhibited by species that exploit the sand and shingle habitat;
- Physical damage (abrasion) - the sand and shingle and the intertidal sandflat and mudflat supporting habitats and the bird species that exploit them are highly sensitive to abrasion (boating, anchoring and trampling), whilst the rocky shore and saltmarsh supporting habitats and the bird species that exploit them display moderate sensitivity to abrasion. Coastal waters and the bird species that exploit this habitat exhibit low sensitivity to abrasion;
- Physical damage (selective extraction) - the sand and shingle and the intertidal sandflat and mudflat supporting habitats and the bird species that exploit them are highly sensitive to selective extraction, whilst the rocky shore supporting habitat and the bird species that exploit this are moderately sensitive to selective extraction. The coastal waters and saltmarsh habitats and the bird species that exploit them exhibit low sensitivity to selective extraction;

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- Non-physical disturbance (noise and visual) - sand and shingle, intertidal sandflat and mudflat, rocky shore, and saltmarsh supporting habitats and the bird species that exploit them are highly sensitive to noise and visual disturbance, whilst birds that exploit coastal waters display low sensitivity to noise and visual disturbance;
- Toxic contamination - the coastal waters, rocky shore, intertidal sandflat and mudflat, and saltmarsh supporting habitats and the bird species that exploit them are moderately sensitive to contamination with synthetic and non-synthetic compounds;
- Non-toxic contamination (nutrient and organic loading) - the rocky shore and intertidal sandflat and mudflat supporting habitats and the bird species that exploit them are moderately sensitive to changes in nutrient and organic loading, whilst coastal waters and saltmarsh supporting habitats and the bird species that exploit them exhibit low sensitivity to nutrient and organic loading;
- Non-toxic contamination (thermal regime) - no sensitivity is exhibited by the supporting habitats and the bird species that exploit them to changes in the thermal regime;
- Non-toxic contamination (turbidity) - the coastal waters supporting habitat and the bird species that exploit it exhibit moderate sensitivity to increased turbidity, no sensitivity is displayed by birds that exploit the other supporting habitats;
- Non-toxic contamination (salinity) - the coastal waters, rocky shore, intertidal sandflat and mudflat, and saltmarsh supporting habitats and the bird species that exploit them exhibit low sensitivity to changes in salinity, no sensitivity is displayed by birds that exploit the other supporting habitats; and
- Biological disturbance - the coastal waters, rocky shore, intertidal sandflat and mudflat, and saltmarsh supporting habitats and the bird species that exploit them are moderately sensitivity to selective extraction and the introduction of non-native species, but exhibit low sensitivity to the introduction of microbial pathogens.

## Teesmouth and Cleveland Coast Ramsar

### Site features

4.2.23 The Teesmouth and Cleveland Coast Ramsar is designated due to the achievement of Ramsar criterion 5 and 6, in that it supports an internationally important assemblage of breeding species (little tern), wintering red knot, and on passage common greenshank, common redshank, northern shoveler, and sandwich tern. Under criterion 6, the site supports internationally important population of wintering red knot and on passage common redshank. The supporting habitat features are considered to be the same as those for the Teesmouth and Cleveland Coast SPA (see paragraph 4.2.19 above) due to the designated area being concurrent and because the same species are present.

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### Conservation objectives

4.2.24 The objectives (see paragraph 4.2.20 above) described for the Teesmouth and Cleveland Coast SPA features that are also features of the Teesmouth and Cleveland Coast Ramsar have been used in this assessment.

### Supporting habitat sub-feature vulnerabilities

4.2.25 The vulnerabilities (see paragraph 4.2.21 above) identified for the Teesmouth and Cleveland Coast SPA features that are also features of the Teesmouth and Cleveland Coast Ramsar are considered to apply within this site.

### Supporting habitat sub-feature sensitivities

4.2.26 The sensitivities (see paragraph 4.2.22 above) identified for the Teesmouth and Cleveland Coast SPA features that are also features of the Teesmouth and Cleveland Coast Ramsar are considered to apply within this site.

## Doggerbank SCI (Germany)

### Site features

4.2.27 The Doggerbank SCI in German waters is located approximately 68km north-east of Dogger Bank Teeside A and 106km north-east of Dogger Bank Teesside B (see **Figure 3.1**).

### Conservation objectives

4.2.28 The conservation objectives for the Doggersbank SCI (Netherlands) 'sandbanks covered all the time' feature are (Bundesamt für Naturschutz 2008):

- Maintenance and restoration of the site's specific ecological functions, biological diversity and natural hydrodynamics and morphodynamics;
- Maintenance and restoration at favourable conservation status of habitat type 1110 (sandbanks which are slightly covered by sea water all the time) together with its characteristic and endangered ecological communities and species; and
- Maintenance and restoration at favourable conservation status of the following Habitats Directive species and their natural habitats: Harbour porpoise and common seal.

### Subtidal sandbanks feature vulnerabilities

4.2.29 The vulnerabilities identified for the sandbank feature of the Dogger Bank cSAC (see paragraphs 4.2.4 to 4.2.7 above) are considered to apply to the feature within this site.

### Subtidal sandbanks feature sensitivities

4.2.30 The sensitivities identified for the sandbank feature of the Dogger Bank cSAC (see paragraph 4.2.8 above) are considered to apply to the feature within this site.

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## Doggersbank SCI (Netherlands)

### Site features

4.2.31 The Doggersbank SCI provides protection to part of the Dogger Bank that occurs in Dutch waters. The western boundary of the SCI is located adjacent to the boundary of Dogger Bank Teesside A, and 34km from the eastern boundary of Dogger Bank Teesside B (see **Figure 3.1**). Currently the site and 'sandbanks covered all the time' feature is considered to be in favourable condition in relation to the extent and distribution of the feature, though it is in unfavourable-inadequate condtion in relation to the quality of the communities (IMARES 2009). Much of the unfavourable condition is perceived to be as a result of sediment disturbance as a result of fishing activities. However, it is noted that it is not perceived to be as a result of sediment disturbance due to storms, i.e. natural processes (IMARES 2009).

### Conservation objectives

4.2.32 The national conservation objectives for the Doggersbank SCI (Netherlands) 'sandbanks covered all the time' feature is: "*maintain distribution and improve quality*" (IMARES 2009). In relation to this objective it is stated that "*the maintenance of the current distribution and surface area, within natural fluctuations and in balance with habitat type H1140 (Mudflats and sandflats not covered by seawater at low tide), is desirable. The typical species should be stable over the medium and long term to ensure that extinction is prevented. A large part of the surface area occupied by the habitat type should have good structure and function*" (IMARES 2009).

### Subtidal sandbanks feature vulnerabilities

4.2.33 The vulnerabilities identified for the sandbank feature of the Dogger Bank cSAC (see paragraphs 4.2.4 to 4.2.7 above) are considered to apply to the feature within this site.

### Subtidal sandbanks feature sensitivities

4.2.34 The sensitivities identified for the sandbank feature of the Dogger Bank cSAC (see paragraph 4.2.8 above) are considered to apply to the feature within this site.

# 4.3 Data collection

## Coastal processes

4.3.1 The coastal process (conceptual) models and numerical modelling used to characterise and determine the changes in coastal processes within the study area, as a result of Dogger Bank Teesside A & B, were supported by a variety of data, as described below.

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4.3.2 Geophysical surveys (see Section 3.2 in **Chapter 9** and **Appendix 9A** of the Dogger Bank Teesside A & B ES for full details) carried out in four campaigns, including:

- Zonal characterisation of the Dogger Bank Zone at a wide 2.5km transect spacing (Gardline Environmental 2011a);
- Detailed survey of Tranche A at a narrow 100m transect spacing (GEMS 2011);
- Detailed survey of Tranche B at a narrow 100m transect spacing (Gardline Environmental 2013a); and
- Detailed survey of the Dogger Bank Teesside A & B Export Cable Corridor between the Dogger Bank Zone and the landfall (Gardline Environmental 2013b).

4.3.3 Geotechnical data was obtained through 56 boreholes and wireline logs (45 in Tranche A) and 96 cone penetration tests (CPTs) across the Dogger Bank Zone (Fugro 2011). The locations are presented in Figure 3.1 in **Chapter 9** of the Dogger Bank Teesside A & B ES.

4.3.4 Three instruments collected wave and tidal current (metocean) data; one at the northern limit of the Dogger Bank Zone, a buoy within Tranche A, and a buoy in Tranche B (see Figure 3.2 in **Chapter 9** of the Dogger Bank Teesside A & B ES for locations) . The time series of data collected is listed in Table 3.1 in **Chapter 9** of the Dogger Bank Teesside A & B ES.

4.3.5 In addition, Mathiesen & Nygaard (2010) and Mathiesen *et al*. (2011) provided modelled metocean data for eight locations within the Dogger Bank Zone (see Figure 3.3 in **Chapter 9** of the Dogger Bank Teesside A & B ES for locations).

## Sediment and sediment quality

4.3.6 Gardline Environmental (2011b) collected 103 seabed sediment grab samples across Tranche A as part of a benthic survey campaign undertaken in May 2011 and August 2011. In 2012, 55 seabed sediment grab samples were collected across Tranche B (Gardline Environmental 2013c). Of the samples collected in Tranche A, three (that are located within Dogger Bank Teesside B) were analysed for contaminants, and 11 of the samples collected in Tranche B were analysed for contaminants. Along the Dogger Bank Teesside A & B Export Cable Corridor, nine samples were analysed for contaminants. Samples were also taken in the intertidal zone, and three samples (from the upper, middle and lower shore locations) were analysed. Figure 4.2 in **Chapter 9** of the Dogger Bank Teesside A & B ES presents the locations of the samples that were analysed for contaminants.

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4.3.7 The surveys used a 0.1m$^2$ stainless-steel Day grab to collect seabed samples for analysis. Samples were analysed (details of the analysis techniques and limits of detection are presented in **Appendix 12A** of the Dogger Bank Teesside A & B ES) for the following metals and hydrocarbons by the National Laboratory Service of the Environment Agency:

- Metals (including arsenic, cadmium, chromium, copper, lead, mercury, and nickel);
- Selenium;
- Boron;
- Total organic carbon (TOC);
- Polyaromatic hydrocarbons (PAHs);
- Total petroleum hydrocarbons (TPH);
- Polychlorinated Biphenyls (PCB); and
- Organotins.

## Marine and intertidal ecology

4.3.8 Sources of desk based information which provided regional characterisation information in relation to the marine and intertidal ecology of the study area included, but were not limited to:

- Dogger Bank Zonal Characterisation Second Edition (Forewind 2011);
- Marine Life Information Network (MarLIN);
- The Mapping European Seabed Habitat (MESH) project; and
- Dogger Bank SAC Selection Assessment (JNCC 2012a).

4.3.9 A number of site specific surveys were commissioned to characterise the existing environment for marine and intertidal ecology. **Table 4.2** (and Figure 3.1 in **Chapter 12** of the Dogger Bank Teesside A & B ES) provides a summary of the surveys and reporting that has been conducted and their outputs. The scope and specification of all surveys were subject to consultation with stakeholders, as identified in Table 2.2 in **Chapter 12** of the Dogger Bank Teesside A & B ES.

4.3.10 Using the geophysical data listed in paragraph 4.3.2 above, and the benthic surveys and drop down video (DDV) carried out within tranches A & B and the Dogger Bank Teesside A & B Export Cable Corridor (Gardline Environmental 2011b; Gardline Environmental 2013c), as listed in **Table 4.2**, Envision produced biotope maps (see **Appendix 12D** of the Dogger Bank Teesside A & B ES). Full details of all surveys and extents are presented in Section 3.2 and Figure 3.2 in **Chapter 12** of the Dogger Bank Teesside A & B ES.

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## Table 4.2 Summary of surveys relevant to assessment of habitats and marine ecology

| Date | Survey type / analysis | Contractor | Key outputs | Location of reporting |
|---|---|---|---|---|
| 2011 / 2012 | Geophysical Survey of Tranche B: side scan sonar, swath bathymetry, AGDS | Gardline Geosurvey Limited | Geophysical data used to inform design of benthic grab sampling survey and in biotope classification. | **N/A** |
| 2012 | Geophysical Survey of Dogger Bank Teesside A & B Export Cable Corridor: side scan sonar, swath bathymetry, AGDS | Gardline Geosurvey | Detailed survey to ascertain ground conditions along cable route. | **N/A** |
| 2012 | Benthic grab sampling campaign of Tranche B and Dogger Bank Teesside A & B Export Cable Corridor | Gardline Environmental Limited | Sediment particle size (Particle Size Distribution (PSD) analysis) and benthic macrofaunal data (grab and DDV). | **Appendix 12A Tranche B and Export Cable Corridor Benthic Survey Report** of the Dogger Bank Teesside A & B ES |
| 2012 | Benthic grab sampling campaign of Tranche A and Dogger Bank Export Cable Corridor | Emu Limited | Sediment particle size (Particle Size Distribution (PSD) analysis) and benthic macrofaunal data (grab and DDV). | **Appendix 12B Tranche A Benthic Survey Report** of the Dogger Bank Teesside A & B ES |
| 2012 | Intertidal and Phase 1 biotope survey of Dogger Bank Teesside A & B export cable landfall | Institute of Estuarine Coastal Studies (IECS) | Biotope maps of intertidal region. | **Appendix 12C Intertidal Benthic Survey Report** of the Dogger Bank Teesside A & B ES |
| 2013 | Tranche B Habitat Mapping Report | Envision | Biotope maps for Tranche B and Dogger Bank Teesside A & B Export Cable Corridor. | **Appendix 12D Tranche B Habitat Mapping Report** of the Dogger Bank Teesside A & B ES |
| 2012 / 2013 | Nearshore fish surveys | Precision Marine Survey Limited (PMSL) | Information on fish species in nearshore area of cable corridor. | **Appendix 13C Nearshore Fish and Shellfish Surveys** of the Dogger Bank Teesside A & B ES |
| 2011 / 2012 | 2m epibenthic beam trawl and otter trawl surveys across Dogger Bank Zone | Brown & May Marine | Marine epibenthic macrofaunal data. | **Appendix 13D Tranche A Fish and Shellfish Characterisation Surveys** of the Dogger Bank Teesside A & B ES |
| 2012 | Sandeel survey | Brown & May Marine | Distribution of sandeels. | **Appendix 13F Sandeel Survey Report** of the Dogger Bank Teesside A & B ES |

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4.3.11 Two cable corridors were surveyed (namely the North cable corridor and the South cable corridor); the southern cable route is the proposed cable corridor for Dogger Bank Teesside A & B, whilst the northern cable corridor is relevant to the proposed Dogger Bank Teesside C & D wind farm development. The main exception is with respect to the outputs of the macrofaunal data analysis, as these outputs are presented as a combined data-set for both cable corridors.

4.3.12 In addition to the benthic grab and drop down video surveys, a series of fish ecology surveys across Tranche B and the Dogger Bank Teesside A & B Export Cable Corridor were undertaken by Brown and May Marine Limited (BMM) and Precision Marine Surveys Limited (PMSL). The surveys comprised:

- A demersal otter trawl and scientific 2m beam trawl was used for sampling at all sampling stations in and around tranches A & B in 2011 and 2012, and along the Dogger Bank Teesside A & B Export Cable Corridor (see **Appendix 13B** and **Appendix 13D** of the Dogger Bank Teesside A & B ES);
- A pelagic otter trawl within Dogger Bank former herring spawning ground and along the Dogger Bank Teesside A & B Export Cable Corridor was carried out in 2011 (see **Appendix 13E** of the Dogger Bank Teesside A & B ES);
- A modified scallop dredge was used to survey sandeel within tranches A & B in 2012 (see **Appendix 13F** of the Dogger Bank Teesside A & B ES);
- Shellfish potting was carried out along the inshore area of the Dogger Bank Teesside A & B Export Cable Corridor (pots were soaked for 68 to 122 hours) in 2012 and 2013 (see **Appendix 13C** of the Dogger Bank Teesside A & B ES); and
- A Trammel net survey was carried out in the inshore area of the Dogger Bank Teesside A & B Export Cable Corridor in 2012 and 2013 (see **Appendix 13C** of the Dogger Bank Teesside A & B ES).

4.3.13 Full details of these surveys all surveys are presented in Section 3 in **Chapter 13** of the Dogger Bank Teesside A & B ES, and Figure 3.3 in **Chapter 12** of the Dogger Bank Teesside A & B ES presents the epibenthic trawl sampling sites.

4.3.14 An intertidal walkover survey was undertaken by the Institute of Coastal and Estuarine Sciences (see **Appendix 12C** of the Dogger Bank Teesside A & B ES) to characterise the communities present at the landfall site, and to identify any species or habitats of national or international conservation importance for the purpose of the EIA. The survey comprised six transect lines placed approximately 500m apart for the entire length of the survey site, with a grid of sampling stations evenly distributed along the transect lines, at upper, middle and lower shore locations (see Figure 3.4 in **Chapter 12** in the Dogger Bank Teesside A & B ES). Mapping was carried out according to the Common Standards Monitoring Guidance littoral sediment and Procedural Guideline 3.1 provided in the JNCC Marine Monitoring Handbook (Wyn & Brazier 2001). Full details of the survey methodology are presented in Section 3.2 in **Chapter 12** of the Dogger Bank Teesside A & B ES.

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### Biotope and habitat classification

4.3.15 The PRIMER v6 (Plymouth Routines in Multivariate Ecological Research) suite of programs (Clarke & Gorley 2006; Clarke & Warwick 2001) was used to analyse the data obtained from the various surveys described above to characterise the benthic communities and habitats within tranches A & B and the Dogger Bank Teesside A & B Export Cable Corridor (see detail in **Appendix 12D** of the Dogger Bank Teesside A & B ES). The analysis identified statistically significant clusters of benthic communities, which were then analysed in order to match them to biotope classes. An initial short-list was derived of the most similar biotope classes for each cluster. These were inspected and options ruled out on the basis of depth zone (infra- and circalittoral) and sediment. The edited short list was then inspected for key species and differences in significant contributors to the statistical classes.

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

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

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

## 4.4 Assessment methodology

### Coastal processes

4.4.1 The influence of the proposed scheme is considered in light of the highly variable nature of the physical processes that characterise the study area. Consequently, where possible, quantifiable parameters are identified and predicted changes presented. However, elements of the assessment relate to long-term or complex systems, which cannot be modelled to present quantifiable changes. In these situations, professional interpretation is undertaken. Much of the determination of change relating to physical processes has been undertaken using modelling techniques, which are described below, and full detailed descriptions are presented in Section 3.3 in **Chapter 9** of the Dogger Bank Teesside A & B ES.

4.4.2 Using the data and survey results described in paragraphs 4.3.1 to 4.3.5 above, a number of conceptual and numerical models were developed to inform the Dogger Bank Teesside A & B ES and this report.

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4.4.3 The hydrodynamic regime (the behaviour of water movements driven by the action of tides and storms) was investigated using a hydrodynamic model to provide a baseline for prediction of changes and quantification of the changes that would arise as a result of Dogger Bank Teesside A & B. Tidal current modelling was therefore carried out using DHI's fully calibrated and developed regional MIKE3-FM hydrodynamic (HD) model, which covers the entire North Sea and is forced by tide, atmospheric pressure and wind stresses. Full details of the model set up and calibration are presented in **Appendix 9A** of the Dogger Bank Teesside A & B ES.

4.4.4 Wave conditions were simulated using the spectral model MIKE21-SW (Spectral Waves), which describes the wave conditions by the directional frequency spectrum. The model includes effects like wave generation due to wind, energy dissipation due to bed friction, white-capping and depth induced wave breaking, depth and current refraction, reflection and diffraction. The wave model has been successfully calibrated against the three largest events that were recorded by the metocean equipment deployed in Tranche A and at the northern boundary of the Dogger Bank Zone (see paragraph 4.3.4).

4.4.5 Dispersion modelling was carried out to simulate the release and spreading of fine sediments (mud to fine sand) as a result of foundation and cable installation activities and scour processes and other activities during the operation of the wind farm. This has been modelled using the 3D model MIKE3-FM Mud Transport (MT), which is integrated with the HD model described in paragraph 4.4.3 above. The model takes into account sediment release (as a function of time, location and sediment characteristics), advection and dispersion of suspended sediments in the water column, settling and deposition of the dispersed sediment, and re-suspension of deposited sediment (predominantly by bed shear stresses from surface waves). Particle size inputs to the model were based on the data derived from the surveys described in Section 4.3 and borehole data collected across Tranche B.

4.4.6 Expert geomorphological assessment, using the landfall conceptual model (see **Appendix 9A** of the Dogger Bank Teesside A & B ES) as a basis, was used to assess the effects of the landfall works on existing physical processes and future evolution of the coastline. The landfall conceptual model provides a baseline understanding of the physical and sedimentary processes operating along the Redcar and Marske-by-the-Sea coastline and, more specifically, in the vicinity of the landfall. The conceptual model was compiled almost entirely from existing data, including wave conditions, sediment transport and coastal change. As long as due regard is taken of data origins and accuracy, predictions based on the extrapolation of historical trends provide a reliable estimate of the most probable evolution of the coastline during the construction and operation of landfall infrastructure.

## Sediment and sediment quality

4.4.7 Recognised guidelines and action levels are utilised to establish the significance of concentrations of potential contaminants that may be present within sediments occurring in the proposed development. If overall concentrations do not generally exceed the higher threshold values of guideline standards, then

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contamination levels are not deemed to be of significant concern and are low risk in terms of impacts on water quality and, subsequently, on ecological receptors. These guidelines are:

- Cefas Action Levels for the disposal of dredged material (Cefas 2000); and
- Canadian Sediment Quality Guidelines for the Protection of Aquatic Life (Canadian Council of Ministers of the Environment (CCME) 2002).

4.4.8 The Cefas Action Levels are used as part of a 'weight of evidence' approach to assessing the suitability of material for disposal at sea, but are not themselves statutory standards. The majority of the materials assessed against these standards arise from dredging activities. These Action Levels are used in conjunction with a range of other assessment methods (e.g. bioassays) and data to assess risk to the environment. Table 3.1 in **Chapter 10** of the Dogger Bank Teesside A & B ES presents the current action levels.

4.4.9 The Canadian Sediment Quality Guidelines involved the derivation of Interim marine Sediment Quality Guidelines (ISQGs) or Threshold Effect Levels (TEL) and Probable Effect Levels (PEL) from an extensive database containing direct measurements of toxicity of contaminated sediments to a range of aquatic organisms exposed in laboratory tests and under field conditions (CCME 2002). Table 3.2 in **Chapter 10** of the Dogger Bank Teesside A & B ES presents the current guideline levels. These values are not statutory standards, and they were designed specifically for Canada and are based on the protection of pristine environments. Consequently, the findings related to these are treated with caution.

4.4.10 The use of the guidance and thresholds described above are used in conjunction with relevant information produced from the hydrodynamic and sediment dispersion modelling to ascertain the potential duration, scale and magnitude of sediment and water quality changes for this assessment.

## Marine and intertidal ecology

4.4.11 The assessment of effects includes (a) the definition of the sensitivity of any receptor, (b) the definition of the magnitude of impact, and (c) the interaction between these two parameters to inform the overall level of effect. Underpinning the approach to the assessment of impacts and effects on the marine ecological receptors is the concept of Valued Ecological Receptors (VERs). The use of VERs enables a wide range of communities to be grouped according to the functional role of the habitat or species, and their specific sensitivities.

4.4.12 The sensitivity of the communities (and VERs) identified in the survey areas are derived from the sensitivity assessments produced by MarLIN guidelines. MarLIN classifies biotopes on a six-point scale of sensitivity (ranging from very high to not sensitive). The sensitivity of a biotope is assessed through the intolerance and recoverability of the species / community / habitat combination which make up the overall biotope.

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4.4.13 The magnitude of the impact (physical, chemical or biological) on communities is considered and defined in terms of the spatial extent, duration and timing (seasonality and / or frequency of occurrence) of the impact in question.

4.4.14 Based on the sensitivity and the magnitude of the impact, expert judgment was then employed to consider and evaluate the likely effect on the species / population / habitat.

## 4.5 Baseline environment

### Physical characteristics

#### Bathymetry

4.5.1 In Dogger Bank Teesside A, water depths range from approximately 30m below LAT along the east and west sides, to 20m below LAT in the centre (see **Figure 4.1**) forming a plateau. Depths of 20m below LAT occur within the plateau whilst elsewhere the seabed is generally low relief with gradients of less than three degrees.

4.5.2 In Dogger Bank Teesside B, water depths also range from approximately 30m below LAT across the centre of the area, with deepest areas at the northern end and shallow areas (20m below LAT) at the southern end (see **Figure 4.1**). Depths of 20m below LAT occur at the edge of a plateau that extends south outside of the area, whilst the majority of the project area is generally low relief with gradients of less than three degrees.

4.5.3 At the landfall site, the seabed can be separated into two zones; a nearshore zone that extends 2.5km from the coast (to a depth of 20m and with a mean gradient of $0.4^{o}$) and an offshore zone that extends from 2.5km to 4km offshore (characterised by a mean gradient of $0.1^{o}$), as shown on **Figure 4.2**.

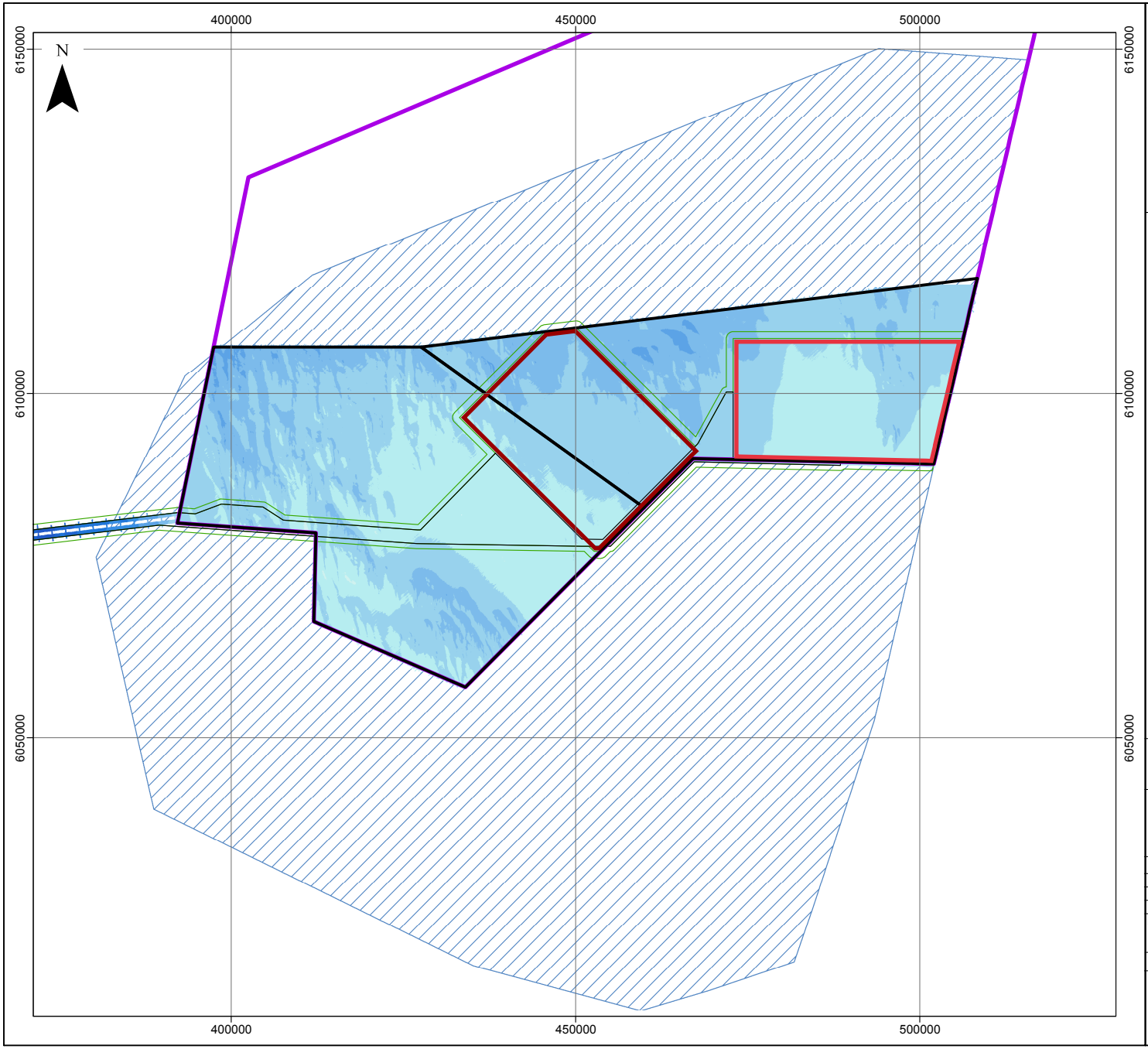
#### Tidal ranges

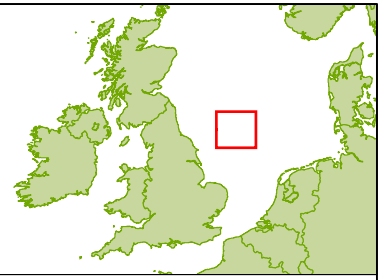
4.5.4 Mathiesen *et al*. (2011) showed that mean high water spring at Dogger Bank Teesside A is 0.65m above mean sea level and 0.95m above mean sea level at Dogger Bank Teesside B. The tidal regime within Dogger Bank is semi-diurnal; the water level rises and falls twice a day

4.5.5 The tidal regime at the landfall site and nearshore zone is semi-diurnal; the water level rises and falls twice a day. The tide levels for the landfall site have been estimated using the tide levels for the River Tees, obtained from 2013 Admiralty Tide Tables. **Table 4.3** shows that the tidal range, the difference between high and low water level, is 4.6m on a spring tide and 2.3m on a neap tide. These are astronomical levels and do not account for meteorological surges.

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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
- Dogger Bank Special Area of Conservation (cSAC)

Bathymetry (m below LAT)

- Above 0
- 0 - 5
- 5 - 10
- 10 - 15
- 15 - 20
- 20 - 25
- 25 - 30
- 30 - 35
- 35 - 40
- 40 - 45
- 45 - 50
- 50 - 55
- 55 - 60
- 60 - 65
- 65 - 70
- 70 - 75
- 75 - 80
- 80 - 85
- 85 - 90

Data Source:
SAC data from JNCC
Tranche A bathymetry from GEMS (2010),
Tranche B bathymetry from Gardline (2011),
Cable corridor bathymetry from Gardline (2013),
Round 3 offshore wind farm boundary © Crown Copyright, 2014

0 10 20
Kilometres

PROJECT TITLE

*DOGGER BANK TEESSIDE A & B*
IfAA Report

DRAWING TITLE

**Figure 4.1 Dogger Bank cSAC showing overlap of Dogger Bank Teesside A & B with bathymetry**

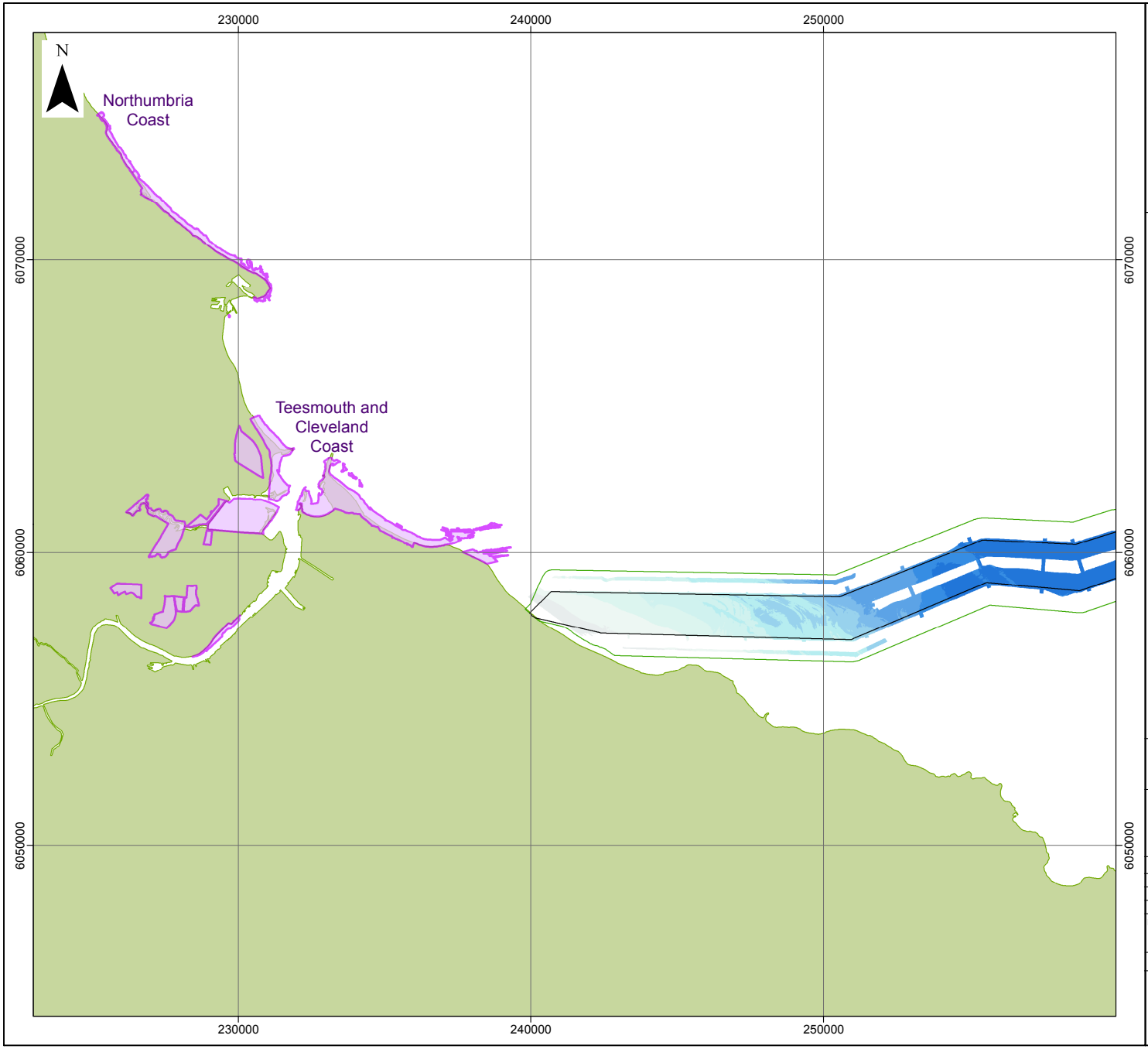
| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 11/10/2013 | PEI3 | GC | DB |
| 2 | 18/03/2014 | DCO Submission | GC | DB |
| | | | | |

DRAWING NUMBER: **9Y0986/TSABHRA/06/R2**

| SCALE | 1:850,000 | PLOT SIZE | A4 | DATUM | WGS84 | PROJECTION | UTM31N |
|---|---|---|---|---|---|---|---|

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## LEGEND

- Dogger Bank Teesside A & B Export Cable Corridor
- Temporary works area
- UK Special Protection Area (SPA)/Ramsar site

Bathymetry (m below LAT)

- 0 - 5
- 5 - 10
- 10 - 15
- 15 - 20
- 20 - 25
- 25 - 30
- 30 - 35
- 35 - 40
- 40 - 45
- 45 - 50
- 50 - 55
- 55 - 60
- 60 - 65
- 65 - 70
- 70 - 75
- 75 - 80
- 80 - 85
- 85 - 90

Data Source:
SPA/Ramsar data from Natural England
Tranche A bathymetry from GEMS (2010),
Tranche B bathymetry from Gardline (2011),
Cable corridor bathymetry from Gardline (2013),
Round 3 offshore wind farm boundary © Crown Copyright, 2014

0 5
Kilometres

PROJECT TITLE

*DOGGER BANK TEESSIDE A & B*
IfAA Report

DRAWING TITLE

**Figure 4.2 Nearshore zone showing the Dogger Bank Teesside A & B export cable corridor with bathymetry**

| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 11/10/2013 | PEI3 | GC | DB |
| 2 | 18/03/2014 | DCO Submission | GC | DB |
| | | | | |

DRAWING NUMBER: **9Y0986/TSABHRA/07/R2**

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Table 4.3 Tidal levels at the River Tees (from the 2013 Admiralty Tide Tables)

| Tide datum[1] | mLAT | mODN |
|---|---|---|
| Mean High Water Spring | 5.5 | 2.65 |
| Mean High Water Neap | 4.3 | 1.45 |
| Mean Sea Level | 3.2 | 0.35 |
| Mean Low Water Neap | 2.0 | -0.85 |
| Mean Low Water Spring | 0.9 | -1.95 |

1 Note: Ordnance Datum Newlyn (ODN) is 2.85m above Lowest Astronomical Tide (LAT)

### Tidal currents

4.5.6 Admiralty chart tidal streams show velocity maxima for the Dogger Bank Zone between 0.2m/s and 0.6m/s, with higher velocities in the west (Admiralty Charts 266, 268 and 1191). Peak flows for mean spring tides reach approximately 0.4m/s and mid-depth peak flows for mean neap tides up to 0.2m/s. Current profile data from the Forewind current profiler indicates that tidal currents are predominantly from the north-east through to the south-east and south-west, and are mainly less than 0.4m/s (Gardline Environmental 2011c) and shown on Figure 4.4 in **Chapter 9** of the Dogger Bank Teesside A & B ES.

4.5.7 Mathiesen & Nygaard (2010) analysed depth-averaged current data at eight locations across the Dogger Bank Zone (see Figure 3.3 in **Chapter 9** of the Dogger Bank Teesside A & B ES for locations). In and around Dogger Bank, the predominant flow directions are north and south with subordinate currents flowing south-south-east and north-north-west, with increasing subordinate current strengths as one travels east and south. Mean current velocities are 0.14m/s to 0.30m/s with maximum velocities of 0.39m/s to 0.91m/s. Mathiesen & Nygaard (2010) also estimated extreme tidal current velocities for return periods of one, ten and 100 years, which were 0.88m/s, 0.98m/s and 1.11m/s respectively. More details are presented in **Appendix 9A** of the Dogger Bank Teesside A & B ES.

4.5.8 Modelled mid-depth peak flows to between 0.20m/s and 0.60m/s off the coast at Redcar BERR (2008). The corresponding mid-depth peak flows for mean neap tides are between 0.10m/s and 0.30m/s for the nearshore zone.

### Wave climate

4.5.9 Monitoring in Tranche A by Gardline Environmental (2011c) recorded a mean significant wave height of 1.7m and a maximum of 6.0m (and shown on Figure 4.3 in **Chapter 9** of the Dogger Bank Teesside A & B ES) with most waves approaching from the northern sector. Mathiesen *et al*. (2011) identified that most waves approach the Dogger Bank from the north and north-north-west sectors, with maximum significant wave heights ranging from 10.2m to 10.6m.

4.5.10 At the nearshore end of the Dogger Bank Teesside A & B Export Cable Corridor, BERR (2008) describes annual mean significant wave heights of less than 1.0m. As offshore waves propagate towards the Redcar and Cleveland coast they are influenced by the seabed and shoreline features and so wave transformation processes occur, resulting in a nearshore wave climate. Generally, nearshore waves approach the landfall from the north-north-east and

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north-east due to these transformation processes. The north-north-east-approaching waves drive sediment transport to the south-east along the Redcar to Marske-by-the-Sea coastline.

### Sediment characteristics and distribution

4.5.11 Geophysical analysis (GEMS 2011) and Gardline Environmental (2013a) showed that the majority (around 90% of 3,535km$^2$) of seabed sediments across tranches A & B are sandy (on the Udden-Wentworth scale), as shown on **Figure 4.3**. Within Dogger Bank Teesside A the majority of the area is sand (95%) with occasionally large patches of gravel (4.9%), whilst within Dogger Bank Teesside B there are small patches of outcrop (1.5%) and gravel (0.3%) dispersed within the predominantly (98% of area) sandy sediments (see **Figure 4.3**). **Table 4.4** presents the extents and percentages of seabed sediments within tranches A & B, the Dogger Bank Teesside A & B Export Cable Corridor, and within Dogger Bank Teesside A and Dogger Bank Teesside B, based on the data shown on **Figure 4.3**. Unit 'c' outcrop in **Figure 4.3** refers to the Dogger Bank Formation (glacial till), which generally comprises consolidated mud with sand and gravel.

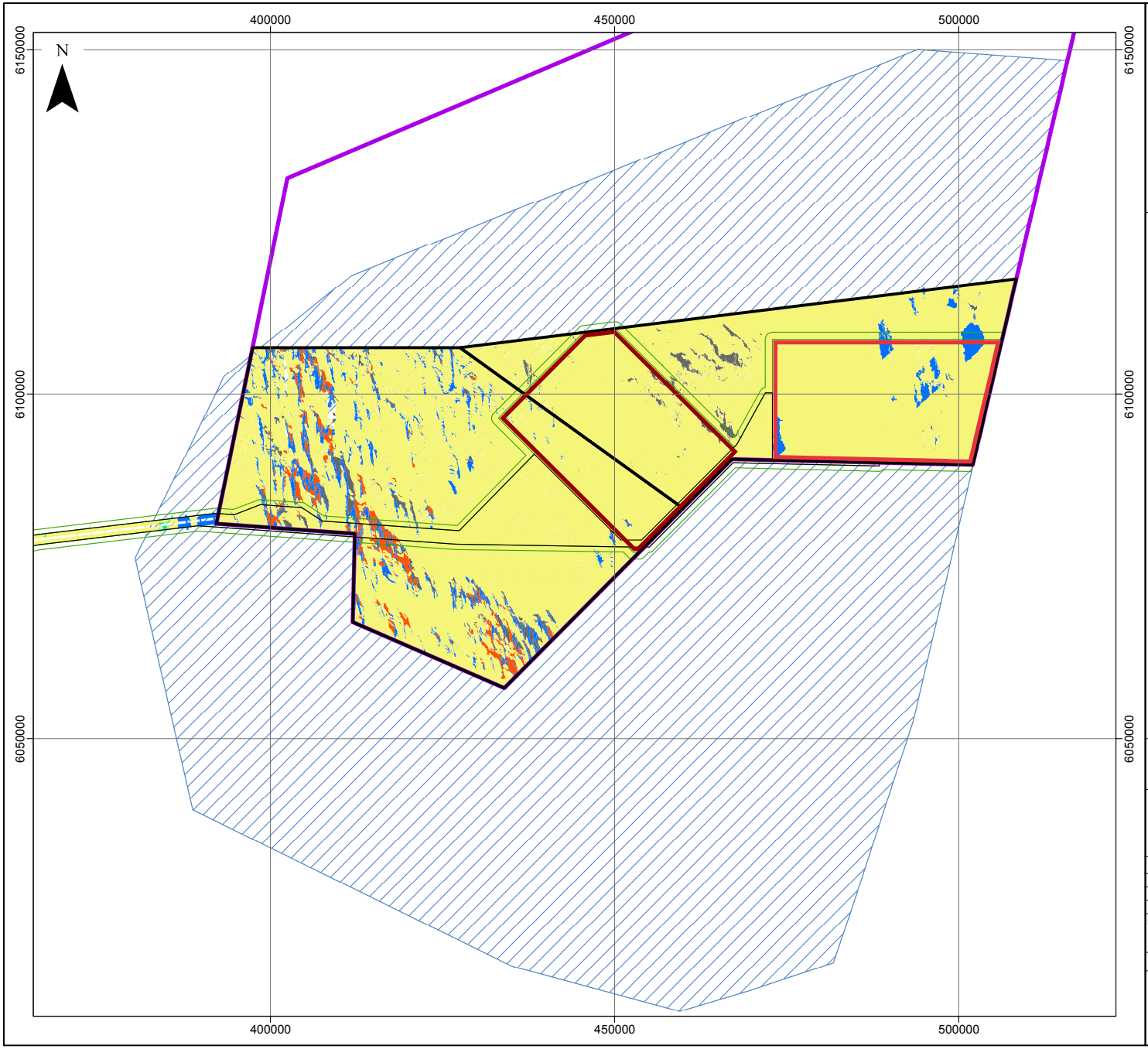
Table 4.4 Extent of seabed sediment types within Dogger Bank Teesside A, Dogger Bank Teesside B, Dogger Bank Teesside A & B and Dogger Bank cSAC

| Seabed sediment types | Extent (km$^2$) with percentages in brackets[1] | | | | |
|---|---|---|---|---|---|
| | Dogger Bank Teesside A | Dogger Bank Teesside B | Dogger Bank Teesside A & B | Surveyed area[2] within Dogger Bank cSAC | Dogger Bank cSAC[3] |
| Boundary | 560.11 | 593.21 | 1,153.32 | 3,535.00 | 12,331 |
| Unit 'c' outcrop | 0.88 (0.16%) | 8.84 (1.49%) | 9.72 (0.84%) | 95.40 (2.70%) | 332.73 |
| Gravel | 27.37 (4.89%) | 1.82 (0.31%) | 29.19 (2.53%) | 180.20 (5.10%) | 628.50 |
| Sand | 531.84 (94.96%) | 582.55 (98.20%) | 1,114.39 (96.62%) | 3,177.72 (89.88%) | 11,083.16 |
| Mixed sediment | 0.00 (0.00%) | 0.00 (0.00%) | 0.00 (0.00%) | 81.50 (2.31%) | 284.32 |
| Till | 0.00 (0.00%) | 0.00 (0.00%) | 0.00 (0.00%) | 0.66 (0.02%) | 2.29 |
| **Total area** | **560.09** | **593.87** | **1,153.30** | **3,535.50** | **12,331.00** |

1 The percentages are those of the extent of each sediment type within the boundary extent.
2 Surveyed area comprises tranches A & B and the Dogger Bank Teesside A & B Export Cable Corridor within the Dogger Bank cSAC.
3 Multiplied up from the surveyed area (tranches A & B and the Dogger Bank Teesside A & B Export Cable Corridor - which covered 28.67% of the cSAC) to provide an indicative figure for coverage within the Dogger Bank cSAC.

4.5.12 Particle size analyses (Gardline 2011b 2012) show that the medium particle diameter ($d_{50}$) for tranches A & B fall predominantly between 0.15mm and 0.22mm (fine sand) and 0.16mm and 0.19mm (fine sand), respectively, with a few samples in the medium to coarse sand categories. Most of the seabed sand samples contain less than 5% gravel and less than 5% mud, and can be categorised as slightly gravelly sand.

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**LEGEND**

- Dogger Bank Zone
- Tranche boundary
- Dogger Bank Teesside
- Dogger Bank Teesside B
- Dogger Bank Teesside A & B Export Cable Corridor
- Temporary works area
- Dogger Bank Special Area of Conservation (cSAC)

Seabed sediment type

- Till
- Sand
- Gravel
- Mixed sediment
- Outcrop

0 10 20
Kilometres

Data Source:
Environmental Designations © JNCC, 2014,
Sediment Distribution data © GEMS, 2011,
Round 3 offshore wind farm boundary © Crown Copyright, 2014

PROJECT TITLE

*DOGGER BANK TEESSIDE A & B*
IfAA Report

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**Figure 4.3 Dogger Bank cSAC showing overlap of Dogger Bank Teesside A & B with sediment distribution**

| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 11/10/2013 | PEI3 | GC | DB |
| 2 | 18/03/2014 | DCO Submission | GC | DB |
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DRAWING NUMBER: **9Y0986/TSABHRA/08/R2**

| SCALE | 1:850,000 | PLOT SIZE | A4 | DATUM | WGS84 | PROJECTION | UTM31N |
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4.5.13 Gravel and sandy gravel cover approximately 5% (182.2km$^2$) of tranches A & B, predominantly in north-south oriented 'strips' across the west of Tranche A (see **Figure 4.3**) corresponding with deeper valleys in the bathymetry, whilst only occurring in patches in Tranche B and particularly in Dogger Bank Teesside B. Seabed sediment samples from the gravel areas show variable median particle diameters (d50) ranging from 1.8mm (granule) to 10.5mm (pebble) with gravel percentages ranging from 49% to 93%. The mud content of the gravel areas is less than 5%.

4.5.14 GEMS (2011) and Gardline Environmental (2013a) also classified areas composed of sand, gravel and diamicton as 'mixed' sediment, covering around 2.3% (81.52km$^2$) of the seabed in tranches A & B, though none was present within Dogger Bank Teesside A or Dogger Bank Teesside B (see **Figure 4.3**).

4.5.15 Along the Dogger Bank Teesside A & B Export Cable Corridor, the seabed is dominated by sand (Gardline Environmental 2013b) as shown on Figure 4.6 in **Chapter 9** of the Dogger Bank Teesside A & B ES, with patches of gravel close to where it connects to Tranche A (see **Figure 4.2**). Between approximately 5km and 25km offshore, the Dogger Bank Teesside A & B Export Cable Corridor passes through mudstone with pockets of till at seabed (Gardline Environmental 2013b), as shown on **Figure 4.3**. Where bedrock or till are near the seabed, cobbles and boulders are present.

4.5.16 Particle size analyses of samples from the Dogger Bank Teesside A & B Export Cable Corridor (Gardline Environmental 2013b) show that the medium particle diameter ($d_{50}$) falls predominantly between 0.15mm and 0.30mm (mainly fine sand with some occasional medium sand). Most of the seabed sand samples contain less than 1.5% gravel and less than 5% mud, and can be categorised as slightly gravelly sand. Several samples contain between 7% and 65% gravel. A breakdown of the particle size distributions of the Dogger Bank Teesside A & B Export Cable Corridor seabed samples is provided in **Appendix 9A** of the Dogger Bank Teesside A & B ES.

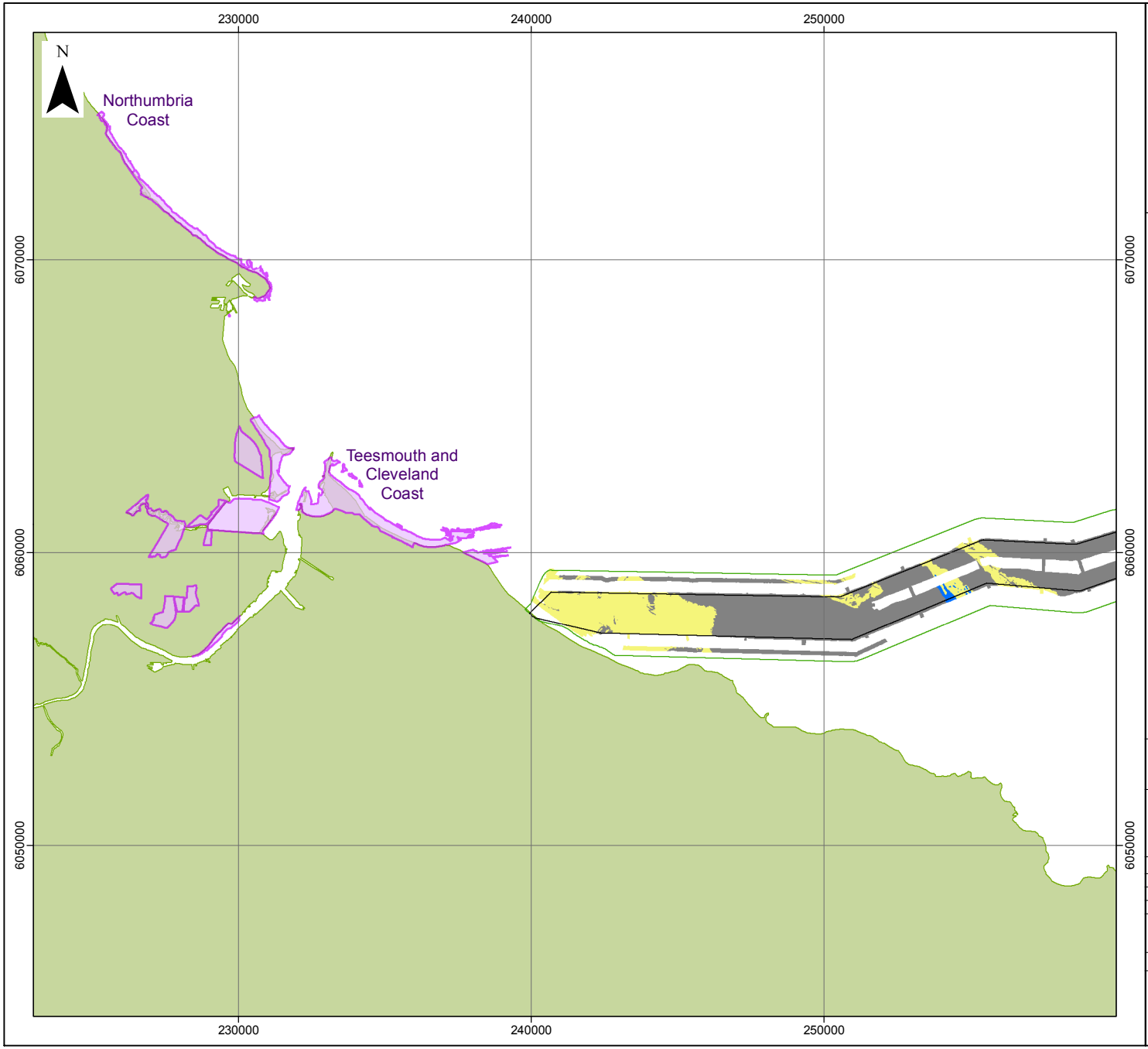
4.5.17 The nearshore sediments along the Dogger Bank Teesside A & B Export Cable Corridor are shown on **Figure 4.4**. Surveys of seabed sediments have been undertaken in Tees Bay as part of the Teesside Offshore Windfarm (EDF Energy 2004) application and ES. The survey indicates that the sediments in Tees Bay are dominated by fine sand with thicknesses of 5m nearer the shore, reducing with distance until only a thin veneer of sand covers bedrock (EDF Energy 2004). Further offshore, increased tidal currents result in largely exposed bedrock which is swept clear of sediments (EDF Energy 2004).

**Geomorphology (offshore bedforms and sediment movement)**

4.5.18 A significant part of the Dogger Bank Zone seabed is relatively featureless (approximately 91.6% of the surveyed area with no evident bedforms, see **Table 4.5**) because tidal current velocities are relatively weak (below 0.4m/s) and, therefore, generally insufficient to generate significant sedimentary features. However, megaripples (wavelengths between 0.5m and 25m) sculpted into both gravel and sand substrates are present in patches within Dogger Bank Teesside A & B, as shown on **Figure 4.5** and **Table 4.5**.

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**LEGEND**

- Dogger Bank Teesside A & B Export Cable Corridor
- Temporary works area
- UK Special Protection Area (SPA)/Ramsar site

Seabed sediment type

- Till
- Sand
- Gravel
- Mixed sediment
- Outcrop

Data Source:
SPA/Ramsar data from Natural England
Tranche A bathymetry from GEMS (2010),
Tranche B bathymetry from Gardline (2011),
Cable corridor bathymetry from Gardline (2013),
Round 3 offshore wind farm boundary © Crown Copyright, 2014

0 5
Kilometres

PROJECT TITLE
*DOGGER BANK TEESSIDE A & B*
IfAA Report

DRAWING TITLE
**Figure 4.4 Nearshore zone showing the Dogger Bank Teesside A & B export cable corridor with sediment distribution**

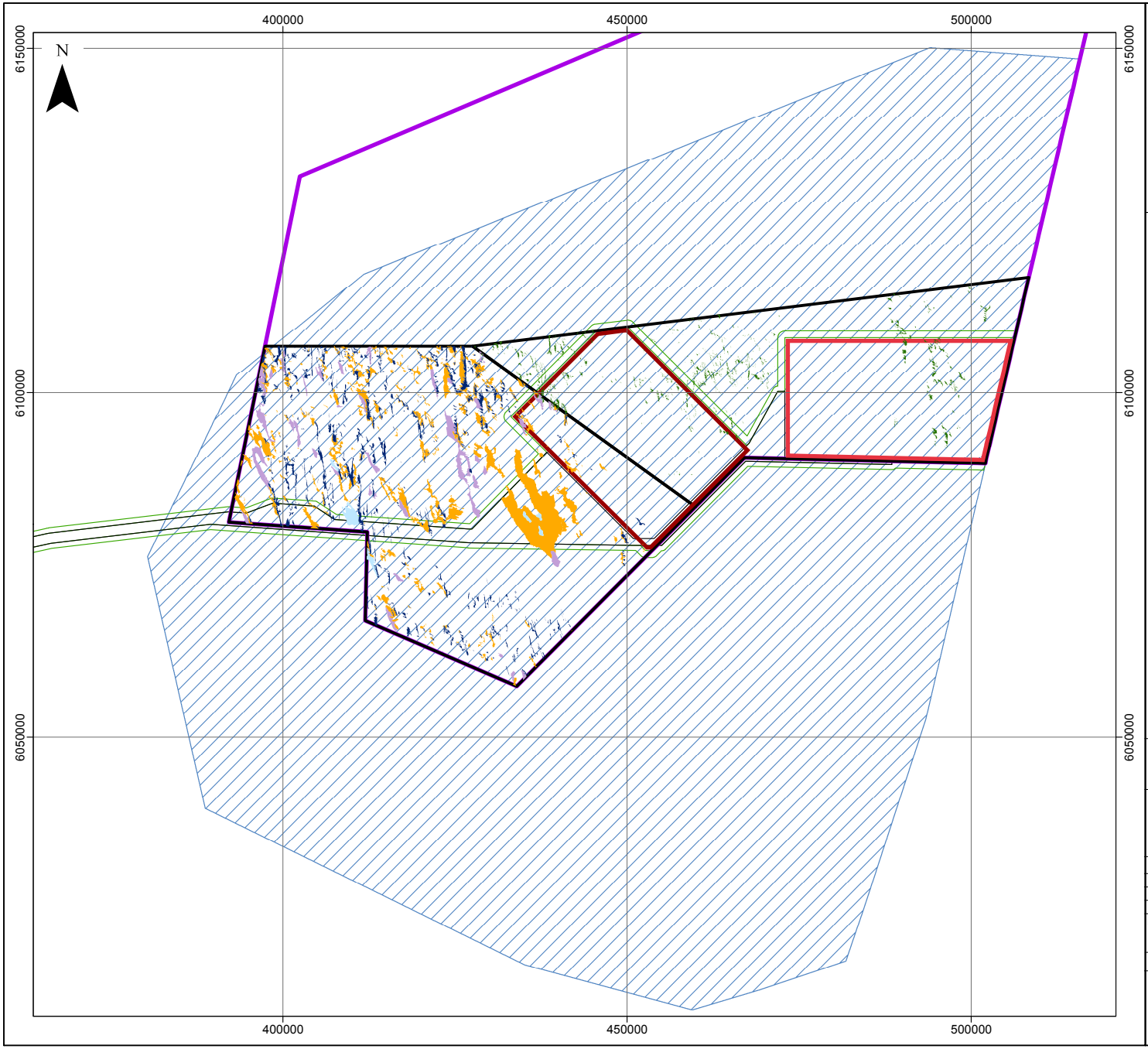
| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 11/10/2013 | PEI3 | GC | DB |
| 2 | 18/03/2014 | DCO Submission | GC | DB |
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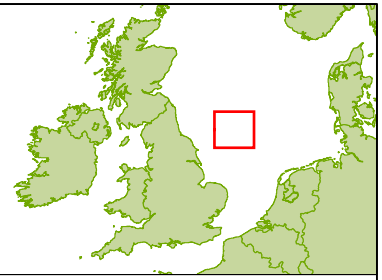
DRAWING NUMBER: **9Y0986/TSABHRA/09/R2**

| SCALE | 1:200,000 | PLOT SIZE | A4 | 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
- Dogger Bank Special Area of Conservation (cSAC)

Bedforms

- Megarippled gravel
- Megarippled sand
- Megarippled sand and sand waves
- Sand waves
- Megarippled gravelly sand

Data Source:
Environmental Designations © JNCC, 2014
Tranche A Sediment © GEMS 2010
Tranche B Sediment © Gardline 2011
Round 3 offshore wind farm boundary © Crown Copyright, 2014

0 10 20
Kilometres

PROJECT TITLE

*DOGGER BANK TEESSIDE A & B*
IfAA Report

DRAWING TITLE

**Figure 4.5 Dogger Bank cSAC showing overlap of Dogger Bank Teesside A & B with bedforms**

| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 11/10/2013 | PEI3 | GC | DB |
| 2 | 18/03/2014 | DCO Submission | GC | DB |
| | | | | |

DRAWING NUMBER: **9Y0986/TSABHRA/10/R2**

| SCALE | PLOT SIZE | DATUM | PROJECTION |
|---|---|---|---|
| 1:850,000 | A4 | WGS84 | UTM31N |

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Table 4.5 Extent of bedforms within Dogger Bank Teesside A, Dogger Bank Teesside B, Dogger Bank Teesside A & B and Dogger Bank cSAC

| Bedform and type | Extent ($km^2$) | | | | |
|---|---|---|---|---|---|
| | Dogger Bank Teesside A | Dogger Bank Teesside B | Dogger Bank Teesside A & B | Surveyed area within Dogger Bank cSAC[1] | Dogger Bank cSAC[2] |
| Boundary | 560.11 | 593.21 | 1,153.32 | 3,534.60 | 12,331.00 |
| Megarippled gravel | 0.96 (0.17%) | 0.00 (0.00%) | 0.96 (0.08%) | 63.59 (1.80%) | 221.84 |
| Megarippled sand | 0.00 (0.00%) | 0.00 (0.00%) | 0.00 (0.00%) | 156.67 (4.43%) | 546.57 |
| Megarippled sand and sand waves | 0.00 (0.00%) | 0.00 (0.00%) | 0.00 (0.00%) | 9.20 (0.26%) | 32.10 |
| Sand waves | 6.84 (1.22%) | 0.00 (0.00%) | 6.84 (0.59%) | 48.58 (1.37%) | 169.48 |
| Megarippled gravelly sand | 4.53 (0.81%) | 4.63 (0.78%) | 9.16 (0.79%) | 18.53 (0.52%) | 64.64 |

1 Surveyed area comprises tranches A & B and the Dogger Bank Teesside A & B Export Cable Corridor within the Dogger Bank cSAC.
2 Multiplied up from the surveyed area (tranches A & B, and the Dogger Bank Teesside A & B Export Cable Corridor) within the Dogger Bank cSAC which covered 28.66% of the cSAC.

4.5.19 Megaripples are present within the gravelly sand areas of Dogger Bank Teesside A (Gardline Environmental 2013b). The crests of the megaripples are aligned north-north-west to south-south-east and north to south, with amplitudes varying from 1.4m to 2.2m. Further details of the bedforms are provided in **Appendix 9A** of the Dogger Bank Teesside A & B ES. The variability in crest orientation and asymmetry of the megaripples indicates that these smaller bedforms are not in dynamic equilibrium with the prevailing tidal current conditions and, therefore, do not represent sediment movement in these areas.

4.5.20 Although there is widespread occurrence of Holocene sands along the Dogger Bank Teesside A & B Export Cable Corridor, there is only limited development of megaripples and sand waves. Both are present along a short section of the Dogger Bank Teesside A & B Export Cable Corridor, at approximately 25km-35km offshore. The largest sand wave is up to 3m high and the bedform crests are generally aligned north east to south west. The megaripples and sand waves are predominantly asymmetric with their steeper sides facing to the south east indicating that they are migrating to the south east.

4.5.21 Connor *et al*. (2006) showed that parts of Dogger Bank are above the stormwave base; hence, waves are able to disturb the seabed and influence the morphology and sediment distribution patterns. According to Van der Molen (2002), sediment transport across Dogger Bank is driven mainly by waves (storms) with minor tidal influence; consequently, wave energy is more important than tidal currents in governing sediment mobilisation. However, Stanev *et al*. (2008) showed that during storm conditions, no clear correlation exists between Dogger Bank bed shear stress and suspended sediment concentrations. They concluded that the availability of re-suspendable sediment at the bed across Dogger Bank is limited.

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4.5.22 Six wrecks have been identified across Tranche A (Wessex Archaeology, unpublished data). Four of these wrecks have no associated scour, whereas two have scour extending to the south-east (broad and shallow scour) and south-south-east (well defined for 80m). The lack of scour around four of the wrecks is consistent with limited sediment transport across Tranche A. Where scour has taken place, the location of the scour hollow is consistent with sediment transport to the south-south-east derived from bedform geometry.

**Geomorphology (coastal sediment sources, transport and sinks)**

4.5.23 The coastline of the landfall site, between Redcar and Saltburn-by-the-Sea, comprises a wide (300m to 400m) sand beach held in place by Saltburn Scar (a rock headland) to the east. Along its western end the beach is backed by a rock revetment built on to the face of a narrow strip of sand dune fronting a till hinterland (British Geological Survey 1998). Here the beach is controlled by groynes. The eastern half is mainly undefended and the beach is backed by a narrow strip of dunes in front of till slopes, apart from a stretch of sea wall in front of Saltburn-by-the-Sea at the eastern extremity.

4.5.24 The dunes are in poor health and are actively eroding, forming a 'veneer' in front of the till hinterland. In places, the dunes are absent and till is exposed at the coast. In front of the till, the beach is composite with pebbles forming an upper storm beach with a wide sandy lower beach. This structure indicates that the pebbles are supplied locally through erosion of the till. In front of the dunes, the upper pebble beach breaks down and there are patches of shingle sometimes shaped into cusps on the beach surface, which is mainly sand.

4.5.25 Net longshore sediment transport is to the east (Babtie 1997; 1999), but only small sediment build-up on the west side of the Redcar groynes indicates that actual longshore sediment transport is low in this area. In addition, the presence of Saltburn Scar does not allow much loss of sediment to the east.

4.5.26 Not all of the alongshore transport of sediment occurs in the intertidal zone. Sediment transport occurs throughout what is termed the 'active' beach profile, which extends offshore from the high water mark to a nearshore point below low water, which is determined by the 'closure depth' of the beach profile (a parameter defined by the wave height and period in the nearshore zone). This could be described as the water depth offshore from which sediment is not disturbed during fair weather (wave) conditions. Whilst the predominant transport is from north-west to south-east, onshore to offshore movement occurs during storms.

4.5.27 Babtie (1999) showed that over the long-term (1858-1990), the mean high water and mean low water marks have retreated by up to 0.8m/yr) but with local accretion at Marske-by-the-Sea (0.01m/yr). Overall, Babtie (1999) estimated that the erosion rate for undefended land has been 0.4m/yr with localised erosion of 0.6m/yr to 0.7m/yr closer to Redcar.

4.5.28 Since 2008, Redcar and Cleveland Borough Council has been monitoring beach morphological change as part of the wider Cell 1 (North East) Regional Coastal Monitoring Programme (Cooper *et al*. 2009). Beach profile RC7 is located within the envelope of the two cable landfall corridors. Figure 4.8 in **Chapter 9**

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of the Dogger Bank Teesside A & B ES shows the variations in beach and coastal slope profile over time between November 2008 and April 2011. The profiles describe changes to foreshore levels of up to 0.6m over this short period.

### Suspended sediments

4.5.29 The Dogger Bank Zone is typically characterised by relatively low suspended sediment concentrations of <10 mg/l (Doerffer & Fisher 1994; Eleveld *et al*., 2006) and high bed shear stresses in the area have been seen to coincide with low concentrations of suspended matter (Stanev *et al*. 2008). Generally, suspended concentrations throughout the Dogger Bank Zone and the Dogger Bank Teesside A & B Export Cable Corridor are not thought to significantly increase over and above 2mg/l (as noted in Eisma (1981) and Eisma & Kalf (1987)).

4.5.30 The main driving force for suspended sediment dynamics in the North Sea is turbulence induced by tidal currents and waves (Stanev *et al*. 2008). The fundamental mechanism controlling sediment re-suspension from the seabed is bed shear stress. Stanev *et al*. (2008) showed that during storm conditions, no clear correlation exists between Dogger Bank bed shear stress and suspended sediment concentrations; consequently, suspended sediment concentrations are low due to the limited availability of re-suspendable sediment at the bed across the Dogger Bank.

4.5.31 Measurements of near bed suspended sediment concentrations in the area of the Teesside Offshore Wind Farm (EDF Energy 2004) recorded variable concentrations of suspended sediments over the survey periods. Figure 12.9 in Chapter 12 of the Teesside Offshore Wind Farm ES (EDF Energy 2004) shows that suspended sediment concentrations offshore range from less than 100mg/l for periods, to in excess of 1000mg/l in a period of ten days. During a storm event, near bed suspended sediment concentrations reached 4,500mg/l. The duration when suspended sediment concentrations exceed 600mg/l can extend for in excess of 24 hours as noted in the surveyed data. The wide variations in suspended sediment concentrations over tidal cycles and particularly during storm events indicate that the offshore and nearshore areas in and close to the Teesmouth and Cleveland Coast SPA and Ramsar site are highly active, and significantly influenced by tidal currents and wave action.

## Sediment quality

### Offshore wind farm

4.5.32 Sediment quality data for Tranche B within the Dogger Bank cSAC from the survey described in paragraph 4.2.20 and for the locations shown on Figure 4.2 in **Chapter 10** of the Dogger Bank Teesside A & B ES is presented in **Table 4.6** (in relation to the Cefas Action Levels) and in **Table 4.7** (in relation to the Canadian Sediment Quality Guideline PEL). Within these tables, data highlighted in yellow indicates concentrations of contaminants over either Cefas Action Level 1 or Canadian Sediment Quality Guideline Threshold Effects Level (TEL). Red indicates concentrations greater than Cefas Action Level 2 or Canadian Sediment Quality Guideline Probable Effects Level (PEL). The Cefas

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Action Levels and Canadian Sediment Quality Guideline Levels are presented in Table 3.1 and Table 3.2 in **Chapter 10** of the Dogger Bank Teesside A & B ES.

4.5.33 The samples taken offshore do not indicate significant levels of contamination across the site. Of the 14 sites sampled within the Tranche B and Dogger Bank Teesside A & B project areas within the Dogger Bank cSAC, only one site (site TB_17 which is located in the centre of Dogger Bank Teesside B - see Figure 4.2 in **Chapter 10** of the Dogger Bank Teesside A & B ES) exceeded the Cefas Action Level 1 for three metal substances. No samples exceeded the Cefas Action Level 2. In order to provide a further indication regarding the potential toxicological effects of the contaminant levels within the offshore sediments, the data has also been compared to the Canadian Sediment Quality Guidelines. Again the offshore sites do not indicate levels of contamination that would be of concern. Whilst contaminant levels at site TB_17 highlight that levels of chromium and copper in the sediments here (if released into the water column) could have toxicological effects, these levels are limited to this one site. Overall, the predominantly sandy nature of the seabed sediments within the Dogger Bank cSAC and project areas significantly reduces the potential for any contaminants to accumulate or be present in high concentrations.

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

4.5.34 Sediment quality data for the Dogger Bank Teesside A & B Export Cable Corridor from the survey described in paragraph 4.2.20 and for the locations shown on Figure 4.2 in **Chapter 10** of the Dogger Bank Teesside A & B ES is presented in **Table 4.8** (in relation to the Cefas Action Levels) and in **Table 4.9** (in relation to the Canadian Sediment Quality Guideline PEL). Within these tables, data highlighted in yellow indicates concentrations of contaminants over either Cefas Action Level 1 or Canadian Sediment Quality Guideline Threshold Effects Level (TEL). Red indicates concentrations greater than Cefas Action Level 2 or Canadian Sediment Quality Guideline Probable Effects Level (PEL).

4.5.35 The results of the sampling and analysis for the samples taken along the Dogger Bank Teesside A & B Export Cable Corridor suggest that whilst sediments generally exceed the Cefas Action Level 1 for copper, chromium and nickel, the concentrations are only marginally above Action Level 1 concentrations at the majority of sites. The near-shore areas do appear to indicate higher concentrations along the export cable route (sites 62 and 64). There is only one exceedance of Action Level 2 and this is for nickel at site 64. In order to provide a further indication regarding the potential toxicological effects of the contaminant levels within the sediments, the data has also been compared to the Canadian Sediment Quality Guidelines. This indicates that contaminant levels at the majority of sites could give rise to toxicological effects (i.e. exceed the PEL) in relation to copper and chromium levels. In the samples collected nearshore, additional parameters (arsenic, lead and PAH naphthalene) indicate potential exceedances of the TEL.

4.5.36 Within the samples analysed from the intertidal zone, no samples exceeded the Cefas Action Level 1 for selected contaminants, and only two samples exceeded the TEL for arsenic. Overall, levels of contaminants are considered to be low.

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Table 4.6 Sediment quality results in Dogger Bank Teesside A & B (within Dogger Bank cSAC) compared to the Cefas Action Levels (Yellow indicates exceedance of Action Level 1)

| Contaminant mg/kg | Offshore (within Dogger Bank Teesside A & B wind farm areas) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TB_1 | TB_4 | TB_6 | TB_10 | TB_13 | TB_17 | TB_19 | TB_25 | TB_33 | TB_36 | TB_40 | TA_85 | TA_8 | TA_4 |
| Arsenic | 2.65 | 2.5 | 2.59 | 2.7 | 2.28 | 5.31 | 2.3 | 2.79 | 3.04 | 2.22 | 2.57 | 1.64 | 1.13 | 2.69 |
| Cadmium | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 | 0.071 | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 | 0.03 | <0.03 | <0.03 |
| Chromium | 15.1 | 22.4 | 11.2 | 25 | 15.1 | 112 | 13.5 | 10 | 13.9 | 21.3 | 11 | 15.5 | 14.8 | 25.4 |
| Copper | 4.24 | 6.06 | 3.73 | 5.18 | 3.15 | 160 | 4.47 | 4.13 | 2.64 | 3.27 | 2.74 | 4.12 | 3.86 | 3.32 |
| Mercury | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 |
| Lead | 6.97 | 7.28 | 7.21 | 7.03 | 6.57 | 12.3 | 8.67 | 12.6 | 6.99 | 9.19 | 7.05 | 8.18 | 6.38 | 6.6 |
| Nickel | 2.79 | 7.44 | 3.21 | 7.84 | 2.85 | 52.4 | 2.37 | 4.57 | 5.82 | 3.72 | 3.63 | 3.7 | 3.07 | 2.96 |
| Zinc | 8.07 | 15.5 | 11.2 | 10.1 | 7.47 | 46.3 | 16 | 11.5 | 10.6 | 14.6 | 7.87 | Not analysed | | |
| Total hydrocarbons | 0.12 | 0.25 | 0.38 | 0.13 | 0.22 | 0.48 | 0.93 | 0.5 | 0.53 | 0.79 | 0.1 | 0.35 | 0.05 | 0.12 |
| PCBs (sum ICES 7) | Below limit of detection (<0.003mg/kg) for all samples | | | | | | | | | | | | | |


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Table 4.7 Sediment quality results in Dogger Bank Teesside A & B (within Dogger Bank cSAC) compared to the Canadian Sediment Quality Guideline Levels (Yellow indicates exceedance of TEL, Red indicates exceedance of PEL)

| Contaminant (units vary) | Offshore (within Dogger Bank Teesside A & B wind farm areas) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TB_1 | TB_4 | TB_6 | TB_10 | TB_13 | TB_17 | TB_19 | TB_25 | TB_33 | TB_36 | TB_40 | TA_85 | TA_8 | TA_4 |
| Arsenic (mg/kg) | 2.65 | 2.5 | 2.59 | 2.7 | 2.28 | 5.31 | 2.3 | 2.79 | 3.04 | 2.22 | 2.57 | 1.64 | 1.13 | 2.69 |
| Cadmium (mg/kg) | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 | 0.071 | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 | 0.03 | <0.03 | <0.03 |
| Chromium (mg/kg) | 15.1 | 22.4 | 11.2 | 25 | 15.1 | 112 | 13.5 | 10 | 13.9 | 21.3 | 11 | 15.5 | 14.8 | 25.4 |
| Copper (mg/kg) | 4.24 | 6.06 | 3.73 | 5.18 | 3.15 | 160 | 4.47 | 4.13 | 2.64 | 3.27 | 2.74 | 4.12 | 3.86 | 3.32 |
| Mercury (mg/kg) | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 |
| Lead (mg/kg) | 6.97 | 7.28 | 7.21 | 7.03 | 6.57 | 12.3 | 8.67 | 12.6 | 6.99 | 9.19 | 7.05 | 8.18 | 6.38 | 6.6 |
| Zinc (mg/kg) | 8.07 | 15.5 | 11.2 | 10.1 | 7.47 | 46.3 | 16 | 11.5 | 10.6 | 14.6 | 7.87 | Not analysed | | |
| Acenaphthene (µg/kg) | <2 | <2 | <2 | 2.35 | <2 | <2 | <2 | <2 | <2 | <2 | <2 | <2 | <2 | <2 |
| Acenaphthylene (µg/kg) | <2 | <2 | <2 | <2 | <2 | <2 | <2 | <2 | <2 | <2 | <2 | <2 | <2 | <2 |
| Anthracene (µg/kg) | <2 | <2 | <2 | <2 | <2 | <2 | <2 | <2 | <2 | <2 | <2 | <2 | <2 | <2 |
| Benzo(a)anthracene (µg/kg) | <2 | <2 | <2 | <2 | <2 | <2 | <2 | <2 | <2 | <2 | <2 | <2 | <2 | <2 |
| Benzo(a)pyrene (µg/kg) | <2 | <2 | <2 | <2 | <2 | <2 | <2 | <2 | <2 | <2 | <2 | <2 | <2 | <2 |
| Chrysene (µg/kg) | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <3 | <3 | <3 |
| Dibenz(a,h)anthracene (µg/kg) | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 |
| Fluoranthene (µg/kg) | <2 | <2 | <2 | <2 | <2 | <2 | <2 | <2 | <2 | <2 | <2 | <2 | 3.25 | <2 |
| Fluorene (µg/kg) | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 |
| Napthalene (µg/kg) | 61.5 | <30 | <30 | 69.6 | <30 | 41 | <30 | <30 | <30 | <30 | <30 | <30 | <30 | <30 |
| Phenanthrene (µg/kg) | <10 | <10 | <10 | <10 | <10 | 10.5 | <10 | <10 | <10 | <10 | <10 | 11.3 | 16.7 | <10 |
| Pyrene (µg/kg) | <3 | <3 | <3 | <3 | <3 | <3 | <3 | <3 | <3 | <3 | <3 | 5.28 | 3.97 | <3 |


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Table 4.8 Sediment quality results in the Dogger Bank Teesside A & B Export Cable Corridor compared to the Cefas Action Levels (Yellow indicates exceedance of Action Level 1, Red indicates exceedance of Action Level 2)

| Contaminant mg/kg | Intertidal zone | | | Dogger Bank Teesside A & B Export Cable Corridor | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 61 | 62 | 64 | 75 | 86 | 95 | 102 | 109 | 114 |
| Arsenic | 7.72 | 6.58 | 8.06 | 20 | 15.3 | 7.14 | 25.5 | 9.87 | 9.42 | 9.77 | 10.1 | 6.74 |
| Cadmium | <0.03 | <0.03 | <0.03 | 0.152 | 0.143 | 0.165 | 0.136 | 0.079 | 0.082 | 0.076 | 0.1 | 0.053 |
| Chromium | 6.94 | 4.99 | 5.97 | 126 | 312 | 387 | 221 | 193 | 233 | 164 | 103 | 66 |
| Copper | 9.54 | 3.12 | 2.84 | 55.9 | 121 | 196 | 62.7 | 116 | 88.8 | 138 | 70.3 | 63.5 |
| Mercury | Not analysed | | | 0.046 | 0.009 | 0.008 | 0.049 | 0.003 | 0.002 | 0.002 | 0.016 | <0.002 |
| Lead | 16.4 | 12 | 13.4 | 58 | 53.5 | 54.2 | 104 | 29.4 | 25.5 | 26.5 | 35.9 | 14.9 |
| Nickel | 3.82 | 2.04 | 2.78 | 56.8 | 149 | 220 | 118 | 106 | 136 | 90.6 | 43.5 | 41.4 |
| Zinc | 40.8 | 29.5 | 30.2 | 113 | 115 | 112 | 118 | 50.3 | 41.2 | 51.9 | 69 | 31 |
| Total hydrocarbons | No results provided | | | 27 | 35.2 | 60.2 | 41 | 5.43 | 3.16 | 4.59 | 10.3 | <3 |
| TBT | Below limit of detection (<0.003mg/kg) for all samples | | | | | | | | | | | |
| PCB | Below limit of detection (<0.003mg/kg) for all samples | | | | | | | | | | | |


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Table 4.9 Sediment quality results in Export Cable Corridor compared to the Canadian Sediment Quality Guideline Levels (Yellow indicates exceedance of TEL, Red indicates exceedance of PEL)

| Contaminant (units vary) | Intertidal zone | | | Dogger Bank Teesside A & B Export Cable Corridor | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 61 | 62 | 64 | 75 | 86 | 95 | 102 | 109 | 114 |
| Arsenic (mg/kg) | 7.72 | 6.58 | 8.06 | 20 | 15.3 | 7.14 | 25.5 | 9.87 | 9.42 | 9.77 | 10.1 | 6.74 |
| Cadmium (mg/kg) | <0.03 | <0.03 | <0.03 | 0.1522 | 0.1433 | 0.1655 | 0.1366 | 0.0799 | 0.0822 | 0.0766 | 0.1 | 0.05336 |
| Chromium (mg/kg) | 6.94 | 4.99 | 5.97 | 126 | 312 | 387 | 221 | 193 | 233 | 164 | 103 | 66 |
| Copper (mg/kg) | 9.54 | 3.12 | 2.84 | 55.9 | 121 | 196 | 62.7 | 116 | 88.8 | 138 | 70.33 | 63.5 |
| Mercury (mg/kg) | Not analysed | | | 0.046 | 0.009 | 0.008 | 0.049 | 0.003 | 0.002 | 0.002 | 0.016 | <0.002 |
| Lead (mg/kg) | 16.4 | 12 | 13.4 | 58 | 53.5 | 54.2 | 104 | 29.4 | 25.5 | 26.5 | 35.9 | 14.9 |
| Zinc (mg/kg) | 40.8 | 29.5 | 30.2 | 113 | 115 | 112 | 118 | 50.3 | 41.2 | 51.9 | 69 | 31 |
| Acenaphthene (µg/kg) | No results provided | | | 8.71 | 6.2 | 7.53 | 4.75 | <2 | <2 | 2.31 | <2 | <2 |
| Acenaphthylene (µg/kg) | No results provided | | | 3.66 | 36.6 | <2 | 3.14 | <2 | <2 | <2 | <2 | <2 |
| Anthracene (µg/kg) | 3.35 | 6.38 | 7.08 | 10.1 | 13.4 | 11.9 | 9.61 | <2 | <2 | <2 | <2 | <2 |
| Benzo(a)anthracene (µg/kg) | 5.18 | 16.4 | 8.83 | 17.2 | 25.9 | 43.6 | 31.3 | 4.16 | 2.64 | 3.65 | 7.34 | <2 |
| Benzo(a)pyrene (µg/kg) | 3.47 | 12.4 | 6.04 | 11 | 17.1 | 32.8 | 24.3 | 3.43 | <2 | 2.53 | 6.22 | <2 |
| Chrysene (µg/kg) | 6.11 | 13.4 | 11 | 38 | 51.5 | 33.6 | 39.6 | <10 | <10 | <10 | <10 | <10 |
| Dibenz(a,h)anthracene (µg/kg) | No results provided | | | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 |
| Fluoranthene (µg/kg) | 11.4 | 39.1 | 28.2 | 26.5 | 29.8 | 71.4 | 44.6 | 4.84 | 2.8 | 4.55 | 11.5 | 2.35 |
| Fluorene (µg/kg) | No results provided | | | 18.2 | 13.4 | 10.4 | <10 | <10 | <10 | <10 | <10 | <10 |
| Napthalene (µg/kg) | <30 | <30 | <30 | 145 | 97 | 51.6 | 63.6 | 44.6 | 52.1 | 46.4 | <30 | <30 |
| Phenanthrene (µg/kg) | 15.9 | 34.8 | 38.7 | 67.9 | 63 | 63.8 | 46.2 | <10 | <10 | <10 | 12.4 | <10 |
| Pyrene (µg/kg) | 10.2 | 33.5 | 32.1 | 27 | 35.2 | 60.2 | 41 | 5.43 | 3.16 | 4.59 | 10.3 | <3 |


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4.5.37 Sediment quality samples analysed for the Teesside Offshore Wind Farm within Tees Bay indicated elevated levels of copper and lead at one out of 17 sites, and elevated levels of Arsenic at 5 out of 11 sites. No levels exceeded the Sediment Quality Guideline PEL (EDF Energy 2004).

## Characteristics, distribution and extent of marine habitats, communities and species

### Communities and distribution - offshore wind farm (tranches A & B)

#### *Regional background*

4.5.38 In general, the biological communities on the Dogger Bank are typical of fine sand and muddy sand sublittoral sediments (JNCC 2011). Species typical of these communities include the polychaetes *Nephtys cirrosa* and *Magelona* spp., mobile amphipods of the genus Bathyporeia, the brittlestar *Amphiura filiformis*, and bivalve molluscs such as *Tellina fabula* (formerly *Fabulina fabula*) and *Mysella bidentata* (Wieking & Kröncke 2001). Epifaunal species include the hermit crab *Pagurus bernhardus*, sand eels *Ammodytes* spp., plaice *Pleuronectes platessa* and the starfish *Asterias rubens*. The site and this feature are a typical example of this type of Annex I sandbank habitat (JNCC 2011).

4.5.39 The dominant biotope associated with the Dogger Bank is SS.SSa.IFiSa.NcirBat (*Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand) which appears to cover the majority of the Dogger Bank Zone (EMU 2011). These community types correspond well with the 'Bank' community described by Wieking & Krönke (2001) which occupies the flat shallow seabed areas on top of the Dogger Bank.

#### *Macrofaunal sampling and univariate data analysis*

4.5.40 Updated zone-wide habitat mapping has been carried out in 2012 by Envision. The results of this updated assessment indicate that the predominant benthic habitat is slightly gravelly sand (indicative of the cSAC as identified in Section 12 in JNCC (2011)) sparsely populated by polychaetes, bivalves and amphipods. Both Tranche B (Dogger Bank Teesside A & B) and Tranche A (Dogger Bank Creyke Beck A & B and Dogger Bank Teesside B) were predominantly sandy in nature although Tranche B was slightly less gravelly (Envision 2012).

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

4.5.42 The benthic habitats found on the Dogger Bank are among the most common habitats found below Mean Low Water Spring (MLWS) around the coast of the United Kingdom. This habitat occurs in a range of environmental conditions, and the mix of sand or gravel, and any bedforms present on the surface of the seabed, depends on factors such as tidal and wave strengths.

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4.5.43 From the sampling (see **Table 4.2** and details in Section 3 in **Chapter 9** of the Dogger Bank Teesside A & B ES) carried out within Tranche B, a total of 7,902 individuals from 211 taxa were recorded from the 51 successful grab samples. Juveniles accounted for 795 individuals from 33 taxa, making up 10% of the total individuals and 16% of the total taxa. Analysis using the RELATE programme within Primer v6 indicated that juveniles may not be exerting an influence on the overall community structure, therefore, the data analyses were performed using the full data set inclusive of juvenile counts.

4.5.44 Overall, the macrofaunal community within Tranche B was dominated by polychaete annelids, contributing 63% of the total individuals and 38% of the total taxa (see **Figure 4.6**). Molluscs were the second most dominant group, with 19% of the total individuals and 26% of the total taxa, while crustaceans contributed just 10% of individuals and 23% of the taxa. The dominance of polychaete taxa is not unusual. Studies by Gage (2001) show polychaetes consistently dominating soft bottom benthos from continental shelves to abyssal plains and revealed that over 50% of total macrofaunal individuals are generally composed of polychaete worms.

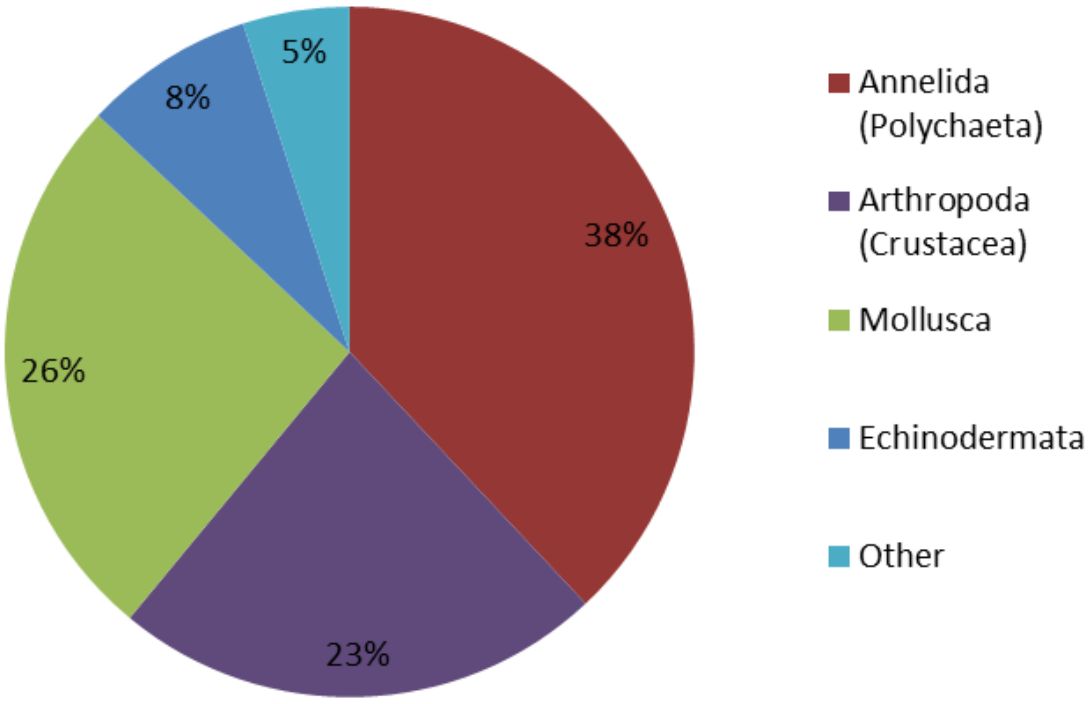



Figure 4.6 Percentage proportions of individual taxa recorded from Tranche B

4.5.45 **Figure 4.7** presents the distribution of species/taxa per 0.1m$^2$ (indicative of diversity) based on the sampling and analysis carried out. The highest macrofaunal density and diversity at the sampled stations contained 413 individuals and 62 taxa, and the faunal community at this station was dominated by polychaetes, contributing 74% of individuals and 48% of taxa. The lowest macrofaunal densities at the sampled stations contained 64 individuals. The majority of stations (80%) recorded <200 individuals per 0.1m$^2$.

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4.5.46 **Figure 4.8** presents the distribution of the number of individuals per 0.1m$^2$ (indicative of density) based on the sampling and analysis carried out. The most abundant and most frequently recorded species within Tranche B, with 2,899 individuals identified in all but one (98%) of the 51 samples, was the polychaete *Spiophanes bombyx*. *S. bombyx* is commonly found in sublittoral sands and sandy muds (Rees *et al*. 2007) and is known to be tolerant to both smothering and substratum loss and to be intolerant to changes in nutrients (Hiscock *et al*. 2005). *S. bombyx* was also the most frequently recorded species in the benthic survey of Tranche A (Emu 2012).

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

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

4.5.49 **Figure 4.9** presents the distribution of macrofaunal biomass per 0.1m$^2$ based on the sampling and analysis carried out. Total biomass was relatively consistent across Tranche B, with the majority of sites recording ≤25g. The highest biomass recorded at any one station was 100.35g, over 99g of which was contributed by echinoderms (three individuals of the sea potato *Echinocardium cordatum*).

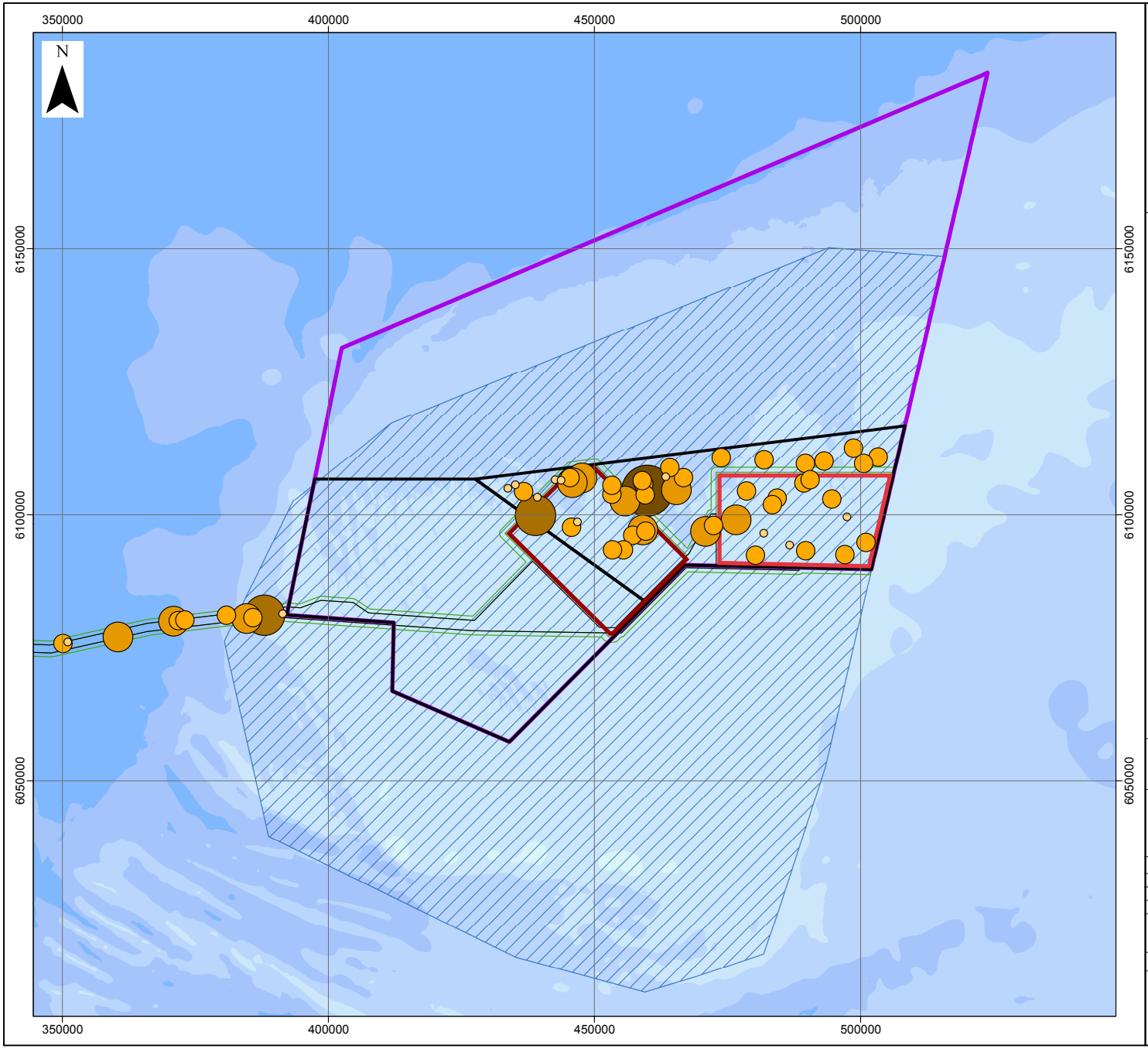
### *Macroinfauna and multivariate data analysis*

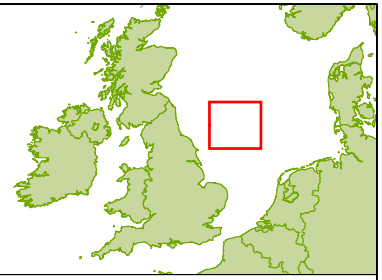
4.5.50 Multivariate analysis of benthic samples identified two main groups (clusters) of stations, with the first group (Cluster h) containing five stations and the second group containing the remaining stations, separated further into six clusters (b to g) and one statistically distinct station. The clusters are characterised in **Table 4.10**.

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

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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
- Dogger Bank Special Area of Conservation (cSAC)

Total numbers of taxa

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

0 10 20
Kilometres

Data Source:
Environmental Designations © JNCC, 2014
Sediment Samples © Gardline Environmental Limited, 2012
Round 3 offshore wind farm boundary © Crown Copyright, 2014
Background bathymetry image derived in part from TCarta data © 2009

PROJECT TITLE

*DOGGER BANK TEESSIDE A & B*
IfAA Report

DRAWING TITLE

**Figure 4.7 Distribution of total numbers of species/taxa per 0.1m²**

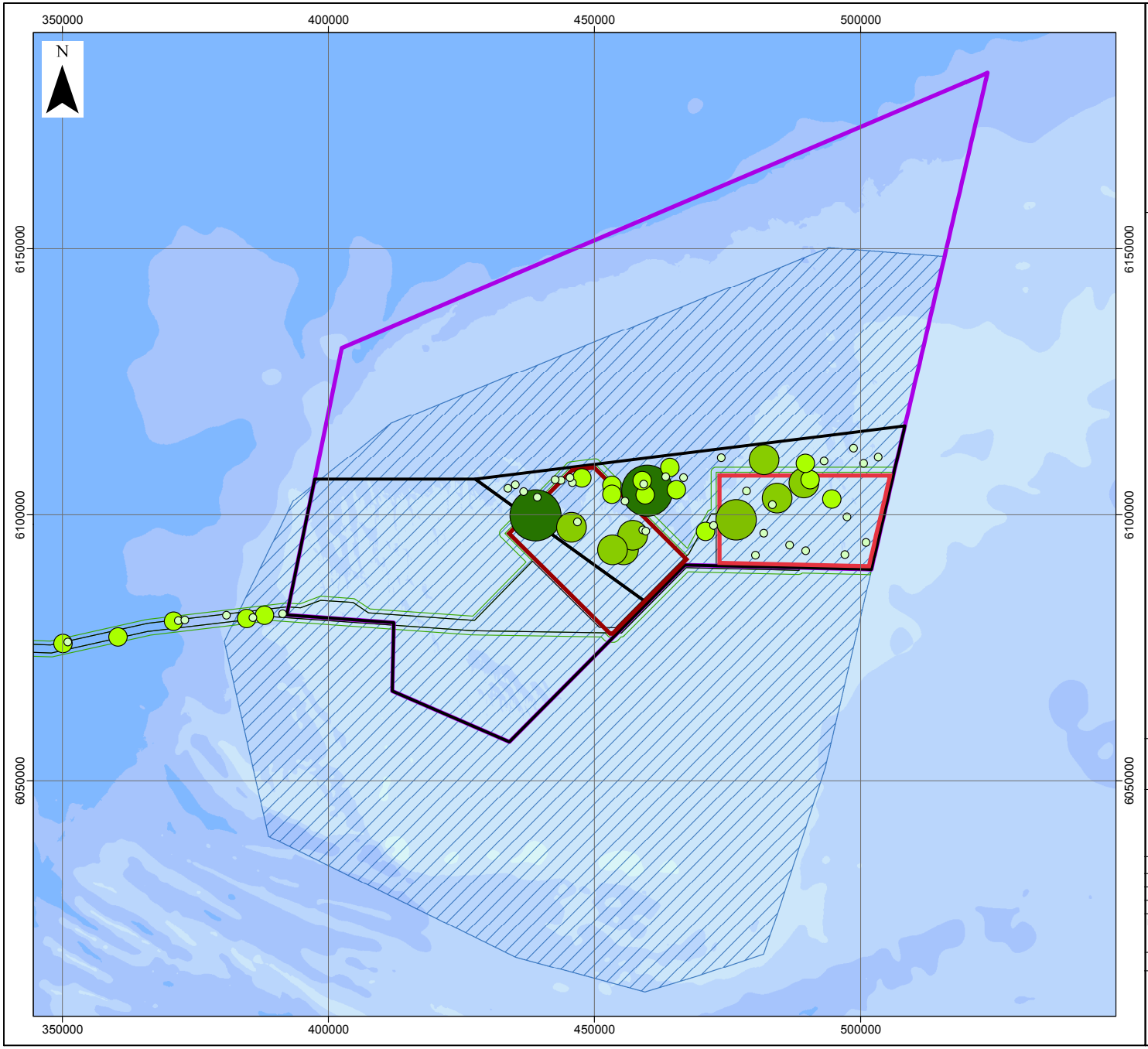
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|---|---|---|---|---|
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| 2 | 18/03/2014 | DCO Submission | GC | DB |
| | | | | |

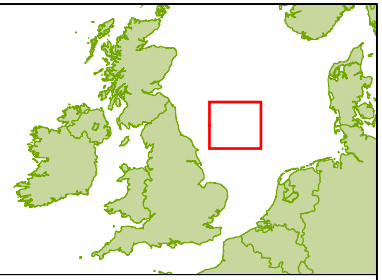
DRAWING NUMBER: **9Y0986/TSABHRA/11/R2**

| SCALE | 1:1,100,000 | PLOT SIZE | A4 | 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
- Dogger Bank Special Area of Conservation (cSAC)

Total numbers of individuals

- < 150
- 151 - 200
- 201 - 250
- 251 - 300
- > 300

0 10 20
Kilometres

Data Source:
Environmental Designations © JNCC, 2014
Sediment Samples © Gardline Environmental Limited, 2012
Round 3 offshore wind farm boundary © Crown Copyright, 2014
Background bathymetry image derived in part from TCarta data © 2009

PROJECT TITLE

*DOGGER BANK TEESSIDE A & B*
IfAA Report

DRAWING TITLE

**Figure 4.8 Distribution of numbers of individuals per 0.1m²**

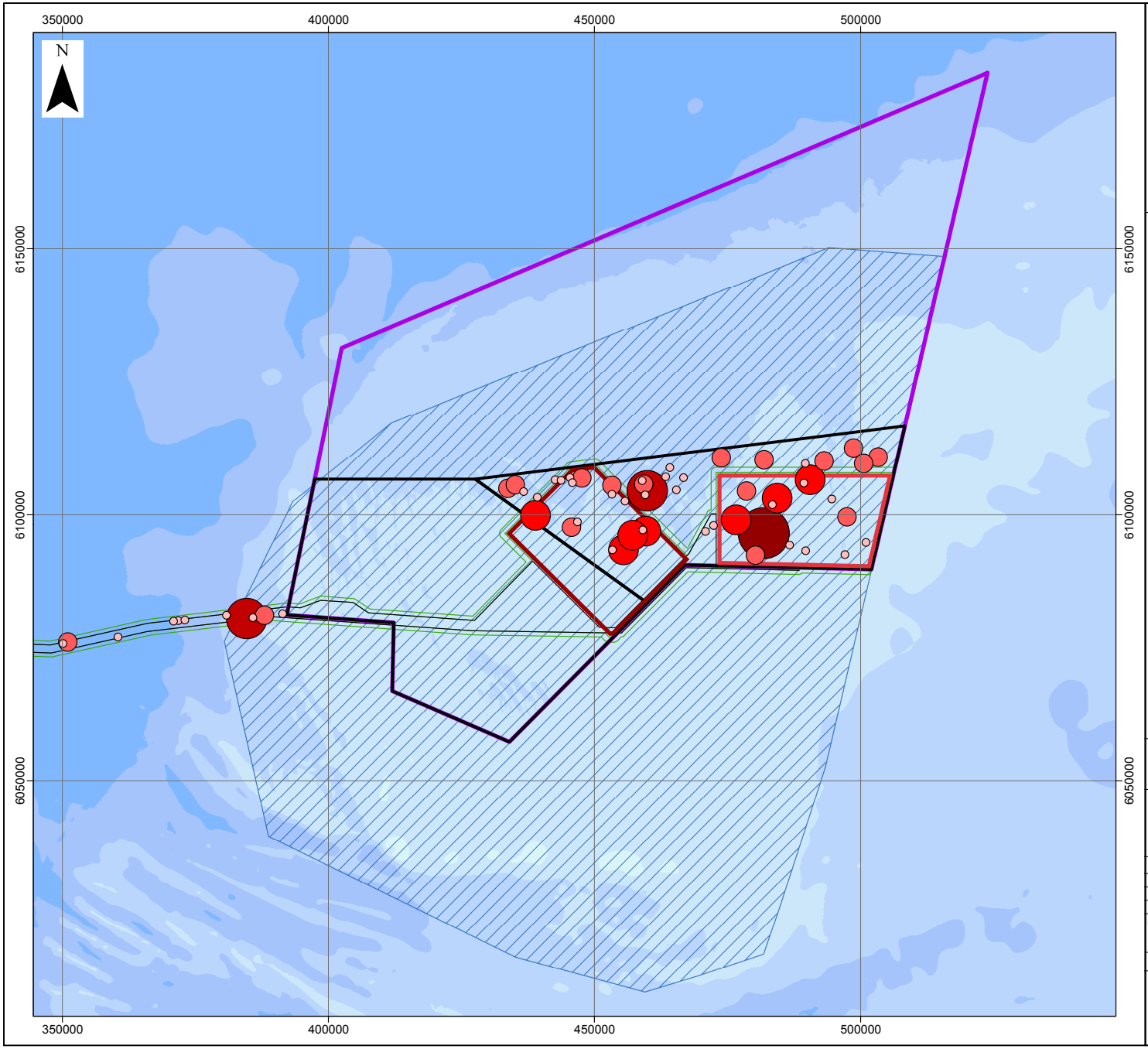
| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 15/10/2013 | PEI3 | GC | DB |
| 2 | 18/03/2014 | DCO Submission | GC | DB |
| | | | | |

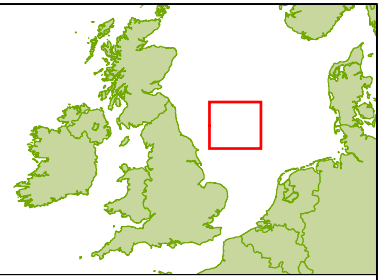
DRAWING NUMBER: **9Y0986/TSABHRA/12/R2**

| SCALE | 1:1,100,000 | PLOT SIZE | A4 | 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
- Dogger Bank Special Area of Conservation (cSAC)

Total Biomass (g AFDW)

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

0 10 20
Kilometres

Data Source:
Environmental Designations © JNCC, 2014
Sediment Samples © Gardline Environmental Limited, 2012
Round 3 offshore wind farm boundary © Crown Copyright, 2014
Background bathymetry image derived in part from TCarta data © 2009

PROJECT TITLE

*DOGGER BANK TEESSIDE A & B*
IfAA Report

DRAWING TITLE

**Figure 4.9 Distribution of macrofaunal biomass**

| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 17/10/2013 | PEI3 | GC | DB |
| 2 | 18/03/2014 | DCO Submission | GC | DB |
| | | | | |

DRAWING NUMBER: **9Y0986/TSABHRA/13/R2**

| SCALE | 1:1,100,000 | PLOT SIZE | A4 | DATUM | WGS84 | PROJECTION | UTM31N |
|---|---|---|---|---|---|---|---|

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Table 4.10 Characteristics of clusters within Tranche B identified via multivariate analysis

| Cluster | Number of stations | Water depths (m) | Predominant sediments | Dominant taxa |
|---|---|---|---|---|
| b | 4 | 23-27 | Sand and gravelly sand | *Spiophanes bombyx*<br>*Bathyporeia guilliamsoniana*<br>*Sigalion mathildae*<br>*Edwardsiidae* |
| c | 3 | 26-30 | Gravelly sand | *Spiophanes bombyx*<br>*Lanice conchilega*<br>*Echinoidea juv.*<br>*Owenia fusiformis* |
| d | 6 | 26-29 | Sand and gravelly sand | *Spiophanes bombyx*<br>*Angulus fabula*<br>*Lanice conchilega*<br>*Magelona filiformis* |
| e | 17 | 23-33 | Sand and gravelly sand | *Spiophanes bombyx*<br>*Bathyporeia guilliamsoniana*<br>*Angulus fabula*<br>*Sigalion mathildae* |
| f | 4 | 29-34 | Sand | *Spiophanes bombyx*<br>*Angulus fabula*<br>*Nephtys juv.*<br>*Owenia fusiformis* |
| g | 11 | 30-36 | Sand and gravelly sand | *Spiophanes bombyx*<br>*Angulus fabula*<br>*Lanice conchilega*<br>*Ensis juv.* |
| h | 5 | 28-34 | Sandy gravel, gravel and muddy sandy gravel | *Spirobranchus*<br>*Spirobranchus triqueter*<br>*Spirobranchus lamarcki*<br>*Pholoe baltica* |

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

4.5.53 The MDS ordination overlain with the Modified Folk results revealed that stations belonging to cluster h were classified as muddy sandy gravel, sandy gravel or gravel, sampled in areas of exposures of boulder clay. All stations within clusters b to g were classified as slightly gravelly sand or gravelly sand.

### *Epibenthos*

4.5.54 Epibenthic communities across Tranche B and the Dogger Bank Teesside Export Cable Corridor were characterised by a series of 2m scientific beam trawl surveys and also data collected via the drop down video surveys undertaken as part of the wider benthic survey campaign (see **Table 4.2**).

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

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

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

4.5.58 Data on epibenthic communities within Dogger Bank Teesside A & B and the Dogger Bank Teesside Export Cable Corridor have also been obtained via the review of data from 2m beam trawl surveys, which were primarily undertaken to characterise the fish and shellfish ecology of the study area, along with otter trawl and potting surveys. Data from these surveys indicate that the following epibenthic species were recorded at the greatest abundances in the 2m beam trawl surveys; amphipods *Stenothoidae* sp. indet, *Atylus swammerdami*, *Scopelocheirus hopei* and *Abludomelita obtusata*, shrimp, *Crangon allmanni*, common starfish, *Asteria rubens*, green sea urchin *Psammechinus miliaris*, sand star *Astropecten* irregularis, common hermit crab *Pagurus bernhardus* and common brittlestar *Ophiothrix fragilis.*

### *Biotopes and VERs*

4.5.59 Based on the benthic sampling as well as images from DDV, still images and geophysical data, Envision produced habitat maps and biotope classifications across tranches A & B and the Dogger Bank Teesside A & B Export Cable Corridor (see **Appendix 12D** of the Dogger Bank Teesside A & B ES). The biotopes listed in **Table 4.11** were grouped into VERs, and their spatial distribution is shown on **Figure 4.10**. Three VERs are present within the Dogger Bank cSAC (VERs A, B, and C), and details are presented in **Table 4.12**.

### Sensitivity

4.5.60 The following descriptions of sensitivity for the Dogger Bank cSAC sandbank feature are extracted from JNCC (2011) with additional information provided regarding sensitivity and recoverability of communities extracted from **Chapter 12** of the Dogger Bank Teesside A & B ES.

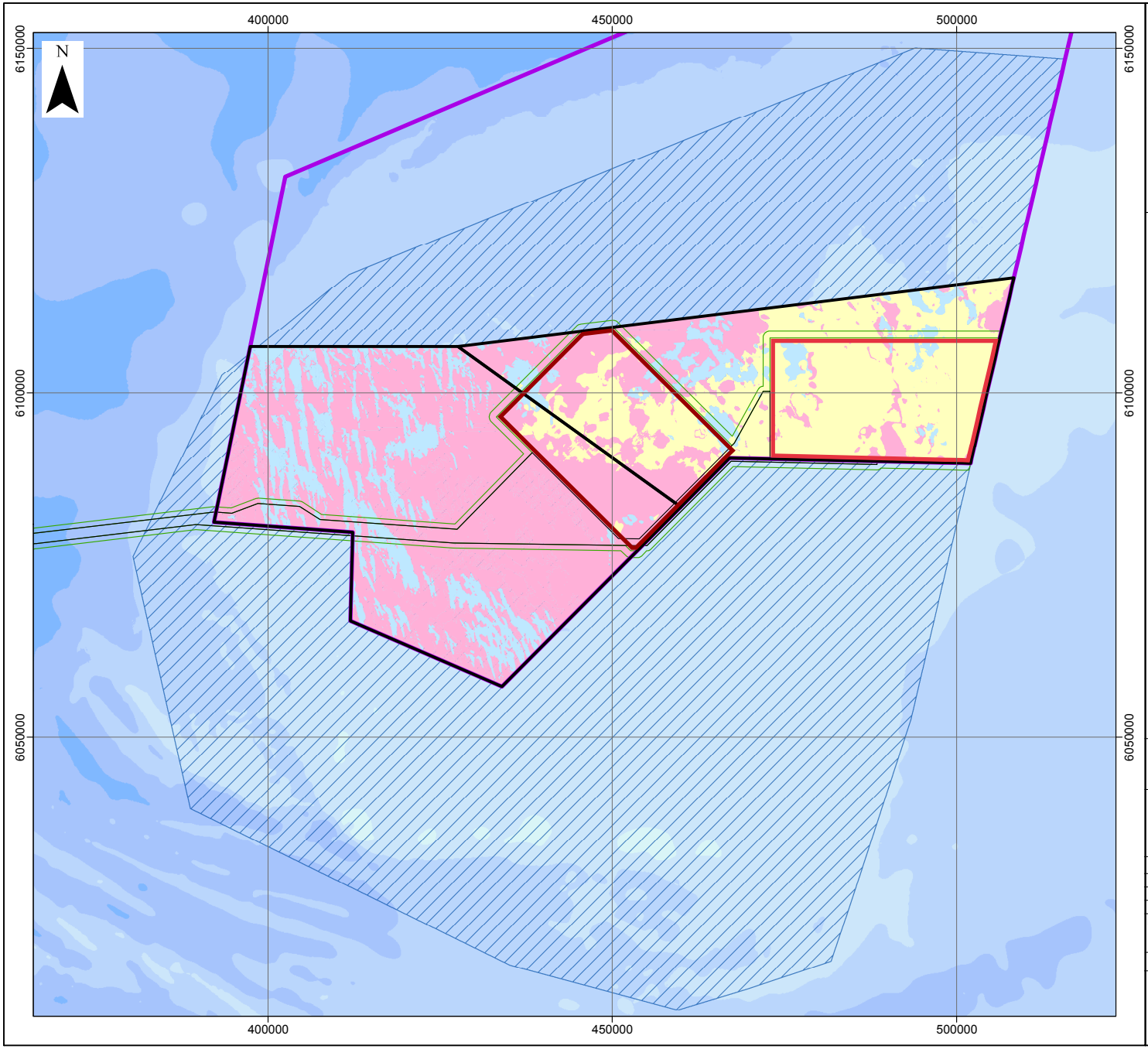
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## Table 4.11 Benthic biotopes identified within Dogger Bank Teesside A & B

| JNCC Marine Habitats Classification (V04.05) biotope codes | Biotope description | Frequency in samples |
|---|---|---|
| SS.SSa.CFiSa.ApriBatPo | *Abra prismatica*, *Bathyporeia elegans* and polychaetes in circalittoral fine sand | 44 |
| SS.Ssa.CFiSa | Circalittoral fine sand | 45 |
| SS.SMx.CMx | Circalittoral mixed sediment | 18 |
| SS.SSa.IMuSa.EcorEns | *Echinocardium cordatum* and *Ensis* spp. in lower shore or shallow sublittoral muddy fine sand | 45 |
| SS.SCS.CCS.MedLumVen | *Mediomastus fragilis*, *Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel | 5 |
| SS.SMx.CMx.OphMx | *Ophiothrix fragilis* and/or *Ophiocomina nigra* brittlestar beds on sublittoral mixed sediment | 15 |
| SS.SCS.ICS.SLan | Dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand | 40 |
| SS.SSa.CMuSa.AbraAirr | *Amphiura brachiata* with *Astropecten irregularis* and other echinoderms in circalittoral muddy sand | 2 |
| SS.SMu.CFiMu.SpnMeg | Seapens and burrowing megafauna in circalittoral fine mud | 1 |


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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
- Dogger Bank Special Area of Conservation (cSAC)

Valued ecological receptor (VER)

- A
- B
- C

0 10 20
Kilometres

Data Source:
VERS © Envision, 2013
Round 3 offshore wind farm boundary © Crown Copyright, 2014
Background bathymetry image derived in part from TCarta data © 2009

PROJECT TITLE

*DOGGER BANK TEESSIDE A & B*
IfAA Report

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**Figure 4.10 Dogger Bank cSAC showing overlap with Dogger Bank Teesside A & B and VERs**

| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 07/10/2013 | PEI3 | GC | DB |
| 2 | 18/03/2014 | DCO Submission | GC | DB |
| | | | | |

DRAWING NUMBER:
**9Y0986/TSABHRA/14/R2**

| SCALE | 1:850,000 | PLOT SIZE | A4 | DATUM | WGS84 | PROJECTION | UTM31N |
|---|---|---|---|---|---|---|---|

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Table 4.12 Valued Ecological Receptors within Dogger Bank Teesside A, Dogger Bank Teesside B, Dogger Bank Teesside A & B and Dogger Bank cSAC

| VER | Representative biotopes | Feature | Area (km$^2$) covered by VER with percentage in brackets | | | |
|---|---|---|---|---|---|---|
| | | | Surveyed area[1] | Dogger Bank Teesside A[2] | Dogger Bank Teesside B[2] | Dogger Bank cSAC[3] |
| **A**. Sandy sediment supporting relatively low diversity benthic communities | SS.SSa.CFiSa.ApriBatPo<br>SS.Ssa.CFiSa<br>SS.SCS.ICS.SLan | Annex I Habitat qualifying feature 'sandbanks that are slightly covered by seawater all the time'. | 1,978.64 (55.95%) | 51.90 (9.27%) | 359.04 (60.52%) | 6,898.99 |
| **B**. Coarse sediments with medium to high diversity benthic communities | SS.SMx.CMx<br>SS.SCS.CCS.MedLumVen<br>SS.SMx.CMx.OphMx | Annex I Habitat qualifying feature 'sandbanks that are slightly covered by seawater all the time'. | 614.38 (17.37%) | 28.05 (5.01%) | 33.74 (5.69%) | 2,142.18 |
| **C -** Muddy sand sediments with medium diversity benthic communities (including sea pens) | SS.SSa.IMuSa.EcorEns<br>SS.SSa.CMuSa.AbraAirr<br>SS.SMu.CFiMu.SpnMeg | Annex I Habitat qualifying feature 'sandbanks that are slightly covered by seawater all the time'. | 943.53 (26.68%) | 480.15 (85.73%) | 200.43 (33.79%) | 3,289.84 |

1 Surveyed area comprises tranches A & B and the Dogger Bank Teesside A & B Export Cable Corridor within the Dogger Bank cSAC.
2 Includes extent of Dogger Bank Teesside A & B Export Cable Corridor within each project area that lies within the Dogger Bank cSAC.
3 Multiplied up from the surveyed area (tranches A & B, and the Dogger Bank Teesside A & B Export Cable Corridor) within the Dogger Bank cSAC which covered 28.68% of the cSAC.


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### *Sensitivity to physical loss*

4.5.61 Loss of habitat would result in the loss of ecological communities supported by the physical habitat. The structure and diversity of sandbank communities are determined by environmental characteristics such as sediment particle size distribution, seabed slope, and water depth. Any change in these environmental parameters (by removing or smothering part of the feature) could result in a loss of or modification to the sandbank habitat and a possible shift in community organisation. Dogger Bank is composed of sediment deposited during the last glaciation and subsequently modified by surrounding prevailing currents and storm influences to give its current formation. It is considered (JNCC 2011) that the sandbank could be replenished by sediment transported by the prevailing currents and storms and recover relatively rapidly between removal activities, therefore, its sensitivity to removal is assessed as moderate, as noted for the subtidal sandbank feature of the cSAC in paragraph 4.2.8. For this assessment, the sensitivity assessments provided by MarLIN have been used to further determine the sensitivity of the component biotopes of VER A, VER B and VER C (Rayment 2008; and Budd 2008) that are present within the Dogger Bank cSAC. The relevant MarLIN 'factor' that has been used is the 'substratum loss' factor. For all three VERs (and their component biotopes), they are identified by MarLIN as being of moderate (ecological) sensitivity to habitat loss, which is in agreement with the sensitivity to this effect as noted for the subtidal sandbank feature of the cSAC described above and in paragraph 4.2.8 (and identified in JNCC (2011)). All three VERs are identified as having medium vulnerability and recoverability to this effect.

4.5.62 Any construction over the feature would lead to the (partial) removal of its ecological communities. The natural development (shift in location and shape of a sandbank) and recovery of the feature may be prevented by any permanent infrastructure itself, but also through changes in the local hydrographic regime, caused by the obstruction. The prevention of prevailing hydrodynamic processes would be considered to prevent the recovery of affected habitat and associated communities. Sensitivity to obstruction is therefore considered to be high, which is in agreement with the sensitivity to this effect as defined for the subtidal sandbank feature of the cSAC in paragraph 4.2.8.

4.5.63 Based on sensitivity assessments provided by MarLIN, of the three VERs in the area of the cSAC within the boundaries of Dogger Bank Teesside A & B (where the greatest increases in suspended sediments and sedimentation (smothering) are predicted to arise), VER A and VER C are judged (as identified by MarLIN) to not be sensitive to smothering whilst VER B is identified as having a very low sensitivity to smothering. The sensitivity of the specific sandbank communities present within Dogger Bank Teesside A & B are identified as having a lower sensitivity to this activity than that noted for the subtidal sandbank feature of the cSAC in paragraph 4.2.8 and in JNCC (2011), which stated that "*The* [sandbank] *feature's ecological communities are also sensitive to smothering at a low level, particularly the lower lying or encrusting typical species*".

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### *Sensitivity to physical damage*

4.5.64 Physical abrasion (for example, by mobile fishing gear) can directly damage the interest feature and its associated species. In particular, larger, fragile, sessile species are likely to be selectively removed from the community and be replaced by more mobile species, rapid colonisers and juvenile stages (Gubbay & Knapman 1999; Sewell & Hiscock 2005). The sensitivity is considered moderate as the soft coral *Alcyonium digitatum* and the bryozoan *Alcyonidium diaphanum* were occasionally found in discrete areas of coarser sediments (Diesing et al. 2009). Using the sensitivity assessments provided by MarLIN to determine the sensitivity of the component biotopes of VER A, VER B, and VER C (Rayment 2008; and Budd 2008) that are present within the Dogger Bank cSAC and may be subject to physical disturbance, the relevant MarLIN 'factor' that has been used is the 'physical disturbance and abrasion' factor. For VER A and VER B and their constituent biotopes, both are considered by MarLIN to have a low (ecological) sensitivity to physical disturbance and abrasion (as would be temporarily produced during construction, operation (maintenance) and decommissioning) and they also exhibit low vulnerability and high recoverability to such disturbance. Both VERs are therefore identified as having a lower sensitivity to this activity than that noted for the subtidal sandbank feature of the cSAC in paragraph 4.2.8 and in JNCC (2011) due to the nature of the communities within these VERs. VER C is considered to have a moderate (ecological) sensitivity to physical loss and abrasion (as would be temporarily produced during construction, operation (maintenance) and decommissioning) as a result of high intolerance to physical disturbance of some key infaunal species but moderate recoverability (based on the EcorEns biotope sensitivity assessment within MarLIN). This is in agreement with the sensitivity to this effect as noted for the subtidal sandbank feature of the cSAC in paragraph 4.2.8 and in JNCC (2011). Further information on the ecological sensitivities of the biotopes within each VER is provided in **Appendix 12F** of the Dogger Bank Teesside A & B ES.

4.5.65 Disturbance of the soft sediments of the feature itself and the sediments surrounding it could affect the sandbank by causing changes in the suspension of sediment. Whilst the increase in suspended particulates may benefit filter feeders, many species are adversely affected by increases in suspended sediment (Hartnoll 1998). Although, even on sandbanks, a shift from predominately sand and gravel to finer sediments may result in a dramatic drop in species richness, abundance and biomass (Desprez 2000), the sensitivity here is considered low as there is the possibility of recovery between disturbance events, which is in agreement with the sensitivity to this effect as noted for the subtidal sandbank feature of the cSAC in paragraph 4.2.8 and in JNCC (2011). Using the sensitivity assessments provided by MarLIN (Rayment 2008; and Budd 2008) to determine the sensitivity of the component biotopes of the VERs that are present within the Dogger Bank cSAC and may be subject to increased suspended sediment concentrations, the relevant MarLIN 'factor' that has been used is the 'increased suspended sediment concentrations'. For VER A and VER B and their constituent biotopes identified within the cSAC, both exhibit a very low (ecological) sensitivity to increased suspended sediment

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concentrations, which again is in agreement with the sensitivity to this effect as noted for the subtidal sandbank feature of the cSAC in paragraph 4.2.8 and identified in JNCC (2011). This is determined based on the low intolerance and high recoverability of the biotopes within these VERs (FfabMag for VER A and MoeVen and MedLumVen for VER B) to this effect or 'factor'. For VER C and its constituent biotopes identified within the cSAC, it exhibits a very low (ecological) sensitivity to increased suspended sediment concentrations, which is a lower sensitivity to this activity than that noted for the subtidal sandbank feature of the cSAC in paragraph 4.2.8 and identified in JNCC (2011) due in part to the specificity of the VER classification and the communities as identified from surveys within Dogger Bank Teesside A & B. None of the communities, which cover the entire range of benthic and epibenthic biotopes across Dogger Bank Teesside A & B (and within the Dogger Bank cSAC) exhibit a moderate or high sensitivity to suspended sediment concentrations, as they are tolerant of increased suspended sediment concentrations (and subsequent smothering), which arises periodically in this area via winter storm events.

## Northumbria Coast SPA and Ramsar

### Communities and distribution

4.5.66 The Northumbria Coast SPA and Ramsar boundary is located outside the area of direct or indirect effects as a result of Dogger Bank Teesside A & B due to distance. Consequently, the supporting habitat of interest would be the waters offshore of the SPA and Ramsar, and the following therefore presents a brief description of the benthic habitats and communities in the offshore area within and adjacent to the Dogger Bank Teesside A & B Export Cable Corridor. The distribution of habitats along the inshore areas of the Dogger Bank Teesside A & B Export Cable Corridor and surrounding area (shallow inshore water supporting habitat) follows a trend that is typical of those parts of the North Sea that are bordered by a rocky coastline. A wave-cut platform extends out some kilometres forming rocky outcrops interspersed by sand and mixed sediments. Rocky biotopes supporting seaweeds are found in shallow water and faunal crusts and turf below this depth. Thereafter, mixed sediments predominate out to 15km to 20km, which then give way to sandy mud habitats and biotopes. The most frequently recorded species of macrofauna within the Dogger Bank Teesside A & B Export Cable Corridor were polychaetes (*Spiophanes bombix* then *Galathowenia oculata*), then brittlestars (class Ophiuroidea), see Section 4.1 in **Chapter 12** of the Dogger Bank Teesside A & B ES. The most frequently recorded epifauna being amphipods (*Stenothoidae* sp. indet, *Atylus swammerdami*, *Scopelocheirus hopei* and *Abludomelita obtusata*), shrimp, *Crangon allmanni*, common starfish, *Asteria rubens*, green sea urchin *Psammechinus* miliaris, sand star *Astropecten* irregularis, common hermit crab *Pagurus bernhardus*, and common brittlestar *Ophiothrix fragilis* (see Section 4.1 in **Chapter 12** of the Dogger Bank Teesside A & B ES). Inshore trammel net and potting surveys along the Dogger Bank Teesside A & B Export Cable corridor and surrounding area recorded edible crab *Cancer pagurus* as the most abundant species, followed by dab *Limanda limanda* and cod *Gadus morhua*, as well as lesser spotted dogfish *Scyliorhinus canicula* (see Section 4.2 in **Chapter 13** of the Dogger Bank Teesside A & B ES). Single specimens of

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thornback ray *Raja clavata,* spotted ray *Raja montagui* and lesser sandeel *Ammodytes tobianus* were recorded. The sensitivities of the inshore shallow water habitat and communities are identified in paragraph 4.2.13.

### Teesmouth and Cleveland Coast SPA and Ramsar

#### Communities and distribution

4.5.67 The habitats and species of the shallow inshore waters adjacent to the Teesmouth and Cleveland Coast SPA and Ramsar site are described in paragraph 4.5.66 above. The inshore sublittoral sediments within Tees Bay are predominantly sandy and dominated by polychaetes (i.e. Nephtys spp., *Spiophanes bombyx*, M*agelona mirabilis*, and *Chaetozone setosa*), amphipods (i.e. *Bathyporeia* spp.), and bivalves (i.e. *Phaxas pellucidus*, *Fabulina fabula*, and *Chamelea gallina*) (Brazier *et al*. 1998). The mouth of the Tees estuary and the area to the north of Redcar is predominantly muddy sand where communities are less diverse than the inshore sandy habitats (Brazier *et al*. 1998). Areas of bedrock with boulders and cobbles are located at Longscar and to the east of West Scar, which comprise silted bedrock and boulders supporting sparse turfs of hydroids and bryozoans, including dead man's finger's *Alcyonium digitatum*, peacock worms *Sabella pavonina*, and hydroids such as *Nemertesia antennina* and *Abiertinaria abietina* (Brazier *et al*. 1998). The sensitivities of the habitats and communities are identified in paragraph 4.2.22.

## 4.6 Assessment of impacts during the construction phase

### Introduction

4.6.1 This section identifies and assesses the impacts that are predicted to occur during the construction phase of Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor in relation to the subtidal sandbanks feature of the Dogger Bank cSAC, the Doggersbank SCI (Netherlands) and the Doggerbank SCI (Germany), as identified in Section 3.5. Impacts have been aggregated under the following headings:

- Alteration to bathymetry;
- Interruption to sediment transport pathways;
- Alteration to the hydrodynamic regime;
- Physical disturbance to the morphology and physical damage to the structural integrity of habitat features;
- Alteration to the extent, composition and distribution of habitat features;
- Changes to suspended sediment levels;
- Changes to the levels of nutrients and contaminants;
- Direct physical damage to habitat feature communities;
- Physical damage from increased suspended sediment concentrations;
- Physical damage (smothering) of habitat features through re-distribution and deposition of sediment; and

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- Physical damage to habitat feature communities from the release of sediment contaminants.

4.6.2 This section also considers the above potential impacts with respect to the supporting habitat features of the Teesmouth and Cleveland Coast SPA and Ramsar site and Northumbria Coast SPA and Ramsar site.

## Alteration to bathymetry

### Dogger Bank cSAC

4.6.3 Works during construction would lead to seabed disturbance (from seabed preparation and side-cast material for gravity base structures and anchor points and moorings) and the placement of structures on the seabed (i.e. jack-up barges) that would alter bathymetry. However, given that the majority of these effects would be temporary and localised in nature, any resulting temporary bathymetric alteration would be unlikely to have a durable influence on other parameters that are influenced by bathymetric conditions. The potential longer term influence of re-distributed sediment produced during construction (e.g. material side-cast from turbine foundation preparation works) and the wind farm structures (e.g. foundations for wind turbines, met masts, offshore collector stations, offshore converter station, and accommodation platforms, vessel moorings, and cable crossing and cable protection for the inter-array, inter-platform and export cables) is considered under the operation phase of the project, see Section 4.7.

### Teesmouth and Cleveland Coast SPA and Ramsar site (supporting habitat features)

4.6.4 No seabed disturbance works would extend into the Teesmouth and Cleveland Coast SPA and Ramsar site, therefore no direct alteration to bathymetry would occur with respect to the supporting habitat features within the site. Long-term changes to bathymetry outside the site are only considered with respect to their influence on the prey resource of the Teesmouth and Cleveland Coast SPA and Ramsar site bird features, described in Section 4.7.

### Northumbria Coast SPA and Ramsar site (supporting habitat features)

4.6.5 No seabed disturbance works would extend into the Northumbria Coast SPA and Ramsar site, therefore no direct alteration to bathymetry would occur with respect to the supporting habitat features within the site. Long-term changes to bathymetry outside the site are only considered with respect to their influence on the prey resource of the Northumbria Coast SPA and Ramsar site bird features, described in Section 4.7.

### Doggerbank SCI (Germany)

4.6.6 No seabed disturbance works would extend into the Doggerbank SCI, therefore no changes to bathymetry would occur within this site.

### Doggersbank SCI (Netherlands)

4.6.7 No seabed disturbance works would extend into the Doggersbank SCI, therefore no changes to bathymetry would occur within this site.

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## Interruption to sediment transport pathways

### Dogger Bank cSAC

4.6.8 Works during construction would lead to the temporary placement of structures on the seabed (i.e. jack-up barges) and seabed disturbance due to seabed preparation works, which would include side-casting of sediment from the installation of gravity base structures and the introduction of anchor points and moorings. These activities would result in temporary obstructions (no more than days or weeks) of a localised nature (effecting areas of habitat immediately up and down current). However, the presence of temporary structures and, in particular, the linear disturbance to the seabed generated by activities such as trenching for cables, have the greatest potential to temporarily interrupt sediment transport on a localised scale. These 'obstructions to sediment transport would be temporary and localised, and would occur at spatially disparate locations across Dogger Bank Teesside A & B. Given this and that these events would occur at different times throughout the construction phase, and that following their removal sediment transport would continue, no permanent changes would be evident due to the construction activities themselves. Consequently, these localised and temporary obstructions would not measurably change either patterns of sediment transport or the volume of sediment transport across the Dogger Bank cSAC during the construction phase. Potential long-term or permanent interruptions to sediment transport pathways are, however, considered in the operation phase (see paragraph 4.7.9).

### Teesmouth and Cleveland Coast SPA and Ramsar site (supporting habitat features)

4.6.9 No construction activities would be undertaken within the designated boundaries of the Teesmouth and Cleveland Coast SPA and Ramsar site. However, works undertaken during the export cable installation (such as trenching / jetting and the presence of jack-up barges) would result in the temporary presence of obstructions on the seabed that could influence sediment transport processes. However, net sediment transport between Redcar and Marske-by-the-Sea is to the south east, driven by waves approaching predominantly from the north (see **Chapter 9** of the Dogger Bank Teesside A & B ES), which is away from the SPA and Ramsar site. Consequently, no change would occur directly or indirectly within the SPA and Ramsar site. Temporary obstruction to offshore sediment transport would not measurably change either patterns of sediment transport or the volume of sediment transport across the offshore supporting habitat during the construction phase. However, the presence of cofferdams within the intertidal zone could influence sediment transport into the supporting intertidal habitat to the south. In the worst case scenario, such obstruction to sediment transport within the construction phase would extend for up to 14 weeks, and given the likely timing of the works during summer when there is a lower level of sediment transport (due to lower wave action). Furthermore, only low sediment transport occurs along this area, as evidenced in the small sediment build up on the west side of the groynes at Redcar. Therefore, the temporary and minor obstruction to sediment transport along the intertidal zone would not represent a noticeable and irreversible impact. The potential long-term impact relating to the

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permanent presence of structures on sediment transport in Tees Bay is considered in the operation phase (see paragraph 4.7.10). Long-term changes to sediment transport are considered with respect to the supporting habitat feature and the subsequent influence on the prey resource of the Teesmouth and Cleveland Coast SPA and Ramsar site bird features, and are described in Section 4.7.

**Northumbria Coast SPA and Ramsar site (supporting habitat features)**

4.6.10 No seabed structures, or seabed disturbance works, would be placed or occur within the Northumbria Coast SPA and Ramsar site. However, as described in paragraph 4.6.9 above, given the temporary nature of the disturbances that would occur during the export cable installation (such as trenching / jetting and jack-up barges), the potential long-term impact relating to the presence of structures on sediment transport in Tees Bay is considered in the operation phase (see paragraph 4.7.11). However, as noted in paragraph 4.6.11 above, the temporary obstruction to offshore sediment transport would not measurably change either patterns of sediment transport or the volume of sediment transport across the offshore supporting habitat during the construction phase. Long-term changes to sediment transport are considered with respect to the supporting habitat feature and the subsequent influence on the prey resource of the Northumbria Coast SPA and Ramsar site bird features, and are described in Section 4.7.

**Doggerbank SCI (Germany)**

4.6.11 No seabed structures would be placed or occur within 43km (nearest point on the north-eastern corner of Dogger Bank Teesside A) of the Doggerbank SCI, therefore no changes to sediment transport would occur within this site due to cable trenching / jetting) and the temporary presence of jack-up barges. Given the localised and temporary nature of the obstructions to sediment transport within Dogger Bank Teesside A & B, and the distance to those locations and the Doggerbank SCI (over which the obstructions are not likely to impact over the short-term), changes to sediment volume and transport within the Doggerbank SCI are not predicted. Potential long-term or permanent interruptions to sediment transport pathways are, however, considered in the operation phase (see paragraph 4.7.12).

**Doggersbank SCI (Netherlands)**

4.6.12 No seabed structures or seabed disturbance works would be placed or occur within the Doggersbank SCI, although structures would be placed and seabed disturbance would occur adjacent to the site. However, as described in paragraph 4.6.8 above in relation to the Dogger Bank cSAC, given the temporary and localised nature of these disturbances or obstructions during the construction phase, any resulting interruptions to sediment transport pathways would be unlikely to persist and influencetransport processes within the SCI.. Potential long-term or permanent interruptions to sediment transport pathways are, however, considered in the operation phase (see paragraph 4.7.13).

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## Alteration to the hydrodynamic regime

### Dogger Bank cSAC

4.6.13 Works during construction would lead to seabed disturbance (from seabed preparation and side-cast material for gravity base structures and anchor points and moorings) and the placement of structures on the seabed (i.e. jack-up barges) within the site that could, temporarily, alter waves and tidal currents (the hydrodynamic regime). However, given the temporary and localised nature of these construction phase disturbances or obstructions, any resulting temporary hydrodynamic alteration would remain within the existing hydrodynamic conditions within this highly variable environment across the cSAC. Potential long-term or permanent changes to the hydrodynamic regime are, however, considered in the operation phase (see paragraphs 4.7.14 to 4.7.16).

### Teesmouth and Cleveland Coast SPA and Ramsar site (supporting habitat features)

4.6.14 No seabed structures or disturbances (from seabed preparation and side-cast material for gravity base structures and anchor points and moorings) or alterations to bathymetry would occur within the Teesmouth and Cleveland Coast SPA and Ramsar site (the nearest being 2km away). As described in paragraph 4.6.13 above, given the temporary nature of the disturbances due to trenching / jetting) for the export cable, any resulting temporary hydrodynamic alteration would remain within the existing hydrodynamic conditions within this highly variable environment across the offshore supporting habitat, and no construction phase impacts are predicted. The potential long-term impact relating to the presence of structures or alterations to bathymetry on the hydrodynamic regime is considered in the operation phase (see paragraph 4.7.17).

### Northumbria Coast SPA and Ramsar site (supporting habitat features)

4.6.15 No seabed structures or disturbances (from seabed preparation and side-cast material for gravity base structures and anchor points and moorings) or alterations to bathymetry would occur within the Northumbria Coast SPA and Ramsar site (the nearest being 20km away). As described in paragraph 4.6.13 above, given the temporary nature of the disturbances due to trenching / jetting) for the export cable, any resulting temporary hydrodynamic alteration would remain within the existing hydrodynamic conditions within this highly variable environment across the offshore supporting habitat, and no construction phase impacts are predicted. The potential long-term impact relating to the presence of structures or alterations to bathymetry on the hydrodynamic regime is considered in the operation phase (see paragraph 4.7.18).

### Doggerbank SCI (Germany)

4.6.16 No seabed structures, or disturbances (from seabed preparation and side-cast material for gravity base structures and anchor points and moorings) or alterations to bathymetry would occur within 43km (nearest point on the north-eastern corner of Dogger Bank Teesside A) of the Doggerbank SCI. Given the temporary and localised nature of these construction phase disturbances or obstructions, no far field effects would be expected to extend into this site and the hydrodynamic conditions within the Doggerbank SCI therefore would remain

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within existing parameters. Potential long-term or permanent changes to the hydrodynamic regime are, however, considered in the operation phase (see paragraph 4.7.19).

**Doggersbank SCI (Netherlands)**

4.6.17 No seabed structures or disturbances (from seabed preparation and side-cast material for gravity base structures and anchor points and moorings) or alterations to bathymetry would occur within the Doggersbank SCI, although the placement of structures, seabed disturbance, and changes to bathymetry would occur adjacent to the Doggersbank SCI. As described in paragraph 4.6.13 above, given the temporary and localised nature of these construction phase disturbances or obstructions, and that no far field effects would be expected to extend into this site, the hydrodynamic conditions within the Doggersbank SCI would remain within existing parameters. Potential long-term or permanent changes to the hydrodynamic regime are considered in the operation phase (see paragraph 4.7.20).

## Physical disturbance to the morphology and physical damage to the structural integrity of habitat features

**Dogger Bank cSAC**

4.6.18 The morphology and structural integrity of the sandbank habitat is determined by the bathymetry and sediment composition and the interactions of waves and tidal currents upon these structural elements. Given the predicted temporary and localised changes to bathymetry (paragraph 4.6.3), sediments (paragraph 4.6.23), suspended sediments (paragraphs 4.6.28 to 4.6.38), sediment transport (paragraph 4.6.8), and hydrodynamic processes (paragraph 4.6.13) at spatially and temporally disparate scales, the impact on the morphology and structural integrity of the Dogger Bank cSAC is predicted to be negligible for the construction phase.

**Teesmouth and Cleveland Coast SPA and Ramsar site (supporting habitat features)**

4.6.19 The morphology and structural integrity of the supporting habitats of the Teesmouth and Cleveland Coast SPA and Ramsar site is determined by the bathymetry and sediment composition and the interactions of waves and tidal currents upon these structural elements. Given that no direct and limited if any potential for indirect, temporary and localised changes to bathymetry (paragraph 4.6.4), sediments (paragraph 4.6.24), suspended sediments (paragraphs 4.6.39 and 4.6.40), sediment transport (paragraph 4.6.9), and hydrodynamic processes (paragraph 4.6.14) are expected, no likely change to the morphology of the supporting habitats would occur during the construction phase.

**Northumbria Coast SPA and Ramsar site (supporting habitat features)**

4.6.20 The morphology and structural integrity of the supporting habitats of the Northumbria Coast SPA and Ramsar site is determined by the bathymetry and sediment composition and the interactions of waves and tidal currents upon these structural elements. Given that no direct and limited if any potential for indirect, temporary and localised changes to bathymetry (paragraph 4.6.5), sediments (paragraph 4.6.25), suspended sediments (paragraphs 4.6.41 and

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4.6.42), sediment transport (paragraph 4.6.10), and hydrodynamic processes (paragraph 4.6.15) are expected due to the distance from the site (over 20km away) from any activities and structures, no change to the morphology of the supporting habitats would occur during the construction phase. However, physical disturbance to the morphology and structural integrity of the supporting habitats of the Northumbria Coast SPA and Ramsar site are considered in the operation phase (see paragraphs 4.7.26) where potentially long-term or permanent impacts could occur.

### Doggerbank SCI (Germany)

4.6.21 The morphology and structural integrity of the sandbank habitat within the Doggerbank SCI is determined by the bathymetry and sediment composition and the interactions of waves and tidal currents upon these structural elements. Given that no direct and limited if any potential for indirect, temporary and localised changes to bathymetry (paragraph 4.6.6), sediments (paragraph 4.6.26), suspended sediments (paragraphs 4.6.43 and 4.6.44), sediment transport (paragraph 4.6.11), and hydrodynamic processes (paragraph 4.6.16) are expected due to the distance from the site (over 43km away) from any activities and structures, no change to the morphology of the sandbank habitat of the Doggerbank SCI would occur during the construction phase.

### Doggersbank SCI (Netherlands)

4.6.22 The morphology and structural integrity of the sandbank habitat within the Doggersbank SCI is determined by the bathymetry and sediment composition and the interactions of waves and tidal currents upon these structural elements. Given that no direct and limited if any potential for indirect, temporary and localised changes to bathymetry (paragraph 4.6.7), sediments (paragraph 4.6.27), suspended sediments (paragraphs 4.6.45 and 4.6.46), sediment transport (paragraph 4.6.12), and hydrodynamic processes (paragraph 4.6.17) are expected, no likely change to the morphology of the supporting habitats would occur on the sandbank habitat of the Doggersbank SCI during the construction phase.

## Alteration to the extent, composition and distribution of habitat features

### Dogger Bank cSAC

4.6.23 Short-term and temporary seabed disturbance (from seabed preparation and side-cast material for gravity base structures and anchor points and moorings) and the placement of structures on the seabed (i.e. jack-up barges) would occur during the construction period at different locations and at different times throughout this phase. In total, over the entire construction phase an estimated area of 35.70km$^2$ (0.3% of the cSAC extent) of sandbank habitat would be disturbed. Given the temporary nature of these construction disturbances, and that they would progress in different areas of the Dogger Bank cSAC throughout the construction phase, the extent of the habitat would decrease much less than the total area noted throughout the construction phase, and the sediment present due to disturbance would be predominantly derived from disturbed sediments and hence not change sediment composition significantly, whilst only localised distribution of sediment would arise. Consequently, the localised

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changes across up to 0.3% of the cSAC, would where temporary (i.e. not occur in areas of permanent footprint loss, see below) be able to recover (predicted to occur within five years), would not structurally affect the sandbank habitat. The potential impact on the extent, composition and distribution of sandbank habitat is, however, considered in the operation phase (see paragraph 4.7.29) where potentially long-term or permanent impacts could occur due to the 'footprint' of structures that would be present in the operation phase.

**Teesmouth and Cleveland Coast SPA and Ramsar site (supporting habitat features)**

4.6.24 No seabed disturbance works or structures would extend into or be placed within the Teesmouth and Cleveland Coast SPA and Ramsar site during the construction phase, therefore, no direct alteration to the extent, composition and distribution of the supporting habitats within the Teesmouth and Cleveland Coast SPA and Ramsar site would occur. Long-term changes to the extent, composition and distribution of the supporting habitats within and outside the Teesmouth and Cleveland Coast SPA and Ramsar site as a result of indirect changes due to alterations to bathymetry, hydrodynamic processes, sediment transport and sediment patterns as a result of Dogger Bank Teesside A & B are considered in paragraph 4.7.30. Their potential influence on the prey resource of the Teesmouth and Cleveland Coast SPA and Ramsar site bird features are also considered later in Section 4.7.

**Northumbria Coast SPA and Ramsar site (supporting habitat features)**

4.6.25 No seabed disturbance works or structures would extend into or be placed within the Northumbria Coast SPA and Ramsar site (20km away from the nearest activities) during the construction phase, therefore, no direct alteration to the extent, composition and distribution of the supporting habitats within the Northumbria Coast SPA and Ramsar site would occur. Long-term changes to the extent, composition and distribution of the supporting habitats within and outside the Northumbria Coast SPA and Ramsar site as a result of indirect changes due to alterations to bathymetry, hydrodynamic processes, sediment transport and sediment patterns as a result of Dogger Bank Teesside A & B are considered in paragraph 4.7.31. Their potential influence on the prey resource of the Northumbria Coast SPA and Ramsar site bird features are also considered later in Section 4.7.

**Doggerbank SCI (Germany)**

4.6.26 No seabed disturbance works or structures would extend into or be placed within 43km of the Doggerbank SCI during the construction phase, therefore, no direct alteration to the extent, composition and distribution of the sandbank habitat within the Doggerbank SCI would occur. Long-term changes to the extent, composition and distribution of the sandbank habitat within the Doggerbank SCI as a result of indirect changes due to alterations to bathymetry, hydrodynamic processes, sediment transport and sediment patterns as a result of Dogger Bank Teesside A & B are considered in paragraph 4.7.32.

**Doggersbank SCI (Netherlands)**

4.6.27 No seabed disturbance works or structures would extend into or be placed within the Doggersbank SCI during the construction phase, therefore, no direct

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alteration to the extent, composition and distribution of the sandbank habitat within the Doggersbank SCI would occur. Long-term changes to the extent, composition and distribution of the sandbank habitat within the Doggersbank SCI as a result of indirect changes due to alterations to bathymetry, hydrodynamic processes, sediment transport and sediment patterns as a result of Dogger Bank Teesside A & B are considered in paragraph 4.7.33.

## Changes to suspended sediment levels

### Dogger Bank cSAC

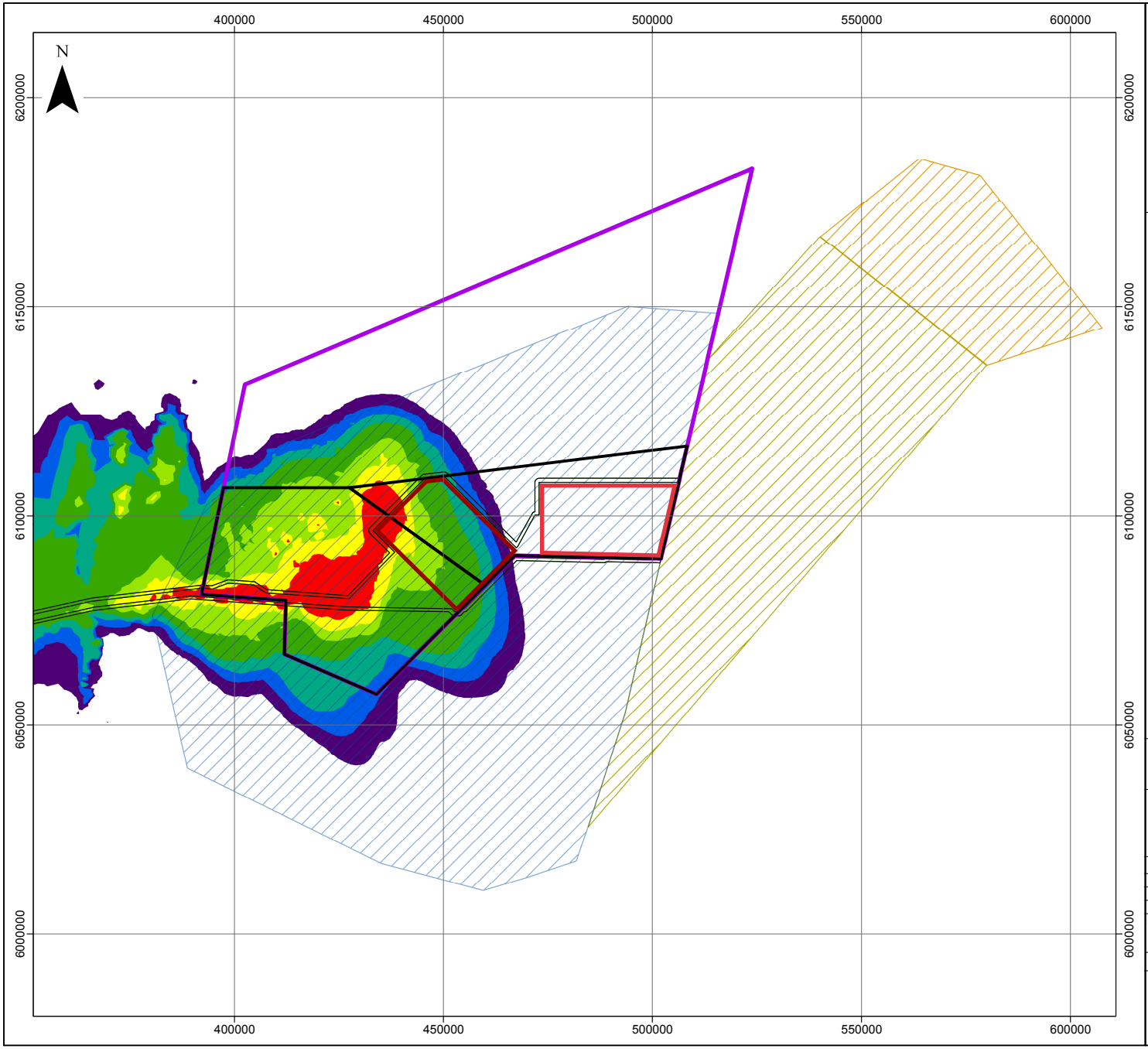
4.6.28 Sediment dispersion modelling was undertaken using the MIKE3-FM MT model, integrated with the MIKE3-FM HD model (see paragraphs 4.4.3 and 4.4.5, with full details in **Appendix 9A** of the Dogger Bank Teeside A & B ES). The worst-case scenario for the modelling, as defined in **Table 2.2**, is based on the installation of 24 x 12m diameter monopile foundations via drilling, with subsequent release of drill arisings (assuming 6,220m$^3$ of material per pile) into the water column and also installation of inter-array and export cables within a 30-day period. This scenario results in the highest (i.e. worst case) increase in suspended sediment concentrations, as well as the largest potential sediment deposition, and has been defined in respect of its potential impact on ecological receptors (notably sandeel). Furthermore, this worst case modelling scenario provides an indication of the duration of increased suspended sediment concentrations, as well as the mobility of any sediments subsequently deposited. The location of these 24 foundations in terms of the modelling process was chosen to be the western part of Dogger Bank Teeside B, due to the proximity of sensitive ecological receptors (i.e. areas with high densities of sandeels).

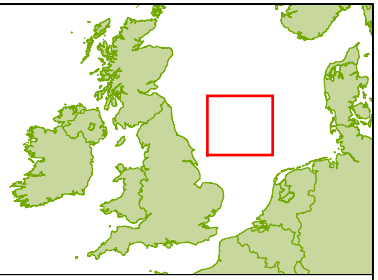
4.6.29 Outputs of the plume modelling present suspended sediment concentrations above background levels (i.e. greater than 2mg/l) generated for a range of scenarios. Whilst depth-averaged suspended sediment concentration is of interest, results are also present for near-bed (within 5cm of seabed) suspended sediment concentrations.

4.6.30 Based on the worst-case scenario, a maximum near-bed suspended sediment concentration (depth-averaged) of >200mg/l is predicted from the location of construction activity (for 24 foundations) to approximately 11km to the north, 5km to the east, 20km to the south, and 3km to the west, with the furthest distance extending 30km in a south-westerly direction (see **Figure 4.11**). The maximum near-bed suspended sediment concentrations are predicted to remain above background levels (of 2mg/l) approximately 33km to the north, 30km to the east, 50km to the south, and in excess of 50km to the west, as shown on **Figure 4.11**. It should be noted that a significant influence occurs due to the construction (jetting and trenching) of the export cable route which extends all the way to the landfall on the model (the landfall extent is shown on **Figure 4.12**). In the nearshore zone the maximum near-bed suspended sediment concentrations (depth-averaged) reach 200mg/l in the area of the landfall works, but drop off to background levels within 15km to 30km (see **Figure 4.12**).

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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
- Dogger Bank Special Area of Conservation (cSAC)
- Doggerbank Site of Community Importance (SCI)
- Doggersbank Site of Community Importance (SCI)

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
Kilometres

Data Source:
Environmental Designations © JNCC, 2014 and European Environment Agency, 2014
Modelling © Danish Hydraulic Institute, 2013
Round 3 offshore wind farm boundary © Crown Copyright, 2014
Background bathymetry image derived in part from TCarta data © 2009

PROJECT TITLE

*DOGGER BANK TEESSIDE A & B*
IfAA Report

DRAWING TITLE

**Figure 4.11 Maximum suspended sediment concentration in the bottom layer predicted over the simulation period during the construction phase in the offshore area**

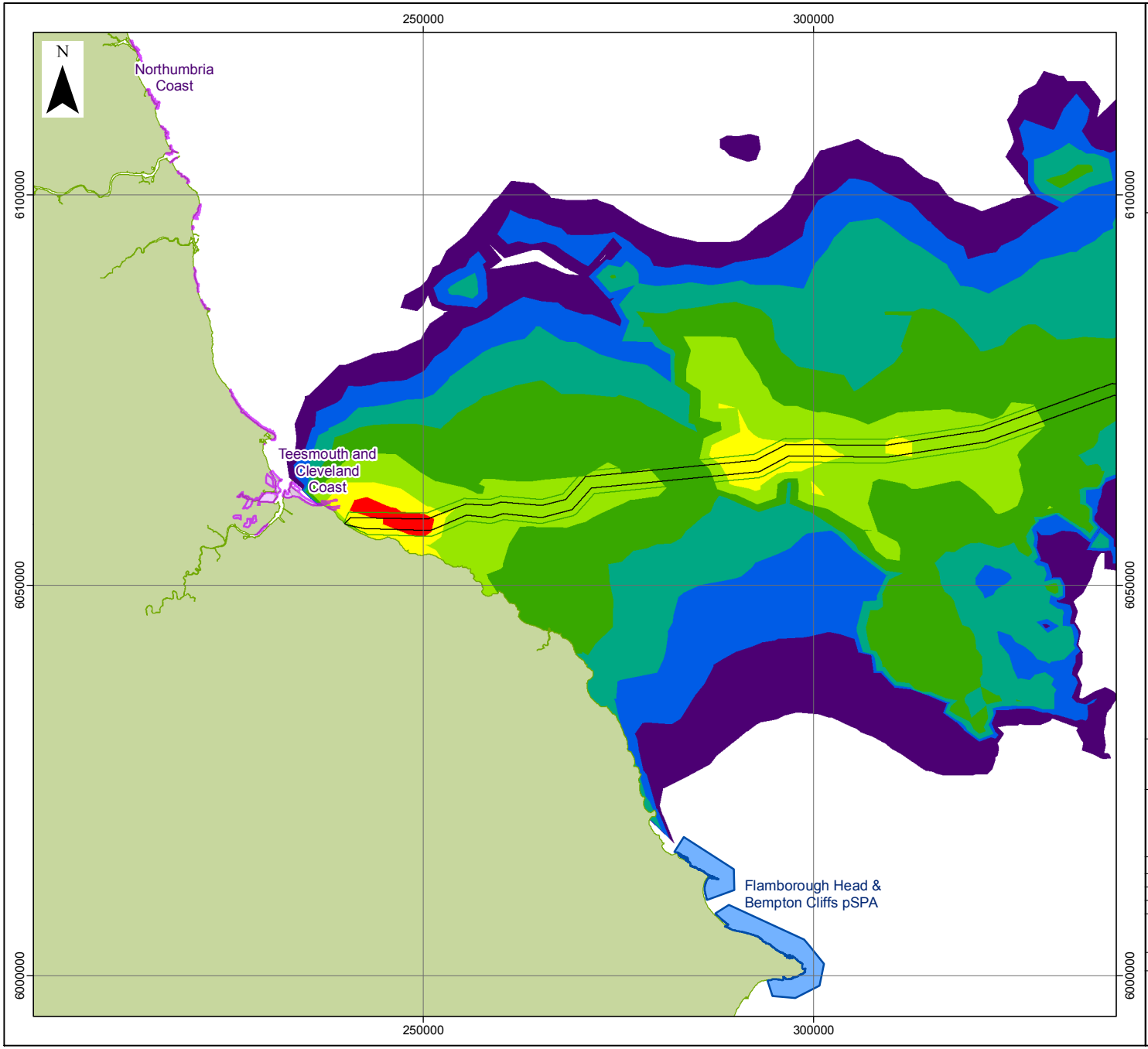
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| 2 | 18/03/2014 | DCO Submission | GC | DB |
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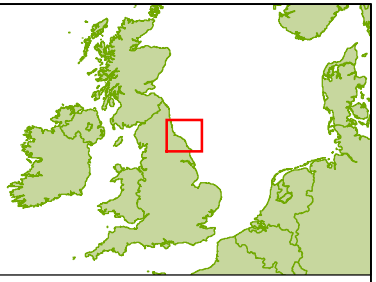
DRAWING NUMBER: **9Y0986/TSABHRA/15/R2**

| SCALE | PLOT SIZE | DATUM | PROJECTION |
|---|---|---|---|
| 1:1,400,000 | A4 | WGS84 | UTM31N |

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## LEGEND

- Dogger Bank Teesside A & B Export Cable Corridor
- Temporary works area
- Flamborough Head & Bempton Cliffs pSPA
- UK Special Protection Area (SPA)/Ramsar site

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
Kilometres

Data Source:
Environmental Designations © JNCC, 2013
Modelling © Danish Hydraulic Institute, 2013

PROJECT TITLE

*DOGGER BANK TEESSIDE A & B*
IfAA Report

DRAWING TITLE

**Figure 4.12 Maximum suspended sediment concentration in the bottom layer predicted over the simulation period during the construction phase in the nearshore zone**

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| 2 | 18/03/2014 | DCO Submission | GC | DB |
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DRAWING NUMBER: **9Y0986/TSABHRA/16/R2**

| SCALE | 1:750,000 | PLOT SIZE | A4 | DATUM | WGS84 | PROJECTION | UTM31N |
|---|---|---|---|---|---|---|---|

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4.6.31 Average near-bed suspended sediment concentrations were predicted as being between 50mg/l and 100mg/l above background within 20km kilometres of the location of the 24 piled foundations, but reducing to background concentrations within 23km to the north, 15km to the east, 28km to the south, and 45km to the west (when not taking into account the export cable), with the furthest distance extending 65km to the south-west, see **Figure 4.13**. In the nearshore zone, average suspended sediment concentrations would not exceed 5mg/l within a band approximately 10km to 15km wide, see **Figure 4.14**.

4.6.32 Exceedance of 2mg/l over the 30-day simulation period (see above) occurs for more than 90% of the time for an area extending approximately 15km to the south-south-west of the turbine construction area (see **Figure 4.15**), with exceedance for more than 50% of the time for an area extending 15km to the north, 8km to the east, 23km to the south, and 23km to the west, with the furthest distance extending 50km to the south-west of the turbine construction area, as shown on **Figure 4.15**. Where levels exceed 2mg/l in large areas, extending 33km to the north, 30km to the east, 60km to the south, and over 60km to the west, these would occur for up to 10% of the 30-day period. In the nearshore zone, the levels exceed 2mg/l for less than 20% of the time (see **Figure 4.16**) in a swathe approximately 70km to 80km wide.

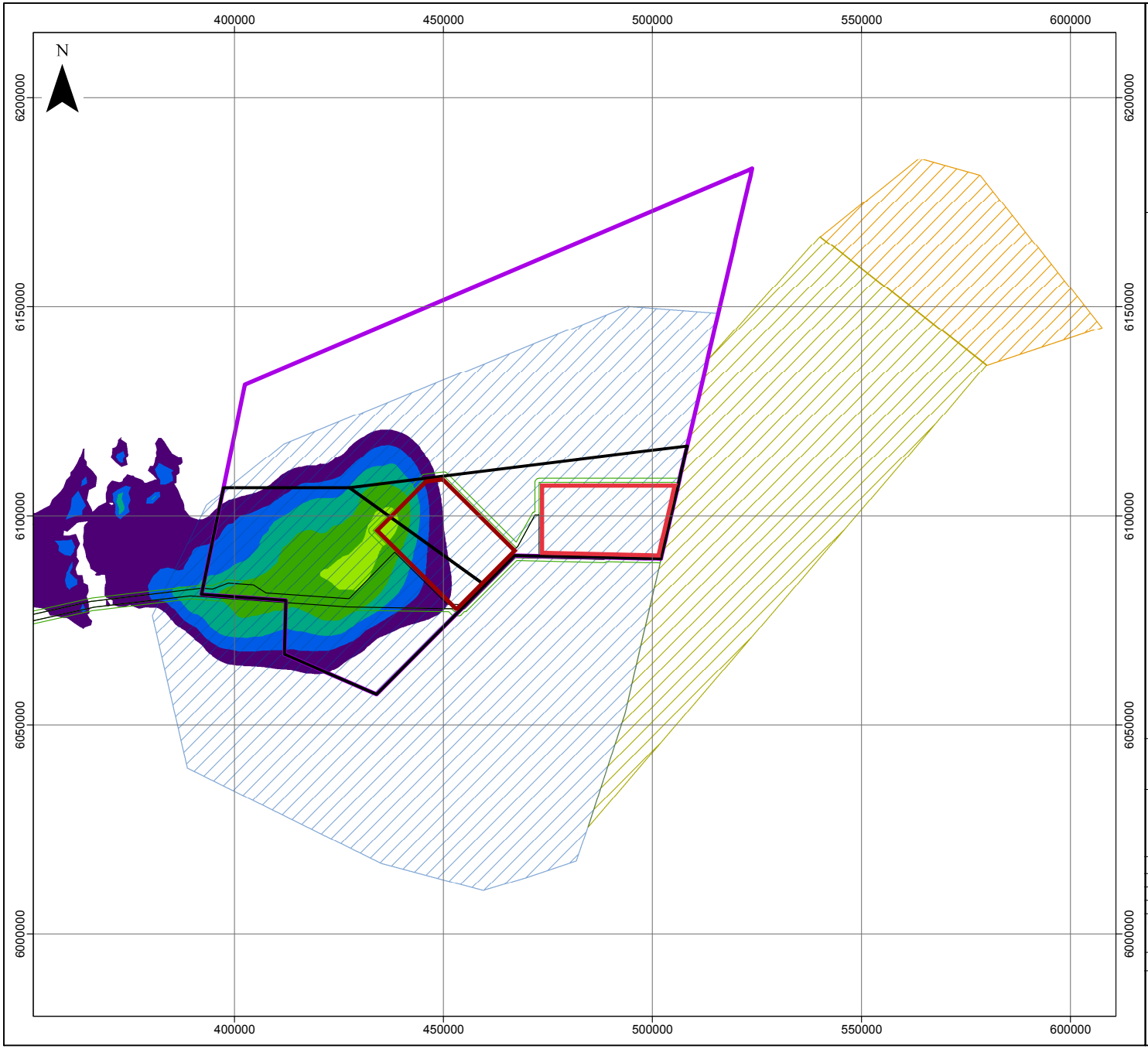
4.6.33 Sedimentation values generated by the modelling work indicate that the maximum deposition depth of between 10mm to 100mm could occur within 10km of the foundations (see **Figure 4.17**). Maximum deposition depths of less than 10mm would extend approximately 20km to the north, 5km to the east, 5km to the south, and 40km to the west, with the furthest distance extending 50km to the south-west of the source of the activity (see **Figure 4.17**). No sediment deposition is predicted to occur beyond approximately 30km to the north, 20km to the east, 35km to the south, and 45km to the west (taking out the material from the export cable installation). In the nearshore zone, the maximum deposition depth does not exceed 5mm, with between 1mm and 5mm occurring in a band between 5km and 10km either side of the export cable (see **Figure 4.18**), with no sediment deposited beyond 35km of the export cable.

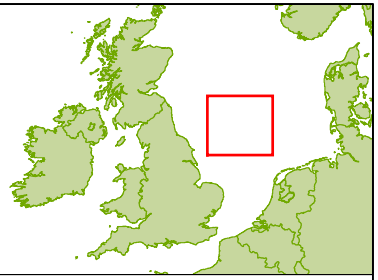
4.6.34 The average deposition depth (see **Figure 4.19**) shows a significantly smaller extent where deposition exceeds 1mm this extends less than 10km from the piled foundations. In the nearshore zone, average deposition depths do not exceed 0.5mm, and only then in a small area between 5km and 10km off the coast (see **Figure 4.20**).

4.6.35 In terms of the persistence of deposited sediment, time series analysis of sediment thickness was undertaken at several discrete points within and outside the development area (see **Figure 4.21**), and the results are presented in **Table 4.13**.

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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
- Dogger Bank Special Area of Conservation (cSAC)
- Doggerbank Site of Community Importance (SCI)
- Doggersbank Site of Community Importance (SCI)

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
Kilometres

Data Source:
Environmental Designations © JNCC, 2014 and European Environment Agency, 2014
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*DOGGER BANK TEESSIDE A & B*
IfAA Report

DRAWING TITLE

**Figure 4.13 Average suspended sediment concentration in the bottom layer predicted over the simulation period during the construction phase in the offshore area**

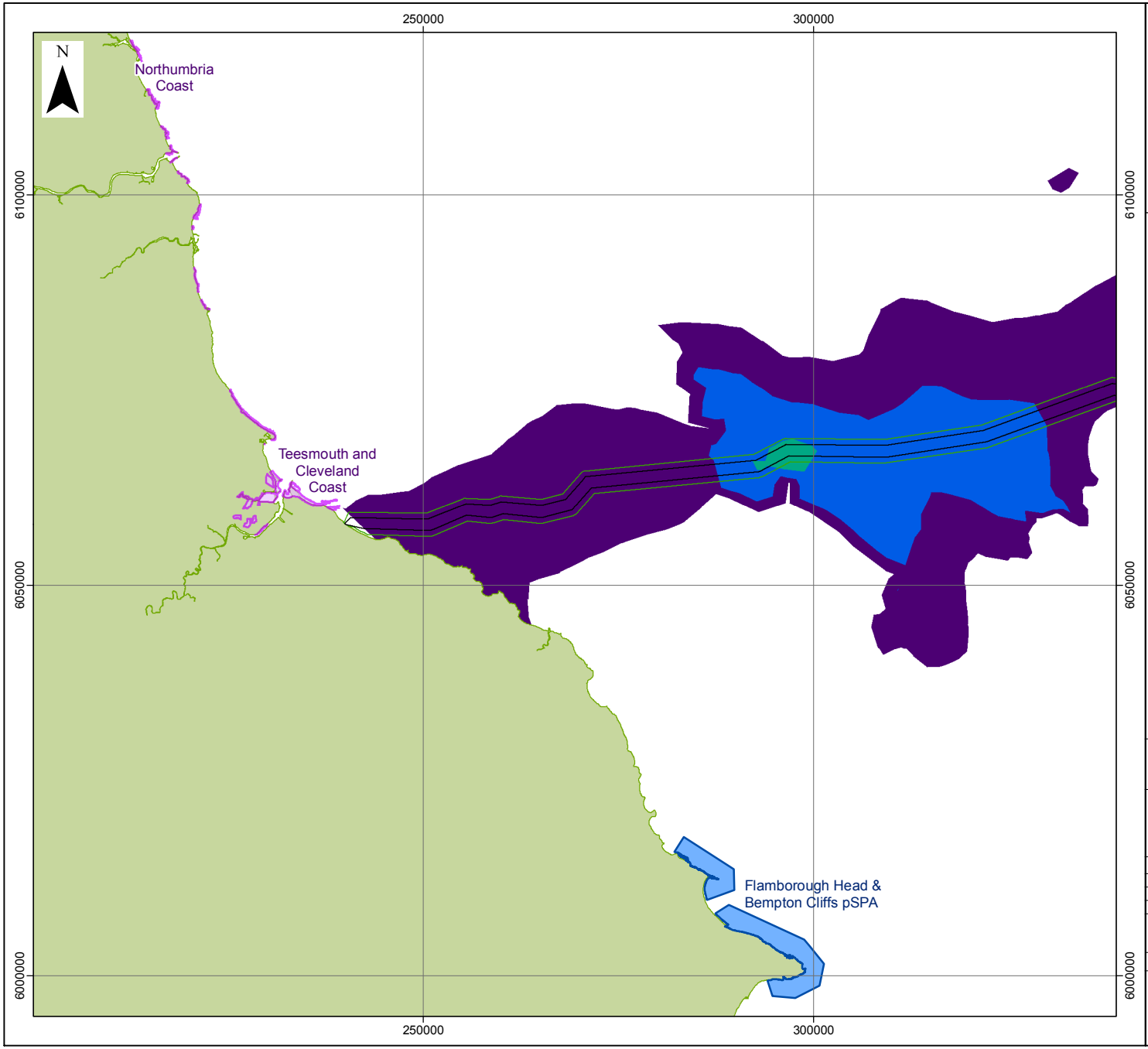
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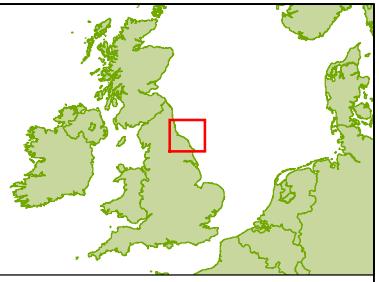
DRAWING NUMBER: **9Y0986/TSABHRA/17/R2**

| SCALE | PLOT SIZE | DATUM | PROJECTION |
|---|---|---|---|
| 1:1,400,000 | A4 | WGS84 | UTM31N |

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**LEGEND**

- Dogger Bank Teesside A & B Export Cable Corridor
- Temporary works area
- Flamborough Head & Bempton Cliffs pSPA
- UK Special Protection Area (SPA)/Ramsar site

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
Kilometres

Data Source:
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PROJECT TITLE

*DOGGER BANK TEESSIDE A & B*
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DRAWING TITLE

**Figure 4.14 Average suspended sediment concentration in the bottom layer predicted over the simulation period during the construction phase in the nearshore zone**

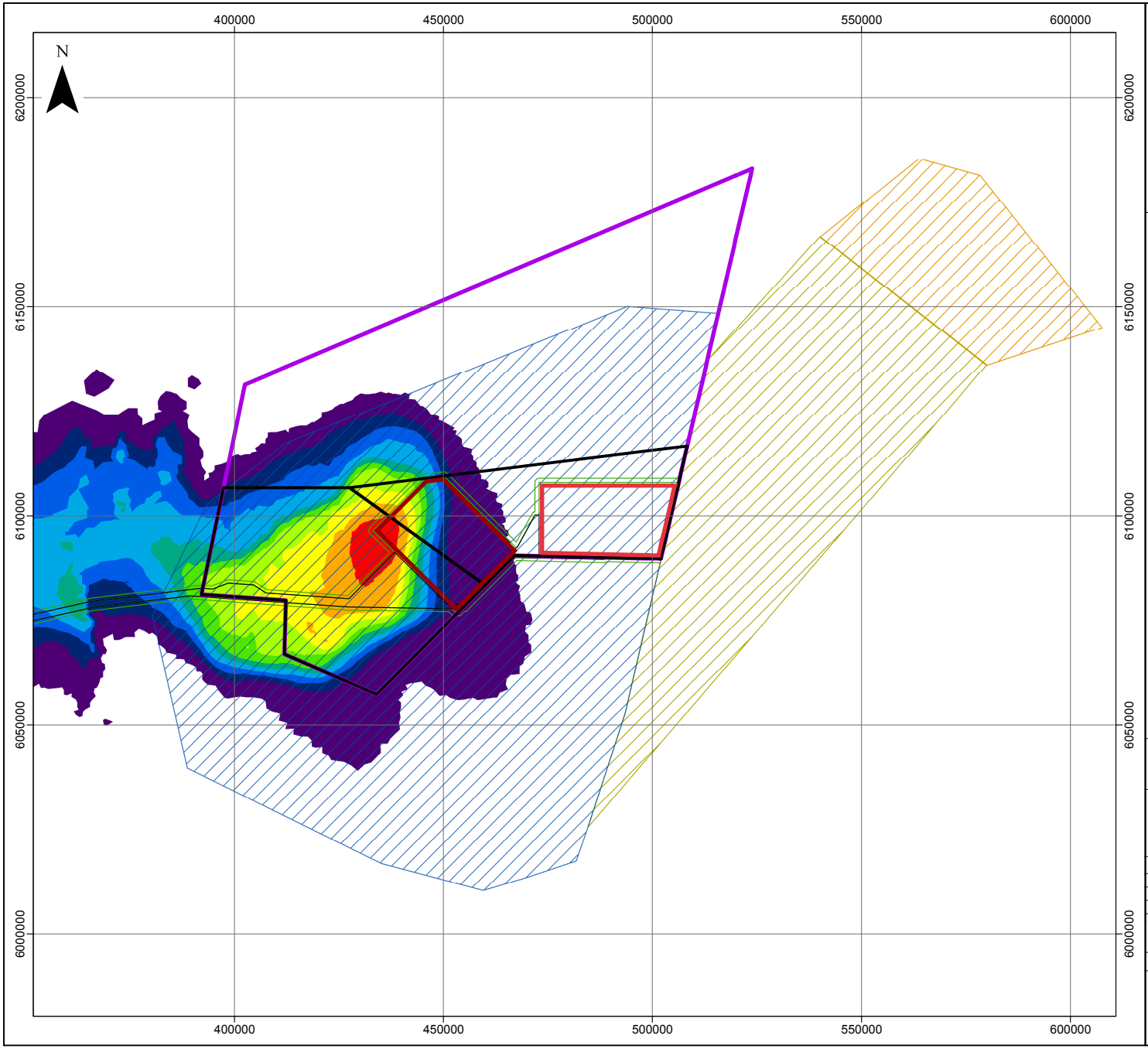
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| 2 | 18/03/2014 | DCO Submission | GC | DB |
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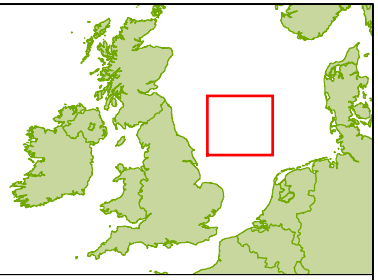
DRAWING NUMBER: **9Y0986/TSABHRA/18/R2**

| SCALE | 1:750,000 | PLOT SIZE | A4 | 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
- Dogger Bank Special Area of Conservation (cSAC)
- Doggerbank Site of Community Importance (SCI)
- Doggersbank Site of Community Importance (SCI)

Exceedance of 2 mg/l (% )

- Above 90
- 80 - 90
- 70 - 80
- 60 - 70
- 50 - 60
- 40 - 50
- 30- 40
- 20 - 30
- 10 - 20
- 0 - 10
- Below 0

0 10 20
Kilometres

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**Figure 4.15 Duration of exceedance of 2mg/l background suspended sediment concentration in the bottom layer predicted over the simulation period during the construction phase in the offshore area**

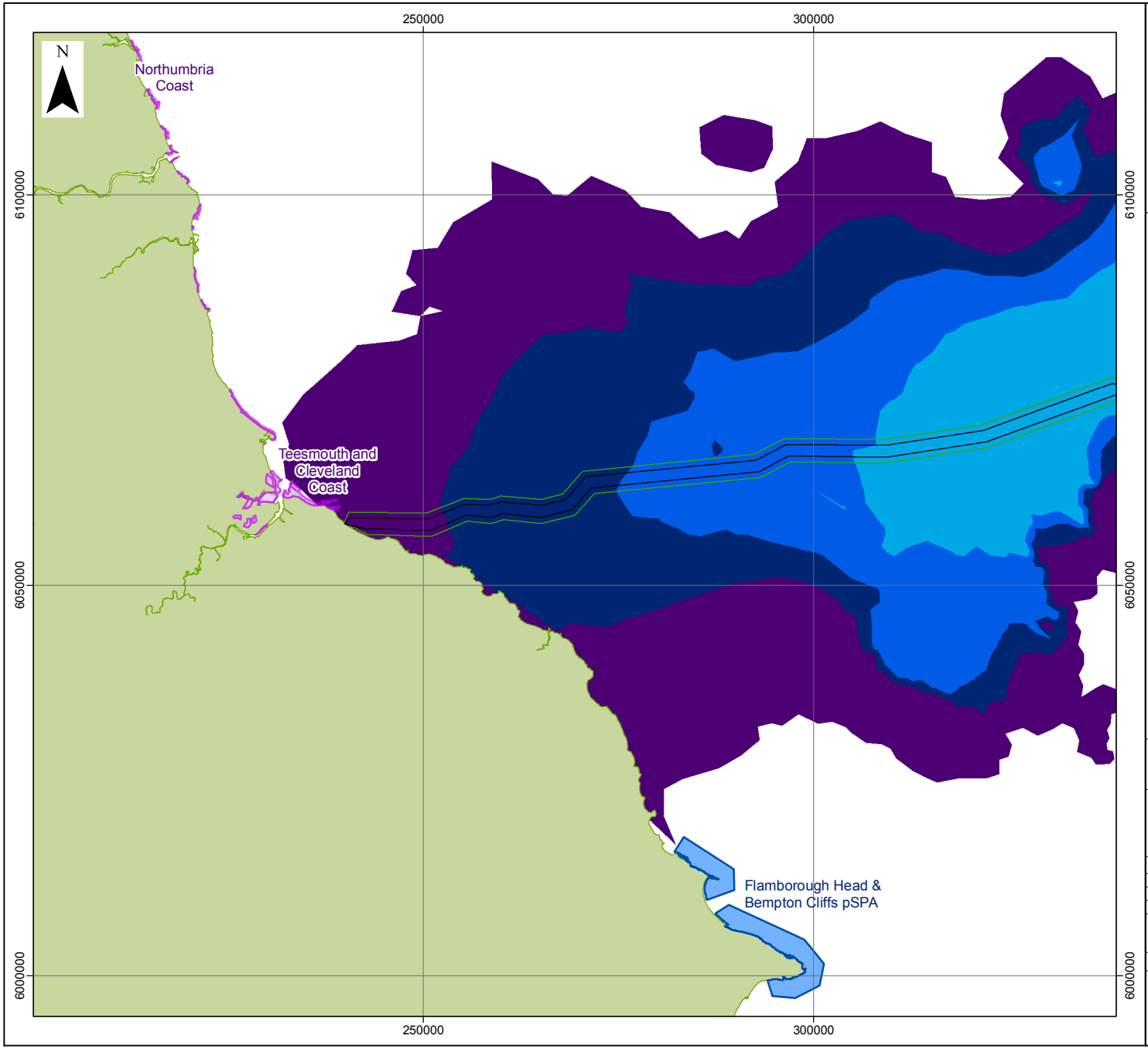
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| 2 | 18/03/2014 | DCO Submission | GC | DB |
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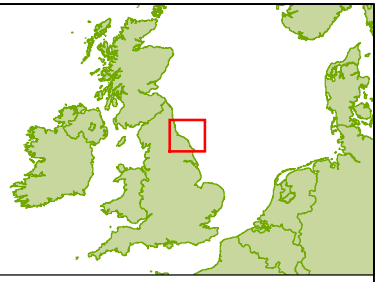
DRAWING NUMBER: **9Y0986/TSABHRA/19/R2**

| SCALE | PLOT SIZE | DATUM | PROJECTION |
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| 1:1,400,000 | A4 | WGS84 | UTM31N |

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**LEGEND**

- Dogger Bank Teesside A & B Export Cable Corridor
- Temporary works area
- Flamborough Head & Bempton Cliffs pSPA
- UK Special Protection Area (SPA)/Ramsar site

Exceedance of 2 mg/l (% )

- Above 90
- 80 - 90
- 70 - 80
- 60 - 70
- 50 - 60
- 40 - 50
- 30- 40
- 20 - 30
- 10 - 20
- 0 - 10
- Below 0

0 10
Kilometres

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**Figure 4.16 Duration of exceedance of 2mg/l background suspended sediment concentration in the bottom layer predicted over the simulation period during the construction phase in the nearshore zone**

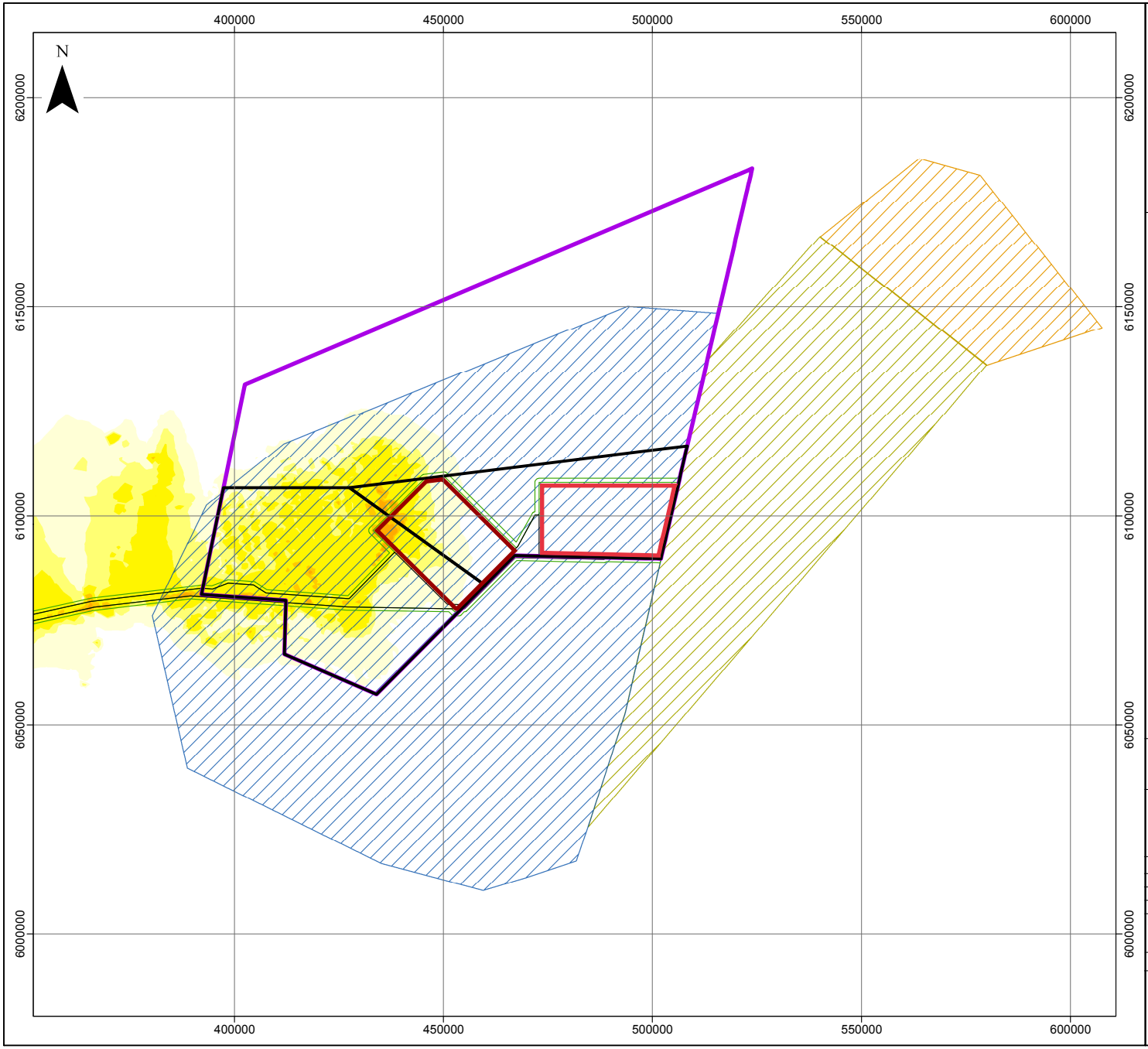
| VER | DATE | REMARKS | Drawn | Checked |
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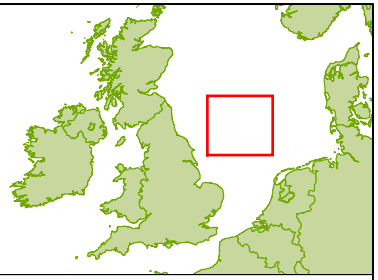
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**LEGEND**

- Dogger Bank Zone
- Tranche boundary
- Dogger Bank Teesside A
- Dogger Bank Teesside B
- Dogger Bank Teesside A & B Export Cable Corridor
- Temporary works area
- Dogger Bank Special Area of Conservation (cSAC)
- Doggerbank Site of Community Importance (SCI)
- Doggersbank Site of Community Importance (SCI)

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
Kilometres

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DRAWING TITLE

**Figure 4.17 Maximum sediment deposition predicted over the simulation period during the construction phase in the offshore area**

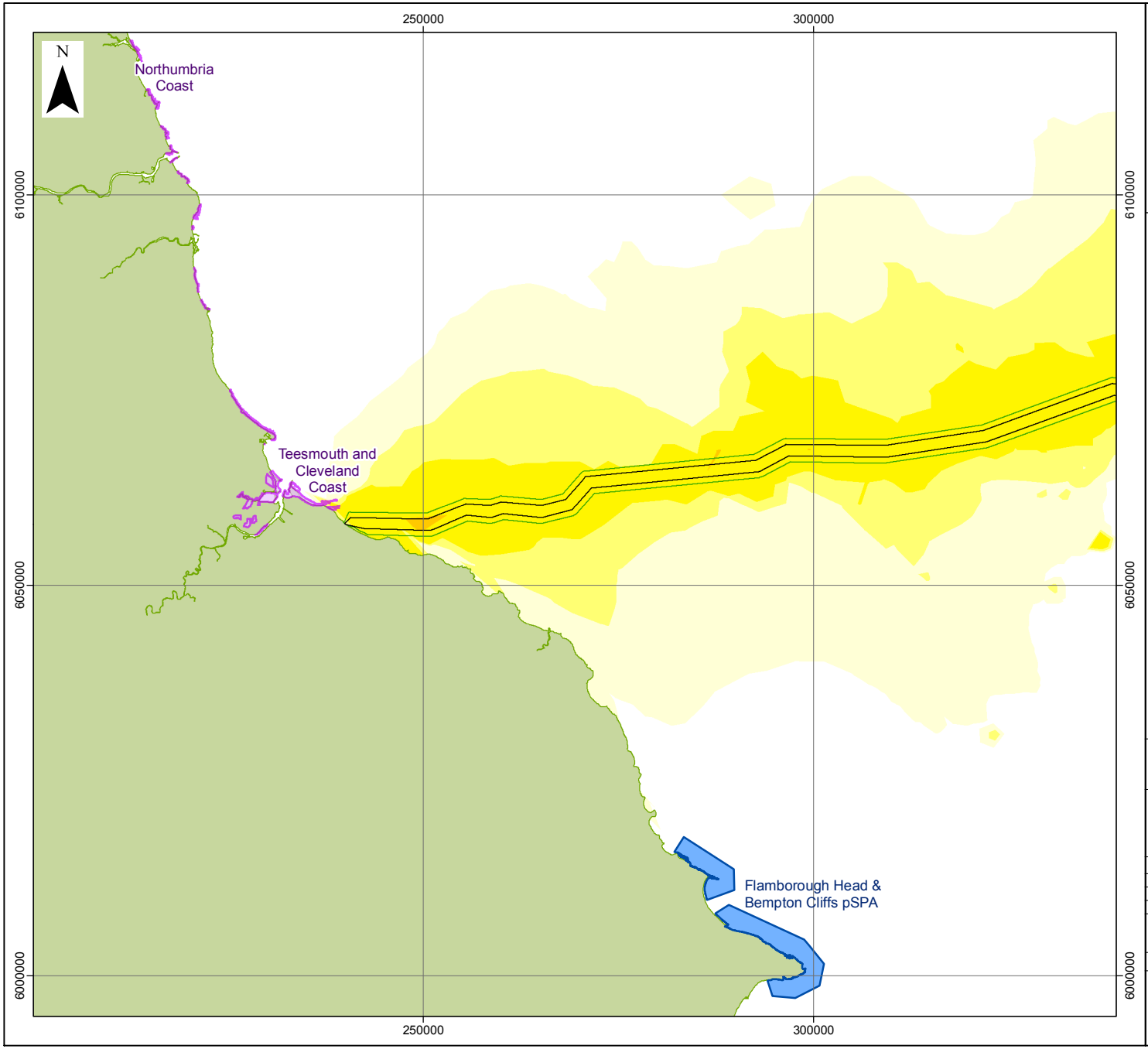
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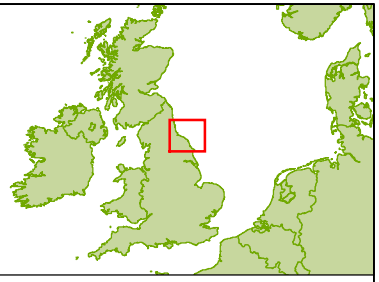
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| SCALE | PLOT SIZE | DATUM | PROJECTION |
|---|---|---|---|
| 1:1,400,000 | A4 | WGS84 | UTM31N |

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## LEGEND

- Dogger Bank Teesside A & B Export Cable Corridor
- Temporary works area
- Flamborough Head & Bempton Cliffs pSPA
- UK Special Protection Area (SPA)/Ramsar site

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
Kilometres

Data Source:
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DRAWING TITLE

**Figure 4.18 Maximum sediment deposition predicted over the simulation period during the construction phase in the nearshore zone**

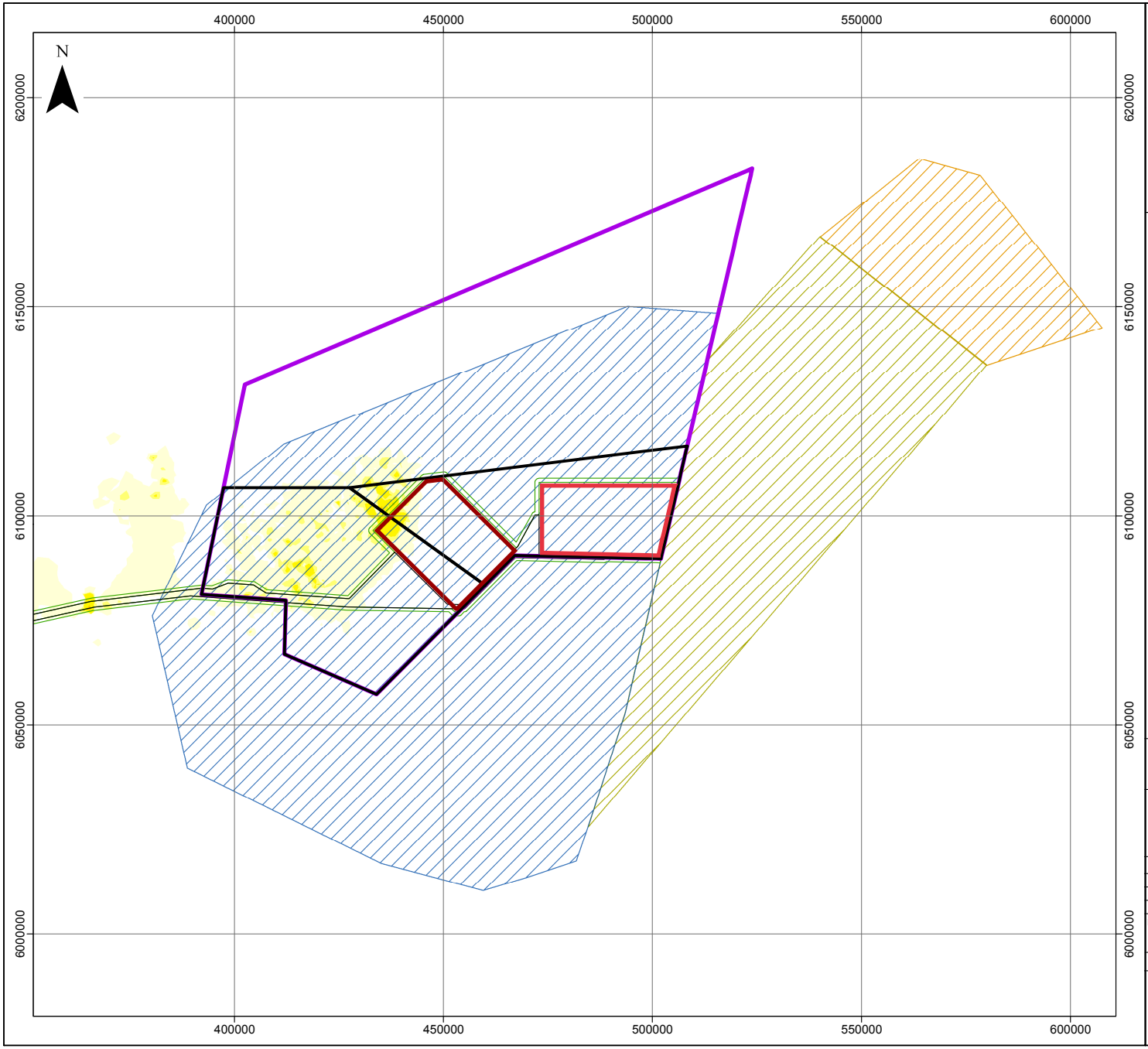
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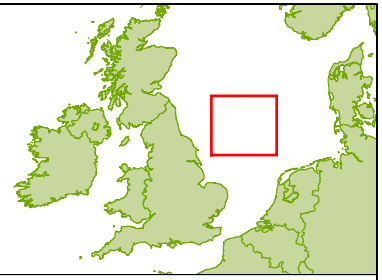
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**LEGEND**

- Dogger Bank Zone
- Tranche boundary
- Dogger Bank Teesside A
- Dogger Bank Teesside B
- Dogger Bank Teesside A & B Export Cable Corridor
- Temporary works area
- Dogger Bank Special Area of Conservation (cSAC)
- Doggerbank Site of Community Importance (SCI)
- Doggersbank Site of Community Importance (SCI)

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
Kilometres

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**Figure 4.19 Average sediment deposition predicted over the simulation period during the construction phase in the offshore area**

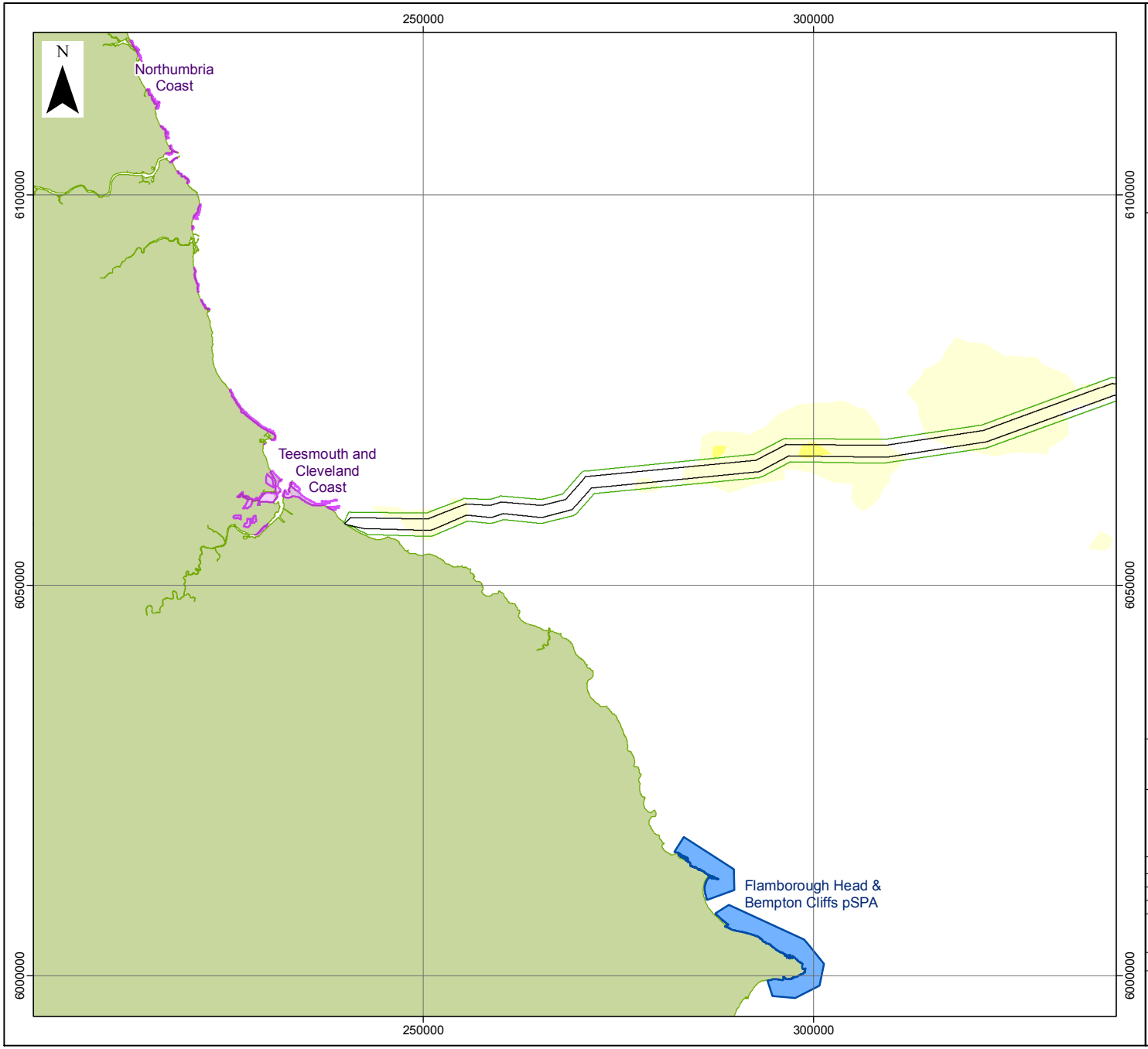
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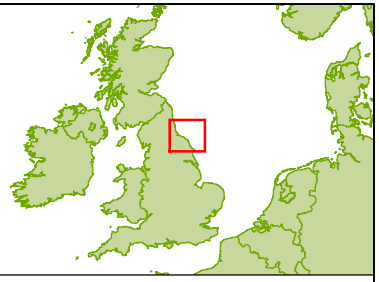
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| SCALE | PLOT SIZE | DATUM | PROJECTION |
|---|---|---|---|
| 1:1,400,000 | A4 | WGS84 | UTM31N |

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## LEGEND

- Dogger Bank Teesside A & B Export Cable Corridor
- Temporary works area
- Flamborough Head & Bempton Cliffs pSPA
- UK Special Protection Area (SPA)/Ramsar site

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
Kilometres

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**Figure 4.20 Average sediment deposition predicted over the simulation period during the construction phase in the nearshore zone**

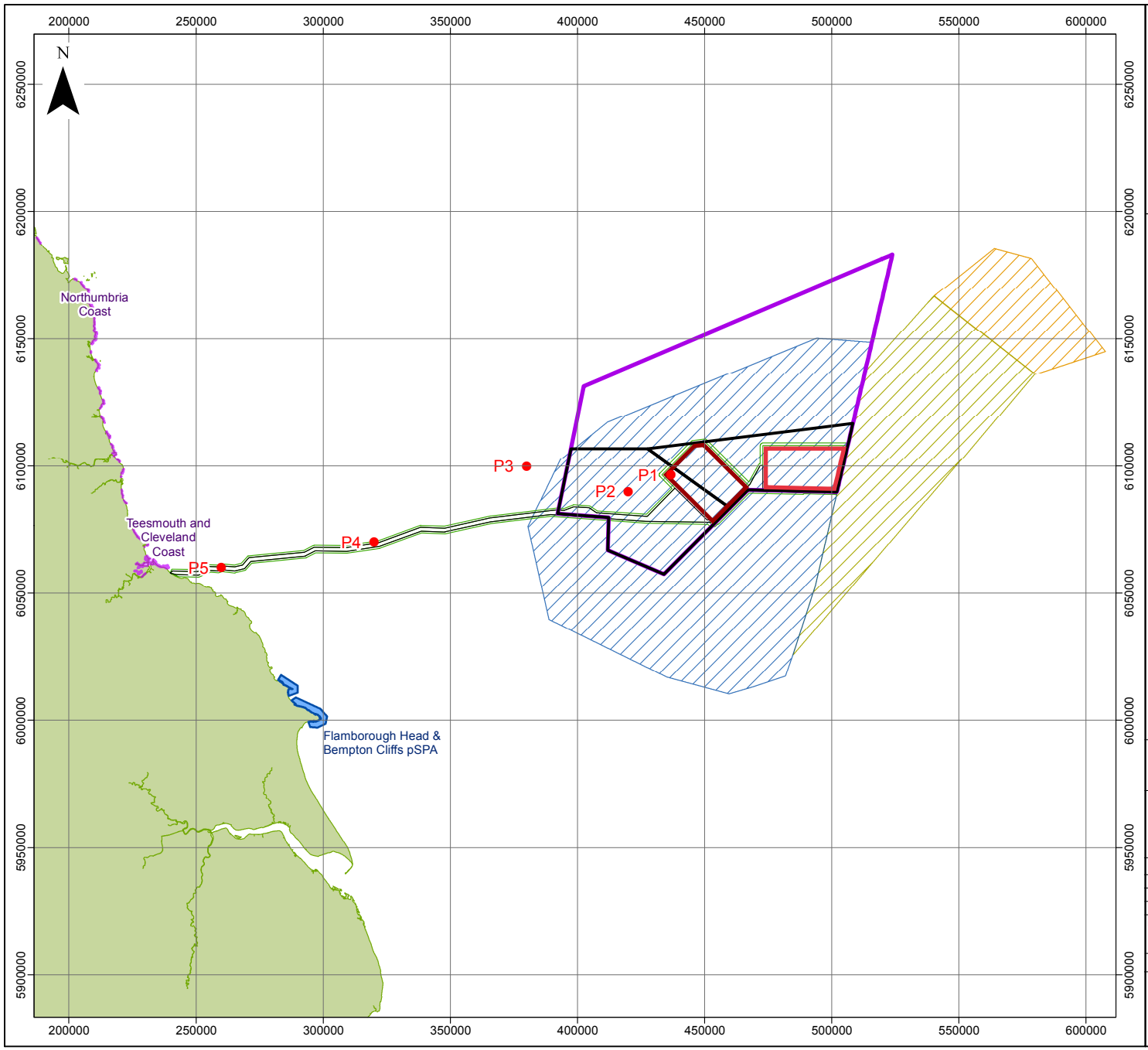
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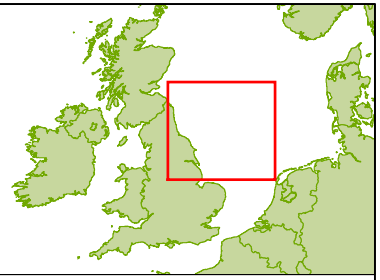
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## LEGEND

- Dogger Bank Zone
- Tranche boundary
- Dogger Bank Teesside A
- Dogger Bank Teesside B
- Dogger Bank Teesside A & B Export Cable Corridor
- Temporary works area
- Dogger Bank Special Area of Conservation (cSAC)
- Doggerbank Site of Community Importance (SCI)
- Doggersbank Site of Community Importance (SCI)
- Flamborough Head & Bempton Cliffs pSPA
- UK Special Protection Area (SPA)/Ramsar site
- Sediment thickness time series analysis point

0 20 40
Kilometres

Data Source:
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DRAWING TITLE

**Figure 4.21 Location of points for sediment thickness time series analysis**

| VER | DATE | REMARKS | Drawn | Checked |
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| 2 | 18/03/2014 | DCO Submission | GC | DB |
| | | | | |

DRAWING NUMBER: **9Y0986/TSABHRA/25/R2**

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Table 4.13 Maximum persistency of sediment thickness over the 30-day simulation period for construction of a 12m monopole

| Point | Maximum thickness (mm) | Maximum continuous time of sediment thickness (hours with days in brackets) | | | | Thickness at end of simulation (mm) |
|---|---|---|---|---|---|---|
| | | >10mm | >7mm | >3mm | >1mm | |
| P1 | 13.71 | 32 (1.33) | 38 (1.58) | 80 (3.33) | 174 (7.25) | <0.1 |
| P2 | 3.19 | 0 | 0 | 10 | 22 | <0.1 |
| P3 | 1.35 | 0 | 0 | 0 | 6 | <0.1 |
| P4 | 1.26 | 0 | 0 | 0 | 2 | <0.1 |
| P5 | 1.00 | 0 | 0 | 0 | 2 | <0.1 |

4.6.36 **Table 4.13** indicates that, within the modelled foundation layout, deposited sediment was predicted to persist at thicknesses greater than 10mm for a day and half and greater than 1mm for just over seven days throughout the 30-day modelling period. At point P2 within 20km to the south-west of the foundations (and generally an area of higher deposition than other compass directions) deposition did not exceed 7mm, but deposition of between 3mm to 7mm persisted for 10 hours (less than half a day) and for depths exceeding 1mm for nearly one day (22 hours). The predicted bed thickness at the end of the 30-day simulation was equal to or less than 0.1mm across the whole of the development footprint. This indicates the lack of potential for any “additive” effect of sediment deposition and, therefore, the maximum depths outlined above represent the actual maximum values predicted to arise.

4.6.37 For the nearshore zone, point P5 on **Figure 4.21**, the results shown in **Table 4.13** indicate that deposition of greater than 1mm (but less than 3mm) would persist for around two hours, and predicted bed thickness at the end of the 30-day simulation would be equal to or less than 0.1mm.

4.6.38 The construction phase for Dogger Bank Teeside A & B, would result in disturbance works such as seabed clearance or trenching / jetting) for cables and piling activities that could result in the re-suspension of seabed sediments, resulting in increased suspended sediment concentrations and sediment deposition across the Dogger Bank cSAC. The increases would occur at different locations and at different concentrations, depths, and durations throughout the construction phase, being both intermittent and temporary. In terms of the sediment deposition, within a month it is predicted that no residual sediment would be present. Given this, no impact on this physical aspect of the sandbanks feature is predicted during the construction phase. The impact on changes in suspended sediment concentrations and sediment deposition on this physical aspect of the sandbanks feature of the Dogger Bank cSAC is, however, considered in the operation phase (see paragraphs 4.7.33 to 4.7.43) where potentially long-term or permanent impacts could occur.

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**Teesmouth and Cleveland Coast SPA and Ramsar site (supporting habitat features)**

4.6.39 The maximum suspended sediment concentrations in the area of the Teesmouth and Cleveland Coast SPA and Ramsar site are predicted to be less than 200mg/l (see **Figure 4.12**), with the average suspended sediment concentrations predicted to be less than 5mg/l (see **Figure 4.14**) during the 30 day simulation period for export cable installation. These levels would occur for less than 10% of the time (or less than three days), as shown on **Figure 4.16**, and the maximum concentrations would occur for a significantly shorter duration (less than an hour). Given the highly variable nature of suspended sediments within and adjacent to the Teesmouth and Cleveland Coast SPA and Ramsar site (see paragraph 4.5.31), these short-term and temporary increases are considered to lie within the natural range of background concentrations.

4.6.40 The maximum sediment deposition depths in the area of the Teesmouth and Cleveland Coast SPA and Ramsar site are predicted to be less than 5mm (see **Figure 4.18**), with average deposition depths of less than 0.1mm predicted (see **Figure 4.20**) during the 30 day simulation period for export cable installation. As noted in paragraph 4.6.38 above, deposited sediment would be rapidly removed through wave and tidal action and, consequently, only a temporary and negligible impact would occur.

**Northumbria Coast SPA and Ramsar site (supporting habitat features)**

4.6.41 No suspended sediment concentration increases would occur within or immediately adjacent to the Northumbria Coast SPA and Ramsar site (see **Figure 4.12** and **Figure 4.14**).

4.6.42 No sediment deposition would occur in or near to the Northumbria Coast SPA and Ramsar site (see **Figure 4.18** and **Figure 4.20**).

**Doggerbank SCI (Germany)**

4.6.43 Taking the results of the modelling of suspended sediment concentations due to disturbance during the construction phase (see paragraphs 4.6.30 to 4.6.32) and applying them to the easternmost location of Dogger Bank Teesside A, which is closest to the Doggerbank SCI, no suspended sediments (maximum or average) would extend into the Doggerbank SCI (see **Figure 4.11** and **Figure 4.13**).

4.6.44 Taking the results of the modelling of sediment deposition due to scour and disturbance during the construction phase (see paragraphs 4.6.33 to 4.6.36) and applying them to the easternmost location of Dogger Bank Teesside A, which is closest to the Doggerbank SCI, no sediment would be deposited within the Doggerbank SCI (see **Figure 4.17** and **Figure 4.19**).

**Doggersbank SCI (Netherlands)**

4.6.45 Taking the results of the modelling of suspended sediment concentations due to disturbance during the construction phase (see paragraphs 4.6.30 to 4.6.32) and applying them to the easternmost location of Dogger Bank Teesside A, which is closest to the Doggersbank SCI, the maximum suspended sediment concentrations are predicted to exceed 200mg/l for up to 10km within the site, falling to 100mg/l for up to 30km within the site, and dropping to background

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levels between 17km and 40km within the site (see **Figure 4.11**). The average suspended sediment concentrations are predicted to exceed 100mg/l for up to 3km within the site, falling to below 20mg/l for up to 7km within the site, and dropping to background levels between 13km and 20km within the site (see **Figure 4.13**). Based on **Figure 4.15**, this indicates that suspended sediment concentrations would exceed background concentrations for 90% of the time in an area extending 5km into the site, for 50% of the time in an area extending 12km into the site, and for less than 10% of the time in an area extending up to 40km into the site.

4.6.46 Taking the results of the modelling of sediment deposition due to disturbance during the construction phase (see paragraphs 4.6.33 to 4.6.36) and applying them to the easternmost location of Dogger Bank Teesside A, which is closest to the Doggersbank SCI, the maximum deposition depths could reach up to 50mm immediately inside the site, decreasing to below 10mm up to 2.5km inside the site, and falling to no increase within 20km inside the site (see **Figure 4.17**). The average deposition depths could reach less than 10mm immediately inside the site, decreasing to below 5mm up to 2.5km inside the site, and falling to no increase within 7.5km inside the site (see **Figure 4.19**). **Table 4.13** presents the predicted persistence of deposited sediments at the points shown on **Figure 4.21**. No points where persistence of sediments were modelled are present within the Doggersbank SCI, however, given that no deposition occurs beyond 20km, the only relevant point where an approximation of the persistence and thickness of deposited sediment within this site would be that within the area of construction activity (foundation piling), i.e. Point P1 in **Table 4.13** and **Figure 4.21**. The persistence of sediments within the Doggersbank SCI, therefore, would be no more than those shown for Point P1 on the immediate boundary of this site and reduce in depth and persistence further into this site. As shown on **Table 4.13**, limited if any deposited sediment would remain within the site after completion of the construction phase. Overall, given the intermittent and temporary nature of increases in suspended sediment concentrations and sediment deposition, no significant alteration to this physical aspect of the subtidal sandbanks feature of the Doggersbank SCI is predicted during the construction phase,

## Changes to the levels of nutrients and contaminants

### Dogger Bank cSAC

4.6.47 The re-suspension of sediments as a result of temporary disturbance during construction would be highly variable both in terms of spatial and temporal distribution. Given that no contaminants are being introduced into the site, all contaminants re-suspended and deposited would derive from the seabed sediments already present within the Dogger Bank cSAC. Given the low levels of contaminants present in sediments within the cSAC (see paragraph 4.5.33) tthe temporary movement, dispersion and settlement of suspended sediment generated during construction would not be expected to alter the chemical properties of the Dogger Bank cSAC sandbanks.

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**Teesmouth and Cleveland Coast SPA and Ramsar site (supporting habitat features)**

4.6.48 The marine environment of and surrounding the Teesmouth and Cleveland Coast SPA and Ramsar site is highly dispersive in nature, as evidenced by the low levels of sediment deposition (see paragraph 4.6.40), and the low residence times for both suspended sediments (see paragraph 4.6.39) and deposited sediments (see paragraph 4.6.40), which indicate rapid mixing (and dilution) of sediments within the water column and rapid dispersal across the coastal zone. Whilst some exceedances of guideline levels of contaminants is recorded within the nearshore area in which the works for the export cable route would take place (see paragraphs 4.5.35 to 4.5.37), the temporary movement, dispersion and settlement of suspended sediments and any contaminants (which would be rapidly dispersed) within them (see paragraphs 4.6.39 and 4.6.40) would not be expected to alter the chemical environment of the site to a measurable degree.

**Northumbria Coast SPA and Ramsar site (supporting habitat features)**

4.6.49 Given that no suspended sediment and no deposited sediment from the construction of the Dogger Bank Teesside A & B Export Cable Corridor would extend in or near to the Northumbria Coast SPA and Ramsar site (see paragraphs 4.6.41 and 4.6.42), no increase in contaminant levels within the supporting habitats could occur within the site as a result of the construction of Dogger Bank Teesside A & B. No effect on supporting habitat outside the Northumbria Coast SPA and Ramsar site would arise, for the reasons described in paragraph 4.6.48 above.

**Doggerbank SCI (Germany)**

4.6.50 Given that no suspended sediment and no deposited sediment from the construction of the Dogger Bank Teesside A & B Export Cable Corridor would extend in or near to the Doggerbank SCI (see paragraphs 4.6.43 and 4.6.44) there would be no pathway by which potential contaminant release could extend into and affect the physical or biological features, and no impact would arise.

**Doggersbank SCI (Netherlands)**

4.6.51 As with the Dogger Bank cSAC, see paragraph 4.6.47 above, given that low levels of contaminants are present from the sediments within the Dogger Bank cSAC the temporary movement, dispersion and settlement of suspended sediment deriving from construction activities would not be expected to alter the chemical properties of the Doggersbank SCI sandbanks.

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## Physical damage to habitat feature communities

### Dogger Bank cSAC

4.6.52 During construction for Dogger Bank Teesside A & B (turbines) and the associated infrastructure (array cables, converters, substations, met masts, foundations, export cables, scour protection, and permanent moorings) a wide range of activities would result in the physical disturbance of sandbank communities within the Dogger Bank cSAC, as described in paragraph 2.6.1 and **Table 2.2**. The sources of physical disturbance during the construction of Dogger Bank Teesside A & B would be (as detailed in **Table 2.2**):

- The installation of up to 1,900km of inter-array cables (19.0km$^2$);
- The installation of 640km of inter-platform cables (6.4km$^2$);
- The installation of the export cable (4.08km$^2$) including anchor footprints;
- Jacking-up of vessels (2.016km$^2$);
- Seabed preparation for turbines and other structures (3.202km$^2$);
- Anchor footprints for the installation of foundations and topside for the structures (0.93km$^2$); and
- Anchor footprints for the installation of the export cable (0.072km$^2$)

4.6.53 Physical disturbance of sandbank habitats and their associated communities would also arise due to the introduction of side-cast and/or dredged material from seabed preparation works. However, because the creation of residual mounds of coarser sediment as a result of seabed preparation works would result in a more long-term (or persistent) change in benthic habitats in these areas, this specific impact is assessed for the operation phase.

4.6.54 The activities listed above would affect areas of the seabed for very short durations (i.e. days). Although construction work would be progressive and physical disturbance associated with each turbine installation or cable laying would be localised to the source of disturbance, in total, over the entire construction phase an estimated area of 35.70km$^2$ would be disturbed. As shown in **Table 4.14**, this would represent physical disturbance to 0.29% of the Dogger Bank cSAC. This disturbance extent assumes all turbines are gravity based and, as such, results in a greater area of disturbance than in the event of piled structures.

4.6.55 Based on information presented in paragraphs 4.5.59 and 4.6.51, a number of calculations were made to illustrate the specific maximum losses of each VER (see **Table 4.12**) within the project areas with respect to the extent of those communities within the Dogger Bank cSAC (see **Table 4.12**). The results are presented in **Table 4.15**, and have been calculated assuming a proportional disturbance across the Dogger Bank cSAC due to the wide distribution of communities. Consequently, 12.23km$^2$ of VER A communities, 1.91km$^2$ VER B communities, and 21.56km$^2$ of VER C communities within Dogger Bank cSAC would be affected by disturbance during the construction phase for Dogger Bank Teesside A & B.

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## Table 4.14 Physical disturbance extents in relation to Dogger Bank cSAC

| Parameter | Extent disturbed ($km^2$) | | |
|---|---|---|---|
| | Dogger Bank Teesside A | Dogger Bank Teesside B | Dogger Bank Teesside A & B |
| Area of Dogger Bank cSAC | 12,331$km^2$ | | |
| Maximum footprint of construction phase effects (temporary disturbance) within the cSAC | 15.81$km^2$ | 15.81$km^2$ | 31.62$km^2$ |
| Maximum footprint of construction phase effects (temporary disturbance) of the Dogger Bank Teesside A & B Export Cable Corridor[a] within the cSAC | 2.48$km^2$ | 1.60$km^2$ | 4.08$km^2$ |
| Total footprint of construction phase effects (temporary disturbance) within the cSAC | 18.29$km^2$ | 17.41$km^2$ | 35.70$km^2$ |
| Total footprint of construction phase effects (temporary disturbance) as a percentage of Dogger Bank cSAC | 0.15% | 0.14% | 0.29% |

[a] Only the footprint of the Dogger Bank Teesside A & B Export Cable Corridor that lies within the Dogger Bank cSAC boundary is listed here.

## Table 4.15 Proportion of VER communities within the Dogger Bank cSAC affected by temporary disturbance during the construction phase

| VER affected | Extent affected ($km^2$ or percentage) | | |
|---|---|---|---|
| | Dogger Bank Teesside A[a] | Dogger Bank Teesside B[a] | Dogger Bank Teesside A & B[a] |
| **VER A** | | | |
| Area within Dogger Bank cSAC[b] ($km^2$) | 6,898.99 $km^2$ | 6,898.99 $km^2$ | 6,898.99 $km^2$ |
| Area within project ($km^2$) | 51.90 $km^2$ | 359.04 $km^2$ | 410.94 $km^2$ |
| Extent affected within project ($km^2$) | 1.70 $km^2$ | 10.54 $km^2$ | 12.23 $km^2$ |
| Percentage of VER affected within Dogger Bank cSAC (%) | 0.02% | 0.15% | 0.18% |
| **VER B** | | | |
| Area within Dogger Bank cSAC[b] ($km^2$) | 2,142.18 $km^2$ | 2,142.18 $km^2$ | 2,142.18 $km^2$ |
| Area within project ($km^2$) | 28.05 $km^2$ | 33.74 $km^2$ | 61.79 $km^2$ |
| Extent affected within project ($km^2$) | 0.92 $km^2$ | 0.99 $km^2$ | 1.91 $km^2$ |
| Percentage of VER affected within Dogger Bank cSAC (%) | 0.04% | 0.05% | 0.09% |
| **VER C** | | | |
| Area within Dogger Bank cSAC[b] ($km^2$) | 3,289.84 $km^2$ | 3,289.84 $km^2$ | 3,289.84 $km^2$ |
| Area within project ($km^2$) | 480.15 $km^2$ | 200.43 $km^2$ | 680.58 $km^2$ |
| Extent affected within project ($km^2$) | 15.68 $km^2$ | 5.88 $km^2$ | 21.56 $km^2$ |
| Percentage of VER affected within Dogger Bank cSAC (%) | 0.48% | 0.18% | 0.65% |

[a] Includes Dogger Bank Teesside A & B Export Cable Corridor.
[b] Based on multiplying up the total VERs in the surveyed areas (tranches A & B and Dogger Bank Teesside A & B Export Cable Corridor that lie within the Dogger Bank cSAC)

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4.6.56 All of the biotopes within VERs A and B comprise species that are adapted to high energy environments and are therefore naturally subject to, and tolerant of, high levels of physical disturbance, i.e. they show high levels of recoverability. However, temporary habitat disturbance from construction works may result in the exposure of previously buried infauna, which in turn may increase the vulnerability of these species to predation from other organisms, such as fish and/or echinoderms (starfish). Even if there is some limited predation, and thus mortality of species, significant declines in overall species richness are unlikely to be seen. The recoverability of these communities is, therefore, assessed as high (Budd 2008; Rayment 2008) and overall (ecological) sensitivity to physical disturbance and abrasion is assessed as low, as identified in paragraph 4.5.64.

4.6.57 The high level of recoverability of the VER A and B communities reflects the relatively dynamic conditions on the Dogger Bank and within the Dogger Bank cSAC. Large parts of the Dogger Bank are situated above the storm-wave base. Klein *et al*. (1999) estimated that, during a storm event, sediment up to medium sand was mobilised in 60m water depth at the northern slope of the Dogger Bank. The communities present here are adapted to the relatively frequent sediment movement and disturbance associated with storm events. It should also be noted that much of the Dogger Bank within the Dogger Bank cSAC has been subject to disturbance associated with bottom-trawling by fishing vessels.

4.6.58 Given this capacity for relatively rapid recoverability and the small total area of the cSAC and the VER A and VER B communities (0.18% and 0.09%, area affected respectively) that would be affected by physical disturbance during construction, it is considered that construction itself would not give rise to any significant alteration to the communities of the sandbanks feature of the Dogger Bank cSAC. A predicted 0.65% of the VER C communities within the Dogger Bank cSAC would be affected by temporary disturbance during construction. The VER C communities display moderate sensitivity to physical disturbance and abrasion (see paragraph 4.5.64 above, and Appendix 12F of in **Chapter 12** of the Dogger Bank Teesside A & B ES for more detail). Following the disturbance events (which would be similar in nature to the existing disturbance associated with bottom trawling) limited subsequent disturbance (considered in the operation phase, see Section 4.7) would occur (as noted and concluded in paragraphs 4.6.8, 4.6.13, 4.6.23, and 4.6.38) and this would enable 0.57% of these communities to recover, therefore no significant alteration to the VER C communities is considered to arise, as the community would recover albeit over a longer timescale than the VER A and VER B communities.

4.6.59 In the event that either area (Dogger Bank Teesside A or Dogger Bank Teesside B) of Dogger Bank Teesside A & B were implemented individually, this would result in a reduction by half of the extent of area affected by disturbance. However, a slightly greater area would be associated with Dogger Bank Teesside A, due to the greater length of the export cable route compared to that for Dogger Bank Teesside B (as shown in **Table 2.2**), although this would not represent a significant alteration to the relative proportions of the communities present.

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**Teesmouth and Cleveland Coast SPA and Ramsar site (supporting habitat features)**

4.6.60 No seabed disturbance works or structures would extend into or be placed within the Teesmouth and Cleveland Coast SPA and Ramsar site, therefore, no physical damage would occur to the supporting habitats within this site during the construction phase. Long-term changes to physical processes, such as the hydrodynamic regime, sediment transport and subsequent changes to sediment composition and suspended sediment concentrations, which potentially could affect supporting habitats within and outside the Teesmouth and Cleveland Coast SPA and Ramsar site are considered in Section 4.7. Their potential influence on the prey resource of the Teesmouth and Cleveland Coast SPA and Ramsar site bird features, are also considered later in Section 4.7.

**Northumbria Coast SPA and Ramsar site (supporting habitat features)**

4.6.61 No seabed disturbance works or structures would extend into or be placed within the Northumbria Coast SPA and Ramsar site, therefore, no physical damage would occur to the supporting habitats within this site during the construction phase. Long-term changes to physical processes, such as the hydrodynamic regime, sediment transport and subsequent changes to sediment composition and suspended sediment concentrations, which potentially could affect supporting habitats within and outside the Teesmouth and Cleveland Coast SPA and Ramsar site are considered in Section 4.7. Their potential influence on the prey resource of the Northumbria Coast SPA and Ramsar site bird features, are also considered later in Section 4.7.

**Doggerbank SCI (Germany)**

4.6.62 No seabed disturbance works or structures would extend into or be placed within the Doggerbank SCI, therefore, no physical damage would occur to the sandbanks communities within this site during the construction phase. Long-term changes to physical processes, such as the hydrodynamic regime, sediment transport and subsequent changes to sediment composition and suspended sediment concentrations, which potentially could affect sandbanks communities within the Doggerbank SCI are considered in Section 4.7.

**Doggersbank SCI (Netherlands)**

4.6.63 No seabed disturbance works or structures would extend into or be placed within the Doggersbank SCI, therefore, no physical damage would occur to the sandbanks communities within this site during the construction phase. Long-term changes to physical processes such as the hydrodynamic regime, sediment transport and subsequent changes to sediment composition and suspended sediment concentrations which potentially could affect sandbanks communities within the Doggersbank SCI are considered in Section 4.7.

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## Physical damage to habitat feature communities from an increase in suspended sediment concentrations

### Dogger Bank cSAC

4.6.64 During the construction phase, there would be disturbance to seabed sediments from a variety of activities, as described in paragraph 2.6.1 and **Table 2.2**, which would result in the re-suspension of sediments and a subsequent increase in suspended sediment concentrations. The suspended sediment concentrations arising would be dependent on a range of physical factors and temporally varied. With respect to benthic and epibenthic communities, it is near-bed (within 5cm of seabed) suspended sediment concentration values that are of particular relevance, as this is the area in which benthic and epibenthic (sandbank) communities exist. Paragraphs 4.6.28 to 4.6.32 present and describe the predicted increases in suspended sediment concentrations determined through modelling of the worst case scenario, with the predicted maximum and average suspended sediment concentrations shown on **Figure 4.11** and **Figure 4.13**, and duration of concentrations above background shown on **Figure 4.15**.

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

4.6.66 The MarLIN factor relevant to this impact is “increased suspended sediment concentrations” (see paragraph 4.5.65) for the communities (see **Table 4.11** and **Table 4.12**) identified within the sandbank communities of the Dogger Bank cSAC. VER A communities comprise biotopes that have no (ecological) sensitivity to increased suspended sediment concentrations (see paragraph 4.5.65), based on the FfabMag community. VER B communities comprise biotopes that have a very low (ecological) sensitivity to increased suspended sediment concentrations (see paragraph 4.5.65), based on the MoeVen and MedLumVen communities. VER C communities comprise biotopes that have a very low (ecological) sensitivity to increased suspended sediment concentrations (see paragraph 4.5.65).

4.6.67 Based on the sandbank benthic communities’ (see paragraph 4.6.66 above) very low sensitivity to (or no sensitivity for VER A communities) and the short-term and for some areas temporary nature of elevated suspended sediment concentrations (described in paragraph 4.6.33 and presented on **Figure 4.15**), the predicted increase would not be expected to result in any significant change to the abundance and / or species composition of the observed infaunal and epifaunal communities. The activities and subsequent elevated levels of suspended sediment concentrations would occur intermittently, for the duration

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of construction (ranging up to 11.5 years), and the spatial extent and concentrations of the suspended sediments would change throughout this period. Whilst it is anticipated that up to 25% of these communities distributed across the Dogger Bank cSAC (see **Figure 4.13**) would experience elevated levels of suspended sediment concentrations at any one time, exposure to these increased concentrations would be, intermittent temporary and short-term over the construction phase.

**Teesmouth and Cleveland Coast SPA and Ramsar site (supporting habitat features)**

4.6.68 A short-term and temporary increase in suspended sediment concentrations (see paragraph 4.6.39) may occur within the area of supporting habitats for the Teesmouth and Cleveland Coast SPA and Ramsar site and its features. However, given that they would be within existing background concentrations (which vary widely over short and long durations as noted in paragraph 4.5.31), they are not expected to result in any change to the communities within the supporting habitats (see paragraph 4.2.19) and prey species for the features of the Teesmouth and Cleveland Coast SPA and Ramsar site.

**Northumbria Coast SPA and Ramsar site (supporting habitat features)**

4.6.69 No increase in suspended sediment concentrations would occur within the supporting habitats directly within the Northumbria Coast SPA and Ramsar site (see paragraphs 4.6.41). Furthermore, in areas of supporting habitat (inshore shallow waters) within the foraging range of little terns suspended sediment concentrations arising during the construction phase are low and temporary (as noted in relation to the shallow inshore waters described in paragraph 4.6.68 above). Consequently, there would be no predicted change in the supporting habitat and therefore only a temporary and spatially intermittent change in prey species due to the temporary nature and negligible levels of suspended sediments predicted, which rapidly reduce back to background concentrations. Such short-term and spatially variable alterations in prey would not be noticeably different to existing variability of prey.

**Doggerbank SCI (Germany)**

4.6.70 Given that no increase in the suspended sediment concentrations would occur (see paragraph 4.6.43) within the Doggerbank SCI, there would be no impact source with respect to the sandbank habitat and communities as a result of the construction of Dogger Bank Teesside A & B.

**Doggersbank SCI (Netherlands)**

4.6.71 Based on the worst-case scenario (see **Table 2.2**) and taking the modelling results (see paragraph 4.6.45 and shown on **Figure 4.11** and **Figure 4.13**) and applying them to the eastern edge of Dogger Bank Teeside A, this indicates that a short-term and temporary increase in suspended sediment concentrations (see paragraph 4.6.39) may occur within the Doggersbank SCI. Where works would take place further than 20km away, suspended sediment concentrations are unlikely to change. For works within 20km of the site, the communities affected are similar in composition and sensitivity to those described for Dogger Bank cSAC (see Section 4.5 and paragraph 4.5.65). As the overall habitat type within the Doggersbank SCI is the same as within the Dogger Bank cSAC (i.e.

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1110 - sandbanks which are slightly covered by seawater at all times – see Jak *et al*. (2009)) the same sensitivity ratings used for assessing potential impacts on the sandbank communities present within the Dogger Bank cSAC can be utilised. In this respect, given the low sensitivity of the sandbank communities to changes in suspended sediment concentrations and the short-term, temporary and intermittent nature of the increase levels of suspended sediment concentrations predicted, no change to the abundance and / or species composition of the infaunal and epifaunal communities within the Doggersbank SCI would be expected.

## Physical damage (smothering) to habitat feature communities through deposition of sediment

### Dogger Bank cSAC

4.6.72 Paragraphs 4.6.33 and 4.6.34 present and describe the predicted sediment deposition associated with the construction phase within the Dogger Bank cSAC determined through modelling the worst case scenario, with results presented in **Figure 4.17** and **Figure 4.19**. The persistence of deposited sediment is described in paragraphs 4.6.36 and 4.6.37 and **Table 4.13**. The predicted deposited sediment thickness at the end of the 30-day simulation was equal to or less than 0.1mm across the whole of the modelled area. This indicates the lack of potential for any "additive" effect of sediment deposition and, therefore, the maximum depths outlined in the paragraphs above represent the actual maximum values predicted to arise on any given community within the Dogger Bank cSAC at any time throughout the duration of the construction phase.

4.6.73 The MarLIN factor relevant to this impact is "smothering" (see paragraph 4.5.63) for the communities (see **Table 4.11** and **Table 4.12**) identified within the sandbank communities of the Dogger Bank cSAC. Both VER A and VER B communities comprise biotopes that have a very low (ecological) sensitivity to smothering (see paragraph 4.5.63), due to the low intolerance and high recoverability of the biotopes within these VERs to smothering. VER C communities display no sensitivity to smothering (see paragraph 4.5.63). Sediment deposition within Dogger Bank occurs naturally during winter storm events and, as such, the communities present are adapted to fluctuations in suspended sediment and periodic sediment deposition.

4.6.74 Based on the very low ecological sensitivity (i.e. high tolerance) to short-term and limited smothering (see paragraph 4.5.63) of VER A and VER B, and no sensitivity of VER C, and the low magnitudes of deposition and the temporary nature of any deposition predicted, it is not envisaged that any significant change in the abundance and / or species composition of the sandbank communities of the Dogger Bank cSAC would occur as a result of short-term and temporary sediment deposition during the construction phase.

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**Teesmouth and Cleveland Coast SPA and Ramsar site (supporting habitat features)**

4.6.75 Sediment disturbed during the construction of the export cable, including the landfall, would be re-suspended and deposited in areas of supporting habitat within and outside (i.e. the shallow coastal waters used by foraging little terns) the Teesmouth and Cleveland Coast SPA and Ramsar site but, as described in paragraph 4.6.40 and shown on **Figure 4.20**, the depth of sediment deposition is predicted to be small and temporary (i.e. would be present for two hours or less as shown on **Table 4.13**). Consequently, the intermittent and temporary deposition of sediment would be highly unlikely to result in a measurable change (in distribution, density or composition) of the communities within the supporting habitats (see paragraph 4.2.19) and prey species (see paragraph 4.6.70) for the features of the Teesmouth and Cleveland Coast SPA and Ramsar site.

**Northumbria Coast SPA and Ramsar site (supporting habitat features)**

4.6.76 No sediment would be deposited within the supporting habitats of the Northumbria Coast SPA and Ramsar site (see paragraphs 4.6.42). Outside the site, sediment deposition is unlikely to occur in subtidal areas within the foraging range of little terns. The depth of sediment deposition within the Tees Bay area is predicted to be very small (see **Figure 4.20**) and temporary (i.e. would be present for less than two hours as indicated on **Table 4.13** for areas where deposition could arise). Consequently, the intermittent and temporary deposition of sediment would not result in a measurable change to the communities within the shallow inshore waters and, subsequently, no alteration (in distribution, density, or composition) to the prey (fish) species for little tern would be expected.

**Doggerbank SCI (Germany)**

4.6.77 Given that no sediment deposition would occur (see paragraph 4.6.44) within the Doggerbank SCI, there would be no impact source for the sandbank habitat and communities as a result of the construction of Dogger Bank Teesside A & B.

**Doggersbank SCI (Netherlands)**

4.6.78 Based on the worst-case scenario (see **Table 2.2**) and taking the modelling results (see paragraph 4.6.46 and shown on **Figure 4.17** and **Figure 4.19**) and applying them to the eastern edge of Dogger Bank Teeside A, indicates that short-term and temporary deposition of sediment (see paragraph 4.6.46) may occur within the Doggersbank SCI. Where works would take place further than 20km away from the Doggersbank SCI boundary, no sediment deposition would occur within the site. Furthermore, no sediment deposition would occur greater than 20km into the Doggersbank SCI during the construction phase. In respect of works within 20km of the site, the communities present (as forming part of the Annex I, sandbanks slightly covered by seawater at all times, habitat type) are similar in composition and sensitivity to those described for Dogger Bank cSAC (see Section 4.5 and paragraph 4.5.63). Hence, given the very low sensitivity of the sandbanks communities to changes in sediment deposition ('smothering') and the short-term, temporary and intermittent nature of the deposited sediment, no change to the abundance and / or species composition of the infaunal and epifaunal communities would be expected within the Doggersbank SCI.

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## Physical damage (contamination) to habitat feature communities through re-suspension and deposition of contaminated sediment

### Dogger Bank cSAC

4.6.79 The mobilisation of sediments via the same processes outlined in the preceding impact assessments, i.e. cable installation, seabed preparation and foundation installation, could lead to the release of any contaminants that may be present within the sediments. Data on contaminant levels is presented in paragraphs 4.5.32 and 4.5.33 and **Table 4.6** and **Table 4.7**, which indicates that contaminant levels in the sediments that would be disturbed are very low, as over 93% of the sampled locations were below the Action Level 1 and PEL.

4.6.80 VER A, VER B and VER C comprise biotopes that have a low to moderate sensitivity to contamination via heavy metals, hydrocarbons and synthetic compounds. Consequently, given the very low concentrations and the short-term duration of contaminants predicted to be present within the sediment that would be re-suspended and deposited (based on the low levels sampled, see above) and the communities' low to moderate sensitivity (and moderate recoverability), no change to the abundance and / or species composition of the infaunal and epifaunal communities is predicted to occur within the Dogger Bank cSAC.

### Teesmouth and Cleveland Coast SPA and Ramsar site (supporting habitat features)

4.6.81 The short-term and temporary increase in suspended sediment concentrations (see paragraph 4.6.39) that may occur within the area of supporting habitats for the Teesmouth and Cleveland Coast SPA and Ramsar site could contain levels of contaminants (see paragraph 4.5.34 to 4.5.37 and **Table 4.8** and **Table 4.9**). However, given the existing background levels, rapid mixing and the dispersive environment (see paragraphs 4.5.34 to 4.5.37 and paragraph 4.6.48), any contaminants present would not be significantly above background concentrations and their presence would be short-term in duration (hours) and temporary (unlikely to occur following the nearshore cable route construction). Consequently, no measurable change to the abundance and / or species composition of the infaunal and epifaunal communities within the supporting habitats of the Teesmouth and Cleveland Coast SPA and Ramsar site is expected.

### Northumbria Coast SPA and Ramsar site (supporting habitat features)

4.6.82 No increase in the suspended sediment concentrations or sediment deposition is predicted directly within the supporting habitats (shallow inshore waters) of the Northumbria Coast SPA and Ramsar site (see paragraphs 4.6.41 and 4.6.42). Furthermore, in areas of supporting habitat (inshore shallow waters) within the foraging range of little terns (albeit outside this site), predicted suspended sediment concentrations and sediment deposition arising during the construction phase are low and temporary (see paragraph 4.6.39 in relation to the area around Teesmouth and Cleveland Coast SPA and Ramsar site), which could result in the presence of contaminants (as noted in paragraph 4.6.80 above). However, given the existing background levels, rapid mixing and the dispersive environment (see paragraphs 4.5.34 to 4.5.37 and paragraph 4.6.48), any

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contaminants present would not be significantly above background concentrations and their presence would be short-term in duration (hours) and temporary (unlikely to occur following the nearshore cable route construction). Consequently, no measurable change to the abundance and / or species composition of the infaunal and epifaunal communities within the shallow inshore waters supporting habitat of the Northumbria Coast SPA and Ramsar site is expected.

**Doggerbank SCI (Germany)**

4.6.83 Given that plumes of suspended sediment concentrations would not extend into the Doggerbank SCI (see paragraph 4.6.43), and that no sediment deposition is predicted within this site (see paragraph 4.6.44), no source of potential contaminant impact is predicted within the Doggerbank SCI.

**Doggersbank SCI (Netherlands)**

4.6.84 The description of suspended sediment concentrations and sediment deposition (see paragraphs 4.6.45 and 4.6.46) indicates that contaminants potentially could be present within the suspended and re-deposited sediments (albeit at low levels as noted in paragraph 4.6.79) in the Doggersbank SCI, as a result of the construction of Dogger Bank Teesside A. However, given the low concentrations and the short-term duration of contaminants that may be present within the suspended sediment plume predicted to be present within the re-suspended and deposited sediments (based on the low levels present) and the communities' low to moderate sensitivity (and moderate recoverability), as they are considered to be similar to those of the Dogger Bank cSAC (see paragraph 4.6.80), no change to the abundance and / or species composition of the infaunal and epifaunal communities would occur within the Doggersbank SCI.

## 4.7 Assessment of impacts during the operation phase

### Introduction

4.7.1 This section identifies and assesses the impacts that are predicted to occur during the operation phase for Dogger Bank Teesside A & B and Dogger Bank Teesside A & B Export Cable Corridor in relation to the subtidal sandbanks feature of the Dogger Bank cSAC, Doggersbank SCI (Netherlands) and Doggerbank SCI (Germany), as identified in Section 3.5. The activities have been aggregated into the following impact headings:

- Interruption to sediment transport pathways;
- Alteration to the hydrodynamic regime;
- Physical disturbance to the morphology and physical damage to the structural integrity of habitat features;
- Alteration to the extent, composition and distribution of habitat features;
- Changes to suspended sediment levels;
- Changes to the levels of nutrients and contaminants;
- Direct physical damage to habitat feature communities resulting from the footprint of the offshore wind farm structures;

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- Indirect physical damage to habitat feature communities as a result of alteration in hydrodynamic processes due to the presence of offshore wind farm structures;
- Physical damage to habitat feature communities from an increase in suspended sediment concentration associated with scouring around structures on the seabed;
- Physical damage (smothering) to habitat feature communities through deposition of suspended sediment from the water column; and
- Physical damage to habitat feature communities from release of sediment contaminants.

4.7.2 This section also considers the above potential impacts with respect to the supporting habitat features of the Teesmouth and Cleveland Coast SPA and Ramsar site and Northumbria Coast SPA and Ramsar site.

## Alteration to bathymetry

### Dogger Bank cSAC

4.7.3 The long-term presence of structures such as wind turbines, met masts, collector stations, converter stations, accommodation blocks, as well as vessel moorings, and inter-array, inter-platform and export cable protection and crossings would result in the alteration of seabed bathymetry. Cable crossing and protection and moorings would cause extremely localised and small changes in bathymetry. However, the gravity bases for the structures would represent a larger change in bathymetry that would exceed several metres in height. Furthermore, the structures themselves would alter the bathymetry as they extend throughout the entire water column. The extent of the predicted alteration to bathymetry as a result of the presence of GBS is 9.40km$^2$ for Dogger Bank Teesside A & B at the seabed. The area that extends throughout the water column and hence falls outside the existing bathymetry range would be the structures that extend to and above the surface. The worst case extent for structures reaching the surface would be a 12m diameter foundation structure for all 212 structures (for each project), which equates to a total area of less than 0.05km$^2$ where the bathymetry would extend above the existing range within the Dogger Bank cSAC as a result of Dogger Bank Teesside A & B (both projects combined, or half that for each project). This would leave in excess of 99.9995% of the bathymetry within Dogger Bank cSAC within the existing range as a result of Dogger Bank Teesside A & B and the remaining 9.35km$^2$ covered by structures (that remain close to the seabed) would fall within the existing bathymetric ranges within the Dogger Bank cSAC. Overall, this is considered to represent an insignificant alteration to the physical nature of the Dogger Bank cSAC.

4.7.4 Coarser sediment (i.e. not suspended or quickly entrained in transport) side-cast from foundation locations as part of seabed preparation is, at each turbine location, predicted to result in a circular mound with a footprint of 750m$^2$ per foundation piled up to form a flat top cone with a maximum height of 9m and a diameter of approximately 31m in its undisturbed state. Re-working by tidal currents would spread these mounds out to form sand waves or similar

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bedforms within the range of existing bathymetry across the site. Given the occurrence of existing bedforms of this nature, this change would also fall within the existing bathymetric conditions of the Dogger Bank cSAC.

**Teesmouth and Cleveland Coast SPA and Ramsar site (supporting habitat features)**

4.7.5 No seabed disturbance works or structures would extend into the Teesmouth and Cleveland Coast SPA and Ramsar site during the operation phase, therefore no direct alteration to bathymetry would occur with respect to the supporting habitat features within the site. No long-term changes to bathymetry within the site are predicted as a result of sediment deposition (see paragraph 4.7.46 which describes the quantitative sediment deposition model results). These negligible if any changes in bathymetry are discussed below with respect to the morphology of supporting habitats and the influence on the supporting habitat communities and relevant prey resource of the Teesmouth and Cleveland Coast SPA and Ramsar site bird features.

**Northumbria Coast SPA and Ramsar site (supporting habitat features)**

4.7.6 No seabed disturbance works or structures would extend into the Northumbria Coast SPA and Ramsar site during the operation phase; therefore, no direct alteration to bathymetry would occur with respect to the supporting habitat features within the site. No long-term changes to bathymetry within the site are predicted as a result of sediment deposition (see paragraph 4.7.48 which describes the quantitative sediment deposition model results). These negligible if any changes in bathymetry are discussed below with respect to the morphology of supporting habitats and the influence on the supporting habitat communities and relevant prey resource of the Northumbria Coast SPA and Ramsar site bird features.

**Doggerbank SCI (Germany)**

4.7.7 No seabed disturbance works or structures would extend into the Doggerbank SCI during the operation phase therefore no direct alteration to bathymetry would occur with respect to the sandbank habitat. In addition, no long-term changes to bathymetry within the site are predicted as a result of sediment deposition as no sediment is predicted to be deposited within the site (described in paragraph 4.7.50). Therefore, no change to the bathymetry of the Doggerbank SCI would occur.

**Doggersbank SCI (Netherlands)**

4.7.8 No seabed disturbance works or structures would extend into the Doggersbank SCI during the operation phase, therefore no direct alteration to bathymetry would occur with respect to the supporting habitat features within the site. In addition, no long-term changes to bathymetry within the SCI are predicted as a result of sediment deposition (see paragraph 4.7.52 which describes the quantitative sediment deposition model results). These negligible if any changes in bathymetry are discussed below with respect to the morphology of the sandbank habitat and communities of the Doggersbank SCI.

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## Interruption to sediment transport pathways

### Dogger Bank cSAC

4.7.9 The presence of an array of structures on the seabed has the potential to interrupt sediment transport pathways. However, the gravity base structures are, in comparison to the scale of Dogger Bank, isolated points which would not obstruct or interrupt the process of sediment transport on a macro scale. Potentially, the inter-array, inter-platform and export cables could result in interruption to sediment transport. However, a significant majority of the length of the cables would be buried and only relatively shallow protection or crossings would be used. These cable protection 'structures' would only extend for lengths of up to several tens of metres and would only stand a maximum 1.5m above the seabed. These heights are commensurate with or lower than the megaripples present within Dogger Bank Teesside A & B and the Dogger Bank cSAC (see paragraphs 4.5.18 and 4.5.19). Consequently, only localised and temporary interruptions to the existing sediment transport are predicted, which would not measurably change the sediment transport across the Dogger Bank cSAC (see paragraphs 4.5.21).

### Teesmouth and Cleveland Coast SPA and Ramsar site (supporting habitat features)

4.7.10 No seabed structures, or seabed disturbance works, would be placed or occur within the Teesmouth and Cleveland Coast SPA and Ramsar site during the operation phase for Dogger Bank Teesside A & B. However, in the subtidal zone, there is a possibility that the cables would be on the surface and protected by rock armour (or some other form of protection), which could potentially create a partial barrier to sediment transport, which could influence sediment movement into the supporting habitats within and outside the Teesmouth and Cleveland Coast SPA and Ramsar site. Rock armour protection is anticipated to be up to approximately 15m wide and stand up to approximately 1.5m above the surrounding seabed, therefore this has been considered. The presence of this structure on the seabed would provide a physical barrier to water flow and sand transport on, and close to, the seabed as described in paragraphs 3.2.14 to 3.2.16. However, the flood current along the Redcar and Cleveland coastline generally is to the south, flowing parallel to the coast, and as the flood tide has slightly stronger currents than the ebb tide, the residual current generally is to the south east away from the Teesmouth and Cleveland Coast SPA and Ramsar site. In addition, whilst some sediment would infill the interstices between adjoining rocks within the structure and some would remain on the up-flow side of the armour that would otherwise have been transported beyond this position on the seabed, the relatively shallow side-slopes of the armour (1 in 4 or 14º) is shallower than the critical angle of repose of wet sand (45º), the 'blocking' effect would be small (compared with, for example, the entrapment against a vertical side slope of a protection structure). Furthermore, the residual current is small and the secondary scour hole created in the down-flow direction on one side of the cable protection would be partially infilled by deposition into the scour on the reverse tide. Overall, given the limited scale of reduction in transport and volume, as noted in paragraph 3.2.16 and described in detail in Section 7.5 in **Chapter 9** of the Dogger Bank Teesside A & B ES, no measurable impact would

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be expected to occur on sediment transport into the areas of supporting habitat of the Teesmouth and Cleveland Coast SPA and Ramsar site. Overall, only localised effects would occur and no interruption to sediment transport would occur.

**Northumbria Coast SPA and Ramsar site (supporting habitat features)**

4.7.11 As described in paragraph 4.7.11 above, only localised and temporary interruption to sediment transport would be expected in the nearshore zone. Given that the Northumbria Coast SPA and Ramsar site is at least 20km away from the export cable, no impact would be expected within the areas of supporting habitat of the Northumbria Coast SPA and Ramsar site bird features.

**Doggerbank SCI (Germany)**

4.7.12 As described in paragraph 4.7.10 above, only localised and temporary interruption to sediment transport would be expected within the Dogger Bank cSAC. Given that the Doggerbank SCI is at least 43km away from the offshore wind farm and structures, no impact would be expected within the areas of sandbank habitat of the Doggerbank SCI.

**Doggersbank SCI (Netherlands)**

4.7.13 As described in paragraph 4.7.10 above, only localised and temporary interruption to sediment transport would be expected within the Dogger Bank cSAC. Whilst the Doggersbank SCI is adjacent to the offshore wind farm and structures, given the localised and temporary nature of the sediment transport interruptions predicted (adjacent to any structures (i.e. wind turbines) only), no impact would be expected within the areas of sandbank habitat of the Doggersbank SCI.

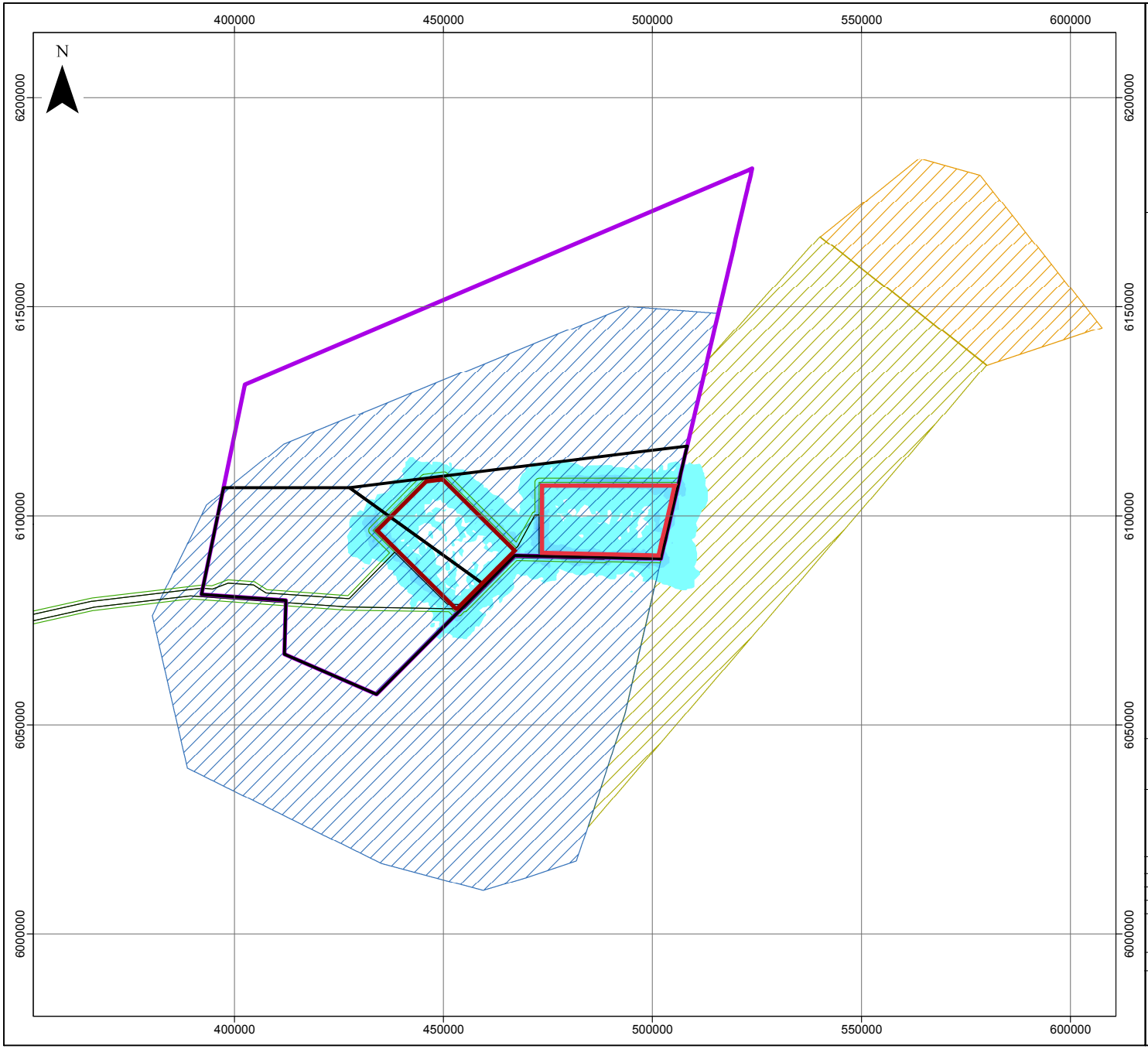
## Alteration to the hydrodynamic regime

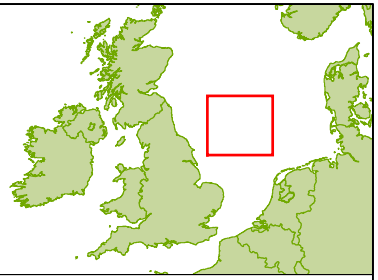
**Dogger Bank cSAC**

4.7.14 The worst-case foundation scenario for potential effects on tidal currents used to model changes in tidal currents at the regional scale is the use of 400 6MW conical gravity base foundations at 750m apart around the perimeter of Dogger Bank Teesside A & B. The regional effects of the foundations on tidal currents have been predicted as changes to current velocity relative to the baseline. The changes were modelled at 30-minute intervals over the 30-day simulation period. The maximum change in current velocity is approximately 0.008m/s (as shown on **Figure 4.22**) along the boundaries, reducing to less than 0.002m/s up to 8km away. This represents a maximum change in current velocity of less than 2% above background within a small area (see **Figure 4.23**).

4.7.15 The strongest effects on tidal currents occur within the developable area and, in particular, close to the northern, southern and western perimeter of Dogger Bank Teesside A. Changes in velocity reduce to background velocities within less than 10km outside the developable area (location of structures). Overall, these negligible changes are within the existing ranges of tidal current velocities across Dogger Bank and surrounding sea areas, and within the Dogger Bank cSAC.

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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
- Dogger Bank Special Area of Conservation (cSAC)
- Doggerbank Site of Community Importance (SCI)
- Doggersbank Site of Community Importance (SCI)

Change in velocity (m/s)

- Above 0.020
- 0.018 - 0.020
- 0.016 - 0.018
- 0.014 - 0.016
- 0.012 - 0.014
- 0.010 - 0.012
- 0.008 - 0.010
- 0.006 - 0.008
- 0.004 - 0.006
- 0.002 - 0.004
- Below 0.002

0 10 20
Kilometres

Data Source:
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Modelling © Danish Hydraulic Institute, 2013
Round 3 offshore wind farm boundary © Crown Copyright, 2014

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**Figure 4.22 Maximum predicted absolute change in depth averaged current velocity during the operation phase**

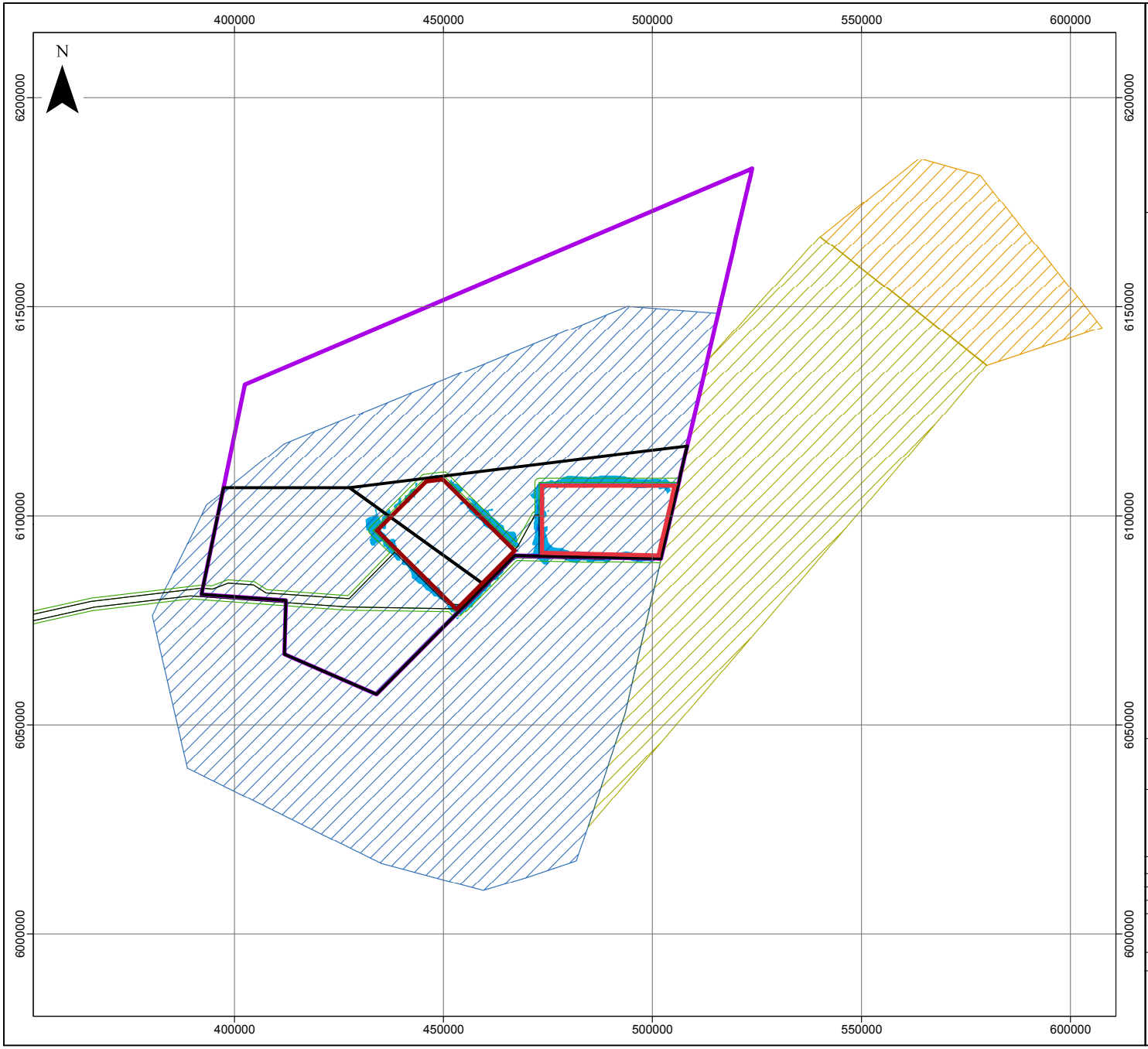
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|---|---|---|---|---|
| 1 | 07/10/2013 | PEI3 | GC | DB |
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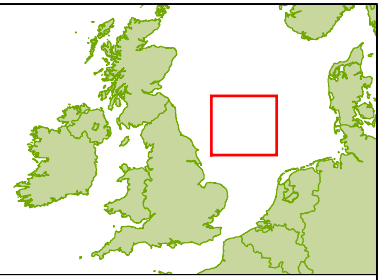
DRAWING NUMBER: **9Y0986/TSABHRA/26/R2**

| SCALE | PLOT SIZE | DATUM | PROJECTION |
|---|---|---|---|
| 1:1,400,000 | A4 | WGS84 | 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
- Dogger Bank Special Area of Conservation (cSAC)
- Doggerbank Site of Community Importance (SCI)
- Doggersbank Site of Community Importance (SCI)

Change in velocity (%)

- Above 5
- 4 - 5
- 3 - 4
- 2 - 3
- 1 - 2
- Below 1

0 10 20
Kilometres

Data Source:
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Modelling © Danish Hydraulic Institute, 2013
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**Figure 4.23 Maximum percentage change in depth averaged current velocity during the operation phase**

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|---|---|---|---|---|
| 1 | 07/10/2013 | PEI3 | GC | DB |
| 2 | 18/03/2014 | DCO Submission | GC | DB |
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DRAWING NUMBER: **9Y0986/TSABHRA/27/R2**

| SCALE | PLOT SIZE | DATUM | PROJECTION |
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| 1:1,400,000 | A4 | WGS84 | UTM31N |

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4.7.16 Based on a number of modelling scenarios (see **Table 2.2** for the worst case scenario), the modelled changes to waves and wave heights during a one year and 50 year storm event in the operation phase are shown on **Figure 4.24** and **Figure 4.25**. The differences in wave height under the 50-year return period condition are less than for the one-year return period, therefore, the one year return period changes are discussed here. For details on why this difference occurs see **Appendix 9A** in the Dogger Bank Teesside A & B ES. The predicted changes are up to +/-0.04m at the southern / south-western and northern / northeastern boundaries of Dogger Bank Teesside A & B, reducing to less than +/-0.02m up to approximately 22km (waves from the north) and 17km (waves from the north-east) from the Dogger Bank Teesside A & B boundary. Significant wave height reduces to less than +/-0.01m up to 75km north of Dogger Bank Teesside A & B for waves from the north. The maximum relative change for the one-year return period waves are shown on **Figure 4.26**, which shows that changes in wave height during storm events are less than 1%, and would be similarly insignificant during 'normal' (no storm) conditions. These percentage changes are within the existing range of wave heights across Dogger Bank and the Dogger Bank cSAC.

**Teesmouth and Cleveland Coast SPA and Ramsar site (supporting habitat features)**

4.7.17 No change in tidal currents or significant wave heights is predicted to occur within the Teesmouth and Cleveland Coast SPA and Ramsar site, or in areas of supporting (shallow coastal water) habitat outside the site (see **Chapter 9** of the Dogger Bank Teesside A & B ES).

**Northumbria Coast SPA and Ramsar site (supporting habitat features)**

4.7.18 No change in in tidal currents or significant wave heights is predicted to occur within the Northumbria Coast SPA and Ramsar site, or in areas of supporting (shallow coastal water) habitat outside the site (see **Chapter 9** of the Dogger Bank Teesside A & B ES).

**Doggerbank SCI (Germany)**

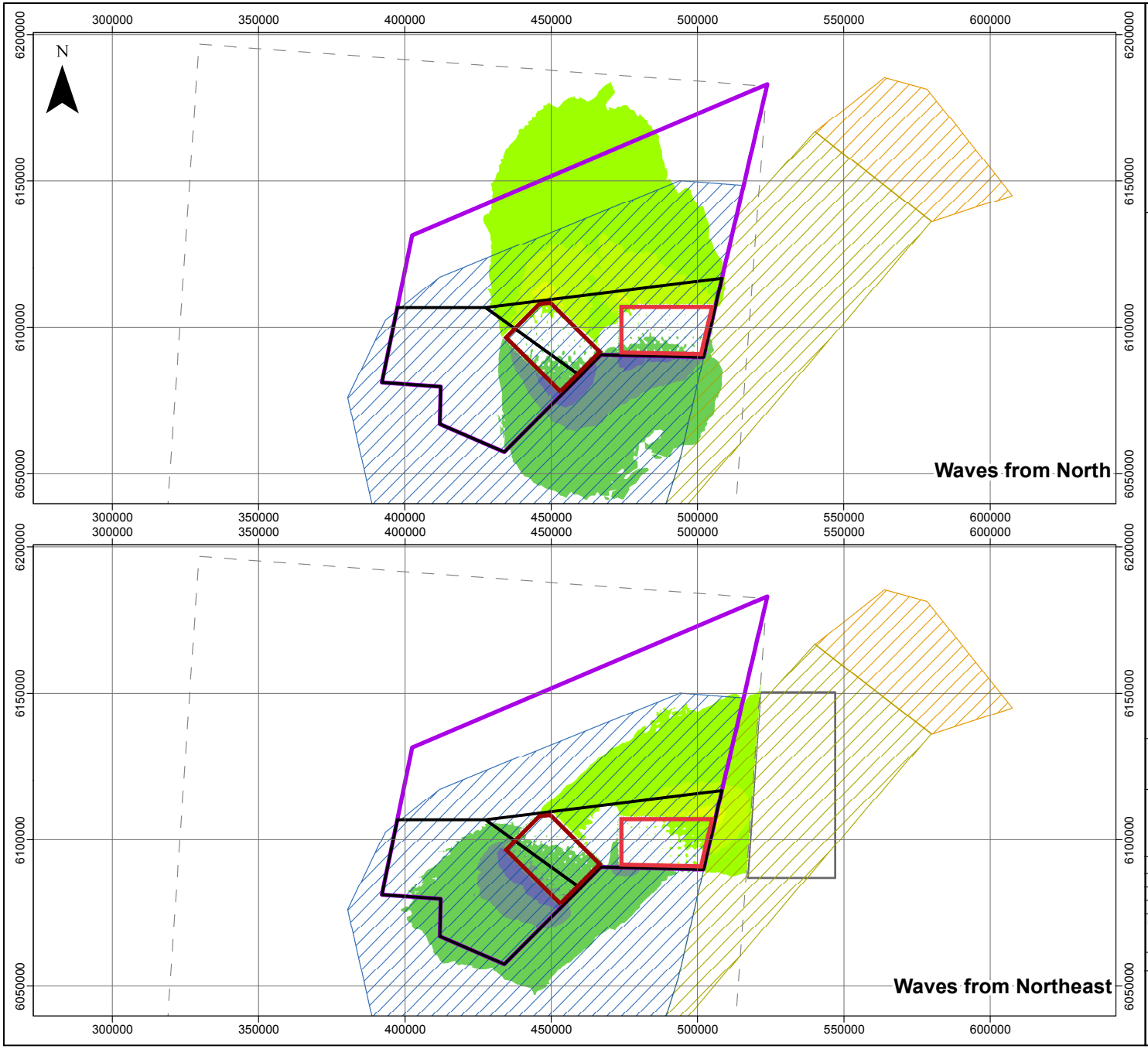
4.7.19 No change in tidal currents or significant wave heights is predicted to occur within the Doggerbank SCI, as shown on **Figure 4.23** and **Figure 4.26**. Given that current velocities would fall to background levels within the Doggerbank SCI, no hydrodynamic change is therefore expected at or within this site.

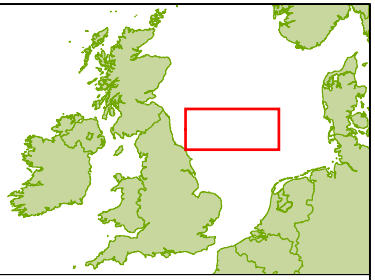
**Doggersbank SCI (Netherlands)**

4.7.20 The maximum predicted change in current velocity is less than 0.006m/s (see **Figure 4.22**) immediately inside the Doggersbank SCI, decreasing to less than 0.004m/s and no measurable change within 10km inside the SCI. This represents a maximum change of less than 1% (see **Figure 4.23**) up to 10km inside the site, and no change beyond this. Predicted changes in significant wave height are negligible (see **Figure 4.24**, **Figure 4.25** and **Figure 4.26**), with a maximum of less than 0.04m immediately within the SCI, reducing to background levels within less than 10km; a less than 1% change in the worst case. Given that such negligible changes would be insignificant compared to the background current velocities and significant wave heights at or within the Doggersbank SCI, no discernible hydrodynamic change would occur to this site.

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**LEGEND**

- Dogger Bank Zone
- Tranche boundary
- Dogger Bank Teesside A
- Dogger Bank Teesside B
- Dogger Bank Special Area of Conservation (cSAC)
- Doggerbank Site of Community Importance (SCI)
- Doggersbank Site of Community Importance (SCI)
- Model boundary
- Potential extent of wave effects into international waters

Change in significant wave height (m)

| | |
|---|---|
| Above 0.09 | -0.01 - 0.00 |
| 0.08 - 0.09 | -0.02 - -0.01 |
| 0.07 - 0.08 | -0.03 - -0.02 |
| 0.06 - 0.07 | -0.04 - -0.03 |
| 0.05 - 0.06 | -0.05 - -0.04 |
| 0.04 - 0.05 | -0.06 - -0.05 |
| 0.03 - 0.04 | -0.07 - -0.06 |
| 0.02 - 0.03 | -0.08 - -0.07 |
| 0.01 - 0.02 | -0.09 - -0.08 |
| 0.00 - 0.01 | Below -0.09 |

0 20 40
Kilometres

Data Source:
Wave height © Royal HaskoningDHV, 2013
Environmental Designations © JNCC, 2014 and European Environment Agency, 2014
Round 3 offshore wind farm boundary © Crown Copyright, 2014

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**Figure 4.24 Difference in significant wave height for one year waves during the operation phase**

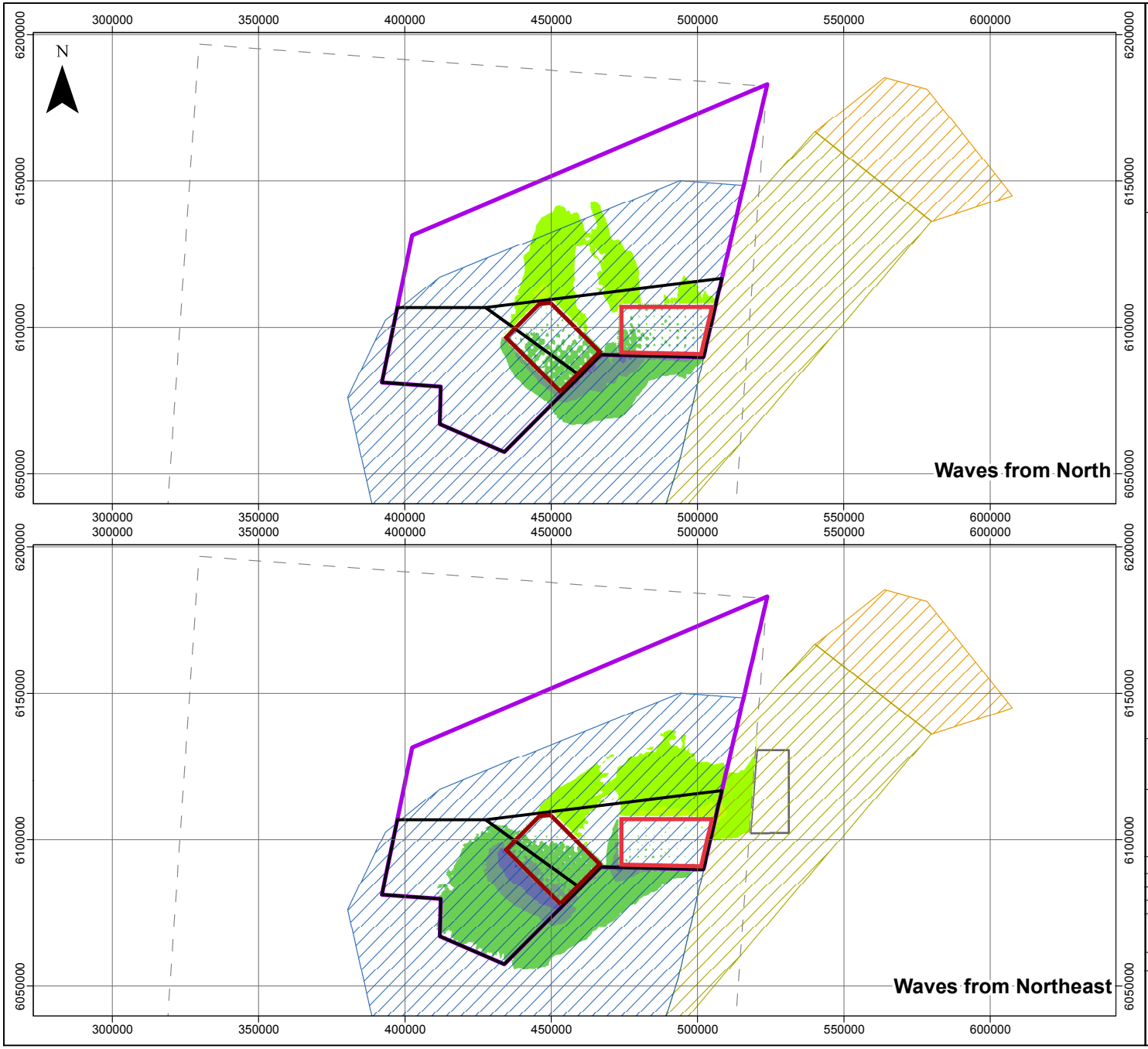
| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
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| 2 | 18/03/2014 | DCO Submission | GC | DB |
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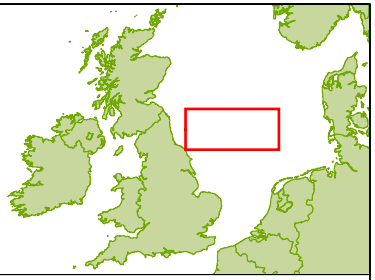
DRAWING NUMBER: **9Y0986/TSABHRA/28/R2**

| SCALE | PLOT SIZE | DATUM | PROJECTION |
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| 1:2,000,000 | A4 | WGS84 | UTM31N |

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**LEGEND**

- Dogger Bank Zone
- Tranche boundary
- Dogger Bank Teesside A
- Dogger Bank Teesside B
- Dogger Bank Special Area of Conservation (cSAC)
- Doggerbank Site of Community Importance (SCI)
- Doggersbank Site of Community Importance (SCI)
- Model boundary
- Potential extent of wave effects into international waters

Change in Significant Wave Height (m)

| | |
|---|---|
| Above 0.09 | -0.01 - 0.00 |
| 0.08 - 0.09 | -0.02 - -0.01 |
| 0.07 - 0.08 | -0.03 - -0.02 |
| 0.06 - 0.07 | -0.04 - -0.03 |
| 0.05 - 0.06 | -0.05 - -0.04 |
| 0.04 - 0.05 | -0.06 - -0.05 |
| 0.03 - 0.04 | -0.07 - -0.06 |
| 0.02 - 0.03 | -0.08 - -0.07 |
| 0.01 - 0.02 | -0.09 - -0.08 |
| 0.00 - 0.01 | Below -0.09 |

0 20 40
Kilometres

Data Source:
Wave height © Royal HaskoningDHV, 2013
Environmental Designations © JNCC, 2014 and European Environment Agency, 2014
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**Figure 4.25 Difference in significant wave height for 50- year waves during the operation phase**

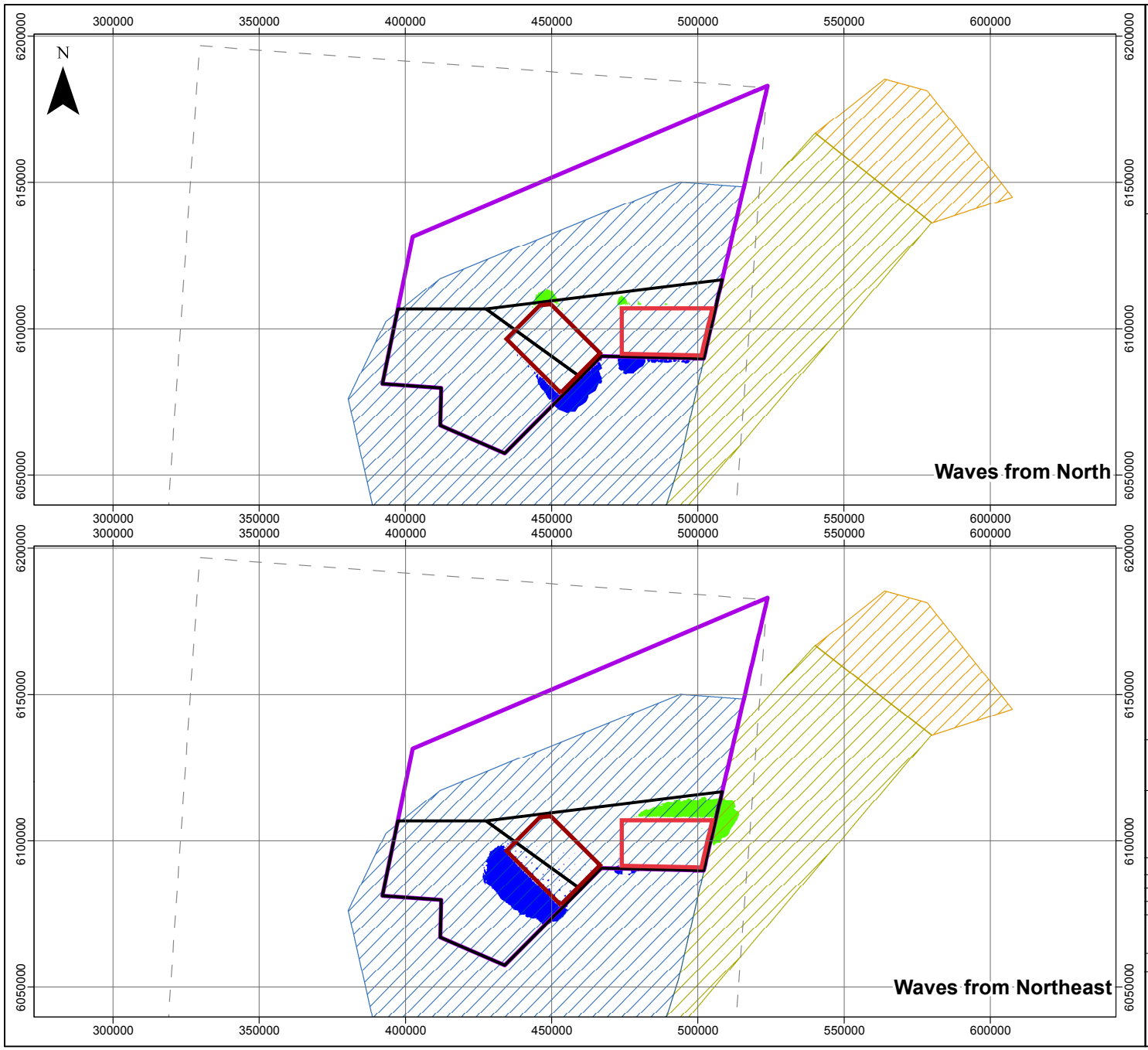
| VER | DATE | REMARKS | Drawn | Checked |
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| 1 | 10/10/2013 | PEI3 | GC | DB |
| 2 | 18/03/2014 | DCO Submission | GC | DB |
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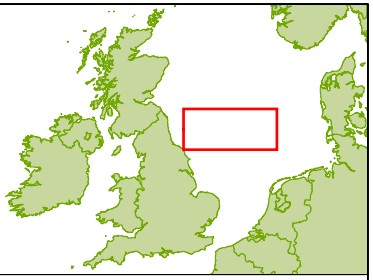
DRAWING NUMBER: **9Y0986/TSABHRA/29/R2**

| SCALE | 1:2,000,000 | PLOT SIZE | A4 | DATUM | WGS84 | PROJECTION | UTM31N |
|---|---|---|---|---|---|---|---|

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**LEGEND**

- Dogger Bank Zone
- Tranche boundary
- Dogger Bank Teesside A
- Dogger Bank Teesside B
- Dogger Bank Special Area of Conservation (cSAC)
- Doggerbank Site of Community Importance (SCI)
- Doggersbank Site of Community Importance (SCI)
- Model boundary

Wave height difference (%)

- 1.5 - 2
- 1 - 1.5
- 0.5 - 1
- 0 - 0.5
- -0.5 - 0
- -1.0 - -0.5
- -1.5 - -1.0
- Below - 1.5

0 20 40
Kilometres

Data Source:
Wave height © Royal HaskoningDHV, 2013
Environmental Designations © JNCC, 2014 and European Environment Agency, 2014
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**Figure 4.26 Percentage change in significant wave height for one year waves during the operation phase**

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|---|---|---|---|---|
| 1 | 12/10/2013 | PEI3 | GC | DB |
| 2 | 18/03/2014 | DCO Submission | GC | DB |
| | | | | |

DRAWING NUMBER: **9Y0986/TSABHRA/30/R2**

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## Physical disturbance to the morphology and structural integrity of habitat features

### Dogger Bank cSAC

4.7.21 The predicted changes in tidal currents (see paragraphs 4.7.14 and 4.7.15) are so small that they are unlikely to affect the bedforms and morphology of the sediments across the cSAC, given that they fall within the existing range of tidal currents across and within the Dogger Bank cSAC.

4.7.22 The predicted changes in wave heights for storm events (see paragraph 4.7.16) are within the existing range of wave heights across Dogger Bank and surrounding sea areas and are unlikely to affect the bedforms and morphology of the sediments within the Dogger Bank cSAC.

4.7.23 **Table 4.16** presents the likely extents of the existing seabed morphological elements (see **Table 4.5** for baseline extents) that could be affected by the presence of structures during the operation phase for Dogger Bank Teesside A & B. Whilst the extents of the bedforms presented in **Table 4.16** could be affected by the footprint of foundations in the worst case scenario, the availability of 'seabed' area around the foundations would enable the features to continue to develop as the various natural processes that have created these morphological features would continue (see paragraph 4.7.24 below).

Table 4.16 Potential alteration to existing bedforms within Dogger Bank cSAC

| Bedform and type | Extent of bedforms affected by presence of structures ($km^2$) in the worst case scenario | | | Extent and percentage of total potentially affected in the worst case scenario | |
|---|---|---|---|---|---|
| | Dogger Bank Teesside A | Dogger Bank Teesside B | Dogger Bank Teesside A & B | Percentage of surveyed area[1] | Percentage of Dogger Bank cSAC[2] |
| Megarippled gravel | 0.047 | 0.000 | 0.047 | 0.07 | 0.02 |
| Megarippled sand | 0.000 | 0.000 | 0.000 | 0.00 | 0.00 |
| Megarippled gravelly sand | 0.221 | 0.209 | 0.430 | 2.32 | 0.67 |
| Megarippled sand and sand waves | 0.000 | 0.000 | 0.000 | 0.00 | 0.00 |
| Sand waves | 0.334 | 0.000 | 0.334 | 0.69 | 0.20 |

[1] See **Table 4.5** for baseline extents which covered tranches A & B and the Dogger Bank Teesside A & B Export Cable Corridor within the Dogger Bank cSAC.
[2] Based on multiplying up the total surveyed area within Dogger Bank cSAC assuming the footprint would affect each bedform equally, based on the percentage present within the surveyed area (see **Table 4.5**).

4.7.24 The morphology of the sandbank habitat is determined by the bathymetry and sediment composition and the interactions of waves and tidal currents upon these structural elements. Only localised changes in these parameters in areas immediately adjacent to the seabed structures is predicted. Across the extent of the cSAC the predicted negligible changes to bathymetry (paragraph 4.7.4), sediment extent, composition and distribution (see paragraph 4.7.29), suspended sediment concentrations (see paragraphs 4.7.34 to 4.7.44), alteration to sediment transport (see paragraph 4.7.9), and hydrodynamic processes (see paragraphs 4.7.14 to 4.7.16), would not give rise to any macro-

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scale morphological change. Consequently, the structural integrity of the sandbanks would be retained for the duration of the operation phase and ongoing natural morphological changes would continue. In addition, material side-cast from seabed preparation works will be impacted regularly by waves and the sediment both transported along the bed and suspended into the water column through this process. The sediment raised into the water column by the wave would then be transported by both the wave itself and tidal currents. The wave provides the initial energy to get the sediment up off the seabed and then tidal currents transport it, albeit only a short distance because of its particle size. Over time the gradual erosion of the top of the cone through wave action and its transport would lower the cone height, and its shape would be adapted into some form of low mound. The shape of the mound would be difficult to determine precisely (and could not be modelled), but given the predominant north and south tidal current directions, and predominant waves to the north, it is assumed that most transport would be north and south forming an elongated north-south mound similar in shape to a sand wave (see Section 6.3 in **Chapter 9** of the Dogger Bank Teesside A & B ES). Whilst, it is not a sand wave in the true sense (i.e. a bedform created by bedload transport by tidal currents) it is 'sand-wave-like' and hence a bedform structure (see paragraph 4.7.4) typical of the Dogger Bank cSAC (see types presented in **Table 4.5** and **Table 4.16**).

**Teesmouth and Cleveland Coast SPA and Ramsar site (supporting habitat features)**

4.7.25 The morphology and structural integrity of the supporting habitats of the Teesmouth and Cleveland Coast SPA and Ramsar site is determined by the bathymetry and sediment composition and the interactions of waves and tidal currents upon these structural elements. Given that no direct and no measurable indirect changes to bathymetry (paragraph 4.7.5), sediments (paragraph 4.7.30), suspended sediments (paragraphs 4.7.45 and 4.7.46), sediment transport (paragraph 4.7.10), and hydrodynamic processes (paragraph 4.7.17) are expected, no likely change to the morphology of the supporting habitats of the Teesmouth and Cleveland Coast SPA and Ramsar site bird features would occur during the operation phase.

**Northumbria Coast SPA and Ramsar site (supporting habitat features)**

4.7.26 The morphology and structural integrity of the supporting habitats of the Northumbria Coast SPA and Ramsar site is determined by the bathymetry and sediment composition and the interactions of waves and tidal currents upon these structural elements. Given that no direct and no measurable indirect changes to bathymetry (paragraph 4.7.6), sediments (paragraph 4.7.31), suspended sediments (paragraphs 4.7.47 and 4.7.48), sediment transport (paragraph 4.7.11), and hydrodynamic processes (paragraph 4.7.18) are expected, no likely change to the morphology of the supporting habitats of the Northumbria Coast SPA and Ramsar site bird features would occur during the operation phase.

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### Doggerbank SCI (Germany)

4.7.27 The morphology and structural integrity of the sandbank habitat of the Doggerbank SCI is determined by the bathymetry and sediment composition and the interactions of waves and tidal currents upon these structural elements. Given that no direct and no measurable indirect changes to bathymetry (paragraph 4.7.7), sediments (paragraph 4.7.32), suspended sediments (paragraphs 4.7.49 and 4.7.50), sediment transport (paragraph 4.7.12), and hydrodynamic processes (paragraph 4.7.19) are expected, no likely change to the morphology of the sandbank habitat of the Doggerbank SCI would occur during the operation phase.

### Doggersbank SCI (Netherlands)

4.7.28 The morphology of the sandbank habitat is determined by the bathymetry and sediment composition and the interactions of waves and tidal currents upon these structural elements. Given that no change to bathymetry (paragraph 4.7.8), intermittent change to sediment extent, composition and distribution (see paragraph 4.7.33), intermittent changes to suspended sediments (see paragraphs 4.7.51 to 4.7.52), no predicted alteration to sediment transport (see paragraph 4.7.13), and intermittent changes to hydrodynamic processes (see paragraphs 4.7.19) are predicted, the morphology of the Doggersbank SCI would continue to be dominated by the natural processes and the naturally varying ranges of these processes. Consequently, no change to the morphology of the Doggersbank SCI would occur and the structural integrity of the sandbank habitat would not be affected during the operation of Dogger Bank Teesside A & B.

## Alteration to the extent, composition and distribution of habitat features

### Dogger Bank cSAC

4.7.29 **Table 4.17** presents the expected alteration to the extent and distribution of the sandbank habitat (see **Table 4.4** for baseline) as a result of the worst case footprint losses arising from the placement of structures for Dogger Bank Teesside A & B. The existing seabed would be replaced through the provision of hard substrate (representing 9.40km$^2$ (0.08%) of the total area of the Dogger Bank cSAC) for the 50 year duration of the operation phase. However, given that set locations for structures are not determined at this stage, the different sediment types are assumed to be affected based on the percentage currently present within Dogger Bank Teesside A & B. Given the negligible extents of the areas affected compared to the size of the overall sandbank, and the dispersed spatial locations of the changes, overall, the development is not considered to result in a significant alteration to the sandbank habitat extent, composition or distribution of the Dogger Bank cSAC. These footprint changes in extent, composition and distribution are not predicted to change further as a result of changes to hydrodynamic processes, sediment transport, or sediment desposition patterns. Changes to hydrodynamic processes (described in paragraphs 4.7.14 to 4.7.16) are within the natural variation of tidal current velocity across Dogger Bank and surrounding areas and is so small that it is unlikely to affect the form of recent sediments over and above the natural tidal processes. Interruptions to sediment transport are limited in scale and

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magnitude but given that only localised interruptions would occur (see paragraph 4.7.9)), and the nature of the sediments in the area, no change to composition is expected as sediment movement will continue. Finally, sediment deposition as a result of scour is (as identified in paragraph 4.7.44) not likely to change noticeably or measurably beyond that existing, and subsequently, no significant change in sediment extent, composition and distribution is predicted.

Table 4.17 Alteration to seabed sediment types within Dogger Bank cSAC in the operation phase

| Bedform and type | Footprint extent (km$^2$) | | | Extent and percentage of total potentially affected by Dogger Bank Teesside A & B | |
|---|---|---|---|---|---|
| | Dogger Bank Teesside A | Dogger Bank Teesside B | Dogger Bank Teesside A & B | Percentage of surveyed area[1] | Percentage of Dogger Bank cSAC[2] |
| Unit 'c' outcrop | 0.008 | 0.067 | 0.079 | 0.08 | 0.02 |
| Gravel | 0.238 | 0.014 | 0.238 | 0.13 | 0.04 |
| Sand | 4.634 | 4.439 | 9.083 | 0.29 | 0.08 |
| Mixed sediment | 0.000 | 0.000 | 0.000 | 0.00 | 0.00 |
| Till | 0.000 | 0.000 | 0.000 | 0.00 | 0.00 |
| Hard substrate | 4.880 | 4.52 | 9.400 | n/a | n/a |

[1] See **Table 4.3** for baseline extents which covered tranches A & B and the Dogger Bank Teesside A & B Export Cable Corridor within the Dogger Bank cSAC.
[2] Based on multiplying up the total surveyed area within Dogger Bank cSAC assuming the footprint would affect each sediment type equally, based on the percentage present within the surveyed area (see **Table 4.3**).

### Teesmouth and Cleveland Coast SPA and Ramsar site (supporting habitat features)

4.7.30 No seabed disturbance works or structures would extend into or be placed within the Teesmouth and Cleveland Coast SPA and Ramsar site, therefore, no direct alteration to the extent, composition and distribution of the supporting habitats within the Teesmouth and Cleveland Coast SPA and Ramsar site would occur. Changes to sediment transport (see paragraph 4.7.10) and sediment deposition (see paragraph 4.7.46) indicate that no change would occur within the site boundary. Small, localised and intermittent changes to seabed habitat could occur within the shallow coastal waters outside the site as a result of localised scour and deposition as described in paragraphs 4.7.45 and 4.7.46. However, these changes would not be measurable compared to the scour and sediment deposition and distribution currently experienced in the shallow inshore water supporting habitat. Therefore, no likely effects would be expected in relation to prey (fish) species that are targeted by foraging breeding little tern.

### Northumbria Coast SPA and Ramsar site (supporting habitat features)

4.7.31 No seabed disturbance works or structures would extend into or be placed within the Northumbria Coast SPA and Ramsar site, therefore, no direct alteration to the extent, composition and distribution of the supporting habitats within the Northumbria Coast SPA and Ramsar site would occur. Changes to sediment transport (see paragraph 4.7.11) and sediment deposition (see paragraph 4.7.48) indicate that no change would occur within the site boundary.

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Small, localised and intermittent changes to seabed habitat could occur within the shallow coastal waters (within foraging range of breeding little tern) outside the site boundary as a result of localised scour and deposition as described in paragraphs 4.7.47 and 4.7.48. However, these changes would not be measurable compared to the scour and sediment deposition and distribution currently experienced in the shallow inshore water supporting habitat. Therefore, no likely effects would be expected in relation to prey (fish) species that are targeted by foraging breeding little tern.

### Doggerbank SCI (Germany)

4.7.32 No seabed disturbance works or structures would extend into or be placed within the Doggerbank SCI, and changes to sediment transport (see paragraph 4.7.12) and sediment deposition (see paragraph 4.7.48) would not extend into the site. Consequently, no alteration to the extent, composition and distribution of the sandbank habitat within the Doggerbank SCI would occur.

### Doggersbank SCI (Netherlands)

4.7.33 No seabed disturbance works or structures would extend into or be placed within the Doggersbank SCI, therefore, no direct alteration to the extent, composition and distribution of the sandbank habitat within the Doggersbank SCI would occur. Changes to sediment transport (see paragraph 4.7.13) and sediment deposition (see paragraph 4.7.50) indicate that negligible and temporary changes could occur within the site, intermittently and throughout the lifetime of Dogger Bank Teesside A & B. These temporary changes would remain within the natural variation of the extent, composition and distribution of the sandbank habitat of the Doggersbank SCI.

## Changes to suspended sediment levels

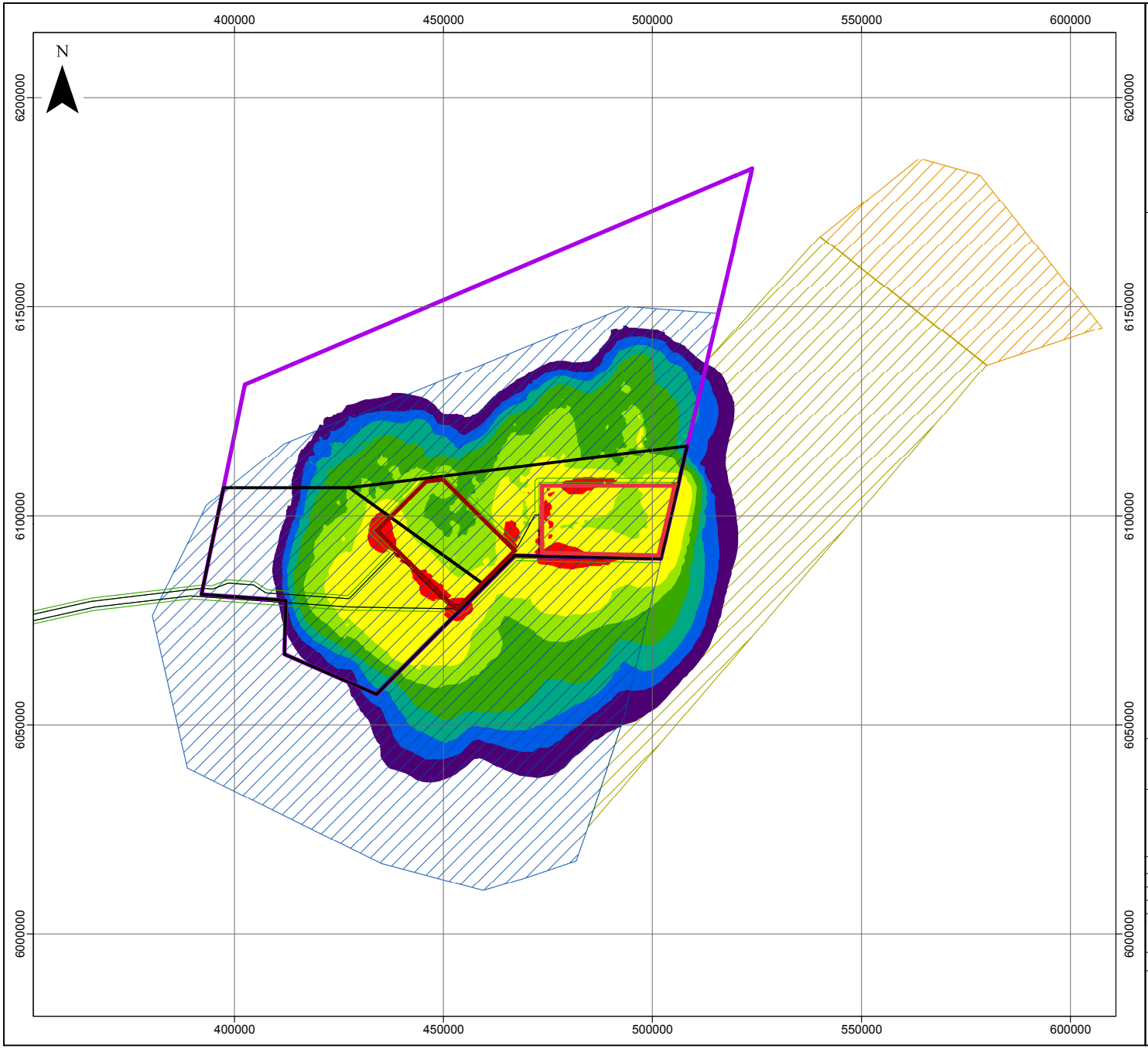
### Dogger Bank cSAC

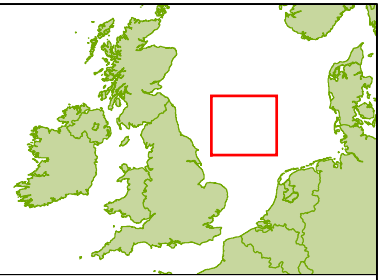
4.7.34 During the operation phase for Dogger Bank Teesside A & B, scour would occur around the base of the foundations of structures (wind turbines, met masts, collector stations, converter station, accommodation platform, cable protection and cable crossings, and mooring points) across the project areas, which would result in the liberation of sediment into the water column and formation of sediment plumes and increased suspended sediment concentrations. Consequently, sediment dispersion modelling was undertaken using the MIKE3-FM MT model, integrated with the MIKE3-FM HD model (see paragraphs 4.4.3 and 4.4.5 and detailed in **Appendix 9A** of the Dogger Bank Teesside A & B ES) to quantify the potential increases in suspended sediment concentrations. The modelling used the worst case scenario for structures present (see **Table 2.2**) across Dogger Bank Teesside A & B, which entailed a model run for a 50 year storm, and modelling was undertaken for a 30-day simulation period.

4.7.35 **Figure 4.27** and **Figure 4.28** show the maximum and the average suspended sediment concentrations predicted at any time over the 30-day simulation period. **Figure 4.29** shows the percentage of the time over the 30-day simulation period that the predicted suspended sediment concentration would remain above the 2mg/l background concentration.

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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
- Dogger Bank Special Area of Conservation (cSAC)
- Doggerbank Site of Community Importance (SCI)
- Doggersbank Site of Community Importance (SCI)

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
Kilometres

Data Source:
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**Figure 4.27 Maximum suspended sediment concentration in the bottom layer predicted over the simulation period after two years of operation**

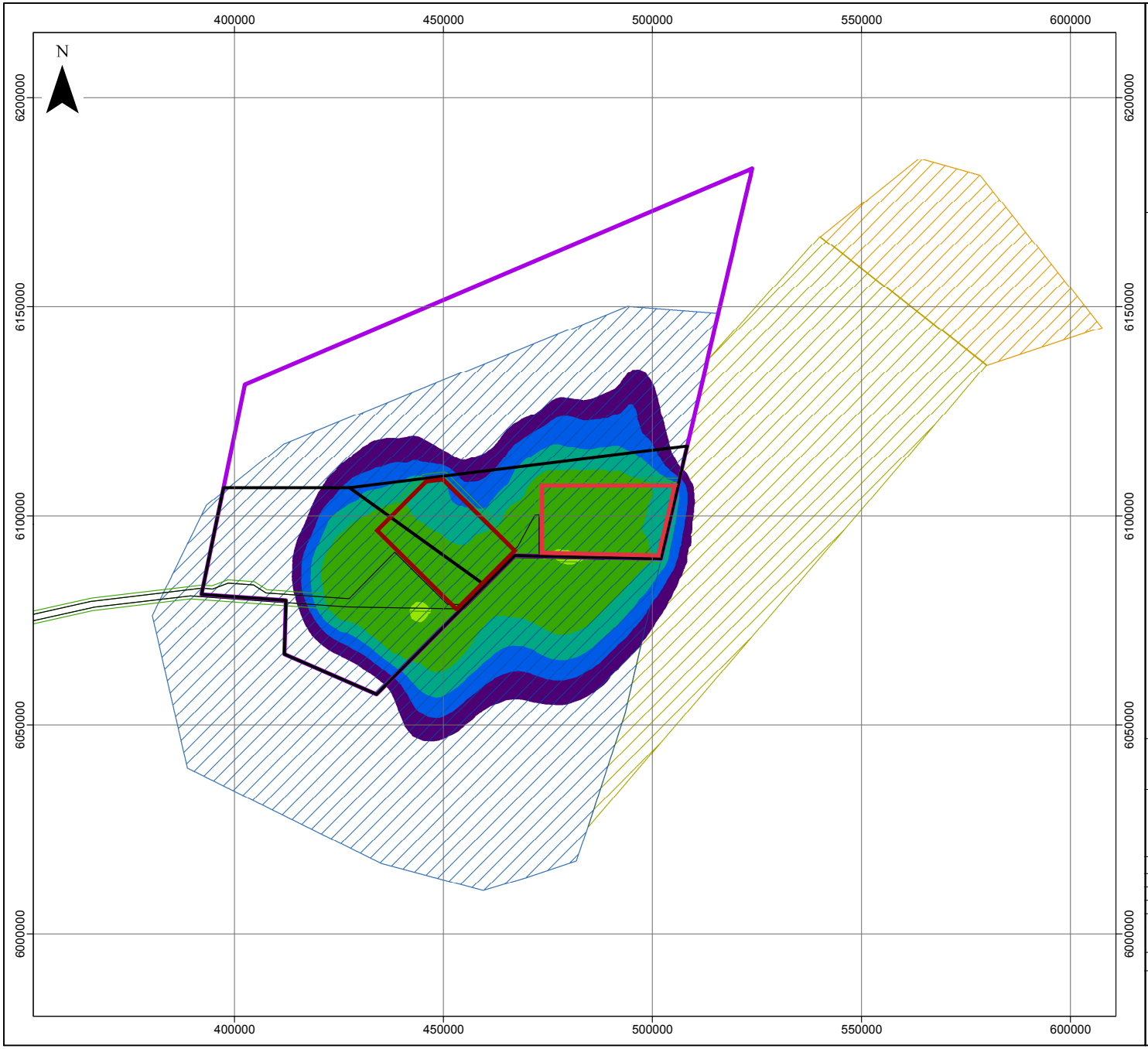
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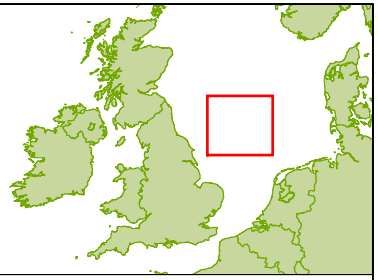
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| SCALE | PLOT SIZE | DATUM | PROJECTION |
|---|---|---|---|
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**LEGEND**

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- Doggerbank Site of Community Importance (SCI)
- Doggersbank Site of Community Importance (SCI)

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
Kilometres

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**Figure 4.28 Average suspended sediment concentration in the bottom layer predicted over the simulation period after two years of operation**

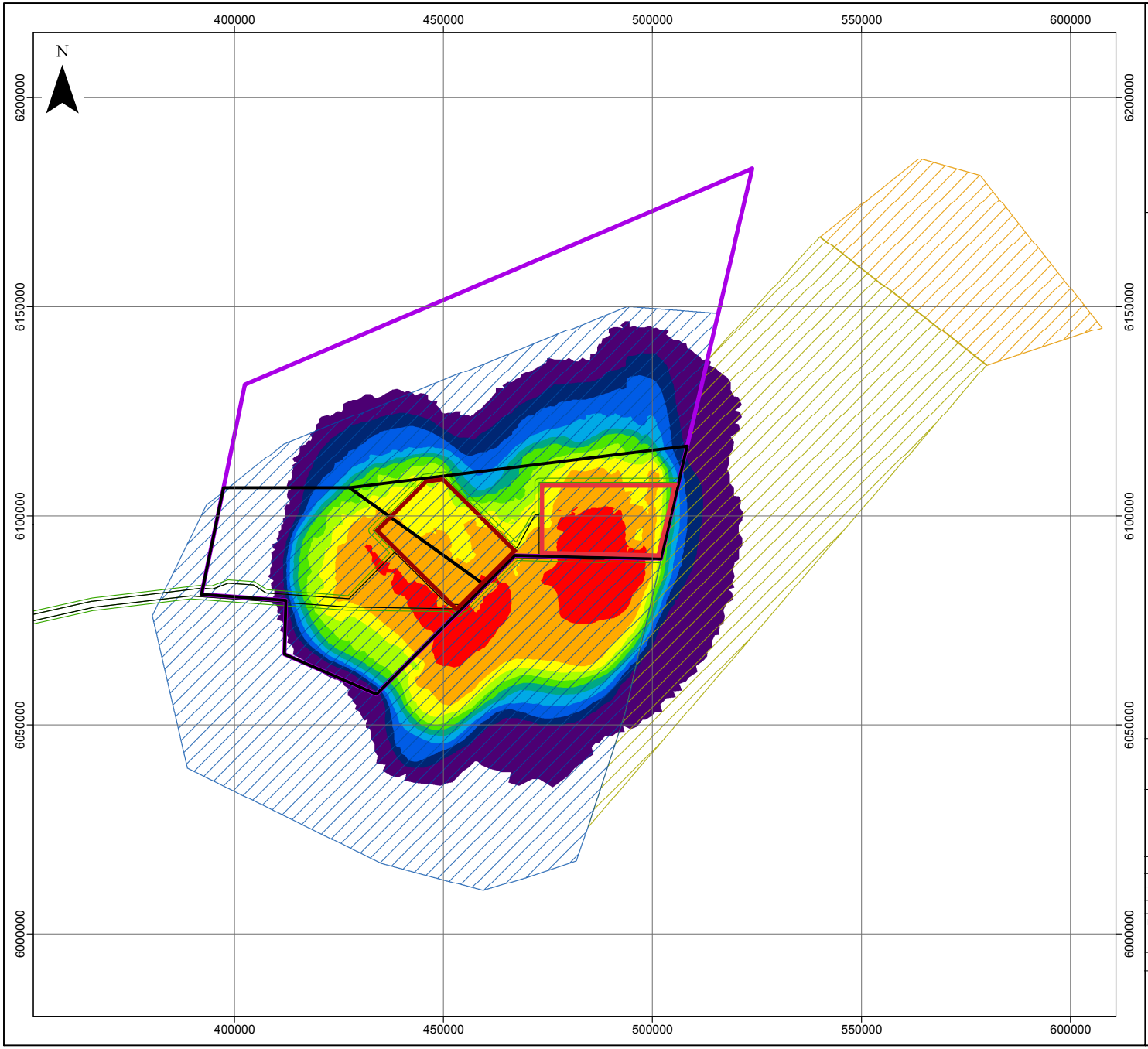
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| 1 | 07/10/2013 | PEI3 | GC | DB |
| 2 | 18/03/2014 | DCO Submission | GC | DB |
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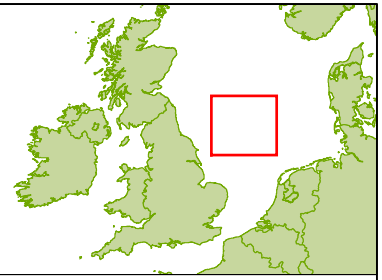
DRAWING NUMBER: **9Y0986/TSABHRA/32/R2**

| SCALE | PLOT SIZE | DATUM | PROJECTION |
|---|---|---|---|
| 1:1,400,000 | A4 | WGS84 | UTM31N |

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**LEGEND**

- Dogger Bank Zone
- Tranche boundary
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- Dogger Bank Teesside B
- Dogger Bank Teesside A & B Export Cable Corridor
- Temporary works area
- Dogger Bank Special Area of Conservation (cSAC)
- Doggerbank Site of Community Importance (SCI)
- Doggersbank Site of Community Importance (SCI)

Exceedance of 2 mg/l (% )

- Above 90
- 80 - 90
- 70 - 80
- 60 - 70
- 50 - 60
- 40 - 50
- 30- 40
- 20 - 30
- 10 - 20
- 0 - 10
- Below 0

0 10 20
Kilometres

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**Figure 4.29 Percentage of time where suspended sediment concentration of 2mg/l is exceeded in the bottom layer over the simulation period after two years of operation**

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|---|---|---|---|---|
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| 2 | 18/03/2014 | DCO Submission | GC | DB |
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DRAWING NUMBER:

**9Y0986/TSABHRA/33/R2**

| SCALE | 1:1,400,000 | PLOT SIZE | A4 | DATUM | WGS84 | PROJECTION | UTM31N |
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4.7.36 Based on the worst-case scenario, the maximum suspended sediment concentration predicted by the model at any time over the 30-day simulation period is predicted to be greater than 200mg/l (=0.2kg/$m^3$) in 20km long and 6km wide patches along the northern and southern boundaries of Dogger Bank Teesside A and the south-western boundary of Dogger Bank Teesside B. Suspended sediment concentrations reduce to 2mg/l approximately 40km to 54km south of the Dogger Bank Teesside A & B southern boundaries and 20km to 37km north of the Dogger Bank Teesside A & B northern boundaries (see **Figure 4.27**).

4.7.37 Average near-bed suspended sediment concentrations were predicted as being between 10mg/l and 50mg/l across Dogger Bank Teesside A & B and for up to approximately 19km to the south. Concentrations reduce to the background of 2mg/l up to approximately 36km south of the Dogger Bank Teesside A & B southern boundaries and up to 26km north of Dogger Bank Teesside A northern boundary (see **Figure 4.28**).

4.7.38 Exceedance of 2mg/l over the 30-day simulation period (see above) occurs for more than 90% of the time in two patches, one to the south of Dogger Bank Teesside B and one within and to the south of Dogger Bank Teesside A, up to 15km south of Dogger Bank Teesside A & B's southern boundaries. Exceedance is generally greater than 70% of the time across the whole of Dogger Bank Teesside A & B (see **Figure 4.29**).

4.7.39 It should be noted that the background concentration (2mg/l) against which the model and outputs of suspended sediment concentration increases are shown, is the average background concentration during normal conditions. No background data is available regarding suspended sediment concentrations across the Dogger Bank (and the Dogger Bank cSAC) during storm events (such as the 50 year storm event modelled). Consequently, consideration has been given to the comparison of scour volumes (which would result in suspended sediment concentration increases) against the naturally occurring volumes that have been calculated (see Section 7.4 in **Chapter 9** of the Dogger Bank Teesside A & B ES) as being released during storm events. **Table 4.18** (from Table 7.2 in **Chapter 9** of the Dogger Bank Teesside A & B ES) presents the comparison between the natural volume of material in suspension and the volume of material released due to scour around the project structures, as calculated.

Table 4.18 Calculated natural suspended volumes during a 50-year storm condition and GBS scour volumes released during a 50-year storm condition

| Storm | Naturally suspended volume ($m^3$) | Maximum scour volume from GBS ($m^3$) | Equivalent bed depth released in suspension (mm) |
|---|---|---|---|
| 50 year | 16,254 | 2,843 | 29 |

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4.7.40 **Table 4.18** shows that, under a 50-year storm condition, the naturally-occurring volumes of suspended sediment are predicted to be almost six times greater than those that could arise due to scour predicted to occur around a 6MW conical GBS foundation under the same (50-year) storm conditions. This equates to an increase in suspended sediment concentrations of less than 18% during a 50-year storm event based on material released within the area of each structure. As this event occurs extremely infrequently and represents a temporary effect, this would not represent a significant difference in the context of the natural range of suspended sediments in an extreme event.

4.7.41 Sedimentation values generated by the modelling work indicate that the maximum deposition is 5mm, with the majority of the project areas subject to maximum deposition of between 0.5mm and 5mm. Sediment deposition reduced to below 0.1mm approximately 16km to 30km from the southern boundaries of Dogger Bank Teesside A & B and 13km to 35km from the northern boundaries (see **Figure 4.30**).

4.7.42 The average deposition depth (see **Figure 4.31**) is predicted to be between 0.5mm and 5mm in a 32km long and 14km wide area located between the two projects. Elsewhere the maximum average deposition is less than 0.5mm reducing to less than 0.1mm approximately 23km south west of Dogger Bank Teesside B and 19km north of Dogger Bank Teesside A.

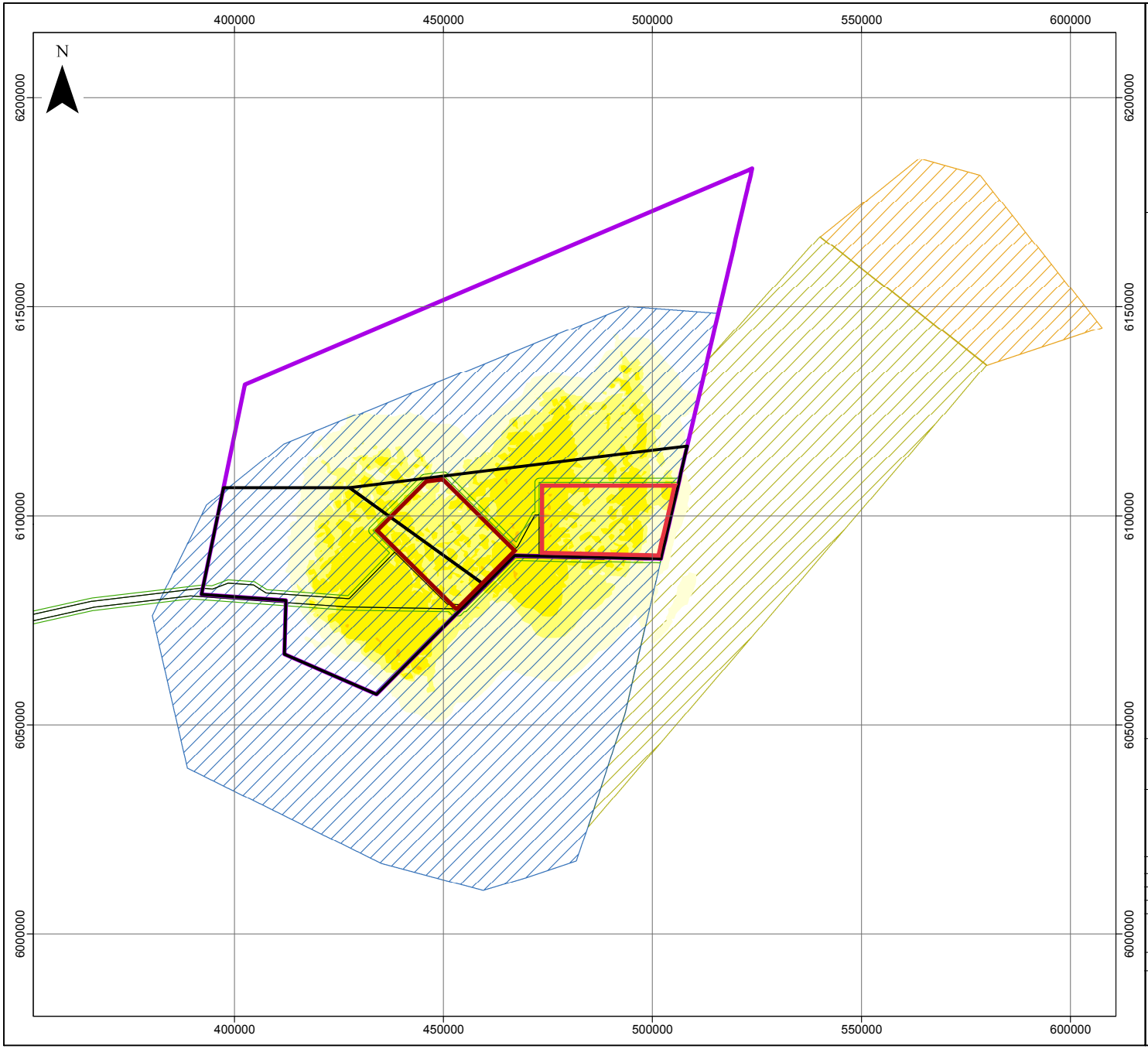
4.7.43 In terms of the persistence of deposited sediment, the results of time series analysis of sediment thickness at several discrete points within and outside the development area (see **Figure 4.32** for locations) are presented in **Table 4.19**.

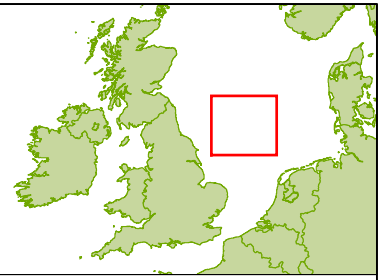
Table 4.19 Maximum persistency of sediment thickness over the 30-day simulation period after two years of operation

| Point | Maximum thickness (mm) | Maximum continuous time of sediment thickness in hours (days in brackets) | | | | Thickness at end of simulation (mm) |
|---|---|---|---|---|---|---|
| | | >10mm | >7mm | >3mm | >1mm | |
| R1 | 1.62 | 0 | 0 | 0 | 72 (3.00) | <0.1 |
| R2 | 0.75 | 0 | 0 | 0 | 0 | <0.1 |
| R3 | 1.65 | 0 | 0 | 0 | 70 (2.92) | <0.1 |
| R4 | 1.06 | 0 | 0 | 0 | 32 (1.33) | <0.1 |
| R5 | 1.74 | 0 | 0 | 0 | 34 (1.42) | <0.1 |
| R6 | 0.96 | 0 | 0 | 0 | 0 | <0.1 |
| R7 | 0.21 | 0 | 0 | 0 | 0 | <0.1 |

4.7.44 **Table 4.19** demonstrates that the maximum predicted sediment thickness is 1.7mm at R5. Thicknesses greater than 1mm persist for 72 hours (3.00 days), 70 hours (2.92 days), 32 hours (1.33 days) and 34 hours (1.42 days) at Points, R1, R3, R4 and R5, respectively. These thicknesses of deposited sediment are negligible in scale and, as evident from the simulation, do not persist, and are representative of occurrences that would arise naturally under extreme events.

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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
- Dogger Bank Special Area of Conservation (cSAC)
- Doggerbank Site of Community Importance (SCI)
- Doggersbank Site of Community Importance (SCI)

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
Kilometres

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**Figure 4.30 Maximum sediment deposition predicted over the simulation period after two years of operation**

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| | | | | |

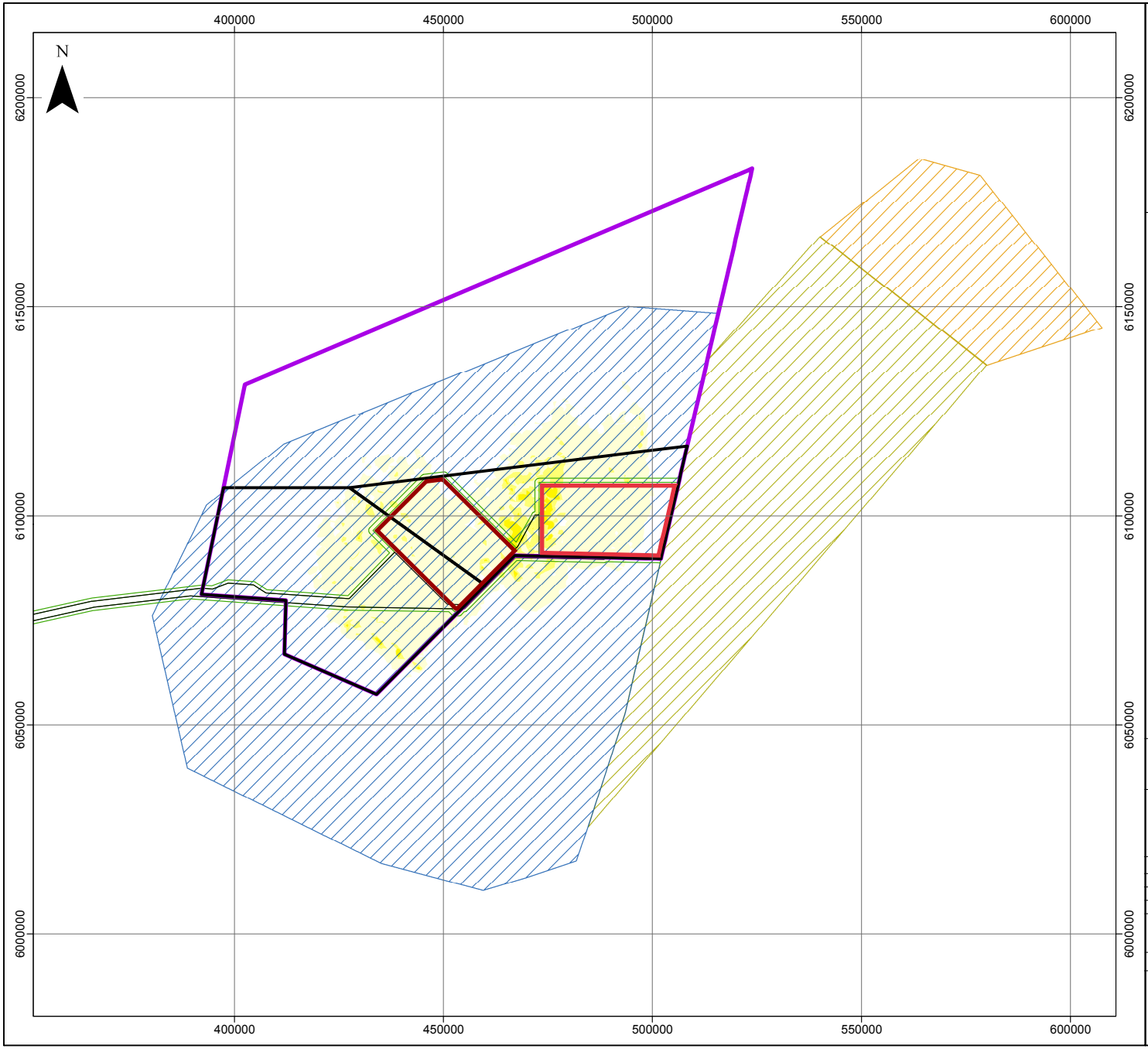
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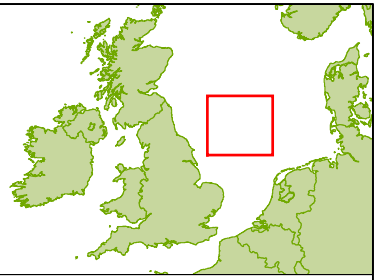
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| SCALE | PLOT SIZE | DATUM | PROJECTION |
|---|---|---|---|
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## LEGEND

- Dogger Bank Zone
- Tranche boundary
- Dogger Bank Teesside A
- Dogger Bank Teesside B
- Dogger Bank Teesside A & B Export Cable Corridor
- Temporary works area
- Dogger Bank Special Area of Conservation (cSAC)
- Doggerbank Site of Community Importance (SCI)
- Doggersbank Site of Community Importance (SCI)

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
Kilometres

Data Source:
Environmental Designations © JNCC, 2014 and European Environment Agency, 2014
Modelling © Danish Hydraulic Institute, 2013
Round 3 offshore wind farm boundary © Crown Copyright, 2014

PROJECT TITLE

*DOGGER BANK TEESSIDE A & B*
IfAA Report

DRAWING TITLE

**Figure 4.31 Average sediment deposition predicted over the simulation period after two years of operation**

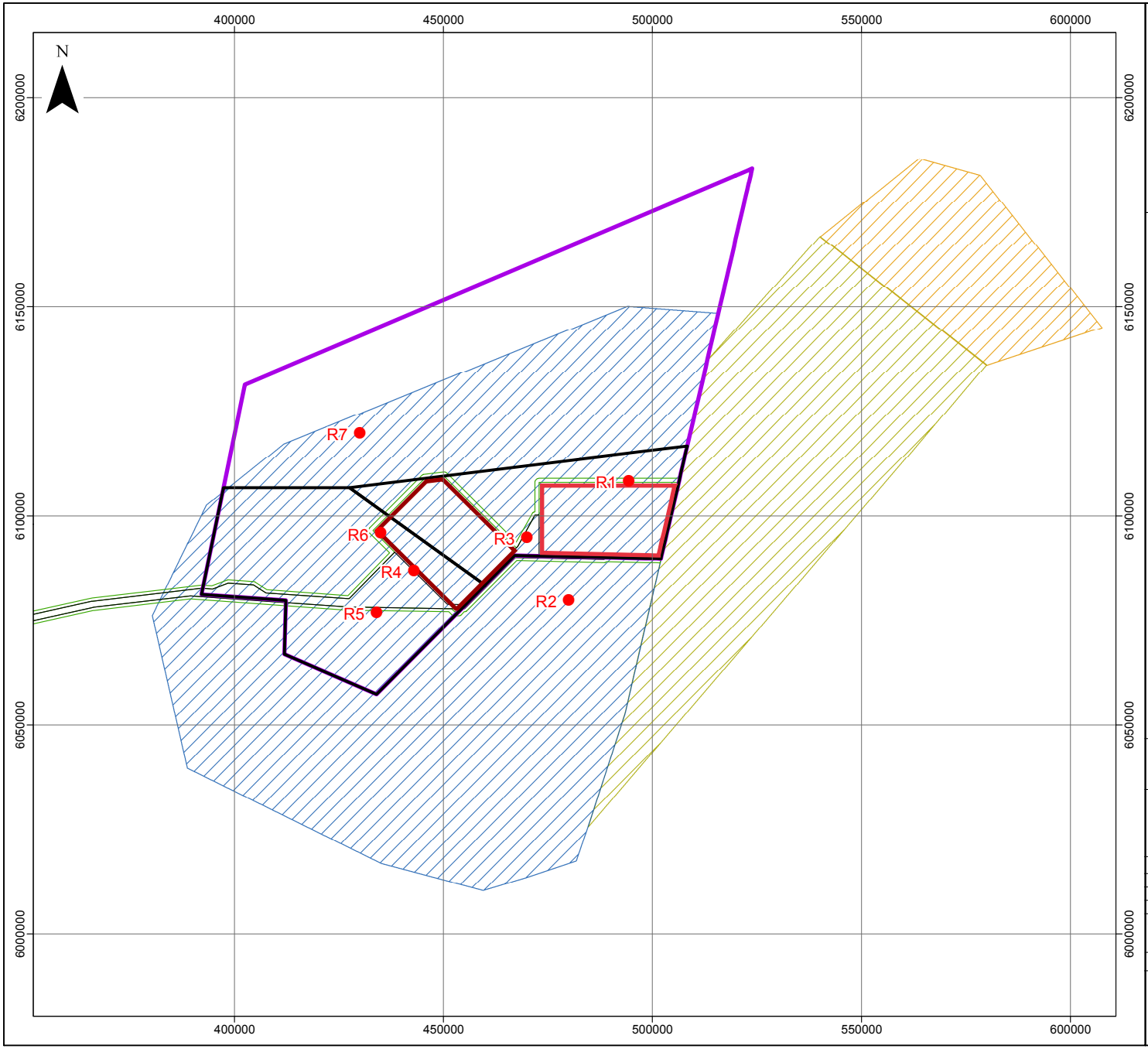
| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 07/10/2013 | PEI3 | GC | DB |
| 2 | 18/03/2014 | DCO Submission | GC | DB |
| | | | | |

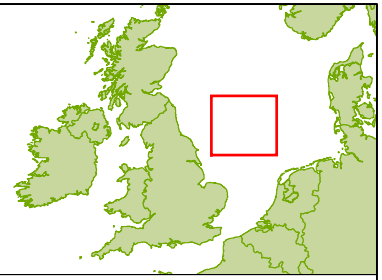
DRAWING NUMBER:
**9Y0986/TSABHRA/35/R2**

| SCALE | PLOT SIZE | DATUM | PROJECTION |
|---|---|---|---|
| 1:1,400,000 | A4 | WGS84 | UTM31N |

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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
- Dogger Bank Special Area of Conservation (cSAC)
- Doggerbank Site of Community Importance (SCI)
- Doggersbank Site of Community Importance (SCI)
- Sediment thickness time series analysis point

0 10 20
Kilometres

Data Source:
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PROJECT TITLE

*DOGGER BANK TEESSIDE A & B*
IfAA Report

DRAWING TITLE

**Figure 4.32 Location of points for sediment thickness time series analysis for the operational phase**

| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 07/10/2013 | PEI3 | GC | DB |
| 2 | 18/03/2014 | DCO Submission | GC | DB |
| | | | | |

DRAWING NUMBER:
**9Y0986/TSABHRA/36/R2**

| SCALE | PLOT SIZE | DATUM | PROJECTION |
|---|---|---|---|
| 1:1,400,000 | A4 | WGS84 | UTM31N |

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**Teesmouth and Cleveland Coast SPA and Ramsar site (supporting habitat features)**

4.7.45 Given that limited scour would occur in the context of the Dogger Bank Teesside A & B Export Cable in the nearshore zone (see paragraphs 3.2.14 to 3.2.16), no modelling has been undertaken to quantify potential change in suspended sediment concentrations in this zone, and hence the area of the Teesmouth and Cleveland Coast SPA and Ramsar site and its supporting habitat features. Any scour would be negligible and temporary in scale and, given the highly variable nature of suspended sediments within and adjacent to the Teesmouth and Cleveland Coast SPA and Ramsar site (see paragraph 4.5.31), these short-term and temporary increases fall within the natural range of background suspended sediment concentrations.

4.7.46 As described in paragraph 4.7.45 above regarding re-suspension of sediments, no measurable change in suspended sediment concentrations and subsequent deposition are likely.

**Northumbria Coast SPA and Ramsar site (supporting habitat features)**

4.7.47 As described in paragraph 4.7.45 above regarding re-suspension of sediments, and given that the supporting habitats of the Northumbria Coast SPA and Ramsar site are 20km away, no change is expected.

4.7.48 As described in paragraph 4.7.45 above regarding re-suspension of sediments, no measurable change in suspended sediment concentrations and subsequent deposition are likely, particularly given the distance (20km) from potential source (i.e. cable protection) of re-suspended sediments.

**Doggerbank SCI (Germany)**

4.7.49 The modelling of suspended sediments due to scour and disturbance during the operation phase for Dogger Bank Teesside A & B shows that no increase in suspended sediment concentrations would extend to or into the Doggerbank SCI (see **Figure 4.27** and **Figure 4.28**).

4.7.50 The modelling of sediment deposition due to re-suspension of sediments as a result of scour and disturbance during the operation phase for Dogger Bank Teesside A & B shows that no sediments would be deposited within the Doggerbank SCI (see **Figure 4.30** and **Figure 4.31**).

**Doggersbank SCI (Netherlands)**

4.7.51 The modelling of suspended sediments due to scour and disturbance during the operation phase for Dogger Bank Teesside A & B shows that the maximum predicted suspended sediment concentrations could reach between 20mg/l to 50mg/l within the Doggersbank SCI (see **Figure 4.27**). The maximum predicted suspended sediment concentrations would decrease to background levels 20km inside the site. Average suspended sediment concentrations could reach between 10mg/l to 20mg/l within the Doggersbank SCI immediately adjacent to Dogger Bank Teesside A & B (see **Figure 4.28**), decreasing to background levels within 10km. These increased levels would be temporary (generally less than 15 days based on **Figure 4.29**) and are considered to fall within the existing ranges predicted to be experienced during storm events (as discussed in paragraphs 4.7.38 and 4.7.39 above).

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4.7.52 The modelling of sediment deposition due to the re-suspension of sediments as a result of scour and disturbance during the operation phase for Dogger Bank Teesside A & B shows that the maximum sediment deposition within the Doggersbank SCI would be less than 0.5mm (see **Figure 4.30**), whilst the average sediment deposition would be less than 0.1mm (see **Figure 4.31**) over a 30-day period around a 50 year storm event. In the context of existing conditions, these predicted levels of deposition would be highly unlikely to be discernible and would fall within the existing ranges experienced during storm events.

## Changes to the levels of nutrients and contaminants

### Dogger Bank cSAC

4.7.53 The re-suspension of sediments as a result of scour and disturbance (maintenance jack-up barge legs) of seabed sediments during the operation phase for Dogger Bank Teesside A & B would be highly variable both in terms of spatial and temporal distribution. No contaminants are being introduced into the Dogger Bank cSAC, as all contaminants re-suspended and deposited would derive from the seabed sediments already present. Consequently, the temporary movement, dispersion and settlement of the suspended sediments and any of the low levels of contaminants (see paragraph 4.5.33) within them would not be expected to alter the chemical properties of the Dogger Bank cSAC sandbanks feature.

### Teesmouth and Cleveland Coast SPA and Ramsar site (supporting habitat features)

4.7.54 Given the negligible concentrations of suspended sediments (see paragraph 4.7.45) and sediment deposition (see paragraph 4.7.46) predicted and the low residence times for both, any localised contaminants would be rapidly dispersed and would not be expected to alter the chemical environment of the supporting habitats within or outside the Teesmouth and Cleveland Coast SPA and Ramsar site to a measurable degree.

### Northumbria Coast SPA and Ramsar site (supporting habitat features)

4.7.55 Given the negligible concentrations of suspended sediments (see paragraph 4.7.47) and sediment deposition (see paragraph 4.7.48) predicted and the low residence times for both, any localised contaminants would be rapidly dispersed and would not be expected to alter the chemical environment of the supporting habitats within or outside the Northumbria Coast SPA and Ramsar site to a measurable degree.

### Doggerbank SCI (Germany)

4.7.56 Given that no suspended sediments (see paragraph 4.7.49) or deposited sediment (see paragraph 4.7.50) would extend into the Doggerbank SCI, there would be no souce or pathway for contaminants to be mobilised and present within the Doggerbank SCI.

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### Doggersbank SCI (Netherlands)

4.7.57 As for the Dogger Bank cSAC (see paragraph 4.7.53) and given the negligible and temporary concentrations of suspended sediments and levels of deposited sediment (see paragraphs 4.7.51 and 4.7.52) predicted to occur, no alteration to the existing levels of contaminants is expected within the Doggersbank SCI.

## Physical loss of habitat feature communities

### Dogger Bank cSAC

4.7.58 Long-term loss of habitat and subtidal sandbank communities would occur as a result of the installation of wind turbine foundation structures and associated scour protection, as well as under all inter-array and export cables where secondary cable protection is required for the lifetime of the project.

4.7.59 Based on the worst-case scenario of 400 x GBS foundations, along with all other related project infrastructure and side-cast mounds (see **Table 2.2**), a total permanent (for the operational life time of the offshore wind farm) habitat loss of 9.40km$^2$ (0.08%) is predicted for Dogger Bank Teesside A & B (see **Table 4.20**). Of this, 7.46km$^2$ would occur within Dogger Bank Teesside A & B (from foundations, array cable protection, scour protection, vessel mooring and side-cast mounds), and the remaining 1.94km$^2$ would occur within the export cable footprint (via cable protection and cable crossings) that lies within the Dogger Bank cSAC boundary and would affect the subtidal sandbank communities present.

Table 4.20 Permanent habitat loss and temporary habitat disturbance extents within the Dogger Bank cSAC during the operation phase

| Feature | Extent (km$^2$) except where expressed as a percentage | | |
|---|---|---|---|
| | **Dogger Bank Teesside A** | **Dogger Bank Teesside B** | **Dogger Bank Teesside A & B** |
| Area of Dogger Bank cSAC | 12,331km$^2$ | | |
| **Long-term physical damage (habitat loss)** | | | |
| Maximum footprint of (habitat loss) of offshore wind farm within the cSAC | 3.73 | 3.73 | 7.46 |
| Maximum footprint of (habitat loss) the Dogger Bank Teesside A & B Export Cable Corridor[1] within the cSAC | 1.15 | 0.79 | 1.94 |
| Total footprint of (habitat loss) within the cSAC | 4.88 | 4.52 | 9.40 |
| Total footprint (habitat loss) as a percentage of the cSAC | 0.04 | 0.04 | 0.08 |
| **Intermittent temporary physical damage (disturbance)** | | | |
| Total footprint of temporary disturbance during the operation phase within the cSAC | 0.904 | 0.904 | 1.808 |
| Maximum yearly footprint of temporary disturbance as a percentage of the cSAC | 0.007% | 0.007% | 0.015% |

[1] Only the footprint of effect within the parts of the Dogger Bank Teesside A & B Export Cable Corridor that lies within the Dogger Bank cSAC boundary listed here.


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4.7.60 Within Dogger Bank Teesside A & B, the loss of habitat from the three habitat community types (VER A, VER B, and VER C) within the Dogger Bank cSAC is estimated as 3.19km$^2$ of VER A, 0.50km$^2$ of VER B, and 5.71km$^2$ of VER C (see **Table 4.21**). In the context of the conservation objectives applicable to the Dogger Bank cSAC, potentially the loss of this area could compromise the favourable condition of the site if extent only is considered. However, the spatial distribution of the loss would be at specific localised areas across the very large spatial extent of the project areas and Dogger Bank cSAC. Given the very small scale of the loss in extent and the dispersed nature of the localised losses, at the level of the cSAC no change in the composition of communities would occur within the Dogger Bank cSAC, as the communities affected (VER A, VER B, and VER C) are extensive and widespread throughout Dogger Bank Teesside A & B and within the Dogger Bank Zone.

Table 4.21 Proportion of VER communities within the Dogger Bank cSAC affected by permanent habitat loss during the operation phase

| VER affected | Dogger Bank Teesside A[1] | Dogger Bank Teesside B[1] | Dogger Bank Teesside A & B[1] |
|---|---|---|---|
| **VER A** | | | |
| Area within Dogger Bank cSAC[2] (km$^2$) | 6.898.99 | 6.898.99 | 6.898.99 |
| Area within project (km$^2$) | 51.90 | 359.04 | 410.94 |
| Extent affected within project (km$^2$) | 0.45 | 2.74 | 3.19 |
| Percentage of VER affected within Dogger Bank cSAC (%) | 0.01% | 0.04% | 0.05% |
| **VER B** | | | |
| Area within Dogger Bank cSAC[2] (km$^2$) | 2,142.18 | 2,142.18 | 2,142.18 |
| Area within project (km$^2$) | 28.05 | 33.74 | 61.79 |
| Extent affected within project (km$^2$) | 0.24 | 0.26 | 0.50 |
| Percentage of VER affected within Dogger Bank cSAC (%) | 0.01% | 0.01% | 0.02% |
| **VER C** | | | |
| Area within Dogger Bank cSAC[2] (km$^2$) | 3,289.94 | 3,289.94 | 3,289.94 |
| Area within project (km$^2$) | 480.15 | 200.43 | 680.58 |
| Extent affected within project (km$^2$) | 4.18 | 1.53 | 5.71 |
| Percentage of VER affected within Dogger Bank cSAC (%) | 0.13% | 0.05% | 0.17% |

[1] Includes Dogger Bank Teesside A & B Export Cable Corridor where present within the Dogger Bank cSAC.
[2] Based on multiplying up the total VERs in the surveyed areas (tranches A & B and Dogger Bank Teesside A & B Export Cable Corridor that lie within the Dogger Bank cSAC)

4.7.61 Consideration is also given to habitat fragmentation. Habitat fragmentation as a phenomenon is more recognised in terrestrial environments, whereby anthropogenic activities, such as clearance of certain habitats or construction of roads across discrete areas, can result in a reduction in overall biodiversity due to certain ecological niches being lost.

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4.7.62 In the context of the introduction of wind farm infrastructure into the Dogger Bank cSAC, whilst this would result in some small-scale habitat loss (0.08%), connectivity between substrate types would not be compromised particularly given the relatively uniform nature of the habitats across the site, the continuation of physical and ecological processes and the mobility of benthic and epibenthic organisms. No significant fragmentation effects would therefore arise.

4.7.63 Overall, given the very small area of habitat that would be lost, the negligible change in apportionment of community types that make up the majority of the Dogger Bank cSAC and, in this respect, the diversity, community structure and typical species representative of the subtidal sandbanks feature would not be affected to a degree that would be ecologically significant.

**Teesmouth and Cleveland Coast SPA and Ramsar site (supporting habitat features)**

4.7.64 No seabed disturbance works or structures would extend into or be placed within the Teesmouth and Cleveland Coast SPA and Ramsar site therefore no direct loss of the supporting habitats would occur within the Teesmouth and Cleveland Coast SPA and Ramsar site. Whilst the placement of cable protection in the nearshore zone outside the site could result in potential loss of the substrate within the shallow coastal waters supporting habitat (composition as described in 4.7.30), the extent of the effect would be insignificant compared to the scale of this feature, and would not influence the prey species for little tern (a feature of the Teesmouth and Cleveland Coast SPA and Ramsar site) to any measurable degree (see Section 6.7 for further assessment in respect of this feature).

**Northumbria Coast SPA and Ramsar site (supporting habitat features)**

4.7.65 No seabed disturbance works or structures would extend into or be placed within the Northumbria Coast SPA and Ramsar site, therefore, no direct loss of the supporting habitats would occur within the Northumbria Coast SPA and Ramsar site. Whilst the placement of cable protection in the nearshore zone outside the site could result in potential loss of the substrate within the shallow inshore waters supporting habitat (composition as described in 4.7.31), the extent of the effect would be insignificant compared to the scale of this feature, and would not influence the prey species for little tern (a feature of the Northumbria Coast SPA and Ramsar site) to any measurable degree (see Section 6.7 for further assessment in respect of this feature).

**Doggerbank SCI (Germany)**

4.7.66 No seabed disturbance works or structures would extend into or be placed within the Doggerbank SCI, therefore, no direct loss of the sandbank habitat would occur within the Doggerbank SCI.

**Doggersbank SCI (Netherlands)**

4.7.67 No seabed disturbance works or structures would extend into or be placed within the Doggersbank SCI, therefore, no direct loss of the sandbank habitat would occur within the Doggersbank SCI.

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## Physical disturbance to habitat feature communities through the introduction of hard substrate and alteration to community structure

### Dogger Bank cSAC

4.7.68 All project infrastructure that has a sub-surface element would represent a suitable surface for colonisation by marine fauna and flora, including species that may not currently be found within the site. This is of particular note in sedimentary environments like Dogger Bank where substrates for colonisation by encrusting epifauna are very limited. Therefore, the presence of foundations and columns for wind turbines, met masts, collector stations, converter station, accommodation platforms, and mooring points would represent new areas for such colonisation, with potential to change the nature of sandbank communities.

4.7.69 Epifaunal species and colonising fauna already exist within the Dogger Bank cSAC (associated with coarser sediments) and these species would be likely to colonise any introduced hard substrate. The exact species assemblages are difficult to predict, however, it is likely that fairly common species would colonise these areas, including species of bryozoans, ascidians and bivalve molluscs.

4.7.70 Of concern is the potential colonisation of hard substrate by alien species and, in effect, these structures acting as 'stepping-stones' for the introduction of these species into UK coastal waters. In 2009 Cefas conducted a review of the state of the benthic ecology around Round One wind farms (Cefas 2009). In this review no invasive or alien species were observed though monitoring was recommended throughout the life span of the wind farms. Furthermore, the dive surveys and DDV of wrecks undertaken by Envision indicates that the fauna likely to colonise turbine subsea structures are those that occur commonly in the region on comparable substrates.

4.7.71 Overall, it is considered that species that are already present on the coarser substrates within the Dogger Bank cSAC would be those most likely to colonise the hard substrate habitat introduced by the wind farm infrastructure. As such, it is concluded that the introduction of these novel substrates into the cSAC would not alter the existing community composition.

### Teesmouth and Cleveland Coast SPA and Ramsar site (supporting habitat features)

4.7.72 No structures would extend into or be placed within the Teesmouth and Cleveland Coast SPA and Ramsar site therefore no alteration would occur to the supporting habitats and their communities within the Teesmouth and Cleveland Coast SPA and Ramsar site. Whilst the presence of cable protection in the nearshore zone outside the site could result in potential loss of the substrate (though the rock armour may in many areas overlie existing rocky substrate and not therefore result in loss) within the shallow coastal waters supporting habitat (composition as described in 4.7.30), the extent of the effect would be insignificant (5.348km$^2$ for the whole Dogger Bank Teesside A & B Export Cable Corridor from landfall to the offshore wind farm) compared to the scale of this feature (the shallow inshore waters of Tees Bay), and would not influence the prey species for little tern (a feature of the Teesmouth and Cleveland Coast SPA and Ramsar site) to any measurable degree.

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### Northumbria Coast SPA and Ramsar site (supporting habitat features)

4.7.73 No structures would extend into or be placed within the Northumbria Coast SPA and Ramsar site therefore no alteration would occur to the supporting habitats and their communities within the Northumbria Coast SPA and Ramsar site. Whilst the presence of cable protection in the nearshore zone outside the site could result in potential loss of the substrate (though the rock armour may in many areas overlie existing rocky substrate and not therefore result in loss) within the shallow inshore waters supporting habitat (composition as described in 4.7.31), the extent of the effect would be insignificant (5.348km$^2$ for the whole Dogger Bank Teesside A & B Export Cable Corridor from landfall to the offshore wind farm) compared to the scale of this feature (the shallow inshore waters of Tees Bay), and would not influence the prey species for little tern (a feature of the Northumbria Coast SPA and Ramsar site) to any measurable extent.

### Doggerbank SCI (Germany)

4.7.74 No structures would extend into or be placed within the Doggerbank SCI, therefore, no alteration would occur to the sandbank habitat and the communities within the Doggerbank SCI.

### Doggersbank SCI (Netherlands)

4.7.75 No structures would extend into or be placed within the Doggersbank SCI, therefore, no alteration would occur to the sandbank habitat and the communities within the Doggersbank SCI.

## Physical damage to habitat feature communities

### Dogger Bank cSAC

4.7.76 During the operation phase for Dogger Bank Teesside A & B there would be the need for regular and un-planned maintenance from jack-up vessels and other heavy offshore equipment, as well as potential cable repairs. These activities would cause localised physical disturbance to subtidal sandbank communities within the Dogger Bank cSAC. The largest source of this temporary disturbance is predicted to be the presence of jack-up vessels, which are estimated to disturb a maximum of 1.808km$^2$ each year in the worst case scenario identified in **Table 2.2**. This disturbance would be short-term in duration (i.e. for days) and could be located across the entirety of the offshore wind farm dependent on which structures were being maintained at the time. Consequently, disturbance of the same locations is unlikely year on year. This would represent an intermittent temporary physical disturbance to less than 0.02% of the Dogger Bank cSAC, as summarised in **Table 4.20**. However, it should be noted that disturbance to this extent of sandbank habitat and their communities as a result of maintenance across the entire wind farm in any one year would be highly unlikely. As described in paragraph 4.5.64, the sandbank (VER A and VER B) communities are considered to have a high tolerance to physical disturbance, exhibiting rapid recovery following disturbance events, whilst VER C communities have moderate sensitivity with longer recovery times. Overall, significant change in species abundance and composition would not be expected given the small scale and temporally disparate nature of the disturbances.

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### Teesmouth and Cleveland Coast SPA and Ramsar site (supporting habitat features)

4.7.77 No operation phase (maintenance) seabed disturbance works would extend into the Teesmouth and Cleveland Coast SPA and Ramsar site, therefore, no physical damage to the supporting habitats would occur within the Teesmouth and Cleveland Coast SPA and Ramsar site. Furthermore, limited if any maintenance is predicted (and cannot therefore be quantified) for the Dogger Bank Teesside A & B Export Cable. Overall, no measurable physical damage is predicted for the supporting habitats outside of the Teesmouth and Cleveland Coast SPA and Ramsar site.

### Northumbria Coast SPA and Ramsar site (supporting habitat features)

4.7.78 No operation phase (maintenance) seabed disturbance works would extend into the Teesmouth and Cleveland Coast SPA and Ramsar site therefore no physical damage to the supporting habitats would occur within the Teesmouth and Cleveland Coast SPA and Ramsar site. Furthermore, limited if any maintenance is predicted (and cannot therefore be quantified) for the Dogger Bank Teesside A & B Export Cable. Overall, no measurable physical damage is predicted for the supporting habitats outside of the Northumbria Coast SPA and Ramsar site.

### Doggerbank SCI (Germany)

4.7.79 No operation phase (maintenance) seabed disturbance works would extend into the Doggerbank SCI, therefore, physical damage to the sandbank habitat and associated communities would not occur within the Doggerbank SCI.

### Doggersbank SCI (Netherlands)

4.7.80 No operation phase (maintenance) seabed disturbance works would extend into the Doggerbank SCI, therefore, physical damage to the sandbank habitat and associated communities would not occur within the Doggerbank SCI.

## Physical damage to habitat feature communities as a result of alteration to hydrodynamic processes, morphology and structural integrity of the sandbank habitat

### Dogger Bank cSAC

4.7.81 Predicted changes to the physical characteristics, hydrodynamic regime and morphology of the sandbank habitat are described in paragraphs 4.7.21 to 4.7.24. The existing sandbank communities are distributed mainly according to sediment type, which is itself linked to over-arching hydrodynamic processes; consequently any change in the latter could result in eventual changes to the sandbank communities. Based on the worst-case scenario (see **Table 2.2**) for this effect predicted by the physical process modelling (400 x 6MW GBS foundations at 750m spacing), a maximum change in current velocity of less than 2% from existing levels could occur within the Dogger Bank cSAC, reducing to no change within 10km of the Dogger Bank Teesside A & B boundaries (see paragraph 4.7.14 and 4.7.15 and **Figure 4.23**).

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4.7.82 The maximum predicted change in flow, less than 0.008m/s, is small and falls within the existing range of tidal current conditions over the Dogger Bank and, therefore, within the Dogger Bank cSAC. Of the VERs (A, B, and C), identified within the Dogger Bank cSAC and Dogger Bank Teesside A & B, the FabMag biotope within VER A is the most sensitive to changes in tidal currents (or 'change in water flow rate' as defined by MarLIN), being ascribed a moderate sensitivity to this effect (factor). However, the benchmark increase in water flow rate required to trigger this moderate sensitivity to this factor is a change of at least two classes from the existing 'weak' flow rate (<0.5m/s - typical tidal currents are less than 0.4m/s in the study area) to 'strong' (1.5m/s – 3m/s). This level of increase in tidal currents is not predicted to arise as a result of Dogger Bank Teesside A & B, as the maximum change in current velocity predicted is less than 0.008m/s. Whilst this would represent a permanent change in hydrodynamic conditions, the changes are of a very small scale and within the existing range such that no discernible response in sandbank communities (alteration to density, diversity, distribution, or biomass) would be predicted due to their low sensitivity overall to negligible changes in tidal flows. Therefore, significant alteration in the abundance and / or species composition of the sandbank communities is not expected. Changes in hydrodynamic processes due to the presence of export cable protection would also be localised and, in the context of the Dogger Bank Teesside A & B Export Cable Corridor within the cSAC, highly unlikely to result in any discernible changes to local currents and subsequently the subtidal sandbank communities within the Dogger Bank cSAC.

**Teesmouth and Cleveland Coast SPA and Ramsar site (supporting habitat features)**

4.7.83 No change to the morphology or structural integrity of the supporting habitats within or outside the Teesmouth and Cleveland Coast SPA and Ramsar site is predicted (see paragraph 4.7.25). Changes in hydrodynamic properties would be localised and small-scale in relation to any protection provided to the export cable. Given that exposed bedrock is present within the coastal waters and the variable nature of the flows (from wave and tides), the communities of the shallow coastal water supporting habitat would not be expected to experience any physical damage and subsequent alteration to community composition. In turn no influence on the prey species for little tern (a feature of the Teesmouth and Cleveland Coast SPA and Ramsar site) is therefore predicted.

**Northumbria Coast SPA and Ramsar site (supporting habitat features)**

4.7.84 No change to the morphology or structural integrity of the supporting habitats within or outside the Northumbria Coast SPA and Ramsar site is predicted (see paragraph 4.7.26). Changes in hydrodynamic properties would be localised and small scale in relation to any protection provided to the export cable. Given that exposed bedrock is present within the coastal waters and the variable nature of the flows (from wave and tides), the communities of the shallow coastal water supporting habitat would not be expected to experience any physical damage and subsequent alteration to community composition. In turn no influence on the prey species for little tern (a feature of the Northumbria Coast SPA and Ramsar site) is therefore predicted.

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### Doggerbank SCI (Germany)

4.7.85 No change to the morphology or structural integrity is predicted for the sandbank habitat within the Doggerbank SCI (see paragraph 4.7.27). Consequently, no alteration in the abundance and / or species composition of the communities would arise within the Doggerbank SCI.

### Doggersbank SCI (Netherlands)

4.7.86 The change in tidal currents described in paragraph 4.7.20 and shown on **Figure 4.22** extends into the Doggersbank SCI, where the maximum percentage change is less than 1%. Modelling showed that average tidal currents would not change within this site (see **Figure 4.23**). Furthermore, no change to the morphology of the Doggersbank SCI is predicted (see paragraph 4.7.28). Overall, given the low sensitivity of sandbank communities to hydrodynamic change (tidal currents) due to their adaptation within an environment where tidal currents are naturally highly variable, storm conditions, and that only very small changes are predicted in the worst case (within the existing range), no discernible alteration in the abundance and / or species composition of the sandbanks communities would arise within the Doggersbank SCI.

## Physical damage to habitat feature communities from increased suspended sediment concentrations

### Dogger Bank cSAC

4.7.87 Details of the predicted changes in suspended sediment concentrations are presented in paragraphs 4.7.34 to 4.7.40 and shown on **Figure 4.27**, **Figure 4.28**, and **Figure 4.29** in relation to changes in the worst case scenario (a 50 year storm event). Further clarification is presented in **Table 4.18**.

4.7.88 The model outputs are similar to those predicted for seabed disturbance during the construction phase; although the average bottom layer suspended sediment concentration predictions are greater than those predicted during the construction phase (see **Figure 4.13**). Therefore, quantitatively the suspended sediment concentration effects would be broadly similar. Only during periods of more intensive water flow (e.g. during storm events), would further scour be likely to occur, because following completion of construction sediment around the structures will have responded to the altered hydrodynamic conditions and reached equilibrium. Consequently, sediment release during the operational phase would be intermittent and as it would also occur during periods of heightened suspended sediment concentrations in the water column (i.e. during storm events), it is unlikely that the sediment released would make any significant difference to background suspended sediment concentration levels.

4.7.89 As discussed with respect to the impact assessment of increased suspended sediment concentrations during the construction phase, VER A communities have no (ecological) sensitivity to increased suspended sediment concentrations, and VER B and VER C communities have a very low (ecological) sensitivity to increased suspended sediment concentrations (see paragraph 4.5.65).


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4.7.90 Based on the sandbank communities' very low sensitivity and the temporary nature of elevated suspended sediment concentrations generated predicted to be as a result of scour during storm events, the predicted increase in suspended sediment concentrations would not be expected to result in any significant change to the abundance and / or species composition of the observed infaunal and epifaunal communities of the Dogger Bank cSAC.

**Teesmouth and Cleveland Coast SPA and Ramsar site (supporting habitat features)**

4.7.91 Limited (if any) localised, temporary and intermittent increases in suspended sediment concentrations (see paragraph 4.7.45) may occur within the area of supporting habitats outside the Teesmouth and Cleveland Coast SPA and Ramsar site. Overall, there would be no predicted change in the supporting habitat (shallow coastal waters) and prey species for the Teesmouth and Cleveland Coast SPA and Ramsar site bird features given the temporary nature and negligible increase in suspended sediment concentrations predicted, particularly given that they fall within the existing range of background concentrations.

**Northumbria Coast SPA and Ramsar site (supporting habitat features)**

4.7.92 Limited (if any) localised, temporary and intermittent increases in suspended sediment concentrations (see paragraph 4.7.46) may occur within the area of supporting habitats outside the Northumbria Coast SPA and Ramsar site. Overall, there would be no predicted change in the supporting habitat (shallow inshore waters) and prey species for the Northumbria Coast SPA and Ramsar site bird features given the temporary nature and negligible increase in suspended sediment concentrations predicted, particularly given that they fall within the existing range of background concentrations.

**Doggerbank SCI (Germany)**

4.7.93 There would be no increase in suspended sediment concentrations within the Doggerbank SCI (see paragraph 4.7.49). Consequently, no impact on the sandbank communities of the Doggerbank SCI would occur.

**Doggersbank SCI (Netherlands)**

4.7.94 Based on the worst-case scenario (see **Table 2.2**), the modelling shows the maximum near-bed suspended sediment concentrations resulting from the operation of Dogger Bank Teesside A & B could reach between 20mg/l to 50mg/l within the Doggersbank SCI (see **Figure 4.27**), decreasing to background levels within 20km. The average near-bed suspended sediment concentrations could reach between 10mg/l to 20mg/l immediately adjacent to Dogger Bank Teesside A & B (see **Figure 4.28**), decreasing to background levels within 10km (see paragraph 4.7.51). The suspended sediment concentrations would be elevated above background by for up to 15 days during a 50 year storm event (see **Figure 4.29**). As the increases are temporary (and would be intermittent, i.e. during storm events), and given the sandbank communities' very low sensitivity and high recoverability to increased suspended sediment concentrations, no change to the abundance and / or species composition of the infaunal and epifaunal communities would occur within the Doggersbank SCI.

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## Physical damage (smothering) to habitat feature communities through increased deposition of sediment

### Dogger Bank cSAC

4.7.95 Sediment scour, suspension and re-deposition would occur due to the presence of wind farm infrastructure on the seabed and any maintenance activities (i.e. presence of jack-up barges and their disturbance to the seabed). Potentially, re-deposited sediment could result in smothering (physical disturbance) to sandbank communities within the Dogger Bank cSAC.

4.7.96 Based on the worst case scenario (as modelled for suspended sediment concentrations, see **Table 2.2**) the model outputs (see paragraphs 4.7.41 to 4.7.44 and **Figure 4.30** and **Figure 4.31**) show that maximum sediment deposition of up to 5mm may occur within Dogger Bank Teesside A and Dogger Bank Teesside B, as shown on **Figure 4.30**. Average sediment deposition is predicted to be less than 5mm across both Dogger Bank Teesside A and Dogger Bank Teesside B, as shown on **Figure 4.23**. The average deposition value reduces to less than 0.1mm approximately 23km to the southwest of Dogger Bank Teesside B and 19km to the north of Dogger Bank Teesside A.

4.7.97 In terms of persistency of deposited sediment, the modelling showed (see **Table 4.19**) that deposition depth would be <0.1mm (i.e. returning to baseline) by the end of the 30-day simulation period, whilst sediment depths of greater than 3mm would not persist for more than a very short duration. The results therefore show that any deposited sediment would not persist for any significant duration and would not, in the long-term, therefore, give rise to an adverse influence upon the benthic communities present within the Dogger Bank cSAC.

4.7.98 The MarLIN factor relevant to this impact is ‘smothering’ (see paragraph 4.5.63) for the communities (see **Table 4.11** and **Table 4.12**) identified within the sandbank communities of the Dogger Bank cSAC. Both VER A and VER B communities have a very low (ecological) sensitivity and high recoverability to smothering (see paragraph 4.5.63), whilst the VER C communities display no sensitivity to smothering (see paragraph 4.5.63). It is also noted that such levels of sediment movement, suspension and re-deposition would be expected to be greater and more extensive during winter storms, a natural occurrence that these communities are adapted to. Based on this very low ecological sensitivity (i.e. high tolerance) to short-term and limited smothering, and the low magnitudes and the temporary nature of any deposition expected, it is predicted that there would be no change in species abundance and composition for the subtidal sandbank communities across the Dogger Bank cSAC.

### Teesmouth and Cleveland Coast SPA and Ramsar site (supporting habitat features)

4.7.99 Limited (if any) localised, temporary and intermittent increases in sediment deposition is predicted within the area of supporting habitats within or outside the Teesmouth and Cleveland Coast SPA and Ramsar site (see paragraph 4.7.46). Overall, there would be no predicted change in the supporting habitat (shallow coastal waters) and prey species for the Teesmouth and Cleveland Coast SPA and Ramsar site bird features given the temporary nature and negligible increase in any deposited sediment predicted, particularly given the

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active and variable nature of sediment movement within the shallow coastal waters of Tees Bay.

**Northumbria Coast SPA and Ramsar site (supporting habitat features)**

4.7.100 Limited (if any) localised, temporary and intermittent increases in sediment deposition is predicted within the area of supporting habitats outside the Northumbria Coast SPA and Ramsar site (see paragraph 4.7.48). Overall, there would be no predicted change in the supporting habitat (shallow inshore waters) and prey species for the Northumbria Coast SPA and Ramsar site bird features given the temporary nature and negligible increase in any deposited sediment predicted, particularly given the active and variable nature of sediment movement within the shallow inshore waters of Tees Bay.

**Doggerbank SCI (Germany)**

4.7.101 There would be no deposition of sediment within the Doggerbank SCI (see paragraph 4.7.50). Consequently, no impact on the sandbank communities of the Doggerbank SCI would occur.

**Doggersbank SCI (Netherlands)**

4.7.102 Based on the worst-case scenario (see **Table 2.2**), modelling showed that the maximum sediment deposition within the Doggersbank SCI would be less than 0.5mm or less than 0.1mm on average (see paragraph 4.7.52), and sediment depths of less than 3mm would persist for a maximum of 3 days during the 30-day simulation period for a 50 year storm event (see **Table 4.19**). Given these very low levels of sediment deposition and the very low sensitivity of the sandbank communities to this effect (see paragraph 4.5.63), no change to the abundance and / or species composition of the infaunal and epifaunal communities would occur within the Doggersbank SCI during the operation phase for Dogger Bank Teesside A & B.

## Physical damage (contamination) to habitat feature communities through re-suspension and deposition of contaminated sediment

**Dogger Bank cSAC**

4.7.103 As noted in paragraphs 4.7.34 to 4.7.44, the mobilisation and deposition of sediments during the operation phase would be temporary and, given the negligible change in contaminants identified in paragraph 4.7.53 and their derivation from within existing sediments within the Dogger Bank cSAC, existing levels of contaminants would not change.

4.7.104 VER A, VER B and VER C comprise biotopes that have a low to moderate sensitivity (and moderate recoverability) to contamination via heavy metals, hydrocarbons and synthetic compounds. Consequently, given this and the very low concentrations and the short-term duration of contaminants predicted to be present within the re-suspended and deposited sediments (based on the low levels present, see above), no change to the abundance and / or species composition of the infaunal and epifaunal communities would occur within the Dogger Bank cSAC during the operation of Dogger Bank Teesside A & B.

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**Teesmouth and Cleveland Coast SPA and Ramsar site (supporting habitat features)**

4.7.105 The negligible, short-term and temporary increase (at most) in suspended sediment concentrations (see paragraph 4.7.45) that may occur within the area of supporting habitats of the Teesmouth and Cleveland Coast SPA and Ramsar site potentially could contain elevated levels of contaminants (see paragraph 4.5.34 to 4.5.37 and **Table 4.8** and **Table 4.9**). However, given the rapid mixing and dispersive environment (see paragraphs 4.5.34 to 4.5.37 and paragraph 4.7.54), any contaminants present would not be significantly above background concentrations and their presence would be short-term in duration (hours) and temporary. Consequently, no measurable change to the abundance and / or species composition of the infaunal and epifaunal communities within the supporting habitats of the Teesmouth and Cleveland Coast SPA and Ramsar site (either within or outside the site boundary) is expected.

**Northumbria Coast SPA and Ramsar site (supporting habitat features)**

4.7.106 The negligible, short-term and temporary increase (at most) in suspended sediment concentrations (see paragraph 4.7.46) that may occur within the area of supporting habitats of the Northumbria Coast SPA and Ramsar site potentially could contain elevated levels of contaminants (see paragraph 4.5.34 to 4.5.37 and **Table 4.8** and **Table 4.9**). However, given the rapid mixing and dispersive environment (see paragraphs 4.5.34 to 4.5.37 and paragraph 4.7.55), any contaminants present would not be significantly above background concentrations and their presence would be short-term in duration (hours) and temporary. Consequently, no measurable change to the abundance and / or species composition of the infaunal and epifaunal communities within the supporting habitats of the Northumbria Coast SPA and Ramsar site (either within or outside the site boundary) is expected.

**Doggerbank SCI (Germany)**

4.7.107 Given that no suspended sediments (see paragraph 4.7.49) or deposited sediment (see paragraph 4.7.50) would extend into the Doggerbank SCI, no souce or pathway for contaminants to be mobilised and present within the Doggerbank SCI exists and, therefore, no potential for impact to occur on the subtidal sandbank communities.

**Doggersbank SCI (Netherlands)**

4.7.108 The description of suspended sediment concentrations and sediment deposition during the operation phase (see paragraphs 4.7.51 and 4.7.52), and the source of the re-suspended and deposited sediment, indicate that no new or increased contaminants would be present above existing levels (see paragraph 4.7.57) within the Doggersbank SCI as a result of the operation of Dogger Bank Teesside A. Consequently, no change to the abundance and / or species composition of the infaunal and epifaunal communities would occur within this site as a result of the mobilisation of contaminants during the operation of Dogger Bank Teesside A & B.

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## 4.8 Assessment of impacts during the decommissioning phase

### Introduction

4.8.1 This section identifies and assesses the impacts that are predicted to occur during the decommissioning phase for Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor in relation to the subtidal sandbanks feature of the relevant European sites, as identified in Section 3.5. The activities have been aggregated into the following impact headings:

- Alteration to bathymetry;
- Interruption to sediment transport pathways;
- Alteration to the hydrodynamic regime;
- Physical disturbance to the morphology and physical damage to the structural integrity of habitat features;
- Alteration to the extent, composition and distribution of habitat features;
- Changes to suspended sediment levels;
- Changes to the levels of nutrients and contaminants;
- Direct physical damage to habitat feature communities;
- Physical damage (smothering) to habitat feature communities through increased deposition of sediment;
- Physical damage from increased suspended sediment concentrations;
- Physical damage (smothering) of habitat feature communities through re-distribution and deposition of sediment; and
- Physical damage to habitat feature communities from release of sediment contaminants.

4.8.2 As described in Section 4.6, no construction related impacts would extend into the supporting habitats within the Teesmouth and Cleveland Coast SPA and Ramsar site boundary. Small-scale, short-term and temporary construction related impacts were predicted, which predominantly relate to the re-suspension of sediments due to disturbance during construction of the export cable route. Given the smaller scale of the physical disturbances that would occur during the decommissioning phase for the Dogger Bank Teesside A & B export cable, similar localised and temporary impacts on the supporting habitat features (predominantly the offshore coastal waters) of the Teesmouth and Cleveland Coast SPA and Ramsar site are predicted.

4.8.3 As described in Section 4.6, no construction related impacts would extend into the supporting habitats within the Northumbria Coast SPA and Ramsar site boundary. Small-scale, short-term and temporary construction related impacts were predicted in the supporting habitat (shallow inshore waters) outside the site boundary, predominantly relating to the re-suspension of sediments due to disturbance during construction of the export cable route. Given the smaller scale of the physical disturbances that would occur during the decommissioning

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phase for the Dogger Bank Teesside A & B Export Cable, similar localised and temporary impacts on the supporting habitat features (the offshore inshore waters) of the Northumbria Coast SPA and Ramsar site are predicted.

4.8.4 As described in Section 4.6, no construction related impacts would extend into or affect the sandbank feature of the Doggerbank SCI (Germany). Consequently, given the smaller scale of the physical disturbances that would occur during the decommissioning phase for Dogger Bank Teesside A & B, no subsequent impacts on the Doggerbank SCI (Germany) are expected.

4.8.5 As described in Section 4.6, negligible, short-term and temporary construction related impacts were predicted in the sandbank feature of the Doggersbank SCI (Netherlands), predominantly relating to the re-suspension and deposition of sediments due to disturbance during construction of the offshore wind farm. Given the smaller scale of the physical disturbances that would occur during the decommissioning phase for Dogger Bank Teesside A & B, similar localised and temporary impacts on the subtidal sandbank features of the Doggersbank SCI would be expected. Consequently, a similar conclusion to that reached for the construction phase (of negligible and temporary impacts) is determined for the decommissioning phase.

4.8.6 The following discussion therefore relates solely to the Dogger Bank cSAC in UK waters given the direct potential for impacts to arise on the sandbank feature during decommissioning.

## Alteration to bathymetry

4.8.7 As with construction (see paragraph 4.6.3), seabed disturbance works during the decommissioning phase for Dogger Bank Teesside A & B have the potential to temporarily alter seabed bathymetry. However, given the temporary nature of the disturbances linked to the potential removal of cables or the presence of jack-up barges during structure decommissioning, and that these would all be removed by the completion of the decommissioning phase, no long-term or permanent impacts would occur. Although piles would be cut off below seabed with the remainder of the structures left *in situ*, and buried cables could potentially be left *in situ* (depending on the Decommissioning Plan), these buried structures would not affect the bathymetry across the Dogger Bank cSAC.

## Interruption to sediment transport pathways

4.8.8 As with construction (see paragraph 4.6.8) seabed disturbance works during the decommissioning phase for Dogger Bank Teesside A & B have the potential to temporarily interrupt sediment transport on a localised scale. However, given the temporary nature of any disturbance associated with the potential removal of cables or the presence of jack-up barges during structure decommissioning, and that these would all be removed by the completion of the decommissioning phase, no long-term or permanent sediment transport impacts would occur. Although piles would be cut off below seabed with the remainder of the structures left *in situ*, and buried cables potentially could be left *in situ* (depending on the Decommissioning Plan), these buried structures would not interrupt or obstruct sediment transport across or within the Dogger Bank cSAC.

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## Alteration to the hydrodynamic regime

4.8.9 As with construction (see paragraph 4.6.13), changes to the waves and tidal currents (the hydrodynamic regime) during the decommissioning phase are considered to be temporary impacts, given that all structures would be removed by completion of decommissioning. Although piles would be cut off below the seabed with the remainder of the structures left *in situ*, and buried cables potentially could be left *in situ* (depending on the Decommissioning Plan), these buried structures would not influence the hydrodynamic regime across or within the Dogger Bank cSAC. Consequently, no long-term or permanent impacts or changes to the hydrodynamic regime would occur during the decommissioning phase for Dogger Bank Teesside A & B.

## Physical disturbance to the morphology and physical damage to the structural integrity of habitat features

4.8.10 The morphology of the sandbank habitat is determined by the bathymetry and sediment composition and the interactions of waves and tidal currents upon these structural elements. Given the temporary changes to bathymetry (paragraph 4.8.7), sediment structure (paragraph 4.8.11), suspended sediments (paragraph 4.8.12), sediment transport (paragraph 4.8.8), and hydrodynamic processes (paragraph 4.8.9) predicted, no long-term or permanent changes would arise on morphology of the sandbank feature given that all structures would be removed (with the exception that piles and cables may be left buried under the seabed as noted in paragraph 4.8.7). Consequently, the structural integrity of the Dogger Bank cSAC would be maintained.

## Alteration to the extent, composition and distribution of habitat features

4.8.11 As with construction (see paragraph 4.6.23) temporary disturbance to seabed sediments would occur during the decommissioning phase. The sediments covered by the hard substrate foundations of the operation phase (9.40km$^2$) would be revealed and, following colonisation and establishment of benthic communities, the extent, composition and distribution of habitat features would be expected to be similar to the pre-construction baseline. Given the temporary nature of any disturbance during the decommissioning phase and that overall the effects of disturbance would be smaller in scale than during the construction phase, there would be no long-term or permanent impacts or changes to the extent, composition and distribution of sandbank habitat within the Dogger Bank cSAC. A return to similar pre-construction conditions would be expected. The presence of piles remaining below seabed or buried cables being left *in situ* (depending on the Decommissioning Plan) would not influence the extent, composition and distribution of sandbank habitat within the Dogger Bank cSAC.

## Changes to suspended sediment levels

4.8.12 As with construction (see paragraph 4.6.28 to 4.6.32), disturbance works (cable removal, lifting foundations, and removal of any structures) during decommissioning could result in the re-suspension of seabed sediments resulting in increased suspended sediment concentrations. However, the quantities of sediment that would be disturbed would be significantly less (12.116km$^2$ compared to 35.70km$^2$, which is 66% less, in terms of area) than

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that during the construction phase due to the lack of piling activity and seabed preparation. Similarly, the sediment deposition depths (see paragraphs 4.6.34 to 4.6.38) would be reduced in comparison to the construction phase due to the smaller volumes of sediment that would be released. As with the construction phase, any deposited sediment would not persist in the longer term and no permanent effects of deposited sediment are predicted.

## Changes to the levels of nutrients and contaminants

4.8.13 As with construction (see paragraph 4.6.47), the re-suspension of sediments as a result of temporary disturbance during decommissioning would be highly variable both in terms of spatial and temporal distribution. Given that no contaminants are being introduced into the site, all contaminants re-suspended and deposited would derive from the seabed sediments already present within the Dogger Bank cSAC, and the amount of material re-suspended would be lower than that for the construction phase (see paragraph 4.8.12 above). Consequently, the temporary movement and dispersion and settlement of the suspended sediments and any of the low levels of contaminants (see paragraph 4.5.33) within them would not be expected to alter the chemical properties within the Dogger Bank cSAC.

## Physical damage to habitat feature communities

4.8.14 During decommissioning, the potential removal of buried cableswould disturb and damage any subtidal sandbank benthic communities that had become established in areas previously disturbed druing cable installation. Other localised disturbance would also arise around foundations as they are lifted or removed. The largest source of this temporary disturbance (see **Table 2.2**) would be the removal of inter-array cables (3.80km$^2$), to the removal of inter-platform cables (1.28km$^2$), removal of the export cable (0.816km$^2$), seabed disturbance during lifting of structures (3.202km$^2$) jacking-up of vessels (2.016km$^2$), and anchor points for vessels in the wind farm (0.93km$^2$) and within the Dogger Bank Teesside A & B Export Cable Corridor (0.072km$^2$). The removal of cables would affect a reduced width of seabed (2m) compared to the construction phase, which assumed a 10m disturbance width. Overall, a maximum predicted extent of subtidal sandbank communities disturbed would be 12.116km$^2$, representing 0.10% of the Dogger Bank cSAC.

4.8.15 The biotopes within VERs A and B comprise species that are adapted to high energy environments and are therefore naturally subject to, and tolerant of, high levels of physical disturbance, i.e. they show high levels of recoverability. However, the biotopes within VER C are moderately sensitive to disturbance due to their longer recovery time. Overall, given the recoverability of the biotopes over time and the negligible area of the Dogger Bank cSAC (0.10%) that would be affected (and considering that the communities are widespread throughout the Dogger Bank cSAC) by physical disturbance during decommissioning on an incremental basis, it is considered that decommissioning would not give rise to any significant impact to the constituent communities of the sandbanks feature of the Dogger Bank cSAC. All temporarily disturbed areas would return to pre-disturbance levels (with some

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areas previously disturbed during the construction phase and to a lesser extent the operation phase) within the short- to medium-term.

4.8.16 After decommissioning there would be no further disturbance and the site would return to a 'naturally' functioning system, though subject to other activities that may take place not related to Dogger Bank Teesside A & B. This would result in a shift in benthic communities from the epifauna and hard substrate adapted fauna (which retained features of the existing VER C communities) towards the typical sediment dwelling communities (VER A, VER B, and VER C) that are currently present throughout the Dogger Bank cSAC.

## Physical damage to habitat feature communities from increased suspended sediment concentrations

4.8.17 During decommissioning, the removal of all components (i.e. foundations, cables, scour protection, etc.) detailed in **Table 2.2** would result in short-term and temporary increases in suspended sediment concentrations generated by the removal of structures from the seabed. Given that the levels of suspended sediment concentrations would be lower than those for the construction phase (see paragraph 4.8.12), that they would be temporary, and based on the sandbank benthic communities' very low sensitivity and high recoverability (see paragraph 4.5.65), the predicted increase in suspended sediment concentrations would not be expected to result in any significant change to the abundance and / or species composition of the observed infaunal and epifaunal communities of the sandbank feature of the Dogger Bank cSAC.

4.8.18 After decommissioning there would be no further disturbance and the suspended sediment concentrations and their distribution would return to a 'naturally' functioning system, though subject to other activities that may take place not related to Dogger Bank Teesside A & B.

## Physical damage (smothering) to habitat feature communities through increased deposition of sediment

4.8.19 Suspended sediment generated by the disturbance of the seabed during the removal of structures from the seabed would be re-deposited within the surrounding area (and within the Dogger Bank cSAC). The levels of sediment deposition would be lower than those for the construction phase (see paragraph 4.8.12). Consequently, based on the sandbank benthic communities' very low sensitivity and high recoverability (see paragraph 4.5.63), and the temporary and very low levels of sediment deposition that would arise no significant change to the abundance and / or species composition of the infaunal and epifaunal communities would be expected.

4.8.20 After decommissioning there would be no further disturbance and the re-suspended sediments and the location and depth of their deposition would return to a 'naturally' functioning system, though subject to other activities that may take place not related to Dogger Bank Teesside A & B.

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### Physical damage (contamination) to habitat feature communities through re-suspension and deposition of contaminated sediment

4.8.21 As any contaminants present in re-suspended and deposited sediments would be of historical origin (i.e. no new contaminants would be introduced) no change to contaminant levels in sediments that may affect the abundance and / or species composition of the infaunal and epifaunal communities of the subtidal sandbanks feature of the Dogger Bank cSAC would be expected.

## 4.9 Summary of assessment findings and conclusions on site integrity of UK sites

4.9.1 This section presents the assessment of the effects of Dogger Bank Teesside A & B on the conservation objectives and related favourable condition criteria of the Annex I features of the marine and coastal SACs/cSACs and supporting habitats of coastal SPAs screened into the HRA process. The conclusions discussed here are based on the assessment of the impacts set out in Section 4.6 (construction phase), Section 4.7 (operation phase), and Section 4.8 (decommissioning phase), based on the worst case scenario (see **Table 2.2**).

4.9.2 The assessment of impact on the integrity of a European site has been undertaken in view of the site's conservation objectives, as listed for the relevant sites and features in Section 4.2. For the purposes of assessment, and in line with accepted guidance (EC 2000), the integrity of a site is defined as "*the coherence of its ecological structure and function, across its whole area, that enables it to sustain the habitat, complex of habitats and/or the levels of populations of the species for which it was classified*".

### Conclusions on integrity of Dogger Bank cSAC

#### Construction phase

4.9.3 The assessment of the construction phase for Dogger Bank Teesside A & B with respect to the Dogger Bank cSAC conservation objectives (listed in paragraph 4.2.2) is presented in **Table 4.22**. The assessment identified that the impacts that could occur within and around the Dogger Bank cSAC boundary and affect the site's subtidal sandbanks feature would be temporary, short-term, small-scale in magnitude, and remain within the existing range experienced and to which the species and communities of the subtidal sandbank feature are adapted. Furthermore, where species and communities would be temporarily affected, they have a low to moderate sensitivity to the disturbance impact and relatively quick recovery would be expected. Consequently, the construction phase for the project would not affect the achievement of favourable condition with respect to the restoration of or impacts on the features of the Dogger Bank cSAC. It is, therefore, concluded that there would not be an adverse effect on the integrity of the Dogger Bank cSAC as a result of the construction of Dogger Bank Teesside A & B.

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### Operation phase

4.9.4 The assessment of the operation phase for Dogger Bank Teesside A & B against the Dogger Bank cSAC conservation objectives (listed in paragraph 4.2.2) is presented in **Table 4.23**. The assessment identified that, apart from long-term habitat loss, the majority of the effects associated with the operation of Dogger Bank Teesside A & B that could occur within and around the Dogger Bank cSAC boundary and affect the site's subtidal sandbanks feature would be temporary, short-term, very small-scale in magnitude, and remain within the ranges currently experienced by the species and communities of the subtidal sandbank feature, and to which they are adapted. Furthermore, where species and communities would be temporarily affected by intermittent disturbance, they have a low to moderate sensitivity to the disturbance impact and relatively quick recovery would be expected. Consequently, the operation phase for the project would not affect the achievement of favourable condition with respect to the impacts on or restoration of the features of the Dogger Bank cSAC. It is therefore concluded that, under the worst case scenario investigated, there would not be an adverse effect on the integrity of the Dogger Bank cSAC as a result of the operation of Dogger Bank Teesside A & B.

### Decommissioning phase

4.9.5 The assessment of the decommissioning phase (see Section 4.8) for Dogger Bank Teesside A & B against the Dogger Bank cSAC's conservation objectives (listed in paragraph 4.2.2) is presented in **Table 4.24**. Given that the effects of the decommissioning phase are the same, albeit smaller in magnitude and intensity, to those described and assessed for the construction phase and, given that all effects would be temporary, it is concluded that there would not be an adverse effect on the integrity of the Dogger Bank cSAC as a result of the decommissioning of Dogger Bank Teesside A & B.

## Conclusions on integrity of the Teesmouth and Cleveland Coast SPA and Ramsar sites supporting habitats

### Construction phase

4.9.6 The assessment of the construction phase for Dogger Bank Teesside A & B with respect to the supporting habitat features of the Teesmouth and Cleveland Coast SPA (and Ramsar site) within Section 4.6 identified that no change to the supporting habitat features would arise outside of the existing range of variability of the physical and chemical processes. As a consequence, it can be concluded that no change to the morphology and structural integrity of the supporting habitat features would occur. No change was also identified with respect to the communities associated with the supporting habitat features. The construction phase for Dogger Bank Teesside A & B would, therefore, not affect the achievement of favourable condition with respect to the maintenance and restoration of the conservation objectives (listed in paragraph 4.2.15) of the supporting habitat features of the Teesmouth and Cleveland Coast SPA (and Ramsar site). With respect to conclusions on the integrity of the site, reference is made to Section 6 in relation to the populations of the Teesmouth and Cleveland Coast SPA (and Ramsar site) bird features.

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Table 4.22 Consideration of the construction phase impacts in relation to the achievement of the conservation objectives for the subtidal sandbank feature of the Dogger Bank cSAC

| Conservation objective | Project implications in relation to the achievement of the conservation objectives |
|---|---|
| Subject to natural change, restore the sandbanks to favourable condition, such that the natural environmental quality is restored. | Predicted increases in suspended sediment concentrations would be spatially and temporally discrete across Dogger Bank and within the range of values that arise under natural, storm induced conditions (see paragraphs 4.6.28 to 4.6.32).<br>All sources of contaminants in re-suspended sediments would derive from the existing very low levels of contaminants present (see paragraph 4.5.33), and no increase in contaminant levels would occur above the existing fractions present in suspended sediments or waters within the cSAC (see paragraph 4.6.47).<br>**Achievement of the conservation objective would not be compromised.** |
| Subject to natural change, restore the sandbanks to favourable condition, such that the natural environmental processes and the extent are maintained. | The construction phase would result in temporary changes to bathymetry (see paragraph 4.6.3); that would not result in any long-term change to natural processes. The long-term effects of bathymetric change are considered in the operation phase.<br>Seabed disturbance works during the construction phase have the potential to temporarily interrupt sediment transport (see paragraph 4.6.8); although it is determined that the small-scale (localised) nature of any interruption to sediment transport would not result in long-term change to the favourable condition of natural processes. The long-term effects of changes to sediment transport patterns are considered in the operation phase.<br>The construction phase would result in temporary changes to tidal currents and waves (see paragraph 4.6.13), however, the predicted temporary changes to these hydrodynamic processes (waves and tides) would not result in long-term change to the favourable condition of natural processes. The long-term effects of hydrodynamic changes are considered in the operation phase.<br>Deposition of re-suspended sediments released during construction would be influenced by existing tidal currents and storm driven processes and would be distributed relative to existing sediments. Due to re-working of sediments released during construction, no significant deposition of sediment is predicted within the Dogger Bank (see paragraphs 4.6.34 to 4.6.38). All sediment re-suspended by tidal currents would be deposited within the site; therefore, there would be no loss of sediment out of the system during the construction phase. The long-term sediment balance is considered in the operation phase.<br>Morphology would be influenced by the cumulative effects of the above natural processes. The temporary changes to bathymetry, sediment transport patterns, tides, waves, and the deposition of sediment predicted for the construction phase would not result in any significant deterioration of the sandbanks feature such that its structural integrity would be affected (see paragraph 4.6.18). Potential long-term changes are considered in the operation phase. Overall, the changes to morphology and its active processes during the construction phase fall within the existing ranges experienced within the Dogger Bank cSAC.<br>**Achievement of the conservation objective would not be compromised.** |


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| Conservation objective | Project implications in relation to the achievement of the conservation objectives |
|---|---|
| Subject to natural change, restore the sandbanks to favourable condition, such that the natural environmental processes and the extent are maintained (continued from above). | The construction phase would result in temporary changes to the extent, composition and distribution of seabed sediments and sandbank habitat (see paragraph 4.6.23). The long-term effects are considered in the operation phase.<br>Temporary disturbance would arise with respect to approximately 0.29% of the benthic communities of the subtidal sandbanks feature of the Dogger Bank cSAC (see paragraph 4.6.54). Given the low to moderate sensitivity of the species (and communities) to physical disturbance and their moderate to high recoverability only a short to medium-term impact would occur, similar to the existing disturbance that occurs with respect to storm conditions (and bottom trawling); disturbance conditions that the communities within the Dogger Bank cSAC are adapted to (see paragraphs 4.6.56 to 4.6.59). In addition, increased suspended sediment concentrations and sediment deposition resulting from seabed disturbance during the construction phase would not cause significant measurable disturbance to those communities outside any areas directly affected by substrate disturbance (see above). Given the very low sensitivity of the communities to increased suspended sediment concentrations and sediment deposition, and given that the changes predicted fall within the range of conditions currently experienced within the Dogger Bank cSAC, no significant changes to the communities are predicted to occur. Overall, no long-term changes in the extent, composition and distribution of the benthic communities are expected.<br>**Achievement of the conservation objective would not be compromised.** |
| Subject to natural change, restore the sandbanks to favourable condition, such that the physical structure, diversity, community structure and typical species, representative of sandbanks which are slightly covered by seawater all the time, in the Southern North Sea, are restored. | The predicted small scale and temporary alteration to subtidal sandbank communities from physical disturbance or sediment deposition (see above) during construction would not significantly alter the diversity, community structure or typical species given the small-scale disturbance that would occur, and the very low to moderate sensitivity and moderate to high recoverability of the communities that could be impacted. Consequently, no long-term change given natural variability in the abundance, biomass, composition, etc., of benthic communities would be expected (see paragraphs 4.6.56 to 4.6.59).<br>**Achievement of the conservation objective would not be compromised.** |


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Table 4.23 Consideration of the operation phase impacts in relation to the achievement of the conservation objectives for the subtidal sandbank feature of the Dogger Bank cSAC

| Conservation objective | Project implications in relation to the achievement of the conservation objectives |
|---|---|
| Subject to natural change, restore the sandbanks to favourable condition, such that the natural environmental quality is restored. | An increase in suspended sediment concentrations as a result of disturbance to seabed sediments (from increased scour due to the presence of structures in the operation phase or from maintenance activities) could affect the achievement of this objective particularly with regard to allowing natural recovery of the subtidal sandbanks feature. However, given the intermittent and temporary predicted nature of any such increase (see paragraphs 4.7.34 to 4.7.40) and that concentrations of suspended sediment would fall within the range of values associated with natural processes (storm induced change) then the predicted increase is not viewed as being significant.<br>All sources of contaminants in scour induced re-suspended sediments would derive from the existing very low levels of contaminants present within the Dogger Bank cSAC (see paragraph 4.5.33), and no increase in contaminant levels would therefore occur above the existing fractions present in suspended sediments or waters within the Dogger Bank cSAC (see paragraph 4.7.53).<br>**Achievement of the conservation objective would not be compromised.** |
| Subject to natural change, restore the sandbanks to favourable condition, such that the natural environmental processes and the extent are maintained. | The presence of structures during the operation phase would result in negligible changes to bathymetry within the Dogger Bank cSAC. 99.9992% of the site would remain unchanged (see paragraph 4.7.59).<br>Though structures could potentially interrupt sediment transport, given that this would be restricted to the immediate vicinity of the structures and would not affect sediment transport processes at the scale of the cSAC (see paragraph 4.7.9).<br>Very small changes to wave and tidal current properties (the hydrodynamic regime) within the Dogger Bank cSAC would occur as a result of the presence of the wind farm structures (see paragraph 4.7.14 to 4.7.16). These predicted changes fall within the existing range of wave heights and tidal currents across the Dogger Bank cSAC.<br>Scour ofsediment would occur around structures and their foundations during the operation phase. Modelling was undertaken for a 50 year storm period to ascertain the depth and persistence of deposited sediments for the worst case scenario. The model results indicate that sediment deposition depth would be extremely low and temporary in terms of persistence and within the predicted existing range of experienced during extreme storm events (see paragraphs 4.7.41 to 4.7.44). Further calculations indicate that the project could result in approximately 18% more material in suspension within the area of structures above the seabed during significant storm events (see paragraph 4.7.40). However, given the variability in suspended sediment concentrations and their deposition patterns, and the temporary nature of the effect this is not considered to be a significant change.<br>*Continued below.* |

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| Conservation objective | Project implications in relation to the achievement of the conservation objectives |
|---|---|
| Subject to natural change, restore the sandbanks to favourable condition, such that the natural environmental processes and the extent are maintained (continued from above). | Morphology would be influenced by the cumulative effects of predicted changes to bathymetry, sediment transport patterns, tides, waves, and the deposition of sediment. Given the natural variability in these processes (and the resultant morphological response across the cSAC to these processes) the very small changes predicted as a result of the project (most falling within the ranges associated with natural conditions) would not, other than small-scale localised change, significantly alter the morphology of structural integrity of the sandbanks feature (see paragraph 4.7.24). All sediment re-suspended by tidal currents would be re-deposited within the site and there would be no long-term loss of sediment out of the system.<br>**Achievement of the conservation objective would not be compromised.** |
| | The physical footprint of the offshore wind farm structures would result in a long-term (until decommissioned) change in the distribution and extent of the substrates within the Dogger Bank cSAC. Harder substrates would increase by 9.40km$^2$, which represents 0.08% of the entire cSAC extent (see paragraph 4.7.59). The other substrate types (gravel, sand, mixed, and unit 'c') would reduce in extent depending on their percentage presence within the Dogger Bank cSAC and the final locations of the wind farm structures. Overall, it is considered that these worst case changes in substrate composition and area extent, at the scale of the cSAC are not significant.<br>Temporary disturbance would arise for less than 0.02% of the subtidal sandbanks communities as a result of the presence of jack-up vessels during maintenance activities in each year of operation (see paragraph 4.7.76). This effect would occur at unique locations year on year, and would be intermittent throughout the lifetime of the wind farm. Its magnitude is considered to be very small-scale, with recovery of affected communities after disturbance (see paragraph 4.7.76). Moreover, disturbance effects would not fall outside of the existing range of the morphological and other active processes within the Dogger Bank cSAC that the benthic communities are subject to.<br>Whilst some community / biotope types may be locally affected by altered substrate type, the presence of biotopes and communities already associated with harder substrates within the Dogger Bank cSAC, indicates that the composition of the existing range of sandbanks communities within the Dogger Bank cSAC would not be altered, other than in terms of very small-scale and localised changes in extent associated with the wind farm structures themselves.<br>**Achievement of the conservation objective would not be compromised.** |
| Subject to natural change, restore the sandbanks to favourable condition, such that the physical structure, diversity, community structure and typical species, representative of sandbanks which are slightly covered by seawater all the time, in the Southern North Sea, are restored. | The small scale and temporary alteration to subtidal sandbank communities predicted due to physical disturbance (see above) or sediment deposition during the operation phase would not significantly alter the communities' diversity, community structure or the typical species present, particularly given the very low to low sensitivity and high recoverability of the communities. The predicted changes to the physical structure and morphology are very small in scale, and fall within the existing range of the physical processes (waves, tides, suspended sediments, sediment deposition, etc.) acting on and within the Dogger Bank cSAC. Furthermore, these processes and other existing activities (such as beam trawling) would continue to influence and result in change in terms of the distribution, extent and composition of the sandbanks communities (see paragraphs 4.7.81 and 4.7.82).<br>**Achievement of the conservation objective would not be compromised.** |


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Table 4.24 Consideration of the decommissioning phase impacts in relation to the achievement of the conservation objectives for the subtidal sandbank feature of the Dogger Bank cSAC

| Conservation objective | Project implications in relation to the achievement of the conservation objectives |
|---|---|
| Subject to natural change, restore the sandbanks to favourable condition, such that the natural environmental quality is restored. | Potential increases in suspended sediment concentrations during decommissioning would not be significant in the context of natural, levels of suspended sediment that arise during storm conditions and the intermittent and temporary nature of any increases associated with decommissioning activities (see paragraph 4.8.12).<br>All sources of contaminants in re-suspended sediments would derive from the existing very low levels of contaminants present (see paragraph 4.5.33), and no increase in contaminant levels would occur above the existing fractions present in suspended sediments or waters within the Dogger Bank cSAC (see paragraph 4.8.13), particularly given the limited disturbance during the decommissioning phase.<br>**Achievement of the conservation objective would not be compromised.** |
| Subject to natural change, restore the sandbanks to favourable condition, such that the natural environmental processes and the extent are maintained. | The decommissioning phase would result in temporary changes to bathymetry (see paragraph 4.8.7) however these temporary changes to bathymetry would not result in long-term change to natural processes. Furthermore, all structures would be removed from the site (or if relevant remain buried) on completion of decommissioning and, therefore, the bathymetry would revert to pre-construction conditions within the Dogger Bank cSAC.<br>Seabed disturbance works have the potential to temporarily interrupt sediment transport (see paragraph 4.8.8) however these temporary and localised changes to sediment transport patterns would not result in long-term change to natural processes. On completion of decommissioning there would be no structures remaining (or extant structures would remain buried) to result in the interruption to, or the obstruction of, sediment transport. Therefore, no long-term or permanent alteration to sediment transport patterns would occur.<br>The decommissioning phase would result in temporary changes to tidal currents and waves (see paragraph 4.8.9) that would not result in long-term or permanent change to natural processes and all effects and changes to hydrodynamic properties would cease on completion of decommissioning.<br>Deposition of re-suspended sediments during decommissioning would be influenced by existing tidal currents and storm driven processes and, as such, sediment would be distributed locally across the Dogger Bank cSAC by the existing natural processes. Given that deposition would fall within the existing ranges experienced during severe storm events (see paragraph 4.8.12), and would be temporary, no long-term changes in the extent, composition and distribution of substrate is expected outside of the existing range occurring within the Dogger Bank cSAC (see paragraphs 4.8.11).<br>*Continued below.* |

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| Conservation objective | Project implications in relation to the achievement of the conservation objectives |
|---|---|
| Subject to natural change, restore the sandbanks to favourable condition, such that the natural environmental processes and the extent are maintained (*continued from above*). | Morphology would be influenced by the cumulative effects of the above natural processes. The temporary changes predicted to the bathymetry, sediment transport patterns, tides, waves, and the deposition of sediment during the short time-scale of the decommissioning phase would not result in a significant deterioration to the sandbanks feature that would affect its structural integrity (see paragraph 4.8.10). Overall, the changes to morphology and its active processes during the decommissioning phase would fall within the existing natural range of these processes experienced within the cSAC. All sediment re-suspended by decommissioning activities would be deposited within the Dogger Bank cSAC therefore there would be no loss of sediment out of the system during this phase. On completion of decommissioning any influences as a result of Dogger Bank Teesside A & B would cease, and no long-term or permanent changes however small would occur.<br>**Achievement of the conservation objective would not be compromised.** |
| | The decommissioning phase would result in temporary changes to the extent, composition and distribution of seabed sediments and sandbank habitat (see paragraph 4.8.11). The removal of project infrastructure would enable reversion over time to a range of sediment extent, composition and distribution fully controlled by natural physical and ecological processes.<br>Temporary disturbance would arise with respect to approximately 0.10% of the benthic communities of the subtidal sandbanks feature of the Dogger Bank cSAC during the decommissioning phase (see paragraph 4.8.14). The low to moderate sensitivity of the species (and communities) that would be affected by physical disturbance and their moderate to high recoverability, together with the very small area affected indicates the effects of disturbance would not be significant at the scale of the cSAC(see paragraphs 4.8.15). In addition, the increased suspended sediment concentrations and sediment deposition due to seabed disturbance would not cause significant measurable disturbance to those communities outside any areas directly affected by substrate disturbance (see above). Given the very low sensitivity of the communities to increased suspended sediment concentrations and sediment deposition, and that these processes currently occur within the cSAC, and that the changes predicted fall within the ranges currently experienced within the cSAC, no significant changes to the communities would be predicted to occur within the Dogger Bank cSAC. Overall, no long-term changes in the extent, composition and distribution of the benthic communities are expected beyond localised temporary changes. All disturbance activities would cease on completion of the decommissioning phase.<br>**Achievement of the conservation objective would not be compromised.** |
| Subject to natural change, restore the sandbanks to favourable condition, such that the physical structure, diversity, community structure and typical species, representative of sandbanks which are slightly covered by seawater all the time, in the Southern North Sea, are restored. | The small scale and temporary alteration to subtidal sandbank communities from physical disturbance or sediment deposition (see above) during decommissioning would not significantly alter the diversity, community structure or typical species given the very small-scale disturbance that would occur, and the very low to low sensitivity and high recoverability of the communities that could be impacted. Given existing variability in aspects such as abundance, biomass, range, etc. (see paragraphs 4.8.14 to 4.8.21) it is expected that any residual alteration to communities as a result of the project would be within the variation shown. Following completion of decommissioning, recovery of locally disturbed communities would occur and no further perturbance would arise.<br>**Achievement of the conservation objective would not be compromised.** |


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### Operation phase

4.9.7 The assessment of the operation phase for Dogger Bank Teesside A & B with respect to the supporting habitat features of the Teesmouth and Cleveland Coast SPA (and Ramsar site) within Section 4.7 identified that no change to the supporting habitat features would arise outside of the existing range of variability of the physical and chemical processes. As a consequence, it can be concluded that no change to the morphology and structural integrity of the supporting habitat features would occur. No change was also identified with respect to the communities associated with the supporting habitat features. The operation phase for Dogger Bank Teesside A & B would, therefore, not affect the achievement of favourable condition with respect to the maintenance and restoration of the conservation objectives (listed in paragraph 4.2.15) of the supporting habitat features of the Teesmouth and Cleveland Coast SPA (and Ramsar site). With respect to conclusions on the integrity of the site, reference is made to Section 6 in relation to the populations of the Teesmouth and Cleveland Coast SPA (and Ramsar site) bird features.

### Decommissioning phase

4.9.8 The assessment of the decommissioning phase for Dogger Bank Teesside A & B with respect to the supporting habitat features of the Teesmouth and Cleveland Coast SPA (and Ramsar site) within Section 4.8 identified that no change to the supporting habitat features would arise outside of the existing range of variability of the physical and chemical processes. As a consequence, it can be concluded that no change to the morphology and structural integrity of the supporting habitat features would occur. No change was also identified with respect to the communities associated with the supporting habitat features. The decommissioning phase for Dogger Bank Teesside A & B would, therefore, not affect the achievement of favourable condition with respect to the maintenance and restoration of the conservation objectives (listed in paragraph 4.2.15) of the supporting habitat features of the Teesmouth and Cleveland Coast SPA (and Ramsar site). With respect to conclusions on the integrity of the site, reference is made to Section 6 in relation to the populations of the Teesmouth and Cleveland Coast SPA (and Ramsar site) bird features.

## Conclusions on integrity of the Northumbria Coast SPA and Ramsar sites supporting habitats

### Construction phase

4.9.9 The assessment of the construction phase for Dogger Bank Teesside A & B with respect to the supporting habitat features of the Northumbria Coast SPA (and Ramsar site) within Section 4.7 identified that no change to the supporting habitat features would arise outside of the existing range of variability of the physical and chemical processes. As a consequence, no change to the morphology and structural integrity of the supporting habitat features would occur. No change was also identified with respect to the communities associated with the supporting habitat features. The construction phase for Dogger Bank Teesside A & B would, therefore, not affect the achievement of favourable condition with respect to the maintenance and restoration of the conservation objectives (listed in paragraph 4.2.11) of the supporting habitat

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features of the Northumbria Coast SPA (and Ramsar site). With respect to conclusions on the integrity of the site, reference is made to Section 6 in relation to the populations of the Northumbria Coast SPA (and Ramsar site) bird features.

**Operation phase**

4.9.10 The assessment of the operation phase for Dogger Bank Teesside A & B with respect to the supporting habitat features of the Northumbria Coast SPA (and Ramsar site) within Section 4.7 identified that no change to the supporting habitat features would arise outside of the existing range of variability of the physical and chemical processes. As a consequence, no change to the morphology and structural integrity of the supporting habitat features would occur. No change was also identified with respect to the communities associated with the supporting habitat features. The operation phase for Dogger Bank Teesside A & B would, therefore, not affect the achievement of favourable condition with respect to the maintenance and restoration of the conservation objectives (listed in paragraph 4.2.11) of the supporting habitat features of the Northumbria Coast SPA (and Ramsar site). With respect to conclusions on the integrity of the site, reference is made to Section 6 in relation to the populations of the Northumbria Coast SPA (and Ramsar site) bird features.

**Decommissioning phase**

4.9.11 The assessment of the decommissioning phase for Dogger Bank Teesside A & B with respect to the supporting habitat features of the Northumbria Coast SPA (and Ramsar site) within Section 4.8 identified that no change to the supporting habitat features would arise outside of the existing range of variability of the physical and chemical processes. As a consequence, no change to the morphology and structural integrity of the supporting habitat features would occur. No change was also identified with respect to the communities associated with the supporting habitat features. The decommissioning phase for Dogger Bank Teesside A & B would, therefore, not affect the achievement of favourable condition with respect to the maintenance and restoration of the conservation objectives (listed in paragraph 4.2.11) of the supporting habitat features of the Northumbria Coast SPA (and Ramsar site). With respect to conclusions on the integrity of the site, reference is made to Section 6 in relation to the populations of the Northumbria Coast SPA (and Ramsar site) bird features.

## 4.10 Summary of assessment findings and conclusions on site integrity of transboundary sites

4.10.1 This section presents the assessment of the effects of Dogger Bank Teesside A & B on the conservation objectives assumed for the Annex I features of the transboundary marine SCIs screened into the HRA process. The conclusions discussed here are based on the assessment of the impacts set out in Section 4.6 (construction phase), Section 4.7 (operation phase), and Section 4.8 (decommissioning phase), based on the worst case scenario (see Table 2.2).

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4.10.2 The assessment of impact on the integrity of the relevant transboundary European sites has been undertaken in view of the Dogger Bank cSAC's subtidal sandbanks feature's conservation objectives, as listed in paragraphs 4.2.2.

## Conclusions on integrity of Doggerbank SCI (Germany)

### Construction phase

4.10.3 The assessment has identified (see Section 4.6) that no construction related impacts (direct or indirect) would extend to the Doggerbank SCI, and therefore no impact would arise on the subtidal sandbank feature. Consequently, it is concluded that there would not be an adverse effect on the integrity of the Doggerbank SCI as a result of the construction of Dogger Bank Teesside A & B.

### Operation phase

4.10.4 The assessment of the operation phase for Dogger Bank Teesside A & B (see Section 4.7) on the subtidal sandbank feature of the Doggerbank SCI identified that no operation phase impacts (direct or indirect) would extend to the Doggerbank SCI, and therefore no impact would arise on the subtidal sandbank feature. Consequently, it is concluded that there would not be an adverse effect on the integrity of the Doggerbank SCI as a result of the operation of Dogger Bank Teesside A & B.

### Decommissioning phase

4.10.5 The assessment has identified (see Section 4.8) that no decommissioning related impacts (direct or indirect) would extend to the Doggerbank SCI (based on the assessment of impacts in the construction phase, which would be greater in scale than those during decommissioning), and therefore no impact would arise on the subtidal sandbank feature. Consequently, it is concluded that there would not be an adverse effect on the integrity of the Doggerbank SCI as a result of the decommissioning of Dogger Bank Teesside A & B.

## Conclusions on integrity of Doggersbank SCI (Netherlands)

### Construction phase

4.10.6 The assessment of the construction phase (see Section 4.6) for Dogger Bank Teesside A & B with respect to the Doggersbank SCI subtidal sandbank feature (using the same conservation objectives as the Dogger Bank cSAC listed in paragraph 4.2.2) identified that the impacts that could occur within and around the Doggersbank SCI boundary would be temporary, short-term, small-scale in magnitude, and remain within the existing range experienced and to which the species and communities of the subtidal sandbank feature are adapted. Furthermore, where species and communities would be temporarily affected, they have a low to moderate sensitivity to the disturbance impact and would recover within five years. Consequently, the construction phase for the project would not affect the achievement of favourable condition of the Doggersbank SCI. It is, therefore, concluded that there would not be an adverse effect on the integrity of the Doggersbank SCI as a result of the construction of Dogger Bank Teesside A & B.

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### Operation phase

4.10.7 The assessment of the operation phase (see Section 4.7) for Dogger Bank Teesside A & B with respect to the Doggersbank SCI subtidal sandbank feature (using the same conservation objectives as the Dogger Bank cSAC listed in paragraph 4.2.2) identified that the impacts that could occur within and around the Doggersbank SCI boundary would be temporary, short-term, very small-scale in magnitude, and remain within the ranges currently experienced by the species and communities of the subtidal sandbank feature, and to which they are adapted. Furthermore, where species and communities would be temporarily affected by intermittent disturbance, they have a low to moderate sensitivity to the disturbance impact and would recover within five years. Consequently, the operation phase for the project would not affect the achievement of favourable condition with respect the features of the Doggersbank SCI. It is therefore concluded that, under the worst case scenario investigated, there would not be an adverse effect on the integrity of the Doggersbank SCI as a result of the operation of Dogger Bank Teesside A & B.

### Decommissioning phase

4.10.8 The assessment of the decommissioning phase (see Section 4.8) for Dogger Bank Teesside A & B with respect to the Doggersbank SCI subtidal sandbank feature (using the same conservation objectives as the Dogger Bank cSAC listed in paragraph 4.2.2) identified that the effects of the decommissioning phase are the same, albeit smaller in magnitude and intensity, to those described and assessed for the construction phase (see paragraph 4.10.6). It is therefore concluded that, under the worst case scenario investigated, there would not be an adverse effect on the integrity of the Doggersbank SCI as a result of the decommissioning of Dogger Bank Teesside A & B.

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# 5 Annex II Designated Species (and their Sites)

## 5.1 Introduction

5.1.1 This section identifies and assesses the predicted impacts of Dogger Bank Teesside A & B on European sites for which Annex II species are a qualifying feature and that have been screened into the appropriate assessment stage of the HRA process (see Section 3.4). These sites and the relevant Annex II species are listed in **Table 5.1** and shown on **Figures 3.2** and **3.3**.

Table 5.1 European sites with Annex II features assessed in this section

| Feature | European sites (site reference on Figure 3.2 for grey seal and Figure 3.3 for harbour porpoise) | Distance (km) | |
|---|---|---|---|
| | | Dogger Bank Teesside A & B Export Cable Corridor[1] | Dogger Bank Teesside A & B |
| **UK** | | | |
| Grey seal | Berwickshire and North Northumberland Coast SAC (UK1) | 91km | 221km |
| | Faray and Holm of Faray SAC (UK2) | 523km | 546km |
| | Humber Estuary SAC and Ramsar site (UK3) | 96km | 194km |
| | Isle of May SAC (UK4) | 199km | 311km |
| **Belgium** | | | |
| Grey seal | SBZ1 pSCI (BE1) | 414km | 402km |
| | SBZ2 pSCI (BE2) | 403km | 389km |
| | SBZ3 pSCI (BE3) | 405km | 387km |
| | Vlakte van de Raan SCI (BE4) | 399km | 380km |
| Harbour porpoise | SBZ1 pSCI (BE1) | 414km | 402km |
| | SBZ2 pSCI (BE2) | 403km | 389km |
| | SBZ3 pSCI (BE3) | 405km | 387km |
| | Vlakte van de Raan SCI (BE4) | 399km | 380km |
| **Denmark** | | | |
| Grey seal | Hirsholmene, havet vest herfor og Ellinge Å's udløb SCI / SAC (DK1) | 638km | 528km |
| | Horsens Fjord, havet øst for og Endelave SCI / SAC (DK2) | 557km | 451km |
| | Sydlige Nordsø SCI / SAC (DK3) | 365km | 255km |
| | Vadehavet med Ribe Å, Tved Å og Varde Å vest for Varde SCI / SAC (DK4) | 446km | 332km |
| | Vadehavet Ramsar (DK5) | 431km | 314km |
| Harbour porpoise | Agger Tange, Nissum Bredning, Skibsted Fjord og Agerø SCI / SAC (DK1) | 476km | 365km |
| | Sydlige Nordsø SCI / SAC (DK2) | 365km | 255km |
| | Vadehavet med Ribe Å, Tved Å og Varde Å vest for Varde SCI / SAC (DK3) | 446km | 332km |
| | Venø, Venø Sund SCI (DK4) | 491km | 379km |

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| Feature | European sites (site reference on Figure 3.2 for grey seal and Figure 3.3 for harbour porpoise) | Distance (km) | |
|---|---|---|---|
| | | Dogger Bank Teesside A & B Export Cable Corridor[1] | Dogger Bank Teesside A & B |
| **France** | | | |
| Grey seal | Récifs et landes de la Hague SCI (FR1) | 543km | 632km |
| Harbour porpoise | | | |
| **Germany** | | | |
| Grey seal | Borkum-Riffgrund (Borkum Reef Ground) SCI (DE1) | 323km | 224km |
| | Hamburgisches Wattenmeer Ramsar (DE2) | 465km | 353km |
| | Helgoland mit Helgoländer Felssockel SCI (DE3) | 425km | 320km |
| | Küsten- und Dünenlandschaften Amrums SCI (DE4) | 448km | 336km |
| | NTP S-H Wattenmeer und angrenzende Kustengebiete SCI (DE5) | 424km | 311km |
| | Steingrund SCI (DE6) | 434km | 328km |
| | Sylter Außenriff (Sylt Outer Reef) SCI (DE7) | 320km | 207km |
| Harbour porpoise | Borkum-Riffgrund (Borkum Reef Ground) SCI (DE1) | 323km | 224km |
| | Doggerbank SCI (DE2) | 169km | 43km |
| | Hamburgisches Wattenmeer SCI (DE3) | 457km | 353km |
| | Helgoland mit Helgoländer Felssockel SCI (DE4) | 425km | 320km |
| | NTP S-H Wattenmeer und angrenzende Kustengebiete SCI (DE5) | 424km | 311km |
| | Steingrund SCI (DE6) | 434km | 328km |
| | Sylter Außenriff (Sylt Outer Reef) SCI (DE7) | 320km | 207km |
| | Unterelbe SCI (DE8) | 506km | 401km |
| **Netherlands** | | | |
| Grey seal | Doggersbank SCI (NL1) | 104km | 0km |
| | Klaverbank SCI (NL2) | 121km | 78km |
| | Noordzeekustzone SCI (NL3) | 289km | 220km |
| | Noordzeekustzone II pSCI (NL4) | 289km | 220km |
| | Vlakte Van der Raan SCI / SAC (NL5) | 388km | 369km |
| | Voordelta SCI (NL6) | 363km | 333km |
| | Waddenzee SCI / SAC (NL7) | 294km | 227km |
| Harbour porpoise | Doggersbank SCI (NL1) | 104km | 0km |
| | Klaverbank SCI (NL2) | 121km | 78km |
| | Noordzeekustzone SCI (NL3) | 289km | 220km |
| | Noordzeekustzone II pSCI (NL4) | 289km | 220km |
| | Vlakte Van der Raan SCI / SAC (NL5) | 388km | 369km |
| **Norway** | | | |
| Grey seal | Rott-Hastein Kjor Ramsar (NO1) | 506km | 394km |
| **Sweden** | | | |
| Harbour porpoise | Kosterfjorden-Väderöfjorden SCI / SAC (SE1) | 719km | 615km |
| | Vrangoskargarden SCI / SAC (SE2) | 707km | 595km |

[1] Distance is measured from the point where the Dogger Bank Teesside A & B Export Cable Corridor emerges from the Dogger Bank Zone (i.e. south-west corner of Tranche A).

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5.1.2 For the two Annex II species under consideration - grey seal and harbour porpoise - the relevant European sites are identified and the sensitivity, vulnerability and conservation objectives for the species presented. Following this, the baseline environment relative to the species feature is described, with reference to specific chapters within the Dogger Bank Teesside A & B ES (where relevant). Potential impacts are then considered and assessed against the conservation objectives of the European sites for the construction, operation, and decommissioning phases of the project.

## 5.2 Grey seal feature and designated sites considered

5.2.1 The Screening Stage (see Section 3 and **Table 5.1**) identified four European sites (though one is both SAC and Ramsar) in UK waters for which grey seal is a feature and where a potential LSE could arise as a result of the construction, operation or decommissioning of the project. These sites are:

- Berwickshire and North Northumberland Coast SAC;
- Isle of May SAC;
- Faray and Holm of Faray SAC; and
- Humber Estuary SAC (and Ramsar site).

5.2.2 A total of 25 transboundary sites (i.e. in non-UK waters) in the North Sea that have been designated or are proposed as sites supporting grey seal populations were identified at the screening stage (see **Table 5.1**). Of these sites, four, Doggersbank SCI and Klaverbank SCI (in Dutch waters) and Borkum-Riffgrund SCI and Sylter Außenriff SCI (in German waters), are sites supporting grey seal in the offshore environment. Only the sites nearest to Dogger Bank Teesside A & B were screened in due to the potential for noise and subsequent effects on their respective populations, namely Doggersbank SCI which is adjacent to the eastern boundary of Dogger Bank Teesside A and Klaverbank SCI which is located some 78km from the boundary of Dogger Bank Teesside A. The remaining 23 transboundary sites are, as for the UK SACs, key breeding and haul out sites for this species and, therefore, are located at significant distance from Dogger Bank Teesside A & B. Consequently, those sites listed in **Table 5.2** were screened out from specific assessment of direct impacts.

5.2.3 The following sections are structured to present information on the UK sites in respect of aspects such as site descriptions, vulnerability, sensitivity, and conservation objectives. Much of this information, notably feature vulnerabilities and sensitivities, is also of relevance to non-UK sites and conclusions on the impacts of the project on all European sites screened into this stage can be made with reference to the assessment work for UK sites. It should also be noted that the impact assessment presented here has been undertaken in respect of the observed population of grey seals that may be present within Dogger Bank Teesside A & B (i.e. the North Sea population). There is some evidence (see paragraphs 5.5.18 to 5.5.30) to indicate that the grey seals observed in Dogger Bank may derive from specific breeding sites (and, hence, SACs) and impacts, therefore, could be specifically linked to individual sites. However, assessment of impacts at the population level effectively means that

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the outcomes are applicable across all designated sites unless there is specific evidence to indicate that usage of the area is largely by individuals from one or more sites only. The assessment work undertaken in respect of UK sites and the UK North Sea grey seal population, therefore, can be applied to determining potential impacts on the entire North Sea grey seal population and, consequently, the non-UK SACs/SCIs designated for this species.

Table 5.2 Transboundary European sites with Annex II grey seal feature screened out of the assessment

| European sites | Distance (km) | |
|---|---|---|
| | Dogger Bank Teesside A & B Export Cable Corridor | Dogger Bank Teesside A & B |
| **Belgium** | | |
| SBZ 1 pSCI | 414km | 402km |
| SBZ 2 pSCI | 403km | 389km |
| SBZ 3 pSCI | 405km | 387km |
| Vlakte van de Raan SCI | 399km | 380km |
| **Denmark** | | |
| Hirsholmene, havet vest herfor og Ellinge Å's udløb SCI / SAC | 638km | 528km |
| Horsens Fjord, havet øst for og Endelave SCI / SAC | 557km | 451km |
| Sydlige Nordsø SCI / SAC | 365km | 255km |
| Vadehavet med Ribe Å, Tved Å og Varde Å vest for Varde SCI / SAC | 446km | 332km |
| Vadehavet Ramsar | 431km | 314km |
| **Germany** | | |
| Borkum-Riffgrund (Borkum Reef Ground) SCI | 323km | 224km |
| Hamburgisches Wattenmeer Ramsar | 465km | 353km |
| Helgoland mit Helgoländer Felssockel SCI | 425km | 320km |
| Küsten- und Dünenlandschaften Amrums SCI | 448km | 336km |
| NTP S-H Wattenmeer und angrenzende Kustengebiete SCI | 424km | 311km |
| Steingrund SCI | 434km | 328km |
| Sylter Außenriff (Sylt Outer Reef) SCI | 320km | 207km |
| **Netherlands** | | |
| Noordzeekustzone SCI | 289km | 220km |
| Noordzeekustzone II pSCI | 289km | 220km |
| Vlakte Van der Raan SCI / SAC | 388km | 369km |
| Voordelta SCI | 363km | 333km |
| Waddenzee SCI / SAC | 294km | 227km |
| **Norway** | | |
| Rott-Hastein Kjor Ramsar | 506km | 394km |

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## Information on UK Sites

5.2.4 Grey seal is an Annex II qualifying feature for three of the UK SACs considered here: Berwickshire and North Northumberland Coast, Faray and Holm of Faray, and the Isle of May. It is present as a qualifying feature for the Humber Estuary SAC, but is not a primary feature for the selection of the site.

### Berwickshire and North Northumberland Coast SAC

5.2.5 Berwickshire and North Northumberland Coast SAC is representative of grey seal breeding colonies in the south-east of its breeding range in the UK. It is the most south-easterly site selected for this species, and in 2010 supported around 3% of annual UK pup production (Special Committee on Seals (SCOS) 2011).

### Faray and Holm of Faray SAC

5.2.6 Faray and Holm of Faray SAC comprise two uninhabited islands in the northern part of Orkney. The islands' support the second-largest breeding colony in the UK and in 2010 contributed around 9% of annual UK pup production (SCOS 2011).

### The Isle of May SAC

5.2.7 The Isle of May SAC lies at the entrance to the Firth of Forth on the east coast of Scotland. The site is the largest east coast breeding colony of grey seals in Scotland and the fourth-largest breeding colony in the UK and in 2010 contributed approximately 4.5% of annual UK pup production (SCOS 2011).

### Humber Estuary SAC

5.2.8 In 2010 the Humber Estuary SAC supported around 3% of annual UK pup production (SCOS 2011).

## Conservation Objectives for UK Sites

### Berwickshire and North Northumberland Coast SAC

5.2.9 The Conservation Objective (English Nature & Scottish Natural Heritage 2000) for the grey seal feature of the Berwickshire and North Northumberland Coast SAC is "*subject to natural change, maintain in favourable condition* (see **Table 5.3**) *the habitats for the grey seal, in particular the extent and suitability of grey seal breeding habitat on the Farne Islands*".

Table 5.3 Attributes, criteria and targets for the grey seal feature relevant to the Berwickshire and North Northumberland Coast SAC

| Attribute | Measure / criteria | Target | Comment on favourable condition |
|---|---|---|---|
| Disturbance | Reduction or displacement of grey seals measured using average count information measured periodically (frequency to be determined). | No significant reduction in numbers or displacement of grey seals from an established baseline, subject to natural change. | Excessive disturbance can cause stress and result in reduced food intake and/or increased energy expenditure. Disturbance in suitable breeding areas may result in a reduced pup production. |

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| Attribute | Measure / criteria | Target | Comment on favourable condition |
|---|---|---|---|
| Extent (rocky and coarse sediment shores – sub-feature) | Total area (ha), measured once during reporting cycle. | No decrease in extent from an established baseline, subject to natural change. | Suitable rocky and coarse sediment shores provide an important breeding and hauling out habitat for grey seals within the site. |

### Faray and Holm of Faray SAC

5.2.10 The Conservation Objective (Scottish Natural Heritage 2006a) for the grey seal feature of the Faray and Holm of Faray SAC is "*to avoid deterioration of the habitats of qualifying species (grey seal) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status. To ensure for the qualifying species that the following are maintained in the long term*:

- *Population of the species as a viable component of the site;*
- *Distribution of the species within site;*
- *Distribution and extent of habitats supporting the species;*
- *Structure, function and supporting processes of habitats supporting the species; and*
- *No significant disturbance* of the species."

5.2.11 **Table 5.4** presents the attributes and criteria for the assessment of favourable condition (Scottish Natural Heritage 2006a), though no targets are currently identified.

Table 5.4 Attributes and criteria for the grey seal feature relevant to the Faray and Holm of Faray SAC and the Isle of May SAC

| Attribute | Measure / criteria |
|---|---|
| **Grey seal** | |
| Population | Breeding number. |
| Species distribution | Presence and population within site. |
| Disturbance | Reduction in breeding success. |
| | Mortality. |
| **Supporting habitats** | |
| Extent | Area of supporting habitats. |
| Distribution | Area of supporting habitat types. |
| Structure | Structure and function of supporting habitats (including physical processes). |

### The Isle of May SAC

5.2.12 The Conservation Objective (Scottish Natural Heritage 2006b) for the grey seal feature of the Isle of May SAC is the same as for the Faray and Holm of Faray SAC (see paragraph 5.2.10 and **Table 5.4**). As with the Faray and Holm of Faray SAC, no favourable condition targets have been identified.


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### Humber Estuary SAC

5.2.13 The Conservation Objective (English Nature 2003b) for the grey seal feature of the Humber Estuary SAC and Ramsar is "*subject to natural change, maintain the wetland hosting a breeding colony of grey seals in favourable condition* (see **Table 5.5**)*, in particular the intertidal mudflats and sandflats*".

Table 5.5 Attributes, criteria, and targets for the grey seal feature relevant to the Humber Estuary SAC

| Attribute | Measure / criteria | Target | Comment on favourable condition |
|---|---|---|---|
| Extent of habitat | Area (ha) measured once per reporting cycle. | No significant decrease in extent from an established baseline, subject to natural change. | The intertidal flats at Donna Nook are an important breeding and haul-out site for grey seals. |
| Disturbance | Reduction, displacement and productivity of grey seals, measured periodically using average count information (frequency to be determined). | No significant reduction in seal numbers, productivity or displacement of seals attributable to human disturbance from an established baseline, subject to natural change. | Excessive disturbance can cause stress to both adults and pups and result in reduced food intake and/or increased energy expenditure. Disturbance in breeding areas may result in a reduced pup production. |

## Feature vulnerabilities for UK Sites

### Berwickshire and North Northumberland Coast SAC

5.2.14 Within the Berwickshire and North Northumberland Coast SAC grey seal are identified as being:

- Highly vulnerable to noise or visual disturbance particularly at haul out sites and breeding sites; and
- Moderately vulnerable to synthetic compounds (e.g. sewage, oil, and chemicals).

### Faray and Holm of Faray SAC

5.2.15 Within the Faray and Holm of Faray SAC grey seal are identified as being vulnerable to:

- Noise and disturbance from vessel movements particularly during the breeding and pupping (late September to late December) and moulting (Jan / Feb) seasons, which could cause injury, mortality, noise disturbance and human presence;
- Disturbance to seals and their habitats as a result of the construction and maintenance of structures, both within and adjacent to the sea, particularly during the breeding, pupping and moulting seasons;
- Entanglement from static fishing gear which could cause mortality; and
- Human disturbance to seals particularly during the breeding, pupping or moulting seasons from visitors (and shellfish collectors) on beaches, recreational vessels (e.g. kayaks, etc.), scuba diving, and scientific research.

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### The Isle of May SAC

5.2.16 Within the Isle of May SAC grey seal are identified as being vulnerable to:

- Noise and disturbance from vessel movements and helicopter movements particularly during the breeding and pupping (late September to late December) and moulting (Jan / Feb) seasons, which could cause injury, mortality, noise disturbance and human presence;
- Entanglement from static fishing gear which could cause mortality;
- Damage to seal haul outs from oil spills;
- Mortality caused by oil spills, i.e. individuals may suffer from respiratory problems and die; and
- Human disturbance to seals particularly during the breeding, pupping or moulting seasons from visitors on beaches, recreational vessels (e.g. kayaks, etc.), scuba diving, and scientific research.

### Humber Estuary SAC

5.2.17 Within the Humber Estuary SAC and Ramsar, grey seal are identified as being:

- Moderately vulnerable to loss by removal or smothering of intertidal mudflats and sandflats at Donna Nook which could affect the suitability of this habitat for the breeding colony of grey seals;
- Having low vulnerability to damage from being entangled in nets or ingesting debris (such as plastic packaging);
- Highly vulnerable to noise or visual disturbance particularly at haul out sites and breeding sites;
- Moderately vulnerable to toxic contamination due to bioaccumulation of contaminants (such as DDT, PCBs, HCBs, and endocrine disruptors) in their fat and resulting effect on their reproductive success; and
- Moderately vulnerable to viruses from other populations or other sources (potentially sewage).

## Feature sensitivities for UK Sites

### Berwickshire and North Northumberland Coast SAC

5.2.18 Within the Humber Estuary SAC and Ramsar, grey seal are identified as being sensitive to:

- Physical loss through removal of breeding and haul out habitat (high level) and smothering of breeding and haul out habitat (low level);
- Physical damage due to entanglement in nets or plastic packaging and ingestion of plastic packaging (low level);
- Noise or visual disturbance (high level);
- Toxic contamination through the synthetic compounds (high level) and non-synthetic compounds (moderate level);

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- Non-toxic contamination through changes in nutrient levels and organic enrichment (low level); and
- Biological disturbance through sensitivity to microbial pathogens (moderate level).

**Faray and Holm of Faray SAC**

5.2.19 The sensitivities for grey seal at this site are linked to the vulnerabilities identified in paragraph 5.2.15 above.

**The Isle of May SAC**

5.2.20 The sensitivities for grey seal at this site are linked to the vulnerabilities identified in paragraph 5.2.16 above.

**Humber Estuary SAC**

5.2.21 Within the Humber Estuary SAC and Ramsar, grey seal are identified as being sensitive to:

- Physical loss through removal or smothering of haul out habitat at Donna Nook (high level);
- Physical damage through entanglement in nets and ingestion of debris (high level);
- Noise or visual disturbance (high level);
- Toxic contamination through the bioaccumulation of PCBs, DDT, HCBs, and endocrine disruptors in the food chain (moderate level);
- Non-toxic contamination through changes in nutrient loading (moderate level); and
- Biological disturbance through sensitivity to infections (high level).

## 5.3 Data collection - grey seal

5.3.1 Generic baseline information with respect to grey seals was obtained from a number of sources, and these are presented in **Table 5.6**.

5.3.2 In order to supplement the generic baseline information, boat-based and aerial surveys have been undertaken as part of the development of the Dogger Bank Zone. Monthly boat-based surveys of Dogger Bank Zone were conducted (by Gardline Environmental on behalf of Forewind) between January 2010 and June 2012 (Gardline Environmental, 2012) with all sightings of marine mammals being recorded on a JNCC marine mammal recording form. Surveys were conducted to provide information during the Zonal Characterisation of the Dogger Bank Zone (EMU, 2010; EMU, 2011), and to provide data for the characterisation of the baseline environment. The survey transects are presented in **Figure 5.1**, and the survey methods for the boat-based surveys are presented in Section 2.1 in **Appendix 11A** of the Dogger Bank Teesside A & B ES and the results are available in Gardline Environmental (2012).

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Table 5.6 Broad-scale data sources to inform the grey seal characterisation at Dogger Bank Teesside A & B

| Title | Nature of the data | Spatial coverage | Data holder | Publication |
|---|---|---|---|---|
| The Coastal Directive Project – JNCC Coasts and Seas of the United Kingdom | The Coastal Directories Project, coordinated by the JNCC, was developed to produce a wide-ranging baseline of environmental information for each part of the UK coastal and near shore marine zone. Each section provides a summary of the regions environment, including protected sites, wildlife habitats and species, human uses, archaeology etc. | Region 6 Eastern England: Flamborough Head to Great Yarmouth | JNCC | Evans, 1995<br>Duck, 1995 |
| Distributions of Cetaceans, Seals, Turtles, Sharks and Ocean Sunfish recorded from Aerial Surveys 2001-2008. | Data on the distributions and abundances of cetaceans, seals, turtles, sharks and ocean sunfish *Mola mola* were collected opportunistically during aerial surveys for waterbirds conducted by Wildfowl and Wetlands Trust Consulting. The report details the distributions of all records of these species collected in areas of waterbird surveys around the UK coast between 2001 and August 2008 using distance-sampling methodology developed in Denmark by National Environment Research Institute (NERI). | Majority of English and Welsh coastline, some areas of Scotland and Northern Ireland | WWT (Consulting) Ltd | WWT, 2009 |
| Harbour seal telemetry data | Pinniped tagging programmes are included as part of regular population monitoring programmes (e.g. Special Committee on Seals (SCOS), 2010). The telemetry data allow usage of coastal and marine areas to be examined.<br>Data from the DECC funded Wash 2012 tagging deployment will not be available until February 2014. | UK wide | SMRU | Sharples *et al.,* 2008 |
| Special Committee on Seals (SCOS) | Scientific advice to government on matters related to the management of seal populations, the Special Committee on Seals (SCOS) formulates this advice. | UK wide | SMRU | SCOS, 2012<br>SCOS, 2011<br>SCOS, 2010 |


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| Title | Nature of the data | Spatial coverage | Data holder | Publication |
|---|---|---|---|---|
| Strategic Environmental Assessment (SEA) 3 | Information on the abundance and distribution of marine mammals within the SEA 3 Block. In particular, important seal breeding colonies in the Humber Estuary, The Wash and the Farne Islands. | Southern North Sea, from Dover to Berwick-Upon-Tweed | DECC | DECC, 2002 |
| Offshore Energy SEA (Appendix A3a.7) | Baseline description of distribution and abundance of marine mammals in UK waters. | UK wide | DECC | DECC, 2009 |
| Offshore Energy SEA (Various Technical Reports) | Boat based marine mammal surveys of the Dogger Bank Zone and North Sea between February 2008 and March 2009. Telemetry of grey seals in the North Sea (conducted by SMRU). | North Sea | DECC | DECC, 2009 |
| North Atlantic Marine Mammal Commission (NAMMCO) Scientific Publications (various titles) | NAMMCO Publications on population and biological data. | Harbour seals in the North Atlantic and Baltic, grey seals in the North Atlantic and Baltic. | Various | NAMMCO |
| Grey seal and harbour seal telemetry data | Pinniped tagging programmes were undertaken as part of regular population monitoring programmes. The telemetry data allowed usage of coastal and marine areas to be examined. | UK wide surveys | SMRU | Sharples *et al.,* 2008 |
| Survey for small cetaceans over the Dogger Bank and adjacent areas in summer 2011 | Report on aerial surveys of Dogger Bank and adjacent areas. | UK, Dutch, Danish and German waters | Institute of Terrestrial and Aquatic Wildlife Research (ITAW), The Institute for Marine Resources and Ecosystems Studies (IMARES) | Gilles *et al*., 2012. 19th ASCOBANS Advisory Committee Meeting Document 5-08 |
| Marine Scotland seal density estimates | Broad scale mapping of seal density estimates at 5x5km resolution | UK | Marine Scotland | Jones *et al*., 2013 |


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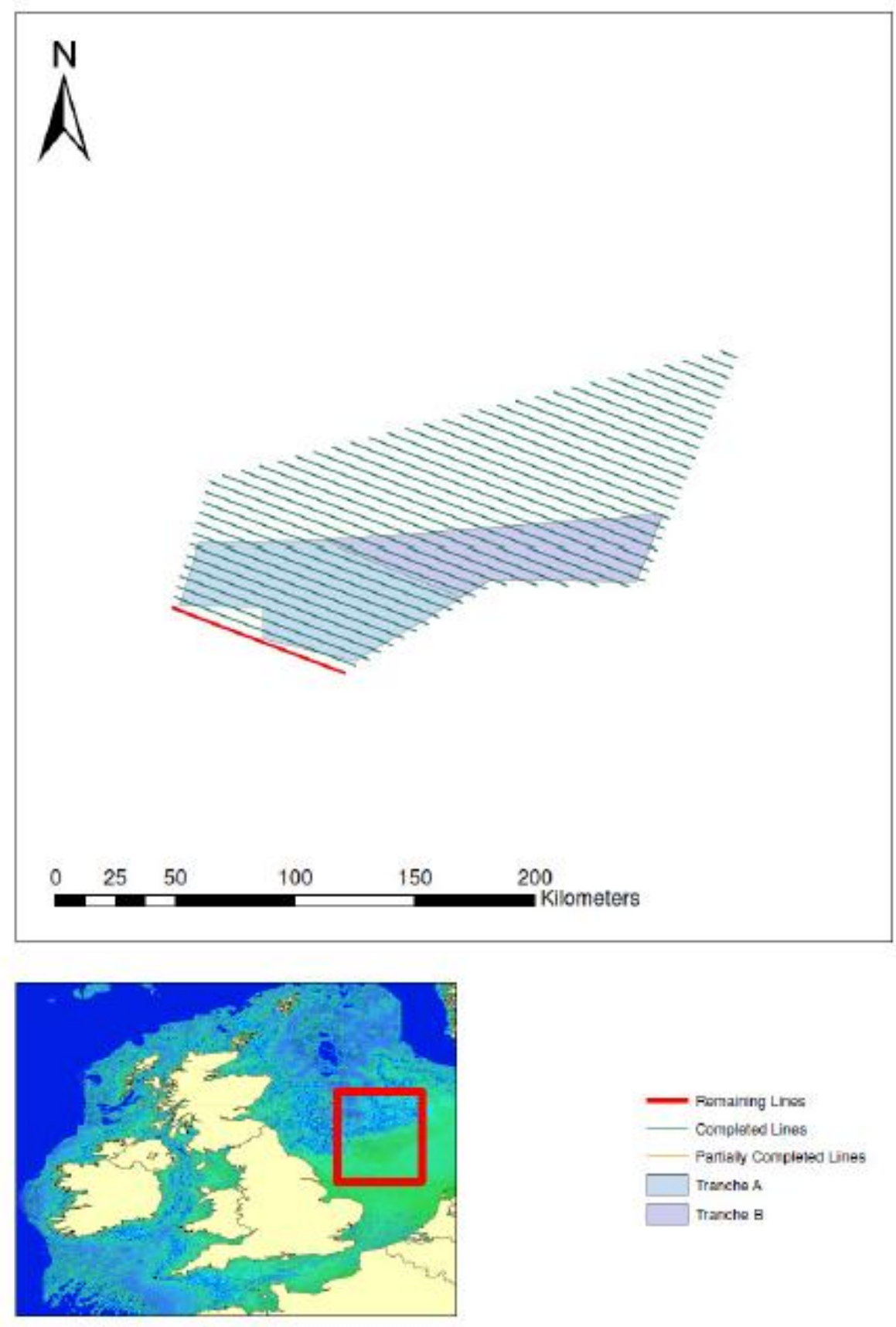



Figure 5.1 Example of survey line (primary and secondary) from August 2011 (Gardline Environmental, 2011c)

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5.3.3 Aerial surveys of Dogger Bank Teesside A & B were conducted between May and August 2009 by the Wildfowl & Wetlands Trust (WWT) at the request of The Crown Estate (WWT 2009). Subsequent aerial surveys (November 2009 to July 2012) were carried out using high definition video camera by HiDef Limited (on behalf of The Crown Estate from November 2009 to March 2010 and on behalf of Forewind from April 2010 to July 2012). Further details of the survey methods are presented in Section 2.2 in **Appendix 11A** of the Dogger Bank Teesside A & B ES and summaries of sightings rates and the results are provided in EMU (2010) and EMU (2011). In addition to survey coverage of the Dogger Bank Zone, aerial surveys since January 2011 covered the south western part of the zone (Tranche A and part of Dogger Bank Teesside B) in greater detail, as illustrated in **Figure 5.2**.

5.3.4 A review of the relevant subsea ambient noise studies has also been undertaken and is presented in **Appendix 5A** of the Dogger Bank Teesside A & B ES.

## 5.4 Assessment methodology - grey seal

### Methodology

#### Assessment of underwater noise

5.4.1 The approach to investigating the potential impacts of underwater noise is informed by the noise propagation modelling work carried out by NPL and detailed in **Appendix 5A** of the Dogger Bank Teesside A & B ES.

5.4.2 It is widely accepted that the principal potential impact upon marine mammals from offshore wind farm development comes from underwater noise resulting from pile driving of foundations (Wursig 2000; Nedwell *et al*. 2003; Thomsen *et al*. 2006). Therefore, it is appropriate to assess this factor as robustly as possible through the use of methods such as noise propagation modelling.

5.4.3 Underwater noise is known to have potential to cause both physiological and behavioural impacts on marine mammals. The potential impacts of underwater noise are dependent on the noise source characteristics (frequency (Hz) and decibels (dB)), the receptor species, the distance from the sound source and noise attenuation within the environment. **Appendix 5A** of the Dogger Bank Teesside A & B ES, Section 2 provides a detailed description of the underwater acoustics. **Appendix 5A** of the Dogger Bank Teesside A & B ES, Section 4 provides information on the noise propagation modelling undertaken. A brief summary of both is provided below.

5.4.4 Sound measurements underwater are usually expressed using the dB scale relative to a reference pressure which is 1µPa. Sound may be expressed in many different ways depending upon the particular type of noise, and the parameters of the noise that allow it to be evaluated in terms of biological effect. In the UK, metrics most commonly used to describe underwater sound from impact piling include peak-to-peak pressure level and Sound Exposure Level (SEL).

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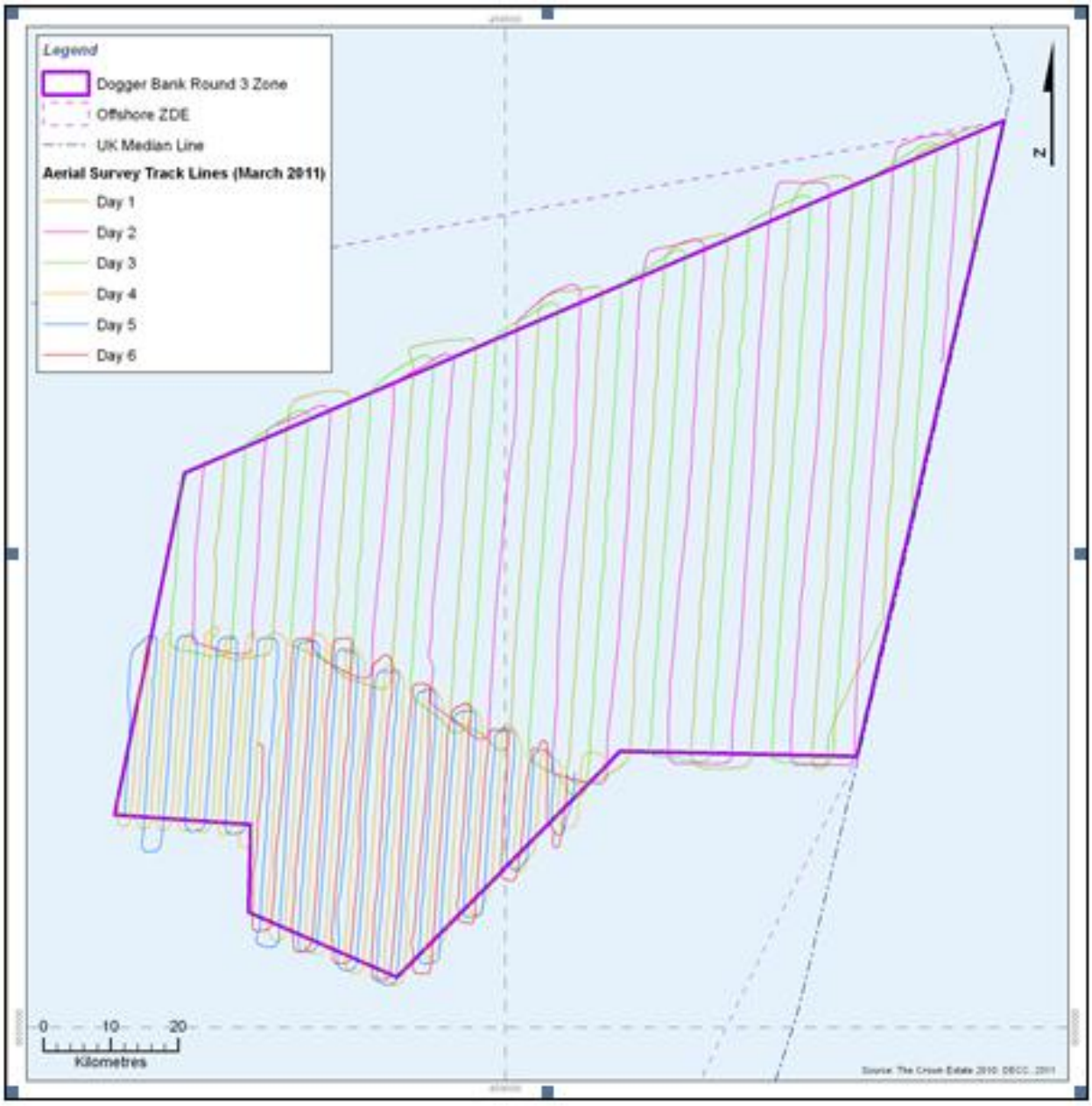



Figure 5.2 Typical flight tracks taken during the HiDef aerial surveys of Dogger Bank Zone and Tranches A & B (EMU 2011)

5.4.5 Peak level is the maximum level of the acoustic pressure, and is usually used to characterise underwater blasts where there is a clear positive peak following the detonation of explosives. Peak to peak level is usually used in calculating the maximum variation in pressure from a positive to a negative within the sound wave. It represents the maximum change in pressure, and is often used to characterise the sound transients from impulsive sources, such as percussive impact piling and seismic airguns. Sound pressure level (SPL) is normally used to characterise noise and vibration of a continuous nature such as drilling, boring or background noise levels. SEL provides a measurement of the total acoustic energy, by summing the acoustic energy over a given period. It takes account of both the SPL and the duration of the presence of the sound in the acoustic environment. SEL therefore, measures the cumulative broadband noise energy.

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5.4.6 In order to assess the effects of noise on different marine mammals, frequency-weighted hearing curves have been developed. Southall *et al*. (2007) outline generalised frequency-weighting (called M-weighting) function for each of five groups of marine mammals based on known or estimated auditory sensitivity at different frequencies. There is, however, a paucity of data, and the auditory functions are precautionary (wide) and likely overestimate the functional bandwidth for most or all species (Southall *et al*. 2007). A modified threshold has been applied for harbour porpoise, based on Lucke *et al*. (2009).

5.4.7 NPL has modelled underwater noise using the energy flux model to propagate an SEL Source Level (SL) to establish the SEL received level as a function of range (see Section 4 in **Appendix 5A** of the Dogger Bank Teesside A & B ES for details). The SEL dose has been modelled for grey seal and harbour porpoise in water functional hearing groups, as defined by Southall *et al*. (2007). By incorporation of the sensitivity of a species group to a particular sound, further consideration of the likelihood of a behavioural response in each species can therefore be made. The effect of the SEL dose has been predicted by summing up the SEL received levels of the entire piling sequence, assuming a fleeing animal (swim speed of 1.5m/s).

5.4.8 The potential negative impacts of noise on marine mammals are: lethal doses (causing fatality) and physical non-auditory injury, auditory injury and behavioural responses. Very close to the source, high peak pressure sound levels have the potential to cause death or severe physical injury that leads to death.

5.4.9 Exposure to high levels of underwater sound can also cause hearing impairment. Sound exposure above certain levels and durations can result in recoverable hearing loss, Temporary Threshold Shift (TTS), or Permanent Threshold Shift (PTS) following greater exposures (at higher intensity or longer duration). Southall *et al*. (2007) define minimum exposure criterion for injury at the level at which single exposure is estimated to cause onset of PTS using TTS data. Southall *et al*. (2007) provide two measures of exposure, peak pressures which are unweighted, and SEL metric which are M-weighted for the relevant marine mammal group. Grey seals fall under group 4 (pinnipeds (seals, sea lions and walruses) listening in water ($M_{pw}$)) and 5 (pinnipeds listening in air ($M_{pa}$)), and harbour porpoise fall within group 3 (odontocetes specialised for using high frequencies).

5.4.10 For the purpose of this assessment, the ‘M-weighted’ sound exposure levels are used to quantify potential occurrence of PTS based on the Southall *et al*. (2007) criteria for pinnipeds (grey seals) in water ($M_{pw}$) and the modified threshold (single strike) for harbour porpoise, as shown in **Table 5.7**.

5.4.11 The M-weighted PTS-onset threshold of 186dB for grey seal represents a conservative approach, and it is considered likely that the 198dB threshold represents the noise levels at which the effects of PTS and TTS start to occur (Thompson & Hastie 2011).

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Table 5.7 Summary of noise criteria used in the assessment for grey seal and harbour porpoise

| Species | Dual injury criteria (PTS) | Behavioural response criteria (TTS / fleeing response) | Behavioural response criteria<br>Likely avoidance of area (Possible avoidance) |
|---|---|---|---|
| Grey seal in water ($M_{pw}$) | 186dB re 1 $\mu Pa^2$.s | 171dB re 1 $\mu Pa^2$.s | 171dB re 1 $\mu Pa^2$.s |
| Harbour porpoise (modified threshold, single strike) | 179dB re 1 $\mu Pa^2$.s | 164dB re 1 $\mu Pa^2$.s | 164dB re 1 $\mu Pa^2$.s (145dB re 1 $\mu Pa^2$.s) |

5.4.12 Behavioural responses or disturbance caused by underwater noise can occur due to exposure to noise at levels below those predicted to cause injury or hearing damage. Once again the thresholds used in the assessment are based on Southall *et al*. (2007) for grey seal, whilst a modified threshold based on Lucke *et al*. (2009) is used for harbour porpoise.

### Calculating impacts

5.4.13 The approach used in calculating the potential number of individuals of grey seal and harbour porpoise impacted by noise from pile driving is dependent on the underlying data confidence. For either species, the potential impacts have been calculated by overlaying impact areas on average densities or over maximum mean densities (in the case of grey seal).

5.4.14 Site specific survey data (see paragraphs 5.3.2 and 5.3.3 above) have been used in the calculation of density surfaces. However, it has been assumed that densities of grey seal and harbour porpoise in areas outwith the surveyed areas are the same as those generated within the surveyed area, to allow consideration of the magnitude of impacts beyond the extent of the survey boundary. This approach has been adopted as the most suitable method in the absence of the Joint Cetacean Protocol (JCP) database, which was not available to Forewind at the time of preparation of this report. It is hoped that the database may be available for incorporation into the final HRA Report. Grey seal density estimates for 5km by 5km cells around the UK, made publically available by Jones *et al*. (2013), are also considered in the assessment.

5.4.15 The scale of the impacts across the regional populations of grey seal and harbour porpoise has been quantified in comparison to the reference populations, as defined in the baseline section (Section 5.5).

## Grey seal sensitivity

### Sensitivity to noise

5.4.16 Pinnipeds (including grey seals) use sound both in air and water for social and reproductive interactions (Southall *et al*. 2007) but not for finding prey.

5.4.17 Grey seal may exhibit a range of behavioural reactions to noise, including orientation or attraction to a noise source, increased alertness, modification of characteristics of their own sounds, cessation of feeding or social interaction, alteration of movement/diving behaviour, temporary or permanent habitat

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abandonment, and in severe cases panic, flight response, stampede or stranding, sometimes resulting in injury or death Southall *et al.* (2007).

5.4.18 Southall *et al.* (2007) also present the fact that the nature of the individuals response would depend upon habituation and sensitisation. An animal's exposure history with regard to a particular sound affects whether it is subsequently less likely (habituation) or more likely (sensitisation) to respond to a stimulus such as sound exposure. The processes of habituation and sensitisation do not necessarily require an association with a particular adverse or benign outcome. Rather, individuals may be innately predisposed to respond to certain stimuli in certain ways. These responses may interact with the processes of habituation and sensitisation for subsequent exposure.

5.4.19 On the basis of available evidence auditory injury (permanent threshold shift or PTS) would be predicted in situations where seals are exposed to levels with a mean pulse weighting of 186dB re 1μPa$^2$/s$^{-1}$ or above, whilst an evident behavioural response (temporary threshold shift or TTS) may arise at a mean pulse weighting of 171dB re 1μPa$^2$/s$^{-1}$ or above (Southall *et al*. 2007). Consequently, sensitivity to permanent auditory injury is considered medium for grey seal.

5.4.20 The nature of the individual's response would depend upon habituation and sensitisation (Southall *et al*. 2007), and behavioural responses differ between captive experiments and measurements/recording in the field. In a captive experiment with food presentation, seals habituated quickly to all sound types presented at normalised received levels of 146dB re 1μPa$^2$/s. However, the fast habituation of avoidance behaviour was also accompanied by a weak sensitisation process affecting dive times and place preference in the pool (Götz & Janik 2010).

5.4.21 The implications of whether the behavioural response is initiated by a startle reflex are also an important consideration. Grey seals that were repeatedly exposed to an acoustic stimulus that elicited a startle response would avoid a food source, whereas individuals exposed to a noise stimulus of the same maximum sound pressure but of a non-startling nature (long rise time) became habituated, and flight responses waned or were absent from the start (Götz & Janik 2011). The application of soft-start procedures during pile driving should mean that startle responses that elicit a greater magnitude of behavioural response would be minimised.

5.4.22 Using data from grey seals tagged on the Dutch Wadden Sea coast, Brasseur *et al.* (2010) concluded that there was some evidence to indicate that seals limited their movements to locations outside the immediate vicinity of two wind farms being constructed off the Dutch coast during the period when pile driving works were being undertaken. Subsequent to the pile driving works, tagged seals were recorded moving through the area in which the wind farms were located.

5.4.23 Based on the available data and expert opinion, grey seal are considered, overall, to have a relatively low sensitivity to underwater noise and the behavioural disturbance (defined as likely avoidance in this assessment) in response to piling noise is unlikely to be strong (Tougaard *et al*. 2009; Thomsen *et al*. 2006).

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5.4.24 Shipping traffic within or adjacent to Dogger Bank Teesside A & B currently consists of large tankers, smaller cargo vessels, tugs, fishing boats and other traffic. There is no evidence to suggest that vessel noise adversely affects grey seals and, given the existing traffic, the populations using the Dogger Bank Zone; animals in the area are likely to be habituated to this type and intensity of underwater noise to at least some degree. Consequently, given the presence of grey seals in areas currently experiencing vessel noise their sensitivity to this effect is predicted to be low.

**Sensitivity to prey availability**

5.4.25 Grey seal exhibit alternate periods of foraging and resting at haul out sites (during which limited or no feeding occurs), with prolonged fasting during annual breeding and moult, when there are marked seasonal changes in body condition (Rosen & Renouf 1997; Bäcklin *et al*. 2011). Although adult seals may be relatively robust to short term (weeks rather than days) changes in prey availability, young and small individuals have a more sensitive energy balance (Harding *et al*. 2005).

5.4.26 Grey seal are considered to have a low sensitivity to minor changes in prey abundance, as their diet flexibility enables individuals to prey upon those fish species that are of in greatest abundance.

**Sensitivity to vessel collisions**

5.4.27 Hull impacts involving seals are not widely reported or recorded, and grey seal are considered, generally, to have negligible sensitivity to this impact.

5.4.28 Since 2008, juvenile grey seal carcasses have been found in the UK with corkscrew like injuries, which are consistent with animals having encountered a single, rotating right-angled blade. It is thought that these injuries are caused by seals being drawn through ducted propellers (Thompson *et al*. 2010). However, there is currently limited data to support ducted propellers as the root cause of these injuries and the total number of seals that may have been injured or killed is largely un-quantified. Taking a precautionary approach, the sensitivity of grey seals to damage from vessels with ducted propellers is considered to be medium.

## 5.5 Baseline environment - grey seal

### Population

5.5.1 The geographical range of the grey seal is restricted to the Northern hemisphere. In the north east Atlantic, distribution is centred on breeding colonies in the UK (predominantly Scotland), Iceland, Norway, Ireland, and The Baltic.

5.5.2 Three main populations of grey seal are recognised: the north-west Atlantic population, the Baltic Sea population, and the north-east Atlantic population. The north-east Atlantic population is found along the coast of Iceland, around the British Isles, along the Atlantic and North Sea coasts, and down to Brittany in France. The three populations are not considered to be sub-species. Along the

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European continent strongholds for breeding are the Dutch Wadden Sea, Amrum in the German Wadden Sea, and Helgoland (Brasseur *et al*. 2010).

5.5.3 Grey seal were historically common around mainland Europe, prior to excessive hunting, mainly in the 11th century, which eradicated breeding in these areas (Harkonen *et al*. 2007). Since the 1970s, small breeding colonies have been re-established at sites in the Netherlands, Germany and France, with moulting sites also established in Denmark. Annual moult surveys are conducted in the Wadden Sea, during the moult and breeding season, by the Trilateral Seal Expert Group (TSEG). The most recent count in 2011 was 4,039, the majority of which are counted in the Netherlands (TSEG 2012). Since 2007, numbers have increased by 15.5% per year; it is likely that this high growth rate is sustained by some temporary immigration from the UK. The 2010 / 2011 count of pups born in this region was 522.

5.5.4 Aerial monitoring of numbers in the Schleswig-Holstein / Wadden Sea indicates that during the moult, there were a maximum of around 4,000 individuals present in 2012 (Brasseur *et al*. 2012). The rapid increase in the population present along the Dutch and German coasts is considered, in part, to be due to immigration of individuals from UK colonies. This is supported by results of satellite tracking that show exchange with areas outside the Wadden Sea (Brasseur *et al*. 2010). The Dutch and German populations of grey seal are, therefore, unlikely to be closed populations and are sustained (and increasing) as a result of the movement of seals across the North Sea from UK colonies.

5.5.5 Approximately 38% of the world's grey seals breed in the UK and 88% of these breed at colonies in Scotland with the main concentrations in the Outer Hebrides and in Orkney. There are also breeding colonies in Shetland, on the north and east coasts of mainland Britain and in SW England and Wales. The total number of pups born at annually monitored colonies in 2010 in the UK was estimated to be 50,174, of which 8,314 (16.5%) were estimated to be from North Sea colonies (including Isle of May, Fast Castle, Inchkeith, Firth of Forth Islands, Donna Nook, Blakeney Point, Horsey, and the Farne Islands (SCOS 2012)). Overall, pup production at UK colonies in the North Sea is increasing (10% to 15% increase across the colonies between 2010 and 2011), which is primarily due to expansion of newer colonies on the coast in Berwickshire (Fast Castle) and East Anglia and southern North Sea (Donna Nook, Blakeney Point and Horsey (SCOS 2011)).

5.5.6 In the UK, surveys of the adult population of grey seal are not routinely made, and the best estimates of population size are derived from estimates of pup production. In 2010 the estimated (based on best fitting model) size of the UK population associated with annual breeding colonies was 99,300 (95% confidence interval of 80,200 to 122,900; SCOS 2012), and the population associated with less regularly monitored colonies was 12,000 (approximate 95% confidence interval of 9,900 to 14,800). Therefore, the total population estimate for UK grey seals based on 2010 data is 111,300 (95% confidence interval 90,100 to 137,700).

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5.5.7 Grey seal from the East Coast, North-east England and South-east England Management Units (MUs) have connectivity with Tranche A and Tranche B, based on the above information. The estimated population size for the MUs (based on data from 2007, 2008, 2010 and 2011) is 24,950 (IAMMWG 2013). In addition, some connectivity has been shown with European colonies, so the most recent count of 4,039 is included in the estimated reference population size. Consequently, the reference population for grey seal used in the assessment is a total of 28,989.

## Behaviour

5.5.8 Grey seal breed annually, when females come ashore to give birth on land or ice during which time the females fast, with the breeding season in the UK being between September and December, November to January in the Wadden Sea, and February to March in the Baltic. They also spend a greater proportion of their time ashore during the annual moult (four months after conception) when delayed implantation of the fertilised egg occurs (Hall 2002). Densities at sea during the breeding season and moult are, therefore, likely to be lower than at other times of the year (DECC 2009).

5.5.9 Telemetry studies indicate that grey seal spend approximately 40% of their time at haul out sites, 12% of their time foraging, and the remainder of their time travelling between haul out and foraging areas (McConnell *et al*. 1992; McConnell *et al*. 1999).

5.5.10 Data from satellite tags have revealed that individual seals often, but not always return to the same foraging areas, making many repeated movement patterns. Despite this, grey seals are considered to be central-place foragers (McConnell *et al*. 1992; McConnell *et al*. 1999). A study reported by McConnell *et al*. (1992) showed that during periods of travel, seals were observed to cover between 75km and 100km per day. This study also revealed that 88% of trips to sea resulted in seals returning to the same haul-out from which they left; these trips were normally relatively short (mean 2.3 days) and not too distant (mean 39.8km). Individuals may, however, travel much further and are known to forage up to 145km from their haul out sites (Thompson *et al*. 1996), over wide estimated home ranges of 1,088km² to 6,400km² (Dietz *et al*. 2003). Consequently, individuals that use dispersed haul outs around the UK and European mainland coasts could theoretically forage within the Dogger Bank Zone. Counts of grey seal in Dutch colonies are currently undergoing exponential rates of increase, reflecting likely immigration from and mixing with UK colonies. Argos telemetry data collected between 2005 and 2006 showed that three of eleven seals tagged at Dutch colonies crossed the North Sea to UK waters and haul out sites in the Moray Firth, Farne Islands and Orkney (see **Figure 5.3**). In the 2006-2007 tagging deployment (of GSM tags) on two of twelve tagged seals appeared to forage towards the Dogger Bank Zone (see **Figure 5.4**).

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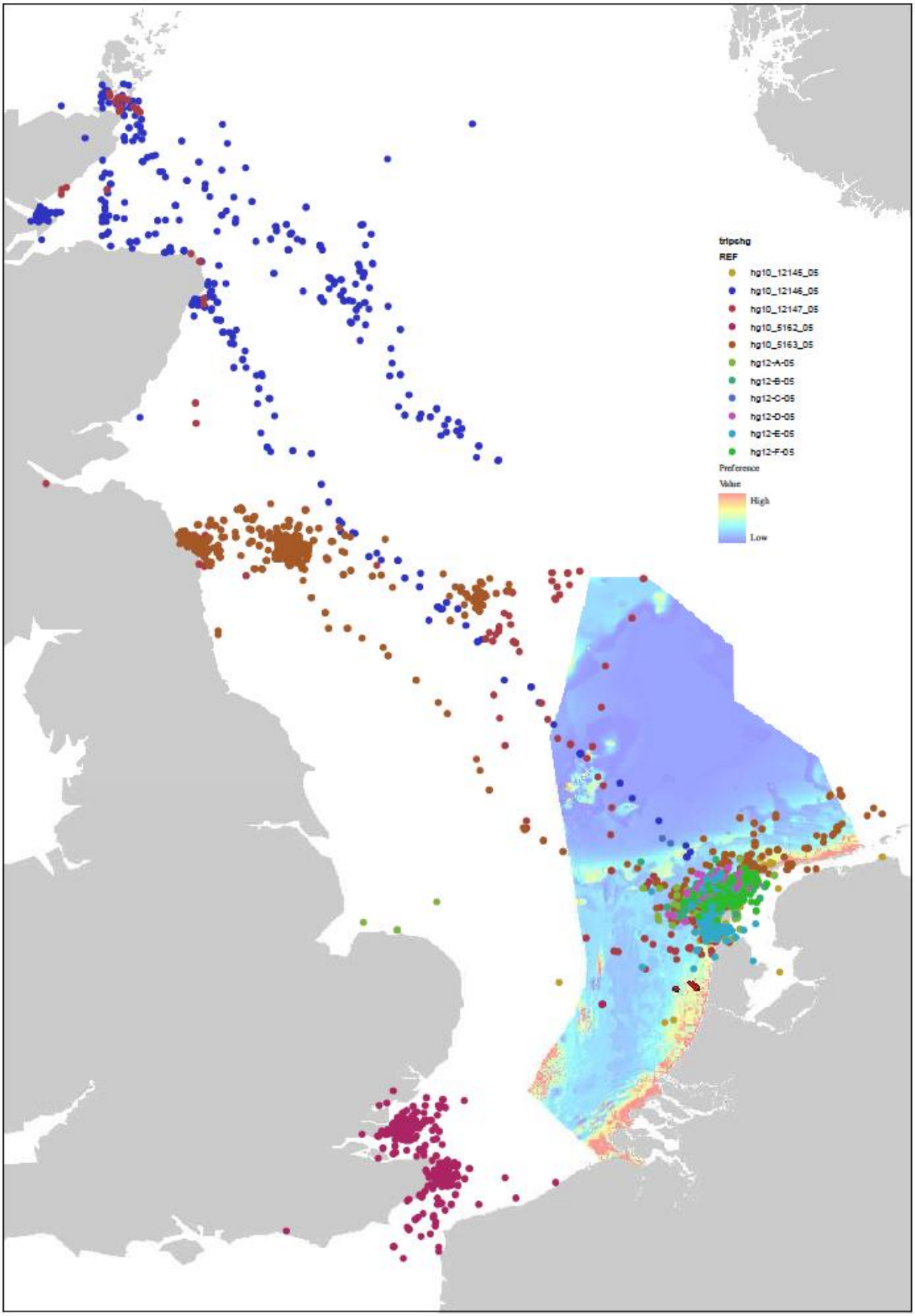



Figure 5.3 Tracking results for grey seals tagged from Dutch haul-out sites (April 2005 to April 2006) from Brasseur *et al.* (2010)

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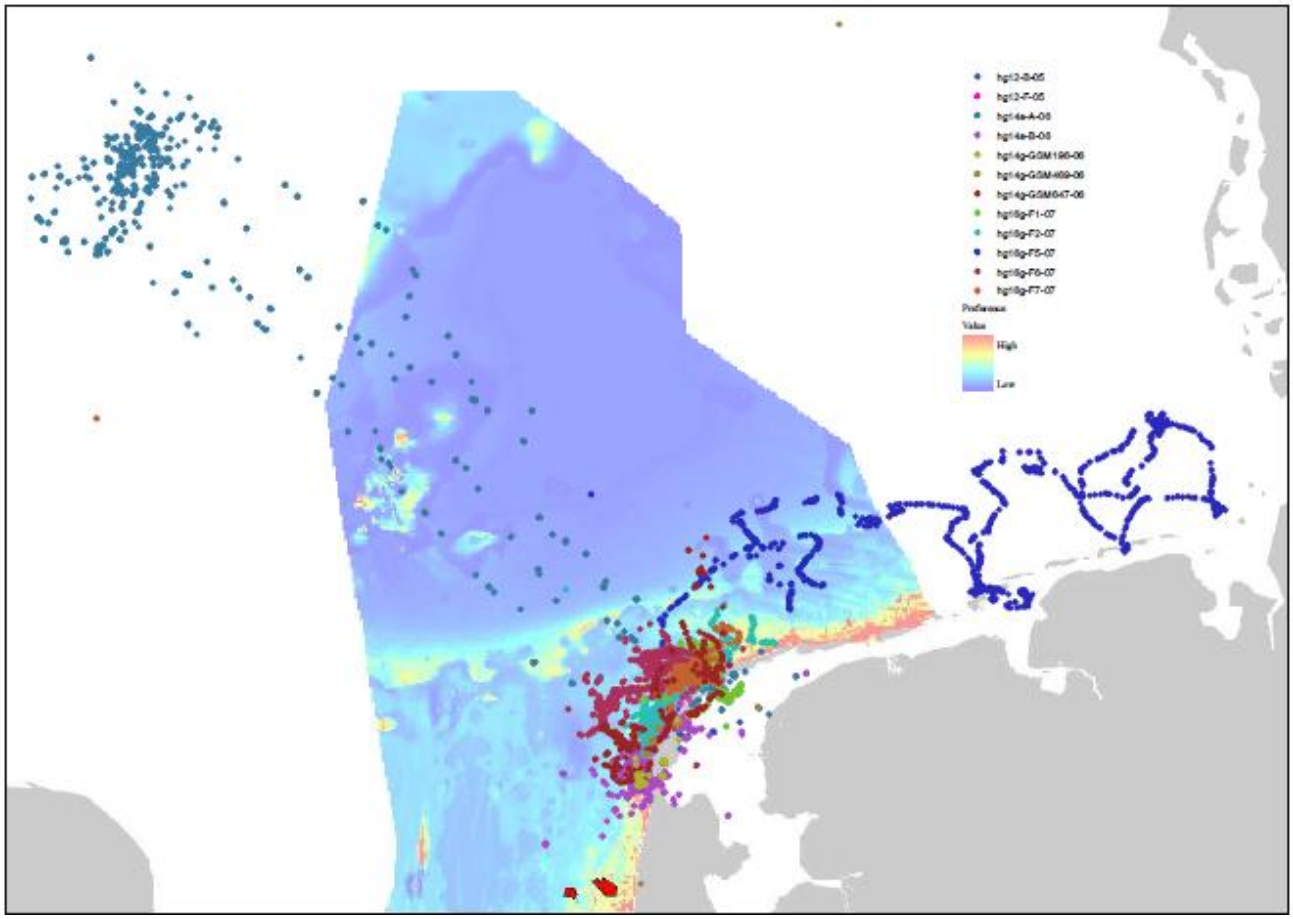


Figure 5.4 Tracking results of grey seals April 2006 to May 2007 from Brasseur *et al.* (2010)

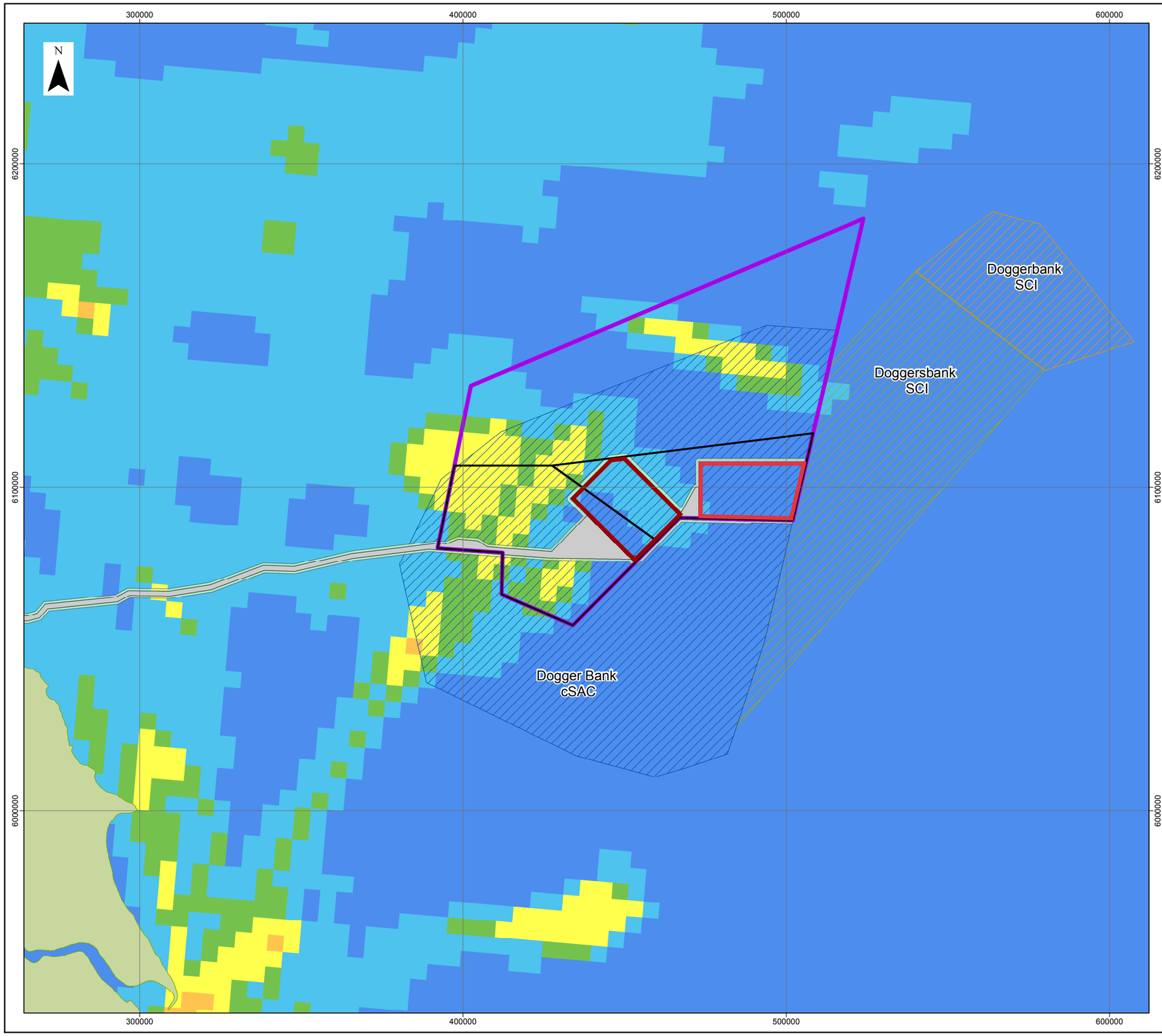
5.5.11 The grey seal is an opportunistic predator of fish and invertebrates. In the North Sea, principal prey items are sandeel, whitefish (cod, haddock, whiting, and ling), and flatfish (plaice, sole, flounder, and dab) (Hammond & Grellier 2006). Studies have identified that between 1985 and 2002 the percentage of sandeel, haddock and cod in the diet of grey seals has increased (Hammond & Grellier 2006).

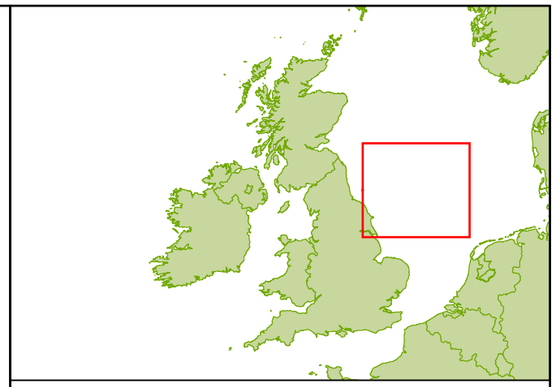
## Development specific population and behaviour

5.5.12 Marine Scotland commissioned SMRU to map grey seal density estimates based on telemetry data around the UK, collected between 1991 and 2011 (SMRU 2013). Within Dogger Bank Teesside A the mean density estimate for 5km by 5km cells is 0.34 grey seals (0.014 per $km^2$). The density estimates range from 0 (minimum lower 25% confidence interval from 45 cells) to 0.161 per $km^2$ (maximum upper 25% confidence interval from 45 cells). Within Dogger Bank Teesside B the mean estimate for grey seal is 0.073 animals per $km^2$, ranging from 0 to 0.775 per $km^2$. There are 38 cells (5km by 5km) overlapping Dogger Bank Teesside B. **Figure 5.5** provides the mean at-sea densities of grey seal in the Dogger Bank Zone and Dogger Bank Teesside A & B Export Cable Corridor based on SMRU (2013).

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**LEGEND**

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

Special Area of Conservation (cSAC)/ Sites of Community Importance (SCI)

- Germany
- Netherlands
- UK

Grey seal at-sea usage

- 0.000 - 1.000
- 1.001 - 5.000
- 5.001 - 10.000
- 10.001 - 50.000
- 50.001 - 100.000
- 100.001 - 150.000
- 150.001 - 913.000

0 10 20 40
Kilometres

Data Source:
Seal Density Data © Marine Scotland 2013
Round 3 offshore wind farm boundary © Crown Copyright, 2013

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*DOGGER BANK TEESSIDE A & B*
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**Figure 5.5 Grey seal mean at-sea densities (SMRU, 2013)**

| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 11/10/2013 | PEI3 | JE | PT |
| 2 | 18/03/2014 | DCO Submission | GC | PT |
| | | | | |

DRAWING NUMBER:
**9Y0986/TSABHRA/37/R2**

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

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5.5.13 Boat based surveys in the Dogger Bank Zone from January 2010 to June 2012 show low numbers present in June to November, and typically low numbers throughout the year, see **Figure 5.6** (from Gardline Environmental 2012).

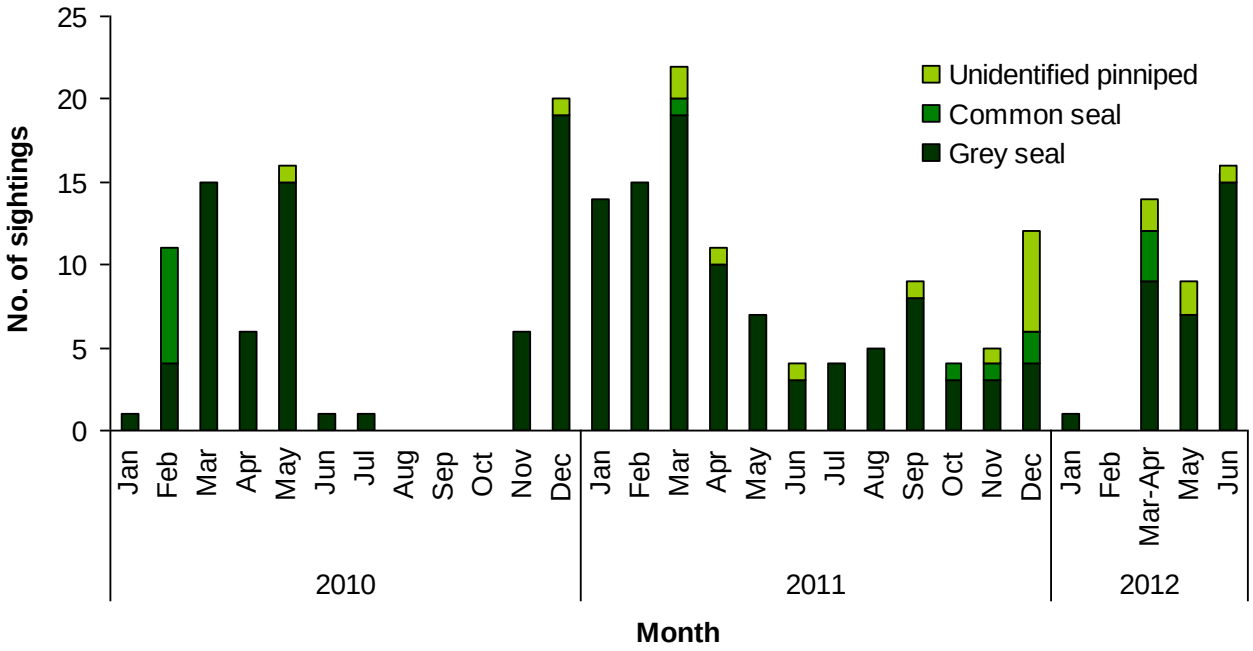



Figure 5.6 Pinniped sightings during boat based surveys of the Dogger Bank Zone (Jan 2010 to Jan 2012) (Gardline Environmental 2012)

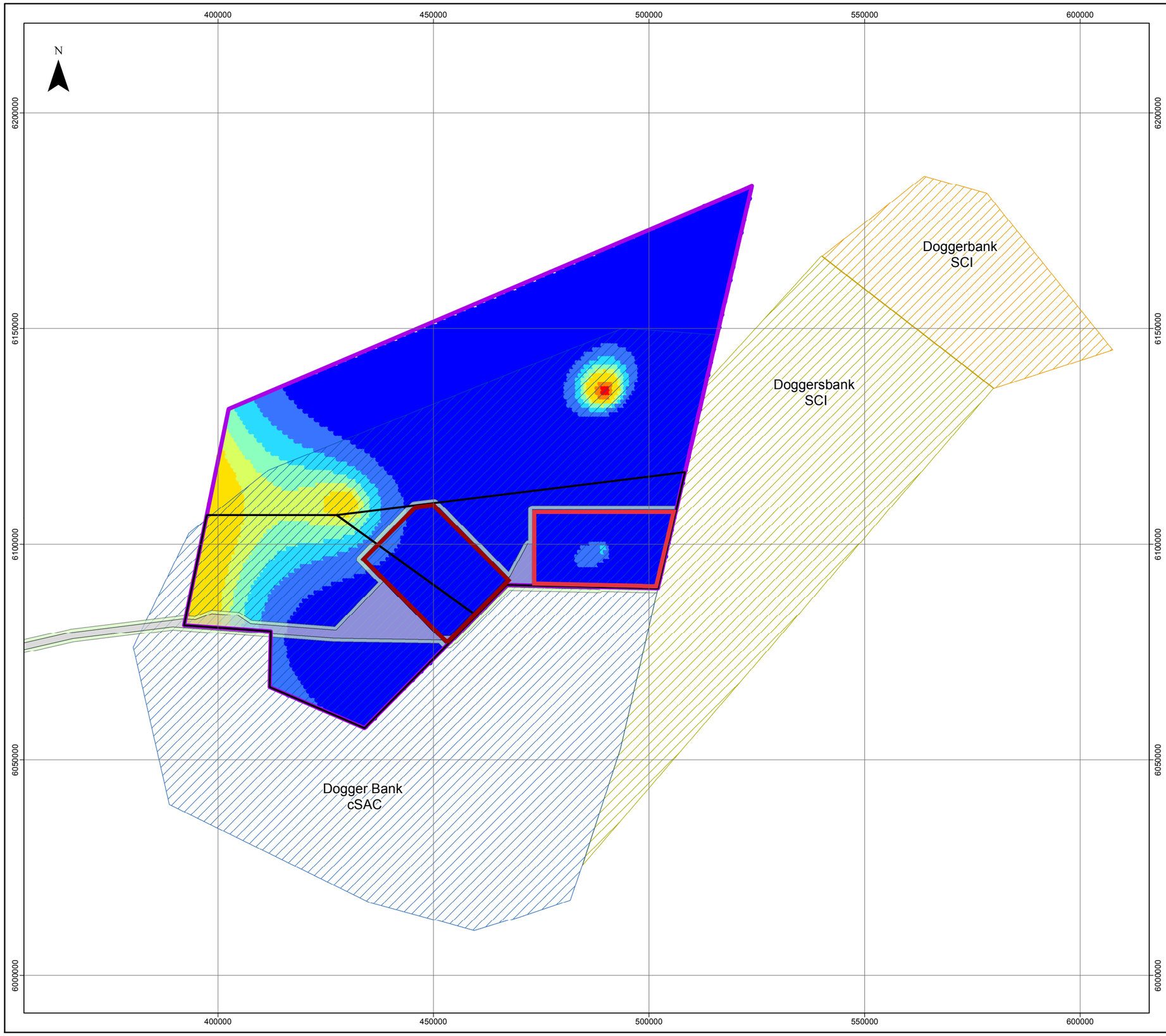
5.5.14 Aerial surveys detected even fewer grey seals, with a maximum of four seals for each month of January 2011 to April 2011 and January 2012 to May 2012. Most winter aerial surveys encountered no grey seal, with other monthly surveys identifying one or two individuals.

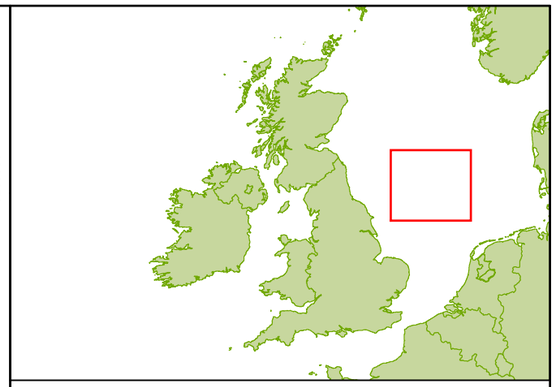
5.5.15 The limited number of sightings means that monthly variation in numbers cannot be examined. Although there was some variation in abundance between years, it was not statistically significant. The estimate of absolute density for all years combined show higher density at the most inshore extent of the zone to the west of Dogger Bank Teesside B. Another peak is shown to the north of Dogger Bank Teesside A. Densities peak in this area at approximately 0.5 seals per $km^2$ in 2011 and 2012, which are comparable to peak estimates from telemetry data (see paragraph 5.5.12 and **Figure 5.5**).

5.5.16 Estimates of average absolute abundance and density over the Dogger Bank Zone for the survey period are 278 (95% confidence interval of 205 to 425) individuals (see **Figure 5.7**), with an average absolute density of 0.02131 (95% confidence interval of 0.01571 to 0.03257) seals per $km^2$ (see **Figure 5.8** and **Figure 5.9**).

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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

Special Area of Conservation (cSAC)/ Sites of Community Importance (SCI)

- Germany
- Netherlands
- UK

Absolute mean density (km²)

- ≤ 0.020
- 0.021 - 0.040
- 0.041 - 0.060
- 0.061 - 0.080
- 0.081 - 0.100
- 0.101 - 0.200
- 0.201 - 0.300
- ≥ 0.301

0 10 20 40
Kilometres

Data Source:
Density data © DMP Stats, 2013
Round 3 offshore wind farm boundary © Crown Copyright, 2014
Background bathymetry image derived in part from TCarta data © 2009

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**Figure 5.7 Absolute mean densities (in km²) of grey seal adjusted for availability**

| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
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| 2 | 18/03/2014 | DCO Submission | GC | PT |
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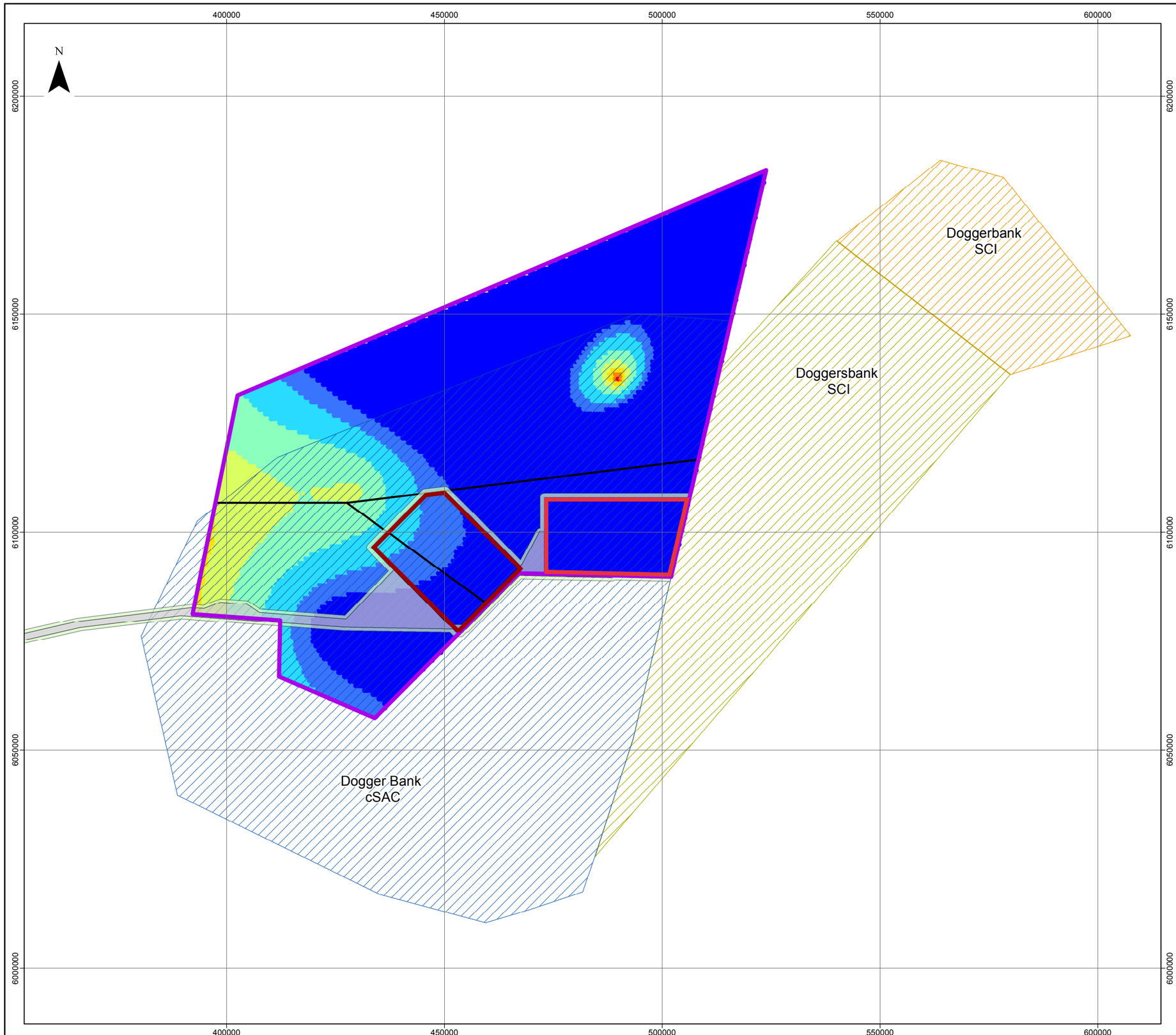
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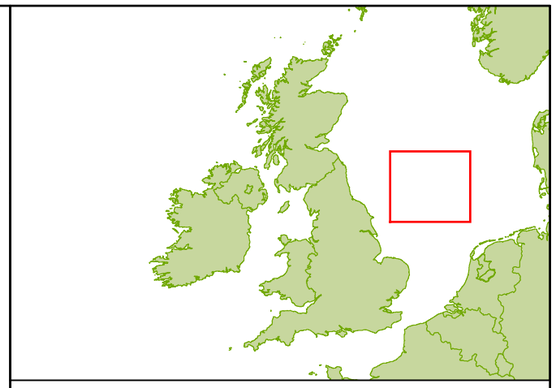
**9Y0986/TSABHRA/38/R2**

| SCALE | 1:900,000 | 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

Special Area of Conservation (cSAC)/ Sites of Community Importance (SCI)

- Germany
- Netherlands
- UK

Absolute mean density (km²)

- ≤ 0.005
- 0.006 - 0.010
- 0.011 - 0.025
- 0.026 - 0.050
- 0.051 - 0.075
- 0.076 - 0.100
- 0.101 - 0.125
- ≥ 0.126

0 10 20 40
Kilometres

Data Source:
Density data © DMP Stats, 2013
Round 3 offshore wind farm boundary © Crown Copyright, 2014
Background bathymetry image derived in part from TCarta data © 2009

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**Figure 5.8 The lower 95% confidence bound for the absolute mean densities (in km²) of grey seal adjusted for availability**

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|---|---|---|---|---|
| 1 | 11/10/2013 | PEI3 | JE | PT |
| 2 | 18/03/2014 | DCO Submission | GC | PT |
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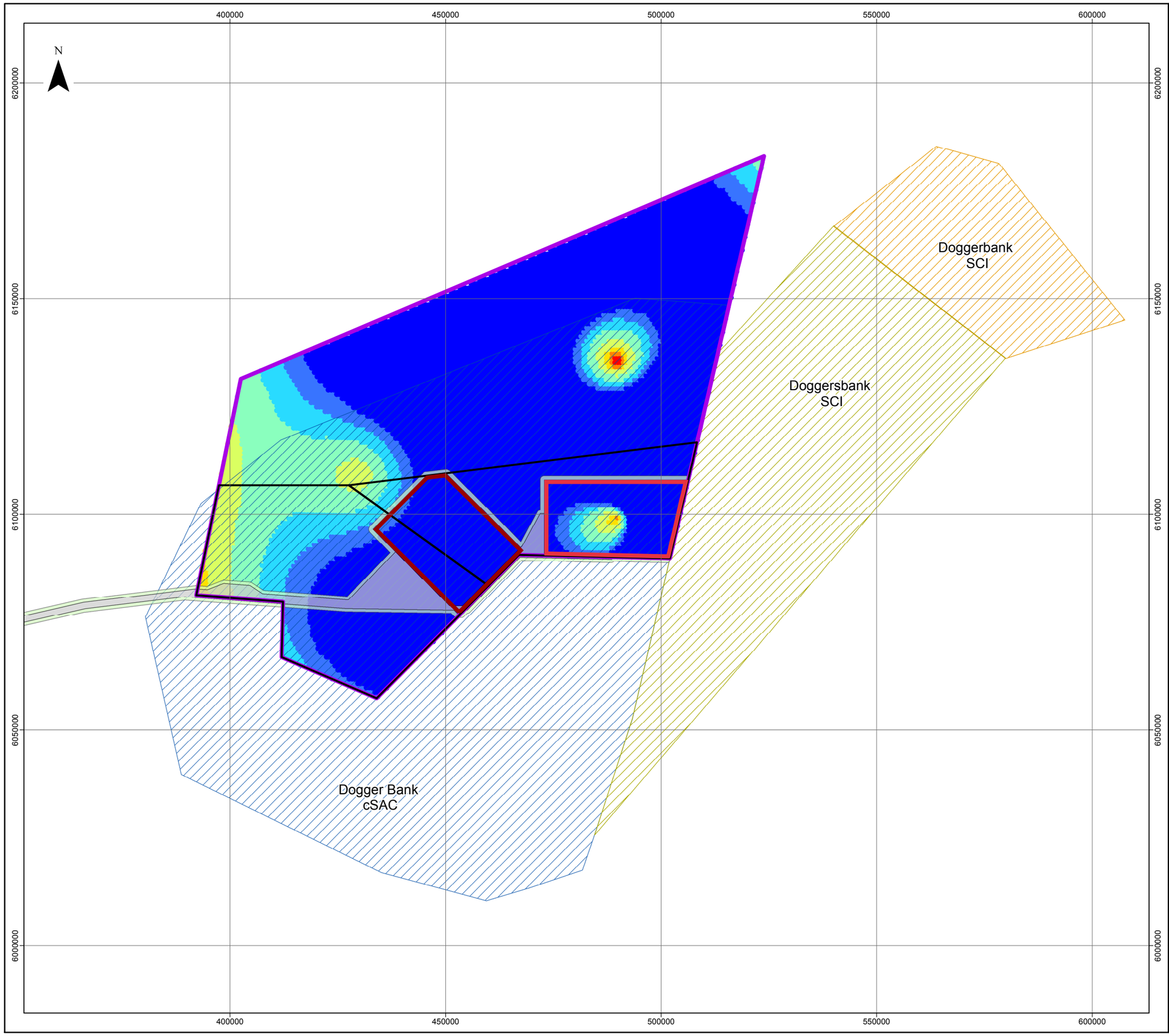
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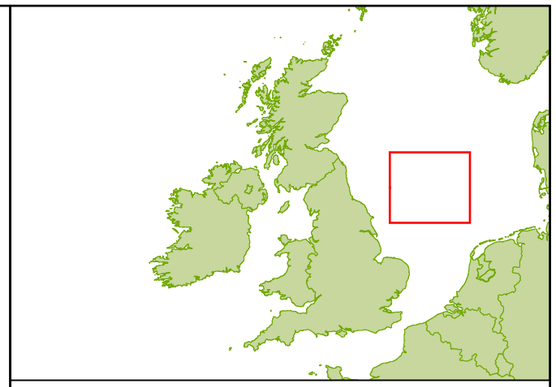
**9Y0986/TSABHRA/39/R2**

| SCALE | 1:900,000 | 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

Special Area of Conservation (cSAC)/ Sites of Community Importance (SCI)

- Germany
- Netherlands
- UK

Absolute mean density (km²)

- ≤ 0.040
- 0.041 - 0.060
- 0.061 - 0.100
- 0.101 - 0.200
- 0.201 - 0.400
- 0.401 - 0.600
- 0.601 - 0.800
- ≥ 0.801

0 10 20 40
Kilometres

Data Source:
Density data © DMP Stats, 2013
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**Figure 5.9 The upper 95% confidence bound for the absolute mean densities (in km²) of grey seal adjusted for availability**

| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 11/10/2013 | PEI3 | JE | PT |
| 2 | 18/03/2014 | DCO Submission | GC | PT |
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DRAWING NUMBER:
**9Y0986/TSABHRA/40/R2**

| SCALE | 1:900,000 | PLOT SIZE | A3 | DATUM | WGS84 | PROJECTION | UTM31N |
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## Mobility of grey seal populations for each designated site

5.5.17 Seal tagging carried out since 1988 was examined to quantify the interactions between the grey seal populations that form part of the UK SACs in relation to, and their potential to interact with, Dogger Bank Teesside A & B. Analysis of all the seal tagging records and the interaction across and within Dogger Bank Teesside A & B was carried out by SMRU and are detailed in **Appendix 14A Dogger Bank Seal Telemetry Report** of the Dogger Bank Teesside A & B ES. Analysis included the use of a 10km buffer, based on the likely maximum range of potential disturbance from pile driving. The result of seal tagging relative to each SAC is identified in the following sub-sections, along with site specific population information, based on the results of the analysis presented in **Appendix 14A** of the Dogger Bank Teesside A & B ES.

### Berwickshire and North Northumberland Coast SAC

5.5.18 This site supports one of the largest breeding colonies of grey seals (roughly 3% of UK pup production) on the North Sea coast. The Farne Islands provide sheltered and undisturbed habitat for pupping (in autumn) and for moulting (in spring) (English Nature & SNH 2000).

5.5.19 There is evidence from tagging to suggest that grey seals feed over a large area of the North Sea (and further afield) at varying times of the year. However, areas close to the Farne Islands characterised by gentle sloping banks of gravely sand are particularly frequented by grey seals. These areas also tend to be the preferred habitat of one of the preferred food sources (sandeels) of grey seals in the area (English Nature & SNH 2000).

5.5.20 Of a total of nine tagged grey seal pups from the Berwickshire and North Northumberland SAC (Farne Islands) none entered the buffer area (Dogger Bank Teesside A & B and 10km). Of a total of 29 adult (aged 1+) grey seal tagged at the Berwickshire and North Northumberland SAC (Farne Islands), two (7%) of these entered Dogger Bank Teesside A & B and the 10km buffer area, with an average of between 1.4% and 2.2% of their at sea locations being in these areas, which equates to 0.15% of the total site population's foraging time at sea.

### Faray and Holm of Faray SAC

5.5.21 The Faray and Holm of Faray SAC population is the second largest breeding group of grey seal in the British Isles with a total population of about 12,000 individuals, with around 3,300 pups produced each year.

5.5.22 The site comprises suitable and undisturbed breeding, moulting and haul-out sites, easy access to freshwater areas, and access to rookery locations. The availability of undisturbed shores and adjacent areas of sea around the islands are important attributes of the site. The near-shore habitats, particularly shallow bedrock reefs, are important foraging grounds for the seals.

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5.5.23 No tagged grey seals recorded within tranches A & B and Dogger Bank Teesside A & B and 10km buffer area had tagging locations commensurate with the Faray and Holm of Faray SAC. Consequently, it is concluded that there was very limited connectivity between the seal colony that is a feature of this SAC and the project area.

**The Isle of May SAC**

5.5.24 The Isle of May SAC seal population is a loyal and growing breeding colony of approximately 5,900 grey seals, with around 1,950 grey seal pups produced at the site annually. The seals are wide ranging for around 9 months of the year, returning to the breeding site to pup and mate between late September and mid-December.

5.5.25 The seals disperse away from the site once the breeding season is over, presumably to feeding areas, though they often remain within a 50km radius of their most favoured haul-out sites. The shallow sandbank and reef habitats at the site are of considerable importance in maintaining a food supply for the seals.

5.5.26 Of a total of 22 tagged grey seal pups from the Isle of May SAC, four (18%) entered the Tranche B and Dogger Bank Teesside A & B and 10km buffer area, with an average of between 0.3% and 1.2% of their at sea locations being in these areas, which equates to 0.22% of the total site's pup population's foraging time at sea. Of a total of 11 adult grey seal tagged at the Isle of May SAC, none entered tranches A & B or Dogger Bank Teesside A & B and the 10km buffer area. However, one of the adult grey seal tagged at Abertay that were recorded within Tranche B and Dogger Bank Teesside A & B and the 10km buffer area also had locations within 5km of the Isle of May SAC. Seals from Abertay Sands were recorded within Tranche B for between 2.9% and 21.4% of their recorded locations. The data indicated that nearly 18% of all tagged seals from Abertay Sands were recorded within 5km of the Isle of May SAC.

**Humber Estuary SAC (and Ramsar site)**

5.5.27 The Humber Estuary SAC and Ramsar site supported a total population of about 2,230 grey seals (English Nature 2003a) in 2001, with 634 pups produced in 2001. In 2009, around 1,371 pups were produced (Humber Management Scheme 2010).

5.5.28 A total of 12 adult grey seal were tagged in the Humber Estuary SAC (Donna Nook); one (8%) of these entered Tranche B and Dogger Bank Teesside A & B and the 10km buffer area, with an average of 34.2% of the at sea locations being in these areas, which equates to 2.74% of the total site population's foraging time at sea.

**Transboundary Sites**

5.5.29 Two non-UK sites designated for their grey seal populations were screened into this stage of the assessment process, and these sites are offshore locations in Dutch waters that provide foraging grounds for grey seal from colonies located in the Wadden Sea. Twenty-three other sites were screened out as they are breeding / haul-out sites on the mainland or offshore sites all of which were a

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significant distance >220km from Dogger Bank Teesside A & B (see **Table 5.2**). As reported above, the vast majority of the North Sea continental European grey seal population is present in the Dutch and German Wadden Sea, with much smaller numbers present in Helgoland, on the Danish and Belgian coasts.

5.5.30 Telemetry data from a total of 29 grey seals tagged from colonies on the Dutch Wadden Sea coast indicated that most spatial usage occurs in proximity to their haul-out sites (Brasseur *et al*. 2010) However, individuals were also observed further offshore, such as at the Frisian front and Dogger Bank. In addition, the telemetry data also shows occasional large-distance migration between the Wadden Sea and Zeeland and between the Netherlands and the UK (see **Figure 5.3** and **Figure 5.4**) with individuals passing through the Dogger Bank Zone. Brasseur *et al*. (2010) suggest, on the basis of the relatively small proportion of seals that were tagged, that such large-scale movement may be commonplace.

## Shipping and vessel movements

5.5.31 The use of the development area and surroundings by shipping and other vessel and boat traffic is detailed in Section 4 in **Chapter 16 Shipping and Navigation** of the Dogger Bank Teesside A & B ES, and is summarised in the following text. Information on vessel movements in Dogger Bank Teesside A & B is important in order to understand the potential collision risk to marine mammals.

5.5.32 The numbers of commercial vessels (commercial ships over 300GT or 500GT, passenger vessels carrying 12 or more passengers, and fishing vessels over 45m in length) passing through or within 10 nautical miles (18.5km) of Dogger Bank Teesside A & B was recorded in surveys as 10 vessels each day, with approximately four vessels each day within Dogger Bank Teesside A and two to three vessels each day within Dogger Bank Teesside B. This would equate to around 3,650 large vessel movements each year. The peak numbers of vessels recorded was 18 within 10 nautical miles (18.5km) of Dogger Bank Teesside A & B, 11 within Dogger Bank Teesside A, and seven within Dogger Bank Teesside B. In spring / summer the breakdown of vessels was: 49% recorded as cargo vessels, 32% are recorded as fishing vessels, 14% are recorded as tankers, and the remaining 5% being a mix of tug and other vessels. In autumn / winter, the breakdown changed to: 39% recorded as cargo vessels, 35% recorded as fishing vessels, 12% recorded as tanker vessels, and the remaining 14% as tug, passenger, recreational and other vessels. These records do not include smaller vessels which are considered to be largely smaller fishing vessels, for which radar and other records show extensive activity outside and to the north-west of Dogger Bank Teesside B. Records show that up to 15 fishing vessels each day were recorded within 10 nautical miles (18.5km) of Dogger Bank Teesside A & B.

5.5.33 Records of vessel movements within and across the Dogger Bank Teesside A & B Export Cable Corridor and 5nm (9.3km) either side in 2011 and 2012 recorded an average of 78 vessels each day, equating to 28,470 vessels each year. These comprised cargo vessels (38%), tanker vessels (32%), fishing vessels (11%), other vessels (9%), tug vessels (4%), passenger vessels (2%), dredge

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vessels (2%), recreational vessels (1%), and HSC and military vessels (both <1%). Extensive recreational activity occurs inshore, with extensive fishing activity also nearshore as well as offshore.

## 5.6 Assessment of impacts during the construction phase - grey seal

5.6.1 This section identifies and assesses the impacts that are predicted to occur during the construction phase for Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor that have potential implications for grey seal populations. The impacts have been aggregated under the following headings:

- Indirect physical damage to the grey seal population as a result of alteration to prey species (fish) distribution, abundance or quality arising from increased suspended sediment concentrations in the water column and re-deposition of sediment from the water column due to the installation of foundations, cables and ancillary structures and the placement of jack-up vessel legs;
- Direct physical damage (mortality) as a result of underwater noise due to pile driving and vessel movements; and
- Direct physical damage (mortality) to the grey seal population as a result of collisions with construction vessels.

5.6.2 It should be noted that the location of the Dogger Bank Zone and the Dogger Bank Teesside A & B Export Cable Corridor for Dogger Bank Teesside A & B precludes the potential for any direct effects on habitats within UK or transboundary SACs designated for their grey seal populations.

### Alteration to prey species and impact on grey seal populations

5.6.3 The impact of the construction of Dogger Bank Teesside A & B on fish abundance is described in detail in Section 6 in **Chapter 13 Fish and Shellfish Ecology** of the Dogger Bank Teesside A & B ES. The assessment predicts short-term and temporary minor adverse impacts to fish populations from increased suspended sediment concentrations, seabed disturbance and construction (particularly piling) noise. Furthermore, in terms of potential impacts on spawning fish, only sandeel are expected to be affected, with short-term and temporary minor adverse impacts predicted (see Section 6.5 of **Chapter 13** of the Dogger Bank Teesside A & B ES) in relation to sediment deposition, which would be short-term and temporary in duration (see paragraphs 4.6.35 to 4.6.38).

5.6.4 Where construction effects may lead to some fish species avoiding areas of disturbance (i.e. displacement would occur), it would be expected that grey seal would either focus their foraging on those fish species remaining within the affected area (assuming that grey seal were themselves not also affected by the same disturbance effects) or move their attention to areas where fish were temporarily displaced.

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5.6.5 The mobility of seals and their flexibility in prey selection suggests that any short term and localised changes in fish abundance during construction would not compromise the ability of grey seal present within Dogger Bank Teesside A & B to gain sufficient prey. Taken together with the relatively low numbers of grey seals present within Dogger Bank Teesside A & B and the low utilisation of the Dogger Bank by grey seals from the four SACs (see paragraphs 5.5.18 to 5.5.28) it is, therefore, concluded that this impact would not have any discernible implications for grey seal populations as a whole or with respect to the designated sites' populations.

## Physical damage due to underwater noise

### Impact of a single piling event

5.6.6 Impact piling noise was modelled for the worst case piling scenario (a 3000kJ hammer) for a range of locations chosen to encompass a range of noise propagation conditions; shallow and deep water, and up-sloping and down-sloping bathymetry (see **Appendix 5A** of the Dogger Bank Teesside A & B ES). A range of hammer energies were initially modelled (i.e. 1,900kJ, 2,300kJ, and 3,000KJ) and a 300kJ hammer energy was used to represent the soft-start of piling and ramping up to the full hammer blow energy (detailed and presented in **Appendix 5A** of the Dogger Bank Teesside A & B ES). Overall, the 3,000kJ hammer energy represents the maximum hammer energy that could be used during the construction phase. Experience from previous wind farm construction shows that the maximum hammer energy is rarely achieved during a piling sequence and then only for a short duration (e.g. Bailey *et al.* 2010; Robinson *et al.* 2011). It should be noted that the pile size has no discernible effect on noise energy output from piling.

5.6.7 In order to determine the spatial extent of underwater noise during the construction phase, sound propagation was modelled from point sources (piling events) around the project boundaries of Dogger Bank Teesside A and Dogger Bank Teesside B. The maximum noise levels related to sensitivity thresholds for grey seal were then used to determine the noise footprint from piling.

5.6.8 The modelling considered three piling sequence lengths (see **Table 5.8**), and the worst case Sequence 3 was used in modelling the SEL dose on grey seal resulting from prolonged exposure. The ranges presented in **Table 5.8** assume a hammer strike at the stated energy and do not take into account any ramp-up of energy (i.e. soft-start).

5.6.9 The SEL dose has been modelled for pinnipeds in water ($M_{pw}$) which is a low frequency functional hearing group defined by Southall *et al*. (2007). The auditory injury impact ranges predicted for grey seal are based on the injury criteria by Southall *et al*. (2007) and data for a harbour seal (Kastak *et al.* 2005).

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Table 5.8 Pile driving parameters for calculating the worst case SEL dose resulting from prolonged exposure based on three pile driving durations

| Parameter | Sequence 1 | Sequence 2 | Sequence 3 |
|---|---|---|---|
| Hammer blow energy (soft-start) | 300kJ | 300kJ | 300kJ |
| Inter-strike interval (soft-start) | 3s | 3s | 3s |
| Number of strikes (soft-start) | 600 | 600 | 600 |
| **Duration (soft start)** | **30 mins** | **30 mins** | **30 mins** |
| Hammer blow energy (full piling) | 3,000kJ | 3,000kJ | 3,000kJ |
| Inter-strike interval (full piling) | 1.5s | 1.5s | 1.5s |
| Number of strikes (full piling) | 1,400 | 4,400 | 12,000 |
| **Duration (full piling)** | **35 mins** | **110mins** | **300 mins** |
| **Duration (total piling time)** | **65 mins** | **140mins** | **330 mins**[2] |

5.6.10 The effect of an SEL dose was predicted by summing up the SEL received levels from the entire piling sequence, assuming a fleeing animal. The model predicts the SEL dose for an animal that moves away from the source, with a swim speed of 1.5m/s (assumed) once piling starts, and continues to move away throughout the piling sequence. Swim speeds for grey seal are based on a harbour porpoise mother-calf pair from Otani *et al*. (2000).

5.6.11 The model is considered very precautionary as it does not account for any time a receptor may spend at or near to the surface (and the reduced sound exposure levels there) or any temporal hearing recovery. Furthermore, the modelling used the worst case sequence (see paragraph 5.6.6) even though this is unlikely to represent the majority of piling events. In addition, pinnipeds (including grey seal) are only expected to exhibit a strong avoidance response at ranges of less than 2km from the pile noise source (see below), although their ability to come to the surface would reduce the effects of prolonged noise exposure and allow some relaxation of TTS.

5.6.12 Based on the modelling described above (and detailed in **Appendix 5A** of the Dogger Bank Teesside A & B ES), distances over which potential instantaneous onset of auditory injury (PTS) and behavioural change (TTS) for grey seal were identified, as presented in **Table 5.9** for both Dogger Bank Teesside A and Dogger Bank Teesside B. The slight differences between the projects are due to differences in the bathymetry within each project area. Ranges for the onset of a PTS in hearing are expected to be up to 200m during piling, whilst a TTS range of less than 1.9km was identified. The use of a soft-start, initiating with the hammer at 300kJ (see paragraphs 5.9.1 to 5.9.3), was calculated to reduce the ranges for potential onset of auditory injury to less than 100m, and for behavioural change (assuming habituation) to less than 400m.

[2] When considering the likely number of blows and hence duration of piling for a single foundation, Forewind drew upon industry experience to generate values for inclusion in the Rochdale envelope. This indicated that across a project there may be a very small number of foundations that require additional piling effort over and above the project norm, in order to satisfactorily install a foundation. It was estimated that for these foundations piling may take up to five hours on top of any soft-start. However, this was not considered to be representative of a realistic average across a project as it is highly unlikely to occur on a significant number of foundations. Consequently, a conservative average of three hours per pile was considered to be appropriate across a whole project.

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Table 5.9 Summary of pinniped (including grey seal) functional hearing group impact ranges for construction at Dogger Bank Teesside A (TA) and Dogger Bank Teesside B (TB) where different

| Impact criterion | Potential range of impact for pinnipeds | | | |
|---|---|---|---|---|
| | 300kJ hammer energy | 1,900kJ hammer energy | 2,300kJ hammer energy | 3,000kJ hammer energy |
| Auditory injury: Instantaneous injury/PTS* (Mpw weighted 186dB re 1µPa$^2$/s$^{-1}$) | <100m | <100m | <100m (TA) <200m (TB) | <200m |
| Auditory injury/behavioural response: TTS/Fleeing response/ Likely avoidance (Mpw weighted 171dB re 1µPa$^2$/s$^{-1}$)** | <400m | <1.5km | <1.5km | <1.7km |

*Southall *et al*. (2007) Injury criteria.
**Southall *et al*. (2007) Single pulse behavioural disturbance.

5.6.13 It should be re-iterated (see paragraph 5.6.11) that these potential impact range results are very precautionary in that they do not account for any time that grey seal may spend at the surface, the reduced sound exposure levels near the surface, or any temporal hearing recovery. As such, the exposure predicted in the model is likely to be an overestimate of the exposure that a grey seal might be subjected to.

### *Lethal and physical injury*

5.6.14 The predicted noise levels in close proximity to the piling activity are comparable to those estimated for auditory injury. Grey seal mortality would only be expected at noise levels substantially above those necessary to cause the onset of auditory injury. The pile driving installation, therefore, is unlikely to result in radiated noise levels beyond a few metres that are sufficient to cause instantaneous mortality in grey seals (Richardson *et al.* 1995 (converted from Yelverton *et al.* (1975) for marine mammals)).

### *PTS impact due to single pile drive and impact on grey seal population*

5.6.15 The range for the onset of a PTS in hearing for grey seal is expected to be less than 200m from piling for both Dogger Bank Teesside A and Dogger Bank Teesside B (see **Table 5.9**), though it should be noted that this range does not include the use of soft-start. The use of a soft-start (initiating the hammer with a 300kJ energy) would reduce the range for potential onset of auditory injury to less than 100m for grey seal.

5.6.16 On the onset of a soft-start, it is expected that grey seal would flee (and 1.5m/s has been assumed, which again is precautionary), and by the time the full hammer energy level is achieved, would be outside the zone of instantaneous injury that would cause a permanent threshold shift (PTS). Therefore, with soft-start, rising to the maximum hammer blow energy of 3,000kJ, the PTS range for Dogger Bank Teesside A and Dogger Bank Teesside B is predicted to be less than 200m for grey seal (see **Table 5.9**).

5.6.17 The cumulative SEL dose for grey seal has been predicted by summing up the pulse SEL over an entire piling sequence, assuming grey seal would swim away

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once piling commences. From the modelled locations the worst case (namely the most westerly locations where noise propagates more efficiently) was selected. The required starting range for grey seal from the pile when pile driving starts, such that grey seal are not over exposed and suffer PTS onset, for the three pile driving sequences (see **Table 5.8**) are shown on **Figure 5.10** (12,600 pile strikes), **Figure 5.11** (5,000 pile strikes), and **Figure 5.12** (2,000 pile strikes). In the case of grey seal, the potential for cumulative SEL dose causing PTS occurs at starting ranges which are much greater (approximately 14km). Therefore, based on the 186dB re 1 $\mu Pa^2.s^{-1}$ threshold and assuming seals do not place their heads out of the water, there is the potential to cause PTS from the cumulative SEL

Table 5.10 Calculation of number of grey seals that could be affected by PTS (instantaneous injury) impact, based on a single pile driving event with 3,000kJ maximum hammer energy, during construction work for Dogger Bank Teesside A or Dogger Bank Teesside B alone

| Density (reference population) | Impact area | Number of seals affected | Percentage of reference population |
|---|---|---|---|
| **Dogger Bank Teesside A** | | | |
| Maximum mean at sea density 0.085 seals per $km^2$ (reference population 28,989) | 0.1$km^2$ | 0.01 | <0.00003 |
| **Dogger Bank Teesside B** | | | |
| Maximum mean at sea density 0.23 seals per $km^2$ (reference population 28,989) | 0.07$km^2$ | 0.023 | <0.00007 |

5.6.18 Overlaying the areas in which generated noise levels may cause PTS with maximum mean at-sea density of grey seal across the Dogger Bank Zone enables an indication of the numbers of grey seal and the percentage of the reference population to be determined. The area of impact, numbers affected (with uncertainty based on 95% confidence interval around density estimates) and the percentage of the grey seal population that this represents in respect of a single pile driving (3,000kJ hammer) event are presented in **Table 5.10** for PTS.

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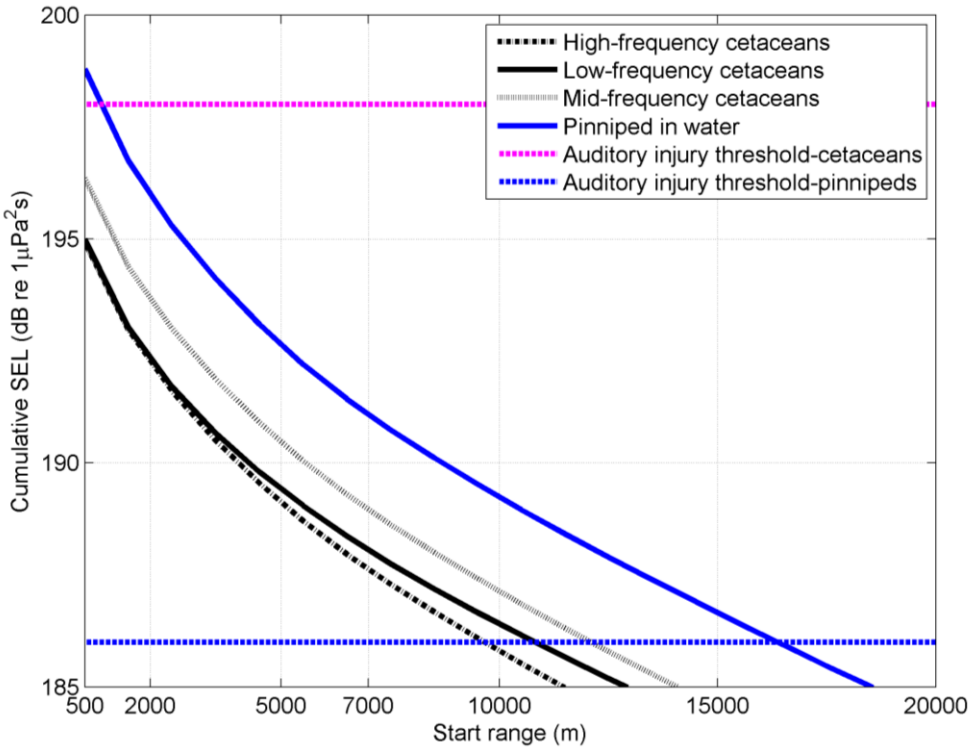



Figure 5.10 Required start range for marine mammals (including pinnipeds, i.e. grey seal) (Southall *et al*. 2007) from the pile when piling starts and auditory injury ranges (PTS onset) - modelled for Dogger Bank Teesside A assuming 12,600 pile strikes and animal swim speeds of 1.5m/s

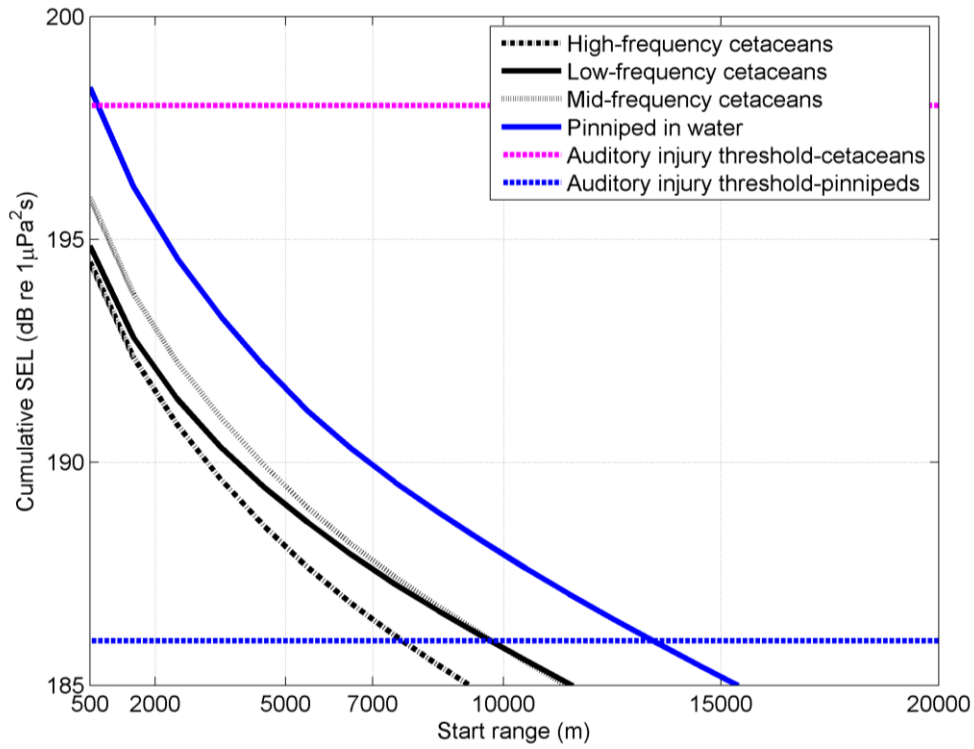



Figure 5.11 Required start range for marine mammals (including pinnipeds, i.e. grey seal) (Southall *et al.* 2007) from the pile when piling starts and auditory injury ranges (PTS onset) - modelled for Dogger Bank Teesside A assuming 5,000 pile strikes and animal swim speeds of 1.5m/s

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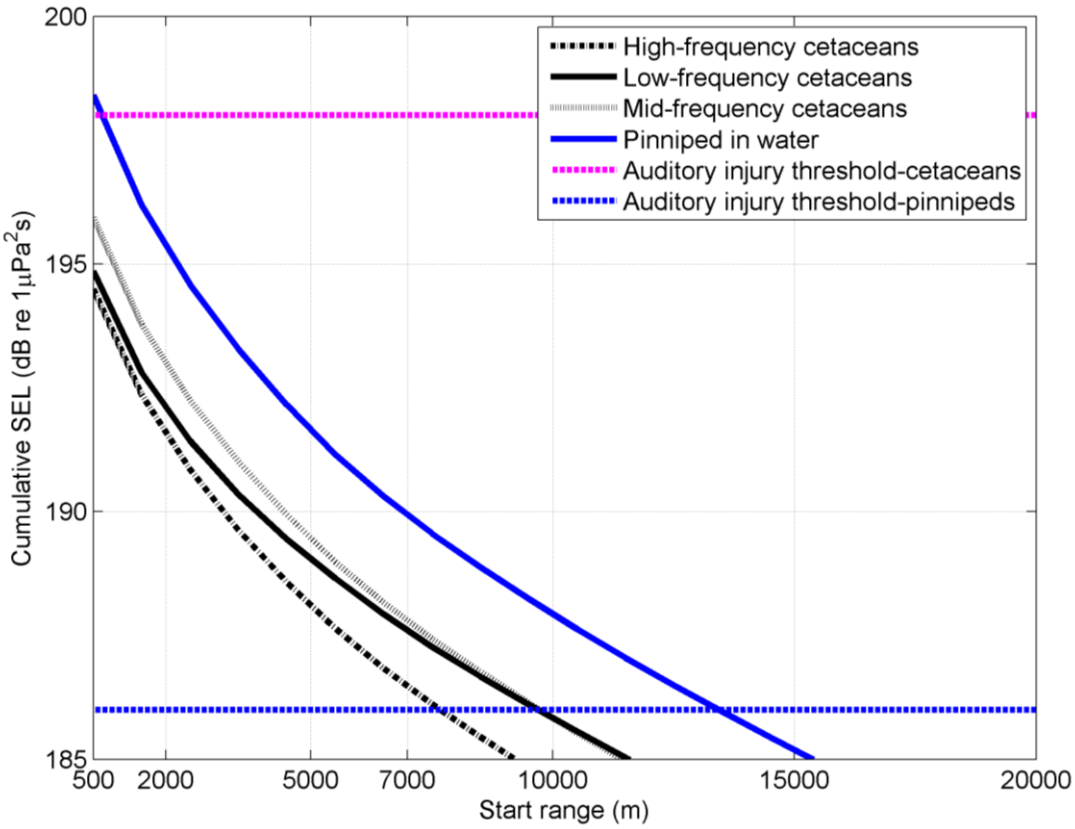



Figure 5.12 Required start range for marine mammals (including pinnipeds, i.e. grey seal) (Southall *et al.* 2007) from the pile when piling starts and auditory injury ranges (PTS onset) - modelled for Dogger Bank Teesside A assuming 2,000 pile strikes and animal swim speeds of 1.5m/s

5.6.19 Given the very small numbers of animals present within Dogger Bank Teesside A & B at any one time, it is apparent that only a very small number (<0.0001% based on maximum mean densities) of the overall reference grey seal population would be at risk of PTS. The level of potential impact in respect of the risk of PTS is considered to be negligible. Proposals to undertake soft-start to piling and other measures to manage piling activity if marine mammals are within close proximity (see paragraphs 5.9.1 to 5.9.3) would further reduce any potential risk of grey seal being affected by instantaneous injury leading to PTS. However, the cumulative SEL dose in grey seal has the potential to lead to PTS over greater ranges than the mitigation zone proposed (see Section 5.9) based on the results of the illustrative modelling shown in **Figure 5.10**, **Figure 5.11**, and **Figure 5.12**. This potential is based on the 186dB re 1 $\mu Pa^2/s^{-1}$ threshold, which can be seen as precautionary. The M-weighted PTS-onset threshold of 186dB for pinnipeds represents a conservative approach, and it is considered likely that the 198dB threshold represents the noise levels at which the effects of PTS start to occur (Thompson & Hastie 2011). The potential for seal to hold their head out of the water to prevent exposure to loud noise should also be considered, therefore the potential for receiving a cumulative SEL dose that could lead to PTS is predicted to be very low, and no implications at the population level are therefore expected.

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### *TTS impact due to single pile drive and impact on grey seal population*

5.6.20 Overlaying the areas in which generated noise levels may cause instantaneous TTS (see **Table 5.9** and **Figure 5.13** and **Figure 5.14** for an example of disturbance zones for Dogger Bank Teesside A and Dogger Bank Teesside B respectively) with maximum mean at-sea density of grey seal across the Dogger Bank Zone enables an indication of the numbers of grey seal and the percentage of the reference population to be determined. The area of impact, numbers affected (with uncertainty based on 95% confidence interval around density estimates) and the percentage of the grey seal population that this represents in respect of a single pile driving (3,000kJ hammer) event are presented in **Table 5.11** for instantaneous TTS.

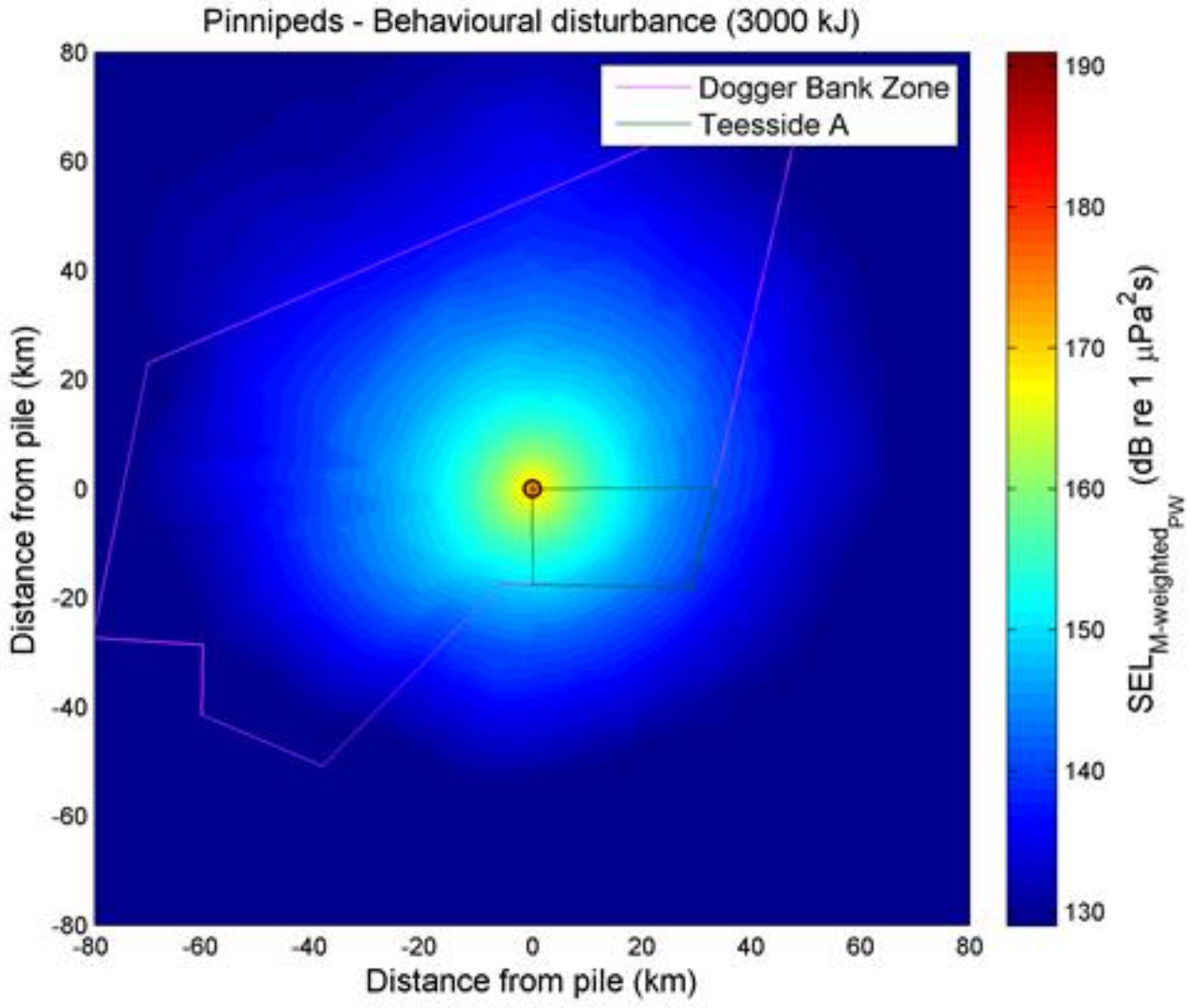



Figure 5.13 Grey seal 'in water' behavioural disturbance zones for Dogger Bank Teesside A using 3,000kJ hammer blow energy SEL 171dB re 1 $\mu Pa^2/s^{-1}$ showing the zone of TTS / fleeing response / likely avoidance (zones of PTS are not shown on the figures as they are so small)

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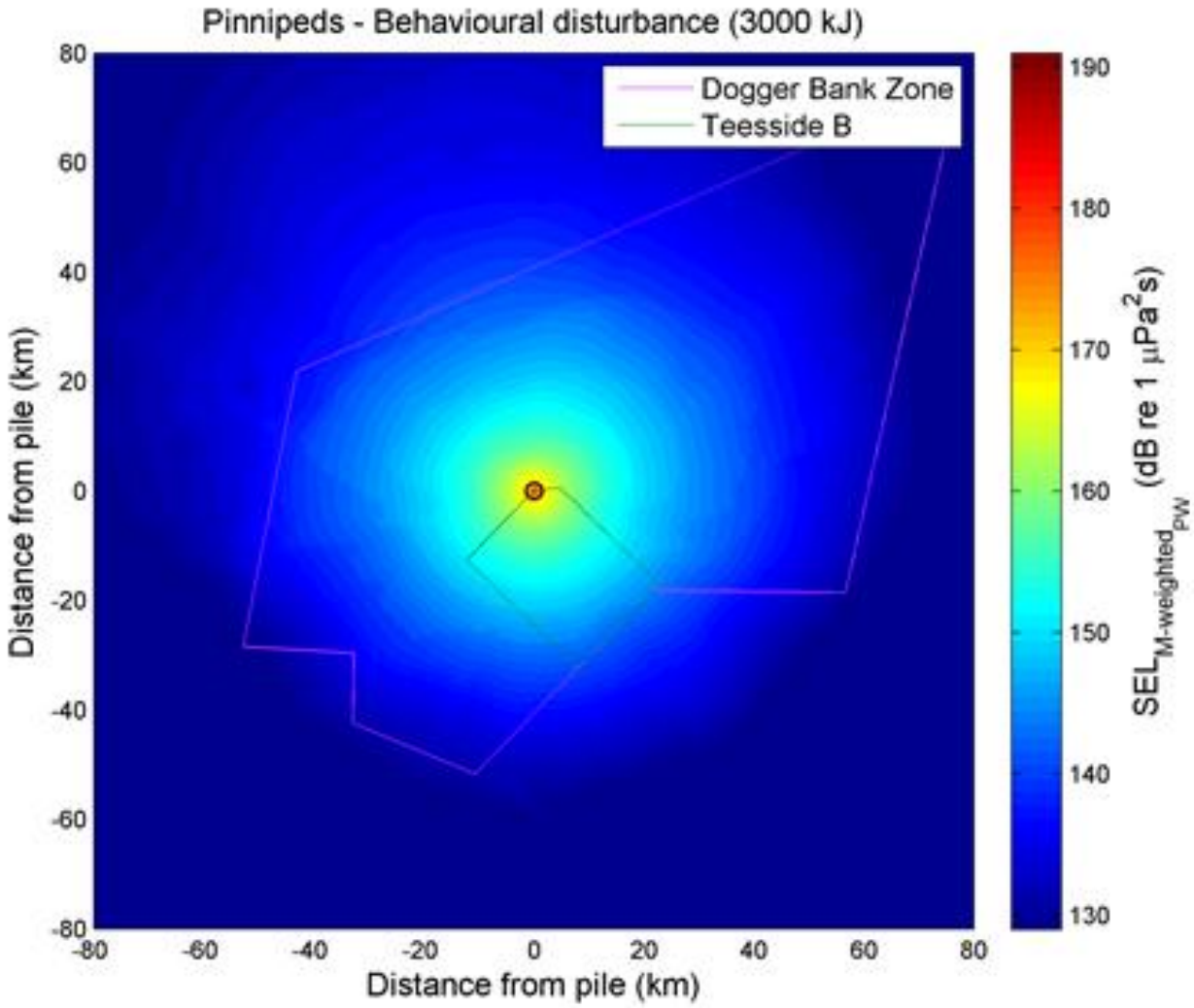



Figure 5.14 Pinnipeds in water behavioural disturbance zones for Dogger Bank Teesside B using 3,000kJ hammer blow energy SEL 171dB re 1 $\mu Pa^2/s^{-1}$ showing the zone of TTS / fleeing response / likely avoidance (zones of PTS are not shown on the figures as they are so small)

Table 5.11 Calculation of number of grey seals that could be affected by TTS (fleeing response / behavioural) impact, based on a single pile driving event with 3,000kJ maximum hammer energy, during construction work for Dogger Bank Teesside A or Dogger Bank Teesside B alone

| Density | Impact area | Number of seals affected | Percentage of reference population |
|---|---|---|---|
| **Dogger Bank Teesside A** | | | |
| Maximum mean at sea density 0.085 seals per $km^2$ (reference population 28,989) | 9$km^2$ | 0.8 | <0.003 |
| **Dogger Bank Teesside B** | | | |
| Maximum mean at sea density 0.23 seals per $km^2$ (reference population 28,989) | 9$km^2$ | 2.1 | <0.007 |

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5.6.21 The potential range for instantaneous TTS in grey seal extends beyond the proposed mitigation zone (see paragraphs 5.9.1 to 5.9.3); but based on the maximum mean densities of grey seal, less than three seals or 0.01% of the population could be exposed to TTS for Dogger Bank Teesside A & B (both projects combined) or one seal for Dogger Bank Teesside A and two seals for Dogger Bank Teesside B.

5.6.22 As set out in **Table 5.11**, the assessment criteria are for a single pile driving event, so at any one point in time a maximum of 0.01% (for Dogger Bank Teesside A & B) of the southern North Sea grey seal population potentially would be affected by TTS. This criteria effectively covers all piling works that would take place within Dogger Bank Teesside A & B during the construction phase. If more than one piling event is taking place, then the percentage of the population affected for a single event would be multiplied by the number of piling events taking place. In the situation where there are two piling events for each project, a maximum of 0.02% of the grey seal population could be exposed to TTS.

**Multiple pile driving**

***PTS impact due to multiple and concurrent pile-driving and impact on grey seal population***

5.6.23 As piling would be progressive and effectively represents a sequence of localised individual disturbance events, seals that may be present in the vicinity of piling would be able to relocate to adjacent areas in order to avoid potential exposure to high underwater noise levels. Each piling event would extend for up to 3.5 hours in duration (including 30 minute soft-start), and a maximum of 600 pile driving events each year has been set, which would result in 2,100 hours of piling a year for each project. As the piling works would be progressive, there would be no spatially cumulative disturbance effect due to piling works. For grey seal, the areas of potential instantaneous injury (PTS) impact are sufficiently small (see **Figure 5.13**) that consideration of overlapping areas of behavioural avoidance is not appropriate and, therefore, this has not been modelled.

5.6.24 As described in paragraph 5.6.19, instantaneous injury (PTS) can be avoided through the use of mitigation for single pile driving events (described in paragraphs 5.9.1 to 5.9.3). The same outcome would also apply to multiple pile driving over the whole construction period, as measures would be in place to avoid the potential for PTS to be realised in the first place. No impact is therefore predicted on individual grey seal or the grey seal population from multiple pile driving during the construction of Dogger Bank Teesside A & B (combined or individually).

***TTS and effect on grey seal population***

5.6.25 Quantification of the potential number of harbour porpoise that would be exposed to noise levels above the threshold that can cause TTS or disturbance is difficult for multiple piling works. It is not possible to quantify the duration of gaps between pile driving events during construction in an individual development area (e.g. Dogger Bank Teesside A or Dogger Bank Teesside B)

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or for the combined project as a whole (i.e. Dogger Bank Teesside A & B). As noted in paragraph 5.6.23 above, for grey seal the areas of disturbance (TTS) impact are sufficiently small (see **Figure 5.13** and **Figure 5.14**) that consideration of overlapping areas of behavioural avoidance is not appropriate, therefore, this has not been modelled. However, consideration has been given to the footprint approach. That is the area of potential impact during pile driving across Dogger Bank Teesside A and Dogger Bank Teesside B would equate to a maximum of the area of Dogger Bank Teesside A and Dogger Bank Teesside B plus the range out to which disturbance can occur (up to 1.7km). This gives an approximate area of 57km$^2$ for Dogger Bank Teesside A and 57km$^2$ for Dogger Bank Teesside B as shown on **Table 5.12**.

Table 5.12 Residual impact footprint and number of grey seals that could be affected by TTS (behavioural) impact (likely avoidance), based on concurrent pile driving event with 3,000kJ maximum hammer energy, during construction work for Dogger Bank Teesside A or Dogger Bank Teesside B alone and combined (Dogger Bank Teesside A & B)

| Density | Impact area | Number of seals affected | Percentage of reference population |
|---|---|---|---|
| **Dogger Bank Teesside A** | | | |
| Maximum mean at sea density 0.085 seals per km$^2$ (reference population 28,989) | 18km$^2$ | 1.5 | 0.005 |
| **Dogger Bank Teesside B** | | | |
| Maximum mean at sea density 0.23 seals per km$^2$ (reference population 28,989) | 18km$^2$ | 4.1 | 0.014 |
| **Dogger Bank Teesside A & B** | | | |
| Average at-sea density (reference population 28,989) | 36km$^2$ | 5.6 | 0.019 |

5.6.26 Given the low numbers of seals affected (see **Table 5.12**), together with the large extent of available alternative foraging area that would not be subject to noise levels likely to elicit a behavioural response, the low sensitivity of grey seals to underwater noise (as well as the mitigation measures identified in paragraphs 5.9.1 to 5.9.3), it is predicted that the complete duration of a worst case piling scenario would have no cumulative implications at the population level.

## Behavioural change due to vessel noise

5.6.27 In respect of noise generated by vessel traffic, it is anticipated (using the realistic worst case) that there would be a maximum of 66 vessels offshore during construction, peaking in year two of the project, with around 1,917 vessel movements (including 220 material transport vessels) in total each year for three years (or 968 vessel movements a year if the construction phase extended for six years) for Dogger Bank Teesside A or Dogger Bank Teesside B alone. Furthermore, it is possible that some existing ship traffic in the area may be excluded during construction, resulting in some displacement of the existing vessel traffic. In addition, it is likely that grey seals using this region are

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habituated to vessel movements and associated underwater noise, and there is no evidence to indicate that grey seals are disturbed by vessel noise. Overall, given the existing levels of vessel traffic (see paragraphs 5.5.32 and 5.5.33) which indicate numbers of around 3,650 a year around Dogger Bank Teesside A & B, it is not expected that the presence and movement of additional vessels during construction would significantly increase underwater noise levels above that of the baseline, such that a measurable behavioural response in grey seal would arise, either from the construction of Dogger Bank Teesside A or Dogger Bank Teesside B alone or concurrently.

### Physical damage as a result of vessel collisions

5.6.28 Given the agility and manoeuvrability of grey seal, and the relatively large size and slower speeds of construction vessels likely to be used during construction, it is considered unlikely that healthy grey seals would be impacted by vessel collisions during construction, except in extreme circumstances.

5.6.29 Guidance on assessing the potential risk of corkscrew injuries has been agreed by the SNCAs (SNCAs, 2012). This guidance suggests that activities at greater than 30 nautical miles (55.5km) from seal colonies (i.e. in areas of greatest use by seals, particularly juveniles) pose a low risk of potential injury. Given the distance between the proposed wind farm development site and the closest (>91km for Dogger Bank Teesside A & B Export Cable Corridor and >194km for offshore wind farm, see **Table 5.1**) grey seal colonies, the risk of such injuries occurring is considered to be low and no impact at the population level would be likely to arise.

## 5.7 Assessment of impacts during the operation phase - grey seal

5.7.1 This section identifies and assesses the impacts that are predicted to occur during the operation phase for Dogger Bank Teesside A & B (including the Dogger Bank Teesside A & B Export Cable Corridor) that have potential implications for grey seal. The impacts have been aggregated as follows:

- Indirect effects on the grey seal population as a result of alteration to prey species (fish) distribution, abundance or quality arising from the obstruction of the seabed causing a physical loss of habitat and scour induced increase in suspended sediment concentrations in the water column due to the presence and operation of the offshore wind farm structures;
- Indirect effects on the grey seal population as a result of behavioural changes arising from the increase in underwater noise levels due to the operation of the wind turbines;
- Direct physical damage (mortality) to grey seal population as a result of collisions with maintenance (operation phase) vessels; and
- Indirect physical damage to harbour porpoise as a result of behavioural changes arising from the presence of structures resulting in a barrier effect.

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## Alteration to prey species and impact on grey seal populations

5.7.2 The predicted impact of the operation of Dogger Bank Teesside A & B on fish abundance is described in detail in Sections 7.2, 7.3, 7.4, 7.5, and 7.6 of **Chapter 13** of the Dogger Bank Teesside A & B ES. The assessment predicts negligible to minor adverse impacts on fish behaviour and populations from small-scale habitat loss (footprint of turbine structures), the presence of hard substrates (turbine structures), and Electro-Magnetic Fields (EMF) (export cable). Key species for which impacts are predicted are sandeel (loss of habitat), cod and plaice, which could be affected very locally and individually by EMF. Studies have shown no evidence of long-term effects on prey species abundance associated with offshore wind farm development, e.g. sandeel at the Horns Rev wind farm (Stenberg *et al*. 2011). Furthermore, studies have observed increases in the abundance of various fish species (including sandeel and cod) within offshore wind farms (Leonhard & Pedersen 2005; Leonhard & Pedersen 2006).

5.7.3 The mobility of seals and flexibility in prey selection, together with evidence indicating that prey abundance is not depleted by offshore wind farm development, suggests that the grey seal foraging resource within the development area (i.e. Dogger Bank Teesside A & B and Dogger Bank Teesside A & B Export Cable Corridor) would not be affected in the operation phase. Taking account of the relatively low numbers of grey seals present within Dogger Bank Teesside A & B, it is concluded that this potential impact would not have any discernible implications for grey seal populations.

## Behavioural change due to underwater noise

5.7.4 Underwater noise levels generated during the operation of wind turbines are at a much lower level than the noise levels generated during construction. The low-level noise generated by wind turbines during the operation phase is likely to be detectable only at short distances over background noise levels and below levels that would elicit a response from marine mammals (Madsen *et al*. 2006; Thomsen *et al*. 2006). Empirical data exists to support no lasting disturbance or exclusion of seals from around or within wind farm sites during the operation phase, notably Tougaard *et al.* (2005), Scheidat *et al.* (2011), and McConnell *et al.* (2012).

## Behavioural change due to vessel noise

5.7.5 During the operation phase of Dogger Bank Teesside A & B the amount of vessel traffic attending to and related to the wind farm would be significantly lower than during construction (see **Table 2.2**). Vessels would be required for wind turbine and cable maintenance, with a maximum of 28 vessels on site at any one time, and up to 730 vessel movements (round trips to port) per year predicted as a worst case (see **Table 2.2**) for Dogger Bank Teesside A or Dogger Bank Teesside B alone. Overall, it is not expected that the presence and movement of vessels during maintenance for Dogger Bank Teesside A & B would significantly increase underwater noise levels above that of the baseline (see paragraphs 5.5.32 and 5.5.33), such that a measurable behavioural response would arise (see paragraph 5.6.27). Therefore, no population level impact is predicted on grey seal.

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### Physical damage as a result of vessel collisions

5.7.6 For the reasons described and assessed in paragraphs 5.6.28 and 5.6.29 and given the lower numbers of vessels expected to be present or travelling to and from Dogger Bank Teesside A & B during the operation phase (see **Table 2.2**), a negligible risk of physical damage as a result of vessel collisions is predicted on the grey seal population.

### Physical barrier to grey seal movements

5.7.7 The presence of a wind farm could be seen as having the potential to create a physical barrier, preventing movement or migration of grey seals between important feeding and / or between breeding areas and populations. Evidence from the Egmond aan Zee offshore wind farm (Lindeboom *et al.* 2011) suggests that marine mammals (including grey seals) may be attracted to the site for foraging and, given their limited response to noise from turbines (see paragraph 5.7.4), no population level impact is predicted on grey seal.

## 5.8 Assessment of impacts during the decommissioning phase - grey seal

5.8.1 This section identifies and assesses the impacts that are predicted to occur during the decommissioning phase for Dogger Bank Teesside A & B (including the Dogger Bank Teesside A & B Export Cable Corridor) that have potential implications for grey seal. The potential impacts have been aggregated as follows:

- Indirect effects to the grey seal population as a result of alteration to prey species (fish) distribution, abundance or quality arising from increased suspended sediment concentrations in the water column and re-deposition of sediment from the water column due to the placement of jack-up vessel legs and removal of structures;
- Direct physical damage (mortality) and indirect behavioural effects as a result of underwater noise due to pile cutting and vessel movements; and
- Direct physical damage (mortality) to grey seal population as a result of collisions with decommissioning vessels.

### Alteration to prey species and impact on grey seal populations

5.8.2 Negligible and temporary disturbance to the seabed would occur during decommissioning, with predicted lower levels of underwater noise, seabed disturbance, increased suspended sediment concentrations, and sediment deposition than during construction. Given that a negligible impact on prey species (as described in paragraphs 5.6.3 to 5.6.5) for the construction phase has been determined, then a similar, if not lesser, impact would be expected during decommissioning. Taken together with the low sensitivity of grey seals to small changes in prey species abundance, no measurable impact on grey seals within Dogger Bank Teesside A & B is predicted.

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### Behavioural change due to underwater noise

5.8.3 There would be no pile driving or use of explosives during decommissioning, consequently underwater noise levels generated during the cutting of piles and other localised decommissioning activities would be lower than those generated during construction. In line with the methodology and approach set out for the construction period, given the significantly lower noise levels that would occur during decommissioning, no auditory damage would be expected. Similarly, the potential for any significant behavioural response (TTS) that would have implications at the population level is not predicted.

5.8.4 Once decommissioning is completed, no additional noise sources would be present or emanate from within Dogger Bank Teesside A & B.

### Behavioural change due to vessel noise

5.8.5 Whilst detail on the number and type of vessels during decommissioning is not available at this stage, it is expected that vessel numbers and subsequent noise effects would be similar to those during the construction phase. Consequently, no measurable behavioural impact is predicted, as described in paragraph 5.6.27, for the duration of decommissioning.

5.8.6 Once decommissioning is completed, no additional vessel movements would occur within or as a result of Dogger Bank Teesside A & B.

### Physical damage as a result of vessel collisions

5.8.7 Whilst detail on the number and type of vessels that would be present during decommissioning is not available at this stage, it is expected that vessel numbers and the subsequent potential for physical damage to grey seals as a result of hull impacts or effects from ducted propellers would be similar to those during the construction phase. Consequently, no measurable population impact is predicted, as described in paragraphs 5.6.28 and 5.6.29, for the duration of decommissioning.

## 5.9 Avoidance / mitigation measures

5.9.1 Following JNCC Guidelines (JNCC 2010), the avoidance of potential harm to grey seals during pile driving events would be achieved through the application of an effective zone of exclusion of up to 500m around the location of the pile driving. There is the potential that marine mammals could be excluded from ranges greater than this (ranging between 700m and 1000m), as the use of alternate mitigation measures are being investigated through initiatives such as the Offshore Renewable Joint Industry Programme (ORJIP). Furthermore, following JNCC guidelines, the provision of a Marine Mammal Observer and/or Passive Acoustic Monitoring (PAM) and/or Acoustic Deterrent Device (ADDs) are expected to be part of the licensing requirement following JNCC guidelines. The final approach to be taken for Dogger Bank Teesside A & B will be determined during the design and implementation of a project-specific Marine Mammal Mitigation Protocol (MMMP).

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5.9.2 The avoidance measure described above is assumed to be effective out to 500m from the noise source. Consequently, in the case of grey seal, PTS injuries would be completely avoided because the calculated maximum impact ranges are less than 500m.

5.9.3 The impact of TTS on grey seal within 500m of the noise source would also be avoided. However, the potential worst case range for TTS for grey seal would extend beyond the mitigation zone (of 500m) by a further 1.2km (see **Table 5.9**). The proposed mitigation would be unlikely to significantly decrease the numbers of seals exposed to TTS but, given the very small numbers of animals likely to be present in development area at any one time, it is apparent that only a very small percentage of the overall grey seal population would be affected (0.02% for two piling events for the concurrent construction of both Dogger Bank Teesside A and Dogger Bank Teesside B). Hence, no implications at the population level are predicted on grey seal.

## 5.10 Summary of assessment findings and conclusions on site integrity of UK sites in relation to grey seal feature

### Introduction

5.10.1 This section presents the assessment of the effects of Dogger Bank Teesside A & B on the conservation objectives and related favourable condition criteria of the Annex II feature (grey seal) for the marine and coastal SACs screened into this stage of the HRA process. The conclusions discussed here are based on the assessment of the impacts described in Sections 5.6, 5.7, and 5.8.

5.10.2 The assessment of effect on the integrity of a European site has been undertaken in view of the site's conservation objectives (see Section 5.2), as listed for the relevant features under the description of impacts. For the purposes of assessment, and in line with accepted guidance (EC 2000), the integrity of a site is defined as "*the coherence of its ecological structure and function, across its whole area, that enables it to sustain the habitat, complex of habitats and/or the levels of populations of the species for which it was classified*". Therefore, the assessment of the construction, operation, and decommissioning of Dogger Bank Teesside A & B against the favourable condition targets for the grey seal features (listed in **Table 5.3**, **Table 5.4**, and **Table 5.5**) for the UK SACs under consideration is presented in **Table 5.13** (for sites in England) and **Table 5.14** (for sites in Scotland).

### Conclusions in relation to grey seal population

5.10.3 Direct injury (PTS) effects are predicted to be negligible (<0.0001%) in terms of the grey seal population (defined in paragraph 5.5.7) in the worst case (cumulative projects) scenario. Disturbance (TTS) effects that could occur as a result of construction activity would be temporary, short-term and of negligible significance for individuals and at the population level (0.019% affected as described in paragraph 5.6.25 and **Table 5.12**). Where individuals may be temporarily affected, they have a low sensitivity to the disturbance impact due to their existing adaptation to noise and vessel movements. In the limited instance where seals may be subject to disturbance, they would be able to move away

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from the source of disturbance in order to continue foraging. Furthermore, there is no evidence to indicate that prey resources would be affected to a measurable degree (see paragraph 5.6.3 to 5.6.5) such that foraging success or energetics of grey seal would be adversely affected. As such, it is concluded that the construction phase for Dogger Bank Teesside A & B combined and individually would not measurably affect the North Sea grey seal population.

5.10.4 For the operational phase of Dogger Bank Teesside A & B, disturbance effects that could give rise to significant impacts on grey seal populations are not expected (see Section 5.7). There is no available evidence to indicate that underwater noise levels generated by operational wind turbines affect or disturb grey seals such that displacement or adverse changes in foraging behaviour would be likely to occur. Vessel noise and collision risk are predicted to have a negligible influence at the population level. As such, it is concluded that the operation phase for Dogger Bank Teesside A & B combined and individually would not measurably affect the North Sea grey seal population.

5.10.5 Given that the effects of the decommissioning phase are likely to be the same, albeit smaller in magnitude and intensity (see Section 5.8), to those described and assessed for the construction phase (see Section 5.6), as summarised in paragraph 5.10.3 above, it is concluded that the decommissioning phase for Dogger Bank Teesside A & B combined and individually would not measurably affect the North Sea grey seal population.

## Berwickshire and North Northumberland Coast SAC

5.10.6 The assessment of the construction, operation, and decommissioning of Dogger Bank Teesside A & B against the favourable condition targets for the grey seal feature of the North Berwickshire and North Northumberland Coast SAC is presented in **Table 5.13**. It should be noted that in tagging studies only 0.15% of the site's grey seal population's time at sea occurred within Dogger Bank Teesside A & B and the surrounding area (see paragraph 5.5.20).

5.10.7 The construction phase effects on the North Sea grey seal population are considered to be negligible (see paragraph 5.10.3 above). Given the low usage of the site by grey seals from the North Berwickshire and North Northumberland Coast SAC, noted in paragraph 5.10.6 above, and the conclusions in relation to the favourable condition of the grey seal feature presented in **Table 5.13**, it is concluded that there would not be an adverse effect on the integrity of the North Berwickshire and North Northumberland Coast SAC as a result of the construction of Dogger Bank Teesside A & B (both projects combined or individually).

5.10.8 The operation phase effects on the North Sea grey seal population are considered to be negligible (see paragraph 5.10.4 above). Given the low usage of the site by grey seals from the North Berwickshire and North Northumberland Coast SAC noted in paragraph 5.10.6 above, and the conclusions in relation to the favourable condition of the grey seal feature presented in **Table 5.13**, it is concluded that there would not be an adverse effect on the integrity of the North Berwickshire and North Northumberland Coast SAC as a result of the operation of Dogger Bank Teesside A & B (both projects combined or individually).

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Table 5.13 Assessment summary of the construction, operation and decommissioning phases for Dogger Bank Teesside A & B in respect of favourable condition targets for English SACs supporting designated Annex II grey seal features (Berwickshire and North Northumberland Coast SAC and Humber Estuary SAC (and Ramsar site))

| Attribute | Measure / criteria | Target | Assessment discussion |
|---|---|---|---|
| **Construction** | | | |
| Extent | Total area (ha), measured once during reporting cycle. | No decrease in extent from an established baseline, subject to natural change. | Construction works would have no direct or indirect effects on the habitats within the designated sites that support the grey seal populations. This is due to the large distance between the location of the SACs and the development area, including the nearest extent of the Dogger Bank Teesside A & B Export Cable Corridor:<br>**Berwickshire and North Northumberland Coast SAC** – 221km to offshore wind farm area, 91km to Dogger Bank Teesside A & B Export Cable Corridor.<br>**Humber Estuary SAC (and Ramsar site)** – 194km to offshore wind farm area; 96km to Dogger Bank Teesside A & B Export Cable Corridor.<br>Tagging data indicates that some individuals from these designated sites may make limited use of Dogger Bank as a foraging area (see paragraphs 5.5.20 and 5.5.28). Dogger Bank can therefore be viewed as supporting habitat for the designated populations. Assessment indicates that small-scale habitat disturbance and behavioural responses of prey species to construction activities (e.g. increased underwater noise levels) would not lead to a measurable reduction in potential prey resources for grey seals (see paragraph 5.6.5). Whilst a very small and temporary alteration to the structure, function and extent of habitat within Dogger Bank Teesside A & B may arise, on the basis of the total area available to foraging grey seals outside of designated sites this is considered to be insignificant. Grey seals also have a high level of prey flexibility and are able to alter foraging patterns and resource utilisation should the need arise (see paragraphs 5.6.4 and 5.6.5). |


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| Attribute | Measure / criteria | Target | Assessment discussion |
|---|---|---|---|
| Disturbance | Reduction or displacement of grey seals measured using average count information measured periodically (frequency to be determined). | No significant reduction in numbers or displacement of grey seals from an established baseline, subject to natural change. | Construction activities would not result in any direct disturbance to grey seals and their displacement from within the defined boundaries of the SACs due to the extreme distance between the designated sites and the development area (see above).<br>Disturbance to grey seals deriving from designated populations and that may be present within Dogger Bank could, however, occur as a result of construction activities, notably in respect of the generation of underwater noise associated with piling works.<br>Evidence suggests that grey seal show a low sensitivity to underwater noise and very strong avoidance behaviour is not elicited. Modelling of noise levels to determine the ranges for potential instantaneous onset of auditory injury (PTS) and behavioural change (TTS) indicate that concurrent piling (two piling operations within each development area) within Dogger Bank Teesside A & B could result in a behavioural response to 0.019% of the UK North Sea grey seal population (see **Table 5.12**).<br>The avoidance measures described in Section 5.9 would significantly reduce the likelihood of permanent auditory injury to grey seals occurring. Given the small number of seals that could potentially be subject to disturbance (i.e. in which an avoidance reaction would be elicited) and the fact that an even smaller percentage of these would be likely to belong to a designated SAC population it is concluded that there would be no discernible effect on designated populations throughout the duration of construction.<br>Vessel movements and associated underwater noise levels would be unlikely to lead to significant behavioural responses given likely habituation to existing vessel movements in the wider area. Combined with the temporary nature of such effects and the low sensitivity of grey seal to underwater noise it is not anticipated that vessel movements during construction would lead to significant disturbance effects.<br>Vessel collision impacts with seals are not widely recorded, though juveniles have been recorded with injuries believed to derive from ducted propellers. The distance to the designated sites would effectively preclude the potential for lethal injury to juvenile seals as these individuals would remain in close proximity to their colonies. No significant mortality to grey seals within the Dogger Bank Zone and, therefore, no impact is anticipated on designated grey seal populations. |


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| Attribute | Measure / criteria | Target | Assessment discussion |
|---|---|---|---|
| **Operation** | | | |
| Extent | Total area (ha), measured once during reporting cycle. | No decrease in extent from an established baseline, subject to natural change. | Operation of the wind farm would have no direct or indirect effects on the habitats within the designated sites that support grey seal populations. This is due to the large distance between the location of the SACs and the development area, including the nearest extent of the Dogger Bank Teesside A & B Export Cable Corridor.<br>Some small-scale benthic habitat loss would occur from within the development area. However, it is highly unlikely that this loss would result in any decrease in prey resource availability and therefore no significant impact on the foraging resource of grey seals is predicted. |
| Disturbance | Reduction or displacement of grey seals measured using average count information measured periodically (frequency to be determined). | No significant reduction in numbers or displacement of grey seals from an established baseline, subject to natural change. | The operation of Dogger Bank Teesside A & B would not result in any direct disturbance to grey seals and their displacement from within the defined boundaries of the SACs due to the extreme distance between the designated sites and the development area (see above).<br>Underwater noise generated by wind turbines is low frequency, low level and extends only short distances underwater. Studies have not shown any behavioural response by grey seals (or other seals) to operational wind farms (see paragraph 5.7.4).<br>There would be an increase in vessel movements within the study area during the operation phase. The number of movements would be much lower than during construction and would not significantly increase the background noise environment (acting only 'locally'). Given the temporary nature of any disturbance effects, potential habituation by seals and the low sensitivity of grey seal to underwater noise it is not anticipated that vessel movements during the operation phase would lead to significant disturbance effects.<br>Vessel collision impacts with seals are not widely recorded, though juveniles have been recorded with injuries believed to derive from ducted propellers. The distance to the designated sites would effectively preclude the potential for lethal injury to juvenile seals as these individuals would remain in close proximity to their colonies. No significant mortality to grey seals within the Dogger Bank Zone, and therefore no impact on designated populations, is anticipated. |


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| Attribute | Measure / criteria | Target | Assessment discussion |
|---|---|---|---|
| **Decommissioning** | | | |
| Extent | Total area (ha), measured once during reporting cycle. | No decrease in extent from an established baseline, subject to natural change. | The extent of potential change to benthic habitat (and prey abundance) would be no more than that described above in relation to construction. Potential impacts would be temporary and would cease on completion of the decommissioning works. Natural recovery of affected areas would be expected within a relatively short timespan (5 to 10 years). |
| Disturbance | Reduction or displacement of grey seals measured using average count information measured periodically (frequency to be determined). | No significant reduction in numbers or displacement of grey seals from an established baseline, subject to natural change. | During decommissioning there would be no pile driving or use of explosives and consequently limited additional underwater noise generated, with the biggest noise source likely to be vessel movements, which are likely to be similar in number to those during construction. Given the temporary nature of any disturbance effects, potential habituation by seals and the low sensitivity of grey seal to underwater noise it is not anticipated that vessel movements during decommissioning would lead to significant disturbance effects. Vessel collision impacts with seals are not widely recorded, though juveniles have been recorded with injuries believed to derive from ducted propellers. The distance to the designated sites would effectively preclude the potential for lethal injury to juvenile seals as these individuals would remain in close proximity to their colonies. No significant mortality to grey seals within the Dogger Bank Zone, and therefore no impact on designated populations, is anticipated. |


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Table 5.14 Assessment summary of the construction, operation and decommissioning phases for Dogger Bank Teesside A & B in respect of favourable condition targets for Scottish SACs supporting designated Annex II grey seal features (Isle of May and Faray and Holm of Faray SAC)

| Attribute | Measure / criteria | Assessment discussion |
|---|---|---|
| **Construction** | | |
| Population | Breeding number. | Given the effects described below regarding mortality (direct or indirect) and subsequent breeding success, the construction of Dogger Bank Teesside A & B is not expected to affect the breeding number of grey seals that form part of SAC designated populations. |
| Species distribution | Presence and population within site. | Given the effects described below regarding mortality (direct or indirect) and subsequent breeding success, the construction of Dogger Bank Teesside A & B is not expected to affect grey seal presence and distribution within designated SACs. |
| Disturbance | Reduction in breeding success. Mortality. | Tagging data indicates that some individuals from the Isle of May may make some limited use of Dogger Bank as a foraging area (see paragraph 5.5.26). Tagging data has not revealed any connectivity between Dogger Bank Teesside A & B and surrounding area with the grey seal population of the Faray and Holm of Faray SAC (see paragraph 5.5.23) although it is possible that grey seal from this site may, on occasion, make use of the Dogger Bank for foraging.<br>Construction activities would not result in any direct disturbance to grey seals and their displacement from within the defined boundaries of the SACs due to the extreme distance between the designated sites and the development area (see below).<br>Disturbance to grey seals deriving from designated populations and that may be present within Dogger Bank could, however, occur as a result of construction activities, notably in respect of the generation of underwater noise associated with piling works.<br>Evidence suggests that grey seal show a low sensitivity to underwater noise and a very strong avoidance behaviour is not elicited. Modelling of noise levels to determine the ranges for potential instantaneous onset of auditory injury (PTS) and behavioural change (TTS) indicate that concurrent piling (two piling operations within each development area) within Dogger Bank Teesside A & B could result in a behavioural response to 0.019% of the UK North Sea grey seal population (see **Table 5.12**).<br>The avoidance measures described in Section 5.9 would significantly reduce the likelihood of permanent auditory injury to grey seals occurring. Given the small number of seals that could potentially be subject to disturbance (i.e. in which an avoidance reaction would be elicited) and the fact that an even smaller percentage of these would be likely to belong to a designated SAC population it is concluded that there would be no discernible effect on designated populations throughout the duration of construction. |


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| Attribute | Measure / criteria | Assessment discussion |
|---|---|---|
| Disturbance (continued) | Reduction in breeding success. Mortality. | Vessel movements and associated underwater noise levels would be unlikely to lead to significant behavioural responses given likely habituation to existing vessel movements in the wider area. Combined with the temporary nature of such effects and the low sensitivity of grey seal to underwater noise it is not anticipated that vessel movements during construction would lead to significant disturbance effects.<br>Vessel collision impacts with seals are not widely recorded, though juveniles have been recorded with injuries believed to derive from ducted propellers. The distance to the designated sites would effectively preclude the potential for lethal injury to juvenile seals as these individuals would remain in close proximity to their colonies. No significant mortality to grey seals within the Dogger Bank Zone and, therefore, no impact on designated populations is anticipated. |
| Extent | Area of supporting habitats. | Construction works would have no direct or indirect effects on the habitats within the designated sites that support the grey seal populations. This is due to the large distance between the location of the SACs and the development area, including the nearest extent of the Dogger Bank Teesside A & B Export Cable Corridor:<br>**Isle of May SAC** – 311km to offshore wind farm area, 199km to Dogger Bank Teesside A & B Export Cable Corridor.<br>**Faray and Holm of Faray SAC** – 546km to offshore wind farm area; 523km to Dogger Bank Teesside A & B Export Cable Corridor.<br>Dogger Bank can be viewed as supporting habitat for the designated populations. Assessment indicates that small-scale habitat disturbance and behavioural responses of prey species to construction activities (e.g. increased underwater noise levels) would not lead to a reduction in potential prey resources for grey seals (see paragraph 5.6.5).<br>Whilst a very small and temporary alteration to the structure and function and extent of habitat within the development area may arise, on the basis of the total area available to foraging grey seals outside of designated sites, and the negligible if any recorded use of tagged grey seals from these sites, this is considered to be insignificant. Grey seals also have a high level of prey flexibility and are able to alter foraging patterns and resource utilisation should the need arise (see paragraphs 5.6.4 and 5.6.5). |
| Distribution | Area of supporting habitat types. | |
| Structure | Structure and function of supporting habitats (including physical processes). | |
| **Operation** | | |
| Population | Breeding number. | Given the effects described below regarding mortality (direct or indirect) and subsequent breeding success, the operation of Dogger Bank Teesside A & B is not expected to affect the breeding number of grey seals that form part of SAC designated populations. |
| Species distribution | Presence and population within site. | Given the effects described below regarding mortality (direct or indirect) and subsequent breeding success, the operation of Dogger Bank Teesside A & B is not expected to affect grey seal presence and distribution within designated SACs. |


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| Attribute | Measure / criteria | Assessment discussion |
|---|---|---|
| Disturbance | Reduction in breeding success.<br>Mortality. | The operation of Dogger Bank Teesside A & B would not result in any direct disturbance to grey seals and their displacement from within the defined boundaries of the SACs due to the extensive distance between the designated sites and the development area (see above).<br>Underwater noise generated by wind turbines is low frequency, low level and extends only short distances underwater. Studies have not shown any behavioural response by grey seals (or other seals) to operational wind farms (see paragraph 5.7.4).<br>There would be an increase in vessel movements within the study area during the operation phase. The number of movements would be much lower than during construction and would not significantly increase the background noise environment (acting only 'locally'). Given the temporary nature of any disturbance effects, potential habituation by seals and the low sensitivity of grey seal to underwater noise it is not anticipated that vessel movements during the operation phase would lead to significant disturbance effects.<br>Vessel collision impacts with seals are not widely recorded, though juveniles have been recorded with injuries believed to derive from ducted propellers. The distance to the designated sites would effectively preclude the potential for lethal injury to juvenile seals as these individuals would remain in close proximity to their colonies. No significant mortality to grey seals within the Dogger Bank Zone and, therefore, no impact on designated populations is anticipated. |
| Extent | Area of supporting habitats. | Operation of the wind farm would have no direct or indirect effects on the habitats within the designated sites that support the grey seal populations. This is due to the large distance between the location of the SACs and the development area, including the nearest extent of the export cable route. Some small-scale benthic habitat loss and change (see Section 4.7) would occur within the development area. However, it is not predicted that this loss and alteration would affect the structure and function of habitats (see **Table 4.23**) such that a decrease in prey resource availability would result. Furthermore, on the basis of the total area available to foraging grey seal outside of designated sites, and the negligible if any recorded use of tagged grey seals from these sites, this is considered to be insignificant. Therefore no significant impact on the foraging resource of grey seals is predicted. |
| Population | Breeding number. | Given the effects described above regarding mortality (direct or indirect) and subsequent breeding success, the operation of Dogger Bank Teesside A & B is not expected to affect the breeding number of grey seals that form part of SAC designated populations. |
| Species distribution | Presence and population within site. | Given the effects described above regarding mortality (direct or indirect) and subsequent breeding success, the operation of Dogger Bank Teesside A & B is not expected to affect grey seal presence and distribution within designated SACs. |


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| Attribute | Measure / criteria | Assessment discussion |
|---|---|---|
| **Decommissioning** | | |
| Population | Breeding number. | Given the effects described below regarding mortality (direct or indirect) and subsequent breeding success, the operation of Dogger Bank Teesside A & B is not expected to affect the breeding number of grey seals that form part of SAC designated populations. |
| Species distribution | Presence and population within site. | Given the effects described below regarding mortality (direct or indirect) and subsequent breeding success, the operation of Dogger Bank Teesside A & B is not expected to affect grey seal presence and distribution within designated SACs. |
| Disturbance | Reduction in breeding success.<br>Mortality. | During decommissioning there would be no pile driving or use of explosives and consequently limited additional underwater noise generated, with the biggest noise source likely to be vessel movements (of a similar number to those during construction). Given the temporary nature of any disturbance effects, potential habituation by seals and the low sensitivity of grey seal to underwater noise it is not anticipated that vessel movements during the operation phase would lead to significant disturbance effects.<br>Hull impacts with seals are not widely recorded, though juveniles have been recorded with injuries believed to derive from ducted propellers. The distance to the designated sites would effectively preclude the potential for lethal injury to juvenile seals as these individuals would remain in close proximity to their colonies. No significant mortality to grey seals within the Dogger Bank Zone and, therefore, no impact on designated populations is anticipated. |
| Extent | Area of supporting habitats. | The extent of disturbance to benthic habitat (and prey abundance) would be no more than that described above in relation to construction. Potential impacts would be temporary and would cease on completion of the decommissioning works. Natural recovery of affected areas would be expected within a relatively short timespan (5-10 years). |
| Distribution | Area of supporting habitat types. | |
| Structure | Structure and function of supporting habitats (including physical processes). | |


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5.10.9 The decommissioning phase effects on the North Sea grey seal population are considered to be negligible (see paragraph 5.10.5 above). Given the low usage of the site by grey seals from the North Berwickshire and North Northumberland Coast SAC, noted in paragraph 5.10.6 above, and the conclusions in relation to the favourable condition of the grey seal feature presented in **Table 5.13**, it is concluded that there would not be an adverse effect on the integrity of the North Berwickshire and North Northumberland Coast SAC as a result of the decommissioning of Dogger Bank Teesside A & B (both projects combined or individually).

## Faray and Holm of Faray SAC

5.10.10 As identified in the baseline (see paragraph 5.5.23), there is no evidence for connectivity between the Faray and Holm of Faray SAC grey seal population and Dogger Bank Teesside A & B study area. However, the assessment has been undertaken for the southern North Sea grey seal population as a whole. Consequently, whilst there is no evidence for direct use of the Dogger Bank Zone by grey seals from the Faray and Holm of Faray SAC, the same conclusions as those derived for the other SACs (see **Table 5.14**) effectively apply to the Faray and Holm of Faray SAC.

5.10.11 The construction phase effects on the North Sea grey seal population are considered to be negligible (see paragraph 5.10.3 above). Given that no usage of the site is recorded by grey seals from the Faray and Holm of Faray SAC, noted in paragraph 5.10.10 above, and the conclusions in relation to the favourable condition of the grey seal feature presented in **Table 5.14**, it is concluded that there would not be an adverse effect on the integrity of the Faray and Holm of Faray SAC as a result of the construction of Dogger Bank Teesside A & B (both projects combined or individually).

5.10.12 The operation phase effects on the North Sea grey seal population are considered to be negligible (see paragraph 5.10.4 above). Given that no usage of the site is recorded by grey seals from the Faray and Holm of Faray SAC, noted in paragraph 5.10.10 above, and the conclusions in relation to the favourable condition of the grey seal feature presented in **Table 5.14**, it is concluded that there would not be an adverse effect on the integrity of the Faray and Holm of Faray SAC as a result of the operation of Dogger Bank Teesside A & B (both projects combined or individually).

5.10.13 The decommissioning phase effects on the North Sea grey seal population are considered to be negligible (see paragraph 5.10.5 above). Given that no usage of the site is recorded by grey seals from the Faray and Holm of Faray SAC, noted in paragraph 5.10.10 above, and the conclusions in relation to the favourable condition of the grey seal feature presented in **Table 5.14**, it is concluded that there would not be an adverse effect on the integrity of the Faray and Holm of Faray SAC as a result of the decommissioning of Dogger Bank Teesside A & B (both projects combined or individually).

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## Humber Estuary SAC

5.10.14 The assessment of the construction, operation, and decommissioning of Dogger Bank Teesside A & B against the favourable condition targets for the grey seal feature of the Humber Estuary SAC (and Ramsar site) is presented in **Table 5.13**. It should be noted that in tagging studies only 2.74% of the site's grey seal population's time at sea occurred within Dogger Bank Teesside A & B and the surrounding area (see paragraph 5.5.28).

5.10.15 The construction phase effects on the North Sea grey seal population are considered to be negligible (see paragraph 5.10.3 above). Given the low usage of the site by grey seals from the Humber Estuary SAC (and Ramsar site), noted in paragraph 5.10.14 above, and the conclusions in relation to the favourable condition of the grey seal feature presented in **Table 5.13**, it is concluded that there would not be an adverse effect on the integrity of the Humber Estuary SAC (and Ramsar site) as a result of the construction of Dogger Bank Teesside A & B (both projects combined or individually).

5.10.16 The operation phase effects on the North Sea grey seal population are considered to be negligible (see paragraph 5.10.4 above). Given the low usage of the site by grey seals from the Humber Estuary SAC (and Ramsar site) SAC, noted in paragraph 5.10.14 above, and the conclusions in relation to the favourable condition of the grey seal feature presented in **Table 5.13**, it is concluded that there would not be an adverse effect on the integrity of the Humber Estuary SAC (and Ramsar site) as a result of the operation of Dogger Bank Teesside A & B (both projects combined or individually).

5.10.17 The decommissioning phase effects on the North Sea grey seal population are considered to be negligible (see paragraph 5.10.5 above). Given the low usage of the site by grey seals from the Humber Estuary SAC (and Ramsar site), noted in paragraph 5.10.14 above, and the conclusions in relation to the favourable condition of the grey seal feature presented in **Table 5.13**, it is concluded that there would not be an adverse effect on the integrity of the Humber Estuary SAC (and Ramsar site) as a result of the decommissioning of Dogger Bank Teesside A & B (both projects combined or individually).

## Isle of May SAC

5.10.18 The assessment of the construction, operation, and decommissioning of Dogger Bank Teesside A & B against the favourable condition targets for the grey seal feature of the Isle of May SAC is presented in **Table 5.14**. It should be noted that in tagging studies only 0.22% of the site's grey seal pup population's time at sea occurred within Dogger Bank Teesside A & B and the surrounding area (see paragraph 5.5.26). No adult grey seal were recorded within the development area, though connectivity with the Abertay Sands population could occur.

5.10.19 The construction phase effects on the North Sea grey seal population are considered to be negligible (see paragraph 5.10.3 above). Given the low usage of the site by grey seals from the Isle of May SAC, noted in paragraph 5.10.18 above, and the conclusions in relation to the favourable condition of the grey seal feature presented in **Table 5.14**, it is concluded that there would not be an adverse effect on the integrity of the Isle of May SAC as a result of the

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construction of Dogger Bank Teesside A & B (both projects combined or individually).

5.10.20 The operation phase effects on the North Sea grey seal population are considered to be negligible (see paragraph 5.10.4 above). Given the low usage of the site by grey seals from the Isle of May SAC, noted in paragraph 5.10.18 above, and the conclusions in relation to the favourable condition of the grey seal feature presented in **Table 5.14**, it is concluded that there would not be an adverse effect on the integrity of the Isle of May SAC as a result of the operation of Dogger Bank Teesside A & B (both projects combined or individually).

5.10.21 The decommissioning phase effects on the North Sea grey seal population are considered to be negligible (see paragraph 5.10.5 above). Given the low usage of the site by grey seals from the Isle of May SAC, noted in paragraph 5.10.18 above, and the conclusions in relation to the favourable condition of the grey seal feature presented in **Table 5.14**, it is concluded that there would not be an adverse effect on the integrity of the Isle of May SAC as a result of the decommissioning of Dogger Bank Teesside A & B (both projects combined or individually).

## 5.11 Summary of assessment findings and conclusions on site integrity of transboundary sites in relation to grey seal feature

5.11.1 The assessment of impacts associated with Dogger Bank Teesside A & B (combined and individually) summarised in paragraphs 5.10.3, 5.10.4, and 5.10.5, indicate that an extremely small percentage of the entire grey seal population of the UK North Sea population would be affected during the construction (Section 5.6), operation (Section 5.7), and decommissioning (Section 5.8).

5.11.2 There is some evidence from tagging studies to indicate that there is movement of seals between colonies on the European continental coast (notably in the Wadden Sea) and the UK (Brasseur *et al*. 2010); see paragraphs 5.5.3 and 5.5.10. This suggests that populations present in the UK and continental Europe are not 'closed' and that the effects of wind farm development in the central North Sea could impact upon the wider North Sea grey seal population. If this is the case, then the magnitude of the impacts predicted using the UK North Sea population as a reference commensurately would be even lower. The tagging study reported in Brasseur *et al.* (2010) also shows that grey seals from Dutch colonies make use of the Dogger Bank for foraging (see paragraph 5.5.10, and **Figure 5.3** and **Figure 5.4**).

5.11.3 As with the UK designated SACs, development of Dogger Bank Teesside A & B would have no direct impacts upon designated supporting habitats for grey seals within transboundary SACs (i.e. those sites listed in **Table 5.1** and **Table 5.2**). With regard to indirect effects (notably disturbance during construction and potential prey displacement) the same conclusions drawn in respect of grey seals that may originate from UK SACs also apply to non-UK designated populations. Essentially, this conclusion reflects the observed data that grey seals spend the majority of their time at sea within relative proximity to their

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breeding colonies and, therefore, would be unlikely to be subject to potential effects associated with development. Additionally, seals that may be present within Dogger Bank potentially could originate from both UK and continental European sites, or potentially be in transit between them. Consequently, making any distinction between UK and continental derived individuals in respect of potential exposure to development effects within Dogger Bank Teesside A & B is, in reality, meaningless and impacts are best considered at the overall North Sea population level. With respect to the grey seal populations that forage within the Doggersbank SCI and Klaverbank SCI (which are located adjacent to or within 78km of Dogger Bank Teesside A & B, respectively), the potential impacts on the foraging population of grey seal within these sites are predicted to be negligible. Only one grey seal tagged from sites outside UK waters (i.e. from a transboundary site) was recorded passing through Dogger Bank Teesside A & B (see paragraph 5.5.10). Therefore negligible numbers of grey seal from transboundary sites that may travel through and forage within Dogger Bank Teesside A & B potentially could be affected by disturbance due to noise and alteration to prey species during the construction phase, and to a lesser extent for the operation and decommissioning phases (which result in significantly smaller noise disturbance). However, as described above, given the negligible population level effect, the distance from Dogger Bank Teesside A & B to these breeding and haul out sites and the limited use of Dogger Bank Teesside A & B, no effect is predicted on the grey seal populations of these sites.

5.11.4 Consequently, it is concluded that there would not be an adverse effect on the integrity of the transboundary sites screened into the assessment (see Section 3) and listed in **Table 5.1** and **Table 5.2**.

## 5.12 Harbour porpoise feature and designated sites considered

### European sites considered

5.12.1 The Screening Stage (see Section 3 and **Table 5.1**) identified 24 European sites supporting this Annex II species where a potential LSE could arise as a result of the construction, operation or decommissioning of Dogger Bank Teesside A & B. These include sites in the Belgian, Danish, Dutch, French, German, and Swedish territorial sectors of the North Sea.

5.12.2 There are no SACs in the UK North Sea territorial waters that support qualifying populations of harbour porpoise. Harbour porpoise was considered as a potential feature in the Dogger Bank cSAC selection process. However, the JNCC concluded as part of their assessment that the Dogger Bank cSAC could not be considered a "*clearly identifiable area essential to the life and reproduction*" of harbour porpoise, and that the species should not be a qualifying feature for the site. The cSAC was therefore given a D grading for this species (based on the presence of harbour porpoise within the site boundary throughout the year), which means that the site does not qualify for this species although it is present. As harbour porpoise is a D graded (non-qualifying) feature on the UK side of Dogger Bank, it does not need to be

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assessed as part of the HRA process. This point was reiterated by the JNCC in their response to consultation on the HRA Screening Report.

5.12.3 The harbour porpoise feature for the German Doggerbank SCI was designated largely on the basis of the density of animals present within the habitat-defined SCI being greater than surrounding areas of the North Sea (JNCC 2009).

5.12.4 However, an understanding of the potential effects of Dogger Bank Teesside A & B on harbour porpoise is still relevant to identifying and determining whether effects on designated sites for this species in non-UK waters could occur. As many of the 24 transboundary sites are a significant distance from Dogger Bank Teesside A & B, direct disturbance is unlikely (but indirect effects could occur). This is in contrast to the Doggerbank SCI (Germany) and Doggersbank SCI (Netherlands) that include harbour porpoise as a qualifying feature, and are located in close proximity (43km and adjacent, respectively) to Dogger Bank Teesside A & B; hence they could potentially experience direct disturbance effects. Given the mobile nature of this species, and the potential for species from the 24 transboundary sites to pass through and forage within Dogger Bank Teesside A & B and the surrounding area, this assessment has considered the population effect on harbour porpoise and how it may affect all 24 of the transboundary sites identified in **Table 5.1**. These sites are as follows:

**Belgium**

- SBZ 1 pSCI;
- SBZ 2 pSCI;
- SBZ 3 pSCI; and
- Vlakte van de Raan SCI.

**Denmark**

- Agger Tange, Nissum Bredning, Skibsted Fjord og Agerø SCI / SAC;
- Sydlige Nordsø SCI / SAC;
- Vadehavet med Ribe Å, Tved Å og Varde Å vest for Varde SCI / SAC; and
- Venø, Venø Sund SCI.

**France**

- Récifs et landes de la Hague SCI;

**Germany**

- Borkum-Riffgrund (Borkum Reef Ground) SCI;
- Doggerbank SCI;
- Hamburgisches Wattenmeer SCI;
- Helgoland mit Helgoländer Felssockel SCI;
- NTP S-H Wattenmeer und angrenzende Kustengebiete SCI;
- Steingrund SCI;
- Sylter Außenriff (Sylt Outer Reef) SCI; and

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- Unterelbe SCI.

**Netherlands**

- Doggersbank SCI;
- Klaverbank SCI;
- Noordzeekustzone SCI;
- Noordzeekustzone II pSCI; and
- Vlakte Van der Raan SCI / SAC.

**Sweden**

- Kosterfjorden-Väderöfjorden SCI / SAC; and
- Vrangoskargarden SCI / SAC.

5.12.5 The information and assessment presented here has been undertaken in respect of the observed population of harbour porpoise that may be present within Dogger Bank Teesside A & B. It is not possible to determine whether harbour porpoise present within the development area may form part of the designated population(s) of any of European sites adjacent to the UK part of Dogger Bank or potentially sites further afield. Consequently, the assessment has been undertaken at the population level and the assumption is that the assessment outcomes will apply to all sites where harbour porpoise is a designated feature, unless it is apparent that effects and potential impacts can be attributed to specific sites.

## 5.13 Data collection - harbour porpoise

5.13.1 Generic baseline information with respect to harbour porpoise was obtained from a number of sources, and these are presented in **Table 5.15**.

5.13.2 In order to supplement the generic baseline information, boat-based and aerial surveys have been undertaken as part of the Dogger Bank Zone projects. Details are presented in paragraphs 5.3.2 and 5.3.3, and in Section 2.1 and 2.2 in **Appendix 11A** of the Dogger Bank Teesside A & B ES. In addition, a review of the relevant subsea ambient noise studies has been undertaken, and are reported in **Appendix 5A** of the Dogger Bank Teesside A & B ES (as noted in paragraph 5.3.4).

## 5.14 Assessment methodology - harbour porpoise

### Methodology

**Assessment of underwater noise**

5.14.1 Details of the approach and methodology used in the assessment of underwater noise are provided in paragraphs 5.4.1 to 5.4.15.

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Table 5.15 Broad-scale data sources to inform the harbour porpoise characterisation at Dogger Bank Teesside A & B

| Title | Nature of the data | Spatial coverage | Data holder | Publication |
|---|---|---|---|---|
| Atlas of Cetacean Distribution in Northwest European Waters "Joint Cetacean Database" | Provides an account of the distribution of all 28 cetacean species that are known to have occurred in the waters off north-west Europe in the last 25 years, data sources: SCANS data, European Seabirds at Sea and the Sea Watch Foundation. | Northwest European waters, including North Sea, Irish Sea and English Channel. | JNCC | Reid *et al.* 2003 |
| Small Cetacean Abundance in the North Sea and Adjacent Waters (SCANS) | Shipboard (890,000km$^2$) and aerial line (150,000km$^2$) transect surveys conducted to provide accurate and precise estimates of abundance as a basis for conservation strategy in European waters. | North Sea, English Channel, Celtic Sea, western Baltic Sea, waters around north east Scotland and the west coast of Norway/Sweden. | SMRU | Surveys conducted in summer 1994. Report by Hammond *et al*. (2002) |
| Small Cetacean Abundance in the Atlantic and North Sea (SCANS II) | SCANS-II provides the most precise broad-scale estimates of cetacean abundance in UK waters, covering over 1,350,000km$^2$ and over 35,000km of survey track line (boat and aerial surveys combined). | SCANS extended west and south into Irish, French and Spanish waters. | SMRU | Surveys carried out in 2005, report published 2008 and re-issued with new analysis. SCANS-II (2008) and Hammond *et al*. (2013). |
| The Coastal Directories Project – JNCC Coasts and Seas of the United Kingdom | The Coastal Directories Project, coordinated by the JNCC, was developed to produce a wide-ranging baseline of environmental information for each part of the UK coastal and near shore marine zone. Each section provides a summary of the regions environment, including protected sites, wildlife habitats and species, human uses, archaeology etc. | Region 6 Eastern England: Flamborough Head to Great Yarmouth and Region 5 North-east England: Berwick-upon-Tweed to Filey Bay. | JNCC | Evans 1995; Duck 1995 |


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| Title | Nature of the data | Spatial coverage | Data holder | Publication |
|---|---|---|---|---|
| Distributions of Cetaceans, Seals, Turtles, Sharks and Ocean Sunfish recorded from Aerial Surveys 2001-2008. | Data on the distributions and abundances of cetaceans, seals, turtles, sharks and ocean sunfish *Mola mola* were collected opportunistically during aerial surveys for waterbirds conducted by Wildfowl and Wetlands Trust Consulting. The report details the distributions of all records of these species collected in areas of waterbird surveys around the UK coast between 2001 and August 2008 using distance-sampling methodology developed in Denmark by National Environment Research Institute (NERI). | Majority of English and Welsh coastline, some areas of Scotland and Northern Ireland | WWT (Consulting) Ltd | WWT 2009 |
| Strategic Environmental Assessment (SEA) 3 | Information on the abundance and distribution of marine mammals within the SEA 3 Block. In particular, important seal breeding colonies in the Humber Estuary, The Wash and the Farne Islands. | Southern North Sea, from Dover to Berwick-Upon-Tweed | DECC | DECC 2002 |
| Offshore Energy SEA (Appendix A3a.7) | Baseline description of distribution and abundance of marine mammals in UK waters. | UK wide | DECC | DECC 2009 |
| Offshore Energy SEA (Various Technical Reports) | Boat based marine mammal surveys of the Dogger Bank Zone and North Sea between February 2008 and March 2009. | North Sea | DECC | DECC 2009 |
| North Atlantic Marine Mammal Commission (NAMMCO) Scientific Publications (various titles) | NAMMCO Publications on population and biological data. | Harbour porpoises in the North Atlantic. | Various | NAMMCO |
| Survey for small cetaceans over the Dogger Bank and adjacent areas in summer 2011 | Report on aerial surveys of Dogger Bank and adjacent areas. | UK, Dutch, Danish and German waters | Institute of Terrestrial and Aquatic Wildlife Research (ITAW), The Institute for Marine Resources and Ecosystems Studies (IMARES) | Gilles *et al*. (2012). 19th ASCOBANS Advisory Committee Meeting Document 5-08 |


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## Harbour porpoise sensitivities

### Sensitivity to changes in prey species and abundance

5.14.2 Harbour porpoise have a relatively high daily energy demand and need to consume between 4% and 9.5% of their body weight in food per day (Kastelein *et al*. 1997). If a harbour porpoise does not capture enough prey to meet its daily energy requirements it can rely on stored energy (primarily blubber) for three to five days, depending on body condition (Kastelein *et al.* 1997). In addition, thermo-regulation, especially in cold water, has high energy costs in marine mammals. Kastelein *et al.* (1997) estimate that a harbour porpoise may have a life expectancy of as little as three days in waters of 20$^{o}$C under starvation conditions. Such effects would be highly unlikely to occur in situations where minor changes in prey abundance and distribution occur, especially if these changes are of a short-term nature. As harbour porpoise take a relatively wide variety of prey species, they are usually able to exploit species present in greatest abundance and are, therefore, considered to have a low sensitivity to minor changes in prey species abundance and distribution.

### Sensitivity to underwater noise

5.14.3 The behavioural and physiological effects of noise on a particular species depend on its intensity, frequency bandwidth, duration and the heterogeneity of ambient physical and environmental parameters such as water depth, salinity and substrate (see Parvin *et al*. (2006), for a review), as well as the particular species' sensitivity to sound. Background underwater noise is generally higher than in air. The potential harmful effects of high-level underwater noise for cetaceans, which depends on variables such as the source noise (frequency and decibels (dB)), species, distance from source and factors such as noise attenuation, can be categorised as follows (Parvin *et al*. 2006):

- **Lethal**: at very close range from the source the peak pressure levels have the potential to cause death, or severe injury leading to death;
- **Physical injury**: at greater range the construction noise may cause physical injury to organs such as the lungs, liver, intestines, ears and other soft tissues surrounding gas containing structures of the body;
- **Hearing impairment**: at high enough sound levels, (generally taken to be 180 dB re. 1µPa for all species of marine mammals) the underwater sound has the potential to cause permanent hearing impairment in marine species; and
- **Behavioural response**: Behavioural responses are influenced by a variety of factors including food motivation, learning processes (e.g. habituation), psycho-physiological features of a sound, and sensation levels. This complexity of animal behaviour is also the most likely reason for the marked variation in responses found across studies.

5.14.4 Non-lethal and behavioural responses such as avoidance of an area may be significant where the man-made noise source is in the vicinity of important areas such as breeding grounds, migratory routes or key feeding grounds for marine mammal populations. More subtle behavioural effects, such as masking of

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marine mammal vocalisations may result in the temporary loss of communication.

5.14.5 In recent years, the potential ecological impacts of underwater noise associated with the construction of offshore wind farms has been a key topic of research. It is widely accepted that impact piling operations are likely to be the principal source of noise likely to impact upon marine life. Less significant sources of noise are also associated with other activities such as increased local vessel movement (many of which have loud bow thrusters to maintain station), seismic surveys, ground preparation and cable laying.

5.14.6 Harbour porpoise auditory injury ranges are based on permanent threshold shift (PTS) values obtained from data reported by Lucke *et al.* (2009). It is assumed that harbour porpoise swim away directly from any sound source, and studies (Tougaard *et al.* 2009; Brandt *et al*. 2011) indicate that they do indeed move away from sound sources, though the timing and noise thresholds could be such that PTS may occur whilst they are fleeing the area, but still remain within a distance where they experience noise levels that could cause PTS, i.e. they are unable to flee sufficiently quickly.

5.14.7 On the basis of available evidence, PTS would be predicted in situations where harbour porpoise were exposed to noise levels with a mean pulse weighting of 179dB re 1µPa$^2$/s$^{-1}$ or above whilst an evident behavioural response (temporary threshold shift or TTS) may arise at a mean pulse weighting of 164dB re 1µPa$^2$/s$^{-1}$ or above (Lucke *et al*. 2009). In addition, a possible behavioural response may occur for harbour porpoise if noise reaches a mean pulse weighting of 145dB re 1µPa$^2$/s$^{-1}$ or higher.

5.14.8 Harbour porpoise may exhibit a range of behavioural reactions to noise, including orientation or attraction to a noise source, increased alertness, modification of characteristics of their own sounds, cessation of feeding or social interaction, alteration of movement/diving behaviour, temporary or permanent habitat abandonment, and in severe cases panic, flight response or stranding, sometimes resulting in injury or death (Southall *et al*. 2007). The nature of an individual's response would depend upon habituation and sensitisation (Southall *et al*. 2007).

5.14.9 Harbour porpoise are considered sensitive to disturbance effects if they are excluded from an area of key prey resource, and unable to find alternative food sources. Based on available data and expert opinion, harbour porpoise are considered to have medium sensitivity to behavioural disturbance (defined as likely avoidance in this assessment) from piling noise (Tougaard *et al*. 2005; Thomsen *et al*. 2006).

5.14.10 Shipping traffic in and adjacent to Dogger Bank Teesside A & B currently consists of large tankers, smaller cargo vessels, tugs, fishing boats and other traffic (see paragraphs 5.5.32 and 5.5.33). There is no evidence to suggest that vessel noise significantly affects harbour porpoise, particularly given the large volume of existing traffic in areas where harbour porpoise are recorded. Consequently, the populations using the Dogger Bank Zone are likely to tolerate (or are habituated to) this type and intensity of underwater noise to at least some degree. Consequently, given the presence of harbour porpoise in areas subject

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to significant vessel movements (and, therefore, associated underwater noise levels) their sensitivity to this effect is predicted to be low.

**Sensitivity to vessel collisions**

5.14.11 Ship collisions with cetaceans are known to occur and can cause injury and death (Wilson *et al*. 2007). Distraction whilst undertaking activities such as foraging and social interactions are proposed as potential reasons as to why collisions occur (Wilson *et al*. 2007). Marine mammals can also be inquisitive, which may increase the risk of collision, though there is an indication that harbour porpoise are relatively shy of vessels. Overall, it is not possible to fully quantify strike rates, particularly as the majority of collisions go unnoticed. In addition, the rate of mortality resulting from ship strikes is unknown, though marine mammals are considered relatively robust to collision effects, as they have a thick sub-dermal layer of blubber, which defends their vital organs from the worst of the impact (Wilson *et al*. 2007). Non-fatal collisions can, however, leave an animal vulnerable to secondary infection, other complications, or predation (Wilson *et al*. 2007). Harbour porpoise are also mobile and relatively fast swimming species that are able to detect the presence of vessels and, therefore, able to avoid collisions by taking evasive action.

5.14.12 Laist *et al.* (2001) concluded that vessels over 80m in length cause the most severe or lethal injuries, but that serious injury rarely occurs if animals are struck by vessels travelling at speeds below 10 knots.

## 5.15 Baseline environment - harbour porpoise

### Behaviour

5.15.1 The North Atlantic harbour porpoise population is divided into a number of sub-populations (Evans *et al*. 2009). Harbour porpoise is one of the most commonly sighted cetacean species in the North Sea (ASCOBANS 2012).

5.15.2 The gestation period for harbour porpoise is ten months, and peak mating activity is likely to occur in August. Females are believed to nurse their calves for between eight and 12 months. Weaning is a gradual process, with young starting to take solid food after a month or two. Off the coast of the British Isles and in adjacent seas, calves have been observed between February and September, particularly during May to August, with a peak in June. This occurrence coincides with the findings of reproductive studies conducted on stranded or by-caught animals (Evans *et al*. 2009).

5.15.3 Harbour porpoise in the North Sea feed mainly on demersal fish, notably small gadoids, clupeids and sandeels (Santos & Pierce 2003). It is believed that the balance of their diet has changed over the past 40 years from herring to whiting dominated, reflecting the change in composition of available food resources (Reid *et al*. 2003).

5.15.4 Genetic evidence from the UK and elsewhere also indicates that males disperse more widely than females (Reid *et al*. 2003).

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5.15.5 Studies using skeletal material, along with studies of tooth structure, genetics and telemetry suggest that sub-populations of harbour porpoise exist in the North Sea and adjacent waters, with the North Atlantic population being divided into a total of 15 management units (Evans *et al*. 2009). The majority of the Dogger Bank Zone is encompassed by the South-western North Sea & Eastern Channel (SWNS) management unit, with the South-western fringes of North-eastern North Sea & Skagerrak unit just to the north and east (see **Figure 5.15)**.

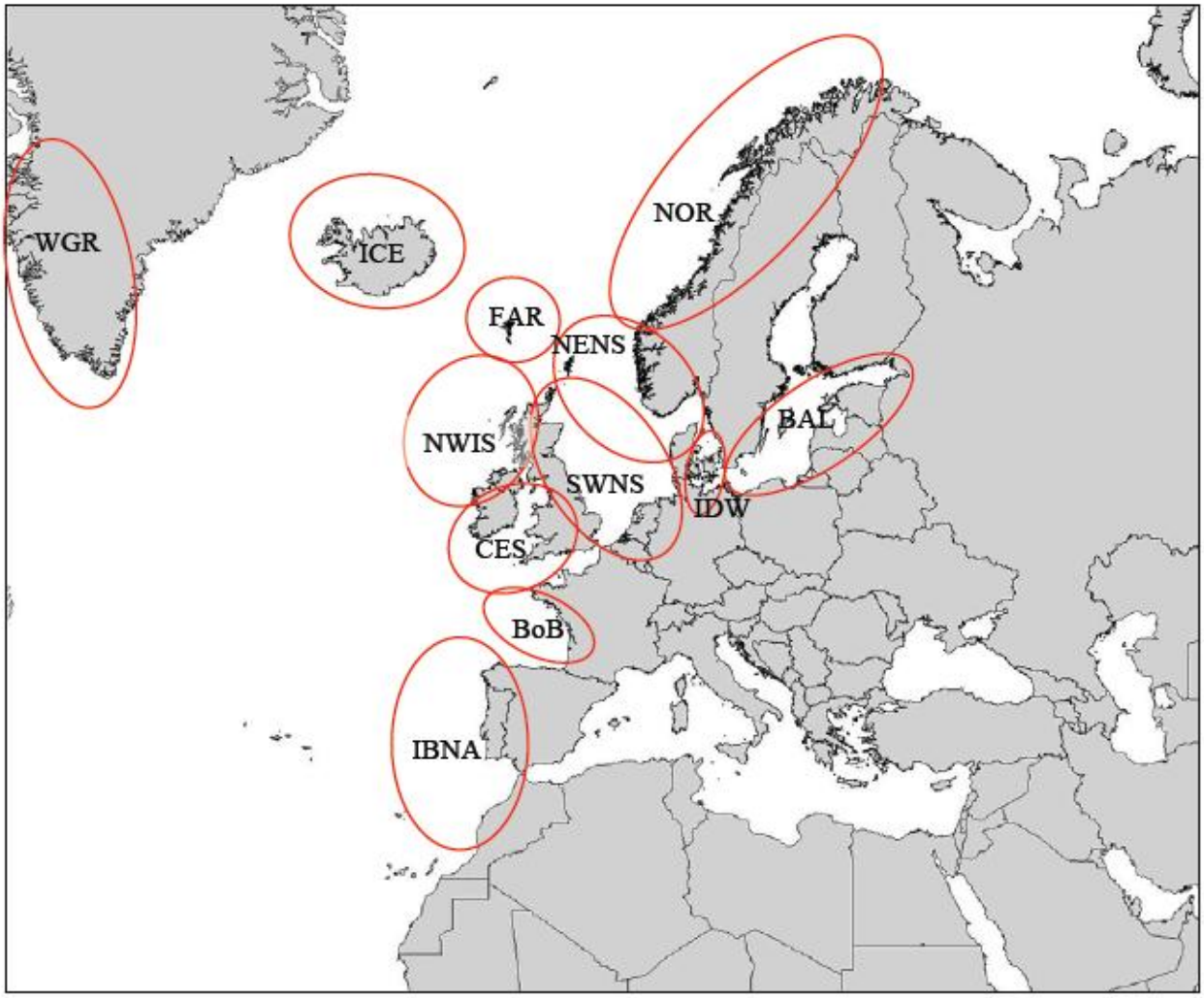



Figure 5.15 Recommended management units for harbour porpoise in the ASCOBANS agreement area and environs (Evans *et al*. 2009)

5.15.6 Harbour porpoise in the North Sea have historically and recently been subjected to high levels of by-catch (e.g. Winship 2009). Winship (2009) estimated the maximum medium estimate of by catch in 1992 in UK and Danish waters to be 11,600 (7,800 to 19,500). Declining fishing effort in the late 1990's and early 2000's led to reduced by-catch modelled estimates of by-catch by Winship (2009) over that time; in 2005 the estimate was 3,000 (1,800 to 5,300) (Winship 2009). Northridge (2011) provides a summary of by-catch monitoring and mitigation measures accomplished by member states and reported through ICES working groups. Based on data from the UK, France, Spain, and Denmark in 2009 extrapolated by-catch of harbour porpoise was 1,100. However, this estimate represents only a patchy overview due to unreliable and

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unrecorded data, and is based on samples from only a minority of fisheries. The implementation of new management procedures (e.g. Camphuysen & Siemensma 2011) should help to reduce and further quantify by-catch. By-catch is, however, likely to remain a significant factor in influencing harbour porpoise populations in the North Sea.

## Population

5.15.7 The SCANS survey was a major international collaborative survey program carried out to provide baseline data on cetacean abundance in the North Sea, Baltic and Celtic Seas. The SCANS project took place in 1994 and estimated the harbour porpoise population of the North Sea at 341,366 (95% confidence interval of 260,000 to 449,000) (SCANS-II, 2008).

5.15.8 The SCANS II project, which aimed to update these estimates, took place in 2005. In 2005, the North Sea harbour porpoise population was 323,968 (95% confidence interval of 256,300 to 549,700) (Hammond *et al.* 2013), indicating that the population had not changed significantly between 1994 and 2005. The Southern North Sea population in 2005 was estimated to be 140,229; the Northern North Sea 33,598; the Central North Sea 58,623; and a European wide population of 375,358 (95% confidence interval of 256,304 to 549,713) (SCANS-II, 2008).

5.15.9 The population used in the assessment is the IAMMWG North Sea (NS) MU), with an estimated abundance of 227,298 (95% confidence interval of 176,360 to 292,948) based on the Hammond *et al*. (2013) analysis. The NS MU comprises ICES area IV, VIId and Division IIIa (Skagerrak and north Kattegat). However, constraining the reference population to this Management Unit could be a conservative approach, as guidance from Marine Scotland (Northridge 2012) suggests that considering large stock areas for harbour porpoise is appropriate; with open borders existing between the North Sea and the Kattegat, the North Sea and Norwegian Sea and between western Channel and Celtic Shelf/Irish Sea.

5.15.10 Despite no overall change in population size, large scale changes in the distribution of porpoise were observed between 1994 (see **Figure 5.16**) and 2005 (see **Figure 5.17**), with the main concentration shifting from North-eastern UK and Denmark to the southern North Sea. This trend is likely the result of changes to the availability of principle prey, notably within the northern North Sea (SCANS-II 2008).

5.15.11 As part of the SCANS II survey analysis, model-based estimates of harbour porpoise abundance were obtained by fitting a General Additive Modelling (GAM)-based density surface model to the survey data that included longitude, latitude, depth and distance to coast. The predictions from these models were used to obtain local density estimates (animals per $km^2$) on a two minute grid (i.e. ~8.15$km^2$). **Figure 5.18** shows the latest North Sea harbour porpoise surface densities derived from the SCANS II dataset (Hammond *et al*. 2013). **Figure 5.19** shows the levels of uncertainty in relation to harbour porpoise density estimates over the UK continental shelf.

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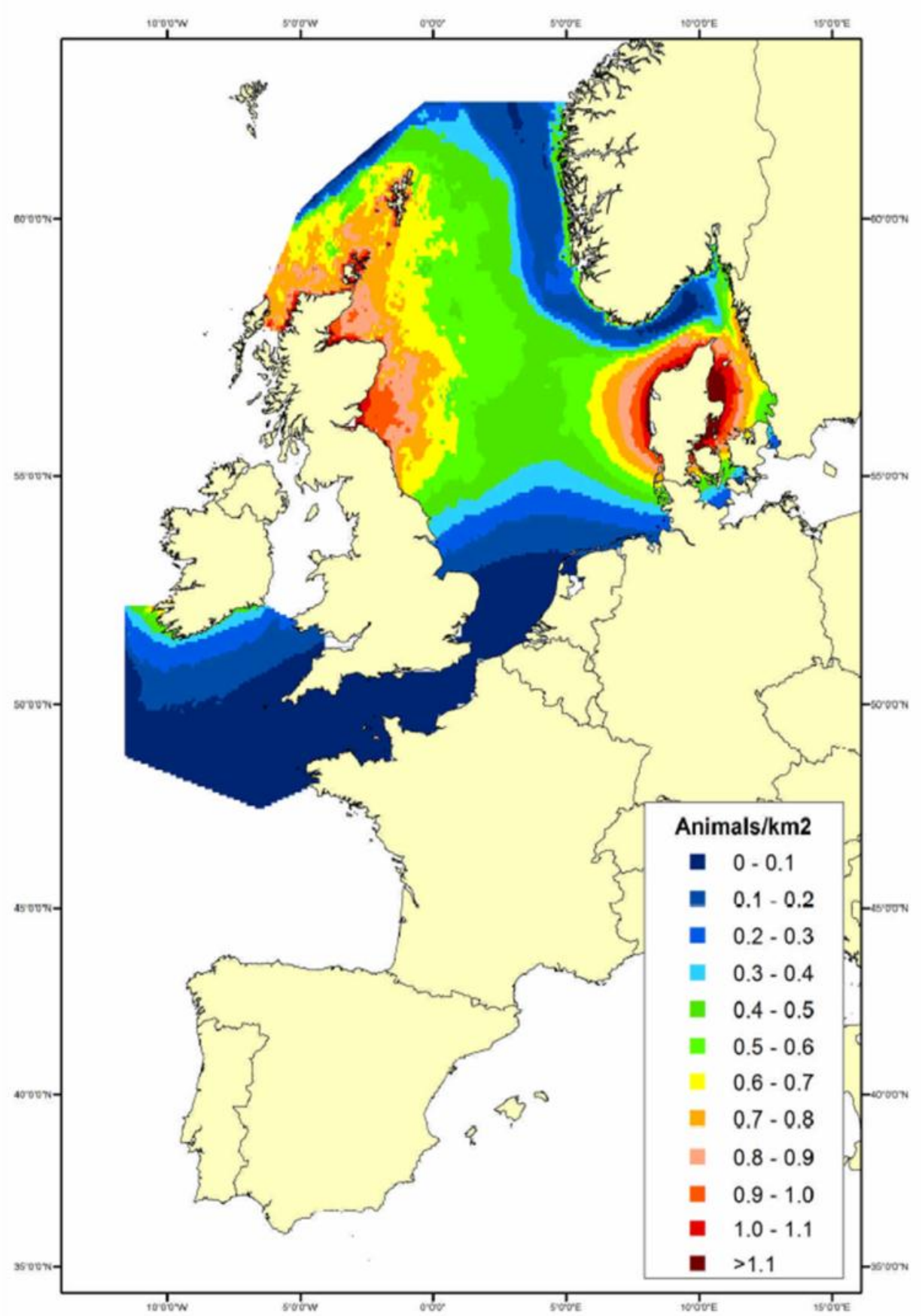



Figure 5.16 Harbour porpoise estimated density surface (animals per km$^2$) in 1994 (SCANS-II 2008)

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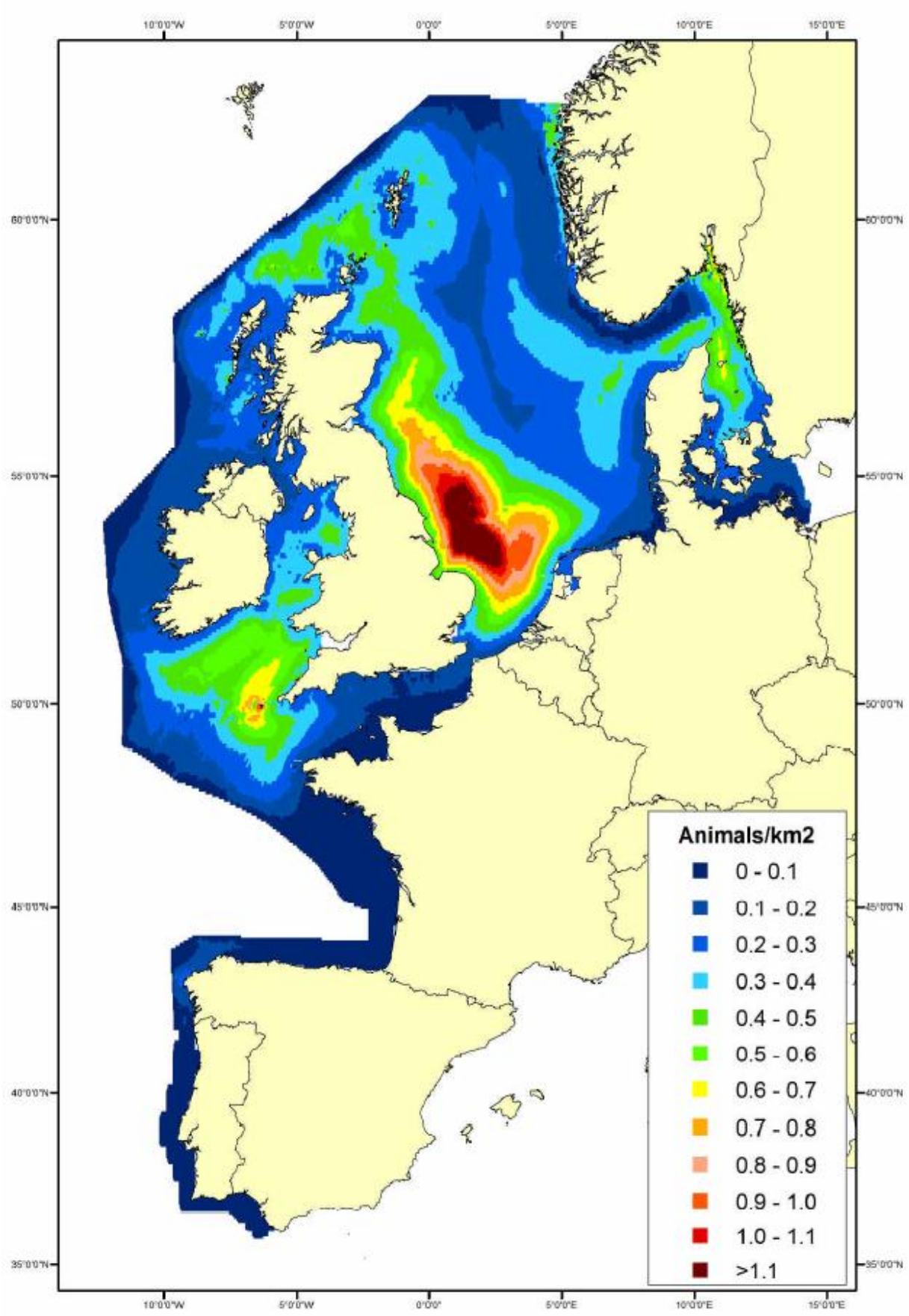



Figure 5.17 Harbour porpoise estimated density surface (animals per km$^2$) in 2005 (SCANS-II 2008)

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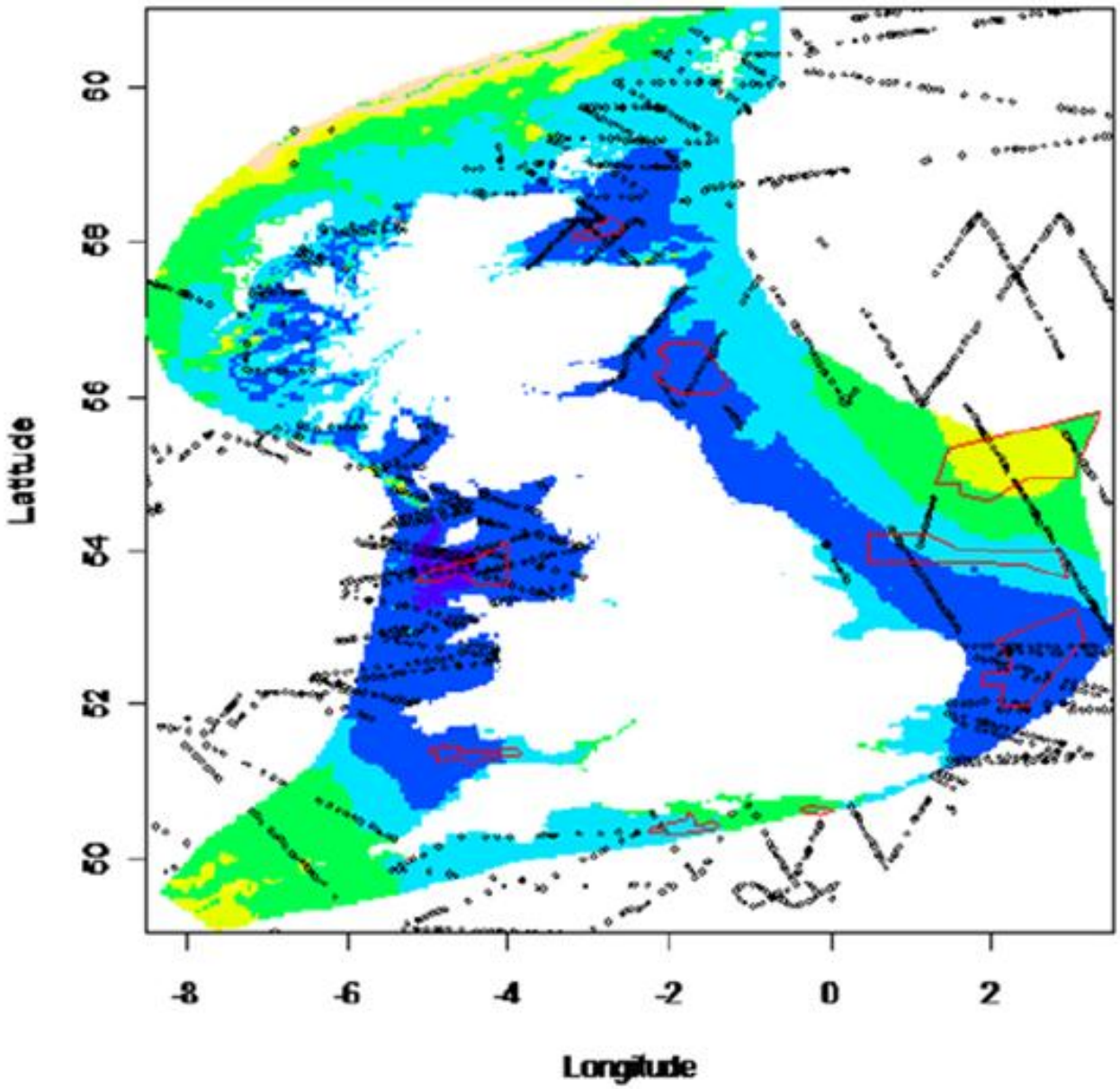



Figure 5.18 Estimates of local harbour porpoise density (animals per km$^2$) from SCANS-II at two- minute grid resolution (Key: Intervals 0 – 0.2 violet, 0.2 – 0.4 deep blue, 0.4 – 0.6 medium blue, 0.6 – 0.8 pale blue, 0.8 -1 blue-green, 1 – 1.2 green, 1.2 – 1.4 yellow; Round 3 zones are shown in red, and dots indicate survey effort (source: SMRU 2010))

5.15.12 The data identified that Dogger Bank Teesside A & B and the surrounding area supported a density of between 1.2 to 1.4 harbour porpoise per km$^2$; with highest densities in the south-western part of the zone (SCANS-II 2008). However, the uncertainty associated with the estimates for porpoise in the Dogger Bank region is high (see **Figure 5.19**), and **Figure 5.16** and **Figure 5.17** indicate that densities and abundance are changeable year on year.

5.15.13 **Figure 5.20** summarises the annual harbour porpoise distribution around the UK from the Atlas of Cetacean Distribution in Northwest European Waters (Reid *et al*. 2003).

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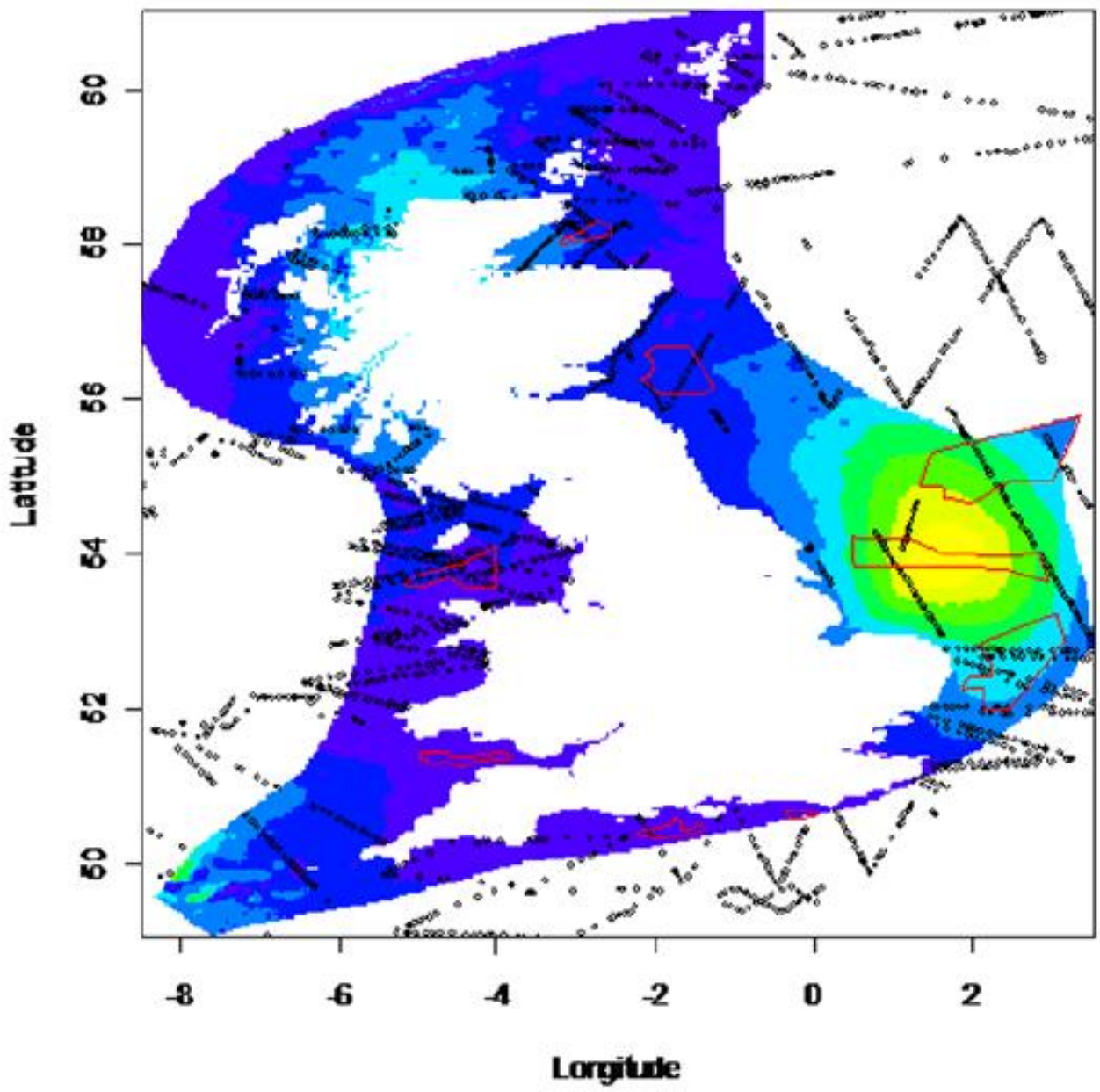



Figure 5.19 Estimates of coefficients of variation of SCANS-II harbour porpoise density at two- minute grid resolution (Key: Intervals 0 – 0.16 violet, 0.16 – 0.3 medium blue, 0.3 – 0.5 pale blue, 0.5 – 1 green, 1 – 2 green-yellow, 2 – 3 yellow, 3+ beige: Round 3 zones are shown in red, and dots indicate survey effort (Source: SMRU 2010))

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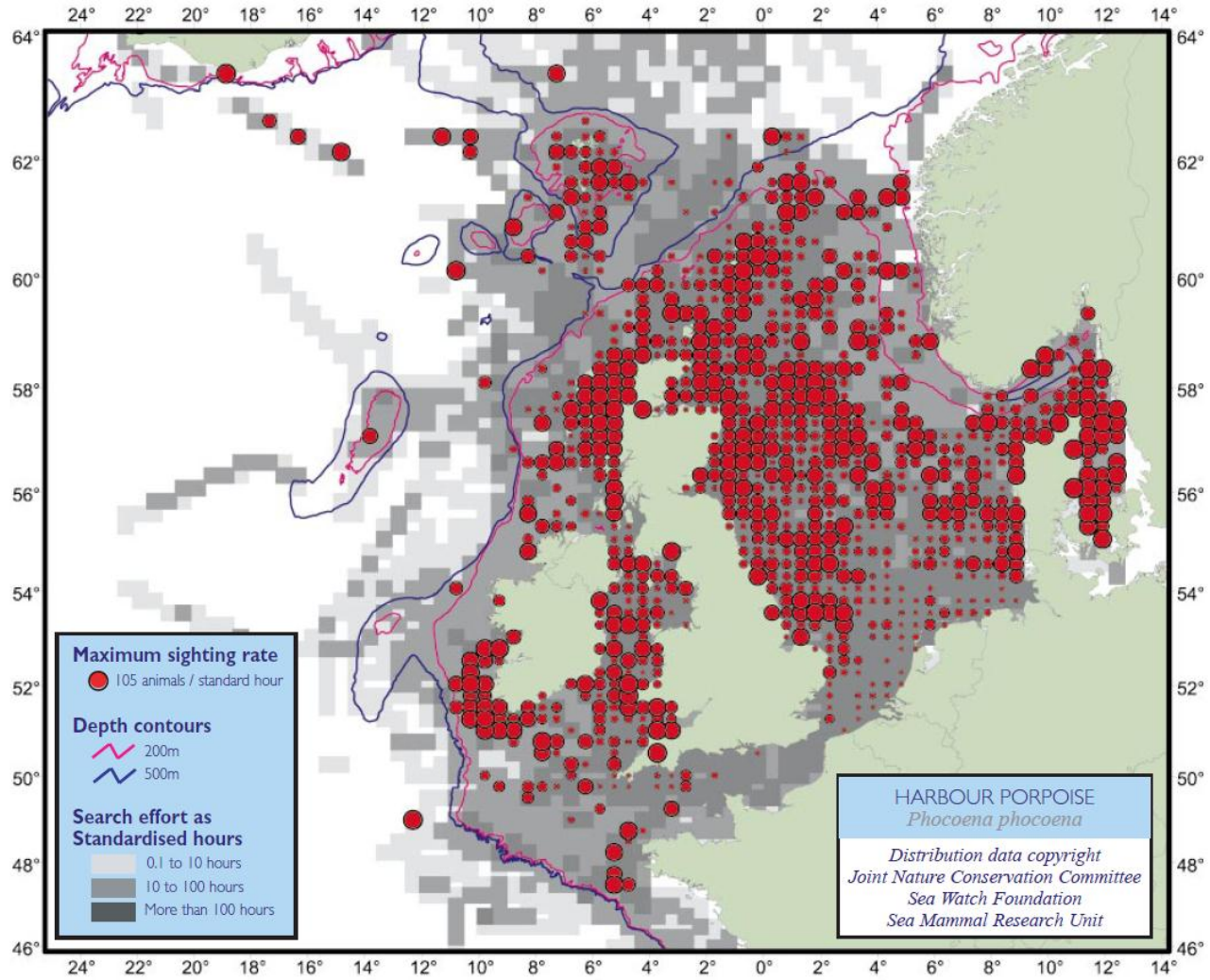



Figure 5.20 Annual harbour porpoise distribution around the UK (Reid *et al*. 2003)

5.15.14 A study of the distribution of cetaceans and pinnipeds (as well as sharks, turtles and ocean sunfish) has also been carried out by the WWT (2009). Data on distribution and abundance were collected opportunistically during aerial surveys for waterbirds conducted by WWT Consulting from 2001-2008. The survey method was comparable to that used for the collection of previous cetacean data including the SCANS project (Hammond *et al*. 2002). The results (see **Figure 5.21**) show a similar distribution to those presented in Reid *et al*. (2003), with higher frequencies close to shore around the west coast and off the Lincolnshire and Yorkshire coasts, but with much higher frequencies recorded off the coast between Norfolk and Kent.

5.15.15 The results from the WWT density mapping (**Figure 5.21**) are also similar to those recorded in the SCANS II project (**Figure 5.16**), in which much larger numbers of harbour porpoise were recorded in the southern North Sea than in the 1994 SCANS surveys.

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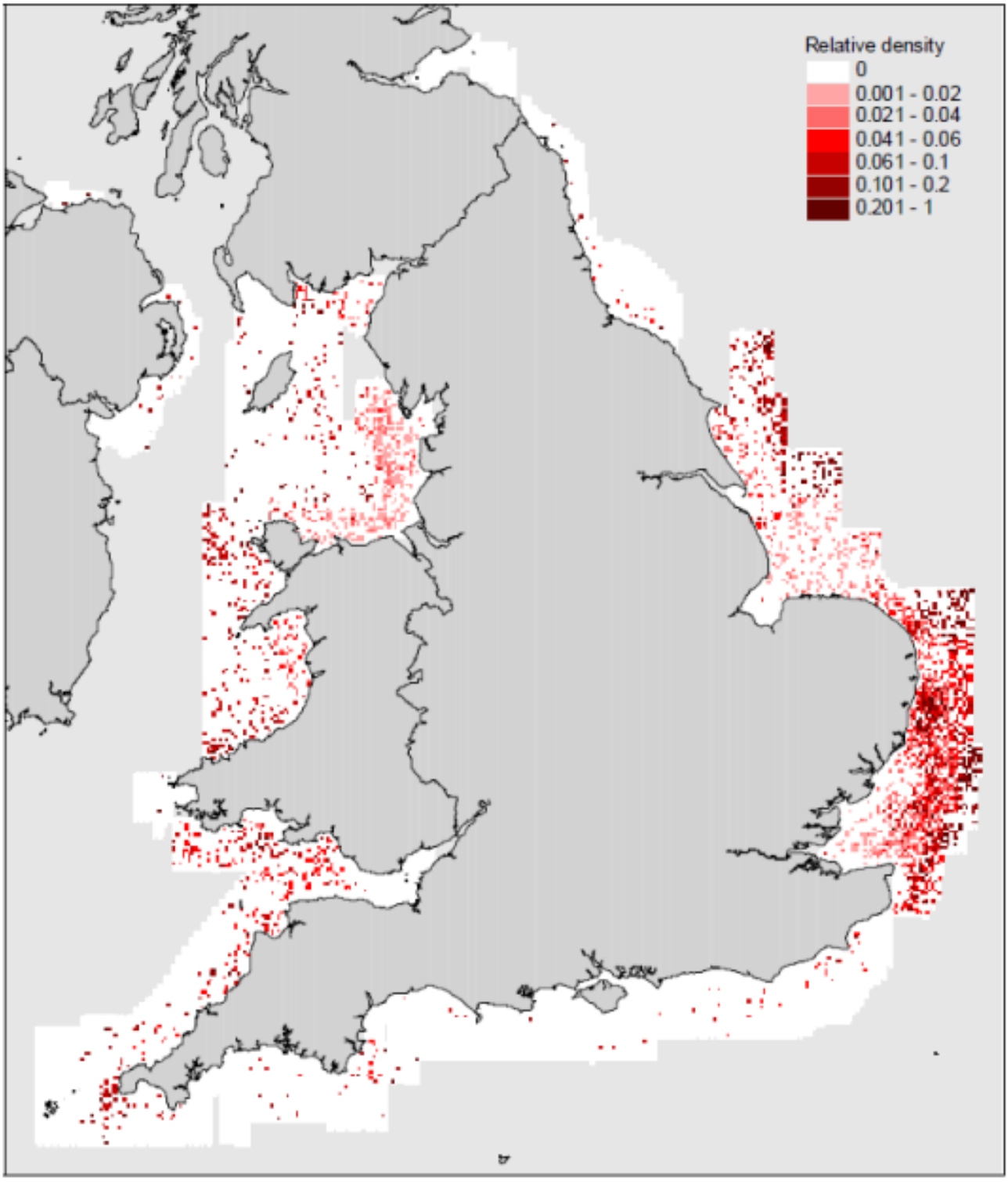



Figure 5.21 Harbour porpoise densities (WWT 2009)

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5.15.16 In late summer (10 survey days completed between 28 July and 1 September) 2011, a dedicated aerial line transect survey was conducted over the Dogger Bank and adjacent area (including UK, Dutch, Danish and German waters) in order to investigate the importance of the marine habitat for marine mammals (Gilles *et al*. 2012; Gilles *et al*. 2011a). The ITAW and IMARES conducted the surveys as part of a wider framework of the Natura 2000 monitoring programme, which also included acoustic surveys and aerial survey in 2010 and 2011 (Gilles *et al*. 2011b). The highest densities were to the western and north-eastern part of the survey area and were lower on the sandbank itself (Gilles *et al*. 2012), as shown on **Figure 5.22**. The abundance estimate for the whole area was 116,448 porpoise, and the average density over the area was 1.82 porpoise per km$^2$ (Gilles *et al*. 2012) as shown on **Figure 5.23**.

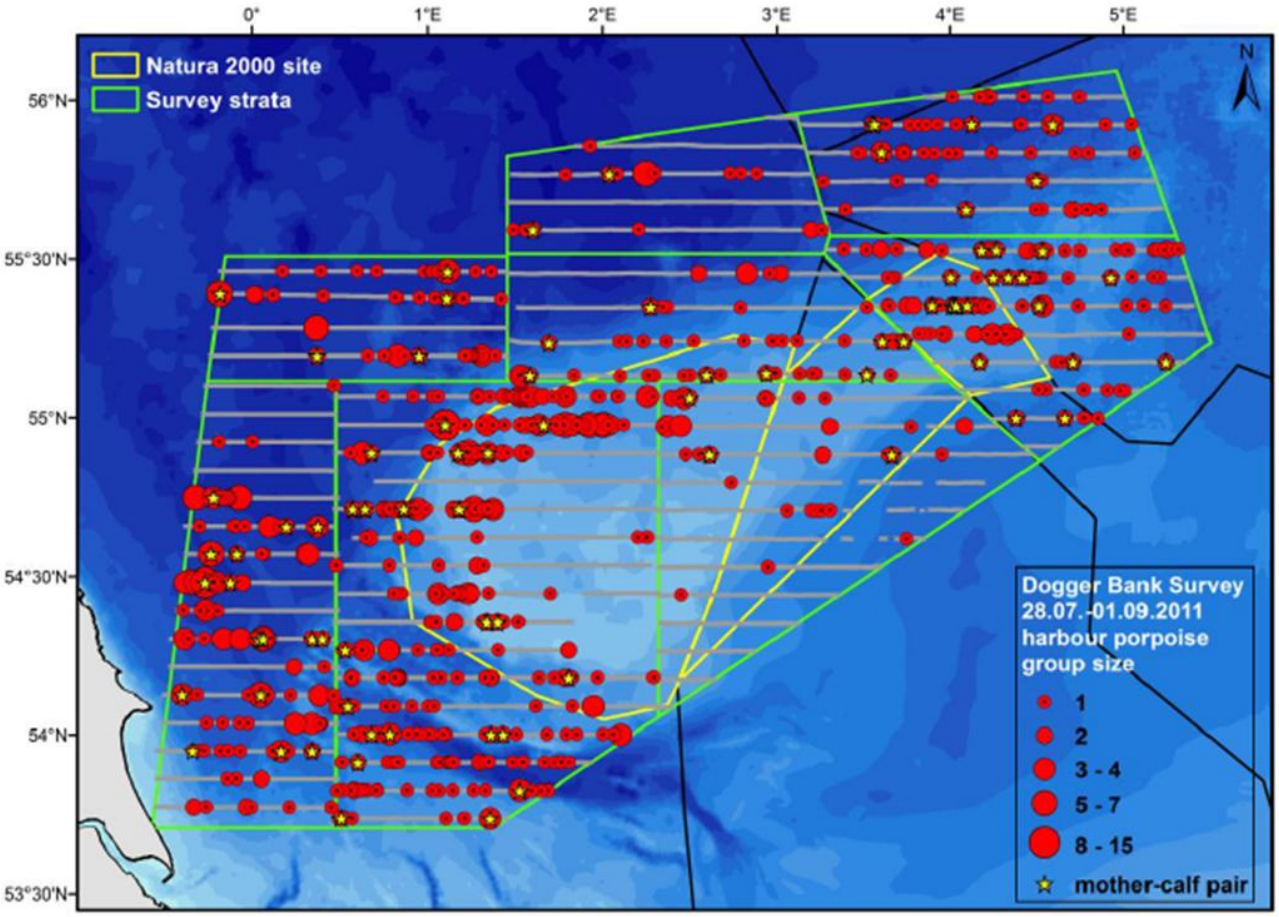



Figure 5.22 Realised survey effort (grey lines) and harbour porpoise group sightings (only effort in good and moderate sighting conditions is shown) – source: Gilles *et al*. (2012)

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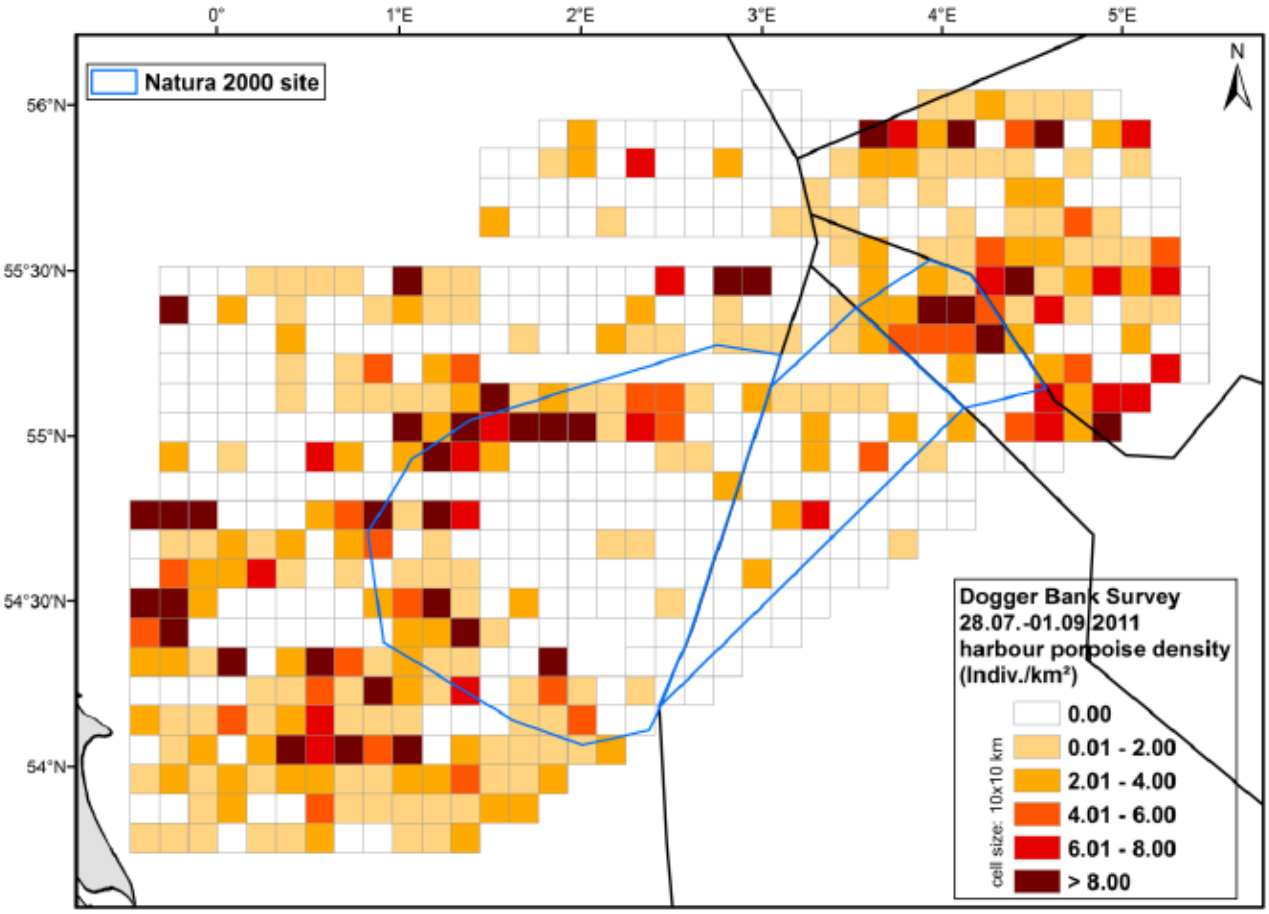



Figure 5.23 Spatial distribution of harbour porpoise density (individuals per km$^2$) during the survey at Dogger Bank in summer 2011 - Source: Gilles *et al*. 2012 (Note grid size is 10km x 10km)

5.15.17 Harbour porpoise satellite telemetry has been conducted in Danish waters (Evans *et al*. 2009), and has shown that animals in the northern Kattegat, the Skagerrak and northern North Sea spend the majority of their time in the north-western North Sea, with occasional trips to the south-western North Sea, including the wider Dogger Bank Zone. Locations of the tagged porpoise are show in **Figure 5.24**.

## Site specific survey results

5.15.18 Dogger Bank Zone-specific monthly boat-based surveys (between January 2010 and June 2012) recorded low numbers of harbour porpoise in Dogger Bank Teesside A & B and the surrounding area between February and April 2010, with an increase in activity in May 2010 (Gardline Environmental 2012c). **Figure 5.25** summarises the number of sightings over the survey period. Sightings increased during spring 2011, peaking in April, and were highest in September 2011 when 81 individuals were identified. The hourly encounter rate in May 2010 was 0.5 animals per hour, or less than 0.1 animals per km$^2$, although this included data recorded at all sea states (Gardline Environmental 2012c). The detection rate per km in May 2010 was lower than that recorded in the Dogger Bank Zone in August and September 2008 (Cork Ecology 2009).


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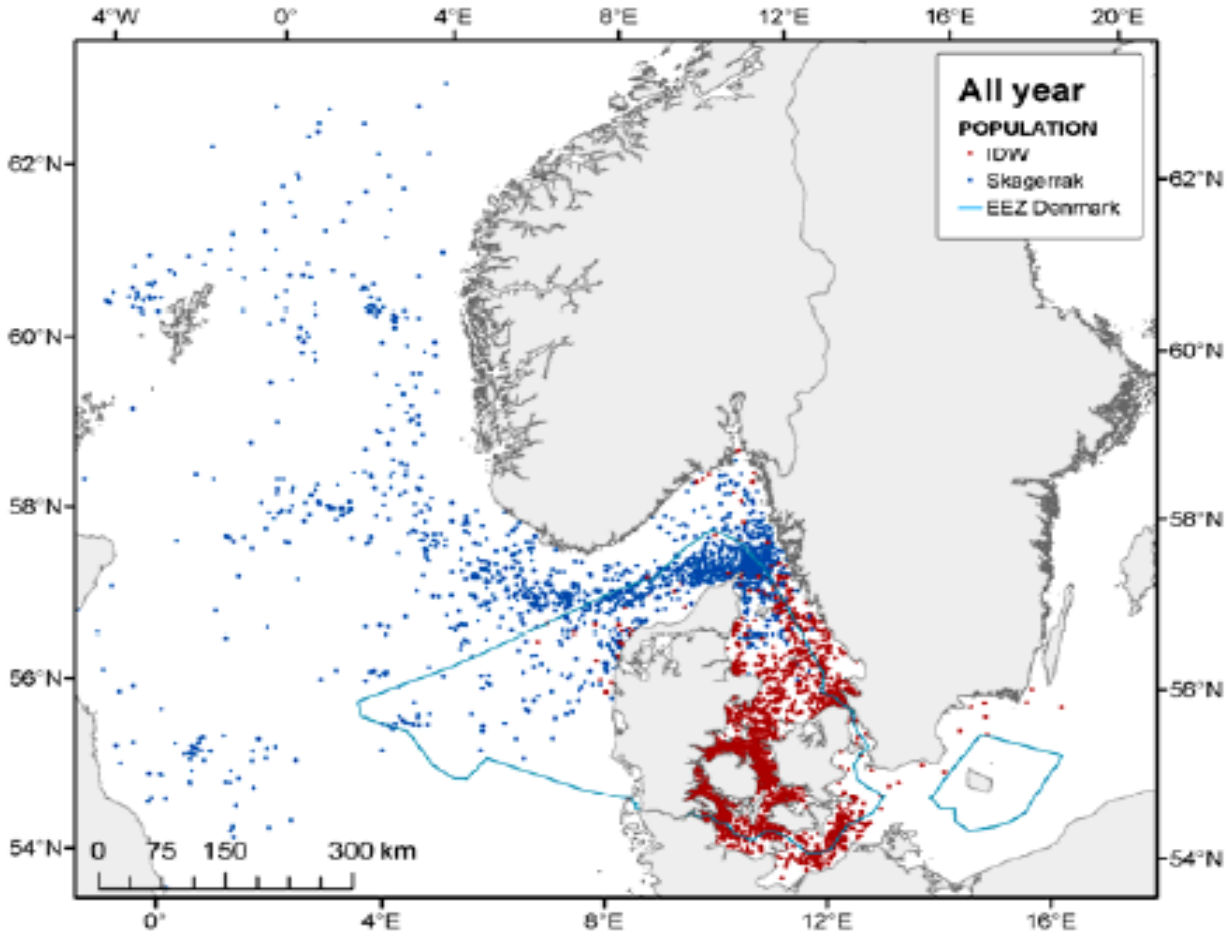



Figure 5.24 Locations (one per day) of 363 radio-tagged porpoises (Key: Porpoise tagged in the Inner Danish Waters are red, and those tagged in the northern tip of Jutland (Skagen) are blue) (N=63 porpoises, N = 4287 locations) - Source: Evans *et al*. (2009)

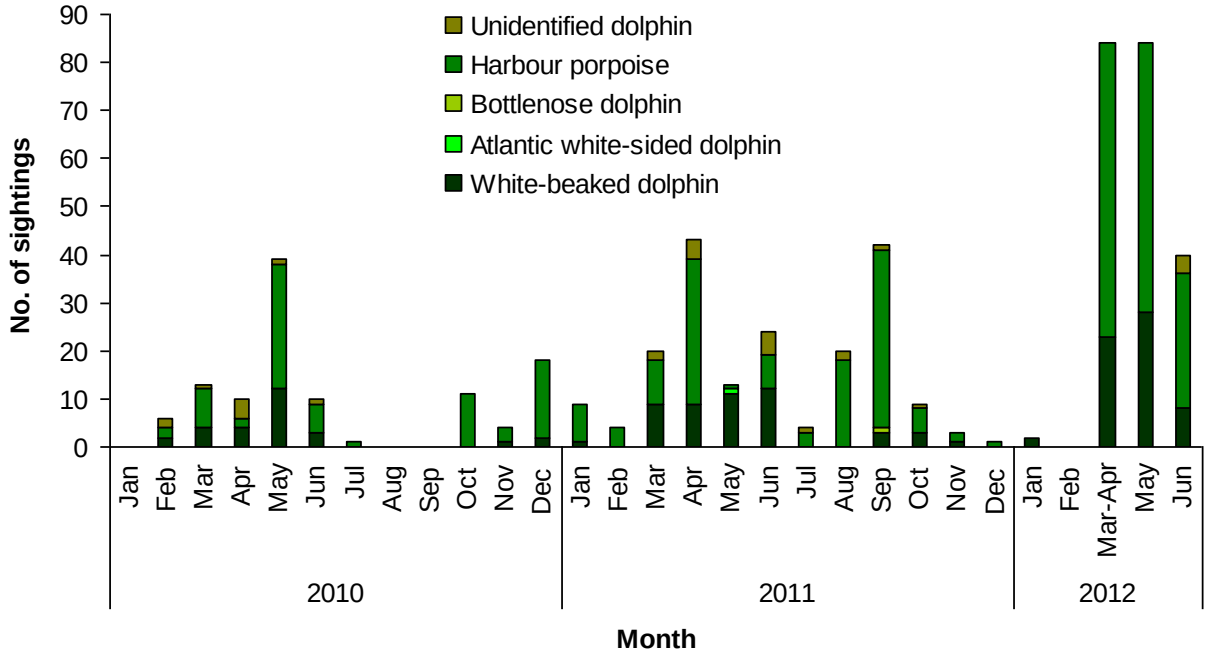



Figure 5.25 Odontocete sightings during boat based surveys January 2010 to January 2012 (Gardline Environmental 2012)


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5.15.19 Aerial surveys of the Dogger Bank Zone using HiDef video cameras have been ongoing since November 2009. Spatial and temporal adaptive modelling to calculate estimates of the abundance surfaces (by month, year and entire survey period), and annual estimates of abundance and associated inference from the high definition surveys was carried out by DMP Statistic Solutions UK Limited (DMP). The large overall number of sightings of harbour porpoise meant that absolute abundance and absolute density could be investigated over temporal (yearly and monthly) and spatial scales. The results show harbour porpoise to be abundant, particularly in May and June each year (see **Figure 5.26**). The highest number of individuals identified in a month was 930, in May 2011.

5.15.20 From this survey data, statistical modelling was undertaken to calculate estimates of the abundance (by month, year and entire survey period), and annual estimates of abundance and associated inference.

5.15.21 Modelled estimates of absolute density of harbour porpoise, calculated from the raw and fitted data, ranged from 0 to 1.5 porpoise per $km^2$ in 2009, from 0 to 2 porpoise per $km^2$ in 2010, from 0 to 4 porpoise per $km^2$ in 2011, and from 0 to 5 porpoise per $km^2$ in 2012 (see **Figure 5.26**). When uncertainty is incorporated (95% confidence interval) in these estimates the ranges are wider, with ranges from 1.2 to 2.5 porpoise per $km^2$ in 2009 and 2010, from 2.5 to 7 porpoise per $km^2$ in 2011, and from 3 to 7 porpoise per $km^2$ in 2012.

5.15.22 Estimates of absolute abundance for harbour porpoise (corrected for availability) appear to peak annually in May to June, and are relatively consistent within years outside these months (see **Figure 5.27**). Estimated abundance within the zone peaks at a value approaching 40,000 in May 2011 and May 2012. The estimated absolute abundance for the zone averaged across years was 8,358 (95% confidence interval of 7,536 to 9,310), and the estimated absolute density across years was 0.64056 harbour porpoise per $km^2$ (95% confidence interval of 0.57756 to 0.71352) after adjusting for availability (see **Figure 5.28** and **Appendix 14A** for further details). Figures showing the upper and lower 95% confidence interval for harbour porpoise mean density are shown on Figures 4.14 and 4.15 in **Chapter 14 Marine Mammals** of the Dogger Bank Teesside A & B ES.

5.15.23 Given the high degree of inter-annual variation in the distribution of harbour porpoise, and the variation in monthly abundance it was agreed during consultation on Dogger Bank Creyke Beck with the JNCC that the use of average densities would be appropriate for assessing potential impacts on this highly mobile species, and therefore this has also been used in this assessment.

5.15.24 It should be acknowledged that the actual density of harbour porpoise would vary over space and time, and the use of average densities provides a simplistic, yet realistic representation of the distribution of animals, and thus the potential number of animals that could be exposed to an impact.

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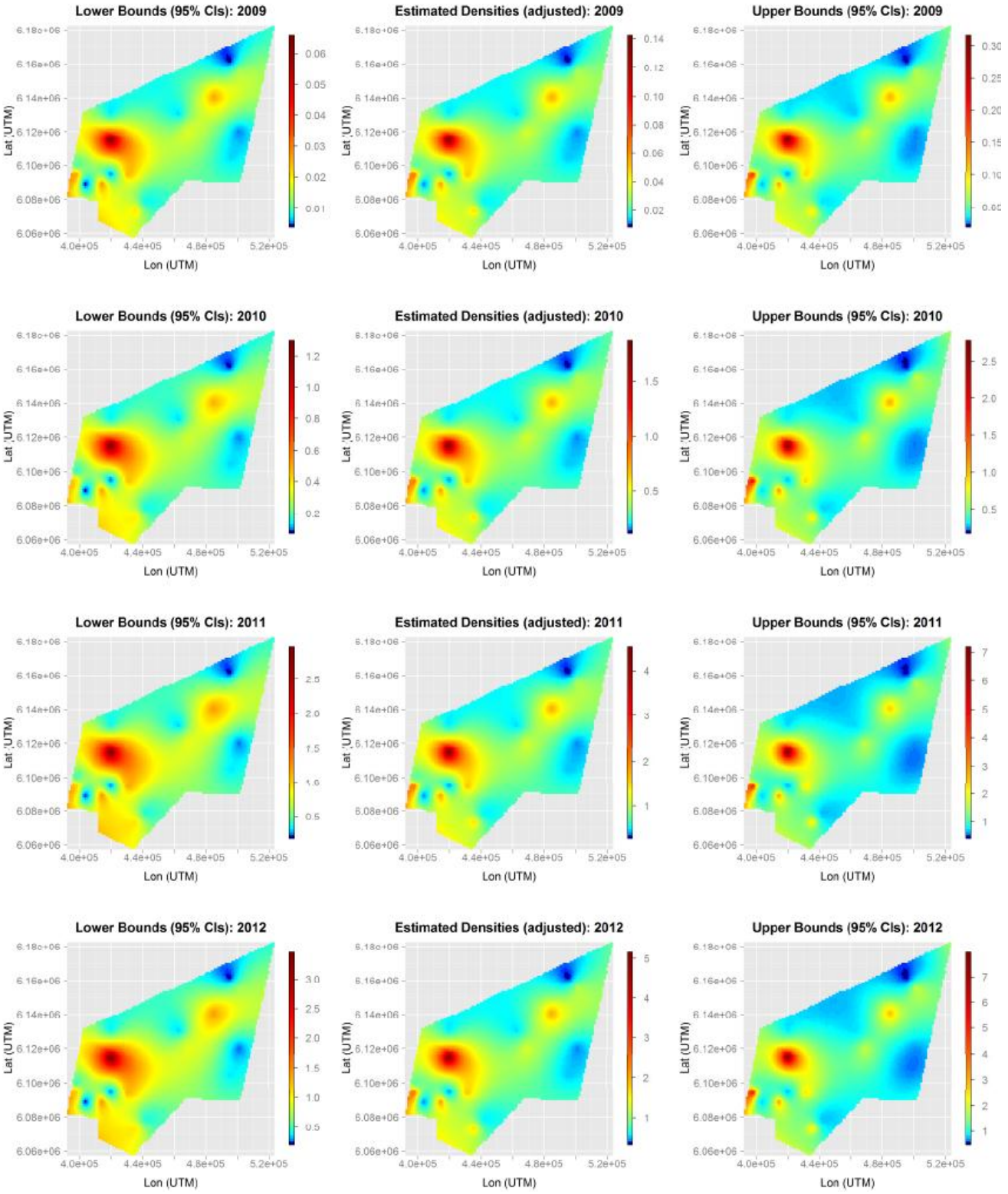



Figure 5.26 Estimated absolute densities, and upper and lower bounds of the associated 95% confidence intervals of harbour porpoise (on a fine grid) per $km^2$ in each year, averaged in each grid cell after adjusting for availability

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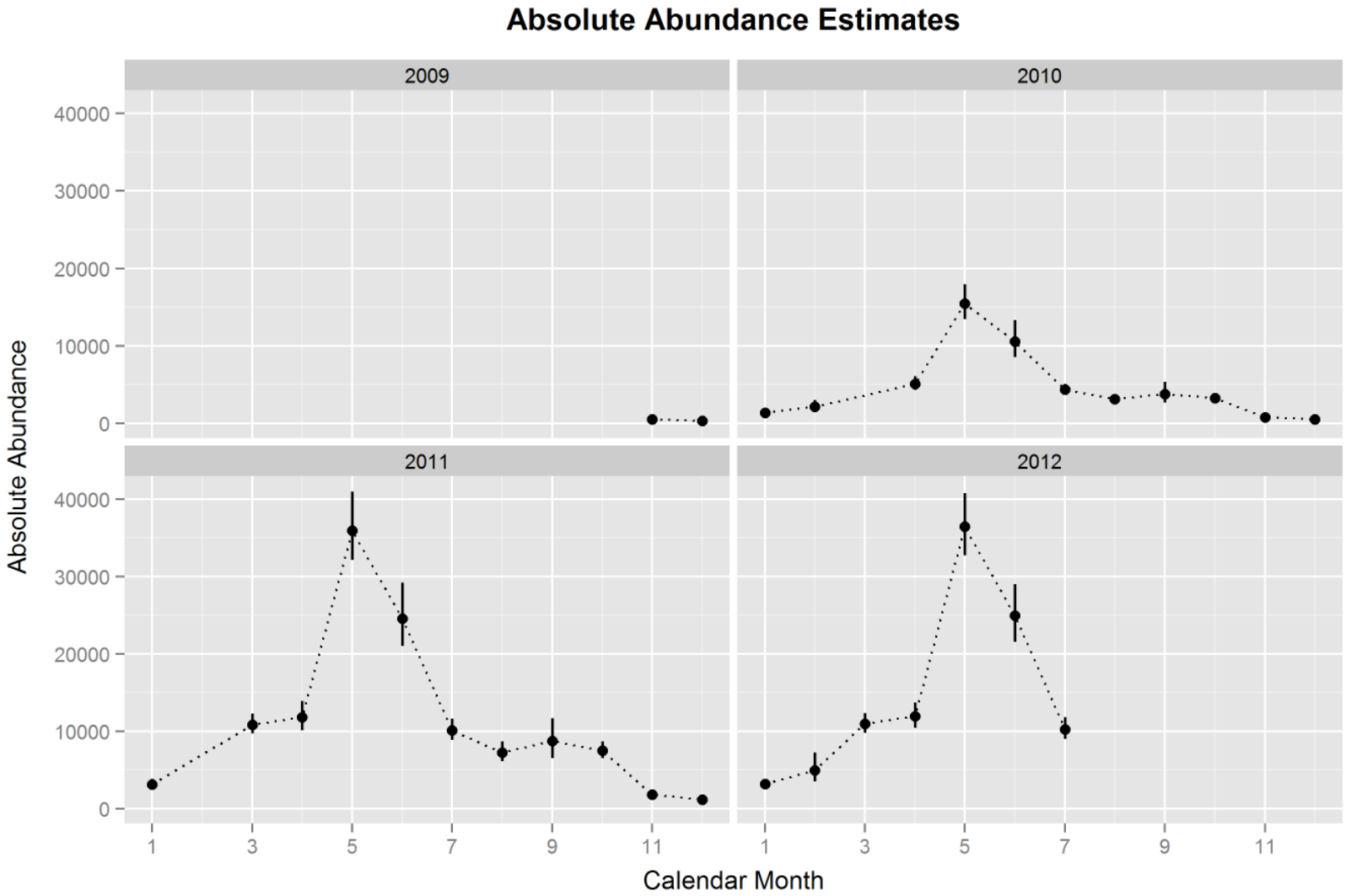
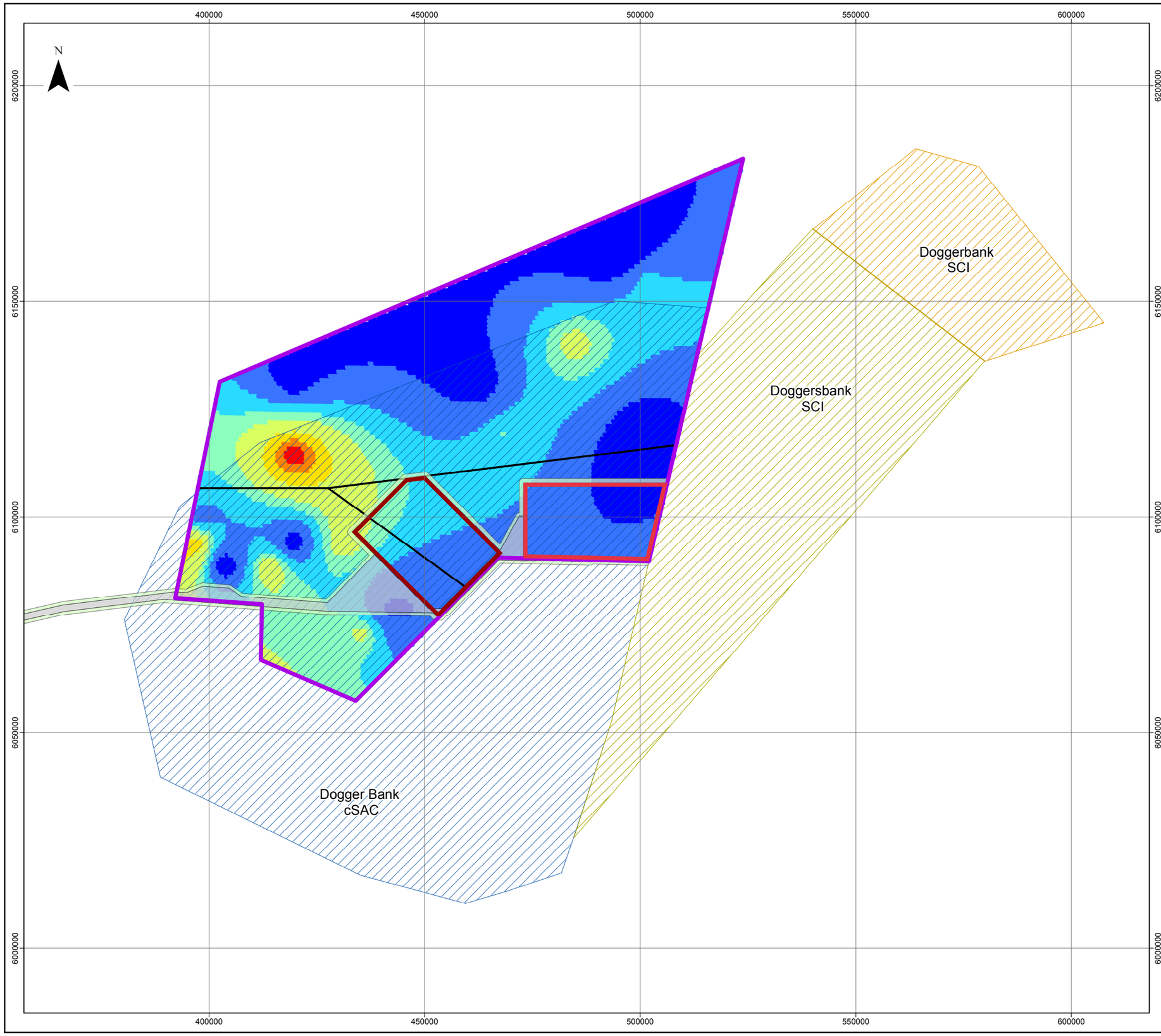
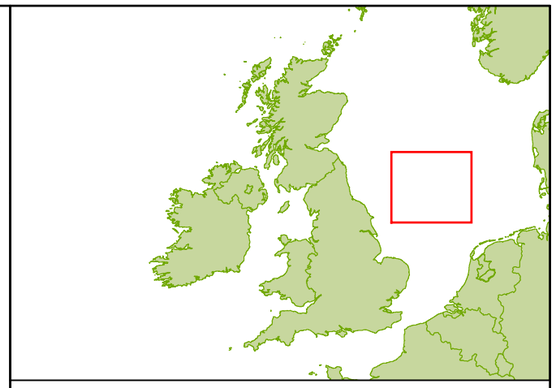



Figure 5.27 Estimates of absolute abundance of harbour porpoise (after adjusting for availability) and associated upper and lower 95% confidence intervals (see Appendix 14A for details of methods of calculation)


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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

Special Area of Conservation (cSAC)/ Sites of Community Importance (SCI)

- Germany
- Netherlands
- UK

Absolute mean density (km²)

- ≤ 0.40
- 0.41 - 0.60
- 0.61 - 0.80
- 0.81 - 1.00
- 1.01 - 1.50
- 1.51 - 2.00
- 2.01 - 2.50
- ≥ 2.51

0 10 20 40
Kilometres

Data Source:
Density data © DMP Stats, 2013
Round 3 offshore wind farm boundary © Crown Copyright, 2014
Background bathymetry image derived in part from TCarta data © 2009

PROJECT TITLE

*DOGGER BANK TEESSIDE A & B*
IfAA Report

DRAWING TITLE

**Figure 5.28 Absolute mean densities (in km²) of harbour porpoise adjusted for availability**

| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 11/10/2013 | PEI3 | JE | PT |
| 2 | 18/03/2014 | DCO Submission | GC | PT |
| | | | | |

DRAWING NUMBER:
**9Y0986/TSABHRA/41/R2**

| SCALE | PLOT SIZE | DATUM | PROJECTION |
|---|---|---|---|
| 1:900,000 | A3 | WGS84 | UTM31N |

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5.15.25 The estimates of density and absolute abundance presented above and generated from the HiDef surveys do not take account of sightings that are 'potentially' harbour porpoise. Although it is likely that the majority, but not all, of these sightings are harbour porpoise, a precautionary approach of assuming all are harbour porpoise was adopted for the assessment. Following the same methods as applied for harbour porpoise, estimates of absolute density were then calculated for the harbour porpoise and potential harbour porpoise combined. Consequently, where 'potential harbour porpoise' records are included, the revised absolute density estimates; when combining the data, produced approximate ranges from 0 to 2 (95% confidence interval of 1.4 to 3.5) harbour porpoise per $km^2$ in 2010, from 0 to 4 (95% confidence interval of 3 to 7) harbour porpoise per $km^2$in 2011, and from 0 to 5 (95% confidence interval of 3 to 8) harbour porpoise per $km^2$ in 2012 (see Figure 11 in **Appendix 14A** of the Dogger Bank Teesside A & B ES). The estimates of absolute abundance for harbour porpoise and potential harbour porpoise combined were 9,344 (95% confidence interval of 6,822 to 12,700), and absolute density was 0.7161 (95% confidence interval of 0.52284 to 0.97333) harbour porpoise per $km^2$ across the survey area (see **Figure 5.29**). Figures showing the upper and lower 95% confidence interval for harbour porpoise and 'potential harbour porpoise' mean density are shown on Figures 4.17 and 4.18 in **Chapter 14** of the Dogger Bank Teesside A & B ES.

## 5.16 Assessment of impacts during the construction phase - harbour porpoise

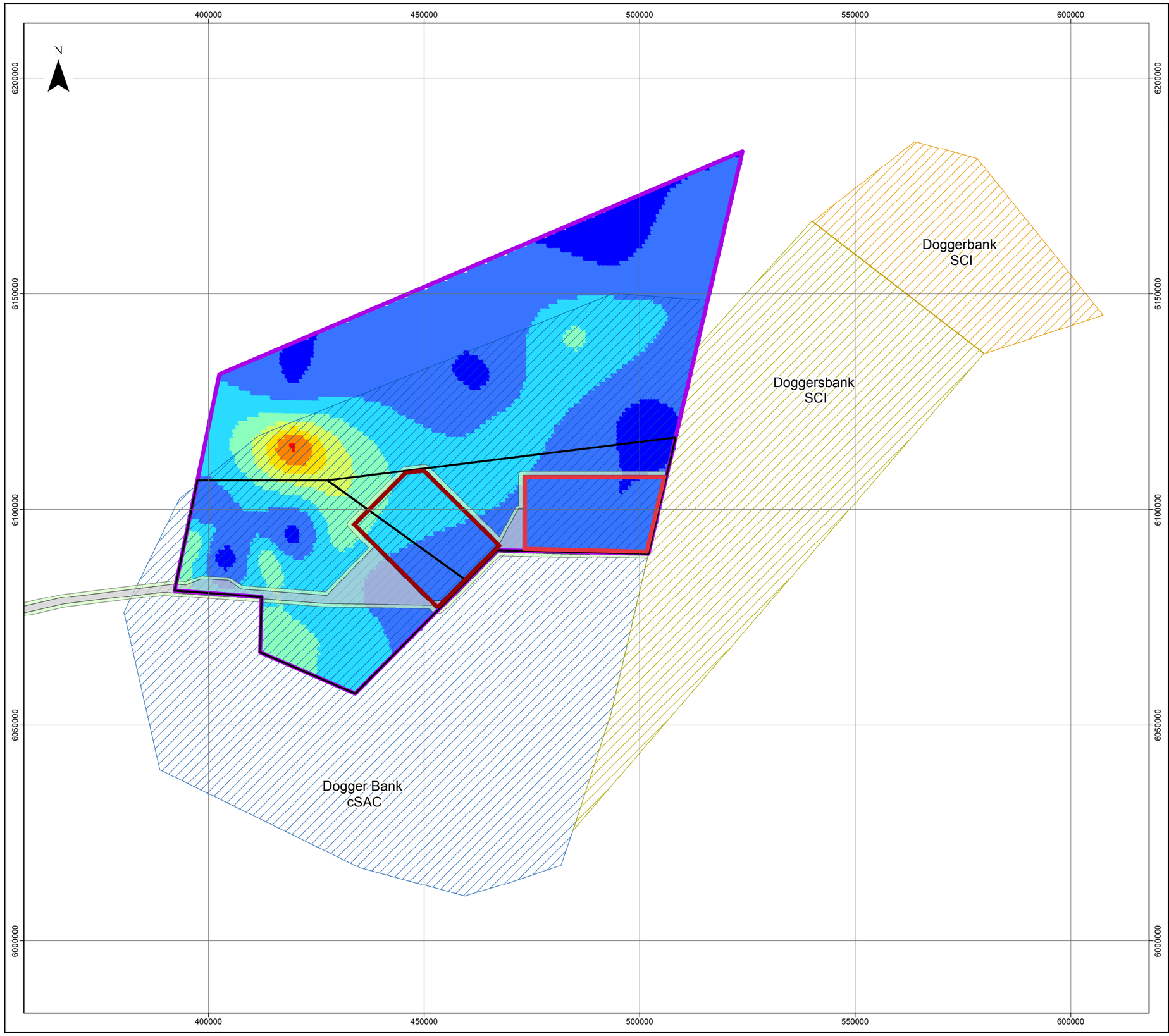
### Introduction

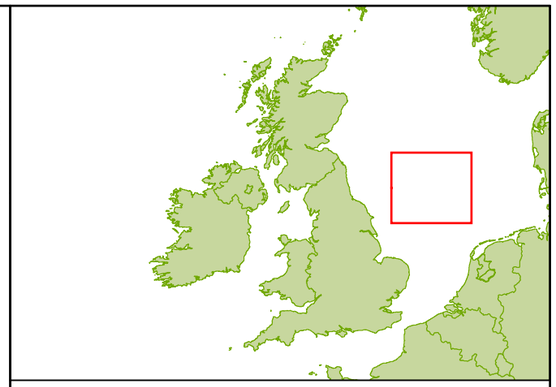
5.16.1 This section identifies and assesses the impacts that are predicted to occur during the construction phase for Dogger Bank Teesside A & B (including the Dogger Bank Teesside A & B Export Cable Corridor) that have potential implications on harbour porpoise. The impacts have been aggregated under the following headings:

- Changes in harbour porpoise prey species (fish) distribution, abundance or quality arising from increased suspended sediment concentrations in the water column and re-deposition of sediment from the water column due to the installation of foundations, cables and ancillary structures and the placement of jack-up vessel legs;
- Direct physical damage (mortality) as a result of underwater noise due to pile driving and vessel movements; and
- Direct physical damage (mortality) to harbour porpoise as a result of collisions with construction vessels.

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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

Special Area of Conservation (cSAC)/ Sites of Community Importance (SCI)

- Germany
- Netherlands
- UK

Absolute mean density (km²)

- ≤ 0.250
- 0.251 - 0.500
- 0.501 - 0.750
- 0.751 - 1.000
- 1.001 - 1.250
- 1.251 - 1.500
- 1.501 - 2.000
- ≥ 2.001

0 10 20 40
Kilometres

Data Source:
Density data © DMP Stats, 2013
Round 3 offshore wind farm boundary © Crown Copyright, 2014
Background bathymetry image derived in part from TCarta data © 2009

PROJECT TITLE

*DOGGER BANK TEESSIDE A & B*
IfAA Report

DRAWING TITLE

**Figure 5.29 Absolute mean densities (in km²) of harbour porpoise and potential harbour porpoise combined, adjusted for availability**

| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 11/10/2013 | PEI3 | JE | PT |
| 2 | 18/03/2014 | DCO Submission | GC | PT |
| | | | | |

DRAWING NUMBER:
**9Y0986/TSABHRA/42/R2**

| SCALE | 1:900,000 | PLOT SIZE | A3 | DATUM | WGS84 | PROJECTION | UTM31N |
|---|---|---|---|---|---|---|---|

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## Changes to prey species abundance and distribution and implications for harbour porpoise populations

5.16.2 The impact of construction of the proposed development on fish abundance is described in detail in Section 6 in **Chapter 13** of the Dogger Bank Teesside A & B ES. The assessment predicts short-term and temporary minor adverse impacts to fish populations from increased suspended sediment concentrations, seabed disturbance and construction (particularly piling) noise. Furthermore, in terms of potential impacts on spawning fish only sandeel are expected to be affected, with short-term and temporary minor adverse impacts predicted (see Section 6.5 in **Chapter 13** of the Dogger Bank Teesside A & B ES) in relation to sediment deposition, which would be short-term and temporary in duration (see paragraphs 4.6.35 to 4.6.38).

5.16.3 As a result of increases in underwater noise levels and localised increases in suspended sediment concentrations, fish may exhibit avoidance reactions and move away from affected areas. It would also be expected that harbour porpoise would react to the same environmental signals and would also avoid the areas of greatest disturbance. Affected individuals could, therefore, move to areas where fish have been temporarily displaced or, if displacement of individual porpoise would be unlikely, alternative prey of greatest abundance within the affected area could be sought.

5.16.4 The mobility of harbour porpoise and their flexibility in prey selection suggests that any short-term and localised changes in fish abundance during construction would not compromise the ability of harbour porpoise to gain sufficient prey. Furthermore, the footprint of any effect on prey species would be spatially less extensive than the area from which porpoise would be likely to be displaced as a result of disturbance during piling (see paragraphs 5.16.20 and 5.16.29). The spatial extent to which prey species would be disturbed and avoid the area (see Section 6 in **Chapter 13** of the Dogger Bank Teesside A & B ES) would be significantly less than that for harbour porpoise. Consequently, any alteration to prey abundance would be unlikely to occur in the areas that harbour porpoise have moved in to as a result of disturbance effects, and would not have any discernible implications for the harbour porpoise population.

## Physical damage due to underwater noise

### Impact of a single piling event

5.16.5 Impact piling noise was modelled for the worst case piling scenario (a 3000kJ hammer) for a range of locations chosen to encompass a range of noise propagation conditions; shallow and deep water; and up-sloping and down-sloping bathymetry (see **Appendix 5A** of the Dogger Bank Teesside A & B ES). A range of hammer energies were initially modelled (i.e. 1,900kJ, 2,300kJ, and 3,000KJ) and a 300kJ hammer energy was used to represent soft-start of piling and ramping up to the full hammer blow energy (detailed and presented in **Appendix 5A** of the Dogger Bank Teesside A & B ES). Overall, the 3,000kJ hammer energy represents the maximum hammer energy that could be used during the construction phase. Experience from previous wind farm construction shows that the maximum hammer energy is rarely achieved during a piling sequence and then only for a short duration (e.g. Bailey *et al.* 2010; Robinson *et*

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*al.* 2011). It should be noted that the pile size has no discernible effect on noise energy output from piling.

5.16.6 In order to determine the spatial extent of underwater noise during the construction phase, sound propagation was modelled from point sources (piling events) around the project boundaries of Dogger Bank Teesside A and Dogger Bank Teesside B. The maximum noise levels related to sensitivity thresholds for grey seal were then used to determine the noise footprint from piling.

5.16.7 The modelling considered three piling sequence lengths (see **Table 5.8**) and the worst case Sequence 3 was used in modelling the SEL dose on harbour porpoise resulting from prolonged exposure. The ranges presented in **Table 5.8** assume a hammer strike at the stated energy and do not take into account any ramp-up of energy (i.e. soft-start).

5.16.8 The auditory injury impact ranges predicted for harbour porpoise are based on PTS threshold values obtained from data reported by Lucke *et al*. (2009) and presented in **Table 5.7**. The effect of an SEL dose was predicted by summing up the SEL received levels from the entire piling sequence, assuming a fleeing animal. The model predicts the SEL dose for an animal that moves away from the source, with a swim speed of 1.5m/s for harbour porpoise once piling starts and continues to move away throughout the piling sequence. Swim speeds are based on a harbour porpoise mother-calf pair from Otani *et al*. (2000). Impact ranges were determined from the modelled location and transects, using one location to approximate the worst case, namely the most north-westerly location where noise propagates more efficiently and hence the largest distance is determined for each noise threshold.

5.16.9 The model is considered to be very precautionary as it does not account for any time a receptor may spend at or near to the surface (and the reduced sound exposure levels there) or any temporal hearing recovery. Furthermore, the modelling used the worst case sequence (see paragraph 5.16.5) even though this is unlikely to represent the majority of piling events.

5.16.10 Based on this modelling, the ranges for potential instantaneous onset of auditory injury (PTS), behavioural (fleeing) response (TTS), and possible behavioural (avoidance of area) response for harbour porpoise present in the development areas for Dogger Bank Teesside A and Dogger Bank Teesside B were identified, and are presented in **Table 5.16**. The ranges presented in **Table 5.16** assume a hammer strike at the stated energy and do not take into account any ramp-up of energy (i.e. soft-start).

5.16.11 These potential impact range results are precautionary, in that they do not account for any temporal hearing recovery (see paragraph 5.16.9 above), the exposure predicted in the model is likely to be an overestimate of the exposure that a harbour porpoise might be subjected to.

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Table 5.16 Summary of harbour porpoise impact ranges for construction at Dogger Bank Teesside A and Dogger Bank Teesside B (the range of impacts primarily varies due to differences in bathymetry)

| Impact criterion | Potential range of impact for harbour porpoise | | | |
|---|---|---|---|---|
| | 300kJ hammer energy | 1,900kJ hammer energy | 2,300kJ hammer energy | 3,000kJ hammer energy |
| **Dogger Bank Teesside A** | | | | |
| Auditory injury: Instantaneous injury / PTS* (pulse SEL 179dB re 1µPa$^2$/s) | <100m | <500m | <600m | <700m |
| Auditory injury / behavioural response: TTS / Fleeing response / Likely avoidance (pulse SEL 164dB re 1µPa$^2$/s)* | <1.5km | 3.2km to 4.2km | 3.5km to 4.6km | 4.0km to 5.5km |
| Behavioural response: Possible avoidance of area (pulse SEL 145dB re 1µPa$^2$/s)* | 10.0km to 13.5km | 20.0km to 28.0km | 21.0km to 30.0km | 22.0km to 33.0km |
| **Dogger Bank Teesside B** | | | | |
| Auditory injury: Instantaneous injury / PTS* (pulse SEL 179dB re 1µPa$^2$/s) | <200m | <500m | <550m | <700m |
| Auditory injury / behavioural response: TTS / Fleeing response / Likely avoidance (pulse SEL 164dB re 1µPa$^2$/s)* | <1.5km | 3.6km to 4.2km | 3.8km to 4.8km | 4.0km to 5.5km |
| Behavioural response: Possible avoidance of area (pulse SEL 145dB re 1µPa$^2$/s)* | 10.0km to 14.0km | 19.5km to 29.5km | 21.0km to 30.5km | 22.0km to 33.5km |

*Lucke *et al.* (2009).

### *Lethal and physical injury*

5.16.12 The predicted noise levels in close proximity to the piling activity are comparable to those estimated for auditory injury. Harbour porpoise mortality would only be expected at noise levels substantially above those necessary to cause the onset of auditory injury. The pile driving installation, therefore, is unlikely to result in radiated noise levels beyond a few metres that are sufficient to cause instantaneous mortality in harbour porpoise (Richardson *et al.* 1995 (converted from Yelverton *et al.* (1975) for marine mammals)).

### *PTS impact due to single pile drive and impact on harbour porpoise population*

5.16.13 Ranges for the onset of a PTS in hearing are expected to be up to 700m from piling for both Dogger Bank Teesside A and Dogger Bank Teesside B (see **Table 5.16**), though it should be noted that this range does not include the use of soft-start and the maximum hammer energy was used for a single pile strike, which is highly unlikely to occur. The use of a soft-start (initiating the hammer with a 300kJ energy) would reduce the range for potential onset of auditory injury to less than 100m for harbour porpoise.

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5.16.14 On the onset of a soft-start, it is expected that harbour porpoise would flee (and 1.5m/s has been assumed, which again is precautionary) and, by the time the full hammer energy level is achieved, would be outside the zone of instantaneous injury that would cause a permanent threshold shift (PTS).

5.16.15 Assuming a hammer blow energy of 3,000kJ, the TTS range for harbour porpoise for both Dogger Bank Teesside A and Dogger Bank Teesside B is predicted to be between 4.0km and 5.5km (see **Table 5.16**).

5.16.16 The cumulative SEL dose for harbour porpoise has been predicted by summing up the pulse SEL over an entire piling sequence assuming harbour porpoise would swim away once piling commences. The required starting range for harbour porpoise from the pile when pile driving starts, such that harbour porpoise are not over exposed and do not suffer PTS onset for the three pile driving sequences (identified in **Table 5.8**), are presented on **Figure 5.10**, **Figure 5.11**, and **Figure 5.12** for 12,600 pile strikes, 5,000 pile strikes, and 2,000 pile strikes respectively.

5.16.17 Overlaying the area in which generated noise levels may cause instantaneous injury (PTS) with average densities of harbour porpoise across the Dogger Bank Zone enables an indication of the percentage of harbour porpoise population that may be affected by piling works for Dogger Bank Teesside A & B. The modelling of the spatial extent over which instantaneous injury could arise, and the number of porpoise and percentage of the population potentially affected as a result of instantaneous injury (PTS) by a single 3,000kJ hammer, are presented in **Table 5.17**.

Table 5.17 Areas ($km^2$) of PTS (instantaneous injury) impact (based on a single pile driving event with 3,000kJ maximum hammer energy), number of harbour porpoises' impacted (and uncertainty based on 95% confidence interval around density estimates), percentage of harbour porpoise reference population impacted for Dogger Bank Teesside A and Dogger Bank Teesside B alone and combined (Dogger Bank Teesside A & B)

| Reference population | Impact area | Impacted number | Percentage of reference population |
|---|---|---|---|
| **Dogger Bank Teesside A or Dogger Bank Teesside B alone** | | | |
| Harbour porpoise density 0.64056 per $km^2$ (227,298) | 1.5$km^2$ | 1.0 (2.8 to 3.5) | 0.0004% |
| Harbour porpoise and potential harbour porpoise density 0.7161 per $km^2$ (227,298) | | 1.1 (2.5 to 4.7) | 0.0005% |
| **Dogger Bank Teesside A & B** | | | |
| Harbour porpoise density 0.64056 per $km^2$ (227,298) | 3.0$km^2$ | 1.9 (5.6 to 7.0) | 0.0008% |
| Harbour porpoise and potential harbour porpoise density 0.7161 per $km^2$ (227,298) | | 2.1 (0.7 to 1.4) | 0.0009% |

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5.16.18 As stated above, the maximum range for PTS is up to 700m from a single pile driving event with a 3,000kJ hammer energy. However, with the inclusion of a proposed 500m exclusion zone (see Section 5.19), the area in which harbour porpoise potentially could be subject to instantaneous injury would reduce to 0.8km$^2$ for each project. This would reduce the total number of harbour porpoise that could be exposed to noise above thresholds that cause instantaneous injury (PTS) to 0.48 (based on average densities) for Dogger Bank Teesside A or Dogger Bank Teesside B. For harbour porpoise and 'potential harbour porpoise', the total number that could be exposed to noise above thresholds that cause instantaneous injury (PTS) would be reduced to 0.54 (based on average densities) for Dogger Bank Teesside A or Dogger Bank Teesside B. For Dogger Bank Teesside A & B combined, the number that could be exposed to noise above thresholds that cause instantaneous injury (PTS) would be reduced to 0.96 harbour porpoise and 1.08 harbour porpoise and 'potential harbour porpoise'. Consequently, the maximum number of porpoise that could be exposed to PTS from a single 3,000kJ piling event in Dogger Bank Teesside A & B would equate to 0.0004% of the reference harbour porpoise or 0.0005% of the reference harbour porpoise when potential harbour porpoise are included.

5.16.19 The predicted impact on the harbour porpoise population due to instantaneous injury is based on the simplistic approach that the animal does not flee the area during the piling works. However, porpoise have been observed to flee from pile driving noise, and this is also assumed to be the case during calculations of exposure based on cumulative SEL. In the case of PTS from instantaneous injury the use of soft-start (see Section 5.19) with a 300kJ hammer (and the 500m exclusion zone) would act as mitigation (or avoidance). If individuals flee the noise source at 1.5m/s once pile driving commences, then they would be significantly more than the required 600m (in the case of 2,300kJ) or 700m (in the case of 3,000kJ hammer) away from the noise source before these hammer energies are reached (as shown in **Table 5.16**). Consequently, with mitigation measures in place, the results of the modelling indicate that individual harbour porpoise would not be exposed to noise thresholds that could over expose the individuals or lead to PTS as a result of cumulative exposure, and no impact is predicted on individuals or the harbour porpoise population as a whole.

### *TTS impact due to single pile drive and impact on harbour porpoise population*

5.16.20 The fleeing ranges for harbour porpoise are based on the acoustic levels which are deemed to cause the onset of TTS, as reported by Lucke *et al.* (2009) and presented in **Table 5.7**. A TTS range of between 4.0km and 5.5km was identified for both Dogger Bank Teesside A and Dogger Bank Teesside B (see **Table 5.16**). A potential behavioural response could extend between 22.0km and 33.0km from piling within Dogger Bank Teesside A, and between 22.0km and 33.5km from piling within Dogger Bank Teesside B (see **Table 5.16**).

5.16.21 The noise modelling identified the spatial extent of potential impact (i.e. the area in which generated noise levels may cause TTS), which are then calculated against the average densities of harbour porpoise across the Dogger Bank Zone to provide a prediction of the numbers of harbour porpoise and the percentage

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of harbour porpoise population that may be affected. The area in which TTS could arise (fleeing response and then residual likely avoidance, and possible avoidance), the number of porpoise and percentage of the population potentially affected by a single 3,000kJ hammer are presented in **Table 5.18**.

Table 5.18 Areas ($km^2$) of TTS (likely avoidance / fleeing response / possible avoidance) impact (based on a single pile driving event with 3,000kJ maximum hammer energy), number of harbour porpoises' impacted (and uncertainty based on 95% confidence interval around density estimates), and percentage of harbour porpoise population impacted for Dogger Bank Teesside A and Dogger Bank Teesside B alone and combined (Dogger Bank Teesside A & B)

| Density | Likely avoidance / fleeing response | | | Possible avoidance | | |
|---|---|---|---|---|---|---|
| | Impact area | Impacted number | Percentage of reference population | Impact area | Impacted number | Percentage of reference population |
| **Dogger Bank Teesside A** | | | | | | |
| Harbour porpoise density 0.64056 per $km^2$ (227,298) | 82.3$km^2$ | 53 (48 to 59) | 0.02% | 2,861$km^2$ | 1,717 (1,548 to 1,913) | 0.76% |
| Harbour porpoise and potential harbour porpoise density 0.7161 per $km^2$ (227,298) | | 59 (43 to 80) | 0.03% | | 1,920 (1,402 to 2,609) | 0.84% |
| **Dogger Bank Teesside B** | | | | | | |
| Harbour porpoise density 0.64056 per $km^2$ (227,298) | 82$km^2$ | 53 (48 to 59) | 0.02% | 2,834$km^2$ | 1,820 1,641 to 2,027) | 0.80% |
| Harbour porpoise and potential harbour porpoise density 0.7161 per $km^2$ (227,298) | | 59 (43 to 80) | 0.03% | | 2,035 (1,485 to 2,765) | 0.90% |
| **Dogger Bank Teesside A & B** | | | | | | |
| Harbour porpoise density 0.64056 per $km^2$ (227,298) | 1,072$km^2$ | 687 (620 to 766) | 0.30% | 5,489$km^2$ | 3,516 (3,170 to 3,917) | 1.55% |
| Harbour porpoise and potential harbour porpoise density 0.7161 per $km^2$ (227,298) | | 768 (561 to 1,044) | 0.34% | | 3,931 (2,870 to 5,343) | 1.73% |

5.16.22 The TTS zones for one pile driving location within Dogger Bank Teesside A and Dogger Bank Teesside B are shown on **Figure 5.30** and **Figure 5.31**.

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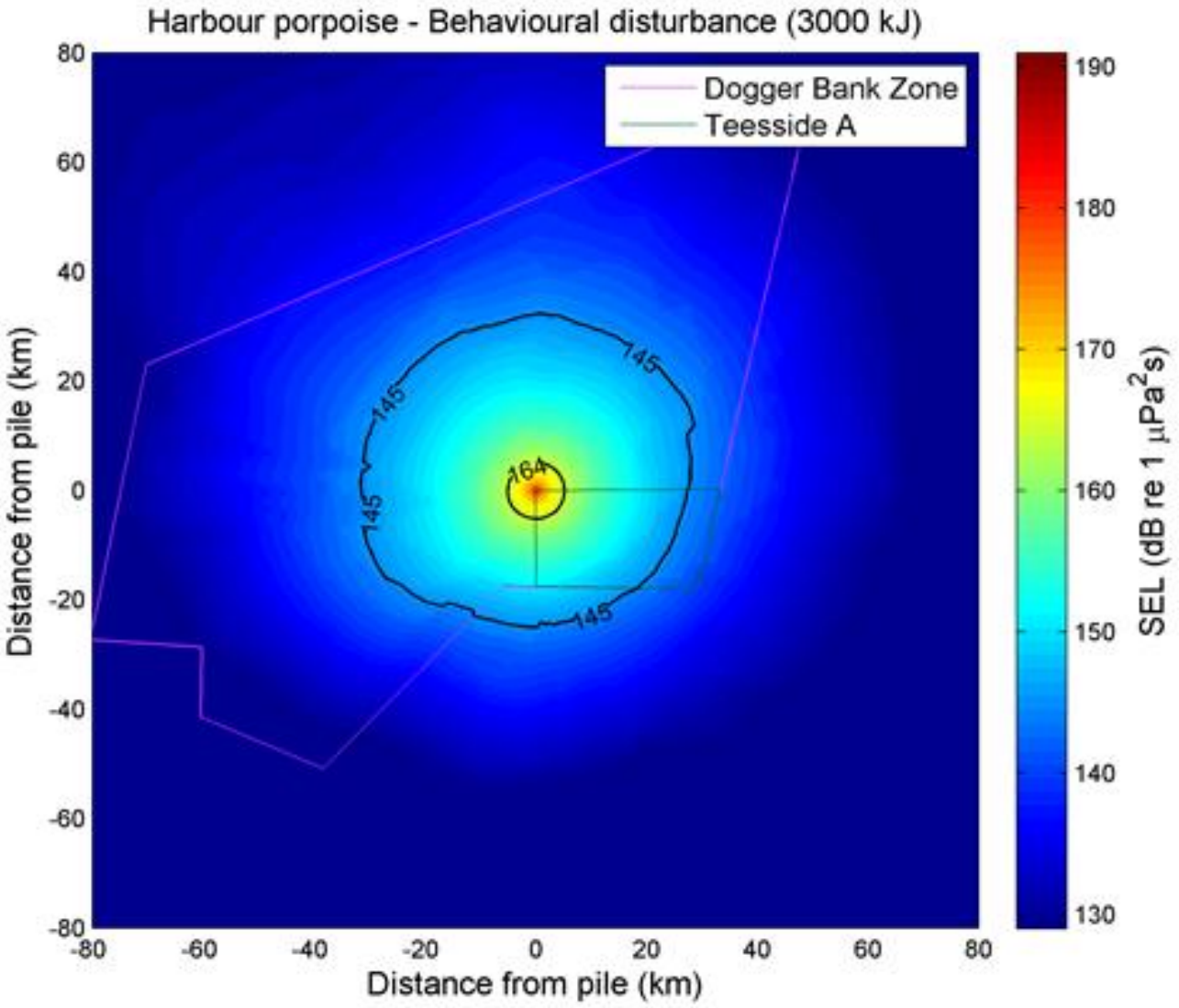



Figure 5.30 Harbour porpoise behavioural disturbance zones for a 3,000kJ hammer blow energy within Dogger Bank Teesside A (Key: SEL 164dB re 1 $\mu Pa^2/s$ represents the zone of TTS or fleeing response and SEL 145dB re 1 $\mu Pa^2/s$ represents the zone of possible avoidance; note that zone of PTS is not shown as it is so small)

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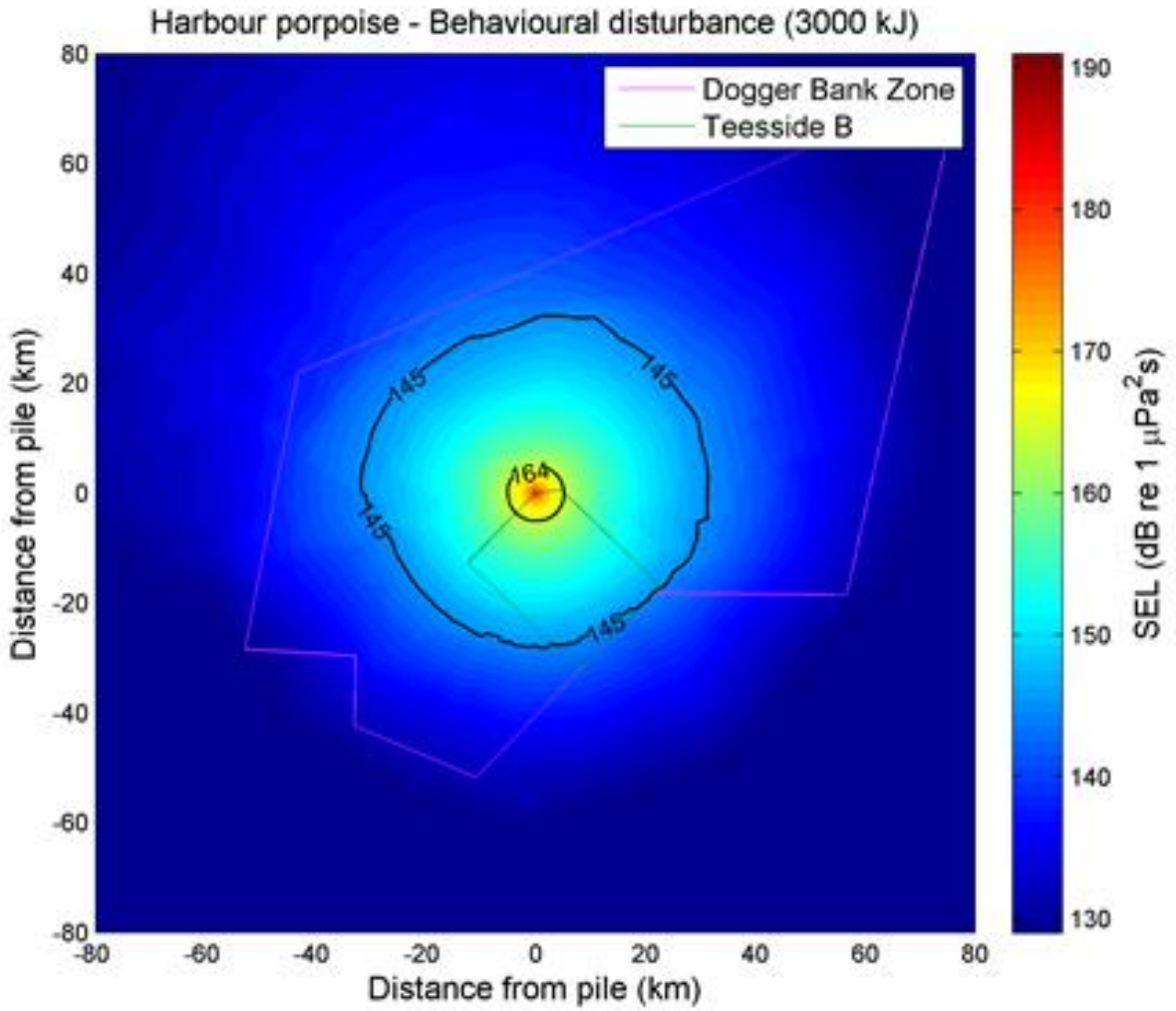



Figure 5.31 Harbour porpoise behavioural disturbance zones for a 3,000kJ hammer blow energy within Dogger Bank Teesside B (Key: SEL 164dB re 1 µPa$^2$/s represents the zone of TTS or fleeing response and SEL 145dB re 1 µPa$^2$/s represents the zone of possible avoidance; note that zone of PTS is not shown as it is so small)

**Multiple pile driving**

***PTS impact due to multiple and concurrent pile-driving and impact on harbour porpoise population***

5.16.23 The worst case scenario for piling activity throughout the construction phase for Dogger Bank Teesside A & B in it's entirety is presented in **Table 2.2**, and represents the worst possible scenario for determining the impact on the harbour porpoise population as a result of piling activities. A summary is also provided in paragraph 5.6.23.

5.16.24 As described earlier, instantaneous injury (PTS) can be avoided through the use of mitigation for single pile driving events. The same outcome would also apply to multiple pile driving over the whole construction period, as measures (see Section 5.19) would be in place to avoid the potential for PTS to be realised in the first place. Therefore, no impact on individual harbour porpoise or the harbour porpoise population is expected from multiple pile driving for Dogger Bank Teesside A & B (combined and individually).

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### *TTS and impact on harbour porpoise population*

5.16.25 Quantification of the potential number of harbour porpoise that would be exposed to noise levels above the threshold that can cause TTS or disturbance has been undertaken using the spatial extent of the potential impact ranges during the construction phase. The noise footprint is taken to be the noise level at a given range or the maximum ranges for a given impact threshold which might occur for each project regardless of the location or number of piling vessels operating within the project boundary. The noise propagation was modelled at various locations along the Dogger Bank Teesside A & B boundaries (see Section 4 in **Appendix 5A** of the Dogger Bank Teesside A & B ES) for harbour porpoise.

5.16.26 The size and number of piles for foundations influences the potential impact footprint. Larger piles (i.e. 12m monopoles for 120 turbines) result in a larger blow force but shorter piling duration, whilst smaller but more numerous piles (i.e. multi-leg foundations for 200 turbines) result in a smaller blow force but much longer piling duration. Considering that the overall duration of the activity has greater implications for behaviour, this scenario was used. Therefore, in determining the effect of multiple piling it is assumed that there would be a maximum of 788 pile driving events for each wind farm in a year, including wind turbines (600 pile driving events) and other structures (188 pile driving events). Overall, for each wind farm the modelling assumes that 2,429 hours of pile driving (including soft-start) would be carried out each year for each piling rig.

5.16.27 Based on the scenario used, it is unlikely that there would be gaps between periods of pile driving of more than three days. However, there are likely to be breaks in activity due to inclement weather or technical problems, and harbour porpoise could potentially return to the construction area. The assessment work undertaken assumes that within each year harbour porpoise do not return to the area under construction due to behavioural exclusion for the duration of the piling programme.

5.16.28 There are a number of further assumptions in the approach:

- The range of noise propagation for TTS and / or behavioural thresholds is the same as the worst case location for the chosen modelling; and
- All pile driving events would be up to the maximum 3000kJ blow force.

5.16.29 The noise modelling carried out and described in paragraphs 5.4.1 to 5.4.12 and paragraph 5.16.26 above identified the spatial extents of potential impact (i.e. the area in which generated noise levels may cause TTS), which are then used together with the average densities of harbour porpoise across the Dogger Bank Zone to provide a prediction of the numbers of harbour porpoise and the percentage of harbour porpoise population that may be affected. The area in which TTS could arise (fleeing response, likely avoidance, and possible avoidance), the number of porpoise and percentage of the population potentially affected are presented in **Table 5.19**, and the disturbance footprints of multiple piling events for Dogger Bank Teesside A are shown on **Figure 5.32**, and for Dogger Bank Teesside B are shown on Figure 6.5 in **Appendix 5A** of the Dogger Bank Teesside A & B ES.

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Table 5.19 Areas (km$^2$) of impact footprint from concurrent pile driving events around the project boundary (based on 3,000kJ hammer energy), number of individuals affected by TTS (likely avoidance and possible avoidance) and uncertainty based on 95% confidence interval around density estimates), and percentage of harbour porpoise population impacted for Dogger Bank Teesside A and Dogger Bank Teesside B alone and combined (Dogger Bank Teesside A & B concurrently and sequentially)

| Density | Likely avoidance | | | Possible avoidance | | |
|---|---|---|---|---|---|---|
| | Affected area | Number affected by TTS | Percentage of reference population | Affected area | Number affected by TTS | Percentage of reference population |
| **Dogger Bank Teesside A** | | | | | | |
| Harbour porpoise density 0.64056 per km$^2$ (227,298) | 1,039km$^2$ | 666 (601 to 742) | 0.29% | 6,008km$^2$ | 3,848 (3,469 to 4,288) | 1.69% |
| Harbour porpoise and potential harbour porpoise density 0.7161 per km$^2$ (227,298) | | 745 (544 to 1,012) | 0.33% | | 4,302 (3,141 to 5,848) | 1.89% |
| **Dogger Bank Teesside B** | | | | | | |
| Harbour porpoise density 0.64056 per km$^2$ (227,298) | 1,072km$^2$ | 687 (620 to 766) | 0.30% | 5,489km$^2$ | 3,516 (3,170 to 3,917) | 1.55% |
| Harbour porpoise and potential harbour porpoise density 0.7161 per km$^2$ (227,298) | | 768 (561 to 1,044) | 0.34% | | 3,931 (2,870 to 5,343) | 1.73% |
| **Dogger Bank Teesside A & B Concurrent Build (overlapping footprints)** | | | | | | |
| Harbour porpoise density 0.64056 per km$^2$ (227,298) | 2,086km$^2$ | 1,336 | 0.59% | 8,866km$^2$ | 5,679 | 2.50% |
| Harbour porpoise and potential harbour porpoise density 0.7161 per km$^2$ (227,298) | | 1,494 | 0.66% | | 6,349 | 2.79% |
| **Dogger Bank Teesside A & B Sequential Build (combined footprints)** | | | | | | |
| Harbour porpoise density 0.64056 per km$^2$ (227,298) | 2,111km$^2$ | 1,353 | 0.60% | 11,497km$^2$ | 7,364 | 3.24% |
| Harbour porpoise and potential harbour porpoise density 0.7161 per km$^2$ (227,298) | | 1,513 | 0.67% | | 8,233 | 3.62% |

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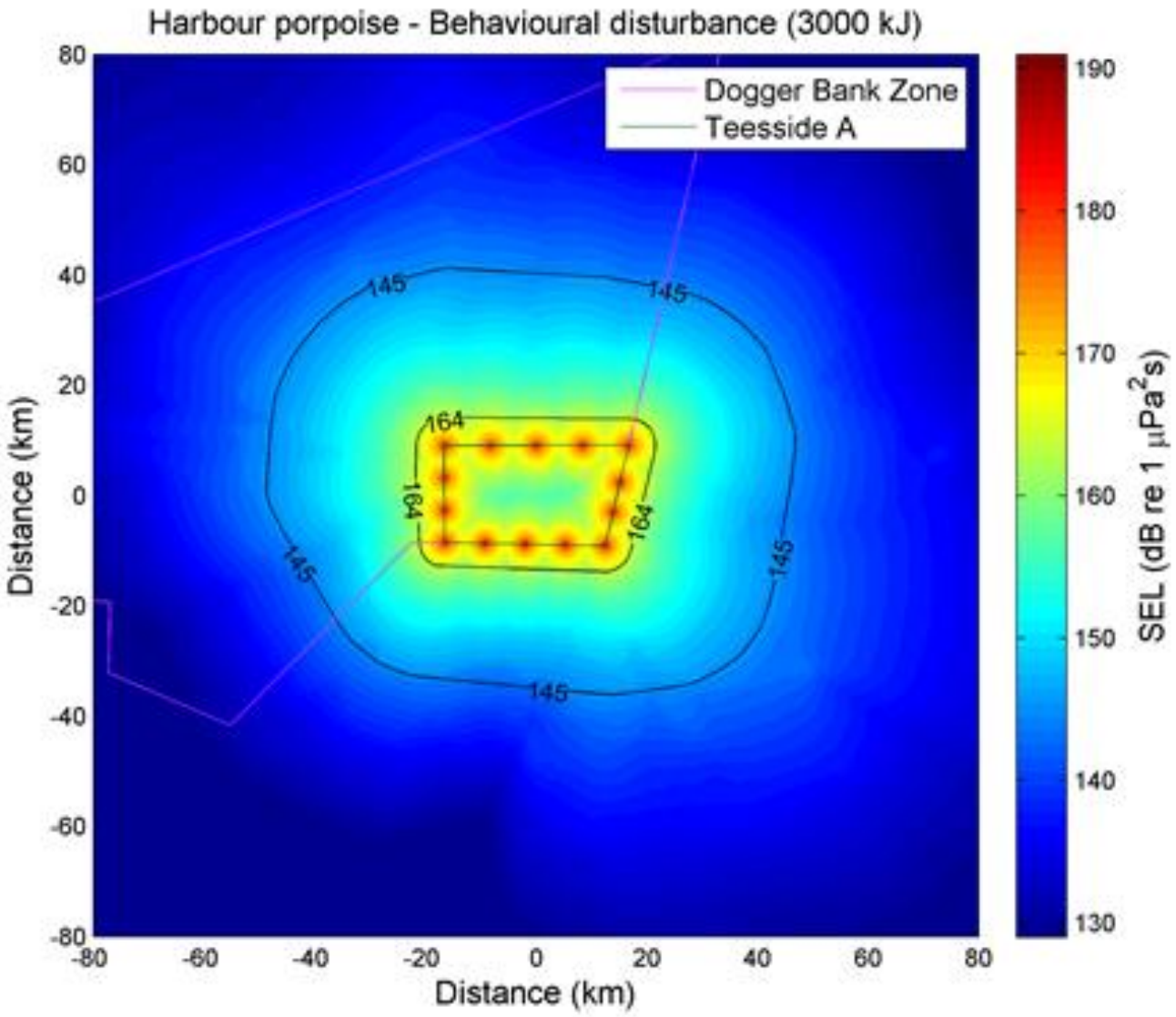



Figure 5.32 Harbour porpoise behavioural disturbance footprint contours resulting from multiple (concurrent) pile driving events at Dogger Bank Teesside A assuming 3,000kJ hammer blow energy (Key: SEL 164dB re 1 µPa$^2$/s represents the zone of TTS or fleeing response and SEL 145dB re 1 µPa$^2$/s represents the zone of possible avoidance; note that zone of PTS is not shown as it is so small)

5.16.30 Although the spatial extent of the noise footprint presented in **Table 5.19** would represent an area greater than that over which individuals potentially would be displaced at any one time, and some of the pile driving is likely to have a maximum blow force of 1900kJ not 3000kJ, this approach provides a spatial worst case for disturbance over the duration of the pile driving programme.

5.16.31 The quantities presented in **Table 5.19** assume that there is 100% response from all individuals within the likely avoidance area, which is considered to be reasonable. However, possible avoidance has also been assumed to be 100%, which is likely to overstate the number of displaced individuals. In the consideration of possible avoidance, the multiple pulses severity scaling score 5/6 was adopted from Southall *et al.* (2007). It is referred to as (possible) avoidance behaviour, because some avoidance response may occur with

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possible inter-individual variation. It may be reasonable to assume that avoidance of the area may occur for only a proportion of the harbour porpoise, with a dose response curve reflecting harbour porpoise closer to the noise source, who receive a higher dose exhibiting a more marked response. Therefore, the numbers potentially affected by possible avoidance may not be affected.

5.16.32 It should also be noted that, by assuming as a worst case that 100% of individuals within the possible avoidance zone respond, the potential for individuals beyond this zone to also respond is accounted for. Assuming a dose response relationship, the potential for some form of behavioural displacement would extend beyond the possible avoidance contour, until the range where the noise stimulus is no longer perceived.

5.16.33 The quantities in **Table 5.19** of the spatial extent and numbers of harbour porpoise showing a behavioural response is the worst case, with a maximum duration of 4,858 hours of pile driving (assuming 200 6MW turbines each with four pin piles) for Dogger Bank Teesside A and Dogger Bank Teesside B, and a total of 9,716 hours for Dogger Bank Teesside A & B, for a construction period of 3 years. This represents pile driving for approximately 18.5% of this duration for Dogger Bank Teesside A and Dogger Bank Teesside B, or 37.0% of the time for Dogger Bank Teesside A & B. However, if the construction phase was six years, the pile driving duration would reduce to 9.2% of the time for Dogger Bank Teesside A and Dogger Bank Teesside B, or 18.4% of the time for Dogger Bank Teesside A & B. In addition, the proportion of time spent pile driving would be considerably reduced if 120 x 10MW turbines were installed using single monopole foundations, to around 5.0% of the overall construction period over a 3 year construction programme for Dogger Bank Teesside A and Dogger Bank Teesside B or 10.0% for Dogger Bank Teesside A & B, or 2.5% of the time over a six year construction programme for Dogger Bank Teesside A and Dogger Bank Teesside B or 5.0% for Dogger Bank Teesside A & B.

5.16.34 The magnitude of the behavioural disturbance effects on harbour porpoise presented in **Table 5.19** does not necessarily result in a direct or indirect effect at the population level of harbour porpoise, but effectively represents the presumed individual response. There is an absence of empirical data to demonstrate the individual consequences of behavioural disturbance, or TTS expressed as likely avoidance or possible avoidance. It is possible that harbour porpoise could be exposed to an increased risk of mortality from prolonged exposure to a behavioural disturbance which impairs their ability to feed, but again no empirical data exist to draw such conclusions. In addition, given the mobility and spatial range of harbour porpoise, the link between temporary and short-term disturbance (e.g. the three to six years of construction) and mortality is not defined by empirical evidence. Making any definitive conclusions on the translation of disturbance related impacts to individuals through to the population level is therefore difficult.

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5.16.35 The nearest approximation is the use of by-catch limits to determine the potential thresholds whereby significant effects on the North Sea harbour porpoise may begin to be evident. Modelling undertaken to determine fisheries by-catch limits for harbour porpoise carried out following the SCANS II survey (SCANS-II 2008) could be used to put the magnitude in context. Although the individual impact of TTS on a harbour porpoise would not result in immediate mortality as by-catch would, it is useful to consider the number of porpoise that would need to be affected (i.e. in this example, as by-catch) in order for a potential population level effect to be reached.

5.16.36 The conservation objective determined by SCANS II with respect to by-catch was "*On average (i.e. 50% of the time) to allow populations to recover to and/or maintain 80% of carrying capacity in the long term (assumed to be 200 years)*" (SCANS-II 2008).

5.16.37 The modelling followed two management approaches; Procedure A was based on the principal of Potential Biological Removal (PBR) and Procedure B based on the IWCs Catch Limit Algorithm (CLA). The key differences were that Procedure A used a single, current estimate of absolute population size, and Procedure B used a time-series of estimates of absolute population size and by-catch. Management Procedure B was considered the most appropriate for harbour porpoise in the North Sea by a joint IWC/ASCOBANS working group. The modelling was carried out for each of the SCANS-II survey blocks.

5.16.38 The results of the modelling suggest that across a range of precautionary levels that between 581 and 2,942 harbour porpoise (between 0.251% and 1.273% of the population) could be by-caught across the Central, Northern and Southern North Sea combined, whilst still achieving the conservation objectives (SCANS-II 2008) described above. Within the SCANS–II survey blocks, the central North Sea showed the lowest capacity to accommodate the take with annual levels of between 90 and 456 (between 0.12% and 0.62% of the population), and the southern North Sea had the greatest capacity to accommodate the take with annual levels of between 420 and 2,124 (between 0.31% and 1.58% of the population (SCANS-II 2008).

5.16.39 The concurrent construction of Dogger Bank Teesside A and Dogger Bank Teesside B could disturb an estimated 1,336 harbour porpoise or 1,494 harbour porpoise and potential harbour porpoise as a result of the impact of TTS, or a behavioural response of 'likely' avoidance, (see **Table 5.19**). If 50% to 75% of the individuals exposed to the noise threshold that could result in 'possible' avoidance were to flee the area (see **Table 5.19** for 100% values), then between 2,840 and 4,259 harbour porpoise or between 3,175 and 4,762 harbour porpoise and potential harbour porpoise could be displaced in the worst case.

5.16.40 The sequential construction of Dogger Bank Teesside A and Dogger Bank Teesside B could disturb an estimated 1,353 harbour porpoise or 1,513 harbour porpoise and potential harbour porpoise as a result of the impact of TTS, or a behavioural response of 'likely' avoidance, (see **Table 5.19**). If 50% to 75% of the individuals exposed to the noise threshold that could result in 'possible' avoidance were to flee the area (see **Table 5.19** for 100% values), then

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between 3,682 and 5,523 harbour porpoise or between 4,117 and 6,175 harbour porpoise and potential harbour porpoise could be displaced in the worst case.

5.16.41 The by-catch modelling suggests between 581 and 2,942 harbour porpoise could be removed from the North Sea population, prior to a significant impact occurring. However, the harbour porpoise numbers considered here relate to those affected by displacement, and, as such, mortality would not be expected. By comparison, to exceed the maximum number of individuals suffering mortality identified in the by-catch modelling, and for which a population level impact may occur, mortality of displaced individuals would have to be greater than 69%of the total number of harbour porpoise or 62% of the total number of harbour porpoise and potential harbour porpoise predicted to be affected by disturbance during the concurrent construction of Dogger Bank Teesside A and Dogger Bank Teesside B. For disturbance as a result of sequential construction, mortality of displaced individuals would have to be greater than 53%of the total number of harbour porpoise or 48% of the total number of harbour porpoise and potential harbour porpoise predicted to be affected by disturbance.

5.16.42 Based on the likely consequences of avoidance and displacement (e.g. changes in prey availability) and the duration of the actual source effect (considering the worst case scenario duration), and given the available feeding area within the harbour porpoise range (and the area over which potential exclusion would occur due to Dogger Bank Teesside A & B's piling activities for the construction phase), it is considered highly unlikely that the levels of mortality (see paragraphs 5.16.40 and 5.16.41 above) at or above 48% could arise. Consequently, a mortality rate that is likely to be significant at the population level, and which would exceed the by-catch objectives, is not predicted for the duration of the construction phase.

## Behavioural change due to vessel noise

5.16.43 Details of increased vessel movements during construction are described in paragraph 5.6.27 and **Table 2.2**. Overall, given the existing levels of vessel traffic (see paragraphs 5.5.32 and 5.5.33), it is not expected that the presence and movement of vessels would significantly increase underwater noise levels above that of the baseline. Whilst some data support the probability that small cetaceans avoid areas of intense boat activity (Thomsen *et al*. 2006) given the density of harbour porpoise in the area, it is likely that they are to some extent habituated to vessel movements. Furthermore, studies indicate that noise levels from large surface vessels are unlikely to cause physiological damage (Malme *et al.* 1989; Richardson *et al*. 1995) to harbour porpoise.

5.16.44 Whilst some localised disturbance may arise, it should be noted that vessel movements are largely expected to be to and from the areas of greatest disturbance (i.e. piling works) as described previously, and as shown on **Figure 5.28** and **Figure 5.29** the highest densities of harbour porpoise are outside of the likely avoidance areas. This has the potential to increase the amount of noise in Dogger Bank Teesside A and Dogger Bank Teesside B, although due to the size of the zones of possible avoidance by harbour porpoise due to pile driving, it is unlikely that a large number of new individuals would be

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exposed to noise disturbance. It should be noted that in the footprint approach to the assessment of underwater noise from pile driving, impacts are considered across the whole project area. As such, the number of individuals displaced due to pile driving and vessel noise combined should not be greater than that described in the assessment of disturbance from pile driving noise described above.

5.16.45 Consequently, it is predicted that a measurable behavioural response to vessel movements and associated underwater noise would not arise for harbour porpoise either from the construction of Dogger Bank Teesside A or Dogger Bank Teesside B alone or combined (Dogger Bank Teesside A & B).

### Physical damage as a result of vessel collisions

5.16.46 The construction phase would use mostly large (>100m) vessels, which are likely to travel at slow speeds of around 10 knots or less; whilst only small workboats and crew transfer vessels (~25m) are likely to operate at greater speed. Given that harbour porpoise would be able to detect such vessels and are likely to avoid them, it is considered unlikely that healthy harbour porpoise would be impacted by vessel collisions during construction.

## 5.17 Assessment of impacts during the operation phase - harbour porpoise

### Introduction

5.17.1 This section identifies and assesses the impacts that are predicted to occur during the operation phase for Dogger Bank Teesside A & B (including the Dogger Bank Teesside A & B Export Cable Corridor) that have potential implications for harbour porpoise. The impacts have been aggregated as follows:

- Changes in harbour porpoise prey species (fish) distribution, abundance or quality arising from increased suspended sediment concentrations in the water column and re-deposition of sediment from the water column due to the presence of foundations and the placement of jack-up vessel legs during maintenance activities;
- Indirect physical damage to harbour porpoise as a result of behavioural changes arising from the increase in underwater noise levels due to the operation of the wind turbines;
- Direct physical damage (mortality) to harbour porpoise population as a result of collisions with maintenance (operation phase) vessels;
- Indirect physical damage to harbour porpoise as a result of behavioural changes arising from the presence of electromagnetic fields from underwater electrical cables; and
- Indirect physical damage to harbour porpoise as a result of behavioural changes arising from the presence of structures resulting in a barrier effect.

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## Changes to prey species abundance and distribution and implications for harbour porpoise populations

5.17.2 The impact of operation of the proposed development on fish abundance is described in detail in Sections 7.2, 7.3, 7.4, 7.5, and 7.6 of **Chapter 13** of the Dogger Bank Teesside A & B ES, and summarised in paragraph 5.7.2. Evidence from monitoring suggests that prey species abundance is not negatively affected within wind farms (e.g. Horns Rev 1 (DTU Aqua 2011)). Consequently, no adverse change in the prey resource available to harbour porpoise within the development area is predicted.

## Behavioural change due to underwater noise

5.17.3 Underwater noise levels generated during the operation of wind turbines are much lower than the noise levels generated during construction. The noise level generated by wind turbines during the operation phase is likely to be detectable only at short distances, though it has been suggested that harbour porpoise may respond to noise from operational wind turbines up to a few hundred metres away (Tougaard *et al*. 2009; McConnell *et al*. 2012).

5.17.4 A recent study has reported attraction of harbour porpoise to an operational Dutch wind farm site, where abundance was higher within the wind farm compared to a similar environment in near-by areas (Scheidat *et al*. 2011). This was assumed to be due to decreased fishing and vessel activity and increased food availability within the wind farm (Scheidat *et al*. 2011).

5.17.5 Operational monitoring at the Horns Rev and Nysted wind farms in Denmark between 1999 and 2006 indicated that numbers of harbour porpoise within Horns Rev were thought to be slightly reduced compared to the wider area during the first two years of operation (Diederichs *et al*. 2008); though it was not possible to conclude that the wind farm was solely responsible for this observed change (Tougaard *et al*. 2009). However, later studies (Diederichs *et al.* 2008) recorded no noteworthy effect on the abundance of harbour porpoise at varying wind velocities at both of the offshore wind farms, following two years of operation.

5.17.6 Even though reports indicate a low probability of an impact on harbour porpoise, modelling has been undertaken using the best available data for the minimum wind turbine spacing of 750m based on a section of the project (15 wind turbines) for 1.5MW devices (detailed in Section 6.2 in **Appendix 5A** of the Dogger Bank Teesside A & B ES), as this is considered to represent the worst case for operational noise from turbines (see **Table 2.2**). Modelling wind turbines of this size (although they are not considered for this development) makes use of the best available data. The model uses the broadband level, unless larger wind turbines are substantially louder it would not necessarily change the outcome of the modelling (it may not be the case that bigger is necessarily louder). The results of noise modelling for turbine noise are presented in **Figure 5.33** for Dogger Bank Teesside A and Dogger Bank Teesside B where turbines would be nearer together, and are considered to be representative across Dogger Bank Teesside A & B.

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5.17.7 Overall, given that the levels of underwater noise during the operation phase (no more than 135dB re 1µPa$^2$/s as shown on **Figure 5.33**) fall below any of the PTS and TTS thresholds (including possible avoidance threshold) identified in **Table 5.7**, there is no indication that anything other than a localised behavioural response, similar to that reported in Tougaard *et al. (*2009) and McConnell *et al.* (2012) would occur. On the basis of this modelling work and evidence from the studies described above, it is considered unlikely that underwater noise levels during the operation phase would adversely affect harbour porpoise behaviour such that a significant impact on the North Sea population would result.

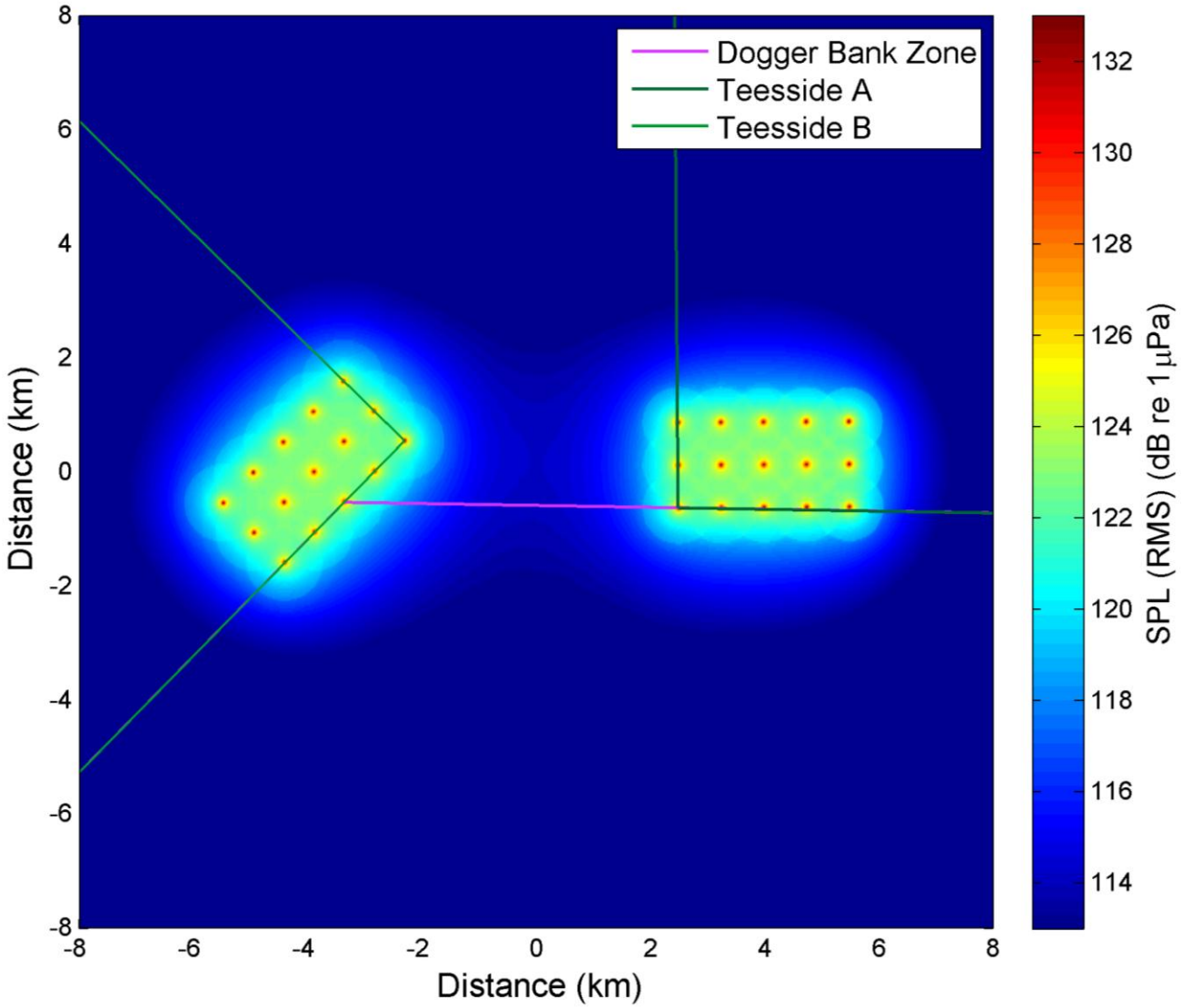



Figure 5.33 Modelled noise map for operational noise (750m turbine spacing) at Dogger Bank Teesside A

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## Behavioural change due to vessel noise

5.17.8 During the operation phase of Dogger Bank Teesside A & B the amount of vessel traffic attending to and related to the wind farm would be significantly lower than during construction (see **Table 2.2**). Vessels would be required for wind turbine and cable maintenance, with a maximum of 28 vessels on site at any one time, and up to 730 vessel movements (round trips to port) per year predicted as a worst case (see **Table 2.2**) for Dogger Bank Teesside A or Dogger Bank Teesside B alone. It is not expected that the presence and movement of maintenance vessels would significantly increase underwater noise levels above that of the baseline. Whilst some localised disturbance may arise, given the relatively low increase in comparison to the baseline levels and the habituation of harbour porpoise (and their ability to avoid vessels) as noted in paragraphs 5.16.43 and 5.16.44, it is predicted that a measurable behavioural response would not arise and no measurable impact on the harbour porpoise population is, therefore, predicted.

## Physical damage as a result of vessel collisions

5.17.9 For the reasons described and assessed in paragraph 5.16.46 and given the lower numbers of vessels predicted to be present or travelling to and from Dogger Bank Teesside A & B during the operation phase (see **Table 2.2**), a negligible risk of collision and impact is predicted. Consequently, no measurable impact is predicted on mortality or subsequently on the North Sea harbour porpoise population.

## Electromagnetic fields

5.17.10 There may be potential for marine mammals to exhibit behavioural changes including displacement due to the presence of electromagnetic fields (EMF) around inter-array cables (Gill *et al*. 2005). There is currently limited information on this effect but it is widely believed that marine mammals use the geomagnetic field of the earth to navigate during long distance migrations (Kirschvink *et al*. 1986; Klinowska 1985)

5.17.11 Although it is assumed that harbour porpoise are capable of detecting small differences in magnetic field strength, this is unproven and is based on circumstantial information. There is also, at present, no evidence to suggest that existing subsea cables have influenced cetacean movements. Harbour porpoise move in and out of the Baltic Sea, with several crossings over operating subsea high voltage direct current cables in the Skagerrak and western Baltic Sea without any apparent effect on their migration pattern.

5.17.12 The export, inter-array and inter-platform cables (see **Table 2.2** for details) would be shielded to meet industry standards, buried or, if burial is not possible, protected by other methods such as mattressing or rock armour. Given the above evidence, and given that the strength of the EMF reduces with distance from the cable (Normandeau Associates 2011) and with burial or shielding the EMF levels emitting into the water column are likely to be of negligible, no measurable impact is predicted on the movement (for foraging or migration) of harbour porpoise and, therefore, no impact is predicted on the North Sea harbour porpoise population.

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### Physical barrier to harbour porpoise movements

5.17.13 The presence of a wind farm could be seen as having the potential to create a physical barrier, preventing movement or migration of harbour porpoise between or to feeding and / or breeding areas. Evidence from the Egmond aan Zee offshore wind farm (Lindeboom *et al.* 2011) suggests that marine mammals (including harbour porpoise) may be attracted to the site for foraging and, given their limited response to noise from turbines (see paragraph 5.17.7), no population level impact is predicted on the North Sea population of harbour porpoise.

## 5.18 Assessment of impacts during the decommissioning phase - harbour porpoise

### Introduction

5.18.1 This section identifies and assesses the impacts that are predicted to occur during the decommissioning phase for Dogger Bank Teesside A & B (including the Dogger Bank Teesside A & B Export Cable Corridor) that have potential implications for harbour porpoise. The potential impacts have been aggregated as follows:

- Changes in harbour porpoise prey species (fish) distribution, abundance or quality arising from increased suspended sediment concentrations in the water column and re-deposition of sediment from the water column due to the placement of jack-up vessel legs and removal of structures;
- Direct physical damage (mortality) to the harbour porpoise population as a result of underwater noise due to pile cutting and vessel movements; and
- Direct physical damage (mortality) to harbour porpoise population as a result of collisions with decommissioning vessels.

### Changes to prey species abundance and distribution and implications for harbour porpoise populations

5.18.2 Negligible and temporary disturbance to the seabed would occur during decommissioning, with predicted lower levels of underwater noise, seabed disturbance, increased suspended sediment concentrations, and sediment deposition than during construction. Given that a negligible impact on prey species (as identified in paragraphs 5.16.2 to 5.16.4) for the construction phase has been determined, then a similar, if not lesser, impact would be expected during decommissioning. Taken together with the low sensitivity of harbour porpoise to minor changes in prey species abundance, no measurable impact on the harbour porpoise population is predicted as a result of the decommissioning of Dogger Bank Teesside A & B.

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## Behavioural change due to underwater noise

5.18.3 There would be no pile driving or use of explosives during decommissioning, consequently underwater noise levels generated during the cutting of piles and other localised decommissioning activities would be lower than those generated during construction (as identified in paragraphs 5.16.5 to 5.16.42). In line with the methodology and approach set out for the construction period, given the significantly lower noise levels that would occur during decommissioning no auditory damage (PTS) would be expected on harbour porpoise. Similarly, the potential for any significant behavioural response (TTS) by harbour porpoise that would have implications at the population level is not predicted. Therefore, no population level effect is predicted.

5.18.4 Once decommissioning is completed, no additional noise sources would be present or emanate from within Dogger Bank Teesside A & B.

## Behavioural change due to vessel noise

5.18.5 Whilst detail on the number and type of vessels that would be required during decommissioning is not available at this stage, it is expected that vessel numbers and subsequent noise effects would be similar to those during the construction phase. Consequently, no measurable behavioural effect is predicted (as described in paragraphs 5.16.43 to 5.16.45) for the duration of decommissioning, and no measurable impact on the North Sea harbour porpoise population is predicted.

5.18.6 Once decommissioning is completed, no additional vessel noise sources would be present or emanate from within Dogger Bank Teesside A & B.

## Physical damage as a result of vessel collisions

5.18.7 Whilst detail on the number and type of vessels required during decommissioning is not available at this stage, as stated above, it is expected that vessel numbers and subsequent potential for physical damage to harbour porpoise as a result of hull impacts would be similar to those during the construction phase. Consequently, no measurable impact is predicted on the North Sea harbour porpoise population (as described in paragraph 5.16.46) for the duration of decommissioning.

5.18.8 Once decommissioning is completed, no additional vessel movements would occur within or between the coast and Dogger Bank Teesside A & B.

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## 5.19 Avoidance / mitigation measures

5.19.1 Following JNCC Guidelines (JNCC 2010), the avoidance of potential harm to grey seals and harbour porpoise (as well as other marine mammals) during pile driving events would be achieved through the application of an effective zone of exclusion of up to 500m around the location of the pile driving. Moreover, the potential exists that marine mammals (grey seal and harbour porpoise) could be excluded from ranges greater than this (ranging between 700m and 1000m), as the use of alternate mitigation measures are being investigated through initiatives such as the Offshore Renewable Joint Industry Programme (ORJIP). Furthermore, the provision of a Marine Mammal Observer and/or Passive Acoustic Monitoring (PAM) and/or Acoustic Deterrent Device (ADDs) is expected to be part of the licensing requirement following JNCC guidelines. The final approach to be taken for Dogger Bank Teesside A & B will be determined during the design and implementation of a project-specific Marine Mammal Mitigation Protocol (MMMP).

5.19.2 For harbour porpoise, the maximum range for instantaneous injury is up to 700m from a single pile driving event (at 3,000kJ max blow force). This is beyond the zone of potential mitigation. Reduction in the impacted area due to the exclusion zone (out to 500m) would further reduce the likelihood of PTS occurring as a result of instantaneous injury. The impacted area (between 500m and 700m) would be reduced to 0.8km$^2$, reducing the potential number of porpoise that could experience noise above thresholds that cause PTS to 0.48, based on average densities for porpoise, or 0.54 for average densities for harbour porpoise and potential harbour porpoise combined for Dogger Bank Teesside A and Dogger Bank Teesside B, based on the assumption that there are no individuals within the exclusion zone. However, this residual impact is also based on the simplistic approach that harbour porpoise do not flee the area and the maximum hammer energy is used with no soft-start.

5.19.3 In the case of PTS from instantaneous injury, the soft-start acts as mitigation, allowing harbour porpoise to flee the area before they are exposed to noise thresholds that can lead to PTS. If harbour porpoise flee the noise source at 1.5m/s once pile driving commences, then they would be more than the required 600m (in the case of 2,300kJ) or 700m (in the case of 3,000kJ hammer) away from the noise source before these hammer energies are reached (**Table 5.16**).

## 5.20 Summary of assessment findings and conclusions on site integrity of transboundary sites in relation to harbour porpoise feature

5.20.1 The assessment shows that only a small percentage of the harbour porpoise population for the North Sea would be affected during the construction (see Section 5.16), operation (see Section 5.17) and decommissioning (see Section 5.18) of Dogger Bank Teesside A & B (concurrent or sequential) in the worst case scenario or for any other scenario (i.e. Dogger Bank Teesside A or Dogger Bank Teesside B alone).

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## Construction phase

5.20.2 During construction, no measurable effects on harbour porpoise are expected to arise from alteration of prey species abundance. Given the mitigation measures to be implemented (see Section 5.19), similarly, no instantaneous injury is predicted for harbour porpoise populations. The key potential impact during construction is TTS (fleeing response and avoidance) arising from underwater noise from piling and, to a significantly lesser extent, vessel movements. Based on the worst case scenario, the total area of likely avoidance and possible avoidance of the construction area for Dogger Bank Teesside A & B by harbour porpoise is predicted to affect a maximum of 3.62% of the harbour porpoise and potential harbour porpoise population within the North Sea (see **Table 5.19**) based on the sequential construction scenario. Given their mobility, and the wide range of prey species that are taken, it is considered that displacement, even if it were to occur at the maximum predicted level, would not result in any significant mortality. Based on a comparison with mortality arising from fisheries by-catch it is calculated that a mortality rate exceeding 48% of displaced individuals would need to be achieved in order for a significant impact at the population level to arise. It is considered highly unlikely that such a level of mortality would occur given the temporary nature of the effect and the habitat flexibility exhibited by harbour porpoise. No significant impact is therefore predicted on the harbour porpoise population as a result of the construction phase for Dogger Bank Teesside A & B (or its individual projects). Consequently, the achievement of favourable condition with respect to the conservation objectives related to the harbour porpoise feature of the transboundary European sites (SCIs and pSCIs) would not be affected.

5.20.3 Overall, it is concluded that there would not be an adverse effect on the integrity of the transboundary European sites (SCIs and pSCIs) listed in **Table 5.1** as a result of the construction of Dogger Bank Teesside A & B (assuming the worst case scenario) or, therefore, for any other scenario (i.e. Dogger Bank Teesside A or Dogger Bank Teesside B alone).

## Operation phase

5.20.4 During the operation phase, no measurable effects on harbour porpoise are expected to arise from alteration of prey species abundance, barrier effect, electromagnetic fields, or vessel collisions. Disturbance effects (e.g. from underwater noise from turbines or maintenance vessels) that could give rise to significant impacts on harbour porpoise populations would not be expected. Studies (see paragraphs 5.17.5 and 5.17.7) indicate that there is no evidence of a reduction in harbour porpoise use of existing wind farms, and potentially indicate there may even be an increase in numbers within wind farms. Modelling for Dogger Bank Teesside A & B (see paragraph 5.17.6) indicates that noise from wind turbines would not be significant and would not be expected to result in an avoidance response. As such it is concluded that the operation phase for Dogger Bank Teesside A & B (or its individual projects) would not affect the achievement of favourable condition with respect to the conservation objectives related to the harbour porpoise feature of the transboundary European sites (SCIs and pSCIs).

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5.20.5 Overall, it is concluded that there would not be an adverse effect on the integrity of the transboundary European sites (SCIs and pSCIs) listed in **Table 5.1** as a result of the operation of Dogger Bank Teesside A & B (assuming the worst case scenario) or, therefore, for any other scenario (i.e. Dogger Bank Teesside A or Dogger Bank Teesside B alone).

## Decommissioning phase

5.20.6 Given that the effects of the decommissioning phase are likely to be the same, albeit smaller in magnitude and intensity, to those described and assessed for the construction phase (see paragraph 5.20.2), and given that all effects would be temporary, it is concluded that there would not be an adverse effect on the integrity of the transboundary European sites (SCIs and pSCIs) listed in **Table 5.1** as a result of the decommissioning of Dogger Bank Teesside A & B in the worst case scenario, or therefore for any other scenario (i.e. Dogger Bank Teesside A or Dogger Bank Teesside B alone).

## Conclusion

5.20.7 Given the above, it is therefore concluded that there would not be an adverse effect on the integrity of the transboundary European sites (SCIs and pSCIs) listed in **Table 5.1** as a result of the construction, operation, and decommissioning of Dogger Bank Teesside A & B in the worst case scenario, or therefore for any other scenario (i.e. Dogger Bank Teesside A or Dogger Bank Teesside B alone) with regard to their harbour porpoise feature and population.

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# 6 Birds Directive Sites (SPAs) Assessment

## 6.1 Introduction

6.1.1 This section of the information for appropriate assessment report provides an analysis of the potential effects of Dogger Bank Teesside A & B on those SPAs and designated bird populations screened into this stage of the assessment process.

6.1.2 Survey data and previous studies show that the Dogger Bank Zone may, at times, support nationally and internationally important numbers of seabirds. Potentially, the Dogger Bank Zone is also on the flyway of a large number of migratory birds moving to and from breeding and wintering grounds. As such, wind farm development within the Dogger Bank Zone may have implications for a large number of designated SPAs and Ramsar sites around the North Sea and potentially further afield.

6.1.3 The screening exercise identified, on the basis of available data, that a likely significant effect with respect to the following groupings of designated sites and species populations could not be discounted as a result of the effects of the proposed Dogger Bank Teesside A & B development:

- SPAs and Ramsar sites designated for breeding seabird populations around the North Sea for the following species: northern fulmar, northern gannet, great skua, Arctic skua, black-legged kittiwake, lesser black-backed gull, great black-backed gull, herring gull, common guillemot, razorbill, and Atlantic puffin. Foraging ranges can be used to determine the sites from which birds observed during the breeding season may derive (see paragraph 6.3.10). However, seabirds present within Dogger Bank Teesside A & B at other times of the year (e.g. wintering / passage) could also derive from these breeding sites and, therefore, it is not possible to specifically eliminate sites from the assessment process solely on the use of foraging range;
- SPAs and Ramsar sites designated for wintering / passage seabird populations for the species listed above, and little gull; and
- SPAs and Ramsar sites that support designated populations of migratory species (including species that may form part of internationally important assemblages of waterbirds) that could, on migration, pass through Dogger Bank Teesside A & B.

6.1.4 The full list of the SPAs and Ramsar sites, together with the designated populations for which a potential LSE has been determined is provided in Section 3 of this report.

6.1.5 The following sections provide further analysis and assessment in respect of both the determination of LSE and the potential for an adverse effect on the integrity of the sites screened in and species populations for which the sites have been designated. The reporting is structured so as to provide assessment

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of the key effects on each of the groupings of birds listed above (e.g. seabirds, migrants), which are then considered in light of their potential implications for the stated conservation objectives applicable to the designated SPAs / Ramsar sites. A description of the baseline data and the methodologies utilised in the assessment process is also provided in order to enable understanding of potential uncertainties and assumptions inherent to the analysis and its outcomes. Much of the assessment presented here is based upon the work presented in the Ornithology Technical Report in **Appendix 11A** of the Dogger Bank Teesside A & B ES; and the reader is referred to this document for further detail in respect of much of the raw data and analytical process.

## 6.2 Data collection and analysis

### Offshore Zone

#### Boat-based surveys

6.2.1 The Dogger Bank Zone was split into a transect area comprising 21 primary lines located 8km apart, and 20 secondary lines, also located 8km apart but placed equidistant between the primary transects in order to create a mesh of transects 4km apart (see **Appendix 11A** of the Dogger Bank Teesside A & B ES).

6.2.2 Monthly boat based surveys within the Dogger Bank Zone have been undertaken by Gardline Environmental Ltd. during the period 2010-2012, with data for this assessment spanning the period between January 2010 and June 2012. Almost 2,500 hours of survey data has been amassed during this period, spanning a total distance of 42,000km (see Table 2.1 in **Appendix 11A** of the Dogger Bank Teesside A & B ES). These surveys followed a modified methodology to that detailed in Camphuysen *et al*. (2004).

6.2.3 Data was collected from the front bridge of the survey vessel in daylight hours at a speed of 10 knots, traversing the straight line transects across the site, as described in Section 2.1 in **Appendix 11A** of the Dogger Bank Teesside A & B ES, using three observers (two observing and one resting at any one time); the full methodology is described in Section 2.1 in **Appendix 11A** of the Dogger Bank Teesside A & B ES. All height recordings were given confidence levels to denote the reduction in accuracy with recording distance (V=Very High confidence, H=High, M=Moderate, L=Low, N=No confidence).

#### Aerial surveys

6.2.4 Aerial surveys have been conducted over the Dogger Bank Zone by Hi-Def Surveying Ltd., commencing in spring 2010 and continuing through into 2012 (see Table 2.2 in **Appendix 11A** of the Dogger Bank Teesside A & B ES). Survey transects were 300m wide and aligned north-south, and were 1.4km apart. The survey was designed that two aircraft could fly in the zone without risk of collision, and in order to improve the ground resolution and consequently identification rates. During the surveys, the survey planes flew at a height of 600m/2000ft, recording High Definition (HD) video that were subsequently analysed by the survey company which would identify any objects on the video. The results of this stage were then passed on to ornithologists at the Wildfowl &

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Wetlands Trust (WWT) consulting for identification to species level. Quality checks were also conducted; for full details of the methodology see Section 2.2 in **Appendix 11A** of the Dogger Bank Teesside A & B ES. Identification to a species level was undertaken wherever possible, but when this was not possible, sightings were assigned to 14 species groups, including:

- auk species;
- big bird;
- black-backed gull species;
- tern species;
- diver species;
- fulmar/gull species;
- grey gull species;
- gull species;
- large gull species;
- large wader species;
- shearwater/auk species;
- skua species; and
- small gull species.

## Export cable corridor

6.2.5 The proposed export cable corridor from Dogger Bank Teesside A & B to the landfall location is shown in **Figure 1.1**. In total, the Dogger Bank Teesside A & B Export Cable Corridor covers an area of 233km$^2$ with an average width of 1.5km. However, the cables themselves are only likely to cover a small proportion of this area.

6.2.6 Due to the narrow width of the Dogger Bank Teesside A & B Export Cable Corridor, and the small proportion of the area taken up by the cables, detailed surveys of the ornithological features of the area were not undertaken. Instead, a desk based review of data was undertaken to determine the potential densities of different bird species that could be exposed to the effects of activities within the Dogger Bank Teesside A & B Export Cable Corridor.

6.2.7 Data were obtained from three sources. The ESAS database summarises data collected from boat and aerial surveys in the North Sea between 1979 and 2002. Data from the JNCC Seabird Monitoring Programme Online Database (JNCC 2012b) were used to determine the size of breeding seabird populations at nearby colonies. Finally, to provide further information of seabird activity within the area of the landfall, data were also obtained from recent county bird reports for Cleveland (Teessmouth Bird Club 2011).

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## Intertidal zone at the Dogger Bank Teesside A & B Export Cable landfall

6.2.8 In general the intertidal area in the vicinity of the cable corridor landfall is characterised as being predominantly coarse sand and gravel at the high shore which transitions into finer sand at the low shore with small amounts of gravel and shell fragments. In most areas there is a distinct strandline clearly marked by deposition of seaweed and debris which supports sand hoppers. In the upper regions of the intertidal zone, there were localised areas of high abundance of bristle worm (*Scolelelpsis scolelelpsis* / *Scolelelpsis squamata*). Further down shore, the amphipods *Pontocrates arenarius* and *Bathyporeia pelagica* were also relatively abundant in localised areas. The macro algae Enteromorpha spp. also occurs sporadically on the low shore. More details can be found in the intertidal landfall study report (see **Appendix 12C** of the Dogger Bank Teesside A & B ES).

6.2.9 The landward edge of the landfall at its northern end is immediately adjacent to some small cliffs (approximately 6m in height) covered in maritime grasses. In addition cobbles/boulders have been positioned by the local council at the high shore, above the strandline, as a coastal defence measure. The landward edge at the southern end tends to be characterised by a sand dune system (see **Appendix 12C** of the Dogger Bank Teesside A & B ES). Phase I habitat information (Peak Ecology 2013) indicate that further inland (<500m), the following habitats occur: coastal grassland, arable fields, amenity grassland, broad leaved woodland (semi-natural) and residential / industrial land.

6.2.10 In order to characterise the baseline ornithology of the study area, two methods of data collection were used: a desk based study and field surveys.

6.2.11 Data was obtained from the BTO Wetland Bird Survey (WeBS) and Non-estuarine Coastal Waterbird Survey (NEWS). The extent of the WeBS count sectors for which data were obtained is shown in **Figure 6.1**. NEWS is a periodic survey designed to complement WeBS coverage by focussing on open coast locations. To date surveys have been undertaken on three occasions these being the winters of 1984/85 (as the Winter Shorebird Count), 1997/98, and 2006/07. The survey is primarily designed to target waterbird species which occur in intertidal areas but records of birds which occur inland and out to sea can also be submitted. Survey areas are shown in **Figure 6.1**.

6.2.12 Field surveys were carried over the two consecutive winters of 2011/12 and 2012/13 but there were differences in survey methodologies as well as the frequency/timing of visits.

6.2.13 In the winter of 2011/12, winter bird surveys (terrestrial) and inland sea-watch surveys were carried out. Additional surveys were also carried out at a further three sites located to the west of the landfall area and an additional site to the east, although these are not considered here, as they are outside of any potential influence of the works. The wintering bird and inland sea-watch surveys were carried out on the same days and a total of eight visits were carried out between the months of November and March: 28/11/2011, 12/12/2011, 17/01/2012, 23/01/2012, 13/02/2012, 16/02/2012, 06/03/2012 and 08/03/2012. Each survey took 1.5 hours and the total visit to the site took a total of 3 hours, with all surveys completed during the period of 07:30am to 14:15pm.

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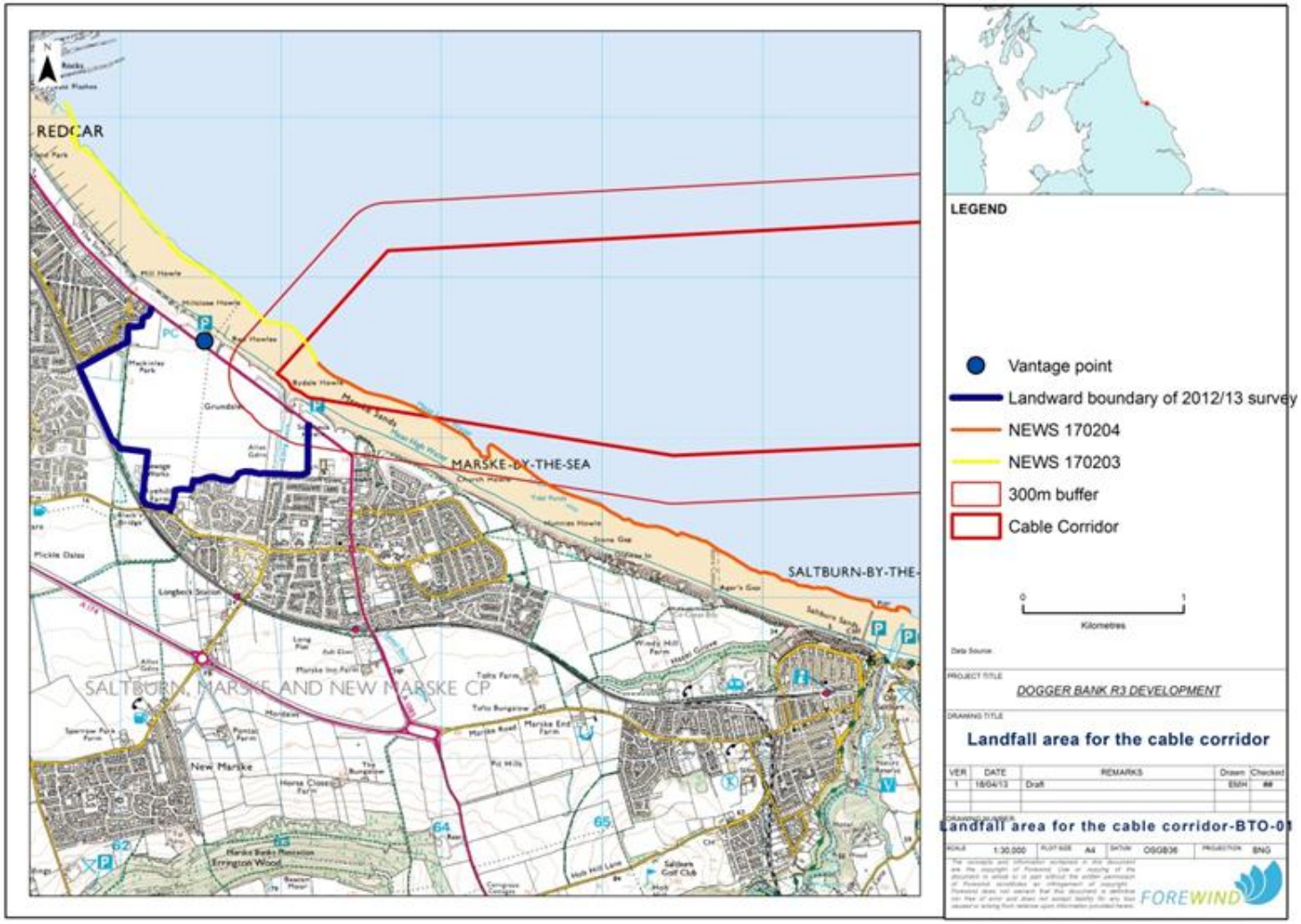



Figure 6.1 Spatial overlap between the Dogger Bank Teesside A & B Export Cable Corridor (thick red outline)/buffer (thin red outline) and the relevant bird surveys: NEWS (pink and yellow line); vantage point used during the winter bird and inland sea-watch surveys in 2011/12 and the inland sea-watch survey in 2012/13 (blue circle) and the inland extent of the winter bird surveys in the winter of 2012/13 (blue line)


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6.2.14 In the winter of 2012/13, autumn passage, wintering bird surveys and inland sea watch surveys were carried out (see **Figure 6.1**). Additional surveys were carried out for inland arable fields between the villages of Yearby and Wilton although these are not considered here. The autumn passage/winter bird surveys (depending on the time of year) were carried out on the same days as the inland sea-watch surveys and a total of fourteen visits were carried out between the months of September and February: 20/09/2012, 27/09/2012, 01/10/2012, 11/10/2012, 02/11/2012, 30/11/2012, 11/12/2012, 19/12/2012, 17/01/2013, 25/01/2013, 12/02/2013, 27/02/2013, 27/02/2013, 28/02/2013. The start time varied from 07.30 to 10.30.

6.2.15 Further details of the survey methodologies are provided in Section 2.6 of **Appendix 11A** of the Dogger Bank Teesside A & B ES.

## 6.3 Assessment approach and methodology

### Introduction

6.3.1 The following sections set out the methods used in assessing the potential effects of Dogger Bank Teesside A & B on bird populations. Specific information is provided on the assessment approach for seabirds and migrant birds in respect of development within the proposed wind farm areas and the export cable route to the landfall location.

6.3.2 The location of Dogger Bank Teesside A & B in the central North Sea, an area that is potentially used by seabirds that originate from protected sites around the North Sea and through which migrants may pass, precludes the use of a simple site-attributional model of impact. An assessment approach has therefore been developed which considers the proportion of birds potentially impacted by an effect in relation to suites of protected sites (to provide North Sea-scale context) and, where appropriate, attribution of impact at the scale of individual protected sites. Additionally, consideration is given to the nature of an effect at broader national and biogeographic scales in order to provide context and reflect the multi-point origin of birds that may use and be present in the proposed development area.

### Estimation of seabird populations

#### Model-based population estimates for the offshore zone

6.3.3 A modelling approach, which combines data collected from aerial and boat-based surveys, has been used to derive population estimates for January 2010 to June 2012 for the Dogger Bank Zone and Dogger Bank Teesside A & B. Whilst it can be assumed that 100% of birds within each transect are detected by aerial surveys (though for diving species – divers, auks – this might not always be the case and consideration of this issue is given in the assessment of impacts), identification of these birds to species level is frequently not possible. Similarly, whilst identification to species level is likely to be accurate using data collected during boat-based surveys, attraction to and disturbance by boats, as well as the time taken to complete the survey, means that the total number of birds detected may give an inaccurate picture of the number using the Dogger Bank Zone. Consequently, the data collected from aerial surveys were used to

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inform the total number of birds within the survey area, whilst data collected from the boat-based surveys was used to inform the species make-up. The full methodology for the generation of population estimates from the survey data is provided in Section 2.3 in **Appendix 11A** of the Dogger Bank Teesside A & B ES.

6.3.4 Over 130 species of bird were recorded within the Dogger Bank Zone during the boat based and aerial surveys (see Section 3 in **Appendix 11A** of the Dogger Bank Teesside A & B ES), of which over 20 are seabirds. Modelling was undertaken to determine the populations and abundance for the seabirds recorded in the aerial surveys, and of those recorded, the following occurred in sufficient numbers to enable monthly population estimates to be calculated:

- Arctic skua;
- Atlantic puffin;
- black-legged kittiwake;
- common guillemot;
- great black-backed gull;
- great skua
- lesser black-backed gull;
- little auk
- northern fulmar;
- northern gannet; and
- razorbill.

6.3.5 Monthly population estimates across the entire Dogger Bank Zone were produced for each of the above eleven species regularly recorded in the survey area. For another ten marine bird species that occurred in the Dogger Bank Zone during boat surveys in lesser numbers (common scoter, white-billed diver, sooty shearwater, European storm-petrel, pomarine skua, herring gull, black-headed gull, common gull, little gull, and Arctic tern) recorded numbers were insufficient to estimate populations following the methodology adopted for the more frequently encountered birds. In these instances, population estimates for these species were derived using monthly estimates of density calculated from the numbers seen, divided by survey effort, which was then multiplied by the size of the area to obtain a population size for the entire area. For all remaining seabirds, their presence in extremely low numbers (less than 10 in the boat surveys), precludes them from being considered further, due to their negligible usage of Dogger Bank Teesside A & B.

**Use of other data sources**

6.3.6 Prior to 1979, little was known about the offshore distribution of marine birds within the North Sea. Data collected using aerial and boat-based surveys between 1979 and 2002 has been collated to form the European Seabirds at Sea (ESAS) database. Data from this dataset were extracted for Dogger Bank Teesside A & B within GIS, as a basis for estimating population size. A subset

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of the ESAS database was used by Skov *et al.* (1995) to identify important bird areas within the North Sea, the data contributing to this analysis are also summarised. These data were also utilised by Stone *et al.* (1995) to map the distribution of seabirds in Northwest European waters.

6.3.7 There are a number of issues that must be taken into consideration when making comparisons of the population estimates derived by the baseline surveys and those based on the historical ESAS surveys:

- The baseline population estimates are based on more recent and intensive survey than those obtained from ESAS. By utilising aerial survey data, they also account for biases that result from birds being attracted to, or disturbed by, survey vessels, and may therefore offer a more realistic estimate of the number of birds present within the project area; and
- Due to the survey design for the baseline, it was possible to derive monthly population estimates. In contrast, ESAS population estimates are only available as combined monthly estimates across years or in some cases as a single estimate for the whole year. This makes it difficult to make direct comparisons of the population estimates derived by the two different sources of data.

## Apportioning of population estimates to protected sites

### Breeding seabirds

6.3.8 For breeding seabird species, information on foraging ranges (Thaxter *et al*. 2012) and data from tagging / GPS studies have been used to determine those populations from protected sites that potentially might be impacted by the effects associated with wind farm development within Dogger Bank Teesside A & B. The mean maximum foraging ranges across all studies reviewed by Thaxter *et al.* (2012) have been used (see **Table 6.1**) as a starting point for all species unless evidence from tracking studies suggests that the mean maximum value may not adequately cover the use of Dogger Bank for foraging by birds during the breeding season. This approach is in line with guidance on the use of foraging ranges presented in JNCC/Natural England (2013a).

Table 6.1 Relevant foraging ranges during the breeding season for key seabird species for the Dogger Bank Zone that occur in the North Sea during the breeding season (after Thaxter *et al*. (2012) unless stated)

| Species | Foraging range | Foraging range used in this assessment |
|---|---|---|
| Northern fulmar | Mean foraging range of 48km, a mean maximum of 400km and a maximum of 580km | Mean maximum |
| Northern gannet | Mean foraging range of 93km, a mean maximum of 230 km and a maximum of 590km | Mean maximum |
| Great skua | Mean foraging range of 87km and a maximum of 219km (for birds foraging offshore, rather than colony-based birds) | Mean |
| Arctic skua | Mean foraging range of 6km, a mean maximum of 63km and a maximum of 75km | Mean maximum |
| Black-legged kittiwake | Mean foraging range of 25km, a mean maximum of 60km and a maximum of 230km (FAME 2012) | Maximum |


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| Species | Foraging range | Foraging range used in this assessment |
|---|---|---|
| Lesser black-backed gull | Mean foraging range of 72km, a mean maximum of 140km and a maximum of 181km | Mean maximum |
| Herring gull | Mean foraging range of 11km, a mean maximum of 61km and a maximum of 92km | Mean maximum |
| Great black-backed gull | Indicative foraging range of approximately 60km | Indicative range |
| Common guillemot | Mean foraging range of 38km, a mean maximum of 84km and a maximum of 340km (FAME 2012) | Maximum |
| Razorbill | Mean foraging range of 24km, a mean maximum of 49km and a maximum of 312km (FAME 2012) | Maximum |
| Atlantic puffin | Mean foraging range of 4km, a mean maximum of 105km and a maximum of 200km | Mean maximum |

6.3.9 For three species, black-legged kittiwake, common guillemot, and razorbill, foraging ranges were taken from FAME (2012), which indicates larger maximum foraging ranges than Thaxter *et al.* (2012). This, together with the use and concentration of birds in the western part of the Dogger Bank Zone during the breeding season, suggests that birds from breeding colonies do forage at least in this area.

6.3.10 For northern gannet, more specific information is available for British, Irish and French breeding colonies (Wakefield *et al*. 2013). This indicates that northern gannets may forage in the zone from both the Flamborough and Filey Coast pSPA and Forth Islands SPA, but not from 10 other colonies considered in the Wakefield *et al*. (2013) study. Thus the Dogger Bank Zone is considered to be within foraging range of birds from these two sites, while (given the foraging range of these birds) it cannot be discounted that birds from the Seevogelschutzgebiet Helgoland SPA in Germany might also forage within the Zone. Information from birds tagged at the Farne Islands SPA also suggests that the Dogger Bank Zone is outside the foraging range of this site, as also supported by the mean foraging range for this species in Thaxter *et al*. (2012). Great black-backed gull was not reviewed by Thaxter *et al*. (2012); therefore, a separate review was conducted, giving a maximum value of 60km reported from Seys *et al*. (2001), based on density of birds from at-sea surveys. However, since this was only one study, with foraging ranges albeit unknown but potentially above this value, 60km is taken as the representative foraging range for this species.

6.3.11 On the basis of the species foraging ranges used for the assessment, protected sites (SPAs, Ramsar sites) within the wider North Sea 'region' supporting designated breeding populations with foraging ranges that overlap with Dogger Bank Teesside A & B have been identified. These sites are listed in **Table 6.2** together with the relevant breeding seabird species. For great skua, Arctic skua, lesser black-backed gull, great black-backed gull and Atlantic puffin, the mean maximum foraging ranges are all less than the distance to Dogger Bank Teesside A & B from the nearest SPA designated breeding populations. Therefore, in respect of these species, no impacts from wind farm construction and operation on designated populations during the breeding season would be expected.

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Table 6.2 SPAs designated for breeding seabirds that fall within the relevant foraging distances to Dogger Bank Teesside A & B

| Site | Northern fulmar | Northern gannet | Black-legged kittiwake | Common guillemot | Razorbill |
|---|---|---|---|---|---|
| Buchan Ness to Collieston Coast SPA | ✓ | | | ✓ | |
| Flamborough and Filey Coast pSPA | ✓ | ✓ | ✓ | ✓ | ✓ |
| Farne Islands SPA | | | ✓ | ✓ | ✓ |
| Forth Islands SPA | ✓ | ✓ | | ✓ | ✓ |
| Fowlsheugh SPA | ✓ | | | ✓ | |
| St Abb's Head to Fast Castle SPA | | | | ✓ | ✓ |
| Troup, Pennan and Lion's Heads SPA | ✓ | | | | |
| Seevogelschutzgebeit Helgoland (Germany) SPA | ✓ | ✓ | | | |

6.3.12 Appendices 1 and 2 in **Appendix 11A** of the Dogger Bank Teesside A & B ES provide information on the seabird population estimates used in the assessment process. Analyses aimed to use up-to-date population estimates for sites in order that impacts based on the population estimates produced for Dogger Bank Teesside A & B from the 2010, 2011 and 2012 survey data were appropriately apportioned. Where available, data for UK sites were taken from the JNCC Seabird Monitoring Programme Online Database (JNCC 2012b) for the most recent year between 2007 and 2011. If no data were available for UK sites from this source for these years, data were obtained from the Seabird 2000 survey (which ran from 1998-2002) and numbers adjusted using country (Scotland, England) Seabird Monitoring Programme trends to provide a value for 2011.

6.3.13 Population estimates used for the Flamborough and Filey Coast pSPA were based on data for 2007 to 2011 and follow guidance provided by Natural England (2013) (see Appendix 3 in **Appendix 11A** of the Dogger Bank Teesside A & B ES). For non-UK sites, data were taken from citation information available through Europa (2012) and Ramsar (2012). While up-to-date population estimates were used to best apportion effects, the proportion of the site population estimated to be impacted was also applied to the citation population for information.

6.3.14 Assessment has been undertaken to determine the significance of impacts upon seabird populations, across the year, both at the level of the suite of protected sites in the wider North Sea 'region' and for each individual site. For the suite of protected sites, the assessment relates the magnitude of each impact determined for the development to the combined species' population for the suite as a whole. For individual protected sites, the magnitude of each impact determined for seabirds during the breeding season is apportioned to each protected site based on population size and distance from the development area (using an inverse distance squared weighting – see paragraph 4.2.7 in **Appendix 11A** of the Dogger Bank Teesside A & B ES).

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6.3.15 It should be noted that even for those species for which Dogger Bank Teesside A and Dogger Bank Teesside B are within the foraging range of breeding colonies, a proportion of the birds present will be non-breeding / immature birds that may not originate from these sites. For gulls and northern gannet, it was possible to derive estimates of this proportion from boat-survey observations of birds in breeding and juvenile plumages. For other species, it is assumed that one third of the total number of birds (Stroud *et al*. 2004; Kober *et al*. 2010) recorded in the Dogger Bank Zone during the breeding season will be non-breeders. These non-breeding birds have been apportioned to protected sites around the North Sea in the same manner as for seabirds outwith the breeding season (see below).

6.3.16 Because a proportion of the birds present within Dogger Bank Teesside A & B during the breeding season for a species will be non-breeding / immature birds that may not originate from sites for which Dogger Bank Teesside A & B is within foraging range, a correction factor has been applied to the key seabirds. This separates the breeding and non-breeding numbers in order to apportion them to sites within the foraging range but also to the non-breeding populations of the wider suite of sites. The correction factors were determined by identifying the proportion of the national breeding populations (identified using the mean seasonal figures from Skov *et al*. (1995) or Stroud *et al*. (2001)) supported by the designated sites (SPAs) based on the UK SPA Review (Stroud *et al*. 2001). In those cases where the proportion of the Great Britain breeding population supported by SPAs is significantly less than 100%, correction factors for apportioning impacts to protected sites have been derived as follows: for great skua (73.7% of the GB population held by the Great Britain SPA suite: Stroud *et al*., 2001), black-legged kittiwake (78.1%), razorbill (76%), a correction factor of 0.80; for northern fulmar (57.3%) a correction factor of 0.60; for Arctic skua (24.4%) and great black-backed gull (32%), a correction factor of 0.40. For all other species, for which the proportion of the Great Britain breeding population supported by SPAs is close to 100%, no correction was calculated. The detailed methodology is presented in paragraph 4.3.114 in **Appendix 11A** of the Dogger Bank Teesside A & B ES. Where it was not possible to derive numbers of breeding birds from sites through identification means, one third of the total number of birds (Stroud *et al*. 2004; Kober *et al*. 2010) present during the breeding season are assumed to be non-breeders. The quantities affected at the site-level have then been related to the species' population size at the site in order to determine the magnitude of the effect.

6.3.17 As the projects are mostly only within the foraging range of protected sites in Great Britain, the apportioning correction factors derived from the values in Stroud *et al*. (2001) were applied to the impacts predicted for breeding birds (see Table 4.23 in **Appendix 11A** of the Dogger Bank Teesside A & B ES).

6.3.18 Recent tracking data for four species (northern gannet, great skua, black-legged kittiwake, and Atlantic puffin) from SPA protected breeding colonies reveals that foraging may be undertaken within the Dogger Bank Zone during either the winter or breeding season (**Table 6.3**). As specific attribution to designated sites is possible for these species, confidence in predicting a potential impact on a designated breeding population may be higher than for other protected sites that

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lie within the maximum foraging range of the Dogger Bank Zone but for which no specific connectivity can be determined.

Table 6.3 Connectivity between species breeding colonies and the Dogger Bank Zone during the breeding season and over winter

| Species | Breeding colony | Breeding season | Over winter |
|---|---|---|---|
| Northern gannet | Flamborough and Filey Coast pSPA, UK | Yes[1] | Yes[4] |
| | Forth Islands SPA (Bass Rock) UK | Yes[2] | |
| | Storstappen, Norway | | Yes[4] |
| | Ulvoyholmen, Norway | | Yes[4] |
| Great skua | Iceland | | Yes[5] |
| | Norway | | Yes[5] |
| Black-legged kittiwake | Fair Isle, UK | | Yes[6] |
| | Flamborough and Filey Coast pSPA, UK | Yes[3] | |
| | Forth Islands SPA (Isle of May) UK | | Yes[6] |
| | Bear Island, Norway | | Yes[6] |
| | Bulbjerg, Norway | | Yes[6] |
| | Hornoya, Norway | | Yes[6] |
| | Hjelmsoya, Norway | | Yes[6] |
| | Cape Krutik | | Yes[6] |
| Atlantic puffin | Forth Islands SPA (Isle of May) UK | | Yes[7] |

[1] Langston & Boggio (2011) and Langston & Teuten (2012).
[2] Hamer *et al.* (2000 and 2001).
[3] RSPB (2011) and FAME (2012);
[4] Fort *et al.* (2012);
[5] Magnusdottir *et al.* (2012);
[6] Frederiksen *et al.* (2012);
[7] Harris *et al.* (2009).

### Non-breeding seabirds

6.3.19 The apportioning of impacts for non-breeding seabirds draws from recent JNCC/Natural England (2013b) guidance.

6.3.20 Seabirds that are present in the project area outwith the defined breeding seasons or during the breeding season as non-breeders potentially may originate from protected sites throughout the species' biogeographic ranges. However, apportioning the determined effects to each protected site on the basis of the size of its population relative to the species' overall biogeographic population may lead to an underestimation of the magnitudes of impacts at some sites, particularly those closest to the Dogger Bank Zone. Therefore, greater weighting has been placed on those protected sites closer to the Dogger Bank Zone. For those species that breed around the North Sea, it is assumed that the birds that are present in the development area outwith the defined breeding seasons or during the breeding season as non-breeders originate from this wider 'region' (see Section 4 in **Appendix 11A** of the Dogger Bank Teesside A & B ES). These results are qualified with new information on the dispersive and wintering areas from tracking studies. For instance, a recent study has shown that kittiwakes from North Sea colonies, such as the Isle of May, may also winter in the North Sea, but that it is unlikely that birds from westerly UK colonies would winter in the North Sea (Frederiksen *et al.* 2012).

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New information also exists on the non-breeding movements and distributions of the northern gannet (e.g. Kubetzki *et al.* 2009; Fort *et al.* 2012).

6.3.21 The magnitude of each impact is thus apportioned to each protected site surrounding the North Sea, according to the size of the species' population at the site relative to that in the wider region as a whole.

6.3.22 During the non-breeding season, a number of protected sites may be connected with the Dogger Bank Zone (see **Table 6.3**); however, studies providing information on seabird usage of an area at this time of year are typically less accurate given the types of devices (geolocators) used to study species in this period. Greater certainty is available for breeding season movements from protected sites where GPS and satellite devices have been used. Given the difficulty of directly linking non-breeding birds observed in the Dogger Bank Zone to specific sites, confidence in predictions at the site-level will be lower than in the attribution of impacts during the breeding season to sites within foraging range (though this will also vary depending on whether species are dependent on relatively few or many sites).

6.3.23 It should be noted that a number of the marine bird species considered in the assessment are also included as winter or passage features of some transboundary SPAs (see Appendix 2 in **Appendix 11A** of the Dogger Bank Teesside A & B ES). These marine SPAs include the Frisian Front SPA (Netherlands), the Eastern German Bight SPA and Sylter Außenriff SCI and SPA (Germany), and Sydlige Nordsø SCI and SPA (Denmark), which were considered in the initial screening exercise. However, as the extent of movements of birds between Dogger Bank Teesside A & B and other marine areas is unknown, it is not possible to ascertain whether there might also be impacts on these sites. Additionally, some of the birds which may be impacted from these marine sites are considered likely to form part of breeding colonies around the North Sea and hence will have been included within the assessment of impacts on these sites, should they also use Dogger Bank Teesside A & B. No further consideration and assessment has, therefore, been given to potential impacts on the designated populations of these marine SPAs.

**Migrants**

6.3.24 A recent review (Wright *et al*. 2012) defined migration zones for those migratory birds designated as features of British SPAs (and other Annex 1 species) that are at potential risk from offshore wind farm development. This review has been used to define which species might migrate through Dogger Bank Teesside A & B. It is difficult to link the birds that might occur in the Dogger Bank Zone on migration to specific sites for three key reasons:

- Due to the distance of the zone offshore and thus the potential coastal and inland sites that birds may originate from;
- Birds may not migrate directly to or from the sites at which they are features; and
- Several sites might be used by the same individuals at different periods of the year (see comments in Appendix 3 of **Appendix 11A** of the Dogger Bank Teesside A & B ES).

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6.3.25 Therefore, no attempt has been made to apportion impacts to individual protected sites. Thus, for migrants, analysis of collision risk and barrier effects has been undertaken with respect to species' national populations. For the assessment of collision risk, while it would be possible to calculate the numbers of birds impacted as a percentage of the total SPA suite (i.e. the total population of each species contained within all SPAs), the derived percentage would be the same as that calculated for the national population.

## Approach and methodology for assessing disturbance and displacement of seabirds during construction and operation

### Disturbance and displacement effects

6.3.26 Disturbance refers to an effect that causes a direct reaction in the behaviour of a bird, e.g. increased vigilance or flight/dive responses. Prolonged disturbance may result in long-term displacement from favoured habitat, which may become permanent if birds are unable to habituate to the cause of the effect. The sensitivity to these effects varies between seabird species and is reflected in a number of sensitivity classifications (e.g. Maclean *et al*. (2009), Furness & Wade (2012)).

6.3.27 At present, there is a limited evidence base on the effects of displacement at offshore wind farms (Rexstad & Buckland 2012). While some studies suggest there may be the potential for species to habituate to this effect, data are nonetheless lacking for most species. Hence, for the purposes of this assessment, a precautionary worst case scenario assumed that displacement will occur at the same level throughout the operational lifetime of the project. The size or magnitude of the impact associated with displacement thus reflects the areal extent of the wind farm project and buffer considered and the proportion of birds assumed to be displaced.

6.3.28 The determination of appropriate displacement rates draws from a review of the literature and recent monitoring studies (see Appendix 4 in **Appendix 11A** of the Dogger Bank Teesside A & B ES), Furness (2013) and recent guidance from JNCC/Natural England (2012).

6.3.29 There is some evidence of displacement effects for species including seaducks, divers and auks (Zucco *et al.* 2006). Radar and visual scan studies for some seaducks, including scoter and long-tailed duck, and divers have recorded displacement effects and also strong avoidance of wind farms post-construction, where changes in flight paths have been noted up to 4km away (APEM 2011; Krijgsveld *et al.* 2011; Petersen *et al.* 2006 and 2011; Petersen & Fox 2007). Comparison of pre- and post-construction surveys at Horns Rev and Nysted has demonstrated displacement of divers and auks from sites (Petersen *et al.* 2006). Northern gannet may also avoid wind farms (Krijgsveld *et al.* 2011). Black-legged kittiwakes show much less avoidance of wind farms, even showing attraction (Krijgsveld *et al.* 2011). Other gull species have also been recorded within wind farms or even attracted to them post-construction (Krijgsveld *et al.* 2011; Petersen *et al.* 2006). However, there is limited information on displacement or macro-avoidance for northern fulmars and skuas (Petersen *et al.* 2006; Krijgsveld *et al.* 2011).

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6.3.30 The available evidence suggests differences do exist in rates of displacement, or attraction, for different species. The relative apparent displacement / attraction rates for different species are not inconsistent with previous assessments of the relative sensitivities of species to disturbance.

6.3.31 The recent JNCC/Natural England (2012) advice note on assessing displacement quotes the scores of Furness & Wade (2012), though it is noted that the sensitivity of northern gannet differs from Furness & Wade (2012) as, while the species might not be highly sensitive to disturbance in general (e.g. ship and helicopter traffic), there are indications of a strong macro-avoidance of offshore wind farms (Krijgsveld *et al*. 2010 and 2011). The guidance also notes that these sensitivity scores give an initial indication of potential displacement levels that may be exhibited by each species and where, in the full range of displacement, the relative sensitivity of each species might lie.

6.3.32 Given the variability in apparent displacement / attraction rates, these sensitivity scores (as given by Furness & Wade (2012)) have been used in provisionally assigning displacement rates from 0% - 100% to take forward in the assessment, see **Table 6.4**. Further modification of these relative rates has then been undertaken where there is additional evidence to suggest that reliance on the vulnerability to disturbance scores may not adequately reflect the likely displacement effect.

Table 6.4 Species-sensitivity to disturbance from boats (derived from Furness & Wade (2012) and Furness *et al*. (2012, 2013)) and rates of displacement for seabirds in relation to an operational wind farm taken forward in this assessment

| Vulnerability to disturbance | Species / species group | Displacement rate based on relative sensitivity |
|---|---|---|
| Very High | Common scoter, velvet scoter, red-throated diver, great northern diver, and black-throated diver. | 100 |
| High | Common goldeneye, great cormorant, and greater scaup. | 75 |
| Medium | Common eider, long-tailed duck, great-crested grebe, Slavonian grebe, shag, razorbill, black guillemot, and common guillemot. | 50 |
| Low | Northern gannet, herring gull, great black-backed gull, little tern, little auk, black-headed gull, common gull, lesser black-backed gull, black-legged kittiwake, Sandwich tern, common tern, roseate tern, Arctic tern, and Atlantic puffin. | 25 |
| Very Low | Great skua, northern fulmar, sooty shearwater, Manx shearwater, European storm-petrel, Leach's storm-petrel, Arctic skua, and little gull. | 0 |

6.3.33 For northern gannet, evidence suggests that although the species might not be highly sensitive to disturbance in general (e.g. ship and helicopter traffic) the species may show strong macro-avoidance of offshore wind farms (Krijgsveld *et al*. 2010 and 2011). Hence, following recent JNCC/Natural England (2012) guidance, a much higher 75% displacement rate than that suggested by the sensitivity scores given by Furness & Wade (2012) for this species, is applied in the assessment.

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6.3.34 With respect to gulls, while some studies suggest that avoidance may occur, the relative evidence for either displacement or attraction is weak, and there is considerable variability in the apparent displacement / attraction rates reported in the available studies (see the review in Appendix 4 of **Appendix 11A** of the Dogger Bank Teesside A & B ES). To reflect the balance between displacement and attraction effects in gulls and also take account of discussions held with stakeholders (see Appendix 3 of **Appendix 11A** of the Dogger Bank Teesside A & B ES) a 0% displacement rate is applied with respect to relevant gull species (i.e. black-legged kittiwake, lesser black-backed gull and great-blacked gull) and no displacement impacts are therefore predicted with respect to these species.

6.3.35 Taking into account the relative rating of sensitivities to disturbance (see **Table 6.4**) and other evidence, displacement would therefore only affect the following seabird species of particular concern for Dogger Bank Teesside A & B:

- Northern gannet – 75% displacement rate;
- Common guillemot and razorbill – 50% displacement rate; and
- Atlantic puffin – 25% displacement rate.

6.3.36 For all other key species (northern fulmar, great skua, and Arctic skua) it is assumed that no or negligible displacement would occur.

6.3.37 For the above species, a 2km buffer has been used in calculating the displacement effect on birds that may be present outside of the developed area. This is in line with the recommended approach set out in JNCC/Natural England (2012).

6.3.38 Displacement rates within buffers are unlikely to be 100% of those in the wind farm area and are likely to decline with increasing distance from the wind farm, as is evident from studies in Denmark (Petersen 2005; Petersen *et al.* 2004 and 2006). As a simple mathematical way to apply a gradient to reflect decreasing avoidance with increasing distance from the wind farm, different displacement rates have been applied for two bands around the wind farm: 0-1km, 75% of the displacement rate for the wind farm; 1km-2km, 25% of the displacement rate for the wind farm (average rate of 50% of the displacement rate for the wind farm over 0-2km).

6.3.39 During the construction and decommissioning phases, the main disturbances are likely to be caused by the construction of the wind turbines themselves, the laying of cables and the boat / helicopter traffic and noise and vibration associated with these activities. These activities would take place across the Dogger Bank Teesside A & B Export Cable Corridor and offshore wind farm, albeit at different locations at different times. The same methodology used for calculating and predicting the magnitude of the effects and determining significance of the displacement impact during the operation phase (see above) has been used to assess displacement for construction and decommissioning. Displacement during construction and decommissioning would result from both disturbance associated with project activities and the presence of completed turbines (although these would likely be non-operational). As such, while disturbance-led displacement would be localised in the area of works,

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displacement resulting from the presence of turbines would gradually increase in magnitude during construction and decrease during decommissioning. To account for this it has been assumed that the number of birds displaced during construction and decommissioning would equate to 50% of the populations of each species present for the duration of the activities within the project area. The only difference being the assumption that only 50% of the populations would be displaced (see above paragraph) during the construction and decommissioning works within the offshore wind farm project areas.

**Displacement linked mortality**

6.3.40 The sensitivity of a specific species to displacement depends on a number of factors, as listed above, but can effectively be equated to habitat degradation or loss. Studies of the impacts of habitat loss on the fitness, i.e. fecundity or survival of individuals and thus on populations as a whole are few. Burton *et al.* (2006) reported how the body condition and survival rates of redshank were impacted following their displacement by a loss of intertidal habitat. However, similar studies of the impacts of habitat loss in the marine environment are lacking. In actuality, the survival of birds displaced through loss of habitat will depend on how close alternative areas are to carrying capacity and thus, whether they are able to support birds displaced from other areas. If areas elsewhere do exist but are limited in quality or extent, and/or already occupied, then increasing pressure on those areas could lead to increased competition for resources (Goss-Custard (1985) and Goss-Custard *et al.* (2002)) and, therefore, potentially, survival rates could be affected.

6.3.41 Following Maclean *et al.* (2009) and Langston (2010), the sensitivity of species to displacement has been taken to reflect the ability of seabirds to tolerate displacement through their flexibility in using alternate habitats. This accords with previous assessments of habitat flexibility (Garthe & Hüppop 2004) and flexibility in foraging behaviour (Furness & Tasker 2000) in determining the sensitivities of species to displacement. A recent assessment of the effects of offshore energy development on marine birds in Scottish water by Furness & Wade (2012) assigned species to a sensitivity classification based on the adaptive capacity of individual species to deal with effective habitat loss. This classification is reproduced in **Table 6.5** and has been used to assist in determining relevant displacement linked mortality rates that are applicable to assessing the impacts on designated site populations for the construction and operation phases of Dogger Bank Teesside A & B.

6.3.42 In essence, these sensitivities (see **Table 6.5**) may be viewed as the relative ability of a species to cope with habitat loss following displacement. Habitat loss in this context (i.e. open marine, offshore environment) relates solely to the function of the habitat as a foraging resource. In this respect any displacement associated mortality would arise as a result of a reduction in the availability of foraging/prey resource to seabirds.

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Table 6.5 Species-sensitivity to habitat loss (derived from Furness & Wade (2012) and Furness *et al*. (2012, 2013))

| Sensitivity due to habitat loss[1] | Species / species group |
|---|---|
| Very High | Red-necked grebe. |
| High | Greater scaup, common eider, long-tailed duck, common scoter, common goldeneye, red-throated diver, black-throated diver, great-crested grebe, Slavonian grebe, little tern, and black guillemot. |
| Medium | Velvet scoter, great northern diver, great cormorant, shag, Sandwich tern, common tern, roseate tern, Arctic tern, common guillemot, razorbill, and Atlantic puffin. |
| Low | Arctic skua, great skua, black-headed gull, common gull, great black-backed gull, black-legged kittiwake, and little auk. |
| Very low | Northern fulmar, sooty shearwater, Manx shearwater, European storm-petrel, Leach's storm-petrel, northern gannet, lesser black-backed gull, and herring gull. |

[1] Scores presented in Furness & Wade (2012) were translated into the same categories as presented in Maclean *et al.* (2009) as follows: 1 = very low, 2 = low, 3 = medium, 4 = high, and 5 = very high.

6.3.43 Given the lack of studies concerned with the impacts of habitat loss in the marine environment and empirical data on actual mortality following displacement, it is difficult to define actual mortality rates associated with the sensitivity ratings set out in **Table 6.5**. This is not least because the availability of alternative habitat below carrying capacity will vary according to specific conditions and is also likely to decrease with cumulative development.

6.3.44 Potential impacts of habitat loss to species' populations may occur both through impacts on productivity and on survival (both of young birds that might be recruited into the breeding population and breeding adults) and will reflect both the sensitivity of species to habitat loss and the availability of alternate habitat below carrying capacity.

6.3.45 A review of the available evidence on displacement mortality of seabirds has been undertaken (see Furness (2013) - **Appendix 11B** of the Dogger Bank Teesside A & B ES) in order to facilitate the setting of predicted mortality rates appropriate for the key seabird species that are present in Dogger Bank Teesside A & B and the 2km buffer zone and for which displacement has been identified as an issue (i.e. northern gannet, common guillemot, razorbill and Atlantic puffin). The key points from this review are summarised below:

- There is a broad consensus that seabird numbers are particularly affected by food abundance, and that this factor (in some cases modulated by fisheries or by climate change) is the single most important influence on seabird population sizes at a regional level. Evidence indicates that seabird population sizes are primarily determined by food abundance in the foraging area around colonies during the breeding season (Elliott *et al*. 2009; Wakefield *et al*. 2013);
- The breeding success of common guillemots, razorbills and shags in the North Sea has shown a positive correlation to sandeel growth rates (Burthe *et al*. 2012);

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- Food availability can affect the foraging ranges of seabirds, with decreased levels of food increasing the distance that birds will travel to feed. A study of breeding northern gannet colonies around the UK concluded that there was a positive correlation between population size and mean foraging trip duration (Lewis *et al*. 2001);
- Evidence strongly suggests that displacement by offshore wind farms could affect seabird breeding success, but is less likely to affect survival rates of breeding seabirds, because birds failing to rear chicks would be expected to abandon breeding before energy or time costs impacted significantly on their own survival;
- Survival rates of seabirds appear to remain high at levels of food supply that start to cause declines in productivity (Cairns 1987; Cury *et al*. 2011). This suggests that a small loss of foraging habitat would normally be within the range of natural variation to which seabird populations have evolved and adapted;
- Fisheries stock assessment data indicate the extremely high year to year variation in abundance of small pelagic fish such as sandeel and sprat. In the Dogger Bank region of the North Sea from 1983 to 2011, the sandeel spawning stock biomass varied between 100,000 tonnes and 1,100,000 tonnes (an 11-fold range), while recruitment of sandeels varied between 5 billion and 950 billion fish (a 190-fold range) (ICES 2010); and
- During the fluctuations in sandeel abundance referred to above, populations of common guillemots and razorbills in the North Sea remained fairly steady and, in fact, at some colonies (e.g. Flamborough and Filey Coast pSPA) increased significantly. This is true both of breeding numbers on North Sea coasts and wintering numbers in the North Sea, although data on the latter are less reliable. The implication of this is that survival rates of common guillemots and razorbills are good even when sandeel abundance is a small fraction of the long-term average abundance.

6.3.46 In respect of the species of potential concern, further information on the potential for mortality to result from displacement can be gained through examination of the specific nature of the habitat resource potentially lost to displacement as a result of wind farm development. As mentioned previously, the habitat function that is effectively 'lost' to seabirds is foraging resource – in this instance, the availability of small fish species that make up the main prey items of auks and northern gannet. Understanding the potential loss of overall prey resource as a result of development is therefore extremely pertinent to determining whether mortality would be likely to arise.

6.3.47 At the wider North Sea level, Dogger Bank Teesside A & B represents approximately 0.1% of total area. The ESAS database indicates that outside the breeding season, and especially in winter, common guillemots and razorbills are distributed across much of this total area, though with somewhat higher concentrations along the east coast of Britain from the Moray Firth to the Dogger Bank, the German Bight, and in the Skagerrak and Kattegat (see for example maps in Stone *et al*. 1995). Concentrations of auks in the Moray Firth have been associated with concentrations of sprats, while those in Skagerrak and

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Kattegat have been associated with concentrations of young herring and sprats. Elsewhere, areas with high densities of sandeels are also likely to represent high quality foraging habitat, since auks can feed on sandeels at the sea bed even during winter. Compared to natural fluctuations of fish abundance which can typically vary by a factor of as much as ten-fold from year to year (see comments above), the loss of 0.1% of foraging habitat would appear to be trivial.

6.3.48 During the breeding season, as central place foragers, seabirds are much more likely to be constrained by the availability of prey resources within their foraging range. The area occupied by the proposed Dogger Bank Teesside A & B wind farm is within foraging range of northern gannet, common guillemot and razorbill colonies from a number of protected sites. A loss of habitat resource to birds from these sites, therefore, may be more critical (than for non-breeding birds) as it may potentially reduce foraging resource from a much more constrained area.

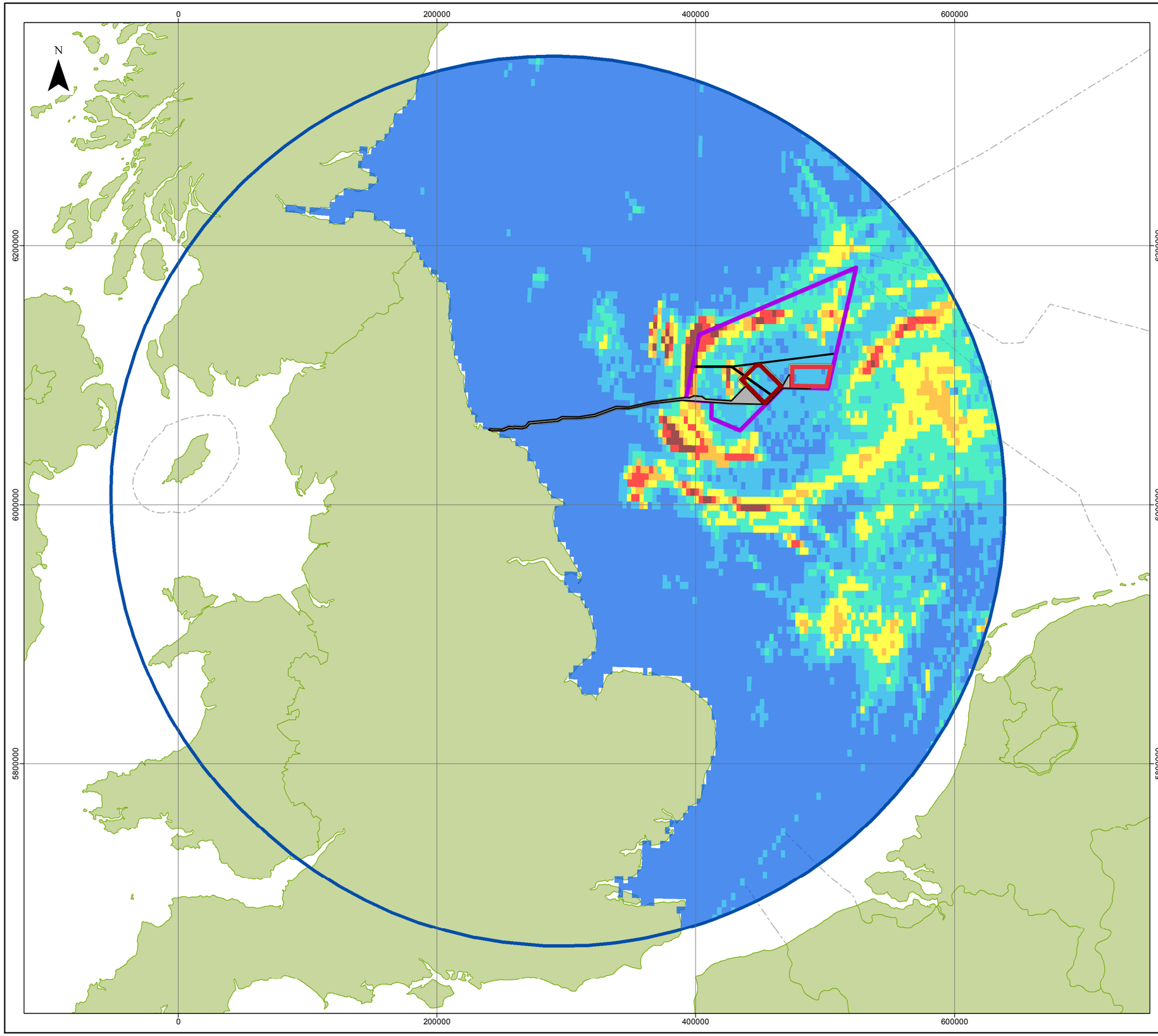
6.3.49 For Dogger Bank Teesside A & B sandeel fisheries data has been used along with foraging range information for the affected species to derive an overall indication of the magnitude of the effective resource loss that could occur and from this then derive a likely mortality rate for the relevant species. The Danish Vessel Monitoring System (VMS) data is assumed to provide a good indicator of the presence and abundance of sandeel in the North Sea. The density of fishing vessel movements (as revealed by the VMS data) is taken to provide a proxy for sandeel abundance, with higher density VMS representing areas with good 'fishing' and therefore suitable areas for sandeel.

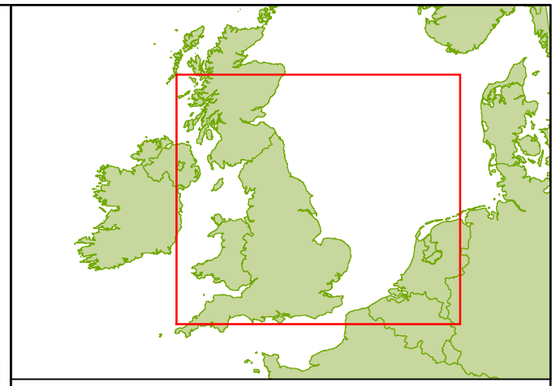
6.3.50 **Figure 6.2** and **Figure 6.3** show the Danish VMS data within the maximum foraging range of common guillemot and razorbill originating from the Flamborough and Filey Coast pSPA and in relation to Dogger Bank Teesside A & B. These overlays of foraging range clearly show that there are extensive areas of good quality sandeel habitat (i.e. auk foraging habitat) that lie outside of Dogger Bank Teesside A & B and within the foraging range of these birds from Flamborough and Filey Coast pSPA. Analysis of the VMS density data from within the foraging range of both species indicates that the total area of 'good' sandeel habitat that would be lost through displacement of birds from Dogger Bank Teesside A & B represents approximately 0.5% of the total 'good' sandeel resource available within maximum foraging range of common guillemot and razorbill from Flamborough and Filey Coast pSPA (see **Table 6.6**). Although this analysis has not been undertaken for auks originating from other colonies within foraging range of Dogger Bank Teesside A & B, it is assumed that a similar percentage loss of foraging resource would also apply.

6.3.51 The very small area of resource affected by the proposed development indicates that, should displacement occur, that there are extensive areas of good quality foraging habitat (as well as areas supporting other target prey species) available to breeding auks outside of the development area. For non-breeding auks the area available for them to re-distribute into is even greater (i.e. much of the North Sea).

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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
- Common guillemot maximum range - 340km

Danish sandeel satellite (VMS) density

- 0 to 2
- 2 to 5
- 5 to 10
- 10 to 20
- 20 to 40
- 40 to 80
- Over 80

0 25 50 100

Kilometres

Data Source:
Environmental Designations © JNCC, 2014 and European Environment Agency, 2014
Round 3 offshore wind farm boundary © Crown Copyright, 2014

PROJECT TITLE

*Dogger Bank Teesside A & B*
IfAA Report

DRAWING TITLE

**Figure 6.2 Common guillemot foraging range off Flamborough Head and Bempton Cliffs SPA and Danish sandeel fishing (VMS data average 2007-2011)**

| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 15/10/2013 | PEI3 | JE | PT |
| 2 | 18/03/2014 | DCO Submission | GC | PT |
| | | | | |

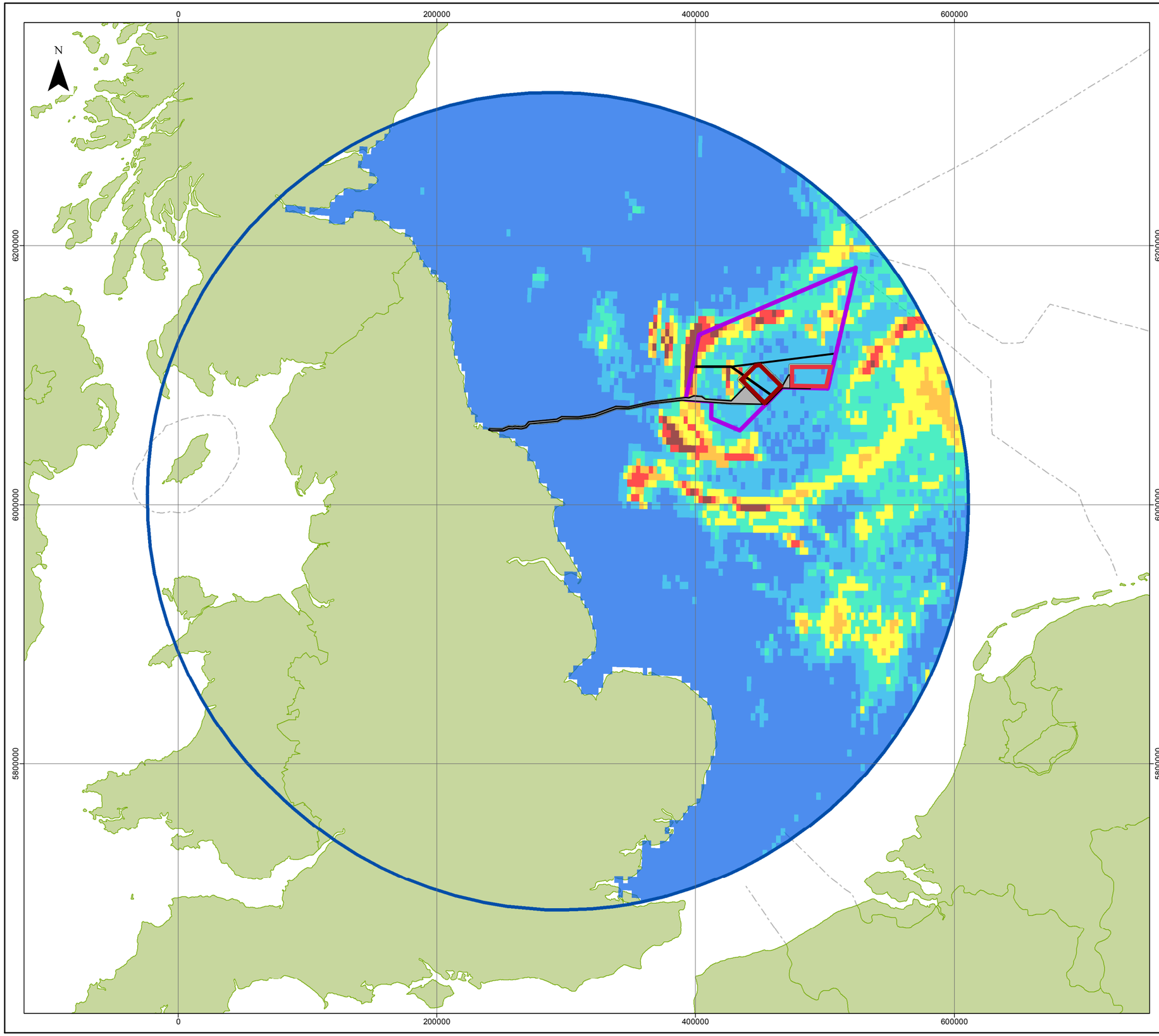
DRAWING NUMBER:

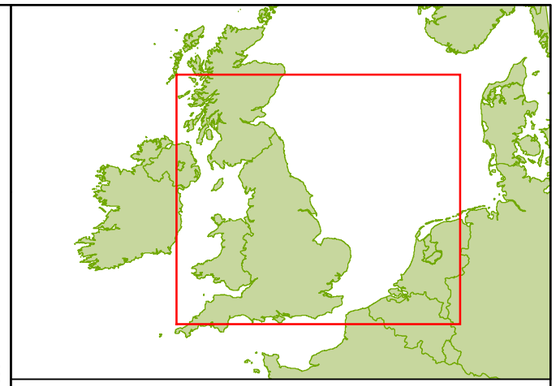
**9Y0986/TSABHRA/43/R2**

| SCALE | PLOT SIZE | DATUM | PROJECTION |
|---|---|---|---|
| 1:3,000,000 | A3 | WGS84 | 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
- Razorbill maximum range - 312km

Danish sandeel satellite (VMS) density

- 0 to 2
- 2 to 5
- 5 to 10
- 10 to 20
- 20 to 40
- 40 to 80
- Over 80

0 25 50 100

Kilometres

Data Source:
Environmental Designations © JNCC, 2014 and European Environment Agency, 2014
Round 3 offshore wind farm boundary © Crown Copyright, 2014

PROJECT TITLE

*Dogger Bank Teesside A & B*
IfAA Report

DRAWING TITLE

**Figure 6.3 Razorbill foraging range off Flamborough Head and Bempton Cliffs SPA and Danish sandeel fishing (VMS data average 2007-2011)**

| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 15/10/2013 | PEI3 | JE | PT |
| 2 | 18/03/2014 | DCO Submission | JE | PT |
| | | | | |

DRAWING NUMBER:

**9Y0986/TSABHRA/44/R2**

| SCALE | PLOT SIZE | DATUM | PROJECTION |
|---|---|---|---|
| 1:3,000,000 | A3 | WGS84 | UTM31N |

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Table 6.6 Calculation of good quality sandeel habitat area within Dogger Bank Teesside A & B as a percentage of foraging area for common guillemot and razorbill originating from Flamborough and Filey Coast pSPA

| VMS density | Area km$^2$ | Area km$^2$ in wind farm | Area km$^2$ in wind farm +buffer | Percentage of total VMS density class |
|---|---|---|---|---|
| **Common guillemot – foraging area = 196,496km$^2$ based on 340km maximum range** | | | | |
| VMS Density 10 to 20 | 657 | 2 | 2 | 0.30 |
| VMS Density 20 to 40 | 201 | 1 | 1 | 0.5 |
| VMS Density 40 to 80 | 99 | 0 | 1 | 1.02 |
| VMS Density >80 | 63 | 1 | 1 | 1.58 |
| **Total** | **1,020** | **4** | **5** | **0.5** |
| **Razorbill – foraging area = 166,801km$^2$ based on 312km maximum range** | | | | |
| VMS Density 10 to 20 | 598 | 2 | 2 | 0.33 |
| VMS Density 20 to 40 | 185 | 1 | 1 | 0.54 |
| VMS Density 40 to 80 | 97 | 0 | 1 | 1.03 |
| VMS Density >80 | 63 | 1 | 1 | 1.58 |
| **Total** | **943** | **4** | **5** | **0.53** |

6.3.52 The existing understanding of the role and dynamics of food abundance in determining the demographics (mortality / productivity) of auk populations when taken together with the very small area of available foraging resource that would be 'lost' as a result of Dogger Bank Teesside A & B, indicates that the most likely consequence of displacement of auks from Dogger Bank Teesside A & B would be no or a very limited increase in mortality. While it is considered that, in this instance, there is a case to be made that no displacement associated mortality would be likely to result from the development of Dogger Bank Teesside A & B, a 5% mortality rate has been adopted in the assessment for common guillemot and razorbill. This is considered to be a precautionary rate and applies to birds throughout the year. The calculations of percentage loss given in **Table 6.6** take into account habitat quality and the overall percentage loss of total available foraging habitat by area (i.e. from within the entire foraging area of birds from individual colonies) would be significantly less that 0.5%. However, it is possible that the better quality habitat provides a greater proportion of the overall prey resource taken by birds and therefore potential loss would have greater consequences than the loss of other areas. Without knowledge of whether the habitat used within the foraging range is at carrying capacity, it is not possible to determine if there is likely to be a direct proportional relationship between the area of good quality habitat lost and potential effect on populations. To reflect this uncertainty and also to take account of other potential factors that may play a role in the overall availability of prey resources (e.g. fluctuations in sandeel stocks) a nominal 5% rate is adopted. This applies to birds throughout the year. Given that the calculated foraging resource implications would also apply to non-breeding Atlantic puffin (there are no designated populations within mean maximum foraging range of Dogger Bank Teesside A & B) the same 5% mortality is assumed to apply.

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6.3.53 In the case of northern gannet, both breeding season foraging ranges and the species' wintering range are large (see **Table 6.1**). Thus for this species, impacts on designated populations of the loss of habitat associated with any one project in the Dogger Bank Zone are expected to be minimal (Furness 2013). However, while relative to the foraging ranges and the species' wintering range the amount of habitat from which birds may be displaced by a single project might be considered minimal for this species, the impacts of cumulative developments may be significant if many are located in high quality habitat. Thus, for this species, a potential mortality rate of 0% is considered in the assessment of displacement for Dogger Bank Teesside A & B alone and 5% for the assessment of the cumulative impacts of Dogger Bank Teesside A & B with other wind farm projects in the North Sea.

6.3.54 In summary, based on the evidence presented here and in **Appendix 11A** of the Dogger Bank Teesside A & B ES, the following mortality rates have been adopted in assessing the impact of displacement on designated seabird populations:

- Northern gannet – 0% mortality rate for Dogger Bank Teesside A & B, 5% for in-combination assessment; and
- Common guillemot, razorbill and Atlantic puffin – 5%.

6.3.55 For all of the other key seabird species, as no displacement effect has been determined, there is no requirement to determine displacement associated mortality and, therefore, no rates are proposed.

**Application of displacement and mortality rates**

6.3.56 The species specific displacement rates set out in **Table 6.4** and the mortality rates discussed above have been used in the impact assessment process and the apportioning of impacts to species populations at individual designated sites. As discussed, these rates have been determined through consideration of the available evidence and comparative use of species sensitivity classifications. In light of uncertainties regarding the actual rates of displacement and mortality, the set of values that have been established for the assessment are considered to be precautionary.

6.3.57 In line with recent guidance on the application of displacement and mortality values in the assessment of the impact of wind farms on seabirds (JNCC/Natural England 2012), a range of alternative values have also been used in the impact apportioning process. The assessment outcomes in using these alternative values are presented in the assessment sections dealing with displacement effects. It should be noted, however, that unless specifically stated in the assessment conclusions, the outcome of the assessment process and apportioning of impacts to individual site populations has been undertaken with respect to the precautionary values that have been adopted.

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### *Assessment of disturbance in the intertidal during landfall works*

6.3.58 During construction work for the export cable landfall within the intertidal zone, disturbance to birds present in the intertidal area could occur as a result of increased noise levels and visual intrusion associated with the works.

6.3.59 Assessment of the potential disturbance impact resulting from the export cable landfall construction works uses the numbers of birds that have been recorded foraging on the intertidal and adjacent areas (if within any potential zone of disturbance) to determine the average numbers per $m^2$. From the length and width of the likely construction area, and the likely distances over which disturbance could affect foraging birds, a potential disturbance zone around the works can be calculated. Based on this area, the average numbers of each species present and hence likely to be disturbed can then be determined. Disturbance is unlikely to extend beyond a buffer of 300m from the boundary of the final export cable corridor itself, this distance representing the maximum distance at which coastal waterbirds typically show behavioural responses to human disturbance (Smit & Visser 1993; Burton *et al*. 2002).

## Assessment of barrier effects during the operation phase

6.3.60 Wind farms may pose a barrier effect to migratory birds or those commuting between breeding sites and offshore feeding areas, which could result in elevated energetic costs (Speakman *et al*. 2009) and thus potentially increased mortality. Increases in the energetic costs of the daily movements of seabirds, or of the movements of migratory birds, have been shown in a number of studies (Tulp *et al*. 1999; Pettersson & Stalin 2003; and Masden *et al*. 2009 and 2010), although Masden *et al.* (2009), in reporting changes in the migratory trajectories of common eiders at a Danish offshore wind farm post-construction, suggested that this had minimal likely effect on energetics. However, it was noted that cumulative effects could be significant for instance if other wind farms or human developments worked in combination to disrupt routes of birds. Desholm & Kalhert (2005) also reported that migrant wildfowl diverted around the Nysted wind farm, and Tulp *et al.* (1999), found that common eiders didn't fly between turbines that were placed 200m apart in the Kattegat.

6.3.61 The assessment of barrier effects for Dogger Bank Teesside A & B concerns both breeding seabirds whose foraging ranges extend to the development area (see **Table 6.1**) and migrating birds.

6.3.62 The list of migrant species for which barrier effects are considered a potential effect is determined by the migration zones summarised in Wright *et al.* (2012), and put into context using the relevant biogeographic populations following that report. The confidence that these species may occur in the Dogger Bank Zone is qualified by observations from the project-specific boat surveys.

6.3.63 For both breeding seabird and migrant species, the numbers of flying birds used in estimating collision risk (see below) have been taken to represent the populations of birds exposed to the potential barrier effects associated with wind farm development. For breeding seabirds, the maximum number of birds recorded during the two breeding seasons covered by the baseline surveys is used.

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6.3.64 An indication of the increase in flight distance posed by the wind farm for both migrants crossing the North Sea and breeding seabirds commuting from their colonies to foraging sites is provided. For breeding seabirds, consideration is given as to whether the increase in flight distance posed by barrier effects might prevent birds from any individual protected site from reaching foraging areas beyond the project area, based on information on the species' foraging range (see **Table 6.1**). Breeding seabirds of five species, northern fulmar, northern gannet, black-legged kittiwake, common guillemot and razorbill, could thus potentially be affected. As there are no breeding colonies of Arctic skua, great skua, great black-backed gull, lesser black-backed gull, and Atlantic puffin within mean maximum foraging range of Dogger Bank Teesside A & B, barrier effects have been discounted for these species.

6.3.65 The increase in flight distance posed by the potential barrier effects associated with wind farm development provides a proxy for the increase in energetic cost and, together with information on the number of birds exposed, is considered in evaluating the potential magnitude of the impact. As it is not possible to fully quantify the number of birds that might potentially be impacted by barrier effects, this is by necessity a qualitative judgement and it should be noted that there is presently little understanding of the thresholds above which such increases might impact survival or breeding productivity (Masden *et al*. 2009; Speakman *et al*. 2009).

6.3.66 Barrier effects will be an on-going effect through the operational lifetime of the project for all species and, thus, there is no potential for species to recover from this effect. As indicated above, there is a limited evidence base for barrier effects and thus while there may be the potential for species to habituate to this effect, for the purposes of this assessment a worst case scenario has been assumed that the project will pose a barrier to 100% of flying birds throughout their lifetime.

6.3.67 For migrants, there is little evidence to indicate whether or not migration may be concentrated within corridors within migration zones (Wright *et al*. 2012) and it cannot be assumed that birds fly directly to or from breeding/wintering areas that are designated as SPAs / Ramsar sites.

6.3.68 For the purposes of the assessment presented here it has been assumed that the wind farm poses a barrier effect to 100% of birds attempting to fly through at risk height (Maclean e*t al*. 2009), which may be over-precautionary. The potential cumulative impacts of barrier effects from multiple wind farms are not likely to be additive (King *et al*. 2009) and thus assessment has been undertaken solely for Dogger Bank Teesside A & B without reference to the individual development areas. There is also uncertainty regarding species' sensitivities to this effect, which has been determined through the proxy of wing-loading (see Section 4 in **Appendix 11A** of the Dogger Bank Teesside A & B ES), in particular how such an assessment of sensitivity may correlate to actual consequences for survival and thus population-level impacts.

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## Assessment of collision risk during the operation phase

### Introduction

6.3.69 The possibility of collisions between birds and turbines is one of the key ornithological effects associated with offshore wind farms.

6.3.70 Collision will be an on-going effect through the operational lifetime of the project, varying in frequency through the year according to the species' population size. The size or magnitude of the risk for each receptor depends on a number of factors including its population in the area of the proposed development, the characteristics and behaviour of the species, notably the proportion of time that they spend flying and the heights at which they fly, and their avoidance reaction to turbines. The latter aspect may include macro / far-field avoidance of the wind farm as a whole, and micro-avoidance of individual turbines (see review by Cook *et al*. (2012)). Other aspects such as the weather and differences between diurnal and nocturnal behaviour between species may also affect the magnitude of any impact.

6.3.71 Collision may potentially impact a number of species groups, including those seabirds that use the area of the proposed development for feeding during the breeding season and other times of year, and waterbirds and terrestrial species that pass through the area on migration in spring and autumn.

6.3.72 Estimates of the probability of any individual bird colliding with a turbine can be obtained from models which incorporate information on the species of concern (flight height data, flight speeds and morphology) and turbine design. From these probabilities and information on the numbers or densities of birds using the area of the wind farm, the potential collision mortality associated with the wind farm can be estimated.

### Seabirds

6.3.73 Collision risk analyses for the operational phase of Dogger Bank Teesside A & B have been run using the Band model, updated for the offshore environment (Band 2012). The updated Band model differs from the original (developed for onshore wind farms (Band *et al*. 2007)) in two key ways. Firstly, bird numbers are input as densities rather than raw counts, which better reflects the way in which data are collected in the offshore environment. Secondly, the updated Band model is capable of incorporating three options for considering flight heights:

- Option 1 - using the basic model, i.e. assuming that a uniform distribution of flight heights between lowest and highest levels of the rotors and using the proportion of birds at risk height as derived from site survey;
- Option 2 - using the basic model, but using the proportion of birds at risk height as derived from generic flight height information; and
- Option 3 - using modelled flight height distributions for each of the study species.

6.3.74 Option 3 allows comparison of the impact of varying the height of turbines to be made and takes account of the fact that collision risk is not distributed evenly within the rotor swept area.

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6.3.75 Collision risk modelling has been undertaken for all seabird species for which sufficient population data were available – northern gannet, northern fulmar, Arctic skua, great skua, lesser black-backed gull, great black-backed gull, black-legged kittiwake, common guillemot, razorbill, little auk, and Atlantic puffin. Monthly population estimates for 2010, 2010/2011 and 2011/2012 for each of these species, in Dogger Bank Teesside A & B were derived following the methodology outlined in Section 2 in **Appendix 11A** of the Dogger Bank Teesside A & B ES, but considered only flying birds, a key assumption of the Band model. The data used in the analysis (including monthly population density estimates, biometric data for individual species, flight behaviour, turbine design and operational parameters) is presented in Section 4 in **Appendix 11A** of the Dogger Bank Teesside A & B ES (including Tables 4.14 to 4.16 and accompanying text).

6.3.76 A total of eight scenarios were considered within the collision risk modelling framework, covering a range of turbine sizes and heights (see Table 4.17 in **Appendix 11A** of the Dogger Bank Teesside A & B ES). Differences between these scenarios were initially assessed assuming a 98% avoidance rate across all three Band model options.

6.3.77 It was considered that Option 3 of the updated Band model offered the most realistic assessment of collision risk within the Dogger Bank Zone. Firstly, it offers the opportunity to input the actual dimensions of the turbines to be used, which means that the proportion of birds flying within the rotor-swept area can be accurately estimated, rather than being constrained to the proportion estimated to be flying above 20m during the boat surveys. More importantly, collision risk is variable within the rotor-swept area. Collision risk is greatest towards the centre of the turbine, where the area of the rotor sweep is greatest. Under Option 1, birds are assumed to be distributed evenly within the rotor-swept area. However, as they are most likely to be clustered towards the lower reaches of the rotor-swept area, this results in an over-estimate of the number of collisions. By using Option 3, it is possible to account for this variable distribution.

6.3.78 Whilst data from the Dogger Bank Zone contributed to the development of modelled flight height bands, the zone itself is considerably further offshore than the other projects considered in Cook *et al*. (2012). However, detailed examination of modelled outputs by Cook *et al*. (2012) suggests that there was no relationship between the distance to shore and the accuracy with which the proportion of birds flying within each flight height band could be predicted. This indicates that differences between the inshore and offshore environments did not have a significant impact on observed flight heights. Additionally, for each species, the proportion of birds observed flying above 20m during the survey programme on Dogger Bank were within the 95% confidence intervals of those predicted to be above this height by the modelled distribution of Cook *et al*. (2012) (see Table 4.16 in **Appendix 11A** of the Dogger Bank Teesside A & B ES). This provides support for the suggestion that the modelled distribution provides a reasonable reflection of flight heights of birds within the Dogger Bank Zone. However, as recommended by Band (2012), results from the alternative model options are also considered in the assessment (see **Appendix 11A** of the

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Dogger Bank Teesside A & B ES) in order to qualify the results of the assessment, although the results of these alternative options are not used in the HRA.

6.3.79 Results of the collision risk analyses for Dogger Bank Teesside A & B are presented in Sections 5.2, 5.3 and 5.4 of **Appendix 11A** of the Dogger Bank Teesside A & B ES and summarised in this report where appropriate. Results have been calculated separately for each month in 2010, 2010/11 and 2011/12, based on the median population estimates and lower and upper confidence limits around these values. Collision estimates based on the means of the monthly values, and thus for the breeding and non-breeding seasons, are also presented.

6.3.80 For the purposes of assessment and the apportioning of impacts to protected sites, collision risk estimates are summed for breeding months and non-breeding months in each of the three years. The impact at the population level (i.e. individual designated SPA populations) associated with collision risk is assessed using the mean monthly estimates across the years.

**Migrants**

6.3.81 Collision risk analyses for migrant birds were run using the Band model, following the guidance specifically for migrants at offshore sites (Annex 6 of Band (2012)). As there are limited data available on the flight heights of birds during migration, only Option 1 (described under marine birds above) for consideration of flight heights was used; i.e. the basic model using the proportion of birds at risk height, with proportions taken from Wright *et al.* (2012). Three scenarios were run, using the lower, central and upper limits of the range of the proportion of birds at risk height, as described in Wright *et al.* (2012).

6.3.82 The 45 species whose migration routes potentially cross the project area were determined using the maps provided in Wright *et al.* (2012). For each of these species, the proportion of the total number of birds crossing the North Sea that would cross the footprint of the wind farm (at any height) during each migration season was calculated using the methods described in Wright *et al.* (2012). The methods described in Wright *et al.* (2012) were also used to determine the reference population relevant to the assessment (i.e. the total number of birds crossing the North Sea during each migration). Details of the derivation of the population for each species are given in Table 4.19 in **Appendix 11A** of the Dogger Bank Teesside A & B ES.

6.3.83 A single scenario for turbine size and height (Option 1 in Table 4.17 in **Appendix 11A** of the Dogger Bank Teesside A & B ES) was considered in collision risk models for migrating birds. Collision risk was modelled with a precautionary avoidance rate of 98%. The value used in collision risk models for the proportion of time wind turbines were operational was taken as the average across the year (94.6% - see Table 4.18 in **Appendix 11A** of the Dogger Bank Teesside A & B ES) as migration occurs in many months, but the distribution of migrating bird numbers across the months during which migration occurs is not known.

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6.3.84 Biometric data and flight speeds of each species, for use in collision risk models, were taken from published information as detailed in Table 4.19 in **Appendix 11A** of the Dogger Bank Teesside A & B ES.

6.3.85 With regard to collision risk, it should be noted that for migrants there is great uncertainty in the numbers of birds likely to pass through the project area and the proportions of these that may fly at heights which pose a risk of collision.

## 6.4 Baseline environment

### Summary of survey data collected in 2010 and 2011 for the Offshore Dogger Bank Zone

6.4.1 The baseline survey results are detailed in **Appendix 11A** of the Dogger Bank Teesside A & B ES, with Tables 3.1, 3.2, and 3.3 presenting the numbers of birds of all species (including seabirds) recorded in each month during boat-based surveys between January 2010 and June 2012, which is summarised in **Table 6.7**. The table presents the total numbers of each species, the peak count, and the average monthly count for the duration of the surveys (January 2010 to June 2012).

Table 6.7 Bird species recorded within the Dogger Bank Zone during boat-based surveys, showing monthly averages and peak counts

| Species | Latin name | Monthly average | Peak | Total |
|---|---|---|---|---|
| **Divers and grebes** | | | | |
| Diver spp. | *Gavia* spp. | 1 | 3 | 14 |
| Black throated diver | *Gavia arctica* | <1 | 2 | 6 |
| Great northern diver | *Gavia immer* | <1 | 2 | 5 |
| Red-throated diver | *Gavia stellata* | 1 | 7 | 24 |
| White billed diver | *Gavia adamsii* | 2 | 11 | 67 |
| Great-crested grebe | *Podiceps cristatus* | <1 | 1 | 1 |
| **Seabirds** | | | | |
| Auk spp. | - | 307 | 2,415 | 8,595 |
| Guillemot/razorbill | *Uria aalge/ Alca torda* | 66 | 750 | 1844 |
| Atlantic puffin | *Fratercula arctica* | 107 | 352 | 2,987 |
| Common guillemot | *Uria aalge* | 2,090 | 9,852 | 58,530 |
| European shag | *Phalacrocorax aristotelis* | <1 | 1 | 2 |
| European storm-petrel | *Hydrobates pelagicus* | 2 | 32 | 45 |
| Great cormorant | *Phalacrocorax carbo* | <1 | 4 | 12 |
| Leach's storm-petrel | *Oceanodroma leucorhoa* | <1 | 6 | 7 |
| Little auk | *Alle alle* | 164 | 1,231 | 4,586 |
| Manx shearwater | *Puffinus puffinus* | 1 | 12 | 37 |
| Northern fulmar | *Fulmarus glacialis* | 1,027 | 3,861 | 28,745 |
| Northern gannet | *Morus bassanus* | 1,268 | 7,872 | 35,514 |
| Razorbill | *Alca torda* | 560 | 3,502 | 15,673 |
| Sooty shearwater | *Puffinus griseus* | 3 | 45 | 70 |

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| Species | Latin name | Monthly average | Peak | Total |
|---|---|---|---|---|
| **Gulls, terns and skuas** | | | | |
| Black-backed gull sp. | *Larus marinus/fuscus* | 4 | 66 | 107 |
| Gull spp. | - | 29 | 331 | 805 |
| Large gull spp. | - | 4 | 55 | 123 |
| Small gull spp. | - | <1 | 1 | 1 |
| Petrel spp. | - | <1 | 10 | 10 |
| Skua spp. | - | 1 | 11 | 30 |
| Small skua spp. | - | <1 | 2 | 3 |
| Tern spp. | *Sterna* spp. | 2 | 26 | 65 |
| Arctic skua | *Stercorarius parasiticus* | 9 | 81 | 256 |
| Arctic tern | *Sterna paradisaea* | 5 | 30 | 126 |
| Black-headed gull | *Chroicocephalus ridibundus* | 11 | 74 | 295 |
| Black-legged kittiwake | *Rissa tridactyla* | 2,573 | 11,504 | 72,054 |
| Comic tern | *Sterna hirundo/paradisaea* | 1 | 13 | 20 |
| Common gull | *Larus canus* | 17 | 86 | 478 |
| Common tern | *Sterna hirundo* | 1 | 13 | 31 |
| Glaucous gull | *Larus hyperboreus* | <1 | 1 | 2 |
| Great black-backed gull | *Larus marinus* | 109 | 416 | 3,044 |
| Great skua | *Stercorarius skua* | 18 | 259 | 512 |
| Herring gull | *Larus argentatus* | 36 | 225 | 1,002 |
| Iceland gull | *Larus glaucoides* | <1 | 1 | 1 |
| Lesser black-backed gull | *Larus fuscus* | 93 | 606 | 2,611 |
| Little gull | *Larus minutus* | 5 | 121 | 129 |
| Mediterranean gull | *Larus melanocephalus* | <1 | 1 | 1 |
| Pomarine skua | *Stercorarius pomarinus* | 3 | 29 | 71 |
| Sabine's gull | *Xema sabini* | <1 | 1 | 2 |
| Sandwich tern | *Sterna sandvicensis* | <1 | 9 | 10 |
| Yellow-legged gull | *Larus michahelis* | <1 | 2 | 4 |
| **Herons, bitterns and egrets** | | | | |
| Grey heron | *Ardea cinerea* | <1 | 3 | 10 |
| Little egret | *Egretta garzetta* | <1 | 1 | 1 |
| **Waterfowl** | | | | |
| Aythya duck spp. | *Aythya* spp. | <1 | 2 | 2 |
| Duck spp. | *Anas* spp. | 1 | 12 | 30 |
| Godwit spp. | *Limosa* spp. | 2 | 42 | 42 |
| Goose spp. | - | 1 | 13 | 14 |
| Small wader sp. | - | 1 | 29 | 34 |
| Swan spp. | *Cygnus* spp. | <1 | 6 | 6 |
| Wader spp. | - | 2 | 37 | 47 |
| Barnacle goose | *Branta leucopsis* | <1 | 4 | 4 |
| Bean goose | *Anser fabalis* | <1 | 2 | 3 |
| Brent goose | *Branta bernicla* | 1 | 24 | 30 |
| Common eider | *Somateria mollissima* | 1 | 17 | 18 |
| Common goldeneye | *Bucephala clangula* | <1 | 1 | 2 |
| Common sandpiper | *Actitis hypoleucos* | <1 | 1 | 1 |
| Common scoter | *Melanitta nigra* | 15 | 73 | 420 |
| Dunlin | *Calidris alpina* | 1 | 12 | 36 |
| Eurasian curlew | *Numenius arquata* | 2 | 36 | 55 |
| Eurasian oystercatcher | *Haematopus ostralegus* | <1 | 3 | 10 |


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| Species | Latin name | Monthly average | Peak | Total |
|---|---|---|---|---|
| Eurasian redshank | *Tringa totanus* | <1 | 6 | 9 |
| Eurasian teal | *Anas crecca* | <1 | 4 | 9 |
| Eurasian wigeon | *Anas penelope* | <1 | 8 | 8 |
| Golden plover | *Pluvialis apricaria* | <1 | 2 | 5 |
| Goosander | *Mergus merganser* | <1 | 3 | 5 |
| Green sandpiper | *Tringa ochropus* | <1 | 1 | 1 |
| Greenshank | *Tringa nebularia* | <1 | 1 | 1 |
| Grey phalarope | *Phalaropus fulicarius* | <1 | 3 | 12 |
| Greylag goose | *Anser anser* | <1 | 10 | 11 |
| Jack snipe | *Lymnocryptes minimus* | <1 | 1 | 1 |
| Little stint | *Calidris minuta* | <1 | 1 | 1 |
| Long-tailed duck | *Clangula hyemalis* | <1 | 1 | 2 |
| Mallard | *Anas platyrhynchos* | <1 | 3 | 6 |
| Northern lapwing | *Vanellus vanellus* | 1 | 13 | 19 |
| Pink-footed goose | *Anser brachyrhynchus* | 2 | 50 | 50 |
| Pintail | *Anas acuta* | <1 | 2 | 3 |
| Pochard | *Aythya ferina* | <1 | 3 | 3 |
| Purple Sandpiper | *Calidris maritima* | <1 | 1 | 1 |
| Red knot | *Calidris canutus* | 1 | 14 | 18 |
| Ringed plover | *Charadrius hiaticula* | <1 | 3 | 9 |
| Ruddy turnstone | *Arenaria interpres* | 1 | 10 | 19 |
| Ruff | *Philomachus pugnax* | <1 | 3 | 3 |
| Sanderling | *Calidris alba* | <1 | 3 | 6 |
| Tufted duck | *Aythya fuligula* | <1 | 2 | 2 |
| Velvet scoter | *Melanitta fusca* | <1 | 5 | 13 |
| Whimbrel | *Numenius phaeopus* | 1 | 19 | 34 |
| White-fronted goose | *Anser albifrons* | <1 | 2 | 2 |
| **Birds of prey and owls** | | | | |
| Owl spp. | - | <1 | 1 | 1 |
| Eurasian sparrowhawk | *Accipiter nisus* | <1 | 4 | 10 |
| Hobby | *Falco subbuteo* | <1 | 1 | 1 |
| Kestrel | *Falco tinnunculus* | <1 | 3 | 13 |
| Long-eared owl | *Asio otus* | <1 | 5 | 6 |
| Merlin | *Falco columbarius* | <1 | 1 | 2 |
| Osprey | *Pandion haliaetus* | <1 | 1 | 1 |
| Short-eared owl | *Asio flammeus* | 1 | 12 | 26 |
| **Terrestrial and passerines** | | | | |
| Acrocephalus warbler spp. | *Acrocephalus* spp. | <1 | 1 | 1 |
| Crest spp. | - | <1 | 1 | 1 |
| Finch spp. | - | <1 | 2 | 2 |
| Hirundines spp. | *Hirundinidae* spp. | <1 | 2 | 2 |
| Lark spp. | - | <1 | 1 | 1 |
| Locustella warbler spp. | - | <1 | 1 | 1 |
| Phylloscopus warbler spp. | *Phylloscopus* spp. | <1 | 2 | 3 |
| Pipit spp. | - | <1 | 2 | 4 |
| Thrush spp. | - | 7 | 169 | 206 |
| Unidentified bunting | - | <1 | 1 | 1 |
| Unidentified passerine | - | 1 | 15 | 34 |
| Warbler spp. | - | <1 | 3 | 7 |


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| Species | Latin name | Monthly average | Peak | Total |
|---|---|---|---|---|
| Barn swallow | *Hirundo rustica* | 2 | 31 | 64 |
| Black redstart | *Phoenicurus ochruros* | <1 | 5 | 8 |
| Blackcap | *Sylvia atricapilla* | 1 | 8 | 25 |
| Bluethroat | *Luscinia svecica* | <1 | 1 | 2 |
| Brambling | *Fringilla montifringilla* | 1 | 9 | 20 |
| Carrion crow | *Corvus corone* | <1 | 3 | 7 |
| Chaffinch | *Fringilla coelebs* | 3 | 77 | 90 |
| Chiffchaff | *Phylloscopus collybita* | 2 | 12 | 51 |
| Collared dove | *Streptopelia decaocto* | 1 | 3 | 15 |
| Common blackbird | *Turdus merula* | 8 | 174 | 223 |
| Common crossbill | *Loxia curvirostra* | <1 | 1 | 1 |
| Common linnet | *Carduelis cannabina* | <1 | 1 | 1 |
| Common redpoll | *Carduelis flammea* | <1 | 1 | 1 |
| Common starling | *Sturnus vulgaris* | 47 | 411 | 1,321 |
| Common swift | *Apus apus* | 1 | 4 | 18 |
| Dark-eyed junco | *Junco hyemalis* | <1 | 1 | 1 |
| Feral pigeon | *Columba livia* | <1 | 3 | 3 |
| Fieldfare | *Turdus pilaris* | 5 | 88 | 130 |
| Garden warbler | *Sylvia borin* | <1 | 2 | 5 |
| Goldcrest | *Regulus regulus* | <1 | 9 | 13 |
| Grasshopper warbler | *Locustella naevia* | <1 | 4 | 5 |
| Greenfinch | *Carduelis chloris* | <1 | 1 | 1 |
| Grey wagtail | *Motacilla cinerea* | <1 | 1 | 2 |
| House martin | *Delichon urbicum* | <1 | 7 | 11 |
| Jackdaw | *Corvus monedula* | <1 | 1 | 1 |
| Lapland bunting | *Calcarius lapponicus* | <1 | 5 | 6 |
| Lesser whitethroat | *Sylvia curruca* | <1 | 1 | 1 |
| Marsh warbler | *Acrocephalus palustris* | <1 | 1 | 1 |
| Meadow pipit | *Anthus pratensis* | 7 | 113 | 192 |
| Northern wheatear | *Oenanthe oenanthe* | 1 | 6 | 25 |
| Pallas's reed bunting | *Emberiza pallasi* | <1 | 1 | 1 |
| Pied flycatcher | *Ficedula hypoleuca* | <1 | 1 | 2 |
| Pied wagtail | *Motacilla alba* | 1 | 4 | 26 |
| Redstart | *Phoenicurus phoenicurus* | 1 | 5 | 17 |
| Redwing | *Turdus iliacus* | 21 | 300 | 593 |
| Reed bunting | *Emberiza schoeniclus* | <1 | 3 | 6 |
| Reed warbler | *Acrocephalus scirpaceus* | <1 | 5 | 10 |
| Ring ouzel | *Turdus torquatus* | <1 | 2 | 2 |
| Robin | *Erithacus rubecula* | 1 | 10 | 27 |
| Sand martin | *Riparia riparia* | <1 | 1 | 1 |
| Sedge warbler | *Acrocephalus schoenobaenus* | <1 | 1 | 1 |
| Siskin | *Carduelis spinus* | <1 | 3 | 6 |
| Skylark | *Alauda arvensis* | <1 | 2 | 11 |
| Snow bunting | *Plectrophenax nivalis* | <1 | 2 | 4 |
| Song thrush | *Turdus philomelos* | 3 | 44 | 97 |
| Tree pipit | *Anthus trivialis* | <1 | 1 | 1 |
| Waxwing | *Bombycilla garrulus* | 2 | 50 | 53 |
| Whinchat | *Saxicola rubetra* | <1 | 1 | 3 |


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| Species | Latin name | Monthly average | Peak | Total |
|---|---|---|---|---|
| Whitethroat | *Sylvia communis* | <1 | 2 | 3 |
| Willow warbler | *Phylloscopus trochilus* | <1 | 2 | 7 |
| Woodcock | *Scolopax rusticola* | <1 | 4 | 10 |
| Woodpigeon | *Columba palumbus* | 1 | 4 | 15 |
| Wren | *Troglodytes troglodytes* | <1 | 4 | 7 |
| Yellow wagtail | *Motacilla flava* | <1 | 2 | 4 |

## Baseline population estimates for marine bird species within the Dogger Bank Zone and Dogger Bank Teesside A & B

6.4.2 Baseline population estimates for the Dogger Bank Zone have been derived using the methodology set out in Section 6.3 for 21 marine bird species as shown in **Table 6.8**. These estimates are used to assess the regional importance of Dogger Bank Teesside A & B for the key species. Patterns in species' annual abundance broadly match those observed by Skov *et al.* (1995) for the North Sea as a whole.

6.4.3 At a zone level, the most abundant species were:

- Common guillemot, with a population of up to 153,538 (90% CIs 141,599-167,402);
- Razorbill, with a population of up to 54,809 (90% CIs 48,976-60,728);
- Black-legged kittiwake, with a population of up to 69,328 (90% CIs 60,120-79,837) (see Tables 3.4, 3.5 and 3.6 in **Appendix 11A** of the Dogger Bank Teesside A & B ES).

6.4.4 The Dogger Bank Zone hosted more than 1% of the Great Britain breeding population of northern fulmar in 2010, black-legged kittiwake in 2010, 2010/11 and 2011/12, great black-backed gull in 2010/11 and 2011/12, common guillemot in 2010, 2010/11 and 2011/12 and razorbill in 2010/11 and 2011/12. It hosted more than 1% of the biogeographic populations of common guillemot in January and February 2010, March and April 2011, and March and April 2012. It hosted more than 1% of the biogeographic populations of razorbill in January, February, October, November and December 2010, February, March and April 2011, and February, March and April 2012 (see Tables 2.3, 3.4, 3.5 and 3.6 in **Appendix 11A** of the Dogger Bank Teesside A & B ES).

6.4.5 Based on the population sizes presented by Skov *et al.* (1995), over the course of the year, the Dogger Bank Zone hosted a significant proportion (>1%) of the North Sea population of:

- Northern fulmar in May and June 2010;
- Northern gannet in October 2012, February to November 2011, and February to June 2012;
- Black-legged kittiwake in 2010, 2011 and 2012;
- Lesser black-backed gull in May to July 2010 and February 2012;
- Great black-backed gull in March to July 2010, March to May 2011 and May to June 2012;

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- Common guillemot in January to June and August to September 2010, January to August 2011, and January to June 2012;
- Razorbill in January, February, March, October and November 2010, March and April 2011, and January and February 2012;
- Little auk in January, October and November 2010; and
- Atlantic puffin in January to March and September to December 2010, January to May and August to September 2011, and January to March 2012.

6.4.6 However, it should be noted that the data on population sizes reported in Skov *et al*. (1995) is up to 18 years older than the observational data gained from Forewind's surveys of Dogger Bank Teesside A & B, and many seabird populations have undergone significant changes in the intervening time period (Mitchell *et al*. 2004; JNCC 2012c).

## Description of marine bird species populations and distribution

### Introduction

6.4.7 The following sections provide an overview of the populations and distributions of the key marine bird species present in the Dogger Bank Zone and Dogger Bank Teesside A & B (inclusive of Dogger Bank Teesside A and Dogger Bank Teesside B ) and for which populations are features of SPAs and Ramsar sites around the greater North Sea region.

6.4.8 These species are: northern fulmar, northern gannet, Arctic skua, great skua, black-legged kittiwake, lesser black-backed gull, great black-backed gull, common guillemot, razorbill, little auk and Atlantic puffin. Monthly population estimates have been calculated for the area covered by Dogger Bank Teesside A & B with incorporated buffers (see Section 6.3 above and Section 4 in **Appendix 11A** of the Dogger Bank Teesside A & B ES).

6.4.9 Other marine bird species were recorded in much smaller numbers and for these species (common scoter, white-billed diver, sooty shearwater, European storm-petrel, pomarine skua, herring gull, black-headed gull, common gull, little gull, and Arctic tern) it was not possible to estimate populations following the modelling approach used for more numerous species. Hence monthly population estimates for Dogger Bank Teesside A & B, as summarised in **Table 6.9**, have been derived using the methodology set out in Section 6.3.

6.4.10 As set out in the HRA Screening Report (see **Appendix A** of the **HRA Report**), a number of the 21 species recorded within the Dogger Bank survey area are not features of any SPA or other protected site in the Greater North Sea OSPAR region. These species are:

- White billed diver;
- Sooty shearwater;
- Pomarine skua; and
- Little auk.

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Table 6.8 Average monthly population estimates (based on data for 2010, 2010/2011 and 2011/2012) for key marine bird species within the Dogger Bank Zone based on models of combined aerial and boat survey data where possible, and extrapolations from densities obtained from boat survey data for remaining species

| Species | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Arctic skua | 2 | 1 | 1 | 1 | 2 | 3 | 10 | 21 | 33 | 20 | 9 | 3 |
| Arctic tern[1] | | | | | 38 | | | | | | | |
| Atlantic puffin | 4,325 | 6,217 | 6,212 | 2,387 | 1,468 | 826 | 557 | 570 | 3,793 | 5,638 | 3,130 | 3,954 |
| Black-headed gull[1] | | 41 | | | | | 156 | | | | | |
| Black-legged kittiwake | 15,404 | 32,057 | 58,160 | 26,009 | 32,718 | 26,167 | 18,766 | 9,880 | 5,151 | 11,752 | 9,787 | 10,800 |
| Common guillemot | 61,252 | 90,183 | 104,935 | 105,160 | 41,807 | 27,955 | 17,522 | 34,615 | 41,391 | 42,519 | 45,551 | 44,811 |
| Common gull[1] | | 56 | | | | | 154 | | | | | |
| Common scoter[1] | | | | | | | | 166 | | | | |
| European storm-petrel | | | | | | | | | 336 | | | |
| Great black-backed gull | 1,862 | 1,658 | 1,234 | 776 | 495 | 303 | 233 | 237 | 312 | 460 | 705 | 1,029 |
| Great skua | 10 | 8 | 8 | 8 | 11 | 16 | 35 | 54 | 64 | 56 | 35 | 19 |
| Herring gull[1] | 317 | | | | | | | | | 317 | | |
| Lesser black-backed gull | 54 | 138 | 295 | 663 | 1,532 | 1,585 | 1,077 | 380 | 100 | 40 | 25 | 25 |
| Little auk | 16,807 | 5,456 | 982 | 183 | 38 | 15 | 2 | 4 | 68 | 1,178 | 7,598 | 14,315 |
| Little gull[1] | | | | | | | | | | 208 | | |
| Northern fulmar | 1,029 | 1,994 | 3,020 | 3,844 | 10,716 | 8,558 | 6,223 | 3,343 | 1,956 | 1,969 | 1,137 | 923 |
| Northern gannet | 779 | 2,434 | 10,312 | 3,447 | 5,782 | 3,027 | 2,793 | 2,474 | 1,683 | 8,862 | 2,743 | 963 |
| Pomarine skua[1] | | | | | | | | | 62 | | | |
| Razorbill | 17,895 | 32,025 | 34,613 | 35,888 | 3,502 | 27,955 | 703 | 3,457 | 6,157 | 21,823 | 14,424 | 8,994 |
| Sooty shearwater[1] | | | | | | | | 88 | | | | |
| White-billed diver[1] | 80 | | | | | | | | | | 80 | |

[1] Numbers of birds were insufficient to estimate monthly population estimates through the preferred modelling approach.


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Table 6.9 Monthly population estimates within Dogger Bank Teesside A & B for less numerous seabirds

| Species | Months present | Monthly population estimates | | | Population 1% threshold | |
|---|---|---|---|---|---|---|
| | | Dogger Bank Teesside A | Dogger Bank Teesside B | Dogger Bank Teesside A & B[1] | GB | Biogeo-graphic |
| Arctic tern | May-Sep | 3 | 4 | 7 | 1,590* | 20,000 |
| Black-headed gull | Feb-May | 4 | 4 | 8 | 22,000 | 42,100 |
| | Jul-Nov | 14 | 14 | 28 | 3,900* | |
| Common gull | Feb-May | 5 | 5 | 10 | 7,000 | 16,400 |
| | Jul-Nov | 13 | 14 | 28 | 1,440* | |
| Common scoter | Aug-Dec | 16 | 16 | 32 | 1,000 | 5,500 |
| European storm-petrel | Sep | 30 | 31 | 61 | 780* | 14,700 |
| Herring gull | Oct-May | 28 | 29 | 58 | 7,300 | 10,200 |
| Little gull | Oct | 19 | 19 | 38 | - | 1,100 |
| Pomarine skua | Sep-Oct | 6 | 6 | 11 | - | 16,250 |
| Sooty shearwater | Aug-Nov | 9 | 8 | 16 | - | 200,000 |
| White-billed diver | Nov-Apr | 7 | 7 | 15 | - | 100 |

[1] In cases where the combined population estimate for Dogger Bank Teesside A & B differs to the total of that presented for each project, this is due to overlap in the buffer extents.
* Breeding season population threshold.

6.4.11 As such, these species were screened out of the assessment (see **Appendix A** of the **HRA Report**) and they are not considered any further in this report.

6.4.12 Subsequent to the initial screening exercise, examination of draft population estimate data for the project area (see **Table 6.9**) was used as a means of further screening the range of species for which it could be determined that the project would give rise to LSE with regard to designated populations. The basis for the conclusion on LSE for these species is provided in HRA Screening Report and is summarised in Section 3 of this report. The species excluded from further consideration are:

- Common scoter (although considered as a migratory species);
- European storm petrel;
- Little gull;
- Black-headed gull;
- Common gull;
- Herring gull;
- Arctic tern; and
- Common tern.

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6.4.13 The following sections provide a summary of relevant information on the remaining marine bird species recorded from within the Dogger Bank Zone and Dogger Bank Teesside A & B, including distribution, seasonality and estimated numbers present within Dogger Bank Teesside A & B. The significance of the estimated abundance of individual species is placed in context of reference national and international populations.

**Northern fulmar**

6.4.14 Northern fulmar is one of the most common species of seabird in the North Atlantic, and widely distributed throughout the North Sea in all months (Tasker *et al*. 1986).

6.4.15 Northern fulmar has a wide-ranging diet including fish and offal and can forage up to 580km from colonies (see **Table 6.1**) although 400km is the mean maximum distance, meaning that the Dogger Bank Zone and Dogger Bank Teesside A & B Export Cable Corridor are within the potential foraging range of birds from some SPAs in Scottish waters.

6.4.16 Northern fulmar is a breeding feature of 26 SPAs and a wintering feature of two SPAs in the Greater North Sea OSPAR region. Dogger Bank Teesside A & B is within foraging range of eight protected breeding sites in Great Britain, and nine protected breeding sites around the North Sea at which the species is a feature. The nearest breeding colony to Dogger Bank is in the Flamborough and Filey Coast pSPA, with a population of 1,447 pairs or 2,894 breeding adults (2008-2011) (Natural England 2013).

6.4.17 Northern fulmar has a breeding population in Great Britain of 498,764 pairs (1% threshold 15,000 individuals) and a biogeographic population of 2,700,000 to 4,100,000 pairs (1% threshold of 102,000 individuals).

6.4.18 The survey data indicates that the Dogger Bank Zone hosted more than 1% of the Great Britain breeding population of northern fulmar in 2010. Based on the population sizes presented by Skov *et al*. (1995), over the course of the year, the Dogger Bank Zone hosted a significant proportion (> 1%) of the North Sea population of northern fulmar in May and June 2010.

6.4.19 In Dogger Bank Teesside A & B, mean populations across the two and a half years of survey peaked in May (see **Table 6.10**), with a mean of 590 birds (90 % CIs = 486-699) in the project area and 805 birds (90% CIs = 663-953) present in the project area plus buffer. The 1% thresholds for populations of national and international importance were not exceeded.

6.4.20 The distribution of northern fulmar (see Figures 3.2, 3.3 and 3.4 in **Appendix 11A** of the Dogger Bank Teesside A & B ES) show that the highest densities occur in the west and north-east of the Dogger Bank Zone, with moderate to high densities occurring in the north-west corner of Dogger Bank Teesside B in spring and summer 2010 and 2012, and moderate densities in Dogger Bank Teesside A in early summer in 2010 and 2012. Though Dogger Bank Teesside A & B are generally outside the highest density areas within the Zone.

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Table 6.10 Baseline population estimates for northern fulmar within Dogger Bank Teesside A, Dogger Bank Teesside B, and Dogger Bank Teesside A & B ('Project' column in the table) and including the 2km buffer ('Buffer' column in the table)

| Year | Month | Dogger Bank Teesside A | | Dogger Bank Teesside B | | Dogger Bank Teesside A & B | |
|---|---|---|---|---|---|---|---|
| | | Project | Buffer | Project | Buffer | Project | Buffer |
| 2010 | January | 29 | 39 | 43 | 58 | 72 | 97 |
| | February | 92 | 127 | 131 | 177 | 223 | 303 |
| | March | 143 | 196 | 148 | 200 | 292 | 397 |
| | April | 317 | 434 | 289 | 390 | 606 | 825 |
| | May | 569 | 781 | 540 | 732 | 1,110 | 1,517 |
| | June | 564 | 773 | 528 | 716 | 1,091 | 1,492 |
| | July | 253 | 347 | 268 | 364 | 522 | 711 |
| | August | 107 | 146 | 114 | 154 | 220 | 300 |
| | September | 71 | 97 | 75 | 102 | 145 | 199 |
| | October | 49 | 67 | 69 | 93 | 118 | 161 |
| | November | 32 | 44 | 44 | 59 | 76 | 103 |
| | December | 45 | 62 | 59 | 80 | 104 | 141 |
| 2011 | January | 46 | 63 | 56 | 75 | 102 | 138 |
| | February | 72 | 98 | 87 | 117 | 158 | 217 |
| | March | 89 | 122 | 72 | 97 | 161 | 218 |
| | April | 102 | 140 | 81 | 109 | 183 | 249 |
| | May | 98 | 135 | 79 | 107 | 177 | 243 |
| | June | 91 | 125 | 76 | 103 | 168 | 228 |
| | July | 101 | 138 | 85 | 115 | 186 | 253 |
| | August | 110 | 151 | 96 | 129 | 206 | 280 |
| | September | 124 | 171 | 107 | 145 | 232 | 316 |
| | October | 119 | 163 | 165 | 224 | 283 | 388 |
| | November | 49 | 67 | 68 | 92 | 117 | 160 |
| | December | 37 | 50 | 48 | 65 | 85 | 115 |
| 2012 | January | 25 | 35 | 33 | 45 | 59 | 80 |
| | February | 98 | 134 | 123 | 167 | 221 | 301 |
| | March | 124 | 170 | 117 | 159 | 241 | 328 |
| | April | 240 | 329 | 199 | 270 | 439 | 599 |
| | May | 258 | 354 | 223 | 303 | 481 | 656 |
| | June | 124 | 170 | 108 | 146 | 231 | 316 |

### Northern gannet

6.4.21 Northern gannet is widespread throughout the North Sea in all months, with most adults remaining all year, while younger birds generally move south in the winter, with some individuals having been recorded off the west coast of Africa at this time (Camphuysen 2005).

6.4.22 Gannets eat a wide variety of fish, including discards from fishing vessels, and can forage up to 590km from colonies, although 230km is the mean maximum distance (see **Table 6.1**). Recent tagging studies indicate that gannets from the Flamborough and Filey Coast pSPA forage within the Dogger Bank Zone (FAME 2012). The species' foraging range means that some gannets from as

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far away as Scotland (the Forth Islands SPA) could also potentially forage within the Dogger Bank Zone during the breeding season.

6.4.23 Northern gannet is a breeding feature of nine SPAs, a wintering feature of five SPAs and a passage feature of five SPAs in the Greater North Sea OSPAR region. There is one breeding colony of gannets within the Offshore ZDE at the Flamborough and Filey Coast pSPA, with 2,501 pairs (1.2% of the GB breeding population) listed by Stroud *et al.* (2001), though numbers have increased significantly in recent years to reach a population of 8,469 pairs or 16,938 breeding adults (2008-2012). It should also be noted that in 2012 there were 11,061 pairs (Aitken *et al*. 2012 - quoted in Natural England (2013)).

6.4.24 Northern gannet has a biogeographic population of 417,579 pairs (1% threshold of 12,527 individuals) and a breeding population of 218,546 actual occupied nests (1% threshold 6,600 individuals) in Great Britain.

6.4.25 In Dogger Bank Teesside A & B, mean populations across the two and a half years of survey peaked in March, with a mean of 1,656 birds (90 % CIs = 1,388-1,972) in the project area and 2,250 birds (90% CIs = 1,882-2,679) present in the project area plus buffer (see **Table 6.11**). The 1% thresholds for populations of national and international importance were not exceeded.

6.4.26 Surveys indicate that numbers of this species in the Dogger Bank Zone peak in early spring with a noticeable secondary peak in the autumn (October), as identified in **Appendix 11A** of the Dogger Bank Teesside A & B ES. Numbers in the Dogger Bank Zone as a whole surpassed the 1% threshold for populations of international importance in the 2011 and 2012 breeding season.

Table 6.11 Baseline population estimates for northern gannet within Dogger Bank Teesside A, Dogger Bank Teesside B, and Dogger Bank Teesside A & B ('Project' column in the table) and including the 2km buffer ('Buffer' column in the table)

| Year | Month | Dogger Bank Teesside A | | Dogger Bank Teesside B | | Dogger Bank Teesside A & B | |
|---|---|---|---|---|---|---|---|
| | | Project | Buffer | Project | Buffer | Project | Buffer |
| 2010 | January | 36 | 50 | 59 | 80 | 95 | 130 |
| | February | 32 | 44 | 46 | 62 | 79 | 107 |
| | March | 46 | 63 | 64 | 86 | 109 | 148 |
| | April | 8 | 11 | 9 | 12 | 17 | 23 |
| | May | 28 | 39 | 34 | 46 | 62 | 85 |
| | June | 63 | 88 | 75 | 100 | 138 | 188 |
| | July | 44 | 61 | 67 | 90 | 111 | 151 |
| | August | 29 | 40 | 44 | 60 | 74 | 100 |
| | September | 38 | 53 | 58 | 78 | 96 | 131 |
| | October | 109 | 150 | 155 | 209 | 264 | 359 |
| | November | 59 | 81 | 76 | 102 | 134 | 183 |
| | December | 108 | 147 | 128 | 172 | 235 | 319 |

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| Year | Month | Dogger Bank Teesside A | | Dogger Bank Teesside B | | Dogger Bank Teesside A & B | |
|---|---|---|---|---|---|---|---|
| | | Project | Buffer | Project | Buffer | Project | Buffer |
| 2011 | January | 80 | 109 | 79 | 107 | 159 | 216 |
| | February | 163 | 224 | 159 | 214 | 322 | 438 |
| | March | 820 | 1,129 | 984 | 1,322 | 1,805 | 2,452 |
| | April | 106 | 147 | 129 | 174 | 236 | 321 |
| | May | 110 | 153 | 141 | 189 | 252 | 342 |
| | June | 104 | 145 | 142 | 191 | 247 | 335 |
| | July | 127 | 176 | 179 | 239 | 306 | 415 |
| | August | 140 | 194 | 205 | 275 | 345 | 469 |
| | September | 163 | 226 | 241 | 325 | 404 | 551 |
| | October | 442 | 607 | 597 | 806 | 1,039 | 1,412 |
| | November | 81 | 111 | 105 | 142 | 186 | 253 |
| | December | 52 | 71 | 59 | 80 | 111 | 151 |
| 2012 | January | 22 | 31 | 26 | 36 | 49 | 66 |
| | February | 300 | 410 | 325 | 438 | 625 | 847 |
| | March | 1,244 | 1,711 | 1,811 | 2,437 | 3,054 | 4,150 |
| | April | 379 | 526 | 434 | 583 | 813 | 1,111 |
| | May | 488 | 679 | 611 | 821 | 1,099 | 1,500 |
| | June | 152 | 212 | 191 | 257 | 344 | 468 |

6.4.27 The surveys indicate that, generally, the distribution of northern gannet is more concentrated in the south and south western part of the Dogger Bank Zone (see Figures 3.8, 3.9 and 3.10 in **Appendix 11A** of the Dogger Bank Teesside A & B ES), though the species occurred throughout the Dogger Bank Zone at moderate densities. Generally, this species occurs in Dogger Bank Teesside A & B at lower densities compared to elsewhere in the Zone, though Dogger Bank Teesside B occasionally has high densities compared to elsewhere (e.g. in March 2011 and 2012). Northern gannet observed in the Dogger Bank Zone during the summer are likely to be from different populations to those observed during the winter (Fort *et al*. 2012).

**Arctic skua**

6.4.28 Arctic skua has a circumpolar distribution, breeding on tundra and coastal moors between 82°N and 56°N. In Britain and Ireland, breeding Arctic skua are restricted to Scotland, particularly the Northern Isles, where they nest in colonies, being present from April to August. During the breeding season (April to July / August) Arctic skua occur in northern waters around Scotland, generally close to the nesting colonies. At the end of the breeding season (August to October), they move south to inshore waters along British and Irish coasts (Stone *et al*. 1995) before migrating to the southern hemisphere. It is estimated that the UK supports approximately 10% of the biogeographic population.

6.4.29 The diet of Arctic skua is particularly broad encompassing fish, insects, berries, offal and carrion, passerines, shorebirds, ducks, terns, birds' eggs, and is also kleptoparasitic taking food from other species. As scavengers, Arctic skuas may also be attracted to boats and activities in the areas which may represent a positive attraction effect.

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6.4.30 Arctic skua in the Greater North Sea OSPAR region is a breeding feature of 12 SPAs and a passage feature of two SPAs.

6.4.31 Estimated numbers in the Dogger Bank Zone as a whole peaked at 49 birds in the post-breeding period in September 2011. While it cannot be assumed that all birds at this time come from British colonies, the estimated population within the Dogger Bank Zone at this time surpasses the 1% threshold for populations of national importance. It should be noted that the estimated numbers of this species in the Dogger Bank Zone are probably underestimated due to the turnover of birds (i.e. birds moving through the zone) during the passage season.

6.4.32 Arctic skua were present in the Dogger Bank Zone in the late summer and autumn. During these months an average of three birds (Figure 3.18; Table 3.18 in **Appendix 11A** of the Dogger Bank Teesside A & B ES) were estimated to occur in Dogger Bank Teesside A & B per month. Mean populations across the two and a half years of survey peaked in September, with a mean of five birds (90 % CIs = 2-14) in the project and seven birds (90% CIs = 3-20) present in the project and buffer. Between January 2010 and June 2012 the 1% thresholds for populations of national and international importance were not exceeded in Dogger Bank Teesside A & B.

6.4.33 The distribution of Arctic skua (see Figures 3.14, 3.15 and 3.16 in **Appendix 11A** of the Dogger Bank Teesside A & B ES) shows that the highest densities occur in the southern part of the Dogger Bank Zone, and are generally present in higher densities within Dogger Bank Teesside A & B than the northern areas of the Zone. Caution should be exercised with over interpreting relative differences, however, given the very small numbers involved.

**Great skua**

6.4.34 As almost two thirds of the world population of great skuas breeds in Orkney and Shetland (Mitchell *et al*. 2004), the North Sea is of great importance to this species. In summer, birds are concentrated at their breeding colonies but in autumn, birds move down the east coast of Britain, through the English Channel and to the Atlantic, where they spend the winter.

6.4.35 Great skua is a breeding feature of seven SPAs and a passage feature of two SPAs in the Greater North Sea OSPAR region.

6.4.36 Estimated numbers in the Dogger Bank Zone as a whole peaked at 104 birds (90% confidence interval of 71 to 148) in the post-breeding period in September 2011. While it cannot be assumed that all birds at this time come from British colonies, and this figure does not surpass the 1% threshold for populations of national importance, it should be noted that the estimated numbers of this species in the Dogger Bank Zone are probably underestimated due to the rapid movement of birds through the Zone (i.e. high turnover) during the passage season.

6.4.37 The baseline monthly population estimates all years showed low numbers of great skua using Dogger Bank Teesside A & B (Figure 3.24 in **Appendix 11A** of the Dogger Bank Teesside A & B ES). The highest number of 13 birds was estimated for September 2011 (90% CIs = 10-22) (Table 3.21). Mean

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populations across the two and a half years of survey peaked in September, with a mean of 8 birds (90 % CIs = 6-14) in the project area and 11 birds (90% CIs = 8-19) present in the project area and buffer. Between January 2010 and June 2012 the 1% thresholds for populations of national and international importance were not exceeded in Dogger Bank Teesside A & B.

6.4.38 On a monthly basis, the densities of great skua within the south-western and western areas of the Dogger Bank Zone (i.e. which encompasses Dogger Bank Teesside A & B) appeared to be higher than elsewhere within the zone (see Figures 3.20, 3.21 and 3.22 in **Appendix 11A** of the Dogger Bank Teesside A & B ES). However, given the very small population estimates some caution should be applied in the interpretation of the distribution data.

**Black-legged kittiwake**

6.4.39 Black-legged kittiwake is widespread throughout the North Sea in all months, with largest numbers occurring in winter (Tasker *et al*. 1986). Black-legged kittiwakes eat a variety of fish, and may forage over 200km from colonies (FAME 2012), although 62km is the estimated mean maximum range (see **Table 6.1**). Tagging studies of kittiwakes are on-going at the Flamborough and Filey Coast pSPA and this work should show whether kittiwakes from this SPA may forage within the Dogger Bank Zone (FAME 2012).

6.4.40 Black-legged kittiwake is a breeding feature of 24 SPAs, a wintering feature of four SPAs and a passage feature of six SPAs in the Greater North Sea OSPAR region. The largest breeding colony of black-legged kittiwake within the Offshore ZDE is at the Flamborough and Filey Coast pSPA, with 83,370 pairs (17.0% of the GB breeding population) listed by Stroud *et al.* (2001), though numbers have fallen more recently and the cited figure for the period 2008-2011 is now 44,520 pairs or 89,041 breeding adults (Natural England, 2013).

6.4.41 Numbers recorded in the Dogger Bank Zone as a whole surpassed the 1% threshold for populations of national importance in the 2010, 2011 and 2012 breeding seasons.

6.4.42 In 2010, the monthly baseline population estimates of black-legged kittiwake within Dogger Bank Teesside A & B peaked between February and March (see **Table 6.12**; highest value in March of 5,594 birds, 90% CIs = 4,899-6,246). Population estimates peaked during March in both 2010/11 (11,376 birds, 90% CIs = 10,196-12,671) and 2011/12 (9,047 birds, 90% CIs = 7,976-10,170) periods (Table 3.24; Figure 3.30 in **Appendix 11A** of the Dogger Bank Teesside A & B ES). Mean populations across the two and a half years of survey peaked in March, with a mean of 8,673 birds (90 % CIs = 7,690-9,696) in the project area and 11,806 birds (90% CIs = 10,462-13,204) present in the project area plus buffer. Between January 2010 and June 2012 the 1% thresholds for populations of national and international importance were not exceeded in Dogger Bank Teesside A & B.

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Table 6.12 Baseline population estimates for black-legged kittiwake within Dogger Bank Teesside A, Dogger Bank Teesside B, and Dogger Bank Teesside A & B ('Project' column in the table) and including the 2km buffer ('Buffer' column in the table)

| Year | Month | Dogger Bank Teesside A | | Dogger Bank Teesside B | | Dogger Bank Teesside A & B | |
|---|---|---|---|---|---|---|---|
| | | Project | Buffer | Project | Buffer | Project | Buffer |
| 2010 | January | 731 | 996 | 1,253 | 1,712 | 1,985 | 2,708 |
| | February | 1,386 | 1,897 | 2,189 | 2,978 | 3,576 | 4,876 |
| | March | 2,196 | 3,006 | 3,398 | 4,604 | 5,594 | 7,613 |
| | April | 652 | 896 | 1,006 | 1,362 | 1,659 | 2,257 |
| | May | 874 | 1,204 | 1,422 | 1,931 | 2,295 | 3,130 |
| | June | 832 | 1,145 | 1331 | 1,813 | 2,163 | 2948 |
| | July | 421 | 580 | 799 | 1,086 | 1,220 | 1,657 |
| | August | 273 | 376 | 518 | 704 | 790 | 1,080 |
| | September | 364 | 503 | 690 | 941 | 1,055 | 1,442 |
| | October | 762 | 1,043 | 1,186 | 1,617 | 1,948 | 2,663 |
| | November | 618 | 846 | 902 | 1,230 | 1,520 | 2,076 |
| | December | 1,044 | 1,425 | 1,439 | 1,958 | 2,483 | 3,378 |
| 2011 | January | 885 | 1,210 | 1,037 | 1,407 | 1,922 | 2,619 |
| | February | 1,499 | 2,053 | 1,742 | 2,362 | 3,242 | 4,412 |
| | March | 4,889 | 6,702 | 6,487 | 8,773 | 11,376 | 15,465 |
| | April | 1,648 | 2,271 | 2,564 | 3,471 | 4,211 | 5,752 |
| | May | 1,592 | 2,194 | 2,555 | 3,445 | 4,146 | 5,640 |
| | June | 1,058 | 1,455 | 1,776 | 2,400 | 2,834 | 3,850 |
| | July | 575 | 791 | 988 | 1,333 | 1,564 | 2,126 |
| | August | 240 | 331 | 422 | 570 | 663 | 902 |
| | September | 136 | 188 | 240 | 325 | 376 | 513 |
| | October | 223 | 305 | 321 | 435 | 544 | 740 |
| | November | 150 | 205 | 212 | 287 | 362 | 493 |
| | December | 315 | 431 | 406 | 550 | 720 | 980 |
| 2012 | January | 362 | 496 | 492 | 669 | 854 | 1,166 |
| | February | 2,123 | 2,900 | 2,703 | 3,672 | 4,826 | 6,571 |
| | March | 3,540 | 4,853 | 5,507 | 7,476 | 9,047 | 12,341 |
| | April | 1,193 | 1,644 | 1,819 | 2,464 | 3,012 | 4,110 |
| | May | 1,235 | 1,705 | 1,999 | 2,708 | 3,234 | 4,413 |
| | June | 760 | 1,048 | 1,236 | 1,675 | 1,996 | 2,720 |

6.4.43 The baseline population estimates for black-legged kittiwake in 2010, 2010/11 and 2011/12 were higher than those derived from ESAS data. ESAS population estimates were at their highest during the combined period of October to March period, with a value of 1,845 birds and at their lowest during the combined period of April to July

6.4.44 Surveys indicate that the distribution of kittiwake is concentrated towards the western edge of the Dogger Bank Zone, though the species occurs throughout the Dogger Bank Zone (see Figures 3.26, 3.27 and 3.28 in **Appendix 11A** of the Dogger Bank Teesside A & B ES).

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### Lesser black-backed gull

6.4.45 The highest numbers of lesser black-backed gull occur in the North Sea in spring and summer, as the species is a partial summer migrant to the area (Tasker *et al*. 1986). Lesser black-backed gull eat a wide variety of fish, including discards and offal from fishing vessels, and are mainly coastal during the breeding season. The species can forage up to 181km from colonies although 132km is the estimated mean maximum range (see **Table 6.1**). Skov *et al.* (1995) noted that lesser black-backed gulls were recorded at low densities off the North Yorkshire coast in September and October, and in the central and southern North Sea between March and June.

6.4.46 Lesser black-backed gull has a breeding population in Great Britain of 110,101 pairs (1% threshold 1,200 individuals) and a wintering population in Great Britain of 124,654 individuals (1% threshold 3,300 individuals). The biogeographic population for the *intermedius* race is 325,000 to 440,000 individuals and that for the *graellsii* race is 530,000 to 570,000 individuals (1% threshold 5,500 individuals). A distinction between the two races was not made during the surveys and for the purposes of assessment they are treated together.

6.4.47 Lesser black-backed gull is a breeding feature of 21 SPAs, a wintering feature of two SPAs and a passage feature of three SPAs in the Greater North Sea OSPAR region. The closest, large breeding colony of lesser black-backed gull to the Dogger Bank Zone is on Outer Trial Bank in The Wash, with 1,378 apparently occupied nests (AONs) recorded during Seabird 2000 (Mitchell *et al*., 2004), although as numbers at the site were previously lower, the species is not included as a feature of The Wash SPA (Stroud *et al*. 2004).

6.4.48 Monthly population estimates show a peak during the early summer (May-June) with few birds being present outside of the summer and no birds present during November 2010. Numbers in the Dogger Bank Zone as a whole surpassed the 1% threshold for populations of national importance in the 2010 breeding season, though those present at this time may be *intermedius* birds from the Scandinavia breeding population.

6.4.49 In 2010, the monthly baseline population estimates of lesser black-backed gull within Dogger Bank Teesside A & B peaked between April and July (highest value in June with 361 birds, 90% CIs = 254-514). In 2010/11 and 2011/12 the populations were estimated to peak earlier, in May, with 189 birds (90% CIs = 136-267) and 99 birds (90% CIs = 39-269) respectively – see **Table 6.13**. Population estimates were lower in 2011/12 than 2010/11 (Table 3.27; Figure 3.36 in **Appendix 11A** of the Dogger Bank Teesside A & B ES). Mean populations across the two and a half years of survey peaked in May, with a mean of 201 birds (90 % CIs = 134-339) in the project area and 274 birds (90% CIs = 183-461) present in Dogger Bank Teesside A & B and the 2km buffer zone.

6.4.50 On a monthly basis, the densities of lesser black-backed gull within the south-eastern and eastern areas of the Dogger Bank Zone were higher than elsewhere within the zone, apart from the far western boundary of the zone (see Figures 3.32, 3.33 and 3.34 in **Appendix 11A** of the Dogger Bank Teesside A & B ES).

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Table 6.13 Baseline population estimates for lesser black-backed gull within Dogger Bank Teesside A, Dogger Bank Teesside B, and Dogger Bank Teesside A & B ('Project' column in the table) and including the 2km buffer ('Buffer' column in the table)

| Year | Month | Dogger Bank Teesside A | | Dogger Bank Teesside B | | Dogger Bank Teesside A & B | |
|---|---|---|---|---|---|---|---|
| | | Project | Buffer | Project | Buffer | Project | Buffer |
| 2010 | January | 8 | 11 | 7 | 9 | 15 | 20 |
| | February | 18 | 24 | 15 | 20 | 32 | 44 |
| | March | 41 | 56 | 34 | 46 | 75 | 101 |
| | April | 87 | 118 | 61 | 83 | 148 | 201 |
| | May | 174 | 238 | 141 | 191 | 315 | 431 |
| | June | 201 | 275 | 160 | 218 | 361 | 498 |
| | July | 82 | 113 | 77 | 104 | 159 | 216 |
| | August | 27 | 37 | 25 | 34 | 52 | 72 |
| | September | 13 | 18 | 11 | 15 | 24 | 33 |
| | October | 3 | 4 | 2 | 3 | 5 | 7 |
| | November | 1 | 1 | 1 | 1 | 2 | 3 |
| | December | 1 | 2 | 1 | 1 | 2 | 3 |
| 2011 | January | 2 | 2 | 1 | 1 | 3 | 4 |
| | February | 5 | 7 | 3 | 4 | 8 | 11 |
| | March | 33 | 45 | 24 | 33 | 57 | 78 |
| | April | 88 | 120 | 64 | 87 | 152 | 210 |
| | May | 108 | 148 | 81 | 110 | 189 | 256 |
| | June | 69 | 94 | 55 | 74 | 124 | 169 |
| | July | 32 | 43 | 26 | 35 | 58 | 79 |
| | August | 12 | 17 | 10 | 13 | 22 | 29 |
| | September | 7 | 10 | 6 | 8 | 13 | 17 |
| | October | 4 | 5 | 3 | 4 | 6 | 9 |
| | November | 3 | 4 | 2 | 3 | 5 | 7 |
| | December | 6 | 8 | 4 | 6 | 11 | 14 |
| 2012 | January | 6 | 9 | 5 | 7 | 11 | 15 |
| | February | 27 | 36 | 19 | 25 | 45 | 61 |
| | March | 36 | 49 | 30 | 41 | 66 | 90 |
| | April | 47 | 65 | 33 | 45 | 80 | 110 |
| | May | 55 | 75 | 44 | 59 | 99 | 135 |
| | June | 52 | 71 | 40 | 54 | 91 | 124 |

### Great black-backed gull

6.4.51 Great black-backed gull has a breeding population in Great Britain of 17,084 pairs (1% threshold of 510 individuals) and a wintering population in Great Britain of 75,860 individuals (1% threshold of 760 individuals). The biogeographic population is 330,000 to 540,000 individuals (1% threshold of 4,350 individuals). The North Sea is of global importance for this species in winter (Skov *et al*. 1995).

6.4.52 Great black-backed gull eat a wide variety of fish, including discards and offal, and seabirds, and are mainly coastal during the breeding season.

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6.4.53 This species is a breeding feature of 17 SPAs and a wintering feature of two SPAs in the Greater North Sea OSPAR region.

6.4.54 Numbers in the Dogger Bank Zone as a whole surpassed the 1% breeding and winter thresholds for populations of national importance, with peak numbers recorded during January and February. There were, however, a high proportion of non-breeders present in the breeding season and the Dogger Bank Zone is beyond the foraging range of any protected breeding site for the species.

6.4.55 In 2010, the monthly baseline population estimates of great black-backed gull within Dogger Bank Teesside A & B peaked in January, February, March, November and December (highest value in January with 360 birds, 90% CIs = 279-427). The population estimates followed a similar trend in 2010/11 and 2011/12 periods – see **Table 6.14**. Populations peaked in January (243 birds, 90% CIs = 189-305) and February (177 birds, 90% CIs = 127-237), respectively (see Table 3.30; Figure 3.42 in **Appendix 11A** of the Dogger Bank Teesside A & B ES). Mean populations across the two and a half years of survey peaked in January, with a mean of 238 birds (90 % CIs = 185-291) in the project area and 324 birds (90% CIs = 250-393) present in the project area plus buffer. Between January 2010 and June 2012 the 1% thresholds for populations of national and international importance were not exceeded in Dogger Bank Teesside A & B.

6.4.56 The densities of great black-backed gull area highest in the south-western and western areas of the Dogger Bank Zone than elsewhere within the zone during the period of January to March when the highest population estimates occur (see Figures 3.38, 3.39 and 3.40 in **Appendix 11A** of the Dogger Bank Teesside A & B ES).

Table 6.14 Baseline population estimates for great black-backed gull for Dogger Bank Teesside A, Dogger Bank Teesside B, and Dogger Bank Teesside A & B ('Project' column in the table) and including the 2km buffer ('Buffer' column in the table)

| Year | Month | Dogger Bank Teesside A | | Dogger Bank Teesside B | | Dogger Bank Teesside A & B | |
|---|---|---|---|---|---|---|---|
| | | Project | Buffer | Project | Buffer | Project | Buffer |
| 2010 | January | 155 | 212 | 204 | 277 | 360 | 488 |
| | February | 97 | 133 | 124 | 167 | 221 | 301 |
| | March | 54 | 75 | 69 | 93 | 123 | 167 |
| | April | 33 | 45 | 27 | 37 | 60 | 83 |
| | May | 20 | 27 | 17 | 23 | 37 | 50 |
| | June | 13 | 18 | 11 | 15 | 24 | 34 |
| | July | 9 | 13 | 8 | 11 | 18 | 24 |
| | August | 10 | 14 | 9 | 13 | 20 | 27 |
| | September | 17 | 24 | 22 | 30 | 40 | 54 |
| | October | 27 | 37 | 35 | 47 | 62 | 84 |
| | November | 50 | 69 | 63 | 85 | 113 | 154 |
| | December | 104 | 143 | 126 | 170 | 230 | 310 |

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| Year | Month | Dogger Bank Teesside A | | Dogger Bank Teesside B | | Dogger Bank Teesside A & B | |
|---|---|---|---|---|---|---|---|
| | | Project | Buffer | Project | Buffer | Project | Buffer |
| 2011 | January | 113 | 155 | 130 | 175 | 243 | 330 |
| | February | 111 | 153 | 128 | 173 | 240 | 327 |
| | March | 109 | 149 | 132 | 178 | 241 | 327 |
| | April | 74 | 102 | 57 | 77 | 131 | 179 |
| | May | 41 | 56 | 32 | 43 | 73 | 99 |
| | June | 24 | 33 | 19 | 25 | 43 | 58 |
| | July | 18 | 25 | 14 | 19 | 32 | 44 |
| | August | 17 | 23 | 14 | 18 | 30 | 42 |
| | September | 19 | 26 | 24 | 32 | 43 | 59 |
| | October | 23 | 32 | 29 | 39 | 52 | 70 |
| | November | 30 | 42 | 38 | 51 | 68 | 92 |
| | December | 52 | 71 | 62 | 83 | 113 | 154 |
| 2012 | January | 51 | 70 | 62 | 83 | 113 | 154 |
| | February | 81 | 111 | 95 | 129 | 177 | 240 |
| | March | 69 | 95 | 88 | 119 | 158 | 213 |
| | April | 60 | 83 | 48 | 64 | 108 | 144 |
| | May | 38 | 52 | 32 | 43 | 69 | 94 |
| | June | 20 | 28 | 17 | 22 | 37 | 50 |

### Common guillemot

6.4.57 Guillemot are found throughout the North Sea in all months, with late summer generally being the most important period, when an estimated 1.8 million birds are in the North Sea, including recently fledged juveniles, moulting adults and non-breeding birds (Skov *et al*. 1995). The most important area lies off the east coast of Scotland and northeast England in July and August. This species may forage up to 340km from colonies (FAME 2012) although 71km is the estimated mean maximum range. The diet largely comprises schooling pelagic fish such as sandeels, clupeids and gadoids, but it will also take crustaceans and other invertebrates.

6.4.58 Common guillemot in the Greater North Sea OSPAR region is a breeding feature of 26 SPAs, a wintering feature of 11 SPAs, and a passage feature Common guillemot has a breeding population in Great Britain of 1,322,354 individuals (1% threshold 13,200 individuals) and a biogeographic population of 2,800,000 to 2,900,000 pairs (1% threshold of 85,000 individuals).

6.4.59 The largest common guillemot breeding colony in proximity to the Dogger Bank Zone is at Flamborough and Filey Coast pSPA, with 16,150 pairs (2.3% of the GB breeding population) listed by Stroud *et al.* (2004), although numbers have risen considerably since and the population (2008-2011) is now given as 41,607 pairs or 83,214 breeding adults (Natural England 2013). Numbers in the Dogger Bank Zone as a whole surpassed the 1% threshold for populations of national importance in the breeding season and the 1% threshold for international importance in the winter.

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6.4.60 Numbers in the Dogger Bank Zone as a whole surpassed the 1% threshold for populations of national importance in the breeding season and the 1% threshold for international importance in the winter months

6.4.61 In 2010, the monthly baseline population estimates of common guillemot within Dogger Bank Teesside A & B peaked from January to April and September to December (highest value in December with 10,513 birds, 90% CIs = 9,792-11,359) (Table 3.30). The population estimates also increased during the winter months in 2010/11 and 2011/12 – see **Table 6.15**. However, higher population estimates were calculated for these months, peaking at 16,188 birds (90% CIs = 15,159-17,360) in March 2010/11 and 16,170 birds (90% CIs = 14,947-17,377) in April 2011/12 (Table 3.33; Figure 3.48 in **Appendix 11A** of the Dogger Bank Teesside A & B ES). Mean populations across the two and a half years of survey peaked in March, with a mean of 13,531 birds (90 % CIs = 12,562-14,536) in the project and 18,428 birds (90% CIs = 17,107-19,807) present in the project and buffer. Between January 2010 and June 2012 the 1% thresholds for populations of national and international importance were not exceeded in Dogger Bank Teesside A & B.

6.4.62 The distribution of common guillemot (see Figures 3.44, 3.45 and 3.46 in **Appendix 11A** of the Dogger Bank Teesside A & B ES) shows that the greatest densities occur in south-west areas of the Dogger Bank Zone. Densities are generally below average for the Zone within both Dogger Bank Teesside A and Dogger Bank Teesside B for most of the year, though often higher in Dogger Bank Teesside B than Dogger Bank Teesside A.

Table 6.15 Baseline population estimates for common guillemot for Dogger Bank Teesside A, Dogger Bank Teesside B, and Dogger Bank Teesside A & B ('Project' column in the table) and including the 2km buffer ('Buffer' column in the table)

| Year | Month | Dogger Bank Teesside A | | Dogger Bank Teesside B | | Dogger Bank Teesside A & B | |
|---|---|---|---|---|---|---|---|
| | | Project | Buffer | Project | Buffer | Project | Buffer |
| 2010 | January | 3,122 | 4,251 | 5,707 | 7,805 | 8,829 | 12,042 |
| | February | 3,619 | 4,949 | 6,150 | 8,370 | 9,769 | 13,317 |
| | March | 3,410 | 4,667 | 5,700 | 7,730 | 9,110 | 12,396 |
| | April | 2,535 | 3,464 | 3,569 | 4,853 | 6,105 | 8,320 |
| | May | 366 | 503 | 732 | 1,006 | 1,098 | 1,507 |
| | June | 319 | 437 | 626 | 864 | 945 | 1,302 |
| | July | 201 | 276 | 460 | 634 | 661 | 910 |
| | August | 284 | 392 | 920 | 1,278 | 1,204 | 1,670 |
| | September | 613 | 848 | 1,980 | 2,766 | 2,593 | 3,617 |
| | October | 2,359 | 3,230 | 3,969 | 5,418 | 6,328 | 8,650 |
| | November | 2,558 | 3,499 | 4,048 | 5,524 | 6,606 | 9,019 |
| | December | 4,196 | 5,726 | 6,317 | 8,597 | 10,513 | 14,323 |

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| Year | Month | Dogger Bank Teesside A | | Dogger Bank Teesside B | | Dogger Bank Teesside A & B | |
|---|---|---|---|---|---|---|---|
| | | Project | Buffer | Project | Buffer | Project | Buffer |
| 2011 | January | 2,852 | 3,898 | 3,815 | 5,181 | 6,667 | 9,074 |
| | February | 3,207 | 4,386 | 4,238 | 5,759 | 7,445 | 10,157 |
| | March | 6,469 | 8,862 | 9,719 | 13,180 | 16,188 | 22,051 |
| | April | 6,546 | 8,974 | 9,638 | 13,146 | 16,184 | 22,112 |
| | May | 875 | 1,202 | 1,787 | 2,448 | 2,662 | 3,650 |
| | June | 610 | 837 | 1,298 | 1,781 | 1,908 | 2,627 |
| | July | 362 | 497 | 786 | 1,077 | 1,148 | 1,573 |
| | August | 237 | 327 | 733 | 1,016 | 970 | 1,344 |
| | September | 143 | 198 | 448 | 623 | 591 | 820 |
| | October | 307 | 419 | 494 | 672 | 800 | 1,093 |
| | November | 252 | 344 | 399 | 543 | 651 | 887 |
| | December | 603 | 824 | 877 | 1,193 | 1,480 | 2,017 |
| 2012 | January | 782 | 1,070 | 1,172 | 1,598 | 1,954 | 2,670 |
| | February | 3,922 | 5,356 | 5,568 | 7,571 | 9,490 | 12,930 |
| | March | 5,649 | 7,739 | 9,645 | 13,117 | 15,293 | 20,837 |
| | April | 6,681 | 9,156 | 9,489 | 12,932 | 16,170 | 22,088 |
| | May | 991 | 1,364 | 2,004 | 2,753 | 2,995 | 4,117 |
| | June | 645 | 887 | 1,310 | 1,799 | 1,955 | 2,687 |

6.4.63 Common guillemot can dive deep underwater and consequently may potentially be missed by aerial surveys. A review of available literature indicates that on average 18.0% of time is spent underwater when foraging at sea, and consequently this proportion of birds may be foraging underwater at any one time (see **Appendix 11A** of the Dogger Bank Teesside A & B ES). This potential additional number of birds that may have been present in the Dogger Bank Zone during the surveys is not reflected in the population estimates given above. However, a correction factor (i.e. 18%) has been applied in calculating the numbers of birds that should be apportioned to individual SPAs as a result of construction and operation effects (e.g. see displacement effects in Section 6.5 and Section 6.6).

**Razorbill**

6.4.64 Razorbill has a breeding population in Great Britain of 164,492 individuals (1% threshold of 1,600 individuals) and a biogeographic population of 1,950,000 individuals (1% threshold of 19,500 individuals).

6.4.65 Razorbills are widely distributed in the North Sea throughout the year, with peak numbers occurring in the winter months (Skov *et al*. 1995). Razorbills may forage over 300km from colonies (FAME 2012) although 58km is the estimated mean maximum range (see **Table 6.1**). The diet largely comprises schooling pelagic fish such as sandeels, clupeids and gadoids, but it will also take crustaceans and other invertebrates.

6.4.66 This species is a breeding feature of 18 SPAs, a wintering feature of five SPAs, and a passage feature of two SPAs in the Greater North Sea OSPAR region. The largest razorbill breeding colony in proximity to the Dogger Bank Zone is at Flamborough and Filey Coast pSPA, with 5,133 pairs (5.2% of the GB breeding

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population) listed by Stroud *et al.* (2004), although numbers have risen significantly and a population of 10,570 pairs or 21,140 breeding adults based on the 2008-2011 period is now given (Natural England 2013).

6.4.67 Numbers in the Dogger Bank Zone as a whole surpassed the 1% threshold for populations of national importance in the breeding season and the 1% threshold for international importance in the winter.

6.4.68 In 2010, there were two main peaks in razorbill population estimates in Dogger Bank Teesside A & B from January to March (highest value in February of 3,978 birds with 90% CIs = 3,537-4,433) and from October to December (highest value in December of 3,890 birds with 90% CIs = 3,448-4,328). In 2010/11, abundance peaked between October and December, then again between March and April (highest in April with 7,254 birds, 90% CLs = 6,459-8,065). In contrast, population estimates produced for 2011/12 peaked between February and April only (highest in April with 6,207 birds, 90% CLs = 5,533-6,935) see **Table 6.16** and Table 3.36; Figure 3.54 in **Appendix 11A** of the Dogger Bank Teesside A & B ES). Mean populations across the two and a half years of survey peaked in March, with a mean of 5,234 birds (90 % CIs = 4,672-5,848) in the project area and 7,130 birds (90% CIs = 6,359-7,961) present in the project area plus buffer. Between January 2010 and June 2012 the 1% thresholds for populations of national and international importance were not exceeded in the project area.

6.4.69 On a monthly basis, the densities of razorbill within the south-western and western areas of the Dogger Bank Zone tended to be higher than elsewhere within the zone (see Figures 3.50, 3.51 and 3.52 in **Appendix 11A** of the Dogger Bank Teesside A & B ES).

Table 6.16 Calculation Baseline population estimates for razorbill for Dogger Bank Teesside A, Dogger Bank Teesside B, and Dogger Bank Teesside A & B ('Project' column in the table) and including the 2km buffer ('Buffer' column in the table)

| Year | Month | Dogger Bank Teesside A | | Dogger Bank Teesside B | | Dogger Bank Teesside A & B | |
|---|---|---|---|---|---|---|---|
| | | Project | Buffer | Project | Buffer | Project | Buffer |
| 2010 | January | 1,164 | 1,584 | 2,187 | 2,991 | 3,351 | 4,568 |
| | February | 1,464 | 2,004 | 2,514 | 3,420 | 3,978 | 5,424 |
| | March | 1,311 | 1,795 | 2,209 | 2,990 | 3,520 | 4,778 |
| | April | 844 | 1,154 | 1,138 | 1,546 | 1,983 | 2,702 |
| | May | 48 | 66 | 69 | 94 | 117 | 160 |
| | June | 44 | 60 | 62 | 84 | 105 | 145 |
| | July | 28 | 38 | 48 | 66 | 76 | 104 |
| | August | 42 | 58 | 148 | 202 | 190 | 261 |
| | September | 119 | 167 | 429 | 588 | 548 | 758 |
| | October | 1,176 | 1,611 | 1,984 | 2,706 | 3,161 | 4,326 |
| | November | 1,083 | 1,481 | 1,684 | 2,297 | 2,767 | 3,782 |
| | December | 1,585 | 2,162 | 2,304 | 3,137 | 3,890 | 5,301 |

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| Year | Month | Dogger Bank Teesside A | | Dogger Bank Teesside B | | Dogger Bank Teesside A & B | |
|---|---|---|---|---|---|---|---|
| | | Project | Buffer | Project | Buffer | Project | Buffer |
| 2011 | January | 770 | 1,053 | 968 | 1,315 | 1,738 | 2,372 |
| | February | 867 | 1,187 | 1,069 | 1,452 | 1,936 | 2,643 |
| | March | 2,447 | 3,355 | 3,527 | 4,777 | 5,974 | 8,147 |
| | April | 3,009 | 4,129 | 4,245 | 5,782 | 7,254 | 9,915 |
| | May | 159 | 219 | 236 | 319 | 395 | 538 |
| | June | 78 | 107 | 123 | 166 | 201 | 274 |
| | July | 23 | 32 | 37 | 50 | 61 | 82 |
| | August | 6 | 8 | 19 | 26 | 24 | 33 |
| | September | 2 | 3 | 6 | 9 | 8 | 12 |
| | October | 11 | 15 | 17 | 23 | 28 | 38 |
| | November | 17 | 23 | 26 | 36 | 43 | 59 |
| | December | 124 | 169 | 171 | 233 | 295 | 403 |
| 2012 | January | 280 | 383 | 407 | 555 | 687 | 936 |
| | February | 2,036 | 2,780 | 2,758 | 3,750 | 4,795 | 6,548 |
| | March | 2,284 | 3,130 | 3,923 | 5,330 | 6,207 | 8,464 |
| | April | 2,464 | 3,379 | 3,321 | 4,523 | 5,785 | 7,894 |
| | May | 223 | 307 | 328 | 444 | 550 | 748 |
| | June | 350 | 482 | 518 | 703 | 869 | 1,186 |

6.4.70 Razorbill can dive deep underwater and consequently may potentially be missed by aerial surveys. A review of the literature indicates that, on average, 16.4% of foraging time at sea is spent underwater, and consequently this proportion of birds may be foraging underwater at any one time (see **Appendix 11A** of the Dogger Bank Teesside A & B ES). This potential additional number of birds that may have been present in the Dogger Bank Zone during the surveys is not reflected in the population estimates given above. However, a correction factor (i.e. 16.4%) has been applied in calculating the numbers of birds that should be apportioned to individual SPAs as a result of construction and operation effects (e.g. see displacement effects in Section 6.5 and Section 6.6).

**Atlantic puffin**

6.4.71 Atlantic puffin is recorded in the North Sea throughout the year, with highest numbers recorded around the main breeding colonies in summer. In winter months, birds disperse to offshore waters (Tasker *et al*. 1986). Puffins eat a variety of mid-water schooling fish, but especially sandeel, and can forage up to 200km from colonies (see **Table 6.1**), although 87km is the estimated mean maximum distance.

6.4.72 Atlantic puffin has a breeding population in Great Britain of 579,189 individuals (1% threshold of 5,800 individuals) and a biogeographic population of 13,500,000 pairs (1% threshold of 135,000 individuals).

6.4.73 Atlantic puffin is a breeding feature of 16 SPAs in the Greater North Sea OSPAR region. The largest puffin breeding colony in proximity to the Dogger Bank Zone is at Flamborough and Filey Coast pSPA with 3,473 pairs (0.8% of the GB breeding population) listed by Stroud *et al.* (2004). The number of birds

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at this site has fallen considerably and based on 2008-2011 data (Natural England 2013) the SPA now supports only 490 pairs of Atlantic puffin.

6.4.74 Numbers in the Dogger Bank Zone as a whole did not surpass the 1% threshold for populations of national importance.

6.4.75 In 2010, there were two main peaks in Atlantic puffin population estimates in Dogger Bank Teesside A & B: from January to March (highest value in March of 471 birds with 90% CIs = 385-572) and from September to December (highest value in December of 870 birds with 90% CIs = 734-1,024). In 2010/11, abundance peaked between September and April (highest in March with 1,189 birds, 90% CLs = 1,052-1,379). In contrast, population estimates showed a general decrease in 2011/12, with a peak in abundance between February and March (highest value was in March with 318 birds, 90% CLs = 270-381) – see **Table 6.17** and Table 3.42; Figure 3.66 in **Appendix 11A** of the Dogger Bank Teesside A & B ES. Mean populations across the two and a half years of survey peaked in March, with a mean of 659 birds (90 % CIs = 569-777) in the project area and 900 birds (90% CIs = 779-1,059) present in the project area plus buffer. Between January 2010 and June 2012 the 1% thresholds for populations of national and international importance were not exceeded in Dogger Bank Teesside A & B.

6.4.76 The distribution of Atlantic puffin (see Figures 3.62, 3.63 and 3.64 in **Appendix 11A** of the Dogger Bank Teesside A & B ES) shows that the greatest densities occur in in the western and north-eastern areas of the Dogger Bank Zone. Dogger Bank Teesside A and Dogger Bank Teesside B are generally in areas of below average density for Atlantic puffin compared to the Zone as a whole.

Table 6.17 Baseline population estimates for Atlantic puffin for Dogger Bank Teesside A, Dogger Bank Teesside B, and Dogger Bank Teesside A & B ('Project' column in the table) and including the 2km buffer ('Buffer' column in the table)

| Year | Month | Dogger Bank Teesside A | | Dogger Bank Teesside B | | Dogger Bank Teesside A & B | |
|---|---|---|---|---|---|---|---|
| | | Project | Buffer | Project | Buffer | Project | Buffer |
| 2010 | January | 124 | 169 | 150 | 205 | 274 | 372 |
| | February | 201 | 275 | 234 | 318 | 435 | 594 |
| | March | 219 | 300 | 252 | 341 | 471 | 642 |
| | April | 49 | 68 | 62 | 83 | 111 | 152 |
| | May | 34 | 47 | 44 | 60 | 78 | 107 |
| | June | 21 | 30 | 27 | 37 | 49 | 67 |
| | July | 12 | 16 | 17 | 23 | 29 | 40 |
| | August | 12 | 16 | 17 | 22 | 28 | 38 |
| | September | 98 | 136 | 209 | 288 | 308 | 425 |
| | October | 136 | 188 | 289 | 397 | 425 | 586 |
| | November | 193 | 265 | 213 | 290 | 406 | 553 |
| | December | 422 | 577 | 448 | 609 | 870 | 1,185 |

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| Year | Month | Dogger Bank Teesside A | | Dogger Bank Teesside B | | Dogger Bank Teesside A & B | |
|---|---|---|---|---|---|---|---|
| | | Project | Buffer | Project | Buffer | Project | Buffer |
| 2011 | January | 418 | 573 | 399 | 541 | 817 | 1,115 |
| | February | 452 | 619 | 432 | 586 | 883 | 1,208 |
| | March | 582 | 799 | 608 | 823 | 1,189 | 1,624 |
| | April | 125 | 172 | 159 | 217 | 284 | 392 |
| | May | 70 | 96 | 91 | 124 | 161 | 222 |
| | June | 35 | 48 | 46 | 63 | 81 | 111 |
| | July | 17 | 24 | 24 | 33 | 42 | 57 |
| | August | 9 | 12 | 12 | 17 | 21 | 29 |
| | September | 28 | 38 | 60 | 82 | 87 | 120 |
| | October | 22 | 30 | 45 | 62 | 67 | 92 |
| | November | 21 | 29 | 23 | 31 | 44 | 60 |
| | December | 50 | 68 | 51 | 70 | 101 | 138 |
| 2012 | January | 61 | 84 | 64 | 87 | 125 | 171 |
| | February | 155 | 212 | 155 | 211 | 310 | 424 |
| | March | 148 | 203 | 170 | 231 | 318 | 433 |
| | April | 40 | 55 | 50 | 68 | 90 | 123 |
| | May | 34 | 46 | 44 | 60 | 78 | 105 |
| | June | 24 | 33 | 31 | 42 | 55 | 76 |

6.4.77 Atlantic puffin can dive deep underwater and may, therefore, potentially be missed by aerial surveys. A review of the literature indicates that on average 20.2% of foraging time at sea may be spent underwater, and consequently this proportion of birds may be underwater at any one time (see **Appendix 11A** of the Dogger Bank Teesside A & B ES). This potential additional number of birds that may have been present in the Dogger Bank Zone during the surveys is not reflected in the population estimates given above. However, a correction factor (i.e. 20.2%) has been applied in calculating the numbers of birds that should be apportioned to individual SPAs as a result of construction and operation effects (e.g. see displacement effects in Section 6.5 and Section 6.6).

## Migrants

6.4.78 Several hundred million birds of many different species cross the North Sea every year from Europe and Scandinavia to Britain during spring and autumn migration (Hüppop *et al*. 2006). Many of these birds are likely to pass over the Dogger Bank Zone during these periods. The main species groups include waterbirds and terrestrial birds including raptors, owls, pigeons, swallows and martins, larks, wagtails, pipits, chats, thrushes, warblers, crows, starlings, finches and buntings. There is a general movement northwards in spring and south in autumn, but the scale of movement is often dependent on prevailing weather conditions and the time of year.

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6.4.79 Waterbirds generally migrate between their breeding, staging (areas where they rest and feed up during migration) and wintering areas along regular routes or "flyways". Research into waterbird migration has found that there are eight global flyways. Waterbirds moving through the UK or using sites as final wintering grounds are considered part of the East Atlantic Flyway (Delaney *et al*. 2009).

6.4.80 A total of 73 species of waterbird and 62 other terrestrial species were recorded during the boat-based surveys of the Dogger Bank Zone as a whole, as shown in Tables 3.1, 3.2 and 3.3 in **Appendix 11A** of the Dogger Bank Teesside A & B ES. Of the waterbirds, 37 are considered to be 'marine' species (seabirds, divers, gulls, terns and skuas, and seaducks), whilst 41 species are considered to be migrants.

6.4.81 Most waterbirds were recorded in low numbers, with Eurasian curlew being the commonest species recorded in 2010, with a peak of 36 in July, and pink-footed goose the commonest in 2011 with 50 recorded in November.

6.4.82 The commonest identified terrestrial birds recorded were starling, redwing, meadow pipit and common blackbird. The numbers of all migrant birds recorded during the boat-based surveys of the Dogger Bank Zone are summarised in **Table 6.6** and provided in full Tables 3.1, 3.2 and 3.3 in **Appendix 11A** of the Dogger Bank Teesside A & B ES.

## Ornithology of the export cable landfall area

6.4.83 **Table 6.18** presents the findings of the various surveys carried out for the landfall zone (based on Table 3.44 in **Appendix 11A** of the Dogger Bank Teesside A & B ES); survey extents are presented in **Figure 6.1**. There is no WeBS data coverage for the area of the export cable landfall. The inter-tidal area overlapped with two sections of the NEWS surveys (covering 2.4km and 4.15km in length) for the winters of 1984/85, 1997/98, and 2006/07. **Table 6.18** presents the results of the NEWS survey, and field surveys carried out over 2011/12 and 2012/13 in the vicinity of the landfall area for the export cable.

6.4.84 This covers a frontage of 2.2km within which the landfall works would take place. The WeBS survey data has been corrected (based on two survey sections) to cover the 2.2km frontage around the landfall. The NEWS data represents one surveyed section which extends across a 1.5km frontage, which has been corrected to account for the 1.4km overlap with the landfall zone. The winter bird survey and the inshore sea watch survey covers the landfall zone and nearshore.

6.4.85 The following species identified and counted at the landfall location (see **Table 6.18**) form part of the designated wintering assemblage population of the Teesmouth and Cleveland Coast SPA (the southern boundary of which is located less than 2km from the landfall site): northern lapwing, ringed plover, and sanderling.

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Table 6.18 Baseline count data for the intertidal study area (export cable landfall) for Dogger Bank Teesside A & B

| Species | NEWS combined[1] | Inland sea-watch surveys 2011/12[2] | Autumn/winter sea-watch surveys 2012/13[2] |
|---|---|---|---|
| Bar-tailed godwit | 0 | 1 | 1 |
| Black-headed gull | 0 | 175 | 318 |
| Carrion crow *Corvus corone* | 0 | 12 | 10 |
| Common gull | 0 | 2 | 4 |
| Common linnet *Carduelis cannabina* | 0 | 0 | 37 |
| Common starling *Sturnus vulgaris* | 0 | 0 | 0 |
| Dunlin | 0 | 47 | 0 |
| Eurasian curlew | 0 | 0 | 1 |
| Eurasian oystercatcher | 65 | 21 | 12 |
| Goldfinch *Carduelis carduelis* | 0 | 0 | 12 |
| Great black-backed gull | 0 | 0 | 2 |
| Great cormorant | 0 | 0 | 1 |
| Grey plover | 0 | 1 | 0 |
| Herring gull | 0 | 0 | 115 |
| Jackdaw *Corvus monedula* | 0 | 0 | 2 |
| Lesser black-backed gull | 0 | 0 | 3 |
| Mediterranean gull | 0 | 0 | 2 |
| Meadow pipit *Anthus pratensis* | 0 | 0 | 2 |
| Northern lapwing | 121 | 0 | 0 |
| Ringed plover | 0 | 18 | 2 |
| Ruddy turnstone | 5 | 5 | 22 |
| Sanderling | 3 | 104 | 3 |

[1] Values given in brackets are the uncorrected counts for two NEWS sections summed together.
[2] Maximum numbers of individuals recorded.

## 6.5 Assessment of impacts during the construction phase

### Introduction

6.5.1 This section provides an assessment of the potential impacts during the construction phase for Dogger Bank Teesside A & B, covering the installation of wind turbines in the offshore area and cable-laying activities within the export cable route corridor (including the landfall). Potential construction impacts highlighted during the EIA Scoping and HRA screening (see **Appendix A** of the **HRA Report**) were:

- Changes in habitat resources (e.g. habitat availability, prey supply); and
- Direct disturbance to birds and displacement as a result of construction activity (for example, an increase in vessel activity, human presence and pile driving activities), which may amount to habitat loss (or change in utilisation) for the period of disturbance.

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## Change in habitat resources

6.5.2 This section of the assessment deals with the implications of changes in habitats that may be utilised by birds during the construction of Dogger Bank Teesside A & B. The location and nature of the proposed project precludes any direct loss of habitat from within the defined boundaries of protected sites (SPA / Ramsar sites). Any impacts on designated bird populations, therefore, would be indirect and relate to:

- The loss of habitat from within foraging areas (i.e. from within Dogger Bank Teesside A & B, the Dogger Bank Teesside A & B Export Cable Corridor and export cable landfall);
- Changes in prey availability as a result of loss of offshore habitat; and
- Fluctuation in prey availability due to changes in water quality and the effects of increased underwater noise levels.

6.5.3 For the purposes of this assessment, the implications of habitat loss (i.e. from the installation of wind turbines) with respect to both direct impacts on birds and prey availability is covered under the section dealing with operational effects. This section, therefore, deals solely with the implications of changes in prey availability that may arise as a result of effects associated with construction activities. This potential impact is covered for both the marine (Dogger Bank Teesside A & B and Dogger Bank Teesside A & B Export Cable Corridor) and coastal environment (landfall).

6.5.4 As highlighted in the screening report, there are no predicted effects likely to impact designated SPA and Ramsar features as a result of works within the terrestrial cable corridor.

**Offshore – Dogger Bank Zone and the Dogger Bank Teesside A & B Export Cable Corridor**

6.5.5 Habitat utilisation by seabirds may be influenced during construction by changes in prey availability. In this instance, all of the seabird species that occur in the offshore zone are foraging for a variety of fish species, but notably sandeel (Furness & Tasker 2000). A reduction in prey resources from within foraging grounds may decrease the ability of seabirds to derive sufficient energy to maintain reproductive condition and / or raise young. While it is possible that such an effect could ultimately have an impact on breeding populations at individual colonies, given the temporary nature of construction activities, a long-term effect solely attributable to construction is considered highly unlikely.

6.5.6 Two construction related effects that may impact upon prey resources are identified and assessed:

- Changes in water quality due to increased suspended sediment concentrations and the effect that this may have on the fish fauna; and
- An increase in underwater noise levels associated with piling works and general construction activity (e.g. vessel movements) and the impact that this may have on fish species of importance as a prey resource to seabirds.

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### *Changes in suspended sediment concentration (SSC) and impact on the fish fauna*

6.5.7 The physical disturbance of the seabed associated with construction works, particularly seabed preparation and/or drilling to facilitate foundation installation and cable installation using energetic means, would result in an increase in suspended sediment concentration and subsequent sediment re-deposition. Modelling work (see **Chapter 9** of the Dogger Bank Teesside A & B ES) concluded that drill arisings associated with the installation of 24 x 12m monopoles constituted the worst case scenario, as this would result in the greatest increased suspended sediment concentrations and sediment deposition from the sediment plume.

6.5.8 The outputs of the plume modelling are described in Section 4.6 of this report (and in **Chapter 9** of the Dogger Bank Teesside A & B ES).

6.5.9 The early life stages of fish, such as eggs and larvae, would not be able to avoid areas subject to increased suspended sediment concentrations, as they may passively drift (if pelagic) or remain (if benthic) in areas where construction works are being carried out. Eggs and larvae are considered to be less tolerant to increased suspended sediment concentrations than later life stages, with larvae being generally considered to be more sensitive than eggs (Appleby & Scarratt 1989).

6.5.10 Available data indicates that a number of fish species, including those forming an important component of the diet of seabirds, are expected to use Dogger Bank Teesside A & B as a spawning and/or nursery ground. Eggs and larvae are generally distributed over large sea areas, in comparison to the area that would be affected by raised suspended sediment concentrations during construction. The interaction between significant elevated suspended sediment concentrations and fish eggs and larvae, therefore, would be very limited, both temporally and spatially.

6.5.11 The effect of sediment re-deposition is of particular importance to species which lay their eggs on the substrate, notably sandeel. The distribution of adult sandeels is thought to provide a good indication of the likely distribution of spawning. Within Dogger Bank Teesside A & B, data on the distribution of fishing grounds (which acts as a proxy for the distribution of sandeel habitat) shows that sandeel are present at relatively low levels throughout the area (see **Chapter 13** of the Dogger Bank Teesside A & B ES).

6.5.12 During construction, maximum sediment deposition thickness is not expected to exceed 5mm and this would reduce to negligible levels within 30 days. It is not anticipated that sediment deposition during the construction phase would result in any changes to the substrate characteristics in the study area (as the sediment released and transported during construction is the same as that forming the existing seabed substrate). Less than 1% of high density, sandeel spawning habitat is anticipated to be affected by increased suspended sediment concentrations and sediment re-deposition. Taking account of the relatively thin deposits of sediment that would arise, their temporary nature and the small area over which significant sediment re-deposition is predicted to occur it is considered unlikely that this would have any discernible effect on egg mortality/viability, such that an effect at the population level would arise (see

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**Chapter 13** of the Dogger Bank Teesside A & B ES). This is particularly so when taken in the context of the existence of other high density sandeel areas over Dogger Bank which would not be affected by construction works associated with Dogger Bank Teesside A & B, as the siting of projects was undertaken intentionally to avoid dense sandeel areas.

6.5.13 For juvenile / adult fish, levels of suspended sediment that may be lethal typically range from hundreds to thousands of mg/l, whilst sub-lethal effects may manifest at significantly lower levels, ranging from tens to hundreds of mg/l, depending on species specific tolerance (Birtwell 1999).

6.5.14 The principal fish species that occur in Dogger Bank Teesside A & B are mobile and, therefore, able to avoid any area of the water column subject to a significant increase in suspended sediment concentration. Given that an increase in suspended sediment concentration within the development areas would be localised and temporary, any disturbance to juvenile / adult fish would be of a short term nature. In addition, the principal fish species are widespread in comparison to the small areas likely to be subject to increased suspended sediment concentration at any one time.

6.5.15 In the particular case of sandeels, there is the possibility that sediment re-deposition may have an effect on buried sandeels, potentially resulting in suffocation and/or behavioural impacts (i.e. fish leaving the sediment due to reduced oxygen levels). Modelling of sediment deposition resulting from construction work predicts only light deposition (approximately 1mm) in areas of high density sandeel occurrence to the west of the boundary of Dogger Bank Teesside B. There is very little potential for such a small thickness of fine sediment to prevent respiration by buried sandeels (see **Chapter 13** of the Dogger Bank Teesside A & B ES). Within Dogger Bank Teesside A & B the low density of sandeel indicates that even in areas where sediment deposition may be greater, any effects, if they were to occur, would be negligible at the population level.

6.5.16 The offshore section of the Dogger Bank Teesside A & B Export Cable Corridor traverses an area of both high and low intensity sandeel spawning and nursery habitat. There are no defined sandeel spawning or nursery or sandeel habitats in the vicinity of the inshore section of the Dogger Bank Teesside A & B Export Cable Corridor. 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 a relatively small area. However, the inshore section of the Dogger Bank Teesside A & B Export Cable Corridor is located within currently active herring spawning grounds. Hence, there is potential for sediment re-deposition to occur in areas where herring eggs have been, or are to be laid. In the context of the spatial extent of the inshore herring spawning area, approximately 0.003% would be affected by export cable installation (see Section 6.5 in **Chapter 13** of the Dogger Bank Teesside A & B ES). Given the temporary nature of any sediment re-deposition, the small thickness of deposited sediment and the very small area of the total spawning resource that would be affected, it is considered

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highly unlikely that the works for the export cable would have any impact on sandeel or herring populations.

6.5.17 For juvenile and adult fish present within the Dogger Bank Teesside A & B Export Cable Corridor, the total area over which increased suspended sediment concentration and subsequent sediment deposition may arise is very small in comparison to the wider distribution of the principal fish species. Increased suspended sediment concentration generated during cable laying operations would be of a temporary nature and adult and juvenile fish would be able to avoid any areas of increased suspended sediment and temporarily use undisturbed areas adjacent to the Dogger Bank Teesside A & B Export Cable Corridor. The potential prey resources for little tern foraging in nearshore waters adjacent to the Teesmouth and Cleveland Coast SPA and Ramsar site and the Northumbria Coast SPA and Ramsar site, therefore, would not be affected by the works (see Section 4.6 and 4.7).

***Increase in underwater noise levels and impact on the fish fauna***

6.5.18 Construction related activities, such as impact pile driving for installation of pin piles and monopiles, rock placement for scour protection and dredging associated with seabed preparation for installation of gravity bases and cable laying related activities, will all generate underwater noise.

6.5.19 The largest potential impacts to fish would be associated with irregular but intensive pile-driving activities, which can give rise to injurious or disturbing sound fields.

6.5.20 Interpretation of the outputs of noise modelling work (see **Appendix 13G** of the Dogger Bank Teesside A & B ES) indicates that during pile driving potential instantaneous injury impact ranges for fish, based on the onset of auditory tissue damage, would be relatively small. These ranges would only be of the order of tens to a few hundred metres assuming 3,000kJ hammer energies. At lower hammer energies the ranges would be smaller. Given the intermittent and short term nature of pile driving activity and the relatively small areas in which lethal/injury impacts could occur, the overall effect is considered to be negligible with respect to fish populations. Soft-start piling would also be utilised (thus enabling fish to flee the immediate vicinity of the works before the highest noise levels are reached), reducing the potential for any lethal impact to occur.

6.5.21 In terms of behavioural impacts the underwater noise modelling shows that startle responses are unlikely to occur at ranges beyond 500m from piling. With the use of a soft-start this range would likely be less than 100m. The impact ranges for disturbance or avoidance indicate that changes in fish swimming and schooling behaviour may, however, be considerably greater (up to tens of kilometres) for hearing sensitive fish swimming in or around the middle of the water column. In terms of fish populations present in the offshore zone, this effect has been assessed as of negligible significance (see Section 6 in **Chapter 13** of the Dogger Bank Teesside A & B ES).

6.5.22 Noise levels at which possible avoidance is predicted to occur in pelagic fish may reach a small area with high densities of sandeel close to Dogger Bank Teesside B. It should be noted, however, that only localised areas will be

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affected at a given time and that high the density sandeel area on the western Dogger Bank Zone boundary would remain unaffected. Given that piling activity will be intermittent, and affect only relatively localised areas and that high density sandeel areas elsewhere will remain unaffected, behavioural avoidance is not expected to lead to any change in sandeel populations or their wider distribution. The availability of this species as a prey item for seabirds within existing foraging grounds would therefore be unaffected. Furthermore, field experiments (Hassel *et al.* 2003 and 2004), in which caged sandeels were exposed to seismic shooting for a period of 2.5 days, found no difference in the abundance of sandeels and only moderate behavioural reactions were detected.

6.5.23 In the case of the export cable, the levels of underwater noise associated with vessel movement, dredging, trenching and rock dumping for cable protection may lead to some localised behavioural responses such as avoidance reactions. Fish mortality would not be expected given both the mobility of fish and the likely generated noise levels (e.g. in comparison to pile-driving activities). The movement of the cable-laying vessel and associated activities can be viewed as a slow-moving, point source of potential disturbance. Local avoidance by fish of areas of water that may be subject to increased noise levels during cable-laying, therefore, would not diminish the prey resource available to foraging birds or affect the overall distribution of prey within foraging grounds normally utilised by birds.

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

6.5.24 The landfall for the export cable is located on the Teesside coast, just to the south-east of Redcar. The works for the landfall and cabling in the nearshore zone would not directly affect any designated SPA or Ramsar site and no direct loss of habitat that supports designated bird populations would therefore arise.

6.5.25 As discussed in Section 4.6, several effects linked to the construction of the export cable landfall (and cabling works in the nearshore zone) have the potential to affect habitat conditions within the Teesmouth and Cleveland Coast SPA and Ramsar site (1.75km to the north-west of the landfall) and the Northumbria Coast SPA and Ramsar site (20km to the north-east). An increase in suspended sediment concentrations may occur within the designated boundary of the Teesmouth and Cleveland Coast SPA. However, any such increase would not lead to changes in sediment conditions within the SPA and no effects on the availability of prey resources for designated bird populations would arise. In respect of the Northumbria Coast SPA and Ramsar site, the works would not affect existing suspended sediment concentrations or sediment deposition within the SPA and no impact on habitat conditions within the site is predicted.

6.5.26 During construction of the export cable landfall, the area of available intertidal habitat for foraging by birds, some of which could potentially derive from SPA designated populations, would be reduced as a result of the presence of cofferdams on the foreshore. The total area to be occupied by the cofferdams is estimated as 200m$^2$ (see **Table 2.2**) and is, therefore, relatively small in the context of the entire shoreline frontage. Furthermore, activities resulting in noise and visual disturbance could temporarily reduce the available foraging habitat

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(see below). The significance of this effect would be dependent on the frequency and intensity of foraging by individuals and species within the areas subject to disturbance, the extent and duration of disturbance, and the availability of suitable alternative foraging habitat.

6.5.27 As presented in **Table 6.18**, with the exception of a flock of 104 sanderling, no significant numbers of marine bird species were identified within the survey area for the intertidal export cable landfall area. The species present were predominantly waders, gulls, and terrestrial (passerine) species. Wintering assemblage species for which the Teesmouth and Cleveland Coast SPA (and Teesmouth and Cleveland Ramsar site) is designated have been recorded within the cable landfall area, these were all recorded in low numbers, which is to be expected given the limited capacity of the intertidal habitat present at the landfall location to support significant numbers of foraging waterbirds. This factor, together with the short-term nature of the construction works (a maximum of six months or one overwintering period) and the small area of habitat that would be affected indicates that the temporary loss of habitat at the landfall area would be highly unlikely to have a measurable impact upon the overall foraging resource available to waterbird species that, potentially, may form part of the designated populations of the Teesmouth and Cleveland Coast SPA and the Teesmouth and Cleveland Coast Ramsar site.

**Summary and conclusion on habitat resource effects**

6.5.28 The sediment transport modelling work undertaken indicates that, even for a worst case scenario, increases in suspended sediment concentration would be unlikely to give rise to biologically significant effects. This is particularly so given the temporary and localised nature of the predicted suspended sediment concentration increase during construction activities. Taking this outcome together with the distribution of principal fish species (including sandeels) and their likely behaviour in areas of increased suspended sediment, indicates that this aspect of change in water quality would be highly unlikely to lead to any adverse change in the distribution and abundance of fish populations within or adjacent to the development area.

6.5.29 With regard to underwater noise, whilst it is recognised that construction activities during wind farm development may lead to localised avoidance reactions in fish, there is no evidence to suggest that such effects would have an adverse impact on either the abundance or distribution of fish within foraging areas used by seabirds.

6.5.30 While construction activity within Dogger Bank Teesside A & B would occur over a long period, in essence the effects that could impact upon habitat utilisation by seabirds would be localised and temporary and would occur within a very extensive offshore area.

6.5.31 These conclusions indicate that the prey resource available to foraging seabirds within and adjacent to Dogger Bank Teesside A & B would not be adversely affected to the extent that utilisation by seabirds would be compromised and that effects at the level of individual species populations would arise. Further assessment of this aspect of habitat usage by foraging seabirds is therefore considered unnecessary and it can be concluded that these effects upon prey

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resources would not be of significance in respect of SPA and Ramsar designated populations of seabirds.

6.5.32 With respect to the landfall works for the export cable, their temporary nature, the very limited loss of available habitat and the very limited foraging resource value of the foreshore to waterbirds, indicates that the works would not have an impact upon the designated populations of the Teesmouth and Cleveland Coast SPA or the Teesmouth and Cleveland Coast Ramsar site.

## Disturbance and displacement during construction

### Introduction

6.5.33 In general, birds may be disturbed by activities that generate sudden movements and sudden noises. Such activities can displace birds from their feeding grounds. Disturbance and displacement effects are interlinked and, in essence, reflect different levels of severity. 'Disturbance' refers to an effect that causes a direct reaction in the behaviour of a bird, e.g. increased vigilance or flight/dive responses. However, prolonged disturbance may result in longer-term displacement from a habitat, which may become permanent if birds are unable to habituate to the cause of the effect. The sensitivity to these effects varies between species (Maclean *et al*. 2009).

6.5.34 Low level disturbance within habitats may cause birds to react through a change of behaviour (e.g. cessation of feeding, diving response in auks), with increasing levels of disturbance causing birds to fly a short distance and, with still further disturbance to move away from the affected area. The first two types of response can lead to:

- A reduction of time spent feeding resulting in a potential reduction in body condition;
- Increased energy expenditure due to avoidance behaviour (e.g. short distance flying movements) resulting in a potential reduction in body condition; and
- Reduced energy intake due to disturbance of core foraging areas resulting in a potential reduction in body condition (i.e. displacement to less valuable habitats).

6.5.35 The movement of birds to other areas (i.e. out of their normal foraging area) due to disturbance has the potential to result in significant impacts on birds using marine habitats. These impacts are:

- Increased energy expenditure due to avoidance flights resulting in a potential reduction in body condition;
- Increased competition with other birds due to increasing densities on undisturbed areas resulting in a loss of body condition; and
- Reduction in area of suitable feeding areas due to lack of alternative suitable habitat resulting in loss of body condition.

6.5.36 The term displacement is used to describe the movements away from areas that normally would be used in the absence of disturbance or other perturbations and, as such, can reflect either short distance movements within a foraging area

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or longer distance movements to unfamiliar areas. The effects of displacement for movements away from a utilised foraging area are governed by:

- The length of time and frequency that the area is disturbed (e.g. influenced by the duration of events and the number of disturbance events per hour);
- The availability of other suitable habitat in the general area;
- The quality of other suitable habitat in the general area;
- The ability of displaced individuals to exploit unfamiliar habitat; and
- The level of competition within other birds in the general area.

6.5.37 For example a single large disturbance event that allows the return of individuals in a short amount of time is likely to have a lesser impact than that associated with a frequent disturbance. Prolonged disturbance may result in longer-term displacement from favoured habitat, which may become permanent if birds are unable to habituate to the cause of the effect.

6.5.38 In general, it is accepted that birds tend to be more affected by the presence of people (human activity) than by noise from equipment; although the two causes of impacts are usually intimately related (i.e. noise is mainly created concurrently with human presence).

6.5.39 During construction the main disturbance effects are likely to be from the construction of the turbines themselves, the laying of cables and the boat/helicopter traffic and associated noise and vibration associated with these activities. The duration of these effects would vary between activities. Further detail on the types of activities that may give rise to disturbance effects is provided in **Chapter 5** of the Dogger Bank Teesside A & B ES.

6.5.40 There have been a number of studies of the susceptibility of different marine species to the disturbance associated with construction activities in the offshore environment, notably in relation to the movements of boats or helicopters. Divers and scoters, for example, have been shown to flush from boats more than 1,000m away (Kaiser *et al.* 2006; Schwemmer *et al*. 2011; Topping & Petersen 2011). Other species such as common goldeneye, great cormorant and great scaup flush at less than 1,000m (Platteeuw & Beekman 1994; Garthe & Hüppop 2004), with common eider and long-tailed duck (Schwemmer *et al*. 2011) and some auks disturbed by boats hundreds of metres away (Ronconi & St. Clair 2002; Bellefleur *et al*. 2009). Species that are much less susceptible to disturbance include terns (Perrow *et al*. 2011), gannet, gulls, fulmar and skuas (Furness & Wade 2012), see **Table 6.4**.

6.5.41 Available evidence on the sensitivities of seabirds that may use the area for foraging suggests that auks (common guillemot, razorbill and Atlantic puffin) are most likely to be susceptible to disturbance effects and therefore may be subject to displacement from areas subject to construction activity.

6.5.42 Disturbance may have an effect on the daily energy and time budgets of seabirds by displacing birds from favoured foraging habitats, potentially forcing them to forage at greater densities in potentially sub-optimal habitats (Larsen & Guillemette 2007).

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6.5.43 The impact of displacement is predicted to be particularly important for breeding seabirds that, as central place foragers, are constrained to obtain food within a certain distance from the breeding colony (Daunt *et al*. 2002; Enstipp *et al*. 2006). Changes in time and energy budgets resulting from displacement have the potential to impact on body condition, and hence survival prospects of breeding adults, and may also reduce breeding success because of changes in provisioning rates. Both these outcomes could have population consequences.

6.5.44 The species specific values used for assessing the magnitude of displacement are provided in **Table 6.4**. From this it can be seen that for northern fulmar, Arctic skua, great skua, black-legged kittiwake, lesser black-backed gull and great black-backed gull the derived displacement value is 0%. In respect of northern gannet, a 75% displacement rate is considered appropriate, however, a 0% mortality rate in respect of the effects of the project alone (i.e. Dogger Bank Teesside A & B only) applies and therefore, even if displacement occurs, no impact would arise. Consequently, for all of these species, no significant impact would arise as a result of disturbance and displacement and no further assessment has been undertaken.

6.5.45 Within the offshore zone, disturbance effects during construction would be localised to the area of construction activity itself. However, as construction progresses displacement effects (macro-avoidance) due to turbine presence (see Section 6.7) would be anticipated to replace the short-term disturbance effects generated during construction. Effectively this means that there would be a linear (by area) progression of displacement of birds across the project area. To account for this, an overall displacement value of 50% of that identified for the operational phase for the project (see **Table 6.4**) has been used in determining the number of birds that potentially could be displaced from the wind farm development area as a result of disturbance during construction.

6.5.46 The following paragraphs provide a summary of the calculated displacement and mortality effects for those species of seabird for which a displacement-mortality impact has been identified (see Section 6.3). These species are:

- Common guillemot;
- Razorbill; and
- Atlantic puffin.

**Common guillemot**

6.5.47 Common guillemot exhibits a medium vulnerability to activities in the marine environment and, therefore, is likely to show a disturbance response. It has a medium sensitivity to the effects of displacement (i.e. effective habitat loss) and, therefore, is considered to have some tolerance to this effect. A precautionary displacement rate of 50% has been assumed for this species on the basis of available evidence (see Section 6.3 in this report and Appendix 4 in **Appendix 11A** of the Dogger Bank Teesside A & B ES).

6.5.48 A mortality rate of 5% following displacement has been assigned to this species across both the breeding and non-breeding seasons, based on knowledge of the foraging ecology of this species and the magnitude of the habitat loss that

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could occur as a result of displacement from the wind farm development area during the construction phase. As discussed in Section 6.3, this is viewed as a precautionary mortality rate and it is anticipated that the actual mortality rate would be lower than this.

6.5.49 Based on mean data, the disturbance and displacement analysis undertaken provides a figure of 2,755 displaced birds (554 during breeding months, and 2,201 during other months of the year). Taking account of potential mortality, these displacement figures result in the loss of 138 birds (19 during the breeding season) across all of the SPAs in the greater North Sea region (see Tables A9.38a-d, Appendix 9 of **Appendix 11A** of the Dogger Bank Teesside A & B ES).

6.5.50 Dogger Bank Teesside A & B is within the foraging range, during the breeding season, of six SPAs around the North Sea at which common guillemot is a feature. The greatest effect would be on the breeding population of Flamborough and Filey Coast pSPA, where on the basis of mean data, an estimated 0.02% of the population could be affected by displacement during the construction phase (see Table A9.38d in Appendix 9 of **Appendix 11A** of the Dogger Bank Teesside A & B ES).

6.5.51 Displacement would affect an estimated 0.01% (mean) of the total population of the suite of protected sites around the North Sea at which common guillemot is a feature. Displacement would affect less than 0.01% of the British breeding population and much less than 0.01% of the species' biogeographic population.

**Razorbill**

6.5.52 Razorbill exhibits a medium vulnerability to activities in the marine environment and therefore is likely to show a disturbance response. It has a medium sensitivity to the effects of displacement (i.e. effective habitat loss), and therefore is considered to have some tolerance to this effect. A precautionary displacement rate of 50% has been assumed for this species on the basis of available evidence.

6.5.53 A mortality rate of 5% following displacement has been assigned to this species across both the breeding and non-breeding seasons, based on knowledge of the foraging ecology of this species and the magnitude of the habitat loss that could occur as a result of displacement from the wind farm development area during the construction phase. As discussed in Section 6.3, this is viewed as a precautionary mortality rate and it is anticipated that the actual mortality rate would be lower than this.

6.5.54 Based on mean data the disturbance and displacement analysis undertaken provides a figure of 902 displaced birds (93 during breeding months, 809 during other months of the year). Taking account of potential mortality, these displacement figures result in the loss of 25 birds (3 during the breeding season) across all of the SPAs in the greater North Sea region (see Tables A9.41a-d, Appendix 9 of **Appendix 11A** of the Dogger Bank Teesside A & B ES).

6.5.55 Dogger Bank Teesside A & B is within the foraging range, during the breeding season, of 5 SPAs around the North Sea at which razorbill is a feature. Disturbance-displacement would affect less than 0.02% (mean) of the total

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population of the suite of protected sites around the North Sea at which the species is a feature. The greatest effect would be at the Flamborough and Filey Coast pSPA, where 0.03% of the population would be impacted (see Table A9.41d, Appendix 9 of **Appendix 11A** of the Dogger Bank Teesside A & B ES).

6.5.56 Displacement led mortality could affect less than 0.02% of the British breeding population and much less than 0.01% of the razorbill's biogeographic population.

**Atlantic puffin**

6.5.57 Atlantic puffin exhibits a low vulnerability to activities in the marine environment and, therefore, is likely to show a limited disturbance response. It has a medium sensitivity to the effects of displacement (i.e. effective habitat loss) and, therefore, is considered to have some tolerance to this effect. A precautionary displacement rate of 25% has been assumed for this species on the basis of available evidence (see Section 6.3 in this report and Appendix 4 in **Appendix 11A** of the Dogger Bank Teesside A & B ES).

6.5.58 A mortality rate of 5% following displacement has been assigned to this species across both the breeding and non-breeding seasons, based on knowledge of the foraging ecology of this species and the magnitude of the habitat loss that could occur as a result of displacement from the wind farm development area during the construction phase. As discussed in Section 6.3, this is viewed as a precautionary mortality rate and it is anticipated that the actual mortality rate would be lower than this.

6.5.59 Based on mean data, the disturbance and displacement analysis undertaken provides a figure of 84 displaced birds (14 during breeding months, and 70 during other months of the year). Taking account of potential mortality, these displacement figures result in the loss of 4 birds (none during the breeding season) across all of the SPAs in the greater North Sea region (see Tables A9.44a-d, Appendix 9 of **Appendix 11A** of the Dogger Bank Teesside A & B ES).

6.5.60 Dogger Bank Teesside A & B is not within the mean maximum foraging range of any SPAs around the North Sea at which Atlantic puffin is a feature. For all SPAs screened into the assessment, the impact of the calculated displacement-led mortality is less than 0.01% of the designated populations (see Table A9.44d in Appendix 9 in **Appendix 11A** of the Dogger Bank Teesside A & B ES).

6.5.61 Displacement-led mortality would affect much less than 0.01% of the total population of the suite of protected sites around the North Sea at which Atlantic puffin is a feature, much less than 0.01% of the British breeding population and much less than 0.01% of the species' biogeographic population.

**Implications of displacement effects for designated SPA seabird populations**

6.5.62 In the context of wind farm development, displacement can be viewed as an alteration in effective habitat / resource availability. For those species that are sensitive to the presence of wind farms and for which avoidance (to a greater or lesser degree – see **Table 6.4**) occurs, overall availability of habitat resources, notably for foraging, may decrease. Although there is no specific wind farm

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related evidence to indicate otherwise, it is possible that a decrease in the total foraging resource available to birds may result in mortality, noting that the effect would vary from species to species (see discussion in Section 6.3). Given the scale of development proposed within the Dogger Bank Zone and for Dogger Bank Teesside A & B, there is the potential that displacement and associated mortality could lead to a reduction, for the duration of construction, in population levels for some seabird species.

6.5.63 During construction, the calculated displacement impact at the individual population level for all of the species and SPAs examined is below 0.03% for breeding and non-breeding birds (combined) and below 0.01% for birds during the breeding season. As would be expected, the greatest effect would occur in respect of SPAs and species that are closest to and therefore within potential foraging range of Dogger Bank Teesside A & B (e.g. Flamborough and Filey Coast pSPA). At the individual SPA level the calculated percentage reductions in populations during construction are considered unlikely to be significant, particularly given that the impact could be assessed as being temporary (i.e. for the duration of construction), and therefore unlikely to result in any discernible change in population levels. However, displacement effects would continue through into the operational phase of the project, where, because of the duration of the displacement effect, the potential for population level impacts may be greater. As such, it is more pertinent to view displacement during the construction phase as the beginning of the displacement impact for the entire lifecycle of the project (i.e. construction-operation-decommissioning), albeit that the magnitude of the impact may vary as construction progresses through into operation. Further discussion on displacement impacts is provided in Section 6.6, where the displacement impact is assessed for individual species and SPAs for the operational phase of the project. No specific assessment in respect of individual species SPA populations is, therefore, provided here.

**Direct effect of underwater noise**

6.5.64 As well as the disturbance effects associated with general construction activities, some seabirds may also be subject to direct disturbance from anthropogenic underwater noise. These species are those which forage underwater for prey, notably auks, divers and seaducks. Gull species feed at the surface and are, therefore, considered less vulnerable (Leopold & Camphuysen 2007).

6.5.65 Although effects of underwater noise associated with pile-driving activity are well-studied for marine mammals and fish (e.g. Madsen *et al*. 2006), very little is known about the effects on seabirds. However, studies quoted by Turnpenny & Nedwell (1994) and visual observations by Leopold & Camphuysen (2007) before and during pile-driving for an offshore wind farm in the Netherlands indicate that non-diving birds (e.g. gulls, fulmar and skuas) are unlikely to be affected. While it is possible that diving birds could be affected by an increase in underwater noise levels, it is considered unlikely that species of auks would suffer mortality as a result of pile-driving. Given the observed sensitivities of auks to construction activity, their presence in proximity (i.e. within several hundred metres) to pile-driving operations, and therefore generated noise levels that could potentially be injurious, is highly unlikely.

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6.5.66 It is recognised that extensive pile-driving would be required across the entire project area and therefore, potentially, a large area in which auks may be present would be affected. However, the nature of construction would mean that displacement effects would progressively preclude any localised impact on diving birds that may occur in the immediate vicinity of the works.

6.5.67 Direct effects on seabirds due to increased underwater noise levels during construction are determined, therefore, to be negligible and would not result in any affect on species populations.

## Disturbance and displacement during laying of export cables

6.5.68 Offshore export cables would be installed from a cable laying vessel or barge, using either a multi-point anchoring or dynamic positioning system. The cable burial methodologies include:

- Direct burial during the laying campaign;
- Pre-trenching; and
- Post-lay burial.

6.5.69 The two latter options have the advantage that the cable lay can be completed rapidly, with the slower task of cable trenching being performed independently. In some cases additional protection may be required after the installation of a cable, for instance if sufficient burial depth is not achievable at the location. The different inter-array and export cabling burial techniques would vary depending on location and the technology available at the time.

6.5.70 There are several aspects that are of significance in assessing the implications of the cable-laying operation. These are:

- The cable-laying vessel would be slow-moving, with an anticipated laying rate of 100m/hour;
- At any one time, the area occupied by the potential source of disturbance (i.e. the vessel) and in which disturbance effects could manifest would be extremely localised and represent a very small area in comparison to the extensive offshore area available to foraging birds;
- The works would take place in an offshore area through which regular and frequent vessel movements take place on a daily basis;
- Any disturbance effects associated with the activity would be transient; and
- The likelihood and extent of disturbance and displacement of seabirds from the cable-laying corridor would vary depending on the sensitivities of the individual species.

6.5.71 With reference to the ratings given by Furness & Wade (2012) (see **Table 6.4**), it is apparent that the majority of the species present in the offshore zone exhibit a very low or low potential vulnerability to vessel-related disturbance. Species such as great skua, Arctic skua and northern fulmar are wide ranging foragers and available observational evidence indicates that such species are largely unaffected by the presence of vessels as they can easily alter flight / foraging patterns to avoid potential sources of disturbance.

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6.5.72 Gull species, including black-legged kittiwake, remain undisturbed by the presence of boats even when in close proximity. This is likely reflected in many gull species foraging strategy of taking discards close to fishing vessels. As such, Garthe & Hüppop (2004) rated gulls and black-legged kittiwake as being of low sensitivity to boat-based disturbance, and the general sensitivity of these species to disturbance was considered by Furness & Wade (2012) to be low.

6.5.73 Northern gannet and Atlantic puffin were also rated as of low vulnerability to disturbance by Furness & Wade (2012) and, therefore, any potential localised and transient source of disturbance would be unlikely to lead to displacement that would have adverse consequences for these species.

6.5.74 As described in Section 6.3, auk species such as razorbill and common guillemot may exhibit a greater sensitivity to human activities in the marine environment than other seabird species. Even if such sensitivities are exhibited in response to the presence of a single, slow-moving vessel, the overall effect of this disturbance effect would be spatially and temporally extremely localised in respect of the ecological energetics of an individual bird.

6.5.75 All of the seabird species present within the offshore zone would forage over a wide area in order to take advantage of both consistent and ephemeral sources of prey. Given the small total area in which cable-laying operations would occur and the locally transient nature of the activity, any disturbance/displacement effects would be highly unlikely to affect foraging behaviour / success such that the fitness of individuals would be compromised and mortality result.

6.5.76 It is, therefore, concluded that disturbance effects associated with cable-laying operations would have an insignificant impact on seabird populations in the offshore area. As such, disturbance and displacement effects associated with this activity are not considered further in this report.

## Disturbance and displacement during cable landfall construction

6.5.77 Construction disturbance (visual and noise) during construction of the cable landfall (e.g. installation of cofferdams and HDD drilling activities) could potentially disturb waterbirds feeding and / or roosting in the intertidal zone, as well as disturbing those foraging in nearby coastal waters. Species display different sensitivities and reactions to noise and visual disturbance. Any impact of disturbance will be dependent on the numbers of each species present, their sensitivity to disturbance, the extent and duration of disturbance, and the availability of alternative foraging areas.

6.5.78 In general, it is accepted that birds tend to be more affected by the presence of people (human activity) than by noise from equipment, although the two causes of impacts are usually intimately related (i.e. noise is mainly created concurrently with human presence). Research on the effects of disturbance on birds using estuarine environments is most often focused on recreational usage of the coast.

6.5.79 The effects on birds of the construction of flood defences on the Humber Estuary have been investigated over a prolonged period by the Institute of Estuarine and Coastal Studies (IECS). These studies have focused on the

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behavioural responses of waterbirds to both visual and aural stimuli (Cutts *et al*. 2009; Mander & Cutts 2003 and 2004).

6.5.80 With respect to the effect of increased noise levels on disturbance responses by birds the work by IECS has provided some data on the levels at which a response reaction is elicited. This work was based on assessment in relation to work from the Wadden Sea, which suggested that, at levels in excess of 84 dB(A), there is a flight response in waterfowl; whilst below 55 dB(A) there is no effect, although at levels between 43 dB(A) and 87 dB(A) no effect on levels of diversity were recorded.

6.5.81 Aural stimuli between approximately 50dB to 85dB would, therefore, appear to result in local behavioural change including cessation of feeding, taking up of alert postures and short distance movement; above this noise level movements away from the area may occur. Disturbance is usually observed to lead to the interruption of birds' normal activity patterns and / or short-distance displacement from the area of disturbance (Dwyer, 2010). Studies suggest that any effects are temporary and in only a small number of cases have disturbance events actually been shown to cause birds to permanently vacate a site.

6.5.82 Some studies have sought to establish the distances at which birds respond to activities that may cause disturbance. From the IECS monitoring work, it was concluded that waterfowl require a buffer zone of between 100m to 200m from construction activity, with the width of the buffer depending on factors such as species, activity, time of year, site topography, weather, tide state and habituation level. During the monitoring of flood defence works (Cutts & Allen 1999), it was found that piling and backhoe activity resulted in reduced usage of intertidal areas by birds but the disturbance was confined to the immediate vicinity of works. Gulls in particular appeared to habituate to disturbance and were observed to feed within 10m of the activity.

6.5.83 Based on data from the above studies, it is apparent that the disturbance response of waterbirds to construction activity is variable but that, in general, effects are confined to areas within 250m of the source of the disturbance.

6.5.84 As presented in **Table 6.18,** no key marine species were identified within the intertidal cable landfall area. The species present were predominantly waders, gulls, and terrestrial species. Three species – northern lapwing, ringed plover and sanderling have been recorded in the vicinity of the export cable landfall area, either during previous surveys or the project-specific surveys. Potentially these birds may form part of the designated wintering assemblage of the Teesmouth and Cleveland Coast SPA, which at its nearest, is approximately 2km from the location of the landfall. The distance from the SPA would, during construction, effectively preclude any direct disturbance effects to birds within the defined boundary of the SPA.

6.5.85 While birds within 250m-300m of the works could be affected through aural and visual stimuli, the remainder of the coastal frontage around the landfall would remain unaffected by the works. Waterbirds potentially displaced from foraging within the zone of disturbance around the landfall, therefore, would be able to relocate to other parts of the frontage or further afield. As the survey data indicates, overall usage of the frontage by waterbirds, either for foraging or

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roosting, is low and probably reflects both the limited available foraging resource and also the existing high level of disturbance (e.g. recreational use, dog-walking etc.) that the frontage is subject to. While the landfall works would further contribute to the overall disturbance levels, this contribution would be localised and of a short-term duration (a maximum of six months or one overwintering period). Coupled with the very limited use of the foreshore area by birds likely to derive from the Teesside and Cleveland Coast SPA, it is considered unlikely that disturbance and localised displacement would have a measurable effect on the designated SPA populations.

6.5.86 It is, therefore, concluded that disturbance effects associated with construction activities at the cable landfall location would not give rise to any significant impacts on waterfowl, wader and seabird species that utilise the intertidal and nearshore area. No adverse impacts on SPA and Ramsar designated species populations are therefore anticipated and disturbance and displacement effects associated with this activity are not considered further in this report.

## 6.6 Assessment of impacts during the operation phase

### Introduction

6.6.1 This section provides an assessment of the potential impacts for the operation phase of Dogger Bank Teesside A & B. Potential effects highlighted as part of the EIA Scoping and HRA screening (see **Appendix A** of the **HRA Report**) were:

- Changes in habitat resources (e.g. habitat availability, prey supply);
- Disturbance and displacement of birds as a result of the presence of the wind farm and maintenance activities (e.g. vessel traffic) which may amount to habitat loss (or change in utilisation);
- Barrier effects; and
- Collision risk.

### Changes in habitat conditions and implications for birds

6.6.2 The development of Dogger Bank Teesside A & B would not have any direct effect on supporting habitat features within designated SPAs or Ramsar sites. However, changes in habitat conditions as a result of development within the Dogger Bank Zone and the area covered by Dogger Bank Teesside A & B could potentially influence the energetics and behaviour of birds that may form part of designated SPA / Ramsar site populations.

6.6.3 For operational wind farms the following effects could lead to changes in habitat conditions that may have consequences for bird utilisation of Dogger Bank Teesside A & B. The majority of these effects relate to potential influence on prey availability rather than leading to direct impacts on seabird populations:

- Seabed habitat loss and the affect of this on potential prey species abundance and distribution;
- Physical disturbance to seabed habitats through maintenance activities;
- The influence of increased underwater noise levels on prey species;

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- The influence of electro-magnetic frequencies on prey species;
- The role that turbine structures on the seabed may have as novel habitats in the offshore ecosystem;
- Potential changes in fishing activity within the footprint of the wind farm and the implications that this may have with respect to prey availability and abundance; and
- The attraction of turbine structures to birds and their use as platforms for perching and roosting.

6.6.4 The effects listed above and their implications for utilisation of the offshore area by seabirds are discussed in the sections that follow.

**Offshore – Dogger Bank Zone and Dogger Bank Teesside A & B Export Cable Corridor**

***Benthic habitat loss and disturbance impact on the fish fauna***

6.6.5 Direct habitat loss may result in loss or fragmentation of foraging or loafing habitat for particular species. For wind farm developments, this is generally relatively small, amounting to the area lost to turbine bases and associated infrastructure; typically <1% of the total development footprint (Drewitt & Langston 2006). With respect to seabirds, this physical loss is likely to be considerably less than any effective habitat loss due to indirect disturbance or displacement from the wind farm area. Effects may be more widespread, however, if developments interfere with the turbidity or quality of the surrounding area of sea. This indirect (secondary) impact of habitat loss may occur if habitats associated with prey species are removed, which would result in the loss of a food resource to birds in the wind farm area.

6.6.6 The installation of turbines would lead to a loss of benthic habitat that may affect birds' prey species. Introduction of foundations and scour protection would result in permanent loss of seabed habitat throughout operation, for which the worst case is considered to be gravity base structure foundations. Maintenance works throughout the lifetime of the development may lead to disturbance of seabed habitats, which in turn may affect benthic communities.

6.6.7 Under the worst case scenario, the total loss of benthic habitat from within Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor) is estimated as 12.53km$^2$, split almost equally between Dogger Bank Teesside A and Dogger Bank Teesside B (see Section 7.1 in **Chapter 12** of the Dogger Bank Teesside A & B ES). This loss would be long-term and occur for the entire duration of the operational phase.

6.6.8 It is estimated that, under a worst case scenario, up to 1.81km$^2$ of seabed within Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor could be disturbed on an annual basis as a result of maintenance activities, largely as a result of the placement of jack-up rigs. Disturbance would be temporary and rapid recovery (within a maximum of 5 years) of benthic communities would be expected (see Section 7.2 in **Chapter 12** of the Dogger Bank Teesside A & B ES), assuming that there was

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not repeated, annual disturbance of the same area (which is expected to be the case).

6.6.9 Assessment of the implications of the long term loss of benthic habitat and disturbance effects to benthic communities on the fish fauna of Dogger Bank is provided in **Chapter 13** of the Dogger Bank Teesside A & B ES. This assessment work concludes that the fish species present in Dogger Bank Teesside A & B have wide distribution ranges and are able to utilise comparatively large areas for spawning/nursery and feeding. The populations and abundance of these species are, therefore, expected to remain unaffected by the small predicted loss of seabed habitat. With regard to sandeel, which is perhaps the major prey species for seabirds foraging out at Dogger Bank, the small loss of habitat is, again, considered to be insignificant in the context of the population dynamics of this species, particularly given the occurrence and wide distribution of high density areas of this species outside of Dogger Bank Teesside A & B. It is notable that sandeel specific post-construction monitoring undertaken at the Horns Rev wind farm has not found evidence of a long term effect on the sandeel population seven years after construction (Stenberg *et al*. 2011).

6.6.10 Within the Dogger Bank Teesside A & B Export Cable Corridor, some direct loss of seabed habitat would occur as a result of cable protection measures and crossings. As for the area of the wind farm itself, this loss of seabed habitat would be 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 and, as nursery, feeding or overwintering grounds. As such, a significant impact on fish populations and abundance within the offshore area is not predicted (see **Chapter 13** of the Dogger Bank Teesside A & B ES). Hence, no impact on the prey resource availability for little tern foraging from the Northumbria Coast SPA and Ramsar site and the Teesmouth and Cleveland Coast SPA and Ramsar site is predicted.

### *Increase in underwater noise levels and impact on the fish fauna*

6.6.11 The main source of noise from wind turbines during the operation phase originates from the wind turbine's gearbox and generator. In addition, noise would also result from surface vessels servicing the wind farm. 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.

6.6.12 Research by Wahlberg & 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 13m/s). Post-construction monitoring of hard substrate communities at Horns Rev (Leonhard & 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.

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6.6.13 It should be noted that a major contribution to 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, therefore, may exceed wind turbine noise (Tougaard *et al*. 2009).

6.6.14 Given the low noise levels predicted (see **Appendix 13G** of the Dogger Bank Teesside A & B ES) any risk of significant behavioural disturbance on fish would be limited to the local area immediately surrounding the wind turbine, which, in total, would represent a very small proportion of the area of Dogger Bank Teesside A & B.

6.6.15 Taking the above findings into account, the assessment presented in **Chapter 13** of the Dogger Bank Teesside A & B ES concludes that it is reasonable to assume that operational noise would be unlikely to have any significant effects such that detrimental changes in fish populations, abundance and distribution would result within Dogger Bank Teesside A & B.

### *Introduction of hard substrate and effect on the fish fauna*

6.6.16 Given the soft seabed environment within Dogger Bank Teesside A & B, sub-surface turbine towers and foundations may require scour protection material, requiring hard substrate introduction. This represents a novel sub-littoral habitat and, if used, these hard substrates can be expected to be colonised by a number of organisms, including a range of encrusting and attaching species such as mussels, barnacles, tubeworms, sponges, hydroids, etc. This is likely to increase local species diversity as well as the abundance and biomass of epifaunal organisms. This increase in diversity and productivity of attached communities may have an effect on fish, resulting in attraction and potential increased productivity.

6.6.17 Post-construction monitoring work at the operational wind farm of Horns Rev, indicated 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 & Pedersen 2005). Research by Andersson *et al*. (2009) on the epibenthic colonisation of concrete and steel experimental pillars where fish assemblages were sampled and compared to natural areas, found an overall higher abundance and species numbers on the pillars (with no difference between steel and concrete pillars) compared to the surrounding soft bottom habitats.

6.6.18 The Horns Rev monitoring follow-up report (Stenberg *et al*. 2011) which examined the changes in the fish community seven years after construction, suggests that the introduction of hard substrate has resulted in minor changes in the fish community and species diversity. The introduction of hard substrate was found to result in higher species diversity close to each turbine with a clear (horizontal) distribution, which was most pronounced in the autumn, when the greatest number of species occurred. In the particular case of sandeels, it should be noted that sandeel specific monitoring carried out in Horns Rev suggests that the construction of the wind farm has not resulted in a detrimental long-term effect on the overall occurrence of sandeels in the area (Stenberg *et al*. 2011).

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6.6.19 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, no significant change in the diversity of organisms and species composition of the benthic and demersal communities was found to occur (Cefas 2009). At Barrow, 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, or between the numbers caught at control locations and within the wind farm area after the wind farm was constructed (Cefas 2009).

6.6.20 These studies indicate that the introduction of hard, novel substrates within Dogger Bank would be unlikely to have an adverse effect upon fish populations and the availability of fish as a prey resource to foraging birds. As suggested by the findings of the monitoring studies, there may, in fact, be the potential for subsea structures within Dogger Bank Teesside A & B to be used as nursery and spawning area and/or provide shelter and increased feeding opportunities to some fish, thus potentially increasing the overall availability of prey to seabirds.

6.6.21 In light of available evidence, the assessment work presented in **Chapter 13** of the Dogger Bank Teesside A & B ES concludes that small changes in the distribution and diversity of fish species would be generally confined to the immediate vicinity of each turbine. Effects would be likely to manifest with respect to individual species rather than the fish assemblage of the Dogger Bank area as a whole. This conclusion indicates that, as a minimum, it can be determined that prey availability for seabirds would not be diminished as a result of development and, potentially, the overall prey resource could be increased in the vicinity of hard substrates.

### *The influence of electromagnetic effects on the fish fauna*

6.6.22 The potential impact of the generation of electro-magnetic fields (EMFs) emitted by electricity cables on fish is assessed in **Chapter 13** of the Dogger Bank Teesside A & B ES.

6.6.23 Most fish species are able to sense EMFs. Elasmobranchs and migratory species, such as eel and Atlantic salmon, are considered the key sensitive receptors to any effects that may manifest, although potentially species such as cod and plaice may be sensitive to EMFs.

6.6.24 The results of post-construction monitoring carried out in operational wind farms do not suggest that EMFs have resulted in significant detrimental impacts on these species. Lindeboom *et al*. (2011) suggest that the presence of the foundations and scour protection and potential changes in the fisheries related to offshore wind farm development have the most impact upon fish species. Similarly, Leonhard & Pedersen (2006) indicate that noise from the wind turbines and EMFs 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

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offshore wind farm (Denmark), focused on detecting and assessing possible effects of EMFs on fish during power transmission, found no differences in the fish community composition after the wind farm became 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 that an impact on a population or community level was likely to be very limited.

6.6.25 For Dogger Bank Teesside A & B, where feasible, cables will be buried. While cable burial does not completely mitigate the influence of EMFs, it reduces exposure of electromagnetically sensitive species to the strongest EMFs 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, alternative protection, such as concrete mattresses, will be used. Fish would, therefore, not be directly exposed to the strongest EMFs as a result of the physical barrier that burial and cable protection would constitute.

6.6.26 Information presented in **Chapter 13** of the Dogger Bank Teesside A & B ES shows that EMF related effects on sensitive fish would be limited to the immediate vicinity of the cables and, therefore, the magnitude of the effect of EMFs is considered to be small. It is expected that EMFs would only result in short term, temporary behavioural effects to sensitive species, notably elasmobranchs and migratory species, and effects at the level of individual species populations or the fish assemblage would not be expected.

6.6.27 In respect of the species of seabirds that occur with regularity in Dogger Bank Teesside A & B, it should be noted that elasmobranchs and migratory fish would be unlikely to make up a significant component of their diet, which largely comprises small pelagic and demersal fish species (e.g. sandeel, herring). The available evidence, therefore, suggests that fish populations and assemblages would not be affected to any significant degree such that prey resource availability to seabirds would be diminished.

### *Changes to fishing activity and influence on prey availability for seabirds*

6.6.28 Changes to fishing activity as a result of the development of Dogger Bank Teesside A & B could potentially affect fish and shellfish species.

6.6.29 Localised reduction in fishing activity (see **Chapter 15 Commercial Fisheries** of the Dogger Bank Teesside A & B ES) may benefit seabed communities, which in turn could have a positive effect on fish populations, provided the productivity of the area increases. In addition, target and by-catch species could 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.

6.6.30 In the particular 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 the construction of the wind farm, hence no effect on fish populations in the vicinity of the Dogger Bank Teesside A & B Export Cable Corridor would be expected.

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6.6.31 The assessment presented in **Chapter 15** of the Dogger Bank Teesside A & B ES concluded that the magnitude of the effect associated with changes in fishing activity during the operation phase for Dogger Bank Teesside A & B would be small, but potentially beneficial with regard to the populations of some of the commercially exploited fish species.

6.6.32 Any beneficial change in benthic communities and fish populations within the wind farm area could increase the overall prey resource available to seabirds that may forage within the wind farm. Conversely, species that take advantage of discards (e.g. northern fulmar, northern gannet, gulls and skuas) could be adversely affected within the wind farm area. If, however, fishing effort is displaced from the wind farm area, rather than reduced in totality across the Zone, then the discard resource utilised by these seabird species would be unlikely to be significantly affected.

### *Attraction of birds to offshore structures*

6.6.33 During the operation phase, turbines may provide platforms for perching and roosting birds (Leopold *et al*. 2010) and could also extend foraging ranges by allowing birds to rest. Evidence suggests that gulls may either fly through or forage within wind farms, or even actively perch on above-surface structures. Moreover, boat traffic associated with maintenance works may attract species such as northern fulmar, northern gannet, skuas and gulls. It is possible that if the base of structures were an attractant for foraging birds that there could be a small increase in collision risk.

6.6.34 At present, although there is limited quantitative evidence of any effects of micro-habitat creation or alteration, the extent of such benefits or adverse impacts for seabirds are likely to be negligible compared to the size of Dogger Bank Teesside A & B and the wider Dogger Bank Zone.

6.6.35 Lighting on the turbines in order to meet aviation and shipping safety requirements may have a number of effects on birds. During the hours of darkness birds may be attracted to lighting as this may provide opportunities for extended feeding periods, shelter and resting places or navigation aids for migrating birds (Tasker *et al*. 1986; Wiese *et al*. 2001). However, potentially this is a complex issue, as the altered light environment may lead to disorientation and attraction or repulsion of birds which, in turn, may affect foraging, reproduction, migration, and communication and potentially increase the risk of collision (Longcore & Rich 2004). Birds may collide with each other or a structure, or become exhausted as a result. Conversely, for unlit turbines at night or during foggy conditions (Trapp 1998), it is possible that the risk of collision may be greater because moving rotors may not be detectable.

6.6.36 Lighting on the turbines is not expected to be sufficiently powerful to act as an attractant and, therefore, lead to an increase in the provision of foraging opportunities for seabird species.

6.6.37 Migrating birds are likely to be particularly susceptible to any adverse effects of lighting. Around two thirds of all bird species migrate during darkness, when collision risk is expected to be higher than during daylight (Hüppop *et al*. 2006).

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6.6.38 Potential disturbance effects from lit structures would be minimised as far as practical. The lighting of turbines would meet minimum legal requirements, namely as set out in the IALA Recommendation O-117 on 'The Marking of Offshore Wind Farms'. Wherever possible and in keeping with the minimum legal requirements, and any other relevant consultation discussions, any unnecessary lighting (particularly that directed outwards) would be avoided to minimise the risks of migrating birds becoming attracted to or disorientated by turbines at night or in poor weather.

### *Export cable landfall*

6.6.39 The cable landfall would remain buried beneath the littoral sands and sediments of the intertidal zone and, consequently, no long-term habitat loss or alteration would occur during the operation phase. No impact on birds using the foreshore as a foraging or roosting area, therefore, would occur and no impacts on SPA and Ramsar site populations are predicted.

## Disturbance and displacement of seabirds

6.6.40 During the operation phase there is potential for the long-term displacement of seabirds from existing areas that they use as foraging habitat as a result of disturbance effects associated with the presence of moving turbines, and maintenance activities (e.g. boat traffic). This displacement constitutes an effective loss of habitat (Desholm & Kalhert 2005).

6.6.41 Behavioural displacement is commonly equated to macro-avoidance, though in the context of collision-risk modelling this refers to the far-field evasive action taken by a flying bird to avoid the wind farm as a whole (Band 2012). 'Micro' or 'near-field' avoidance refers to the evasive action taken by a bird in the vicinity of a turbine within the wind farm to avoid collision. Displacement, in contrast, reflects the long-term loss of birds from an area of habitat. Although different, the macro-avoidance rates recorded in studies of birds flight paths can inform on the potential displacement rates of different species.

6.6.42 Radar and visual scan studies for some seaducks, including scoter and long-tailed duck, and divers have recorded displacement effects and strong avoidance of wind farms post-construction (APEM 2011; Krijgsveld *et al*. 2011; Petersen *et al*. 2006 and 2011; and Petersen & Fox 2007). There is also evidence from monitoring studies to indicate that auks may be sensitive to disturbance effects, resulting in relatively high levels of displacement from wind farms (Petersen *et al*. 2006; Krijgsveld *et al*. 2011). Comparison of pre- and post-construction surveys at Horns Rev and Nysted has demonstrated displacement of divers and auks from wind farm sites (Petersen *et al*. 2006). Northern gannets also show strong avoidance behaviour to wind farms (Krijgsveld *et al*. 2011) suggesting higher levels of displacement. Black-legged kittiwakes show little to no avoidance of wind farms, even showing attraction (Krijgsveld *et al*. 2011). Other gull species have been recorded within wind farms and as attracted to them post-construction (Krijgsveld *et al.* 2011; Petersen *et al*. 2006). There is limited information on displacement or macro-avoidance for northern fulmars and skuas (Petersen *et al*. 2006; Krijgsveld *et al*. 2011), hence a precautionary approach has been taken in respect of these species.

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6.6.43 Displacement would be an on-going effect through the operational lifetime of the project, varying in frequency through the year according to the species' population size, and has the potential to impact birds throughout the range of the species' biogeographic population.

6.6.44 As stated previously, studies of the impacts of displacement (effective habitat loss) on the survival of individuals and thus on populations as a whole are few and wholly lacking in the marine environment. It is thus necessary to draw on other available ecological information (e.g. prey resource dynamics) and qualitative assessments of the ability of birds to tolerate this effect through their flexibility in using alternate habitats (see discussion in Section 6.3).

6.6.45 Potential rates of mortality for birds displaced from foraging areas have been equated to the habitat flexibility characteristics of individual species (see **Table 6.5**) and the availability of suitable foraging habitat in determining the potential level of impact at the population level.

6.6.46 The following paragraphs provide a summary of the calculated displacement and mortality effects for species of seabird for which a displacement effect has been identified (see Section 6.3). These species are:

- Common guillemot;
- Razorbill; and
- Atlantic puffin.

6.6.47 For all other species of seabirds screened into this assessment, displacement and / or mortality resulting from displacement is predicted to be negligible. It should be noted that, at the level of the individual project, it has been assumed that no mortality of northern gannet would result from displacement from the wind farm area (see Section 6.3).

6.6.48 The calculated numbers of seabirds affected by displacement and mortality have been apportioned to individual SPAs in line with the methodology set out in Section 6.3 and for each species the percentage of the SPA population affected is provided. Conclusions regarding the predicted displacement impacts on individual SPA populations are provided in Section 6.8.

**Common guillemot**

6.6.49 A mortality rate of 5% following displacement has been assigned to this species across both the breeding and non-breeding seasons, based on knowledge of the foraging ecology of this species and the magnitude of the habitat loss that could occur as a result of displacement from the wind farm development area during the construction phase. As discussed in Section 6.3, this is viewed as a precautionary mortality rate and it is anticipated that the actual mortality rate would be lower than this.

6.6.50 Based on mean data, the disturbance and displacement analysis undertaken provides a mean of 5,511 displaced birds (1,108 during breeding months, 4,403 during other months of the year). Taking account of potential mortality, these displacement figures result in the loss of 276 birds (37 during the breeding season) across all of the SPAs in the greater North Sea region (see Tables

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A9.39a-d, Appendix 9 of **Appendix 11A** of the Dogger Bank Teesside A & B ES).

6.6.51 Dogger Bank Teesside A & B is within the foraging range, during the breeding season, of six SPAs around the North Sea at which the species is a feature (see **Table 6.19**).

Table 6.19 Calculated displacement-mortality impact for common guillemot within foraging range of Dogger Bank Teesside A & B during the operation phase (totals based on averaged data for 2010, 2010/2011 and 2011/2012) -figures provided for estimated number of mortalities and percentage of current SPA populations affected

| European site | Dogger Bank Teesside A & B | | | | | |
|---|---|---|---|---|---|---|
| | Breeding | | Non-breeding | | Total | |
| | Number of birds | % population | Number of birds | % population | Number of birds | % population |
| Farne Islands SPA | 7.6 | 0.01 | 17.6 | 0.02 | 25.2 | 0.03 |
| Flamborough and Filey Coast pSPA | 19.7 | 0.02 | 22.8 | 0.02 | 42.4 | 0.04 |
| Forth Islands SPA | 2.1 | 0.01 | 8.0 | 0.02 | 10.1 | 0.03 |
| Fowlsheugh SPA | 2.3 | <0.01 | 16.5 | 0.02 | 18.8 | 0.02 |
| St Abb's Head to Fast Castle SPA | 5.1 | 0.01 | 16.0 | 0.02 | 21.1 | 0.03 |
| **Transboundary site** | | | | | | |
| Seevogelschutzgebiet Helgoland SPA | 0.2 | <0.01 | 1.4 | 0.02 | 1.5 | 0.02 |

6.6.52 The greatest effect would be on the designated population of Flamborough and Filey Coast pSPA, where an estimated 0.04% reduction in the population (0.02% of the adult breeding population) could occur as a result of displacement and mortality effects (see **Table 6.19** and Table A9.39d in Appendix 9 in **Appendix 11A** of the Dogger Bank Teesside A & B ES).

6.6.53 For the other five SPAs within maximum foraging range, displacement would affect approximately 0.03% (mean), of the total population of the suite of protected sites around the North Sea at which common guillemot is a feature (see **Table 6.19** and Table A9.39d in Appendix 9 in **Appendix 11A** of the Dogger Bank Teesside A & B ES). Displacement would affect less than 0.02% of the British breeding population of common guillemot and affect much less than 0.01% of the biogeographic population of common guillemot.

6.6.54 The calculated 0.04% reduction in the population of common guillemot at Flamborough and Filey Coast pSPA is not considered to be significant for a number of reasons. The reduction in the adult breeding population would be 19 birds out of a population of c. 83,000 individuals (i.e. 0.02% of the population). While a further 23 birds have been apportioned to this SPA as a result of displacement during the non-breeding season, in reality the foraging area available to birds outside of the breeding season is extremely large and mortality as a result of displacement is considered unlikely to occur (see Furness 2013 in **Appendix 11B** of the Dogger Bank Teesside A & B ES). There is also evidence

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to indicate that usage of a site such as Dogger Bank, which lies significantly beyond the mean maximum foraging range of common guillemot, by birds during the breeding season would not be optimal and is likely to result in breeding failure rather than direct mortality of adult birds (see Furness 2013 in **Appendix 11B** of the Dogger Bank Teesside A & B ES). The breeding failure of 19 adults (assumed to represent 19 pairs) would be highly unlikely to result in a discernible impact at the population level of the pSPA.

6.6.55 In line with guidance (JNCC/Natural England 2012) on the assessment of displacement effects, a range of alternative displacement and mortality values are presented in **Table 6.20** and the corresponding predicted impact on the SPA population provided. While the assessment work presented in this report and the ES is based upon a 50% displacement rate and 5% mortality rate, alternative, lower values may be applicable to this species. A full range of alternative displacement and mortality values for this species is presented in Appendix 10 of **Appendix 11A** of the Dogger Bank Teesside A & B ES.

6.6.56 Post-construction monitoring from the Robin Rigg wind farm (Walls *et al*. 2012) indicates that the observed displacement rate during the operational phase of the wind farm is about 30% for auk species (common guillemot and razorbill). Whilst only one year of published monitoring data is currently available, indications from this one site are that displacement rates for these species may be significantly lower than the precautionary 50% rate utilised in this assessment. As shown in **Table 6.20**, adopting a 30% displacement rate would reduce the displacement impact on the site population at Flamborough and Filey Coast pSPA from 0.04% to 0.024% of the population.

**Razorbill**

6.6.57 A mortality rate of 5% following displacement has been assigned to this species across both the breeding and non-breeding seasons, based on knowledge of the foraging ecology of this species and the magnitude of the habitat loss that could occur as a result of displacement from the wind farm development area during the construction phase. As discussed in Section 6.3, this is viewed as a precautionary mortality rate and it is anticipated that the actual mortality rate would be lower than this.

6.6.58 Based on mean data the disturbance and displacement analysis undertaken provides a figure of 1,804 displaced birds (186 during breeding months, 1,618 during other months of the year). Taking account of potential mortality, these displacement figures result in the loss of 49 birds (five during the breeding season) across all of the SPAs in the greater North Sea region (see Tables A9.42a-d, Appendix 9 of **Appendix 11A** of the Dogger Bank Teesside A & B ES).

6.6.59 Dogger Bank Teesside A & B is within the foraging range, during the breeding season, of 5 SPAs around the North Sea at which razorbill is a feature (see **Table 6.21**). Disturbance-displacement would affect less than 0.04% (mean) of the total population of the suite of protected sites around the North Sea at which the species is a feature. The greatest effect would be at the Flamborough and Filey Coast pSPA, where 0.06% of the population would be impacted (see Table A9.42d, Appendix 9 of **Appendix 11A** of the Dogger Bank Teesside A & B ES).

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Table 6.20 Number of common guillemots affected and population impacts for SPAs within foraging range of Dogger Bank Teesside A & B for a range of displacement and mortality values for the operation phase

| Site name | 50% Displacement | | | 40% Displacement | | | 30% Displacement | | |
|---|---|---|---|---|---|---|---|---|---|
| | Breeding | Non-breeding | Total % | Breeding | Non-breeding | Total % | Breeding | Non-breeding | Total % |
| **Farne Islands SPA** | | | | | | | | | |
| 10% mortality | 16 | 36 | 0.06 | 13 | 29 | 0.05 | 10 | 22 | 0.04 |
| **5% mortality** | **8** | **18** | **0.03** | 6 | 14 | 0.02 | 5 | 11 | 0.02 |
| 1% mortality | <2 | 4 | <0.01 | <2 | 3 | <0.01 | 1 | 2 | <0.01 |
| **Forth Islands SPA** | | | | | | | | | |
| 10% mortality | 4 | 16 | 0.06 | 3 | 13 | 0.05 | 3 | 10 | 0.04 |
| **5% mortality** | **2** | **8** | **0.03** | 2 | 6 | 0.02 | 1 | 5 | 0.02 |
| 1% mortality | <1 | <2 | <0.01 | <1 | <2 | <0.01 | <1 | 1 | <0.01 |
| **Flamborough and Filey Coast pSPA** | | | | | | | | | |
| 10% mortality | 40 | 46 | 0.08 | 32 | 36 | 0.06 | 24 | 28 | 0.05 |
| **5% mortality** | **20** | **23** | **0.04** | 16 | 18 | 0.03 | 12 | 14 | 0.02 |
| 1% mortality | 4 | 12 | <0.01 | 3 | 4 | <0.01 | 2 | 3 | <0.01 |
| **Fowlsheugh SPA** | | | | | | | | | |
| 10% mortality | 4 | 34 | 0.04 | 3 | 27 | 0.03 | 2 | 20 | 0.02 |
| **5% mortality** | **2** | **17** | **0.02** | 2 | 14 | 0.02 | 1 | 10 | 0.01 |
| 1% mortality | <1 | 3 | <0.01 | <1 | 3 | <0.01 | <1 | 2 | <0.01 |
| **St. Abb's Head to Fast Castle SPA** | | | | | | | | | |
| 10% mortality | 10 | 32 | 0.06 | 8 | 26 | 0.05 | 6 | 20 | 0.04 |
| 5% mortality | **5** | **16** | **0.03** | 4 | 13 | 0.02 | 3 | 10 | 0.02 |
| 1% mortality | 1 | 3 | <0.01 | <1 | 2 | <0.01 | <1 | 2 | <0.01 |


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Table 6.21 Estimated percentage of current SPA populations of razorbill within foraging range of Dogger Bank Teesside A & B affected by disturbance and displacement during the operation phase

| European site | Dogger Bank Teesside A & B | | | | | |
|---|---|---|---|---|---|---|
| | Breeding | | Non-breeding | | Total % | |
| | Number of birds | % population | Number of birds | % population | Number of birds | % population |
| Farne Islands SPA | 0.1 | 0.01 | 0.4 | 0.04 | 0.5 | 0.05 |
| Flamborough and Filey Coast pSPA | 4.3 | 0.02 | 11.4 | 0.04 | 15.7 | 0.06 |
| Forth Islands SPA | 0.2 | 0 | 3.4 | 0.04 | 3.6 | 0.04 |
| St Abb's Head to Fast Castle SPA | 0.3 | <0.01 | 2.3 | 0.04 | 2.6 | 0.04 |

6.6.60 Displacement led mortality would affect less than 0.06% of the British breeding population and much less than 0.01% of the species' biogeographic population.

6.6.61 In line with JNCC/Natural England guidance (2012) on the assessment of displacement effects, a range of alternative displacement and mortality values for this species is presented in **Table 6.22**. A full range of alternative displacement and mortality values for this species is presented in Appendix 10 of **Appendix 11A** of the Dogger Bank Teesside A & B ES.

6.6.62 As with the common guillemot population at Flamborough and Filey Coast pSPA, the razorbill population has also shown a dramatic increase in the past few decades, with a 190% increase since designation (see Appendix 1 in **Appendix 11A** of the Dogger Bank Teesside A & B ES). Viewed in this context, the predicted 0.06% reduction that could result from displacement and mortality during the operation phase for Dogger Bank Teesside A & B would be more than offset by the population growth since designation and potential continued growth of the colony, even at a substantially lower rate than has been achieved over the past ten years.

6.6.63 For razorbill it is particularly notable that by far the greater component of the displacement impact relates to non-breeding birds (see **Table 6.21**) and the number of birds affected during the breeding season is very small, less than one bird at each SPA (see Table A9.42d in Appendix 9 in **Appendix 11A** of the Dogger Bank Teesside A & B ES), apart from in the Flamborough and Filey Coast pSPA, where up to 5 birds could be affected. These numbers suggest that impacts at the population level during the breeding season would be highly unlikely to occur. Given the large-scale mixing of non-SPA breeding birds with SPA designated populations during the non-breeding season, apportioning of non-breeding birds to SPAs is likely to be over precautionary, and the total impact, as assessed here, is therefore likely to be an overestimate.

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Table 6.22 Number of razorbill affected and population impacts for SPAs within foraging range of Dogger Bank Teesside A & B for a range of displacement and mortality values for the operation phase

| Site name | 50% Displacement | | | 40% Displacement | | | 30% Displacement | | |
|---|---|---|---|---|---|---|---|---|---|
| | Breeding | Non-breeding | Total % | Breeding | Non-breeding | Total % | Breeding | Non-breeding | Total % |
| **Farne Islands SPA** | | | | | | | | | |
| 10% mortality | 0.2 | 0.8 | 0.1 | 0.16 | 0.6 | 0.08 | 0.12 | 0.5 | 0.06 |
| 5% mortality | **0.1** | **0.4** | **0.05** | <0.1 | 0.3 | 0.04 | <0.1 | 0.2 | 0.03 |
| 1% mortality | <0.1 | <0.1 | 0.01 | <0.1 | <0.1 | <0.01 | <0.1 | <0.1 | <0.01 |
| **Forth Islands SPA** | | | | | | | | | |
| 10% mortality | 0.4 | 6.8 | 0.08 | 0.3 | 5.4 | 0.06 | 0.2 | 4 | 0.05 |
| 5% mortality | **0.2** | **3.4** | **0.04** | 0.2 | 2.7 | 0.03 | <0.1 | 2 | 0.02 |
| 1% mortality | <0.1 | <1 | <0.01 | <0.1 | <1 | <0.01 | <0.1 | 0.4 | <0.01 |
| **Flamborough and Filey Coast pSPA** | | | | | | | | | |
| 10% mortality | 9 | 23 | 0.12 | 6.8 | 18 | 0.1 | 5 | 14 | 0.07 |
| 5% mortality | **4.3** | **11.4** | **0.06** | 3.4 | 9 | 0.05 | 2.6 | 7 | 0.04 |
| 1% mortality | 0.9 | 2 | 0.01 | 0.7 | 1.6 | <0.01 | 0.5 | 1.4 | <0.01 |
| **St. Abb's Head to Fast Castle SPA** | | | | | | | | | |
| 10% mortality | 0.6 | 5 | 0.08 | 0.5 | 4 | 0.06 | 0.4 | 3 | 0.05 |
| 5% mortality | **0.3** | **2.3** | **0.04** | 0.2 | 2 | 0.03 | 0.2 | 1.4 | 0.02 |
| 1% mortality | <0.1 | 0.5 | <0.01 | <0.1 | 0.4 | <0.01 | <0.1 | 0.3 | <0.01 |


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### Atlantic puffin

6.6.64 A mortality rate of 5% following displacement has been assigned to this species across both the breeding and non-breeding seasons, based on knowledge of the foraging ecology of this species and the magnitude of the habitat loss that could occur as a result of displacement from the wind farm development area during the construction phase. As discussed in Section 6.3, this is viewed as a precautionary mortality rate and it is anticipated that the actual mortality rate would be lower than this.

6.6.65 Based on mean data, the disturbance and displacement analysis undertaken provides a figure of 168 displaced birds (28 during breeding months, and 140 during other months of the year). Taking account of potential mortality, these displacement figures result in the loss of eight birds (none during the breeding season) across all of the SPAs in the greater North Sea region (see Tables A9.45a-d, Appendix 9 of **Appendix 11A** of the Dogger Bank Teesside A & B ES).

6.6.66 Dogger Bank Teesside A & B is not within the mean maximum foraging range of any SPAs around the North Sea at which Atlantic puffin is a feature. For all SPAs screened into the assessment, the impact of the calculated displacement-led mortality is less than 0.01% of the designated populations (see Table A9.45d in Appendix 9 in **Appendix 11A** of the Dogger Bank Teesside A & B ES).

6.6.67 Displacement-led mortality would affect less than 0.01% of the total population of the suite of protected sites around the North Sea at which Atlantic puffin is a feature. Displacement would affect much less than 0.01% of the British breeding population and the species' biogeographic population.

6.6.68 A full range of alternative displacement and mortality values for this species is presented in Appendix 10 of **Appendix 11A** of the Dogger Bank Teesside A & B ES.

## Disturbance – export cable landfall

6.6.69 No regular activities would take place within the cable landfall area throughout the operation phase. Whilst the potential for maintenance of the buried cable could arise, this is both unlikely and would be temporary in nature. Consequently, similar residual impacts as those identified for the construction phase would arise. That is, no short-term impacts on possible European site (Teesmouth and Cleveland Coast SPA and Ramsar site) populations of the waterbird species recorded within the area of the cable landfall (see **Table 6.17**).

## Barrier effects

### Introduction

6.6.70 The assessment of barrier effects for Dogger Bank Teesside A & B concerns both breeding seabirds whose foraging ranges extend to the development area and migrating birds that may pass through the wind farm. The methodological approach to assessing the potential barrier effect of the development on these two groups of birds is set out in Section 6.3.

6.6.71 The species-specific sensitivity to barrier effects primarily reflects the tolerance of the individual bird species to the increased energetic costs associated with

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barrier effects. As indicated by Maclean *et al.* (2009), the impact on survival of a given barrier and concomitant deviation in flight will differ between species – large, bulky species with small wing areas (i.e. those which have high wing-loadings) are likely to be more adversely affected than those that do not. Based on this assumption, Maclean *et al.* (2009), used body mass and wing-length ratios to devise sensitivities for different species. For the purposes of assessment, and using available evidence, other groupings of birds have been included in this classification (see **Table 6.23**).

Table 6.23 Species-specific sensitivities to barrier effects (following Maclean *et al.* (2009)

| Species-specific sensitivity | Species |
|---|---|
| Very High | Black-throated diver. |
| High | Red-throated diver, great cormorant, geese, and auks. |
| Medium | Ducks. |
| Low | Northern fulmar, skuas, and gulls. |
| Negligible | Northern gannet, terns, and passerines. |

6.6.72 These sensitivities have been used in assessing the potential for Dogger Bank Teesside A & B to act as a barrier to birds in flight, either in relation to foraging effort or migratory pathways.

**Breeding seabirds**

6.6.73 As set out in **Table 6.1**, Dogger Bank Teesside A & B is within foraging range of six seabird species – northern fulmar, northern gannet, black-legged kittiwake, common guillemot, razorbill and Atlantic puffin – from protected sites for which they are features. Potentially, therefore, Dogger Bank Teesside A & B may pose a barrier to these species reaching part of their foraging grounds during the breeding season. For these species outside of the breeding season, and for all other seabird species on passage or wintering in the North Sea, it is assumed that barrier effects would not arise.

6.6.74 Estimates of the maximum numbers of breeding adult birds of these species in flight in the project areas, based on upper 90% confidence limits and estimates of the proportions of birds in flight from boat surveys, are provided in **Table 6.24**.

Table 6.24 Estimates of the numbers of breeding adult birds in flight and within foraging range of Dogger Bank Teesside A & B

| Species | Breeding season | Mean |
|---|---|---|
| Northern fulmar | Mar-Sep | 152 (123-182) |
| Northern gannet | Apr-Sep | 151 (128-180) |
| Black-legged kittiwake | Apr-Sep | 866 (773-961) |
| Common guillemot | May-Jul | 169 (156-186) |
| Razorbill | May-Jul | 54 (43-66) |

6.6.75 The following sections provide an assessment of the predicted magnitude of the barrier effect that may occur for each of the identified seabird species within foraging range of Dogger Bank Teesside A & B.

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### Northern fulmar

6.6.76 Based on upper 90% confidence limits and estimates of the proportions of birds in flight from boat surveys, it was estimated that there would be maxima of 182 adult northern fulmars in flight in Dogger Bank Teesside A & B in the breeding season using 2010, 2010/11 and 2011/12 data 2010 data and a mean of 152 across the three years.

6.6.77 The numbers of birds potentially exposed to a barrier effect represent less than 0.1% of national or biogeographic northern fulmar populations. The apportioning of these estimates to individual protected sites is summarised in Table A9.31 in Appendix 9 in **Appendix 11A** of the Dogger Bank Teesside A & B ES, which indicates that up to 5% of the northern fulmar population at the Flamborough and Filey Coast pSPA potentially might be exposed to this effect, which is considered further in paragraphs 6.6.91 to 6.6.93. For all other SPAs within the foraging range of Dogger Bank Teesside A & B, less than 1% of the breeding northern fulmar populations could be affected.

6.6.78 The average increase in flight distance across the North Sea due to the presence of Dogger Bank Teesside A & B is approximately 25km. This represents 6.3% of northern fulmar's mean maximum foraging range of 400km. The proposed development area is between 164km and 388km from the designated SPAs' which support populations of northern fulmar, which potentially could be impacted by this effect. This increase in flight distance might prevent birds from Troup, Pennan and Lions Heads SPA from reaching foraging areas beyond Dogger Bank Teesside A & B.

### Northern gannet

6.6.79 Based on upper 90% confidence limits and estimates of the proportions of birds in flight from boat surveys, it was estimated that there would be maxima of 180 adult northern gannets in flight in Dogger Bank Teesside A & B in the breeding season using 2010, 2010/11 and 2011/12 data 2010 data and a mean of 151 across the three years.

6.6.80 The numbers of birds exposed to this effect represent less than 0.1% of national or biogeographic northern gannet populations. The apportioning of these estimates to individual protected sites is summarised in Table A9.32 in Appendix 9 in **Appendix 11A** of the Dogger Bank Teesside A & B ES. At Flamborough and Filey Coast pSPA an estimated 0.34% of the breeding northern gannet population could be affected, while for the other two SPAs within mean maximum foraging range less than 0.1% of the breeding northern gannet populations could be affected.

6.6.81 The average increase in flight distance due to the barrier presented by Dogger Bank Teesside A & B is approximately 25km (10% of northern gannet's mean maximum foraging range of 230km). The proposed development area is 164km from the Flamborough and Filey Coast pSPA, the only protected site within foraging range from which birds potentially could be exposed to this effect.

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### Black-legged kittiwake

6.6.82 Based on upper 90% confidence limits and estimates of the proportions of birds in flight from boat surveys, it was estimated that there would be maxima of 961 adult black-legged kittiwakes in flight in Dogger Bank Teesside A & B in the breeding season using 2010, 2010/11 and 2011/12 data 2010 data and a mean of 866 across the three years.

6.6.83 The numbers of birds exposed to this effect represent less than 0.1% of national or biogeographic black-legged kittiwake populations. The apportioning of these estimates to individual protected sites is summarised in Tables A9.34 in Appendix 9 in **Appendix 11A** of the Dogger Bank Teesside A & B ES. This indicates that 1.1% of the breeding black-legged kittiwake population at the Flamborough and Filey Coast pSPA could be subject to the barrier effect of Dogger Bank Teesside A & B, and this is considered further in paragraph 6.6.94.

6.6.84 The average increase in flight distance due to the barrier presented by Dogger Bank Teesside A & B is approximately 25km (10.8% of the black-legged kittiwake's maximum foraging range of 231km). The proposed development area is 164km from the Flamborough and Filey Coast pSPA, the only protected site within foraging range from which birds potentially could be exposed to this effect.

### Common guillemot

6.6.85 Based on upper 90% confidence limits and estimates of the proportions of birds in flight from boat surveys, it was estimated that there would be maxima of 186 adult common guillemots in flight in Dogger Bank Teesside A & B in the breeding season using 2010, 2010/11 and 2011/12 data 2010 data and a mean of 169 across the three years.

6.6.86 The numbers of birds exposed to this effect represent less than 0.1% of national or biogeographic common guillemot populations. The apportioning of these estimates to individual protected sites is summarised in Tables A9.40 in Appendix 9 in **Appendix 11A** of the Dogger Bank Teesside A & B ES, which indicates that for all of the SPAs within maximum foraging range during the breeding season less than 0.1% of the common guillemot populations potentially could be affected.

6.6.87 As above, the average increase in flight distance due to the barrier presented by Dogger Bank Teesside A & B is approximately 25km (7.4% of the common guillemot's maximum foraging range of 340km). The proposed development area is between 164km and 340km from the protected sites within foraging range that potentially could be exposed to this effect. This increase might prevent birds from two sites – Fowlsheugh SPA and Forth Islands SPA – from reaching foraging areas beyond the project area.

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### Razorbill

6.6.88 Based on upper 90% confidence limits and estimates of the proportions of birds in flight from boat surveys, it was estimated that there would be maxima of 66 adult razorbills in flight in Dogger Bank Teesside A & B in the breeding season using 2010, 2010/11 and 2011/12 data 2010 data and a mean of 54 across the three years.

6.6.89 The numbers of birds exposed to this effect represent less than 0.1% of national or biogeographic razorbill populations. The apportioning of these estimates to individual protected sites is summarised in Table A9.43 in Appendix 9 in **Appendix 11A** of the Dogger Bank Teesside A & B ES, which indicates that less than 0.15% of the breeding razorbill populations at all of the SPAs within foraging range potentially would be exposed to this effect.

6.6.90 The average increase in flight distance due to the barrier presented by Dogger Bank Teesside A & B is approximately 25km (8.0% of the razorbill's maximum foraging range of 312km). The proposed development area is between 164km and 308km from the protected sites within foraging range that would be potentially exposed to this effect. This increase might prevent birds from two sites – Forth Islands SPA and St Abb's Head to Fast Castle SPA – from reaching foraging areas beyond the project area.

### Implications of barrier effects for designated breeding seabird SPA populations

6.6.91 Based on the analysis presented in **Appendix 11A** of the Dogger Bank Teesside A & B ES (as summarised above), it is unlikely that Dogger Bank Teesside A & B would act as a significant barrier to the foraging movements of breeding seabirds. For all species with SPA designated breeding colonies within the foraging range of Dogger Bank Teesside A & B, only two species (northern fulmar and black-legged kittiwake) were identified where greater than 1% of the breeding population at individual SPAs potentially could be affected.

6.6.92 For northern fulmar, up to 5% of the population at the Flamborough and Filey Coast pSPA might be influenced by the barrier posed by Dogger Bank Teesside A & B. On the basis of the mean maximum foraging range of this species, the deviation to the direct flight line due to the presence of Dogger Bank Teesside A & B would represent a relatively small deviation (c. 6.25%) of the mean maximum range (400km). This suggests that the energetic costs of only a small number of the breeding birds present at Flamborough and Filey Coast pSPA and that may forage beyond Dogger Bank Teesside A & B would be increased. It is unlikely that the approximate 6% increase in flight distance that could be incurred by birds flying in a direct line from the breeding colony would be ecologically significant (i.e. that foraging success and, by proxy, breeding success would be adversely affected). This is particularly so given:

- Birds may be able to alter their flight routes from the colony to take account of the presence of the wind farm and, therefore, avoid the additional energetic cost that flying around the wind farm would incur;
- For accomplished and effective fliers the 6% increase in flight distance may equate to less than a direct 6% energy loss; and

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- Birds may combine shorter foraging flights with longer ones that extend beyond the wind farm. In this respect, it is notable that the average foraging range for fulmar is 48km. Thus, not all foraging flights would be subject to a barrier effect and the deviation to the flight line posed by Dogger Bank Teesside A & B is, therefore, likely to be significantly less than 6% of the total distance of all flights.

6.6.93 Given the above, it is considered unlikely that the potential barrier effect posed by Dogger Bank Teesside A & B would adversely affect the energetics of individual northern fulmar originating from Flamborough and Filey Coast pSPA, such that an effect at the population level would arise.

6.6.94 As with northern fulmar, the analysis undertaken indicates that breeding black-legged kittiwake from Flamborough and Filey Coast pSPA could be subject to a barrier effect, with an estimated 1.1% of the population being affected. For this species, Dogger Bank Teesside A & B is well beyond the mean maximum foraging range of 60km (see **Table 6.1**), suggesting that the resource available at Dogger Bank is sufficiently attractive to warrant longer foraging flights than is typical for this species. While there is evidence from recent tracking studies (FAME 2012) that indicates that black-legged kittiwake may travel up to 230km on foraging flights, such long-distance flights may be atypical for the species and apply to specific breeding colonies. If birds from the Flamborough and Filey Coast pSPA are making regular use of Dogger Bank as a foraging area, then it is likely that, as birds are already travelling well beyond their mean maximum range in order to reach the site, further foraging beyond Dogger Bank rarely occurs. If this is the case, then Dogger Bank Teesside A & B would not act as a barrier to foraging movements but would instead exert a displacement effect on those birds that presently forage within the area. Evidence for this situation can be gained from the monthly density plots for this species (see Figures 3.26 to 3.28 in **Appendix 11A** of the Dogger Bank Teesside A & B ES) which clearly show that the greatest densities of black-legged kittiwake during the breeding season occur along the western edge of Dogger Bank (and to the west of Dogger Bank Teesside A & B) and that densities further to the east rapidly decrease. This suggests that there is likely to be limited foraging by birds from Flamborough and Filey Coast pSPA beyond the western boundary of the Dogger Bank Zone and, in this respect, wind farm development in Dogger Bank Teesside A and Dogger Bank Teesside B would not act as a barrier to movements to key foraging grounds for this species.

6.6.95 For all other species, where the barrier effect has been determined to affect less than 1% of the breeding populations at individual sites, it is considered that the barrier effect posed by Dogger Bank Teesside A & B would not have any discernible impact upon seabird populations. This is particularly so given that, for many of the breeding colonies / sites included in the analysis, Dogger Bank is located at the extreme edge of foraging ranges for seabird species with colonies within foraging range. This suggests that even for the small percentage of birds from these SPAs that may make use of the area for foraging the increase in energetics that the presence of wind farm development may pose would be negligible in the context of the total distance of all foraging flights undertaken.

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### Barrier effects - migrants

6.6.96 An assessment of the potential barrier effects posed by Dogger Bank Teesside A & B to the 45 species' populations of terrestrial and waterbird migrants that are UK SPA features whose migration zones (defined by Wright *et al*. 2012) overlap with the project area is provided in **Table 6.25**.

6.6.97 The percentages of Great Britain or Great Britain and Ireland populations estimated to pass through Dogger Bank Teesside A & B at risk height (following Wright *et al.* (2012)) and thus exposed to potential barrier effects were less than 1% for most species considered, but greater than 1% for 17 species' populations (see **Table 6.25**). The estimates of numbers passing through Dogger Bank Teesside A & B greatly exceed the numbers recorded within Dogger Bank Teesside A & B by boat surveys, though it should be noted that boat surveys were not designed to record migrants and as they only provide a (diurnal) snapshot of birds flying close to the sea, they will inevitably greatly underestimate overall numbers of migrants.

6.6.98 For the purposes of assessment it was assumed that the wind farm development would pose a barrier effect to 100% of birds attempting to fly through at risk height (Maclean *et al*. 2009), which is likely to be an over-precautionary approach. In particular, there is considerable uncertainty as to the actual consequences for survival, and thus for population-level impacts, from the increase in energy expenditure associated with an increase in flight distance for those birds exposed to barrier effects.

6.6.99 The increase in flight distance due to the barrier presented by Dogger Bank Teesside A & B varies by direction of flight. The shortest approximately east-west route across the North Sea passing through the project equates to a maximum of approximately 25km (an increase of 4% on the ca. 575km route) in order for birds to circumvent the project area. For all other routes, the potential percentage increase in the migration route would be less than 4%. This postulated increase in flight distance is precautionary in that it assumes that deviation in the flight line would occur rather than birds altering their flight height to avoid the wind farm and the need to deviate from their flight path.

6.6.100 Considering both the small percentage of migrating bird populations likely to be involved and the relative increase in flight distance that Dogger Bank Teesside A & B could exert, it is concluded that the potential barrier posed by wind farm development would not have a detrimental impact upon the energetics of migratory birds such that an effect at either the population or individual protected site level would arise. As a result of the methodology used, the results of this analysis apply to all SPAs in Great Britain and Ireland designated for their migratory bird populations and for which potential overlap of routes with the Dogger Bank Zone are identified, and not just those SPAs originally screened into the HRA process.

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Table 6.25 Assessment of barrier effect posed by Dogger Bank Teesside A & B on birds migrating across the North Sea

| Species | Dogger Bank Teesside A | | Dogger Bank Teesside B | | Dogger Bank Teesside A & B | |
|---|---|---|---|---|---|---|
| | Number crossing project | % national population | Number crossing project | % national population | Number crossing project | % national population |
| Bean goose | 9 | 1.25 | 11 | 1.46 | 18 | 2.50 |
| Light-bellied brent goose (Svalbard population) | 2 | 0.06 | 2 | 0.06 | 2 | 0.06 |
| Common shelduck | 385 | 0.51 | 431 | 0.57 | 771 | 1.02 |
| Eurasian wigeon | 2,353 | 0.45 | 2,635 | 0.50 | 4,715 | 0.90 |
| Gadwall | 36 | 0.16 | 45 | 0.20 | 60 | 0.27 |
| Eurasian teal | 593 | 0.24 | 665 | 0.27 | 1,189 | 0.48 |
| Mallard | 1,636 | 0.36 | 1,833 | 0.40 | 3,279 | 0.71 |
| Northern pintail | 72 | 0.24 | 81 | 0.27 | 144 | 0.48 |
| Northern shoveler | 58 | 0.30 | 54 | 0.28 | 98 | 0.52 |
| Common pochard* | 227 | 0.30 | 212 | 0.28 | 385 | 0.52 |
| Tufted duck | 436 | 0.42 | 488 | 0.47 | 873 | 0.85 |
| Greater scaup | 2 | 0.02 | 2 | 0.02 | 3 | 0.03 |
| Common scoter | 20 | 0.02 | 22 | 0.02 | 39 | 0.03 |
| Velvet scoter | 13 | 0.50 | 14 | 0.56 | 25 | 1.01 |
| Common goldeneye | 148 | 0.51 | 166 | 0.57 | 297 | 1.02 |
| Red-breasted merganser | 1 | 0.03 | 1 | 0.03 | 2 | 0.06 |
| Goosander (non-breeding) | 18 | 0.55 | 20 | 0.62 | 36 | 1.10 |
| Great bittern | 2 | 0.44 | 2 | 0.62 | 3 | 0.75 |
| Great crested grebe | 51 | 0.21 | 56 | 0.23 | 86 | 0.35 |
| Slavonian grebe | 2 | 0.16 | 2 | 0.18 | 3 | 0.32 |
| Hen harrier (breeding) | <1 | 0.03 | <1 | 0.06 | <1 | 0.09 |
| Hen harrier (non-breeding) | 6 | 1.49 | 6 | 1.67 | 11 | 2.98 |
| Eurasian coot | 199 | 0.19 | 174 | 0.17 | 273 | 0.26 |
| Eurasian oystercatcher (non-breeding) | 793 | 0.40 | 888 | 0.44 | 1,588 | 0.79 |
| Common ringed plover (non-breeding) | 315 | 0.43 | 347 | 0.48 | 626 | 0.86 |
| Golden plover (non-breeding) | 1,574 | 0.39 | 1,267 | 0.32 | 2,737 | 0.68 |
| Grey plover | 421 | 0.85 | 464 | 0.94 | 836 | 1.70 |


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| Species | Dogger Bank Teesside A | | Dogger Bank Teesside B | | Dogger Bank Teesside A & B | |
|---|---|---|---|---|---|---|
| | Number crossing project | % national population | Number crossing project | % national population | Number crossing project | % national population |
| Northern lapwing | 3,834 | 0.85 | 4,225 | 0.94 | 7,614 | 1.70 |
| Red knot | 1,349 | 0.40 | 1,489 | 0.44 | 2,681 | 0.79 |
| Sanderling | 358 | 0.60 | 395 | 0.66 | 712 | 1.19 |
| Dunlin *Calidris alpine schinzii* (passage) | 29 | 0.79 | 33 | 0.90 | 59 | 1.60 |
| Dunlin *Calidris alpina alpina* (passage & winter) | 3,052 | 0.70 | 2,926 | 0.67 | 5,072 | 1.16 |
| Ruff* | 24 | 1.01 | 24 | 0.98 | 43 | 1.80 |
| Common snipe | 3,989 | 0.40 | 4,403 | 0.44 | 7,927 | 0.79 |
| Black-tailed godwit | 41 | 0.72 | 41 | 0.74 | 75 | 1.34 |
| Bar-tailed godwit* | 482 | 0.89 | 544 | 1.00 | 971 | 1.79 |
| Whimbrel | 93 | 0.40 | 95 | 0.41 | 179 | 0.78 |
| Eurasian curlew (non-breeding) | 733 | 0.90 | 679 | 0.83 | 1,323 | 1.62 |
| Greenshank | <1 | 0.06 | <1 | 0.06 | <1 | 0.10 |
| Common redshank (breeding) | 24 | 0.08 | 25 | 0.08 | 44 | 0.15 |
| Common redshank Icelandic population (non-breeding) | 993 | 0.36 | 1,043 | 0.38 | 1,872 | 0.68 |
| Common redshank mainland Europe population (non-breeding) | 230 | 0.92 | 257 | 1.03 | 461 | 1.84 |
| Ruddy turnstone | 190 | 0.40 | 213 | 0.44 | 381 | 0.79 |
| Short-eared owl | 6 | 0.57 | 7 | 0.64 | 12 | 1.15 |
| European nightjar | 4 | 0.04 | 7 | 0.06 | 8 | 0.07 |


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6.6.101 The migration routes and information presented in Wright *et al*. (2012) demonstrate that for many species there is significant movement of migratory birds between continental sites (from and to the Netherlands in particular) and the UK. Important sites are designated as SPAs/Ramsar sites (e.g. the Waddenzee). Many of the migratory birds on passage and wintering at SPAs in the Netherlands and Germany would arrive via routes that would not encounter the Dogger Bank Zone. However, given interchange and/or onward movement of birds to the UK, part of the populations that are present at these continental sites could be affected by collision. As such, the results of the analysis also apply to SPAs used by birds on return migration from the UK.

## Collision risk - seabirds

6.6.102 Results of the collision risk analyses for individual seabird species that occur within Dogger Bank Teesside A & B (including separate analysis for Dogger Bank Teesside A and Dogger Bank Teesside B) are presented in Sections 5.2, 5.3 and 5.4 in **Appendix 11A** of the Dogger Bank Teesside A & B ES. In each case, results are presented separately for each month in 2010, 2011 and 2012 and the mean of the three years, using the median population estimates and lower and upper confidence limits around these values.

6.6.103 For the purposes of assessment and the apportioning of impacts to protected sites, collision risk estimates are summed for breeding months and non-breeding months in each of the two years. The magnitude of the impact associated with collision risk is assessed using the mean of the estimates across the two years.

6.6.104 As discussed in the methodology section, a precautionary avoidance rate of 98% (SNH 2010; Cook *et al.* 2012) has been utilised in the collision risk modelling for all species except northern gannet. For this species, a 99% avoidance rate has been used in the assessment; a rate that is considered more likely to represent the strong macro-avoidance response of this species (Krijgsveld *et al.* 2011; RWE Npower Renewables 2013). Alternative collision rates are also provided in Appendix 11A of the ES, see **Table 6.26**.

6.6.105 The results of the collision risk analysis for Dogger Bank Teesside A & B are presented in **Table 6.26**. The number of northern fulmar, Arctic skua, great skua, common guillemot and Atlantic puffin colliding with turbines is predicted to be less than one bird per year. Razorbill similarly has a predicted low risk, with 2 collisions per year predicted assuming a 98% avoidance rate.

6.6.106 The collision risk modelling, therefore, indicates that for a number of species only very small numbers of birds would be involved. It is considered that the predicted very low number of annual collisions for these species would be highly unlikely to have a discernible effect at the population level, either with regard to individual designated site-based populations or wider North Sea populations. No further assessment of the effect of collision risk on the designated populations of the following species, therefore, has been undertaken as part of this report:

- Northern fulmar;
- Arctic skua;

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- Great skua;
- Common guillemot;
- Razorbill; and
- Atlantic puffin.

6.6.107 Further analysis in respect of the above species is provided in **Appendix 11A** of the Dogger Bank Teesside A & B ES. It should, however, be noted that given the very low numbers of predicted collisions no apportioning of predicted mortality to individual SPAs has been undertaken.

6.6.108 The annual collision estimates for northern gannet, black-legged kittiwake, lesser black-backed gull and great black-backed gull are predicted to be, potentially, of greater significance (see **Table 6.26**). Further analysis of the estimated collision risk for these species is provided in the following sections.

**Northern gannet**

6.6.109 The overall northern gannet population in Great Britain and Ireland increased in size between the 1985-88 and 1998-2002 seabird censuses (Mitchell *et al.* 2004), and has continued to increase in recent years. As such, there is capacity for the species' population to accommodate a threshold of deaths through collision with offshore wind turbines (WWT 2012). Nevertheless, as is typical for many seabird species, the northern gannet is long-lived with an annual survival rate of over 90% and a corresponding low reproductive rate.

6.6.110 Using a 99% avoidance rate, analysis provided an estimate of 68 (90% confidence interval = 56 to 80) collisions per year (34 during the breeding seaons and 34 during the non-breeding season) based on the mean of collision estimates. Dogger Bank Teesside A & B is within mean maximum foraging range of three SPAs around the North Sea for which breeding northern gannet is a feature. **Table 6.27** summarises the apportioning of the estimated collision mortality to individual protected sites.

6.6.111 Predicted losses of northern gannet at SPAs screened into the assessment range between 0.01% to 0.05% of designated populations. Losses attributable to the breeding season range between 0.01% to 0.04% of designated populations (see Table A9.33d in Appendix 9 in **Appendix 11A** of the Dogger Bank Teesside A & B ES). Further discussion and assessment of the predicted collision losses is presented below with respect to the two UK SPAs (Flamborough and Filey Coast pSPA and Forth Islands SPA) that are within foraging range (mean maximum range used for Flamborough and Filey Coast pSPA and telemetry data for inclusion of the Forth Islands SPA) and for which the highest estimated losses could occur.

6.6.112 Apart from the designated northern gannet population of the Seevogelschutzgebiet Helgoland SPA (0.02% of population affected), for all other SPAs examined (see **Table 6.27**) the predicted collision losses would represent less than 0.01% of the designated populations. Such losses are not considered to be of consequence at the individual designated population level.

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Table 6.26 Annual collision risk estimates (with 90% confidence limits) for study species within Dogger Bank Teesside A & B assuming a worst case scenario of 200 x 6MW wind turbines for each wind farm with a lower rotor tip height of 26m above highest astronomical tide and estimates generated using Option 3 of Band collision risk model, which corrects for variable collision risk within the rotor-swept area (figures in brackets are breeding adult bird numbers)

| Species | Avoidance rate | Dogger Bank Teesside A | | | Dogger Bank Teesside B | | | Dogger Bank Teesside A & B | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Collisions | % national population | % bio-geographic population | Collisions | % national population | % bio-geographic population | Collisions | % national population | % bio-geographic population |
| Northern fulmar | 98% | 1 (0) | (<0.01) | <0.01 | 1 (0) | (<0.01) | <0.01 | 1 (1) | (<0.01) | <0.01 |
| | 99% | 0 | 0 | 0 | 0 | 0 | <0.01 | 1 (0) | (<0.01) | <0.01 |
| | 99.5% | 0 | 0 | 0 | 0 | 0 | <0.01 | 0 | 0 | <0.01 |
| Northern gannet | 98% | 61 (33) | (0.02) | 0.01 | 75 (35) | (0.02) | 0.01 | 136 (68) | (0.03) | 0.01 |
| | 99% | 30 (16) | (0.01) | <0.01 | 38 (18) | (0.01) | <0.01 | 68 (34) | (0.02) | 0.01 |
| | 99.5% | 15 (8) | (<0.01) | <0.01 | 19 (9) | (<0.01) | <0.01 | 34 (17) | (0.01) | <0.01 |
| Arctic skua | 98% | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 99% | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 99.5% | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Great skua | 98% | 0 | 0 | 0 | 0 | 0 | 0 | 1 (0) | <0.01 | <0.01 |
| | 99% | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 99.5% | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Black-legged kittiwake | 98% | 53 (33) | (<0.01) | <0.01 | 81 (54) | (0.01) | <0.01 | 134 (87) | (0.01) | <0.01 |
| | 99% | 26 (16) | (<0.01) | <0.01 | 41 (27) | (<0.01) | <0.01 | 67 (44) | (0.01) | <0.01 |
| | 99.5% | 13 (8) | (<0.01) | <0.01 | 20 (13) | (<0.01) | <0.01 | 34 (22) | (<0.01) | <0.01 |
| Great black-backed gull[1] | 98% | 28 (10) | 0.02 (0.03) | 0.01 | 30 (7) | 0.03 (0.02) | 0.01 | 58 (17) | 0.05 (0.05) | 0.02 |
| | 99% | 14 (5) | 0.01 (0.01) | <0.01 | 15 (4) | 0.01 (0.01) | <0.01 | 29 (9) | 0.03 (0.03) | 0.01 |
| | 99.5% | 7 (3) | 0.01 (0.01) | <0.01 | 7 (2) | 0.01 (0.01) | <0.01 | 15 (4) | 0.01 (0.01) | <0.01 |
| Lesser black-backed gull[2] | 98% | 16 (10) | <0.01 (<0.01) | <0.01 | 16 (11) | <0.01 (<0.01) | <0.01 | 33 (20) | 0.01 (0.01) | 0.01 |
| | 99% | 8 (5) | <0.01 (<0.01) | <0.01 | 8 (6) | <0.01 (<0.01) | <0.01 | 16 (10) | <0.01 (<0.01) | <0.01 |
| | 99.5% | 4 (3) | <0.01 (<0.01) | <0.01 | 4 (3) | <0.01 (<0.01) | <0.01 | 8 (5) | <0.01 (<0.01) | <0.01 |


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| Species | Avoidance rate | Dogger Bank Teesside A | | | Dogger Bank Teesside B | | | Dogger Bank Teesside A & B | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Collisions | % national population | % bio-geographic population | Collisions | % national population | % bio-geographic population | Collisions | % national population | % bio-geographic population |
| Common guillemot | 98% | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 99% | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 99.5% | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Razorbill | 98% | 1 (0) | (0) | <0.01 | 1 (0) | (0) | <0.01 | 2 (0) | (0) | <0.01 |
| | 99% | 0 | 0 | 0 | 1 (0) | (0) | <0.01 | 1 (0) | (0) | <0.01 |
| | 99.5% | 0 | 0 | 0 | 0 | 0 | 0 | 1 (0) | (0) | <0.01 |
| Atlantic puffin | 98% | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 99% | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 99.5% | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |


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### *Flamborough and Filey Coast pSPA*

6.6.113 The greatest relative losses are estimated for the northern gannet population of Flamborough and Filey Coast pSPA. Here, just over seven adult birds (and three non-breeding birds) could be lost annually as a result of collision. As discussed in Section 6.4, there is evidence from tracking data that the foraging range from breeding gannet colonies is partitioned and there is limited overlap in foraging ranges between colonies (Wakefield *et al*. 2013). As such, it is possible that a larger majority of the gannet observed at Dogger Bank could derive from the Flamborough and Filey Coast pSPA than has been apportioned to this site. If all of the estimated gannet collisions during the breeding season were apportioned to this SPA, then just over 21 adult birds could be lost annually (see **Table 6.27**).

6.6.114 The estimated total annual collision loss would represent an increase of 0.79% in background mortality for gannet at this site (see **Table 6.27**). This indicates that such collision losses would not be significant at the population level. Further understanding of the magnitude of the predicted collision losses can also be gained by looking at the outputs of population models that are available for the Flamborough and Filey Coast pSPA northern gannet population.

6.6.115 A Population Viability Analysis (PVA) has recently been undertaken on behalf of the Strategic Ornithological Support Services (SOSS) group in order to determine the cumulative impacts of existing and consented wind farms on UK gannet populations (WWT 2012).

6.6.116 The findings of the SOSS PVA were revisited as part of the Triton Knoll Offshore Wind Farm application process. In their position statement on ornithology, Natural England noted that the SOSS PVA work was based on a gannet population of 3,940 'pairs' (2003/2004) compared to the 2009 population of 7,859 'pairs'. Using the later population figures and adopting a precautionary interpretation of the outputs of the PVA model, Natural England indicated that a 'harvest' of up to 113 Gannets (of any age) per year would have only a 5% chance of affecting the long term success of the SPA population (in terms of growth). A less precautionary value, based on the mean of the model predictions, indicates that 303 gannets could be harvested and result in a 50% chance of the SPA population no longer growing. In respect of these findings, Natural England note that the PVA calculations were undertaken upon population growth data for the overall GB population (c. 1.3% per annum) rather than specifically for the Flamborough and Filey Coast pSPA colony, which has experienced average growth for the last 20 years of c.12.5%. It should also be noted that the latest 2008-2011 data for the Flamborough and Filey Coast pSPA (including proposed extension) shows that the population has increased since 2009 and numbered 8,469 pairs and in 2012 numbered 11,061 pairs (Aitken *et al*. 2012). Both these factors (i.e. greater growth than that nationally and larger population than used in the PVA calculations) indicate that the 'harvest' of gannet could be substantially higher than 113 birds and still be within precautionary limits.

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Table 6.27 Apportioning to designated SPA populations of estimated losses (number of individuals) of northern gannet due to collision with wind turbines in Dogger Bank Teesside A & B

| European site | Dogger Bank Teesside A | | | Dogger Bank Teesside B | | | Dogger Bank Teesside A & B | | | Percentage increase in background mortality |
|---|---|---|---|---|---|---|---|---|---|---|
| | Breeding | Non-breeding | Total % | Breeding | Non-breeding | Total % | Breeding | Non-breeding | Total % | |
| Fair Isle SPA | 0 | 0.58 | 0.01 | 0 | 0.75 | 0.01 | 0 | 1.32 | 0.01 | 0.18 |
| Forth Islands SPA | 6.0 | 8.92 | 0.01 | 7.3 | 11.6 | 0.01 | 14.1 | 20.52 | 0.03 | 0.36 |
| Flamborough and Filey Coast pSPA | 3.2 | 1.36 | 0.02 | 3.9 | 1.77 | 0.03 | 7.1 | 3.13 | 0.05 | 0.79 |
| Hermaness, Saxa Vord and Valla Field SPA | 0 | 3.92 | 0.01 | 0 | 5.09 | 0.01 | 0 | 9.01 | 0.01 | 0.18 |
| Noss SPA | 0 | 1.57 | 0.01 | 0 | 2.04 | 0.01 | 0 | 3.61 | 0.01 | 0.18 |
| Sule Skerry and Sule Stack SPA | 0 | 0.75 | 0.01 | 0 | 0.98 | 0.01 | 0 | 1.73 | 0.01 | 0.18 |
| **Transboundary sites** | | | | | | | | | | |
| Cote de Granit Rose-Sept Iles SPA | 0 | 3.14 | 0.01 | 0 | 4.08 | 0.01 | 0 | 7.22 | 0.01 | 0.18 |
| Seevogelschutzgebiet Helgoland SPA | 0.02 | 0.02 | 0.01 | 0.01 | 0.02 | 0.01 | 0.03 | 0.04 | 0.02 | 0.36 |


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6.6.117 Several Potential Biological Removal (PBR) model/calculations are also available. Outputs from the PBR work presented as part of the Triton Knoll Offshore Wind Farm assessment (RWE Npower Renewables 2012) were considered by Natural England. Utilising a range of calculation parameters ($N_{min}$ (population size) and the recovery factor (*f*) (*f* is a user-defined parameter designed to reflect levels of concern regarding recovery and the management of the species in question)), it was determined that the PBR for gannet lies in the range of 214 to 491 birds. Using a recovery factor of 0.4 (which Natural England state is appropriate for the population at Flamborough and Filey Coast pSPA), the PBR ranges between 286 to 393 birds, depending on the population growth rate used and whether a correction factor is applied to the population count. For Hornsea Project One, a PBR for the northern gannet population of the Flamborough and Filey Coast pSPA is calculated as 452 adult birds (Appendix J in SMart Wind (2013)). This figure is based on the latest population data for the SPA and an *f* value of 0.5.

6.6.118 PBR analysis for the Flamborough and Filey Coast pSPA northern gannet population is presented in **Appendix E** of the **HRA Report**. This PBR work takes into account the recent increase in the breeding population of gannet at Flamborough. Based on the revised population level and the status of the population (i.e. considered to be of least concern and increasing), an f value of 0.5 is considered to be appropriate and a PBR value of 503 (for adult breeding gannet) is calculated.

6.6.119 Based on both the available PVA work and the PBR analysis it is apparent that the calculated collision losses (seven breeding adult gannet and three non-breeding) that could arise annually during the operation phase for Dogger Bank Teesside A & B is substantially below the population model threshold values. If gannet currently attributed to the Forth Islands SPA were also attributed to Flamborough and Filey Coast pSPA, the total of 21 adult breeding birds and up to 23 non-breeding birds (i.e. 44 birds in total) would still be significantly below the calculated PBR thresholds.

6.6.120 The population of northern gannet at the Flamborough and Filey Coast pSPA is, given the significant increase in size since designation, in favourable condition. The estimated increase in mortality arising as a result of collision during the operation of Dogger Bank Teesside A & B is considered to be very small in relation to the total breeding population.

### *Forth Islands SPA*

6.6.121 For the Forth Islands SPA, the predicted losses of 14 adult breeding birds would represent 0.01% of the population. With the inclusion of non-breeding birds the percentage of the population that could be impacted rises to 0.03%. The breeding northern gannet population of the Forth Islands SPA (which includes the large gannetry of Bass Rock) has increased substantially since designation with over 55,000 pairs at the last count being recorded. This represents a 156% increase in the population since designation of this site. The loss of a small number of birds from this large, and increasing, population would be very unlikely to have an adverse impact upon population levels.

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6.6.122 A threshold mortality that could be sustained for the Bass Rock gannet colony (part of the Forth Islands SPA) was calculated as part of the WWT (2012) PVA analysis for this species. This mortality threshold was calculated as 2,000 birds. On the basis of this PVA work, the loss of up to 35 birds per year is significantly below the likely threshold of mortality increase at which a decline in the population of northern gannet at the Forth Islands SPA would be likely to be significant.

**Black-legged kittiwake**

6.6.123 Black-legged kittiwake is a long-lived species, with an annual survival rate of over 90% and a corresponding low reproductive rate and thus is considered to have a very high species-sensitivity (i.e. a low tolerance) to this effect.

6.6.124 Using a 98% avoidance rate, analysis provided an estimate of 134 (90% confidence interval = 119 to 152) collisions per year (87 during the breeding season and 48 outside of the breeding season) based on the mean of collision estimates. Of these 134 birds, assuming that 80% form part of designated SPA populations, the total number of collisions attributable to SPAs is 107 (56 during the breeding season and 52 outside the breeding season).

6.6.125 Dogger Bank Teesside A & B is within maximum foraging range of only one SPA - Flamborough Head and Bempton Cliffs. Table A9.35d in Appendix 9 of **Appendix 11A** of the Dogger Bank Teesside A & B ES summarises the apportioning of the estimated collision mortality to individual protected sites. Predicted losses of black-legged kittiwake at SPAs screened into the assessment process range between 0.01% to 0.07% of designated populations. Further discussion and assessment of the predicted collision losses is presented below with respect to the Flamborough and Filey Coast pSPA population.

6.6.126 For SPAs located outside of the maximum foraging range of Dogger Bank Teesside A & B, the apportioned collision losses (involving non-breeding birds only) would represent 0.01% of the designated populations (see Table A9.35d in Appendix 9 of **Appendix 11A** of the Dogger Bank Teesside A & B ES). Whilst black-legged kittiwake populations at many SPAs have declined significantly in the past couple of decades (see Appendix 1 in **Appendix 11A** of the Dogger Bank Teesside A & B ES), these estimated losses are not considered to be significant at the population level. For all of the SPAs where collision losses would affect non-breeding birds only, the estimated increase in the rate of background mortality is calculated as 0.17%, again indicating that the calculated collision losses are not significant.

6.6.127 Total collision losses, using the mean of data, would represent less than 0.01% of the total population of the overall suite of protected sites around the North Sea at which the species is a feature and less than 0.01% of the species' British population. There are no national population estimates for this species for the winter.

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### *Flamborough and Filey Coast pSPA*

6.6.128 The greatest relative collision losses are predicted for the black-legged kittiwake population of the Flamborough and Filey Coast pSPA. Here, just over 55 adult birds during the breeding season and 12 birds during the non-breeding season (of which seven would be adults, assuming 60% of non-breeders are adults) could be lost annually as a result of collision.

6.6.129 As for northern gannet, PBR outputs are available from several sources (Triton Knoll Offshore Wind Farm (RWE Npower Renewables 2012), Hornsea Project One (Smart Wind 2013), and Dogger Bank Creyke Beck (Forewind 2014)).

6.6.130 The Triton Knoll PBR works, as recorded in the Ornithology Statement of Common Ground between Natural England, JNCC and RWE Npower Renewables, provides a PBR figure of 381 of adult kittiwake that could be removed annually from the Flamborough and Filey Coast pSPA population without having a detrimental effect on the sustainable growth of the population. This figure is based on a very precautionary *f* value of 0.1 and a 2008 population count which is now out of date.

6.6.131 For Hornsea Project One, SMart Wind (2013), present both a PBR calculation and PVA model for black-legged kittiwake at Flamborough Head.The PBR used for assessment purposes in the Hornsea Project One HRA Report (Appendix J) is 1,023 adult birds (SMart Wind 2013).

6.6.132 PBR analysis for the Flamborough and Filey Coast pSPA black-legged kittiwake population is also provided as part of the consolidated ornithological addendum for Dogger Bank Creyke Beck (Forewind 2014). This work provides a suggested PBR value of 1,718 adult birds, based on an *f* value of 0.3 and a breeding population of 89,040 birds (the latter figure is based on the latest population estimate provided by Natural England – Natural England (2013)). The reasoning for the use of an *f* value of 0.3 is presented in **Appendix E** of the **HRA Report**, but essentially relates to the fact that the kittiwake population of Flamborough and Filey Coast pSPA is not threatened and is open to immigration (i.e. it is not a closed, endangered population). It should also be stated that, following the original arguments presented by Dillingham and Fletcher (2008) on the attribution of *f* values to threatened populations, the use of an *f* value of 0.3 is considered to be precautionary. For illustration purposes PBR values using other f values are presented in **Appendix E** of the **HRA Report**.

6.6.133 The calculated collision loss of 62 adult breeding birds as a result of operation of Dogger Bank Teesside A & B is significantly below the PBR threshold calculated for the Flamborough and Filey Coast pSPA colony (Forewind 2014) and represents 8% - 16% of the available 'harvest' for this species, depending on the PBR threshold used. It is estimated that the collision losses would increase background mortality by 1.34% (see Table A9.35d in Appendix 9 of **Appendix 11A** of the Dogger Bank Teesside A & B ES), a figure that is not considered to be significant in the context of the longer term sustainability of the black-legged kittiwake population at Flamborough and Filey Coast pSPA.

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### Lesser black-backed gull

6.6.134 Lesser black-backed gull is a long-lived species with an annual survival rate of over 90% and a corresponding low reproductive rate and thus is considered to have a Very High species-sensitivity (i.e. a low tolerance) to this effect.

6.6.135 Using a 98% avoidance rate, analysis provided an estimate of 33 (90% confidence interval = 21 to 53) collisions per year (20 birds during the breeding season and 12 birds outside of the breeding season) based on the mean of collision estimates. All of these collisions are potentially attributable to SPA designated populations.

6.6.136 Dogger Bank Teesside A & B is outside the foraging range of any protected sites designated for breeding populations of this species.

6.6.137 Predicted losses of lesser black-backed gull from SPAs screened into the assessment process would represent less than 0.01% of designated populations (see Table A9.36d in Appendix 9 in **Appendix 11A** of the Dogger Bank Teesside A & B ES) and a 0.12% increase in background mortality for this species.

6.6.138 Given the relatively small number of birds involved apportioned across all of the relevant SPAs (19 in total; two in the UK), it is concluded that collision losses would not lead to any decline in SPA designated populations.

6.6.139 Total collision losses would represent less than 0.01% of the total population of the overall suite of protected sites around the North Sea at which the species is a feature and less than 0.01% of the species' British population. It should be noted, however, that national winter population estimates for gulls come from a survey of terrestrial habitats and inshore waters (Burton *et al.* 2013) and thus do not include birds that frequent offshore waters, and so underestimate the overall national populations.

### Great black-backed gull

6.6.140 The great black-backed gull is long-lived, with an annual survival rate of over 90% and a corresponding low reproductive rate and thus is considered to have a very high species-sensitivity (i.e. a low tolerance) to this effect.

6.6.141 Using a 98% avoidance rate, analysis provided an estimate of 58 (90% confidence interval = 40 to 85) collisions per year (17 birds during the breeding season and 41 birds outside of the breeding season) based on the mean of collision estimates. Of these 58 birds, the total number of collisions attributable to SPAs is nine (all non-breeding).

6.6.142 Dogger Bank Teesside A & B is outside the foraging range of any protected sites designated for breeding populations of this species.

6.6.143 Predicted losses of great black-backed gull from SPAs screened into the assessment process would represent less than 0.09% of designated populations (see Table A9.37d in Appendix 9 in **Appendix 11A** of the Dogger Bank Teesside A & B ES) and a 0.35% increase in background mortality for this species.

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6.6.144 Given the relatively small number of birds involved apportioned across all of the relevant SPAs (17 in total; five in the UK), it is concluded that collision losses would not lead to any decline in SPA designated populations.

6.6.145 Total collision losses, using mean data, would represent 0.09% of the total population of the overall suite of protected sites around the North Sea at which the species is a feature and less than 0.1% of the species' British population.

6.6.146 As above, it should be noted that national winter population estimates for gulls come from a survey of terrestrial habitats and inshore waters (Burton *et al.* 2013) and thus do not include birds that frequent offshore waters; therefore, underestimating the overall national populations. It should also be noted that the estimated numbers of this species in the Dogger Bank Zone are possibly underestimated due to the potential turnover of birds at this time.

## Collision risk - migrants

6.6.147 The migration zones (defined by Wright *et al*. (2012)) of 45 species' populations of terrestrial or waterbird migrants that are UK SPA features overlap with the development area for Dogger Bank Teesside A & B.

6.6.148 Estimated numbers of potential collisions for these 45 species of migrants have been modelled based on the numbers of birds predicted to pass through the wind farm area, a 98% avoidance rate and expert judgement to determine the proportion of individuals likely to be flying at a height which places them at risk of collision (see **Appendix 11A** of the Dogger Bank Teesside A & B ES). Three scenarios were run using the lower, central and upper limits of the range of the proportion of birds at risk height as described in Wright *et al.* (2012) with the central value used for the purposes of assessment.

6.6.149 Collision risk estimates suggest that on an annual basis the potential mortality associated with Dogger Bank Teesside A & B is likely to represent significantly less than 0.1% of the Great Britain or Great Britain and Ireland population of each of the 45 species that have a migration zone that overlaps with Dogger Bank Teesside A & B (see **Table 6.28**).

### Implications of collision risk estimates for designated SPA migrant bird populations

6.6.150 Due to the lack of knowledge concerning species' precise migration routes and likely variability in routes taken by birds, no attempt has been made to apportion potential collision risk losses to individual protected sites, although SPAs around the North Sea supporting populations that could be affected have been screened into the HRA process. As a result of the methodology used, the results of this analysis apply to all SPAs in Great Britain and Ireland designated for their migratory bird populations and for which potential overlap of routes with the Dogger Bank Zone have been identified. It should also be noted that there is significant uncertainty in the determination of the numbers of birds passing through the project area and the proportion of these likely to be flying at heights which pose a risk of collision. However, the analysis is considered to provide an indicative estimate of the potential magnitude of collision risk and the percentage of the GB populations that could be affected.

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Table 6.28 Estimated mean annual collisions for migrant birds and their populations during the operation of Dogger Bank Teesside A & B (both projects combined) and the individual projects

| Species | Dogger BankTeesside A | | | Dogger Bank Teesside B | | | Dogger Bank Teesside A & B | | |
|---|---|---|---|---|---|---|---|---|---|
| | Collisions | % reference population | % migration zone | Collisions | % reference population | % migration zone | Collisions | % reference population | % migration zone |
| Bean goose | 0.02 | <0.1 | 4.18 | 0.02 | <0.1 | 4.87 | 0.03 | <0.1 | 8.33 |
| Light-bellied brent goose (Svalbard population) | 0.004 | <0.1 | 0.19 | 0.003 | <0.1 | 0.19 | 0.003 | <0.1 | 0.19 |
| Common shelduck | 0.75 | <0.1 | 3.39 | 0.70 | <0.1 | 3.80 | 1.23 | <0.1 | 6.80 |
| Eurasian wigeon | 4.26 | <0.1 | 3.16 | 3.95 | <0.1 | 3.54 | 6.98 | <0.1 | 6.33 |
| Gadwall | 0.07 | <0.1 | 1.81 | 0.07 | <0.1 | 2.25 | 0.09 | <0.1 | 3.01 |
| Eurasian teal | 1.01 | <0.1 | 3.17 | 0.94 | <0.1 | 3.55 | 1.65 | <0.1 | 6.35 |
| Mallard | 3.10 | <0.1 | 3.39 | 2.88 | <0.1 | 3.80 | 5.07 | <0.1 | 6.80 |
| Northern pintail | 0.14 | <0.1 | 3.17 | 0.13 | <0.1 | 3.55 | 0.22 | <0.1 | 6.35 |
| Northern shoveler | 0.10 | <0.1 | 2.71 | 0.08 | <0.1 | 2.52 | 0.14 | <0.1 | 4.59 |
| Common pochard | 0.41 | <0.1 | 2.71 | 0.31 | <0.1 | 2.52 | 0.56 | <0.1 | 4.59 |
| Tufted duck | 0.77 | <0.1 | 3.14 | 0.72 | <0.1 | 3.51 | 1.26 | <0.1 | 6.29 |
| Greater scaup | 0.003 | <0.1 | 2.60 | 0.003 | <0.1 | 2.40 | 0.005 | <0.1 | 4.30 |
| Common scoter | 0.04 | <0.1 | 3.17 | 0.03 | <0.1 | 3.55 | 0.06 | <0.1 | 6.35 |
| Velvet scoter | 0.02 | <0.1 | 3.72 | 0.02 | <0.1 | 4.17 | 0.04 | <0.1 | 7.45 |
| Common goldeneye | 0.26 | <0.1 | 3.39 | 0.25 | <0.1 | 3.80 | 0.43 | <0.1 | 6.80 |
| Red-breasted merganser | 0.03 | <0.1 | 2.28 | 0.001 | <0.1 | 2.20 | 0.003 | <0.1 | 3.86 |
| Goosander (non-breeding) | 0.004 | <0.1 | 3.67 | 0.03 | <0.1 | 4.11 | 0.06 | <0.1 | 7.35 |
| Great bittern | 0.09 | <0.1 | 1.25 | 0.01 | <0.1 | 1.77 | 0.01 | <0.1 | 2.15 |
| Great-crested grebe | 0.003 | <0.1 | 2.10 | 0.08 | <0.1 | 2.30 | 0.13 | <0.1 | 3.52 |
| Slavonian grebe | 0.0002 | <0.1 | 3.17 | 0.003 | <0.1 | 3.55 | 0.005 | <0.1 | 6.35 |
| Hen harrier (breeding* | 0.01 | <0.1 | 0.60 | 0.0003 | <0.1 | 1.25 | 0.0005 | <0.1 | 1.85 |


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| Species | Dogger BankTeesside A | | | Dogger Bank Teesside B | | | Dogger Bank Teesside A & B | | |
|---|---|---|---|---|---|---|---|---|---|
| | Collisions | % reference population | % migration zone | Collisions | % reference population | % migration zone | Collisions | % reference population | % migration zone |
| Hen harrier (non-breeding) | 0.34 | <0.1 | 3.72 | 0.01 | <0.1 | 4.17 | 0.02 | <0.1 | 7.45 |
| Eurasian coot | 1.44 | <0.1 | 0.76 | 0.25 | <0.1 | 0.66 | 0.39 | <0.1 | 1.04 |
| Eurasian oystercatcher (non-breeding) | 0.25 | <0.1 | 3.17 | 1.34 | <0.1 | 3.55 | 2.36 | <0.1 | 6.35 |
| Common ringed plover (non-breeding) | 0.03 | <0.1 | 3.45 | 0.23 | <0.1 | 3.81 | 0.41 | <0.1 | 6.86 |
| Golden plover (non-breeding) | 2.67 | <0.1 | 3.15 | 1.78 | <0.1 | 2.53 | 3.79 | <0.1 | 5.47 |
| Grey plover | 0.72 | <0.1 | 3.42 | 0.66 | <0.1 | 3.76 | 1.17 | <0.1 | 6.78 |
| Northern lapwing | 6.65 | <0.1 | 3.42 | 6.07 | <0.1 | 3.76 | 10.79 | <0.1 | 6.78 |
| Red knot | 2.22 | <0.1 | 3.18 | 2.03 | <0.1 | 3.51 | 3.60 | <0.1 | 6.33 |
| Sanderling | 0.57 | <0.1 | 3.18 | 0.52 | <0.1 | 3.51 | 0.92 | <0.1 | 6.33 |
| Dunlin *Calidris alpine schinzii* (passage) | 0.05 | <0.1 | 3.16 | 0.04 | <0.1 | 3.58 | 0.08 | <0.1 | 6.39 |
| Dunlin *Calidris alpina alpina* (passage & winter) | 4.78 | <0.1 | 2.78 | 3.80 | <0.1 | 2.67 | 6.49 | <0.1 | 4.63 |
| Ruff | 0.04 | <0.1 | 4.03 | 0.03 | <0.1 | 3.92 | 0.06 | <0.1 | 7.22 |
| Common snipe | 6.54 | <0.1 | 3.19 | 5.98 | <0.1 | 3.52 | 10.61 | <0.1 | 6.34 |
| Black-tailed godwit | 0.04 | <0.1 | 2.90 | 0.03 | <0.1 | 2.95 | 0.06 | <0.1 | 5.36 |
| Bar-tailed godwit | 0.86 | <0.1 | 3.55 | 0.80 | <0.1 | 4.01 | 1.41 | <0.1 | 7.16 |
| Whimbrel | 0.17 | <0.1 | 3.24 | 0.14 | <0.1 | 3.31 | 0.26 | <0.1 | 6.23 |
| Eurasian curlew (non-breeding) | 1.42 | <0.1 | 3.58 | 1.09 | <0.1 | 3.32 | 2.09 | <0.1 | 6.46 |
| Greenshank | 0.0003 | <0.1 | 2.47 | 0.0002 | <0.1 | 2.38 | 0.0004 | <0.1 | 4.07 |
| Common redshank (breeding) | 0.04 | <0.1 | 3.14 | 0.03 | <0.1 | 3.30 | 0.06 | <0.1 | 5.91 |


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| Species | Dogger BankTeesside A | | | Dogger Bank Teesside B | | | Dogger Bank Teesside A & B | | |
|---|---|---|---|---|---|---|---|---|---|
| | Collisions | % reference population | % migration zone | Collisions | % reference population | % migration zone | Collisions | % reference population | % migration zone |
| Common redshank Icelandic population (non-breeding) | 1.67 | <0.1 | 2.89 | 1.45 | <0.1 | 3.04 | 2.57 | <0.1 | 5.45 |
| Common redshank mainland Europe population (non-breeding) | 0.39 | <0.1 | 3.68 | 0.36 | <0.1 | 4.12 | 0.63 | <0.1 | 7.37 |
| Ruddy turnstone | 0.31 | <0.1 | 3.17 | 0.29 | <0.1 | 3.55 | 0.51 | <0.1 | 6.35 |
| Short-eared owl | 0.01 | <0.1 | 3.28 | 0.01 | <0.1 | 3.67 | 0.02 | <0.1 | 6.56 |
| European nightjar | 0.01 | <0.1 | 0.75 | 0.01 | <0.1 | 1.27 | 0.01 | <0.1 | 1.35 |


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6.6.151 The migration routes and information presented in Wright *et al*. (2012) demonstrate that for many species there is significant movement of migratory birds between continental sites (from and to the Netherlands in particular) and the UK. Important sites are designated as SPAs/Ramsar sites (e.g. the Waddenzee). Many of the migratory birds on passage and wintering at SPAs in the Netherlands and Germany will arrive via routes that would not impinge upon the Dogger Bank Zone. However, given interchange and/or onward movement of birds to the UK, part of the populations that are present at these continental sites could be affected by collision. As such, the results of the analysis also apply to SPAs that form staging posts for onward migration to the UK or sites used by birds on return migration from the UK.

6.6.152 Given the very small percentages of populations that potentially could be impacted, it is concluded that collision related mortality during the operation of Dogger Bank Teesside A & B would not pose a threat to the maintenance of migratory populations that form the designated features of SPAs in Great Britain or other countries bordering the North Sea.

## 6.7 Cumulative assessment of impacts on designated bird populations

6.7.1 The previous sections have set out the predicted impacts for a range of effects on designated bird populations that could arise from the development of Dogger Bank Teesside A & B. This section considers the potential for cumulative impacts on the SPA populations to arise from the various effects assessed.

6.7.2 The four main effects of wind farm development covered in this assessment are: habitat loss, disturbance and displacement, collision risk and barrier effects. A cumulative impact could arise where more than one of these effects results in an impact on the same designated population. The potential for this cumulative impact to occur is determined largely by the sensitivities of individual species to the specific effects listed above and whether a species is susceptible to more than one of the effects. For the purposes of this part of the assessment, these species specific sensitivities are set out in **Table 6.29** for each of the species / receptors assessed along with a summary of the conclusions derived from the assessment work so that the potential for a cumulative impact to arise can be determined. Where it is apparent that a species / receptor is sensitive to and could be subject to more than one effect then further assessment of the cumulative impact is provided.

6.7.3 On the basis of the summary information presented in **Table 6.29** it is apparent that a project cumulative impact on designated populations has the potential to arise only with respect to northern gannet and black-legged kittiwake for collision mortality and barrier effects; and common guillemot and razorbill with respect to displacement mortality and barrier effects. There are no species that would be affected, to any significant degree, by both displacement and collision mortality.

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Table 6.29 Summary of impact findings for individual species / receptors to determine the potential for project cumulative impacts to arise

| Species / group | Habitat loss (prey resource loss) | Displacement mortality | Collision mortality | Barrier effect |
|---|---|---|---|---|
| Northern fulmar | Not significant | No displacement | Not significant <1 bird / year across all SPAs | Yes – populations at seven SPAs could be affected |
| Northern gannet | Not significant | No displacement | Yes – 68 birds across all SPAs | Yes – populations at three SPAs could be affected |
| Arctic skua | Not significant | No displacement | Not significant <1 bird / year across all SPAs | Not applicable |
| Great skua | Not significant | No displacement | Not significant <1 bird / year across all SPAs | Not applicable |
| Lesser black-backed gull | Not significant | No displacement | Yes – 34 birds across all SPAs | Not applicable |
| Great black-backed gull | Not significant | No displacement | Yes – 9 birds across all SPAs | Not applicable |
| Black-legged kittiwake | Not significant | No displacement | Yes – 107 birds across all SPAs | Yes – populations at one SPA could be affected |
| Common guillemot | Not significant | Yes - 50% displacement and 5% mortality rates assumed | Not significant <1 bird / year across all SPAs | Yes – populations at five SPAs |
| Razorbill | Not significant | Yes - 50% displacement and 5% mortality rates assumed | Not significant <2 birds / year across all SPAs | Yes – populations at four SPAs |
| Atlantic puffin | Not significant | Yes - 50% displacement and 5% mortality rates assumed | Not significant <1 bird / year across all SPAs | Not applicable |
| Migratory birds | Not applicable | Not applicable | Not significant <0.1% for all species assessed | Not significant at the population level |

## Collision mortality and barrier effects

6.7.4 This potential project cumulative impact relates solely to northern gannet and black-legged kittiwake and would only apply to SPAs that are within the foraging range of Dogger Bank Teesside A & B. While a potential impact on breeding birds from the barrier that Dogger Bank Teesside A & B could pose has been identified, as discussed in Section 6.6 above, the location of the proposed wind farm is highly likely to preclude any significant and adverse effect on the energetics of individual birds such that a population impact would arise.

6.7.5 For northern gannet, the number of birds potentially affected by the barrier effect of the wind farm would represent from 0.07% - 0.34% of the SPA populations examined (see Table A9.32 in Appendix 9 of **Appendix 11A** of the Dogger Bank Teesside A & B ES). This magnitude of impact is not considered to be

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significant at the population level, particularly given the habitat flexibility shown by this species and its extensive foraging range, and mortality as a result of any barrier effect is considered highly unlikely. It is, therefore, considered that no significant cumulative impact on SPA designated populations of northern gannet would arise as a result of collision mortality and barrier effects (see also paragraph 6.7.10).

6.7.6 In the case of black-legged kittiwake, the potential barrier effect would affect up to 1.1% of the Flamborough and Filey Coast pSPA. For black-legged kittiwake foraging from Flamborough Head, on the basis of distributional data, it is suggested that the majority of birds forage along the western edge of Dogger Bank and that wind farm development further to the east would not compromise overall foraging effectiveness such that a population impact (i.e. mortality) would arise (see Section 6.6). It is therefore concluded that no significant cumulative impact with displacement mortality would arise (see also paragraph 6.7.10).

## Displacement mortality and barrier effects

6.7.7 This potential project cumulative impact relates solely to common guillemot and razorbill and would only apply to SPAs that are within the foraging range of Dogger Bank Teesside A & B.

6.7.8 For common guillemot the number of birds potentially affected by the barrier effect of the wind farm would represent from 0.01% - 0.08% of the SPA populations examined (see Table A9.40 in Appendix 9 of **Appendix 11A** of the Dogger Bank Teesside A & B ES). This magnitude of impact is not considered to be significant at the population level for the reasons set out in Section 6.6 and and mortality as a result of any barrier effect is considered highly unlikely. Therefore, no significant cumulative impact with displacement mortality would arise (see also paragraph 6.7.10).

6.7.9 In respect of razorbill, for the four SPAs within the foraging range of Dogger Bank Teesside A & B the barrier effect exerted by the wind farm would affect less than 0.15% of all of the considered populations (see Table A9.43 in Appendix 9 of **Appendix 11A** of the Dogger Bank Teesside A & B ES). This magnitude of impact is not considered to be significant at the population level for the reasons set out in Section 6.6 and mortality as a result of any barrier effect is considered highly unlikely. Therefore, no significant cumulative impact with displacement mortality would arise (see also paragraph 6.7.10).

## Conclusion on project cumulative impacts

6.7.10 For the range of effects that could impact upon the seabird species and migratory bird populations screened into the assessment, it is apparent that, for all of the cases examined where the potential for a project cumulative impact could arise, one of the contributory impacts is not significant (in this instance – the potential impact of the barrier effect). It is therefore concluded that no significant cumulative impacts on SPA designated populations would arise and therefore conclusions regarding the impact of Dogger Bank Teesside A & B in respect of the relevant SPA conservation objectives can be drawn with reference to the influence of impacts arising from individual effects. This is covered in the following section.

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## 6.8 Summary of assessment findings and conclusions on site integrity

### Introduction

6.8.1 The following sections provide a brief summary of the findings of the assessment work in respect of the SPAs and Ramsar sites screened into the HRA process. The summary is presented in respect of the effects of Dogger Bank Teesside A & B (by itself) on the main species/groups of birds for which the SPAs and / or Ramsar sites are designated.

6.8.2 As set out in Section 3, the assessment work presented in this report has been undertaken on an iterative basis. Many SPAs and Ramsar sites, notably those designated for their migratory waterbird populations, were screened into the assessment process prior to any detailed assessment work being made available. As a consequence, a precautionary view was taken that the potential for LSE could apply to a large number of designated SPA and Ramsar site bird populations. As the subsequent assessment work following screening demonstrates, the determined impact of Dogger Bank Teesside A & B on many designated bird populations could be considered to represent no LSE. However, the LSE screening conclusions have not been revisited and, in line with the overall assessment approach, a conclusion in respect of the appropriate assessment stage of the HRA process is provided here that encompasses any potential determination of LSE for the relevant SPAs and Ramsar sites.

6.8.3 A tabulated summary of these findings in respect of each SPA and / or Ramsar site screened into the assessment is also provided in **Appendix F** of the **HRA Report**, along with a conclusion on the effect of the project on the integrity of the various designated features and sites.

### Application of conservation objectives

6.8.4 In order to inform the appropriate assessment process and determine whether an adverse effect on the integrity of a designated site (SPA and / or Ramsar site in this case) could arise, reference to the conservation objectives of the relevant designated site needs to be made.

6.8.5 The defined conservation objectives set out what is needed to ensure the 'favourable condition' of the designated feature. The term 'favourable condition' is used to represent the concept of Favourable Conservation Status for the interest features of an individual SPA. Conservation objectives are used as the basis from which management measures and monitoring programmes may be developed for the designated sites.

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6.8.6 In order to deal with the large number of features and SPAs requiring assessment, a generic set of conservation objectives that typically apply to the feature types (i.e. Article 4.1 or Article 4.2 populations) have been used as a reference against which to determine whether an adverse effect on integrity may arise. These Conservation Objectives are those provided by Natural England in respect of the suite of English SPAs and are as follows:

*"With regard to the individual species and/or assemblage of species for which the site has been classified ('the Qualifying Features' listed below);*

*Avoid the deterioration of the habitats of the qualifying features, and the significant disturbance of the qualifying features, ensuring the integrity of the site is maintained and the site makes a full contribution to achieving the aims of the Birds Directive.*

*Subject to natural change, to maintain or restore:*

- *The extent and distribution of the habitats of the qualifying features;*
- *The structure and function of the habitats of the qualifying features;*
- *The supporting processes on which the habitats of the qualifying features rely;*
- *The populations of the qualifying features; and*
- *The distribution of the qualifying features within the site."*

6.8.7 Similar conservation objectives also apply to Scottish SPAs and are given as:

*"To avoid deterioration of the habitats of the qualifying species (listed below) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and*

*To ensure for the qualifying species that the following are maintained in the long term:*

- *Population of the species as a viable component of the site;*
- *Distribution of the species within site;*
- *Distribution and extent of habitats supporting the species;*
- *Structure, function and supporting processes of habitats supporting the species; and*
- *No significant disturbance of the species."*

6.8.8 Overall, it can be stated that the conservation objectives for the SPAs are aimed at maintaining bird populations and/or the diversity of species within a defined assemblage through the protection of habitats supporting them and management against the potentially negative impacts of disturbance. In respect of favourable condition, two key attributes of bird features are applied - population size of individual species or groups of species and extent of habitats used by the birds within the designated site for nesting, roosting, feeding etc. Attributes relating to the maintenance of habitat quality (e.g. food availability) and preventing/managing activities that may cause disturbance to designated populations are also generally applied, including instances where it can be

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demonstrated that impacts could occur to birds outside of designated sites but which may form part of a designated population.

6.8.9 In the following sections, a summary is provided on whether the effects of the proposed project would compromise the conservation objectives applicable to the designated features screened into the process (and by association their respective SPAs) and, therefore, the achievement of favourable condition. An assessment is then provided on whether the project would have an adverse effect on the integrity of the SPAs screened into the assessment. A conclusion with respect to each designated feature and site (SPA and / or Ramsar) is provided in the summary table provided in **Appendix F** of the **HRA Report**.

## Direct habitat loss and alteration

### Offshore

6.8.10 Available data and evidence indicates that benthic habitat loss / alteration as a result of the installation and operation of wind turbines and other structures in the wind farm would not have a significant affect on the overall prey resource available to foraging seabirds. A significant impact on designated seabird populations is not therefore predicted.

6.8.11 Seabird prey resources (specifically fish) within the development area could be temporarily affected by increased underwater noise levels during construction. However, this effect would be localised to the immediate area of piling works and temporary displacement of the resource is predicted rather than loss or decrease in availability. During the operation phase for Dogger Bank Teesside A & B, the turbine structures potentially could act as attractants for some fish species and, coupled with potential restrictions on fishing activity, an overall increase in prey availability within the wind farm could occur. However, the impact of such an increase, were it to occur, on seabird populations is extremely difficult to determine and therefore no potential assessed benefit is attached to this effect. Overall, it is concluded that direct habitat loss and alteration would have no significant impact on designated seabird populations.

### Landfall

6.8.12 During installation of the export cable and connection to the substation some disturbance to nearshore and intertidal habitat would occur. This disturbance would be temporary and occur within an area that is of very limited use, as a foraging resource, for waterbirds. A significant impact on designated waterbird populations is not, therefore, predicted.

## Disturbance and displacement effects

6.8.13 Existing sensitivity classifications for disturbance and habitat use together with available evidence on the potential ecological consequences of displacement have been used in defining project-appropriate displacement and mortality values for seabird species that may be affected by disturbance during construction and operation of the wind farm. Using the assigned values the number of birds that could be affected, based on the estimated populations (using means of survey data) within the development area, has been calculated

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and these numbers apportioned to relevant SPAs to determine impacts on designated populations.

6.8.14 In the context of wind farm development, displacement can be viewed as an alteration in effective habitat availability. For those species that are sensitive to the presence of wind farms and for which avoidance occurs, overall availability of habitat resources, notably for foraging, may decrease. Because there is no specific wind farm related evidence to indicate otherwise, it is assumed that a decrease in the total foraging resource available to birds may result in mortality; although the magnitude of the effect will vary from species to species. Given the scale of development proposed would the Dogger Bank Zone and for Dogger Bank Teesside A & B, there is the potential that displacement and associated mortality could lead to reduction, for the duration of wind farm operation, in population levels for a number of seabird species. Information from a range of ecological studies dealing with seabird foraging ecology and prey resource fluctuations, together with determination of the area of high quality foraging resource (using sandeel fisheries data as a proxy for habitat quality) that birds may be displaced from within Dogger Bank Teesside A & B, has been used to determine appropriate mortality rates for the project.

6.8.15 The assessment of displacement effects in respect of designated SPA populations for the operation phase also incorporates the assessment view with respect to the construction phase. This approach reflects the fact that the displacement impact is not confined to any one phase of the project and occurs throughout the entire project lifecycle. Assessment of the potential disturbance and displacement effects that might occur during cable laying operations concluded that any effects would be temporary, very localised and, therefore, would not have any implications at population levels.

6.8.16 For northern fulmar, northern gannet, Arctic skua, great skua, black-legged kittiwake, lesser black-backed gull and great black-backed gull the assigned displacement or mortality value is taken as 0%. For these species, no displacement impact would arise and no adverse effect on the integrity of SPAs designated for these species populations would arise. Displacement associated mortality is, therefore, only predicted to occur for common guillemot, razorbill and Atlantic puffin. The calculated displacement impact varies by species and protected site and is summarised below.

**Common guillemot**

6.8.17 Adopting a 50% displacement rate and a 5% mortality rate it is calculated that approximately 0.04% of the total population of the suite of protected sites (26 SPAs) around the North Sea at which the species is a feature would be affected.

6.8.18 The greatest effect would be on the designated population of Flamborough and Filey Coast pSPA, where an estimated 0.04% reduction in the population (0.02% during the breeding season) could occur as a result of displacement and mortality. For the other five SPAs within maximum foraging range the estimated reduction in the designated populations would be less than 0.03% of the designated populations. For SPA populations outside of foraging range the calculated displacement-mortality impact is less than 0.02% (see Table A9.39d in Appendix 9 of **Appendix 11A** of the Dogger Bank Teesside A & B ES).

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6.8.19 These calculated displacement-mortality losses to the common guillemot populations at the various SPAs examined are not considered to be significant. This is particularly so given that precautionary displacement and mortality rates have been used in assessing the potential impact at the population level. Analysis of the availability of good quality foraging habitat within range of colonies on the east coast of the UK indicates that approximately 0.5% of available habitat would be 'lost' as a foraging resource. It is considered unlikely that this 0.5% loss would directly translate into a 5% mortality of displaced birds and, therefore, the impact is likely to be less than that determined.

6.8.20 On the basis of the information presented in this report and the precautionary values adopted, it is concluded that displacement impacts would not result in an adverse effect on the integrity of SPAs designated for their common guillemot populations.

**Razorbill**

6.8.21 Adopting a 50% displacement rate and a 5% mortality rate it is calculated that approximately 0.04% of the total population of the suite of protected sites (17 SPAs) around the North Sea at which the species is a feature would be affected.

6.8.22 The greatest effect would be on the designated population of Flamborough and Filey Coast pSPA, where an estimated 0.06% reduction in the population (0.02% of the breeding population) could occur as a result of displacement and mortality effects. Apart from the population of the Farne Islands (predicted 0.05% reduction) for all other SPAs screened into the assessment the predicted displacement impact would represent 0.04 of the designated razorbill population (see Table A9.42d in Appendix 9 of **Appendix 11A** of the Dogger Bank Teesside A & B ES).

6.8.23 As with the conclusions reached for common guillemot, these calculated displacement-mortality losses to the razorbill populations at the various SPAs examined are not considered to be significant.

6.8.24 On the basis of the information presented in this report and the precautionary values adopted, it is concluded that displacement impacts would not result in an adverse effect on the integrity of SPAs designated for their razorbill populations.

**Atlantic puffin**

6.8.25 In total, this species is a feature of 16 SPAs situated around the North Sea. Dogger Bank Teesside A & B is outside the mean maximum foraging range during the breeding season of any SPAs supporting qualifying populations of Atlantic puffin.

6.8.26 Displacement-led mortality would affect less than 0.01% of the total population of the suite of protected sites around the North Sea at which Atlantic puffin is a feature.

6.8.27 These calculated displacement-mortality losses to the Atlantic puffin populations at the various SPAs examined are not considered to be significant.

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6.8.28 On the basis of the information presented in this report and the precautionary values adopted, it is concluded that displacement impacts would not result in an adverse effect on the integrity of SPAs designated for their Atlantic puffin populations.

## Collision impacts

6.8.29 Potential losses of birds as a result of collision with wind turbines have been calculated using the Band model. For the purposes of assessment the outputs of the extended model, Option 3 (Band 2012) have been utilised for those species deemed to be at potential risk, i.e. some species of seabirds and migratory birds.

**Seabirds**

6.8.30 The number of northern fulmar, Arctic skua, great skua, common guillemot and Atlantic puffin predicted to collide with turbines is predicted to be less than one bird per year. Razorbill similarly has a predicted low risk, two collisions annually are predicted assuming a 98% avoidance rate. It is considered that the very low number of predicted annual collisions for these species would be highly unlikely to have a discernible effect at the population level, either with regard to individual designated site-based populations or wider North Sea populations. On the basis of the modelling undertaken it is concluded that collision mortality during the operation phase for Dogger Bank Teesside A & B would not result in an adverse effect on the integrity of SPAs designated for their northern fulmar, Arctic skua, great skua, common guillemot, razorbill and Atlantic puffin populations.

### *Lesser black-backed gull*

6.8.31 Dogger Bank Teesside A & B is outside the foraging range of any protected sites designated for breeding populations of lesser black-backed gull. Predicted losses of lesser black-backed gull from SPAs screened into the assessment process would represent less than 0.01% of designated populations and less than a 0.1% increase in background mortality for this species.

6.8.32 Given the relatively small number of birds (33) involved, apportioned across all of the relevant SPAs this level of loss is not considered to have the potential to result in an adverse effect on the integrity of SPAs screened into the assessment for their designated for their lesser black-backed gull populations.

### *Great black-backed gull*

6.8.33 All SPAs screened into the HRA supporting great-black backed gull populations are located outside the maximum foraging range of this species. The collision risk analysis provided an estimate of nine birds being lost from the suite of SPAs, representing 0.09% of populations at individual sites and a 0.35% increase in background mortality for this species. Given the small number of birds involved, apportioned across all of the relevant SPAs (17 in total; five in the UK), it is concluded that no adverse effect on the integrity of screened SPAs designated for great black-backed gull due to Dogger Bank Teesside A & B would arise.

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### *Northern gannet*

6.8.34 Using a 99% avoidance rate, collision risk modelling provided an estimate of 68 collisions per year (21 breeding birds and 47 non-breeding birds) based on mean collision estimates. Dogger Bank Teesside A & B is within mean maximum foraging range of two SPAs (Flamborough and Filey Coast pSPA and the Forth Islands SPA) around the North Sea for which breeding northern gannet is a feature.

6.8.35 Predicted losses of northern gannet at SPAs screened into the assessment process ranges between 0.01% to 0.05% of designated site's northern gannet populations. For SPAs located at a distance outside of the mean foraging distance from Dogger Bank Teesside A & B, the predicted collision losses would represent less than 0.01% of the designated populations.

6.8.36 The greatest impact would occur in respect of the northern gannet population at the Flamborough and Filey Coast pSPA, where up to 0.05% of the population (representing a 0.79% increase in background mortality) could be impacted on an annual basis. Examination of available PVA studies (WWT 2012) and PBR values (Forewind 2014) for this species indicates that the predicted level of collision losses are well below mortality thresholds at which a population decline for this species at Flamborough and Filey Coast pSPA might occur. A similar conclusion, using available PVA work, is also reached with regard to the northern gannet population of the Forth Islands SPA.

6.8.37 For all of the SPAs examined, the conclusion is therefore reached that the small losses that could occur as a result of collision due to Dogger Bank Teesside A & B would not have any consequences at population levels such that an adverse effect on the integrity of the screened SPAs designated for this species would arise.

### *Black-legged kittiwake*

6.8.38 Using a 98% avoidance rate, collision risk modelling analysis provides an estimate of 107 (56 during the breeding season and 52 outside the breeding season) collisions per year attributable to SPA designated populations of this species. Dogger Bank Teesside A & B is within maximum foraging range of just one SPA - Flamborough and Filey Coast pSPA.

6.8.39 Predicted losses of black-legged kittiwake at SPAs screened into the assessment process range between 0.01% to 0.07% of the designated sites' populations. For SPAs located outside of the maximum foraging range of Dogger Bank Teesside A & B, the apportioned collision losses (involving non-breeding birds only) would represent 0.01% of the designated populations and represent an estimated increase in the rate of background mortality calculated as 0.17%, indicating that the calculated collision losses are not significant.

6.8.40 At Flamborough and Filey Coast pSPA, the loss of 67 birds (62 adult birds, 54 of these during the breeding season) would represent 0.07% of the SPA population and an increase in the rate of background mortality of 1.34%. Based on PBR outputs (Forewind 2014), the predicted losses are below a mortality threshold level that would lead to a significant increase in the risk of further decline of the population occurring. Although the designated black-legged

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kittiwake population of the Flamborough and Filey Coast pSPA is currently in unfavourable condition, the predicted collision losses from Dogger Bank Teesside A & B alone would be unlikely to significantly contribute to the overall rate of decline.

6.8.41 For all of the SPAs examined, the conclusion is therefore reached that the losses that could occur as a result of collision due to Dogger Bank Teesside A & B would not have consequences at population levels such that an adverse effect on the integrity of SPAs designated for black-legged kittiwake would arise.

### Migratory birds

6.8.42 For migratory birds, the migration zones (defined by Wright *et al.* (2012)) of 45 species' populations of terrestrial or waterbird migrants that are UK SPA features overlap with the development area for Dogger Bank Teesside A & B. Estimated numbers of potential collisions for these 45 species of migrants were modelled based on the numbers of birds predicted to pass through the wind farm area, a 98% avoidance rate and expert judgement to determine the proportion of individuals likely to be flying at a height which places them at risk of collision.

6.8.43 Collision risk estimates suggest that on an annual basis the potential mortality associated with Dogger Bank Teesside A & B is likely to represent significantly less than 0.1% of the Great Britain or Great Britain and Ireland population of each of the 45 species that have a migration zone that overlaps with Dogger Bank Teesside A & B (see **Table 6.28**). For many species there is significant movement of migratory birds between continental sites (in the Netherlands in particular) and the UK. Many of these sites are designated SPAs (e.g. the Waddenzee). As such, the results of the analysis also apply to SPAs that form staging posts for onward migration to the UK or sites used by birds on return migration from the UK. As a result of collision losses due to Dogger Bank Teesside A & B, an adverse effect on the integrity of the screened SPAs designated for their migratory bird populations is not therefore predicted.

## Barrier effects

### Seabirds

6.8.44 It is unlikely that Dogger Bank Teesside A & B would act as a significant barrier to the foraging movements of breeding seabirds. For all species with SPA designated breeding colonies within the foraging range of Dogger Bank Teesside A & B, only two species (northern fulmar and black-legged kittiwake) were identified where greater than 1% of the breeding population at individual SPAs potentially could be affected.

6.8.45 For northern fulmar, up to 5% of the population at the Flamborough and Filey Coast pSPA might be potentially influenced by the barrier posed by Dogger Bank Teesside A & B. On the basis of the mean maximum foraging range of this species, the deviation to the direct flight line would represent a relatively small 6.3% of the maximum foraging range of 580km. It is unlikely that the approximate 6.3% in flight distance that could be incurred by birds flying in a direct line from the breeding colony would adversely affect the energetics of

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individual northern fulmar originating from Flamborough and Filey Coast pSPA, such that an effect at the population level would arise.

6.8.46 Breeding black-legged kittiwake from Flamborough and Filey Coast pSPA could be subject to a barrier effect, with an estimated 1.1% of the population being affected. For this species, Dogger Bank Teesside A & B is significantly beyond the mean maximum foraging range of 60km, suggesting that the resource available at Dogger Bank is sufficiently attractive to warrant longer foraging flights than is typical for this species. The greatest densities of black-legged kittiwake during the breeding season occur along the western edge of Dogger Bank (and to the west of Dogger Bank Teesside A & B), with numbers of birds rapidly decreasing to the east. This distribution of birds during the breeding season indicates that there is likely to be limited foraging by birds from Flamborough and Filey Coast pSPA beyond the western boundary of the Dogger Bank Zone and into the area covered by Dogger Bank Teesside A & B and, in this respect, the site would not act as a barrier to movements.

6.8.47 For all other species, where the barrier effect has been determined to affect less than 1% of the breeding populations at individual sites, it is considered that the effect posed by Dogger Bank Teesside A & B would not have any discernible impact upon seabird populations. This is particularly so given that, for many breeding colonies/sites, Dogger Bank is located at the extreme edge of the maximum foraging range (and well beyond the mean maximum distance) for the seabird species within foraging range. This suggests that even for the small percentage of birds from these SPAs that may make use of the area for foraging, the increase in energetics that the presence of wind farm development may pose would be negligible in the context of the total distance of all foraging flights undertaken.

6.8.48 The overall conclusion is that, for breeding seabirds, wind farm development at Dogger Bank Teesside A & B would not exert an appreciable barrier effect, such that detrimental impacts on designated populations at individual SPAs would arise. An adverse effect on the integrity of those SPAs and their designated populations for which a potential barrier effect has been identified is not therefore predicted.

**Migratory birds**

6.8.49 An assessment of the potential barrier effects posed by Dogger Bank Teesside A & B based on overlap with the migration zones (defined by Wright *et al*. (2012)) of 45 species' populations of terrestrial and waterbird migrants that are UK SPA features has been undertaken.

6.8.50 The percentages of Great Britain or Great Britain and Ireland populations estimated to pass through the project area at risk height (following Wright *et al.* (2012)) and thus that would be exposed to potential barrier effects were less than 1% for most species considered, but over 1% for 17 species' populations (see **Table 6.25**).

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6.8.51 The increase in flight distance due to the barrier presented by Dogger Bank Teesside A & B would vary by direction of flight. The shortest approximately east-west route across the North Sea in order for birds to circumvent the project area would equate to a maximum of approximately 25km (an increase of 4% on the ca. 575km route, assuming the shortest North Sea crossing) in order for birds to circumvent the project area. For all other routes, the potential percentage increase in the migration route would be less than 4%. This postulated increase in flight distance is precautionary in that it assumes that deviation in flight line would occur rather than birds increasing their flight height and, therefore, avoiding the need to deviate.

6.8.52 Considering both the small percentage of migrating bird populations likely to be involved and the relative increase in flight distance that Dogger Bank Teesside A & B could exert, it is concluded that the potential barrier posed by wind farm development would be unlikely to have a detrimental impact upon the energetics of migratory birds. An adverse effect on the integrity of designated SPA migratory bird populations as a result of the potential barrier posed by the wind farm is not therefore predicted.

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# 7 Assessment of In-combination Effects

## 7.1 Introduction

7.1.1 Regulation 61 of the Habitats Regulations requires the competent authority to make an appropriate assessment of any plan or project which is likely to have a significant effect on a European site, either alone or in-combination with other plans or projects. This process is also identified in Regulation 25(1) of the Offshore Habitats Regulations. As the terms of Regulations 25 and 61 are the same, for the purposes of this assessment, reference (where required) is made solely to Regulation 61.

7.1.2 For the in-combination assessment presented below, the criteria for other projects (and considering the recommendations in Advice Note Ten (The Planning Inspectorate 2013) is:

- Built and operational projects (but see paragraph 7.2.2 below for limitations);
- Approved but uncompleted projects;
- Projects under construction;
- Projects for which an application has been made, that are under consideration by the consenting authorities and for which refined information and robust assessment outcomes are available; and
- Projects which are reasonably foreseeable, i.e. projects for which an application has not yet been submitted, but which are likely to progress before completion of the development and for which sufficient information and robust assessment outcomes are available at the date of any appropriate assessment in order to assess the likelihood of in-combination effects.

7.1.3 The approach (see also paragraphs 7.2.20 to 7.2.23) taken herein in dealing with in-combination effects is to identify environmental parameters (receptors) where a spatial (the area over which impacts may accumulate or interact) and temporal (where impacts occur in parallel over time) overlap of the effects on these receptors may occur due to the influence of different plans and projects. For these identified overlaps, the likelihood and nature of any increase (or possible decrease) in the significance of an impact is then assessed. This aspect of the assessment process is, however, heavily reliant on the availability of sufficient information on the projects and plans being considered, both in terms of project design and activities, as well as their environmental impacts.

7.1.4 Where such data (both quantitative and qualitative) is available, assessment of potential in-combination effects is provided. If, however, data is partial and/or unavailable because of the status of the project, for the purposes of this assessment, consideration has been given, where appropriate and taking into account the criteria set out above, to likely generic in-combination effects.

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Further discussion of the data used from projects in the assessment of individual receptors is provided in the relevant sections below. Assessment of the predicted in-combination impacts is made in the context of the relevant European sites and their features' conservation objectives.

## 7.2 Screening of projects for the assessment of in-combination effects

7.2.1 The plans and projects to be included within the assessment of in-combination effects for Dogger Bank Teesside A & B have been determined through a screening process (see Section 3.6). For each European site and its feature(s), or relevant groupings of features (e.g. ornithology), the following steps have been undertaken in order to screen the list of projects and plans for the assessment:

- Step 1 – identify the key effects of Dogger Bank Teesside A & B on each European site and/or relevant features and define their spatial and temporal extent. Note that where potential effects have been screened out in the first instance (see Sections 3.4 and 3.5 and the specific European site and feature assessments within Sections 4 to 6) these are not carried through into the in-combination assessment; and
- Step 2 - identify the individual plans and projects that may result in the same or similar effects on a site and/or relevant features. A list of categorised plans and projects has been produced. These plans and projects are located within a very large study area encompassing the greater North Sea and beyond, and are referred to as the 'long list' (see **Chapter 33** of the Dogger Bank Teesside A & B ES).

7.2.2 With regard to built and operational projects, particularly existing offshore wind farms, it is considered that the influence of these projects on environmental receptors would be encompassed within the baseline as defined by the specific environmental surveys undertaken for the project. Consideration of these projects, as part of the in-combination assessment, is therefore limited to those projects that became operational over the timeframe during which survey data was collected for Dogger Bank Teesside A & B. This timing position has been adopted as it is possible that the effects of projects becoming operational during the survey periods will not be captured by the baseline information.

7.2.3 As stated in the ornithological technical report (see **Appendix 11A** of the Dogger Bank Teesside A & B ES) the effects on designated bird populations of SPAs are assessed based on the most recent reference population estimates, rather than the population estimates at the time of designation. Similarly, for the extent and distribution of Annex I habitats within SACs and, where relevant, Annex II species populations, the most up to date data has been used in the assessment process. This approach enables the in-combination LSE test and appropriate assessment to be undertaken using data that incorporates the effects of operational projects up to the point of the project survey period. In effect, this approach also avoids the potential for double counting the potential effects of operational projects – once as part of the baseline and again as part of the in-combination assessment.

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## Types of projects considered in the in-combination assessment

7.2.4 For the purposes of the HRA process, consideration of in-combination effects is limited to the following projects (in line with the criteria set out in paragraph 7.1.1):

- Other offshore wind farms;
- Oil and gas installations;
- Aggregate extraction and dredging; and
- Existing, and planned construction of, subsea cables and pipelines.

7.2.5 A brief summary of the impacts that could arise as a result of interactions between Dogger Bank Teesside A & B and the project types listed above is provided in the following sections, along with a discussion regarding other types of activities not considered.

### Offshore wind farms

7.2.6 Effects associated with other offshore wind farms would be similar to those predicted for Dogger Bank Teesside A & B and, therefore, these projects have the greatest potential for in-combination impacts on the designated interests screened into and assessed in this IfAA report. Key effects relate to:

- Underwater noise generation during construction and the impact on marine mammals;
- Mortality of seabirds and migratory birds as a result of collision with turbines during the operation phase; and
- Disturbance to and displacement of seabirds from foraging areas during the operation phase.

### Oil and gas installations

7.2.7 As the oil and gas industry (exploration and extraction) is long established in the North Sea, its impacts on the environment are relatively well documented and understood. It is considered that, because of the relatively long timeframe over which projects have been operational, any impacts associated with extraction (other than future spill / pollution events) will be incorporated into the environmental baseline defined for the assessment of Dogger Bank Teesside A & B. Other than the potential for accidental spillages and pollution events from existing facilities, in-combination effects, therefore, will relate to projects that are planned (e.g. exploration surveys) and/or in the process of being developed. The main effects associated with oil and gas exploration and extraction include:

- Increased underwater noise levels during exploration and production;
- Potential localised habitat loss and disturbance to seabed habitats during exploration and production;
- Increased human activity around platforms and associated disturbance and displacement effects (birds and marine mammals);
- Emissions to air and water; and
- Accidental spillages and pollution events.

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7.2.8 No specific information on future oil and gas exploration activities in the vicinity of Dogger Bank Teesside A & B, e.g. seismic surveys during exploration, is available. Seismic surveys, should they occur, would have an impact for the duration of the survey, which typically lasts for less than two weeks.

7.2.9 Seabed disturbance associated with oil and gas development (e.g. the Cygnus Field development) is largely related to the installation of subsea infrastructure (e.g. pipelines and subsea manifolds) during the construction phase. Impacts on seabed substrates and communities during this phase would be expected to be localised to the vicinity of the works. Given the localised nature of disturbance, the potential for any in-combination effects is considered to be extremely low.

7.2.10 During construction and operation, activities around surface installations may lead to some disturbance and displacement effects to seabirds and, potentially, marine mammals. Displacement would be extremely localised (i.e. to the immediate vicinity of the installation) and mortality would not be expected. New field developments in the southern North Sea tend to comprise tie-backs, which, as they are located on the seabed, would not have any displacement effects. The potential for in-combination effects to arise is, therefore, considered to be extremely low.

7.2.11 There are no oil fields in the southern North Sea and, therefore, the risk of a significant oil spill is negligible. Accidental spills from bunkering operations may arise, but the volumes involved in such events are typically relatively small and effects localised as a result of the implementation of response plans. In-combination effects are difficult to predict because of the accidental nature of such events, however, given that the potential impact of spills would be localised, temporary and of a small-scale, no significant in-combination impacts would be anticipated.

7.2.12 Atmospheric emissions are not predicted to have any direct impact on any qualifying species or habitat and no in-combination impacts with Dogger Bank Teesside A & B would be likely to occur.

**Aggregate extraction and dredging**

7.2.13 Existing aggregate extraction and dredging activities are on-going operations and, therefore, any impacts that they generate form part of the baseline environment against which the effects of Dogger Bank Teesside A & B have been assessed. Potential in-combination impacts, therefore, would be confined to those aggregate extraction and/or dredging projects that are planned within licensed or proposed sites.

7.2.14 The key effects associated with aggregate extraction and dredging are:

- Disturbance to the seabed and loss/alteration of seabed communities/habitats;
- Generation of increased levels of suspended sediment and sediment deposition; and
- Vessel movements / activity that may cause disturbance and displacement of seabirds and marine mammals by vessels.

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7.2.15 Disturbance to the seabed and alteration to seabed communities would be largely confined to the licensed extraction area and, therefore, unless extraction areas fall within the footprint of the wind farm project area, direct in-combination impacts would not arise. Potentially, in the case of Dogger Bank Teesside A & B, in-combination impacts could occur if licensed extraction were to occur from within the Dogger Bank cSAC (and affect the same designated features (see Section 7.3)).

7.2.16 Sediment released into the water column during dredging may generate a sediment plume that could combine with sediment released during construction work for the wind farm. However, the potential for significant spatial and temporal interaction of plumes to occur is considered unlikely, given the intermittent nature of plume generation from aggregate sites and the temporary and localised nature of any increase in suspended sediment concentrations.

7.2.17 Disturbance and displacement effects arising from vessel activity would be localised to the immediate vicinity of the vessel and of a temporary nature. Given that there are already high levels of vessel activity adjacent to the project area, the potential for any significant in-combination impacts is considered to be extremely low.

**Installation of subsea pipelines and cables**

7.2.18 Any impacts associated with existing cables and pipelines on the seabed will be part of the baseline environment. The majority of pipelines in the southern North Sea are buried and evidence (OSPAR 2009) from existing pipeline projects indicates that recovery of benthic communities is rapid (<2 years). In this respect, the impacts of any proposed pipeline / cabling projects would be expected to be similar to those associated with the export cable works for Dogger Bank Teesside A & B. In-combination impacts would only arise if subsea pipeline projects were to take place within the Dogger Bank cSAC. There are no known pipeline development projects that would directly or indirectly interact with Dogger Bank Teesside A & B within and surrounding the Dogger Bank cSAC.

**Other activities**

7.2.19 Existing activities which do not, or have not in the past required a consent (such as commercial fishing and shipping movements) and which have been carried out historically, are judged to have influenced the existing baseline environment as recorded to date. Predicting future changes in such activities (and the effects of such changes) is not possible with a level of certainty that would provide any meaningful results for the in-combination assessment and, in particular, the outcomes of the assessment. Therefore, these types of existing and ongoing activities are not included in the in-combination assessment.

## Criteria for selection of projects for in-combination assessment

7.2.20 The plans and projects screened into this in-combination assessment are derived from the projects assessed in the cumulative impact sections of the relevant ES chapters (i.e**. Chapters 9**, **12**, **14**, and **Appendix 11A** of the Dogger Bank Teesside A & B ES). In turn, the projects considered in the ES chapters were screened from the long list of projects described in **Chapter 33** of the

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Dogger Bank Teesside A & B ES. While the projects considered in the ES for each receptor group of interest form the initial basis for the in-combination assessment, consideration has also been given to the individual projects listed to determine whether, for HRA purposes, relevant impact pathways would exist and spatial and temporal interactions of different projects' could arise such that designated site features could be affected.

7.2.21 In order to reach scientifically robust in-combination conclusions, consideration has been given to the confidence that can be applied to the assessment outcomes reported in documentation for the projects with which a potential interaction of effects could arise. The following confidence level criteria have been adopted:

- Good confidence - projects that are under construction. For these projects, data and the assessment outcomes for this data is / should be available that enables both quantitative and qualitative analysis with the effects of Dogger Bank Teesside A & B to be undertaken;
- Medium confidence – projects that are consented but yet to be implemented. For these projects, while it is likely that implementation will occur, it is not certain that this will take place. However, quantitative data and assessment outcomes that enable in-combination assessment to be undertaken will have been agreed and made available through the consenting process; and
- Low confidence (but see paragraph 7.2.22 below) - projects for which an application has been made and / or are at the pre-application stage. From experience of the consenting process to date it is apparent that, as the assessment and consenting process progresses, significant changes in assessment methodologies and, therefore, assessment conclusions reached can arise. This is particularly the case with respect to the assessment of impacts on ornithological interests, where modifications to the methods used and presented in application documentation (including materials for HRA) that are promoted post-application by both developers and statutory consultees may substantially alter the original assessment outcomes. Given the potential for significant changes in assessment outcomes to occur after the pre-application stage, it is considered that only limited confidence can be placed in some of the materials available for these projects.

7.2.22 With regard to the final project category listed above, it is entirely possible for assessment work relating to some parameters and receptors that quantitative data (e.g. survey results), modelling work (e.g. underwater noise modelling) and some assessment outcomes may be fully realised and considered robust enough to be able to utilise in the in-combination assessment. Where this is the case, information and assessment outcomes from projects falling into this category have been used and the projects are specifically considered in the in-combination assessment in respect of the relevant receptor. Where it is considered that confidence in the existing status of the project assessment outcomes is low for particular parameters / receptors, the reasons for exclusion of project data from the in-combination assessment is provided.

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7.2.23 On the basis of the categories set out above, the in-combination assessment for Dogger Bank Teesside A & B is limited to those projects for which there is a good to medium confidence in the assessment outcomes. Unless it can be demonstrated that data/outputs are robust and agreed through the application process, then information from the projects that fall into the low confidence category is excluded from the assessment.

7.2.24 In the following sections, the in-combination assessment is presented for each of the main receptors (European site(s) and features) as for the assessment of the project alone. The relevant projects defined by the categories set out above are listed and an assessment conclusion in light of the conservation objectives applicable to the relevant sites is provided.

## 7.3 Assessment of in-combination effects on the integrity of the Dogger Bank cSAC

7.3.1 This section screens the activities and effects of Dogger Bank Teesside A & B against the potential activities of other plans and projects, in order to assess the in-combination effects on the subtidal sandbanks feature of the Dogger Bank cSAC.

### Screening of other projects

7.3.2 The following effects have been identified and examined in the alone assessment of Dogger Bank Teesside A & B with respect to the subtidal sandbanks feature of the Dogger Bank cSAC:

- Alteration to bathymetry from the presence of structures during the operation phase. Structures present during construction and decommissioning would be temporary;
- Interruption to sediment transport during the operation phase. Structures present during construction and decommissioning would be temporary and therefore would not influence long term sediment transport;
- Alteration to hydrodynamic processes (waves and tidal currents) during the operation phase. Structures present during construction and decommissioning would be temporary and therefore would not influence long term hydrodynamic processes;
- Physical disturbance to the morphology and physical damage to the structural integrity of sandbank habitat during the operation phase. Temporary influences on morphological factors (such as waves, tides, bathymetry, sediment transport, etc.) during construction and decommissioning would not result in morphological change over the long-term;
- Alteration to the extent, composition and distribution of sandbank habitat during construction (temporary), operation (permanent) and decommissioning (temporary). The operation phase impact could be considered as permanent, though structures would be removed in the decommissioning phase;

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- Changes to suspended sediment levels as a result of disturbance or scour during construction (temporary), operation (intermittent and long-term) and decommissioning (temporary);
- Changes to the levels of nutrients and contaminants during construction, operation and decommissioning. These impacts are temporary and intermittent and are not considered to be significant;
- Direct physical loss (substratum loss) to subtidal sandbank communities during the operation phase due to the footprint of fixed structures and introduction of new (hard) substrate and associated communities. This effect is permanent though structures would be removed in the decommissioning phase;
- Direct physical damage (disturbance) to subtidal sandbank communities during construction (seabed disturbance), operation (seabed disturbance as a result of maintenance activities) and decommissioning (seabed disturbance). This effect is short-term, temporary, and reversible;
- Physical damage to subtidal sandbank communities from increased suspended sediment concentrations during construction, operation, and decommissioning. This effect is short-term and temporary;
- Physical damage to subtidal sandbank communities due to the release of potential contaminants within sediments. Natural scour and re-suspension of sediment already maintains a natural range of contaminants in the water column (in suspension) and in deposited sediments, therefore no overall change is predicted as no new contaminants would be introduced;
- Indirect physical damage (smothering) to subtidal sandbank communities through increased deposition of sediment during construction, operation, and decommissioning. This effect is short-term and temporary; and
- Indirect physical damage (hydrodynamic alteration and morphological change to sandbank features) to subtidal sandbank communities through presence of structures during the operation phase. This effect is long-term and reversible.

7.3.3 Screening of the above effects against other projects and plans has been undertaken in order to determine those projects that have the potential to interact with the effects of Dogger Bank Teesside A & B and on the Dogger Bank cSAC and its subtidal sandbanks feature. The 'study area' used to identify which projects should be considered was derived from identifying the direct and indirect pathways and the likely 'extent' of those pathways in order to encompass projects whose effects occur within or outside the cSAC but which could extend into the cSAC, and thus combine with those effects identified from Dogger Bank Teesside A & B alone. The key pathway for effects is the aquatic environment, whereby physical, chemical and biological effects would extend through and within the cSAC. This 'extent' was determined using the likely hydrodynamic processes and the distance over which 'water' (and any subsequent physical, chemical or biological disturbances) could travel over a number of tidal cycles. In the HRA Screening Report (see paragraph 5.4.16 in **Appendix A** of the **HRA Report**) this was identified as 50km from the offshore

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project boundary and 25km from the export cable corridor (see **Figure 7.1**). The results of the screening are presented in **Table 7.1** (for physical processes) and **Table 7.2** (for ecological features), and the projects that are screened in or out (see **Figure 7.1)** are listed below. These projects comprise offshore wind farms, aggregate dredging, and oil and gas developments.

7.3.4 The initial screening (projects identified in **Table 7.1** and **Table 7.2**) identified a number of projects that had the potential to generate effects which could overlap spatially or temporally with those identified for Dogger Bank Teesside A & B, and for which sufficient information regarding their likely effects or activities is available in order to enable the assessment of in-combination effects on Dogger Bank cSAC. Further consideration of potential interactions enabled the following projects to be screened out of the assessment.

7.3.5 Hornsea Project One Offshore Wind Farm would not result in any direct loss of or disturbance to subtidal sandbanks feature in the Dogger Bank cSAC due to its distance (more than 34km) from the cSAC. In addition, only a limited amount of suspended sediment would be released through seabed preparation, as sand and gravel predominates within the area (Chapter 1, paragraph 1.4.14 in Smart Wind Limited (2012)) and would only be transported a short distance as a result of disturbance. In addition, given the likely direction of fine sediment transport in the water column and the distance to the Dogger Bank cSAC (see **Figure 7.1**), increased suspended sediment concentrations generated during works for Hornsea Project One would not impinge upon the cSAC. No in-combination effect with development of Dogger Bank Teesside A & B is, therefore, anticipated on the Dogger Bank cSAC.

7.3.6 A number of projects would not result in any direct loss of or disturbance to the subtidal sandbanks feature of the Dogger Bank cSAC due to their distance (see **Figure 7.1**) from the cSAC. Furthermore, given the distances of these projects to the Dogger Bank cSAC, generated suspended sediment (and any contaminants present) would not be transported into the cSAC. Therefore, no in-combination effects are expected on the Dogger Bank cSAC as a result of Dogger Bank Teesside A & B and the following projects:

- Hornsea Project Two Offshore Wind Farm (>100km away);
- Triton Knoll Offshore Wind Farm (>100km away);
- Westermost Rough Offshore Wind Farm (>100km away);
- Humber Gateway Offshore Wind Farm (>100km away);
- Teesside Offshore Windfarm (>100km away);
- Idunn Energipark (>100km away);
- HS-20 Offshore Wind Farm (>90km away);
- Nord-Ost Passat I, II and III Offshore Wind Farm (>85km away);
- Blyth Demonstration Site Offshore Wind Farm (>60km away);
- Aggregate Areas 448 and 449 (both >100km away); and
- Underground Coal Gasification project (>100km away).

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Table 7.1 In-combination assessment screening for marine physical processes (project screening)

| Type of project | Project title | Project status | Predicted construction/development period | Distance from Dogger Bank Teesside A & B | Confidence in project details | Confidence in project data | Carried forward to in-combination assessment? |
|---|---|---|---|---|---|---|---|
| Offshore Wind Farm | Dogger Bank Creyke Beck A & B | Pre-application | 2016-2027 | 5km south west of Dogger Bank Teesside B | High | High | Yes |
| Offshore Wind Farm | Dogger Bank Teesside C & D | Pre-application | 2018/19-2029 | 5km north of Dogger Bank Teesside B | High | Medium | Yes |
| Offshore Wind Farm | Hornsea Project One | Pre-application | 2015 on | 100km south of Dogger Bank Teesside B | Medium | Medium | No – due to distance |
| Offshore Wind Farm | Hornsea Project Two | Pre-application | 2015 on | 100km south of Dogger Bank Teesside B | Medium | Medium | No – due to distance |
| Offshore Wind Farm | Teesside Offshore Windfarm | Construction | 2013 | 4km north of Dogger Bank Teesside A & B Export Cable Corridor | High | High | Yes |
| Offshore Wind Farm | Blyth Demonstration | Application submitted | 2014 on | 60km north-north west of Dogger Bank Teesside A & B Export Cable Corridor | High | High | No – due to distance |
| Offshore Wind Farm | H2-20 | Application submitted | Not confirmed | 90km north east of Dogger Bank Teesside A | Medium | Medium | No – due to distance |
| Offshore Wind Farm | Idunn Energipark | Concept / early planning | Not confirmed | 140km north-north east of Dogger Bank Teesside A | Medium | Medium | No – due to distance |
| Offshore Wind Farm | Nord-Ost Passat I, II and III | Concept / early planning | Not confirmed | 85km east of Dogger Bank Teesside A | Medium | Medium | No – due to distance |
| Aggregate Licence Area | Area 466 | Application | Not confirmed | 30km west-north west of Dogger Bank Teesside B | High | High | Yes |
| Aggregate Licence Area | Area 485 (1 and 2) | Application | Not confirmed | 60km south west of Dogger Bank Teesside B | High | High | Yes |


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Table 7.2 In-combination assessment screening for marine and intertidal ecology (project screening)

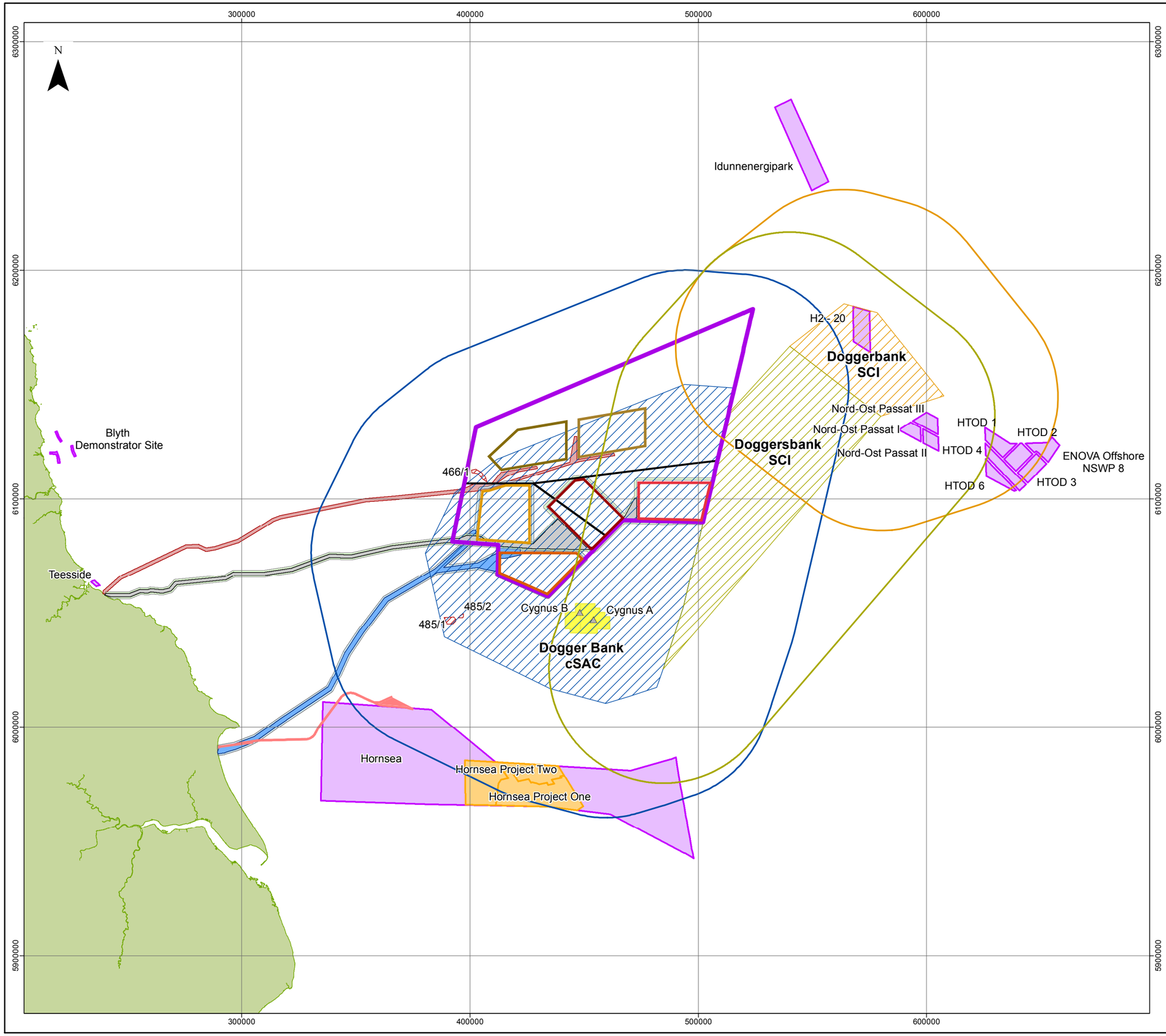
| Type of project | Project title | Project status | Predicted construction / development period | Distance from Dogger Bank Teesside A & B (km) | Confidence in project details | Confidence in project data | Carried forward to in-combination assessment | Rationale for not carrying into in-combination assessment |
|---|---|---|---|---|---|---|---|---|
| Offshore Wind Farm | Dogger Bank Creyke Beck A | Application | Post 2016 | 28km / 4km from Dogger Bank Teesside A & B. 1km from Dogger Bank Teesside A & B Export Cable Corridor. | High | High | Yes | N/A |
| Offshore Wind Farm | Dogger Bank Creyke Beck B | Application | Post 2016 | 46km / 6km from Dogger Bank Teesside A & B. Overlaps Dogger Bank Teesside A & B Export Cable Corridor. | High | High | Yes | N/A |
| Offshore Wind Farm | Dogger Bank Teesside C | Pre-Application | Post 2017 | 31km / 8km from Dogger Bank Teesside A & B. 24km from Dogger Bank Teesside A & B Export Cable Corridor. | High | High | Yes | N/A |
| Offshore Wind Farm | Dogger Bank Teesside D | Pre-Application | Post 2017 | 13km / 8km from Dogger Bank Teesside A & B. 21km from Dogger Bank Teesside A & B Export Cable Corridor. | High | High | Yes | N/A |
| Offshore Wind Farm | Dogger Bank Other Developments | Potential | Not confirmed | Not confirmed. | Low | Low | No | Low data confidence |
| Offshore Wind Farm | Hornsea Project One | Application | Post 2015 | 116km / 99km from Dogger Bank Teesside A & B. 97km from Dogger Bank Teesside A & B Export Cable Corridor. | High | Medium | No | Due to distance from receptor and ‘dilution’ of effect over this distance |

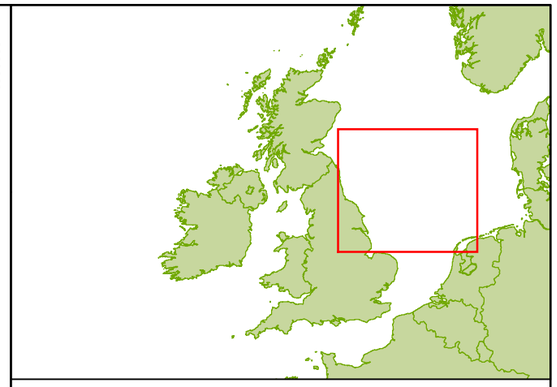

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| Type of project | Project title | Project status | Predicted construction / development period | Distance from Dogger Bank Teesside A & B (km) | Confidence in project details | Confidence in project data | Carried forward to in-combination assessment | Rationale for not carrying into in-combination assessment |
|---|---|---|---|---|---|---|---|---|
| Offshore Wind Farm | Hornsea Project Two | Pre-Application | Post 2017 | 113km / 95km from Dogger Bank Teesside A & B.<br>95km from Dogger Bank Teesside A & B Export Cable Corridor. | Medium | Medium | No | Due to distance from receptor and 'dilution' of effect over this distance |
| Offshore Wind Farm | Hornsea (Other Developments) | Potential | Not confirmed | Not confirmed. | Low | Low | No | Low data Confidence |
| Offshore Wind Farm | Triton Knoll | Consented | 2017 - 2021 | 192km / 169km from Dogger Bank Teesside A & B.<br>137km from Dogger Bank Teesside A & B Export Cable Corridor. | High | High | No | Due to distance from receptor and 'dilution' of effect over this distance |
| Aggregate extraction | Area 466/1 | Application area | Decision expected 2012 | 65km / 28km from Dogger Bank Teesside A & B.<br>24km from Dogger Bank Teesside A & B Export Cable Corridor. | High | Medium | Yes | N/A |
| Aggregate extraction | Area 485/1 | Application area | Not confirmed | 90km / 63km from Dogger Bank Teesside A & B.<br>32km from Dogger Bank Teesside A & B Export Cable Corridor. | High | Medium | Yes | N/A |
| Aggregate extraction | Area 485/2 | Application area | Not confirmed | 86km / 59km from Dogger Bank Teesside A & B.<br>40km from Dogger Bank Teesside A & B Export Cable Corridor. | High | Medium | Yes | N/A |


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## 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
- Aggregate application area
- Offshore wind farm
- Hornsea Project One &Two
- Humber CCS proposed corridor
- Cygnus proposed subsurface infrastructure
- Cygnus gas field development

Candidate Special Area of Conservation (cSAC)/Sites of Community Importance (SCI)

| | |
|---|---|
| Germany | 50km Buffer |
| Netherlands | 50km Buffer |
| UK | 50km Buffer |

0 10 20 40
Kilometres

Data Source:
Environmental Designations © JNCC/European Environment Agency, 2014
European UK offshore wind farm & Aggregate areas © The Crown Estate, 2014
European wind farm boundary data supplied by MarineFind, 2013

PROJECT TITLE

*Dogger Bank Teesside A & B*
IfAA Report

DRAWING TITLE

**Figure 7.1 Other projects within the North Sea for consideration of in-combination effect on Dogger Bank cSAC**

| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 15/10/2013 | PEI3 | LW | PT |
| 2 | 18/03/2014 | DCO Submission | LW | PT |
| | | | | |

DRAWING NUMBER:

**9Y0986/TSABHRA/45/R2**

| SCALE | PLOT SIZE | DATUM | PROJECTION |
|---|---|---|---|
| 1:1,700,000 | A3 | WGS84 | UTM31N |

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7.3.7 A low confidence in the project assessment outcomes for future offshore wind farm development within the Hornsea Zone (other than Hornsea Project One) has resulted in these potential projects being excluded from the assessment. Effectively there are insufficient details available at present in order to enable their inclusion in a robust in-combination assessment.

7.3.8 Consequently, the following projects have been considered in the in-combination assessment with respect to the Dogger Bank cSAC:

- Dogger Bank Creyke Beck A & B Offshore Wind Farm;
- Dogger Bank Teesside C & D Offshore Wind Farm;
- Area 466/1 Aggregate Extraction; and
- Area 485/1 and 485/2 Aggregate Extraction.

7.3.9 Based on the projects screened in and the potential in-combination effects, **Table 7.3** presents the projects and related effects that could occur and impact on the subtidal sandbank feature of the Dogger Bank cSAC, and that are therefore assessed in detail.

Table 7.3 Potential in-combination effects of other projects on the Dogger Bank cSAC)

| Effect on site feature | Dogger Bank Creyke Beck A & B | Dogger Bank Teesside C & D | Area 466/1 | Area 485/1 & 2 |
|---|---|---|---|---|
| **Dogger Bank Teesside A & B construction phase** | | | | |
| Direct physical loss (obstruction)[1] | NO | NO | NO | NO |
| Direct physical damage (disturbance) | YES | YES | YES | YES |
| Indirect physical damage (smothering) | YES | YES | YES | YES |
| Direct physical damage (increased suspended sediment concentrations) | YES | YES | YES | YES |
| **Dogger Bank Teesside A & B operation phase** | | | | |
| Disturbance to morphology / structural integrity | YES | YES | YES | YES |
| Direct physical loss (obstruction) | YES | YES | NO | NO |
| Direct physical damage (disturbance) | YES | YES | YES | YES |
| Indirect physical damage (hydrodynamic change) | YES | YES | YES | YES |
| Indirect physical damage (smothering) | YES | YES | YES | YES |
| Direct physical damage (increased suspended sediment concentrations) | YES | YES | YES | YES |
| **Dogger Bank Teesside A & B decommissioning phase** | | | | |
| Direct physical loss (obstruction) | YES | YES | NO | NO |
| Direct physical damage (disturbance) | YES | YES | NO | NO |
| Indirect physical damage (smothering) | YES | YES | NO | NO |
| Direct physical damage (increased suspended sediment concentrations) | YES | YES | NO | NO |

[1] Considered under physical damage for temporary loss and under operation phase for long-term and/or permanent loss.

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## Impacts on feature and site

### Alteration to bathymetry

7.3.10 The in-combination long-term presence of the structures associated with Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D (such as wind turbines, met masts, collecter stations, converter stations, accommodation blocks, as well as vessel moorings, and inter-array, inter-platform and export cable protection and crossings) would result in a similar alteration of seabed bathymetry to that predicted for Dogger Bank Teesside A & B. The spatial extent of the Dogger Bank cSAC within which bathymetry could be altered and that would fall outside the existing range is approximately 1.70km$^2$ (0.014%) for the wind farm projects (see **Table 7.4**). Aggregates Areas 466/1, 485/1 and 485/2 could also result in bathymetry changes, the extent would be variable depending on timing and spatial distribution of extraction over their lifetimes. However, the majority of this alteration would remain within the existing bathymetric range forthe aggregate extraction areas and the majority of the wind farm projects within the Dogger Bank cSAC. Overall, this is considered to represent an insignificant alteration to the physical nature of the Dogger Bank cSAC specifically with regard to the physical and structural elements of the site.

Table 7.4 Footprint extents and types during the operation phase for projects within Dogger Bank cSAC

| Project | All structure footprint within Dogger Bank cSAC | | All structure footprint outside of bathymetry range within Dogger Bank cSAC | |
|---|---|---|---|---|
| | Extent (km$^2$) | Percentage of cSAC | Extent (km$^2$) | Percentage of cSAC |
| Dogger Bank Creyke Beck A | 3.94 | 0.03% | 0.35 | 0.003% |
| Dogger Bank Creyke Beck B | 3.69 | 0.03% | 0.35 | 0.003% |
| Dogger Bank Teesside A | 4.88 | 0.04% | 0.25 | 0.002% |
| Dogger Bank Teesside B | 4.52 | 0.04% | 0.25 | 0.002% |
| Dogger Bank Teesside C[1] | 4.70 | 0.04% | 0.25 | 0.002% |
| Dogger Bank Teesside D[1] | 4.70 | 0.04% | 0.25 | 0.002% |
| **TOTAL** | **26.43** | 0.21% | 1.70 | 0.014% |

[1] Values assumed using largest extent from Dogger Bank Teesside A & B as this project has been further refined following Dogger Bank Creyke Beck.

### Interruption to sediment transport pathways

7.3.11 The presence of structures on the seabed has the potential to interrupt sediment transport pathways. However, gravity base and monopole structures associated with wind farm development would, in comparison to the scale of Dogger Bank, represent isolated points which would not obstruct or interrupt the process of sediment transport on a macro or site scale. Potentially, protection provided to sections of cable that is not buried could result in interruption to sediment transport if the cables run perpendicular to the direction of sediment transport. However, a significant majority of the length of the cables will be buried and only relatively shallow protection or crossings would be used for Dogger Bank Teesside A & B and Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D. Protection ‘structures’ would only extend for up to several tens of meters and would only stand a maximum 1.5m above the seabed. These


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heights are commensurate with or lower than the megaripples and sand waves present within tranches A & B within the Dogger Bank cSAC. Consequently, there would be only localised interruption (see paragraph 4.7.9 in relation to Dogger Bank Teesside A & B alone) to the limited sediment transport within the study area (see paragraphs 4.5.18 to 4.5.22). It is therefore considered that protection to cables, where installed, would not measurably change either patterns of sediment transport or the volume of sediment transported across the Dogger Bank cSAC as a result of other developments in-combination with Dogger Bank Teesside A & B. Given the relatively shallow nature of aggregate extraction, and the nature of bathymetric change associated with such activity, no wide-scale alteration to sediment transport patterns is predicted and no interaction with the effects of Dogger Bank Teesside A & B and other projects would be expected.

**Alteration to the hydrodynamic regime**

7.3.12 The worst-case foundation scenario for potential effects on tidal currents used to model changes in tidal currents and waves is based on 200 6MW conical gravity base foundations at a minimum of 750m spacing for Dogger Bank Teesside A and Dogger Bank Teesside B and also for each of the other projects within the Dogger Bank Zone (i.e. Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D). The maximum absolute change (increase or decrease) in depth-averaged tidal current velocity over the 30-day simulation period is shown on **Figure 7.2**. The strongest effect occurs along the project boundaries where the density of the foundations is highest. The greatest effect is predicted along the western boundaries of Dogger Bank Creyke Beck B and Dogger Bank Teesside D where the maximum change is just over 0.01m/s in small patches less than 1km wide. Maximum changes of up to 0.004m/s occur across most of each project with changes reducing to 0.002m/s up to approximately 17km outside the project development boundaries. The maximum increase therefore is up to 3% within the immediate environs of all turbine foundations reducing to 1% within all projects, and reaching no change within 17km (see **Figure 7.3**). Overall, these small-scale changes are within the existing range of tidal current velocities across Dogger Bank and surrounding sea areas, and within the Dogger Bank cSAC. Any alteration in the hydrodynamic regime associated with aggregate extraction would be confined to the immediate area of the licensed site. Given the distance of aggregate extraction sites 485/1 and 485/2 from Dogger Bank Teesside A & B, the potential for additive and synergistic interaction of effects on the hydrodynamic regime between the projects is considered highly unlikely. Overall, the small-scale changes to tidal currents are within the natural variation of tidal current velocity across Dogger Bank and surrounding sea areas (baseline levels presented in paragraphs 4.5.6 and 4.5.7). Consequently, no significant alteration to the hydrodynamic regime (tidal currents) of the Dogger Bank cSAC would occur as a result of Dogger Bank Teesside A & B and other projects.

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7.3.13 The same four wave conditions that were used to model Dogger Bank Teesside A & B only (see Section 4.4) have been applied in the wave model runs for the cumulative projects scenario and their description is not repeated here. Maximum changes in significant wave height are for one-year waves from the north and north east (as shown on **Figure 7.4**). For one-year waves from the north the changes are up to +/-0.06m at the southern and northern boundaries of all the projects, reducing to less than +/-0.02m up to approximately 30km to the south of the southern boundary of Dogger Bank Creyke Beck A and greater than 60km to the north of the northern boundaries of Dogger Bank Teesside C & D. For one-year waves from the north east, changes are up to +/-0.05m at the south western and north-eastern boundaries of the projects, reducing to less than +/-0.02m up to approximately 65km south west of south western boundary of Dogger Bank Creyke Beck A & B and north east of the Dogger Bank Teesside D boundary. The effects on wave heights are within the natural variation of wave height across Dogger Bank. The predicted alteration as a result of infrastructure presence on the Dogger Bank would not affect wave height at the coast due to the long fetch distance between the point of effect and the coastline. No significant alteration to the hydrodynamic regime (waves) of the Dogger Bank cSAC as a result of the combined effects of Dogger Bank Teesside A & B and other projects is therefore predicted.

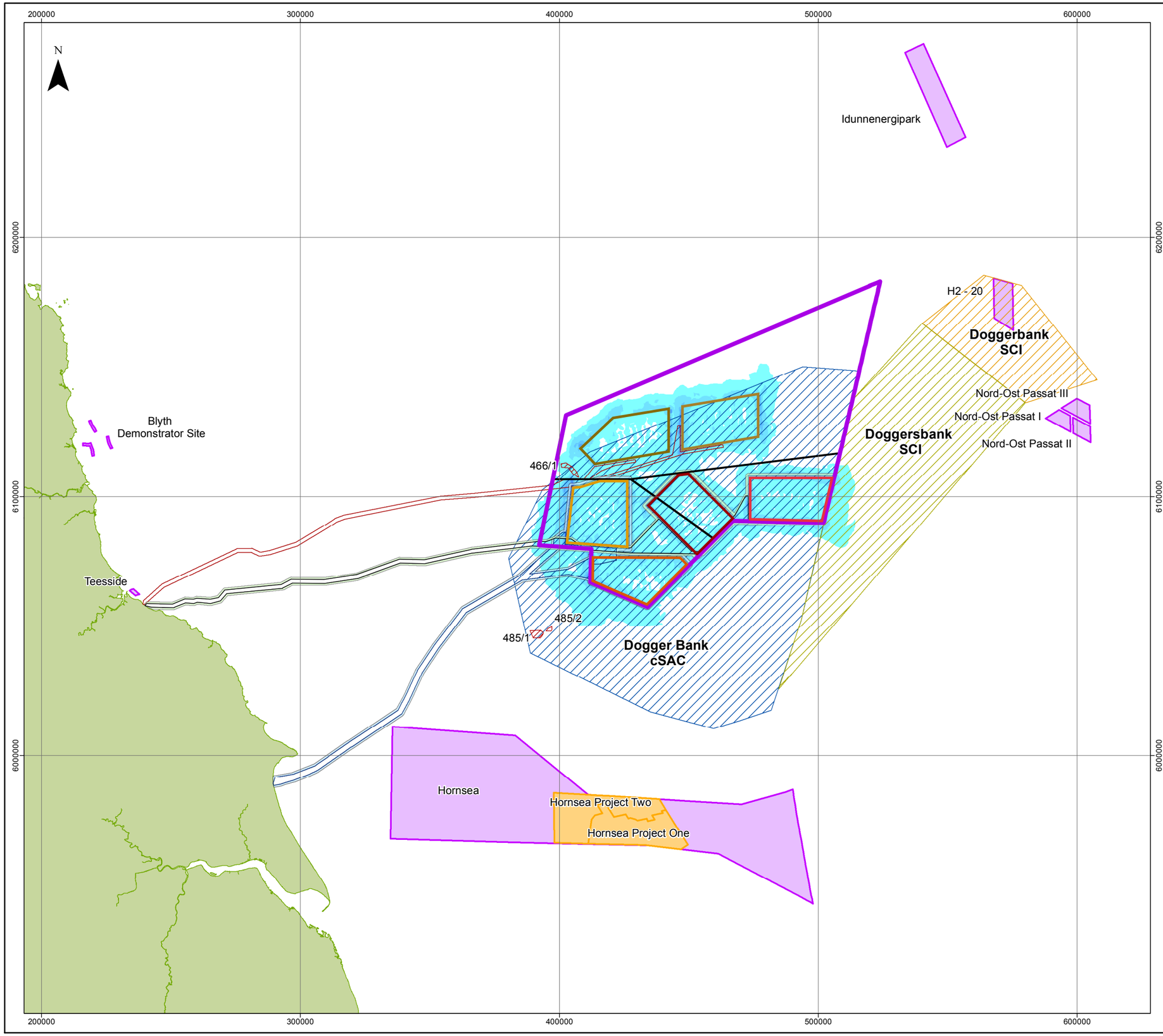
**Physical disturbance to the morphology and physical damage to the structural integrity of sandbank habitat**

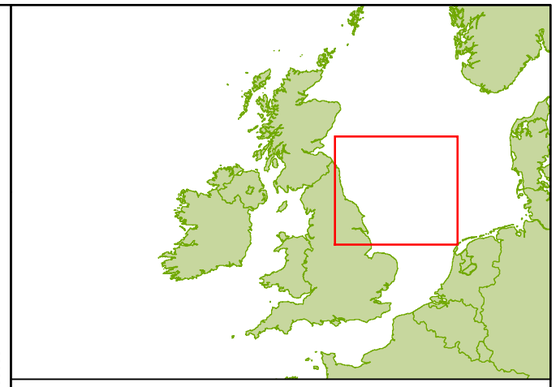
7.3.14 Some small-scale and localised influence on sandbank morphology is expected in areas immediately adjacent to seabed structures associated with all of the wind farm projects as a result of changes in hydrodynamics and sediment transport. However, no wide-scale changes to hydrodynamic processes (see paragraphs 7.3.12 and 7.3.13), bathymetry (see paragraph 7.3.10), sediment transport (see paragraph 7.3.11), suspended sediments (see paragraph 7.3.17 to 7.3.19), and sediment extent, composition and distribution (see paragraph 7.3.15 and 7.3.16) would arise across the Dogger Bank cSAC as a result of the interaction of effects between Dogger Bank Teesside A & B and other projects. Apart from small-scale localised change, the morphology of features within the Dogger Bank cSAC would be maintained as natural processes would remain unaffected. The structural integrity of the designated sandbank features would therefore be retained for the duration of the combined operation phase and ongoing natural morphological changes to the features would continue to occur.

**Alteration to the extent, composition and distribution of sandbank habitat**

7.3.15 Whilst the habitat alteration likely to result due to both temporary and permanent footprint of the wind farm projects (Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D) and aggregate extraction projects will occur within areas of ‘sandbank’ habitat within the Dogger Bank cSAC, the alteration will arise across all sandbank community types. These communities / habitat types are widespread across the region and, as such, any permanent loss via project developments will not lead to the loss of any one discrete sandbank habitat type. Permanent alteration of habitat would occur from the placement of structures associated with the wind farm projects, as shown in **Table 7.5**.

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## 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
- Aggregate application area
- Offshore wind farm
- Hornsea Project One & Two

Change in velocity (m/s)

- Above 0.020
- 0.018 - 0.020
- 0.016 - 0.018
- 0.014 - 0.016
- 0.012 - 0.014
- 0.010 - 0.012
- 0.008 - 0.010
- 0.006 - 0.008
- 0.004 - 0.006
- 0.002 - 0.004
- Below 0.002

Candidate Special Area of Conservation (cSAC)/Sites of Community Importance (SCI)

- Germany
- Netherlands
- UK

0 10 20 40
Kilometres

Data Source:
Modelling © Danish Hydraulic Institute, 2013
Environmental Designations © JNCC/European Environment Agency, 2014
European UK offshore wind farm & Aggregate areas © The Crown Estate, 2014
European wind farm boundary data supplied by MarineFind, 2013

PROJECT TITLE

*Dogger Bank Teesside A & B*
IfAA Report

DRAWING TITLE

**Figure 7.2 Maximum predicted cumulative change in depth-averaged tidal current velocity caused by 6MW conical GBS#1 foundations**

| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 15/10/2013 | PEI3 | LW | PT |
| 2 | 18/03/2014 | DCO Submission | LW | PT |
| | | | | |

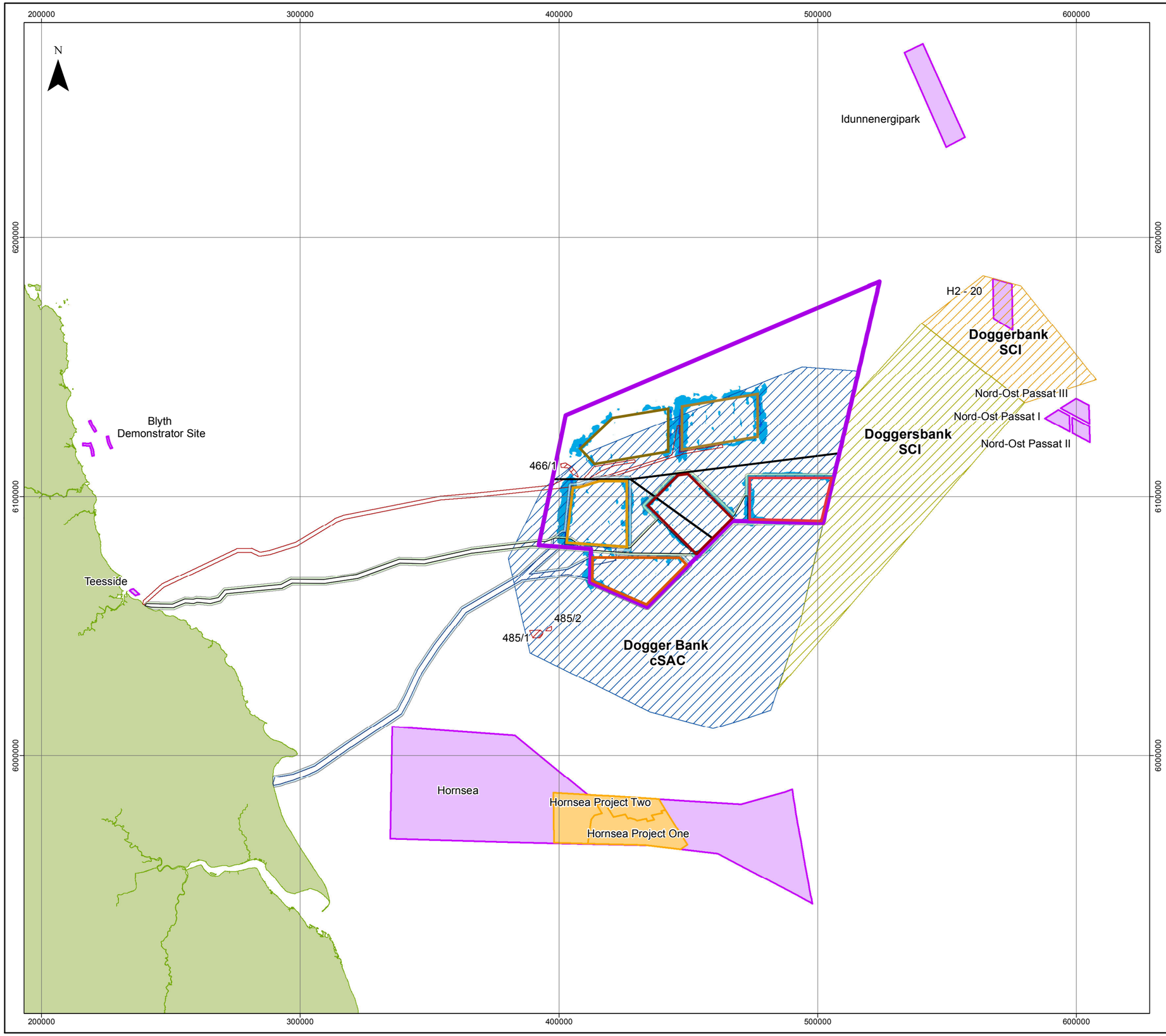
DRAWING NUMBER:

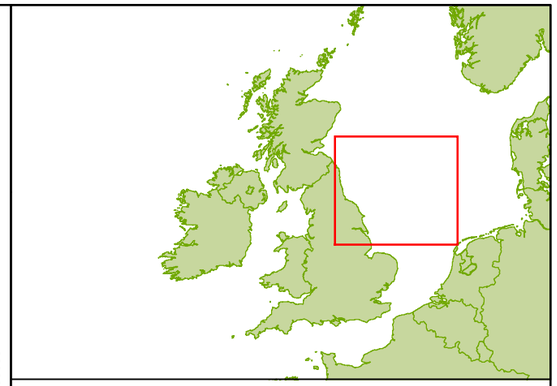
**9Y0986/TSABHRA/46/R2**

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

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## 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
- Aggregate application area
- Offshore wind farm
- Hornsea Project One & Two

Change in velocity (%)

- Above 5
- 4 - 5
- 3 - 4
- 2 - 3
- 1 - 2
- Below 1

Candidate Special Area of Conservation (cSAC)/ Sites of Community Importance (SCI)

- Germany
- Netherlands
- UK

0 10 20 40
Kilometres

Data Source:
Modelling © Danish Hydraulic Institute, 2013
Environmental Designations © JNCC/European Environment Agency, 2014
European UK offshore wind farm & Aggregate areas © The Crown Estate, 2014
European wind farm boundary data supplied by MarineFind, 2014

PROJECT TITLE

*Dogger Bank Teesside A & B*
IfAA Report

DRAWING TITLE

**Figure 7.3 Maximum percentage cumulative change in depth-averaged tidal current velocity caused by 6MW conical GBS#1 foundations**

| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 15/10/2013 | PEI3 | LW | PT |
| 2 | 18/03/2014 | DCO Submission | JE | PT |
| | | | | |

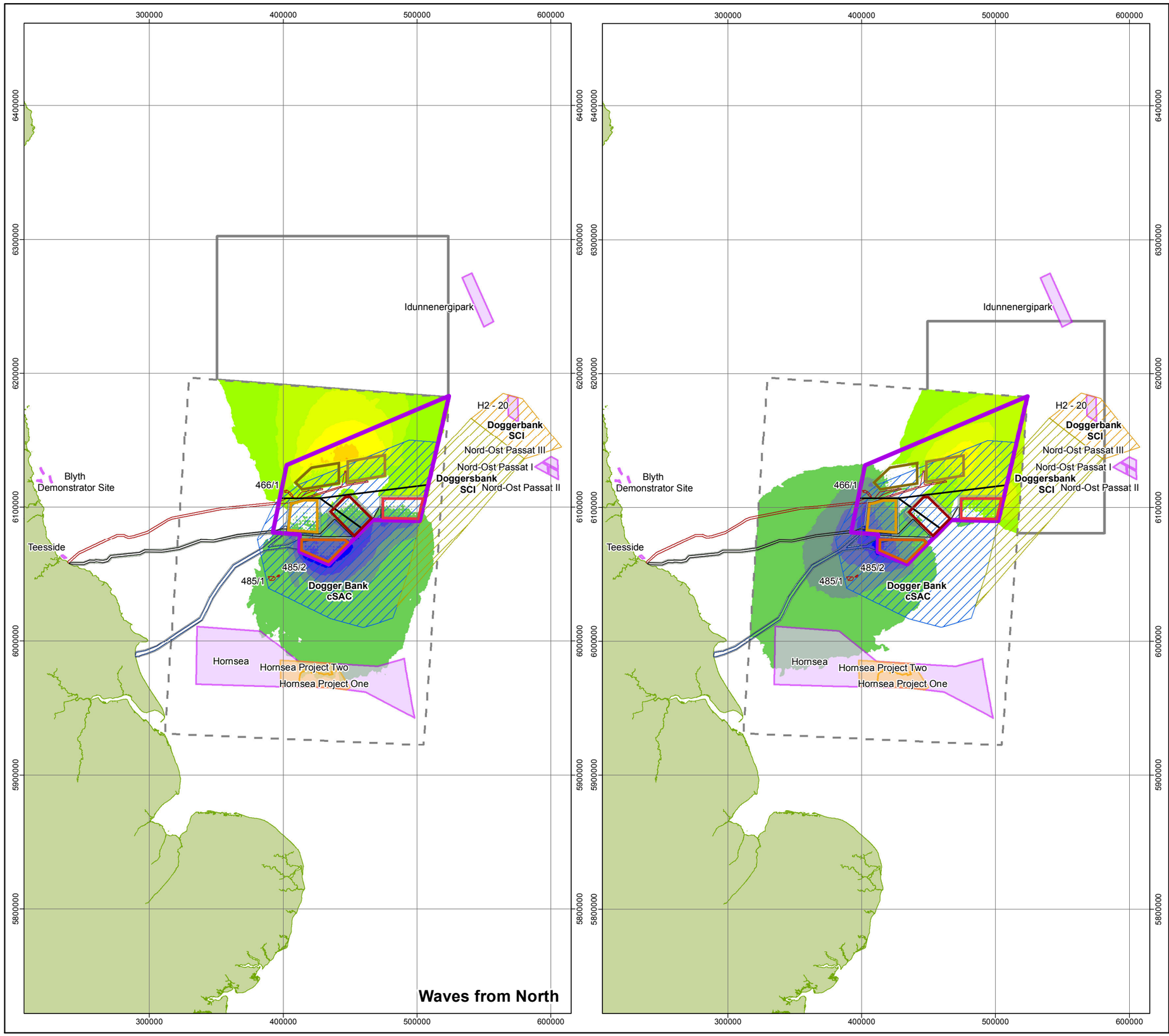
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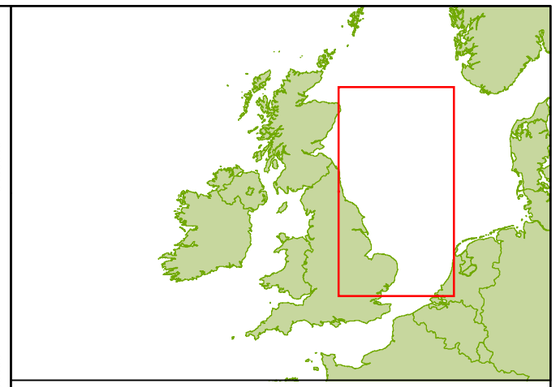
**9Y0986/TSABHRA/47/R2**

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

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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
- Aggregate application area
- Offshore wind farm
- Hornsea Project One & Two

Candidate Special Area of Conservation (cSAC)/ Sites of Community Importance (SCI)

- Germany
- Netherlands
- UK

- Model boundary
- Potential extent of wave effects into international waters

Change in significant wave height (m)

- Above 0.09
- 0.08 - 0.09
- 0.07 - 0.08
- 0.06 - 0.07
- 0.05 - 0.06
- 0.04 - 0.05
- 0.03 - 0.04
- 0.02 - 0.03
- 0.01 - 0.02
- 0.00 - 0.01
- -0.01 - 0.00
- -0.02 - -0.01
- -0.03 - -0.02
- -0.04 - -0.03
- -0.05 - -0.04
- -0.06 - -0.05
- -0.07 - -0.06
- -0.08 - -0.07
- -0.09 - -0.08
- Below -0.09

Data Source:
Modelling © Danish Hydraulic Institute, 2013
Environmental Designations © JNCC/European Environment Agency, 2014
UK offshore wind farm & Aggregate areas © The Crown Estate, 2014
European wind farm boundary data supplied by MarineFind, 2014

0 10 20 40
Kilometres

PROJECT TITLE

*Dogger Bank Teesside A & B*
IfAA Report

DRAWING TITLE

**Figure 7.4 Cumulative changes to significant wave height for one-year waves from the north and northeast caused by 6MW conical GBS#1 foundations**

| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 15/10/2013 | PEI3 | LW | PT |
| 2 | 18/03/2014 | DCO Submission | JE | PT |
| | | | | |

DRAWING NUMBER:

**9Y0986/TSABHRA/48/R1**

| SCALE | PLOT SIZE | DATUM | PROJECTION |
|---|---|---|---|
| 1:2,900,000 | A3 | WGS84 | UTM31N |

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Table 7.5 Footprint extents and change in composition of habitat types within the Dogger Bank cSAC in the operation phase for Dogger Bank Teesside A & B and other projects

| Seabed sediment types | Extent within Dogger Bank cSAC (km$^2$)[a] | Footprint extent (km$^2$)[b] | | | Extent within Dogger Bank cSAC following scheme changes (km$^2$) |
|---|---|---|---|---|---|
| | | Dogger Bank Teesside A & B | Dogger Bank Creyke Beck A & B | Dogger Bank Teesside C & D | |
| Unit 'c' outcrop | 332.73 | -0.079 | -0.333 | -0.254 | 332.06 (-0.20%) |
| Gravel | 628.50 | -0.238 | -0.605 | -0.479 | 627.18 (-0.21%) |
| Sand | 11,083.16 | -9.083 | -6.280 | -8.449 | 11,059.35 (-0.21%) |
| Mixed sediment | 284.32 | 0.000 | -0.413 | -0.217 | 283.69 (-0.22%) |
| Till | 2.29 | 0.000 | 0.000 | -0.002 | 2.29 (-0.09%) |
| Hard substrate | 0.00 | +9.400 | +7.631 | +9.40 | 26.43 (+0.21%) |

[a] See **Table 4.4** for baseline extents which covered tranches A & B and the Dogger Bank Teesside A & B Export Cable Corridor within the Dogger Bank cSAC. The total extent is based on multiplying up the total surveyed area within Dogger Bank cSAC assuming the footprint would affect each sediment type equally, based on the percentage present within the surveyed area.
[b] See **Table 7.4** above for total values, which have then been separated into sediment types based on the percentage distribution within the surveyed areas (from **Table 4.4**).

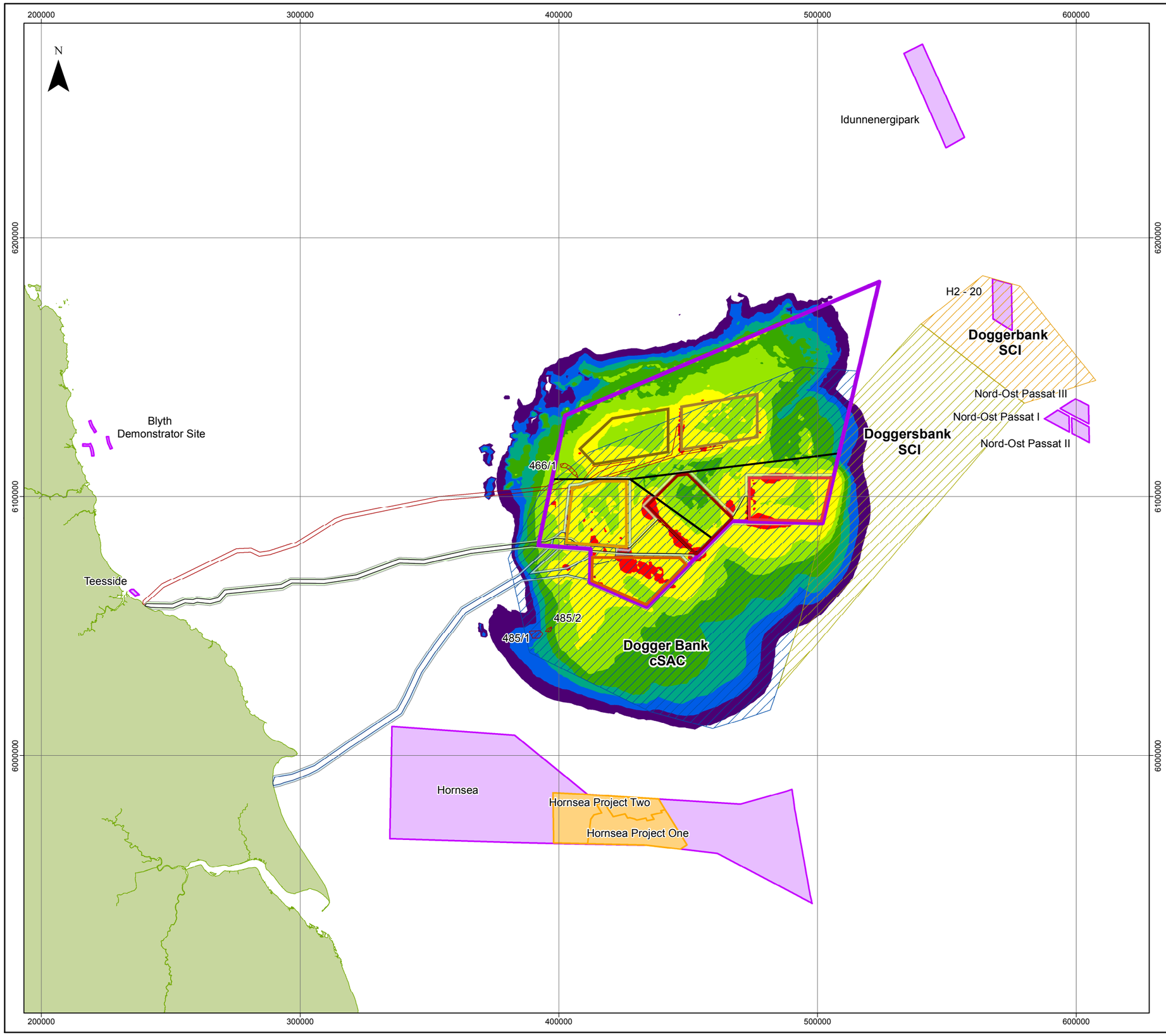
7.3.16 The introduction of hard substrate would, under a worst case scenario, cover approximately 26.43km$^2$ (or 0.21%) of the total area of the sandbank habitat within the Dogger Bank cSAC. The presence of the hard substrates would result in a small alteration to the extent, distribution and composition of the habitat types within the cSAC. However, the calculated change in extent of each of the seabed sediment types would not be at a scale that is considered significant with respect to sandbank habitat extent, composition or distribution at the site (Dogger Bank cSAC) level (see **Table 7.5**). Furthermore, the presence of unit 'c' outcrop and gravel which are likely to support communities suited to and likely to colonise hard substrate within the cSAC is noted.

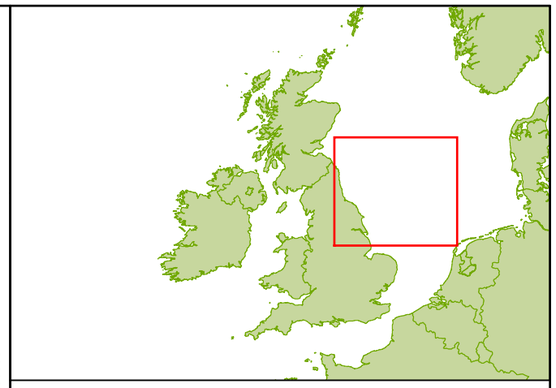
**Changes to suspended sediment levels**

7.3.17 The changes to suspended sediment levels during the operation phase for Dogger Bank Teesside A & B are detailed in paragraphs 4.7.34 to 4.7.40. The changes in suspended sediments during the operation phase for Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D were modelled for a worst case 50 year storm scenario. The results are shown on **Figure 7.5** (showing maximum suspended sediment concentrations in the bottom layer), **Figure 7.6** (showing average suspended sediment concentrations in the bottom layer), and **Figure 7.7** (showing the exceedance time during the simulation of the predicted suspended sediment concentration above the background of 2mg/l).

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## 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

Candidate Special Area of Conservation (cSAC)/ Sites of Community Importance (SCI)

- Germany
- Netherlands
- UK

- Aggregate application area
- Offshore wind farm
- Hornsea Project One & Two

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
Environmental Designations © JNCC/European Environment Agency, 2014
UK offshore wind farm & Aggregate areas © The Crown Estate, 2014
European wind farm boundary data supplied by MarineFind, 2014

PROJECT TITLE

*Dogger Bank Teesside A & B*
IfAA Report

DRAWING TITLE

**Figure 7.5 Maximum cumulative suspended sediment concentrations in the bottom layer predicted over the 30 day simulation period in the operation phase for Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B, and Dogger Bank Teesside C & D**

| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 15/10/2013 | PEI3 | LW | PT |
| 2 | 18/03/2014 | DCO Submission | JE | PT |
| | | | | |

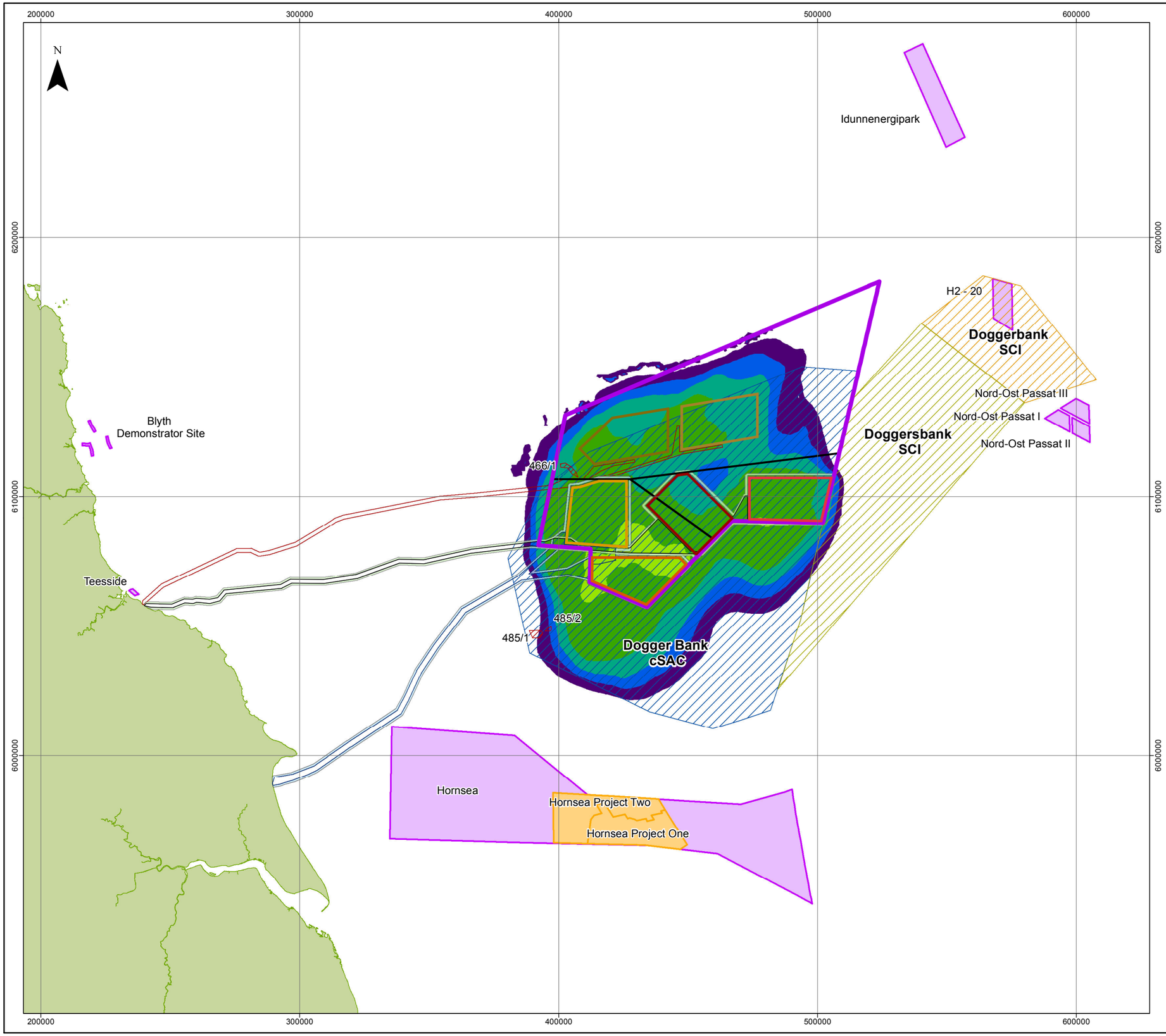
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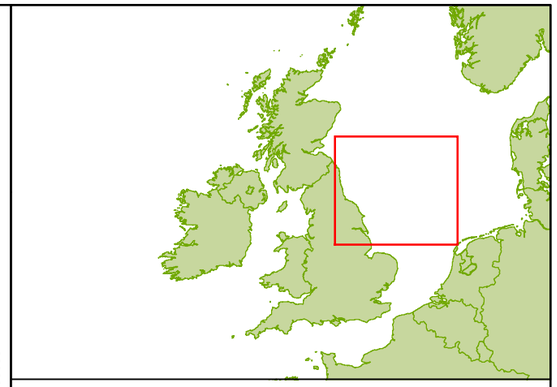
**9Y0986/TSABHRA/49/R2**

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

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## 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
- Aggregate application area
- Offshore wind farm
- Hornsea Project One & Two

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

Candidate Special Area of Conservation (cSAC)/ Sites of Community Importance (SCI)

- Germany
- Netherlands
- UK

0 10 20 40
Kilometres

Data Source:
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Environmental Designations © JNCC/European Environment Agency, 2014
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PROJECT TITLE

*Dogger Bank Teesside A & B*
IfAA Report

DRAWING TITLE

**Figure 7.6 Average cumulative suspended sediment concentrations in the bottom layer predicted over the simulation period in the operation phase for Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B, and Dogger Bank Teesside C & D**

| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 15/10/2013 | PEI3 | LW | PT |
| 2 | 18/03/2014 | DCO Submission | JE | PT |
| | | | | |

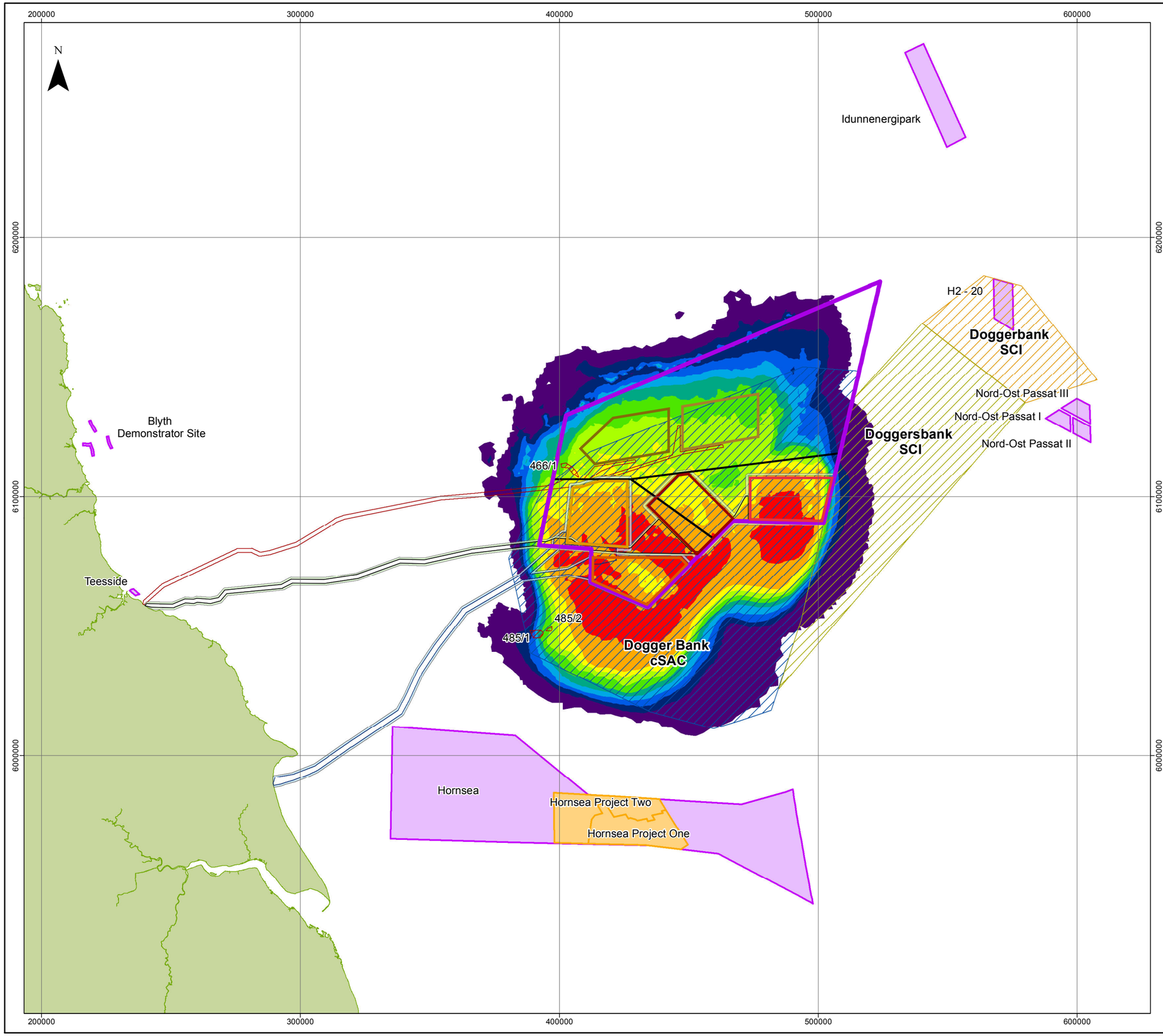
DRAWING NUMBER:

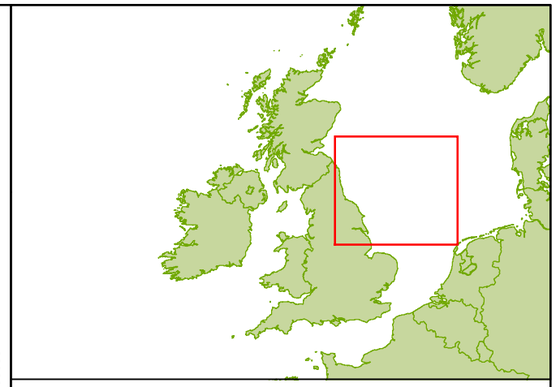
**9Y0986/TSABHRA/50/R2**

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

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## 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

Candidate Special Area of Conservation (cSAC)/ Sites of Community Importance (SCI)

- Germany
- Netherlands
- UK

- Aggregate application area
- Offshore wind farm
- Hornsea Project One & Two

Exceedance of 2 mg/l (%)

- Above 90
- 80 - 90
- 70 - 80
- 60 - 70
- 50 - 60
- 40 - 50
- 30- 40
- 20 - 30
- 10 - 20
- 0 - 10
- Below 0

0 10 20 40
Kilometres

Data Source:
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European UK offshore wind farm & Aggregate areas © The Crown Estate, 2014
European wind farm boundary data supplied by MarineFind, 2014

PROJECT TITLE

*Dogger Bank Teesside A & B*
IfAA Report

DRAWING TITLE

**Figure 7.7 Percentage of time predicted over the simulation period where suspended sediment concentration of 2mg/l is exceeded in the bottom layer for operation phase of Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B, and Dogger Bank Teesside C & D**

| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 15/10/2013 | PEI3 | LW | PT |
| 2 | 18/03/2014 | DCO Submission | JE | PT |
| | | | | |

DRAWING NUMBER:

**9Y0986/TSABHRA/51/R2**

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

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FOREWIND

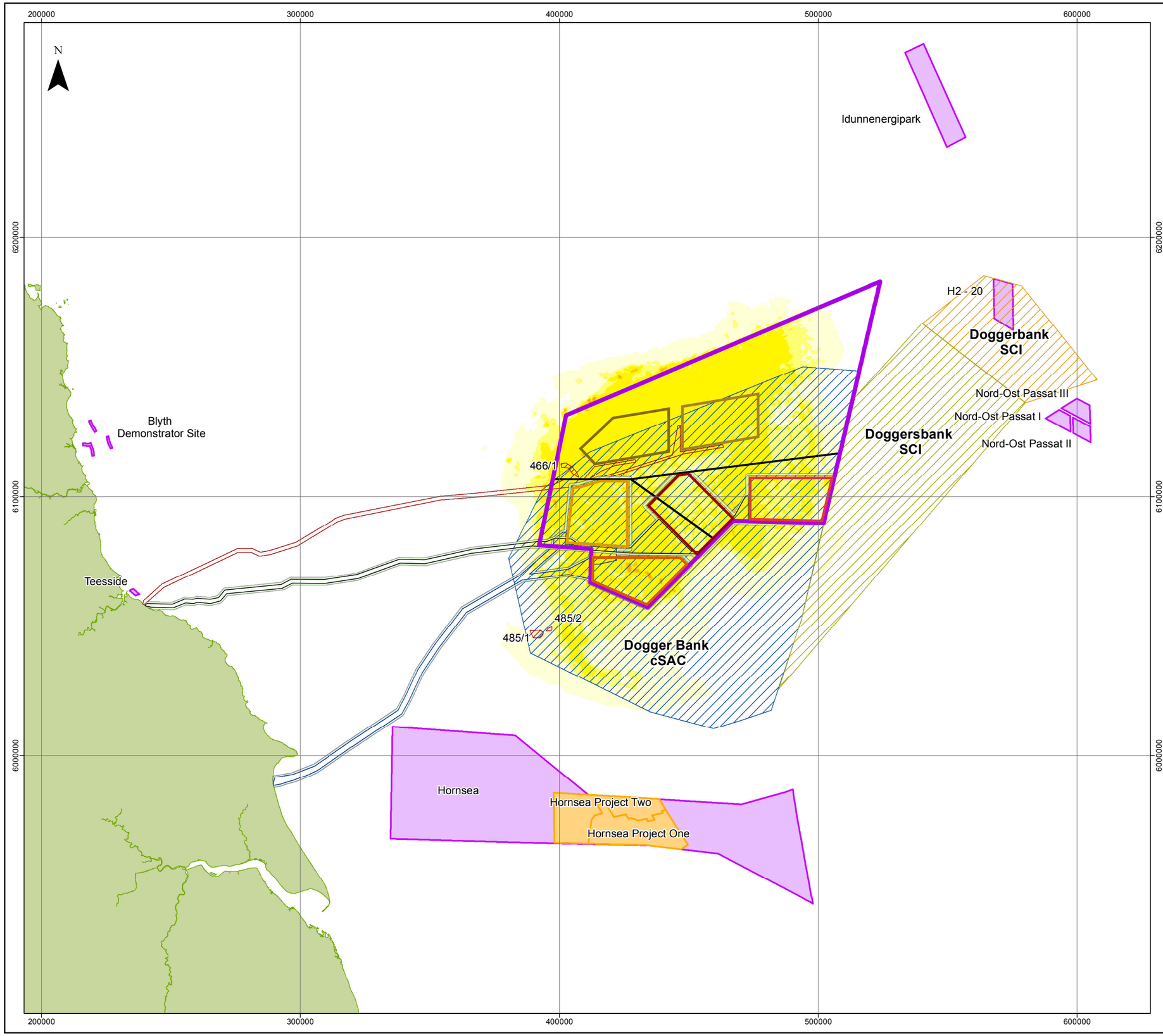
7.3.18 The maximum suspended sediment concentration is predicted to be greater than 200mg/l in 22km long, 7km wide patches along the boundaries of all projects except Dogger Bank Teesside C (see **Figure 7.5**). Across all projects, suspended sediment concentrations are generally greater than 50mg/l. Concentrations reduce to background levels of 2mg/l up to approximately 55km south of the southern project area boundaries and up to 39km north of the northern project area boundaries. The predicted average suspended sediment concentrations are between 50mg/l and 100mg/l across the adjacent boundaries of Dogger Bank Creyke Beck A & B (see **Figure 7.6**). Predicted depth average suspended sediment concentrations across all projects are generally 10mg/l and 50mg/l reducing to the background of 2mg/l up to approximately 39km south of the southern project area boundaries and up to 24km north of the northern project area boundaries. The predicted exceedance of a background concentration of 2mg/l (a conservative estimate in such a storm event) is greater than 90% of the 30-day simulation period in large areas across and up to 17km south of Dogger Bank Creyke Beck A and Dogger Bank Teesside A. Exceedance is generally greater than 70% across Dogger Bank Creyke Beck A & B and Dogger Bank Teesside A & B, reducing to 50% to 70% across Dogger Bank Teesside C & D. However, under normal (day to day) conditions, the amount of sediment released as a result of scour at the structures for Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D is insignificant within the context and background of the Dogger Bank cSAC.

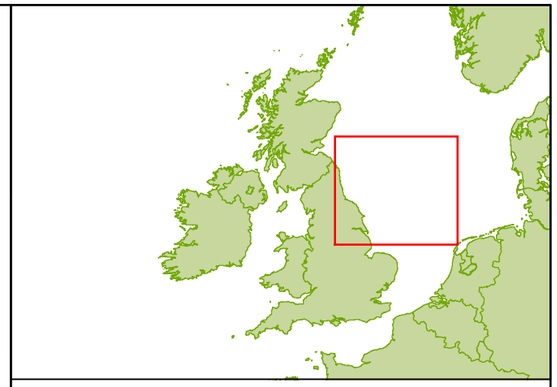
7.3.19 The sediment plumes generated from extraction activities in aggregate extraction areas 466/1, 485/1 and 485/2 would be very small in comparison to the modelled (worst case) operational plume for Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D described above. In addition, the plumes from the aggregate extraction projects would be spatially and temporally intermittent. Hence, the footprint of the short-lived aggregate extraction plumes within the larger operational plumes of Dogger Bank Teesside A & B and Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D would have little effect on the overall size of the combined plume and would be unlikely to lead to greater suspended sediment concentrations. In essence, it is concluded that the combined sediment plume for all projects would therefore effectively represent that formed through the interaction of the plumes between Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D.

7.3.20 Sediment deposition of the combined offshore wind farm projects based on modelling of a 50 year storm are presented in **Figure 7.8** (maximum sediment deposition) and **Figure 7.9** (average deposition). Time series analysis of sediment persistence was carried out for a number of locations across the Dogger Bank, and the locations are shown on **Figure 7.10**. **Table 7.6** presents the results of the sediment persistence at these sites, based on the 50 year storm scenario.

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## 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

Candidate Special Area of Conservation (cSAC)/ Sites of Community Importance (SCI)

- Germany
- Netherlands
- UK

- Aggregate application area
- Offshore wind farm
- Hornsea Project One & Two

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
Environmental Designations © JNCC/European Environment Agency, 2014
UK offshore wind farm & Aggregate areas © The Crown Estate, 2014
European wind farm boundary data supplied by MarineFind, 2014

PROJECT TITLE

*Dogger Bank Teesside A & B*
IfAA Report

DRAWING TITLE

**Figure 7.8 Maximum sediment deposition over the simulation period in the operation phase for Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B, and Dogger Bank Teesside C & D**

| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 15/10/2013 | PEI3 | LW | PT |
| 2 | 18/03/2014 | DCO Submission | JE | PT |
| | | | | |

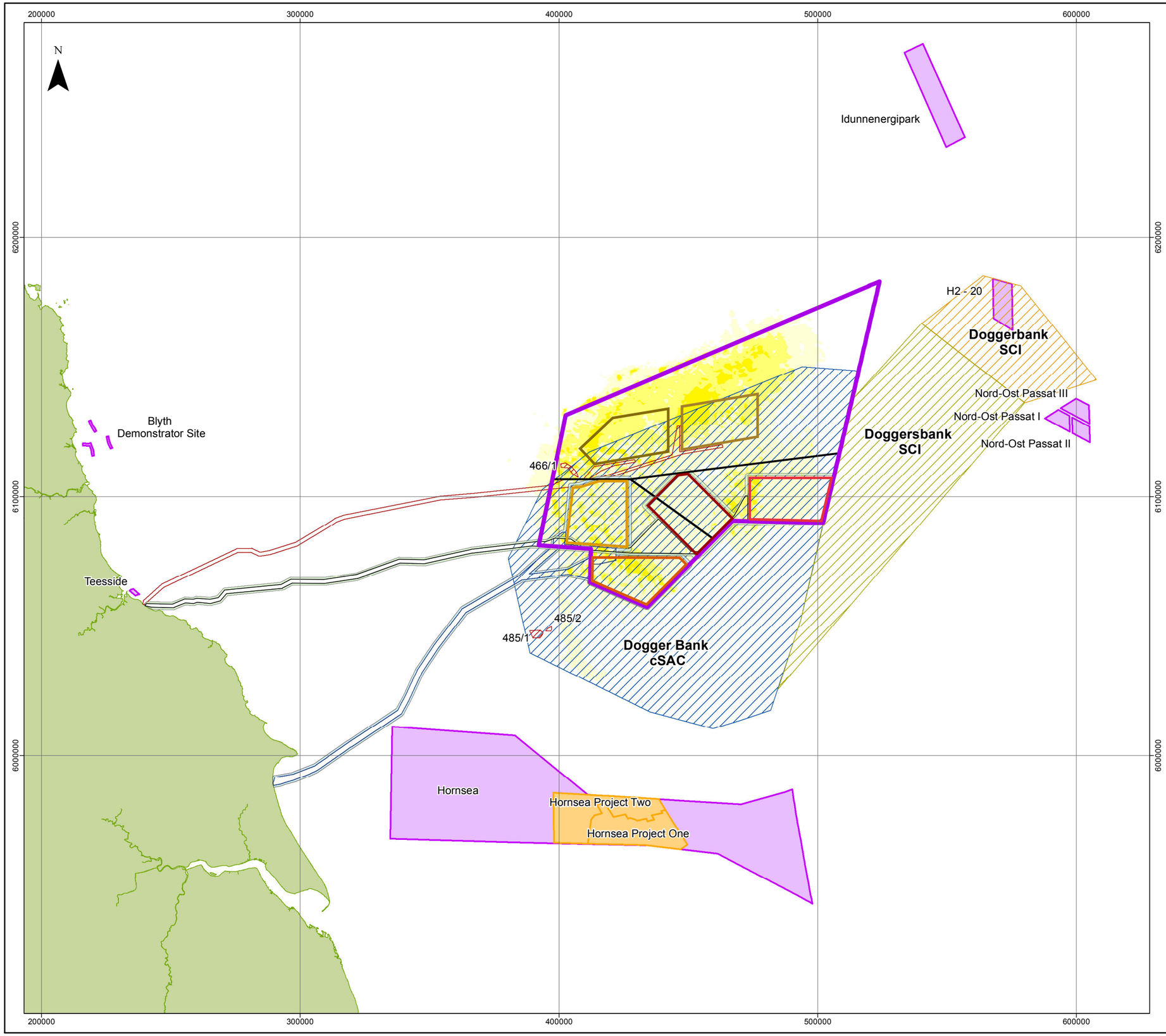
DRAWING NUMBER:

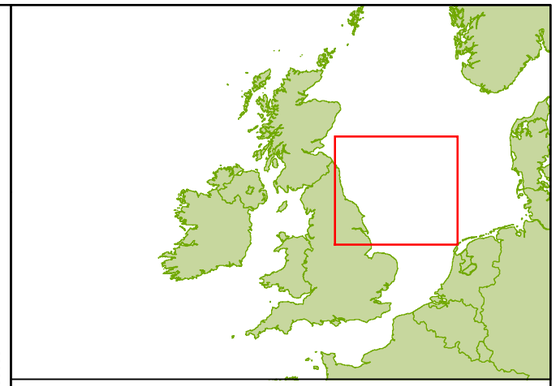
**9Y0986/TSABHRA/52/R2**

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

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## 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

Candidate Special Area of Conservation (cSAC)/ Sites of Community Importance (SCI)

- Germany
- Netherlands
- UK

- Aggregate application area
- Offshore wind farm
- Hornsea Project One & Two

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
Environmental Designations © JNCC/European Environment Agency, 2014
UK offshore wind farm & Aggregate areas © The Crown Estate, 2014
European wind farm boundary data supplied by MarineFind, 2014

PROJECT TITLE

*Dogger Bank Teesside A & B*
IfAA Report

DRAWING TITLE

**Figure 7.9 Average sediment deposition over the simulation period in the operation phase for Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B, and Dogger Bank Teesside C & D**

| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 15/10/2013 | PEI3 | LW | PT |
| 2 | 18/03/2014 | DCO Submission | JE | PT |
| | | | | |

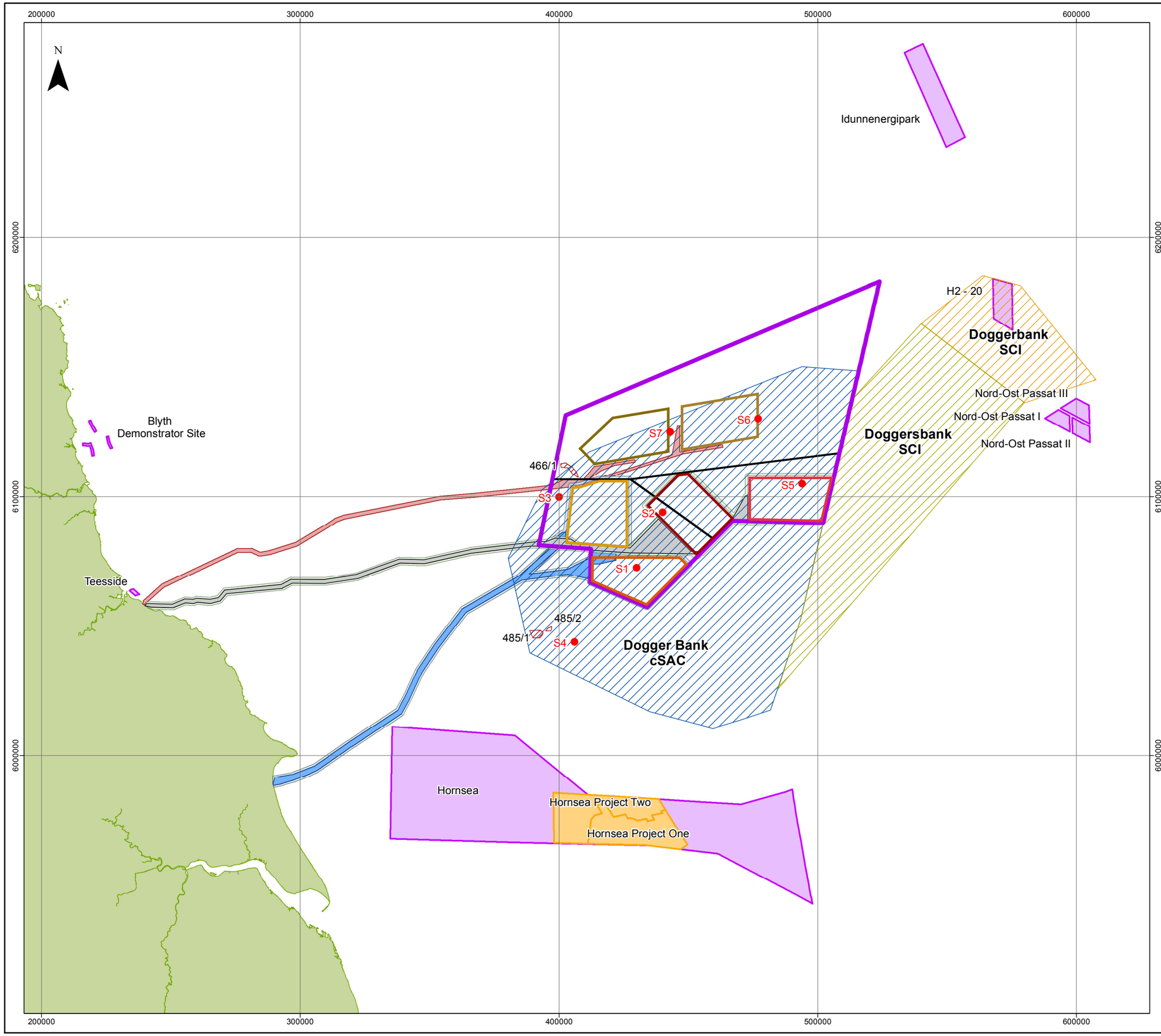
DRAWING NUMBER:

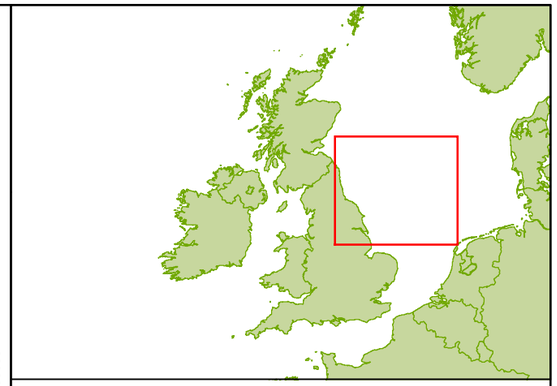
**9Y0986/TSABHRA/53/R2**

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

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## 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
- Sediment thickness time series analysis point
- Aggregate application area
- Offshore wind farm
- Hornsea Project One & Two

Candidate Special Area of Conservation (cSAC)/ Sites of Community Importance (SCI)

- Germany
- Netherlands
- UK

0 10 20 40
Kilometres

Data Source:
Modelling © Danish Hydraulic Institute, 2013
Environmental Designations © JNCC/European Environment Agency, 2014
UK offshore wind farm & Aggregate areas © The Crown Estate, 2014
European wind farm boundary data supplied by MarineFind, 2014

PROJECT TITLE

*Dogger Bank Teesside A & B*
IfAA Report

DRAWING TITLE

**Figure 7.10 Location of points for sediment thickness time series analysis in the operation phase for in-combination assessment**

| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 15/10/2013 | PEI3 | LW | PT |
| 2 | 18/03/2014 | DCO Submission | JE | PT |
| | | | | |

DRAWING NUMBER:

**9Y0986/TSABHRA/54/R2**

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

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Table 7.6 Maximum persistency of sediment thickness over the 30-day simulation period for 50 year storm in the operation phase

| Point | Maximum thickness (mm) | Maximum continuous time of sediment thickness (hours with days in brackets) | | | | Thickness at end of simulation (mm) |
|---|---|---|---|---|---|---|
| | | >10mm | >7mm | >3mm | >1mm | |
| S1 | 5.70 | 0 | 0 | 244 (10.17) | 322 (13.83) | 0.13 |
| S2 | 1.22 | 0 | 0 | 0 | 52 (2.17) | <0.1 |
| S3 | 1.18 | 0 | 0 | 0 | 50 (2.08) | <0.1 |
| S4 | 1.03 | 0 | 0 | 0 | 2 | <0.1 |
| S5 | 1.41 | 0 | 0 | 0 | 38 (1.58) | <0.1 |
| S6 | 1.63 | 0 | 0 | 0 | 6 | <0.1 |
| S7 | 2.17 | 0 | 0 | 0 | 80 (3.33) | <0.1 |

7.3.21 The majority of the project areas are predicted to have maximum thickness of sediment over the simulation period of 5mm, reducing to 0.1mm about 31km to 43km from the southern boundaries of the project areas and 23km to 33km from the northern boundaries (see **Figure 7.8**). Average deposition is predicted to be 0.1mm to 0.5mm in numerous patches across and outside most of the project areas (**Figure 7.9**). The largest patch is up to 22km long and up to 12km wide. Average deposition is generally higher across Dogger Bank Teesside C & D than across the other projects. Average deposition is predicted to reduce to 0.1mm close to the southern boundaries and approximately 12km to 32km north of the northern boundaries. The maximum sediment thickness is 5.7mm at S1 and thicknesses greater than 3mm and 1mm persist for 244 hours (10.17 days) and 332 hours (13.83 days), respectively (see **Table 7.6**). At all other points, thicknesses never exceed 2.2mm and persist at greater than 1mm between 2 hours (0.08 days) (S4) and 80 hours (3.33 days) (S5).

**Changes to the levels of nutrients and contaminants (Dogger Bank cSAC)**

7.3.22 Given that no contaminants are being introduced into the cSAC from Dogger Bank Teesside A & B (see paragraph 4.7.53), Dogger Bank Creyke Beck A & B, Dogger Bank Teesside C & D, and aggregate extraction projects (Area 466/1, 485/1 and 485/2), no change to levels of contaminants or nutrients would occur. The potential impacts of any changes in the levels of nutrients and contaminants on sandbanks communities are considered in subsequent sections.

**Direct physical loss (obstruction) to subtidal sandbank communities**

7.3.23 Throughout the operation of the three (currently at application stage) aggregate extraction sites (466/1 - partially within the Dogger Bank cSAC, 485/1 and 485/2 - both within the Dogger Bank cSAC) whilst significant disturbance to subtidal sandbank communities would arise from dredging activities, no long-term substrate loss would occur as sediment would be left in situ. This would enable re-colonisation and recovery of benthic communities to occur following the cessation of extraction.

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7.3.24 For the operation of Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D up to 26.43km$^2$ (or 0.21%) of the subtidal sandbank feature within the cSAC would be altered as a result of the presence of structures. It is however considered that much of this area will be colonised over time by organisms that are representative of the hard substrate communities (e.g. gravel) that are already present within the Dogger Bank cSAC. While the introduction of the structures would lead to a loss of area of natural sandbank habitat, there would be an increase in the extent of hard substrate within the cSAC, resulting in an overall alteration to the extent of the various subtidal sandbank communities (see **Table 7.7** for extents). As with Dogger Bank Teesside A & B, recovery of affected areas would be expected following decommissioning of the wind farms.

Table 7.7 Footprint extents and change in composition of communities within the Dogger Bank cSAC during the operation phase for Dogger Bank Teesside A & B and other projects

| Community types | Extent within Dogger Bank cSAC (km$^2$)[a] | Footprint extent (km$^2$)[b] | | | Extent within Dogger Bank cSAC following scheme changes (km$^2$) | Percentage change in Dogger Bank cSAC |
|---|---|---|---|---|---|---|
| | | Dogger Bank Teesside A & B | Dogger Bank Creyke Beck A & B | Dogger Bank Teesside C & D | | |
| VER A | 6,898.99 | 3.19 | 5.52 | 5.26 | 6,885.02 | 0.20 |
| VER B | 2,142.18 | 0.50 | 2.11 | 1.63 | 2,137.94 | 0.20 |
| VER C | 3,289.84 | 5.71 | 0.00 | 2.51 | 3,281.62 | 0.25 |

[a] See **Table 4.12** for baseline extents from surveyed areas (which covered tranches A & B and the Dogger Bank Teesside A & B Export Cable Corridor) within the Dogger Bank cSAC. The total extent is based on multiplying up the total surveyed area within Dogger Bank cSAC assuming the footprint would affect each community type equally, based on the percentage present within the surveyed area.
[b] See **Table 7.4** above for total values, which have then been separated into community types based on the percentage distribution within the surveyed areas (from **Table 4.4**).

7.3.25 Overall, the worst case reduction in extent of the subtidal sandbank feature of the Dogger Bank cSAC as a result of physical loss due to obstruction by structures from all projects would be up to 0.21% of total site area, noting that colonisation of introduced habitat would occur over time by the existing communities that are present on hard substrates within the cSAC. Similar combined impacts in respect of habitat fragmentation and community composition and distribution would be expected to occur (see paragraph 4.7.62). It is assumed that wind farm project infrastructure would be removed following decommissioning at the end of the operational phase, therefore, the impact is not considered to be permanent.

**Direct physical damage (disturbance) to subtidal sandbank communities**

7.3.26 Temporary and short-term disturbance effects would arise as a result of the construction, operation and decommissioning of Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D, which could act in-combination with the disturbance effects from Dogger Bank Teesside A & B operation and decommissioning phases. Similarly, the operation of the three aggregate extraction projects (466/1, 485/1, and 485/2) could also take place during the

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construction phase, and these would also result in disturbance to subtidal sandbanks communities. Though no overlap in spatial extent of disturbance effects between the projects is expected, there could be an additive effect. If, assuming a worst case scenario where Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D and Dogger Bank Teesside A & B are built synchronously and the aggregate extractions are in operation, approximately 109.41km$^2$ (0.89%) of the subtidal sandbank communities of the Dogger Bank cSAC could be disturbed during the construction phase (see **Table 7.8**). This extent would not occur at one time but across the three to six years of construction of each wind farm (i.e. therefore annually affecting 0.31% of the site each year including aggregate extractions). Given that this period extends over several years, recovery of communities in areas subject to initial disturbance would be expected during this period, with the remainder continuing to recover during the operation phase.

Table 7.8 Disturbance extents and communities affected within the Dogger Bank cSAC during the construction phase for Dogger Bank Teesside A & B and other projects

| Community types | Extent within Dogger Bank cSAC (km$^2$)[a] | Disturbance extent (km$^2$)[b] | | | | | Percentage affected in Dogger Bank cSAC |
|---|---|---|---|---|---|---|---|
| | | Dogger Bank Teesside A & B | Dogger Bank Creyke Beck A & B | Dogger Bank Teesside C & D[c] | Aggregate Areas[d] | Total | |
| VER A | 6,898.99 | 12.23 | 25.62 | 19.97 | 1.85 | 59.67 | 0.86 |
| VER B | 2,142.18 | 1.91 | 9.82 | 6.20 | 0.72 | 18.65 | 0.87 |
| VER C | 3,289.84 | 21.56 | 0.00 | 9.52 | 0.00 | 31.09 | 0.94 |

[a] See **Table 4.12** for baseline extents from surveyed areas (which covered tranches A & B and the Dogger Bank Teesside A & B Export Cable Corridor) within the Dogger Bank cSAC. The total extent is based on multiplying up the total surveyed area within Dogger Bank cSAC assuming the footprint would affect each community type equally, based on the percentage present within the surveyed area.
[b] The total values have then been separated into community types based on the percentage distribution within the surveyed areas (from **Table 4.4**).
[c] Values assumed using largest extent from Dogger Bank Teesside A & B as this project has been further refined following the Dogger Bank Creyke Beck DCO submission.
[d] Assumed that a nominal 10% of the area of each of the Aggregate Areas (i.e. 466/1 (1.11km$^2$), 485/1 (1.21km$^2$), and 485/2 (0.25km$^2$)) are dredged at any one time, leading to temporary habitat disturbance (see Table 10.3 in **Chapter 12** in the Dogger Bank Teesside A & B ES). Extent is derived from percentage of VERs within Dogger Bank Creyke Beck A & B projects due to their proximity.

7.3.27 The estimated area of annual disturbance during the operation phase would be significantly smaller in extent than during construction, with a worst case predicted annual disturbance of 8km$^2$ (0.06%) of subtidal sandbank communities affected within the Dogger Bank cSAC (see **Table 7.9**). It should also be noted that the areas affected annually may be different, enabling each previously disturbed area to recover, and areas of disturbance would be small (due to the size of the jack-up barge spud leg footprint) and localised, allowing for more rapid recovery due to communities and species in the immediate surrounding area to colonise the disturbed area. Furthermore, aggregate extraction operations would only take place for up to 15 years and would therefore cease during the operation phase for Dogger Bank Teesside A & B,

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reducing the annual extent disturbed to 0.04% of subtidal sandbank communities within the Dogger Bank cSAC.

Table 7.9 Disturbance extents and communities affected within the Dogger Bank cSAC in the operation phase for Dogger Bank Teesside A & Band other projects

| Community types | Extent within Dogger Bank cSAC ($km^2$)[a] | Disturbance extent ($km^2$)b | | | | | Percentage affected in Dogger Bank cSAC |
|---|---|---|---|---|---|---|---|
| | | Dogger Teesside Beck A & B | Dogger Bank Creyke Beck A & B | Dogger Bank Teesside C & D[c] | Aggregate Areas[d] | Total | |
| VER A | 6,898.99 | 0.63 | 1.30 | 1.01 | 1.85 | 4.79 | 0.07 |
| VER B | 2,142.18 | 0.10 | 0.50 | 0.31 | 0.72 | 1.64 | 0.08 |
| VER C | 3,289.84 | 1.08 | 0.00 | 0.48 | 0.00 | 1.56 | 0.05 |

[a] See **Table 4.12** for baseline extents from surveyed areas (which covered tranches A & B and the Dogger Bank Teesside A & B Export Cable Corridor) within the Dogger Bank cSAC. The total extent is based on multiplying up the total surveyed area within Dogger Bank cSAC assuming the footprint would affect each community type equally, based on the percentage present within the surveyed area.
[b] The total values have then been separated into community types based on the percentage distribution within the surveyed areas (from **Table 4.4**).
[c] Values assumed using largest extent from Dogger Bank Teesside A & B as this project has been further refined following the Dogger Bank Creyke Beck DCO submission.
d Assumed that a nominal 10% of the area of each of the Aggregate Areas (i.e. 466/1 (1.11$km^2$), 485/1 (1.21$km^2$), and 485/2 (0.25$km^2$)) are dredged at any one time, leading to temporary habitat disturbance (see Table 10.3 in **Chapter 12** of the Dogger Bank Teesside A & B ES).

7.3.28 Disturbance during the decommissioning phase would be similar to but of less extent than that during construction. On completion of decommissioning, all disturbance activities would cease and full and relatively rapid recovery of affected benthic communities in accordance with prevailing baseline conditions would be expected.

7.3.29 Overall, given the low sensitivity of the communities and the existing adaptation of subtidal sandbanks communities to the effects of substrate disturbance (e.g. via storm induced wave activity), and their high recoverability, the communities would recover from the disturbance activities during construction, operation, and decommissioning within several years.

**Indirect physical damage (hydrodynamic alteration) to subtidal sandbank communities**

7.3.30 Given the negligible predicted changes to the hydrodynamic regime and morphology of the sandbank feature (see paragraphs 7.3.12 to 7.3.14), any changes in current velocity, wave activity etc. would not significantly affect the morphology of existing sandbank features. Any changes would be localised (to the immediate areas of turbine structures) but occur over a widely distributed area of Dogger Bank. However, the modelling work and conclusions for Dogger Bank Teesside A & B alone (see Section 4.7), indicates that physical parameters would remain within the range of natural variability, such that no alteration in the species composition of benthic communities that characterise the subtidal sandbanks feature of the Dogger Bank cSAC is predicted to occur.

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**Physical damage to subtidal sandbank communities from increased suspended sediment concentrations**

7.3.31 Aggregate Area 466 is located 30km north west of Dogger Bank Teesside B and may become licensed during the lifetime of Dogger Bank Teesside A & B. The aggregate area is located on the edge of the predicted (modelled) extent of the maximum and average suspended sediment concentrations that could be generated during construction of Dogger Bank Teesside A & B (see **Figure 4.12** and **Figure 4.13**), though it is located within both the maximum and average suspended sediment concentrations during construction of Dogger Bank Creyke Beck A & B. Aggregate Areas 485/1 and 485/2 are situated outside the modelled extent of maximum and average suspended sediment concentrations generated during construction of Dogger Bank Teesside A & B and Dogger Bank Creyke Beck A & B. The extent of the sediment plume generated at these aggregate extraction sites would be localised, intermittent (dredging is likely to occur once a week) result in relatively low suspended sediment concentrations (less than 5mg/l up to 2km away) and be temporary, with sediments being re-suspended over a 6 hour duration. Given the very small-scale extent and the short-term duration of the overlap between the suspended sediment plume generated during aggregate extraction and that associated with the construction of Dogger Bank Teesside A & B , any increase in the predicted impact on subtidal sandbank communities (above that which would result from development of Dogger Bank Teesside A & B alone) would be negligible and no synergistic in-combination effect is predicted on the subtidal sandbanks feature as a whole for the Dogger Bank cSAC.

7.3.32 During the operation phase for Dogger Bank Teesside A & B all three aggregate areas (Aggregate Area 466, 485/1, and 485/) would not fall within the area of increased suspended sediment concentrations generated from the Dogger Bank Teesside A & B development during a 50 year storm (see **Figure 4.27** and **Figure 4.29**). However, combined with the Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D, the aggregate extraction sites would lie within the maximum and average suspended sediment concentrations generated during a 50 year storm event (see **Figure 7.5** and **Figure 7.6**). Consequently, sediment relased into the water column during aggregate extraction activities could have the potential to act in-combination with any sediment released during the operation phase for Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D. The additive effect of an increase in suspended sediment concentrations from the aggregate extraction sites (which are spatially separated) described in paragraph 7.3.27 above, would be temporary. Furthermore, it would be unlikely that aggregate dredging would take place during a severe storm event (i.e. such that interaction of generated plumes from all developments would arise). Given the small-scale extent of the overlap between the aggregate sites' plume and that of Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D, and its short-term duration, any increase in the predicted impact on subtidal sandbank communities that would result would not be significant. Therefore, no synergistic in-combination effect is predicted on the subtidal sandbanks feature as a whole for the Dogger Bank cSAC.

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7.3.33 In determining the potential in-combination effect of increased suspended sediment concentrations from Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D with the effect of Dogger Bank Teesside A & B, the worst case construction programme has been used. This worst case is defined as Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D all being built simultaneously.

7.3.34 Simultaneous construction would result in the generation of suspended sediment plumes that could overlap depending on the tides and storminess along with the pattern of construction. Given the temporary nature of the increased suspended sediment concentrations, along with natural variation in suspended sediment concentrations during storms the combined effect is considered to be similar to that of Dogger Bank Teesside A & B alone, albeit over a larger extent of the cSAC.

7.3.35 Given the very low sensitivity of the subtidal sandbank communities to short-term and temporary increases in suspended sediment concentrations and ability to rapidly recover from such effects, no significant in-combination impact to the subtidal sandbank communities from this effect is predicted on this feature of the Dogger Bank cSAC during the construction, operation and decommissioning of Dogger Bank Teesside A & B in-combination with other projects.

**Indirect physical damage (smothering) to subtidal sandbank communities**

7.3.36 Potentially, sediment deposition from the sediment plume generated during aggregate extraction could interact with re-deposited sediment from construction of Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D. Sediment deposited from the construction phase of Dogger Bank Teesside A & B could occur at the same time as all the projects in a worst case scenario. Whilst sediment may not be deposited in the same area (i.e. overlapping sediment deposition areas), sediment deposition could affect a larger extent of the subtidal sandbank feature of the Dogger Bank cSAC.

7.3.37 Based on the outputs from the hydrodynamic modelling work, Aggregate Area 466/1 is located within the extent of the footprint of the maximum suspended sediment plume generated during construction (via re-suspension of sediment due to scour around the operational structures during a storm event or maintenance activities) of Dogger Bank Teesside A & B (see **Figure 4.19**), but outside the average sediment deposition area (see **Figure 4.20**) and outside all areas in operation (see **Figure 4.30** and **Figure 4.31**). Sediment deposition extents for all wind farm projects overlap with Aggregate Area 466/1 (see **Figure 7.8** and **Figure 7.9**). No detailed information is available on the intensity of activity (frequency of dredging, volume of dredging, and sediment plume) for Aggregate Area 485/1 and 485/2; however, conclusions have been drawn for these sites on the basis of available information on the effects of Aggregate Area 466 (see above). Whilst no overlap of sediment deposition between Dogger Bank Teesside A & B and the aggregate areas (485/1 and 485/2) occurs (see **Figure 4.19**, **Figure 4.20**, **Figure 4.30**, and **Figure 4.31**), these sites are located within the areas of in-combination sediment deposition that could arise from interaction of all three of the wind farm projects (see **Figure 7.8** and **Figure 7.9**).

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7.3.38 Sediment released into the water column during construction of the wind farms and operation of the aggregate extraction sites would lead to a greater increase in suspended sediment concentrations and sediment deposition within areas of sediment plume overlap between the projects. The extent of this interaction is difficult to establish with any certainty. However, given the localised extent of the sediment plume generated at these aggregate sites, the intermittent source of suspended sediment (dredging is likely to occur once a week) and the relatively low concentrations (less than 5mg/l), subsequent re-deposition is likely to be negligible. In relation to the wind farm projects, as noted for Dogger Bank Teesside A & B alone, deposition of sediment during the construction phase would be short-term and temporary as any deposited sediment has a relatively short residence time. Consequently, given the the tolerance of the benthic communities to sediment movement / deposition and the temporary nature of any deposition, no in-combination effect that would give rise to changes in the existing composition, extent and distribution of benthic communities is predicted for the Dogger Bank cSAC subtidal sandbank feature.

7.3.39 Although overlap of depositional areas from Dogger Bank Teesside A & B, and Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D could occur, it is unlikely that sediment from aggregate extraction Area 466 would contribute any additional and significant amounts of sediment to that which may result from these projects combined. As with the alone assessment for Dogger Bank Teesside A & B, any in-combination sediment deposition would be temporary and, given the very low sensitivity and high tolerance of the benthic communities to sediment movement / deposition, no discernible effect is predicted on the Dogger Bank cSAC subtidal sandbank feature during the construction phase for Dogger Bank Teesside A & B in-combination with other projects.

7.3.40 The very small thicknesses of sediment deposition predicted for the operation phase (as described in paragraph 7.3.21) and temporary persistence of deposited sediment (see **Table 7.6**) indicate that any impacts on benthic communities would be temporary and likely to be within the range of conditions that the fauna is subject to under natural disturbance events. As a consequence, no in-combination effect that would give rise to changes in the existing composition, extent and distribution of benthic communities is predicted for the Dogger Bank cSAC subtidal sandbank feature.

7.3.41 The amount of sediment re-suspended and deposited during the decommissioning phase for Dogger Bank Teesside A & B could potentially combine with the sediment deposited during the decommissioning of Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D if they all occur at the same time. However, given that the extent and intensity of disturbance during the decommissioning phase for these projects (and given that aggregate extraction operations would have ceased) would be lesser in scale than that for the combined effect during construction of these projects, no discernible effect is predicted on the Dogger Bank cSAC subtidal sandbank feature during the decommissioning phase for Dogger Bank Teesside A & B in-combination with other projects (see detail in paragraph 7.3.40).

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## Assessment against Conservation Objectives and conclusions on integrity

7.3.42 Overall, the following conclusions are drawn in respect of the in-combination assessment for the Dogger Bank cSAC:

- Changes in hydrodynamics (current velocities, wave height) and sediment transport dynamics would be very localised (i.e. to the immediate vicinity of individual project areas; turbine locations in the case of wind farms) although widespread across Dogger Bank. However, these changes would not be within the range of natural variation exhibited by these physical parameters and would be highly unlikely to give rise to any discernible change in the extent and morphology of sandbank features and the benthic communities that these features support;
- Rapid recovery of benthic communities within areas of the Dogger Bank cSAC affected by seabed disturbance during construction and operation is anticipated for all of the projects examined;
- The total area of habitat that would be lost (due to presence of hard substrate) for all projects combined for the duration of the operational phase for Dogger Bank Teesside A & B is not considered to be significant (less than 0.22%) at the scale of the Dogger Bank cSAC; and
- Where perceived negative effects arise (such as the temporary reduction in the extent of the sandbanks feature) potentially beneficial effects could offset these effects, such as reduced fishing activity in areas adjacent to installed structures.

7.3.43 Consequently, it is considered that the favourable condition target aimed at restoring the sandbanks feature would not be compromised (see **Table 7.10**) and that there would not be an adverse effect on the integrity of the Dogger Bank cSAC as a result of Dogger Bank Teesside A & B in-combination with other plans and projects.

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Table 7.10 In-combination assessment against the Conservation Objectives for the subtidal sandbanks feature of the Dogger Bank cSAC

| Conservation Objective | Assessment discussion |
|---|---|
| Subject to natural change, restore the sandbanks to favourable condition, such that the natural environmental quality is restored. | There would be localised, temporary and intermittent increases in suspended sediment concentrations resulting from Dogger Bank Teesside A & B in-combination with other projects (e.g. aggregate extraction, other wind farm developments), particularly if Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D are constructed at the same time, or overlapping. Spatially, the areas of the cSAC potentially affected would vary over time and, consequently, the subtidal features likely to be affected would also vary over the duration of any concurrent and overlapping construction activities. However, all of the sandbanks communities have a low sensitivity to increased suspended sediments, and comprise species that are adapted to intermittently high levels of suspended sediment (i.e. during storm events). Consequently, given that the highest sediment concentration levels would be short-term in nature and remain within the range of concentrations exhibited under natural conditions, restoration to natural environmental quality (suspended sediments) would not be compromised.<br>Increased suspended sediment concentrations that could arise during the operation phase (due to re-suspension of sediment as a result of scour around installed structures) would be significantly lower and occur less frequently than for the construction phase. Both temporally and quantitatively suspended sediment concentrations generated through scour during storm events would effectively be subsumed into natural background levels during these events.<br>During decommissioning the greatest source of re-suspended sediment is likely to derive from the process of removing buried cables, and is predicted to be significantly lower in quantity and duration than that for construction given that the majority of sediment disturbed would be sand and gravel. Consequently, given the short-term and temporary nature of the in-combination effects of decommissioning of Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B, and Dogger Bank Teesside C & D (the aggregate extraction projects do not have a project life that extends to this phase) the predicted concentration levels are again expected to fall within natural variability.<br>Following decommissioning, no additional suspended sediment concentrations would derive from project (or human) activities related to Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B, and Dogger Bank Teesside C & D, and given the project timescales for the other projects considered here, further disturbance to the natural environment is not predicted.<br>**Conservation objective would not be affected.** |

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| Conservation Objective | Assessment discussion |
|---|---|
| Subject to natural change, restore the sandbanks to favourable condition, such that the natural environmental processes and the extent are maintained. | As stated above, during the construction of Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D there would be combined disturbance to seabed sediments, as well as potential disturbance due to aggregate extraction, which could result in re-suspended sediments being deposited within the cSAC. The short residence time and thinness (several millmetres) of redeposited sediment that could arise from all projects combined are considered to be representative of conditions that arise naturally (e.g. during storm events).<br>Significantly less sediment would be re-suspended during the operation phase for Dogger Bank Teesside A & B in-combination with other projects compared to the construction phase. Given that the majority of deposition would be linked to storm events, and given the natural cycle of sediment deposition and movement during tides, the natural processes are expected to remain within the current levels of variability.<br>Significantly lower levels of sediment re-suspension and deposition would occur during decommissioning, and on completion there would be no additional re-suspended sediments and deposited sediments outside of those naturally recycling within the cSAC.<br>The hydrodynamic changes arising during the operation phase of Dogger Bank Teesside A & B in-combination with other projects would be negligible and within the range of natural variability occurring within the cSAC. The predicted small-scale, localised changes in hydrodynamics would not alter the morphology of the sandbank habitat across the cSAC, and its structural integrity would therefore be maintained.<br>On completion of the decommissioning stage, no disturbance to hydrodynamic processes would arise due to the removal of structures from the cSAC.<br>**Conservation objective would not be affected.** |
| | The extent of the sandbanks feature would reduce slightly for some of the seabed types with an associated increase in the extent of hard substrate for the duration of the operation phase for Dogger Bank Teesside A & B in-combination with Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D. The extent affected in-combination would be no more than 0.22% of the sandbank feature, with the predicted loss/change in substrate type being distributed locally throughout much of the cSAC. Following completion of decommissioning however, the extent of sandbank feature would return to the current baseline. This small loss/change in the composition and extent of the sandbanks featurewould not compromise achieving restoration of the feature in the longer term.<br>**Conservation objective would not be affected.** |

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| Conservation Objective | Assessment discussion |
|---|---|
| Subject to natural change, restore the sandbanks to favourable condition, such that the physical structure, diversity, community structure and typical species, representative of sandbanks which are slightly covered by seawater all the time, in the Southern North Sea, are restored. | Given the low sensitivity of the sandbank communities to the temporary and intermittent effects predicted to occur during the construction phase, no significant alteration to the physical structure, diversity, community structure, and typical species is expected during the construction phase for Dogger Bank Teesside A & B in-combination with other projects.<br>As increased suspended sediment concentrations, sediment deposition, and hydrodynamic changes during the operation phase are considered to remain within natural variability of these processes, no influence of the projects in-combination is expected in relation to the physical structure, diversity, community structure, and typical species of the sandbanks communities. Furthermore, the localised, and in total, small-scale, reduction in the extent of the feature resulting from the footprint of structures during the operation phase would not result in a change in the physical structure, diversity, community structure, and typical species of the sandbanks communities throughout the cSAC. Consequently, the long-term but temporary changes would not alter the ability for the sandbanks communities and their diversity, community structure, and typical species to be restored as a result of Dogger Bank Teesside A & B in-combination with the other projects.<br>On completion of the decommissioning stage, the sandbanks communities would not be subject to any project linked disturbance effects or influences that would prevent achieving restoration to favourable condition if this had not already been secured.<br>**Conservation objective would not be affected.** |

## 7.4 Assessment of in-combination effects on the integrity of transboundary sites supporting Annex I habitats

7.4.1 This section screens the activities and effects of Dogger Bank Teesside A & B against the potential activities of other plans and projects, in order to assess the in-combination effects on the subtidal sandbanks feature (see screening of features and activities in Sections 3.4 and 3.5) of the Doggerbank SCI (Germany) and Doggersbank SCI (Netherlands).

7.4.2 However, considering that no physical effects (suspended sediments, sediment deposition, or hydrodynamic (tidal currents and waves) changes) would extend into or near to the Doggerbank SCI (Germany), no source of potential impact would arise as a result of the construction, operation, and decommissioning of Dogger Bank Teesside A & B alone (see conclusions in Section 4.10), and no in-combination effect could arise. It is noted that, the Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D projects are located further away from the Doggerbank SCI, and no synergistic or additive effects (spatially) were recorded during the modelling results as discussed in relation to Dogger Bank cSAC (see Section 7.3 above) to extend into the Doggerbank SCI, which confirms that no in-combination effect is likely.

### Screening of other projects

7.4.3 The effects considered in the in-combination assessment of the Dogger Bank cSAC identified in paragraph 7.3.2 have been examined for the Doggersbank SCI (Netherlands).


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7.4.4 Consequently, the same projects and plans considered for the in-combination assessment of the Dogger Bank cSAC, listed in paragraph 7.3.8, have been considered here. However, given the distance of the aggregate extraction projects from the Doggersbank SCI, these have not been considered further. Therefore, the in-combination assessment considers Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B, and Dogger Bank Teesside C & D and the potential effects on the Doggersbank SCI subtidal sandbank feature. The potential effect on the grey seal and harbour porpoise features of the Doggersbank SCI are discussed and considered in Sections 7.6 and 7.7.

## Projects and potential effects screened in for in-combination assessment on the subtidal sandbank feature of the Doggersbank SCI

7.4.5 Based on the projects screened in and the potential in-combination effects, **Table 7.11** presents the projects and related effects that could occur and impact on the subtidal sandbank feature of the Doggersbank SCI, and which are therefore assessed in detail. The table has utilised the findings and conclusions of the assessments undertaken and reported in Sections 4.6, 4.7, 4.8, and concluded in Section 4.10.

Table 7.11 Potential in-combination effects of other projects on the subtidal sandbank feature of the Doggersbank SCI

| Effect on site feature | Dogger Bank Creyke Beck A & B | Dogger Bank Teesside C & D |
|---|---|---|
| **Dogger Bank Teesside A & B construction phase** | | |
| Direct physical loss (obstruction)[1] | NO | NO |
| Direct physical damage (disturbance) | NO | NO |
| Indirect physical damage (smothering) | YES | YES |
| Direct physical damage (increased suspended sediment concentrations) | YES | YES |
| **Dogger Bank Teesside A & B operation phase** | | |
| Disturbance to morphology / structural integrity | YES | YES |
| Direct physical loss (obstruction) | NO | NO |
| Direct physical damage (disturbance) | NO | NO |
| Indirect physical damage (hydrodynamic change) | YES | YES |
| Indirect physical damage (smothering) | YES | YES |
| Direct physical damage (increased suspended sediment concentrations) | YES | YES |
| **Dogger Bank Teesside A & B decommissioning phase** | | |
| Direct physical loss (obstruction) | NO | NO |
| Direct physical damage (disturbance) | NO | NO |
| Indirect physical damage (smothering) | YES | YES |
| Direct physical damage (increased suspended sediment concentrations) | YES | YES |

[1] Considered under physical damage for temporary loss and under operation phase for long-term and/or permanent loss.

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## Impacts on subtidal sandbank feature of the Doggersbank SCI

### Physical damage to subtidal sandbank communities from increased suspended sediment concentrations during construction

7.4.6 The suspended sediment concentrations generated during the construction phase for Dogger Bank Teesside A & B in-combination with the other projects are predicted to respond in a similar manner to those of Dogger Bank Teesside A & B alone (see paragraph 4.6.45). If all projects were constructed at the same time there would be an overlap in areas of increased suspended sediment concentrations, however, as with Dogger Bank Teesside A & B alone, these would be short-term and temporary in nature. They would also change and reduce depending on the location of specific construction activity within the various projects. Consequently, as described in paragraph 4.6.71, given the low sensitivity of subtidal sandbanks communities to changes in suspended sediment concentrations and the short-term, temporary and intermittent nature of the increase levels of suspended sediment concentrations, no change to the abundance and / or species composition of the infaunal and epifaunal communities would be expected within the Doggersbank SCI.

### Physical damage (smothering) to habitat feature communities through deposition of sediment during construction

7.4.7 The sediment deposition as a result of seabed disturbance and re-suspended sediments (see above) during the construction phase for Dogger Bank Teesside A & B in-combination with the other projects are predicted to respond in a similar manner to those of Dogger Bank Teesside A & B alone (see paragraph 4.6.46). If all projects were constructed at the same time there would be an overlap in areas of sediment deposition, however, as with Dogger Bank Teesside A & B alone, the sediments would persist for a short duration, and would therefore be temporary in nature. The depth and duration of persistence would also change and reduce depending on the location of specific construction activity within the various projects. As described in paragraph 4.6.78, given the very low sensitivity of the subtidal sandbanks communities to changes in sediment deposition (‘smothering’) and the short-term, temporary and intermittent nature of the deposited sediment, no change to the abundance and / or species composition of the infaunal and epifaunal communities would be expected within the Doggersbank SCI.

### Alteration to bathymetry

7.4.8 No structures would be placed within the Doggersbank SCI from any of the projects therefore no change to bathymetry would occur (as noted in paragraph 4.7.8).

### Interruption to sediment transport pathways

7.4.9 Whilst the Doggersbank SCI is adjacent to the offshore wind farm and structures, given the localised and temporary nature of the sediment transport interruptions (and only adjacent to any structures (i.e. wind turbines) which are spread across Dogger Bank Teesside A) no impact would be expected within the areas of sandbank habitat of the Doggersbank SCI (see paragraph 4.7.13). Given the distance of the other wind farm projects from the Doggersbank SCI

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(and conclusion of no impact from Dogger Bank Teesside A & B alone) no sediment transport interruptions or obstruction would extend into the Doggersbank SCI.

**Alteration to the hydrodynamic regime**

7.4.10 The alterations to the hydrodynamic regime as a result of Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D are described in paragraphs 7.3.12 and 7.3.13. Tidal current change within the Doggersbank SCI are predicted to be less than 0.006m/s, whilst significant wave heights would increase by less than 0.4m, during a 50 year storm event, which indicates negligible if any change in normal conditions. Given that such small-scale changes would be close to the background current velocities and significant wave heights at or within the Doggersbank SCI, no discernible hydrodynamic change would occur to this site and no in-combination impact is predicted on the subtidal sandbank feature.

**Physical disturbance to the morphology and physical damage to the structural integrity of habitat feature**

7.4.11 No change to bathymetry (paragraph 7.4.8) would arise, whilst small-scale and intermittent change to sediment extent, composition and distribution (see paragraph 7.4.12), suspended sediment concentrations (see paragraphs 7.4.13 and 7.4.14), sediment transport (see paragraph 7.4.9), and hydrodynamic processes (see paragraphs 7.4.10) are predicted. Any changes would fall within the range of natural variation in these processes and, consequently, no change to the morphology of the sandbank feature of the Doggersbank SCI is predicted. The structural integrity of sandbank habitat would therefore not be affected through the combined effects of other projects with Dogger Bank Teesside A & B.

**Alteration to the extent, composition and distribution of habitat feature**

7.4.12 No seabed disturbance works or structures would extend into or be placed within the Doggersbank SCI in the operation phase for all projects therefore no direct alteration to the extent, composition and distribution of the sandbank habitat within the Doggersbank SCI would occur. Changes to sediment transport (see paragraph 7.4.9) and sediment deposition (see paragraph 7.4.14) indicate that very small-scale, if any, changes could occur within the site. Such changes would be localised, temporary and intermittent throughout the operation phase for Dogger Bank Teesside A & B in-combination with other projects. Furthermore, the existing variable and changing nature of the subtidal sandbank habitat within the Doggersbank SCI and the temporary nature of any sediment deposition indicate that no measurable change to the extent, composition and distribution of the subtidal sandbank habitat of the Doggersbank SCI would occur as a result of the operation of Dogger Bank Teesside A & B in-combination with other projects.

**Changes to suspended sediment concentrations and sediment deposition**

7.4.13 The modelling of suspended sediments due to scour and disturbance during the operation phase for Dogger Bank Teesside A & B and other projects is described and detailed in paragraph 7.3.17 to 7.3.18 and shown on **Figures 7.5**,

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**7.6**, and **7.7**. The increases predicted would be temporary (generally less than 15 days) and are considered to fall within the existing ranges experienced during storm events.

7.4.14 The modelling of sediment deposition during the operation phase for Dogger Bank Teesside A & B and other projects is described and detailed in paragraph 7.3.19 to 7.3.20 and shown on **Figures 7.8** and **7.9**. The increases predicted would be of a small-scale (less than 10mm) and temporary in duration of persistence and are considered to fall within the existing ranges experienced within the site.

**Physical damage to subtidal sandbank communities from increased suspended sediment concentrations during the operation phase**

7.4.15 The suspended sediment concentrations generated during the operation phase for Dogger Bank Teesside A & B in-combination with other projects (see paragraph 7.4.13) are predicted to respond in a similar manner to those of Dogger Bank Teesside A & B alone (see paragraph 4.6.45). Given the low sensitivity of subtidal sandbanks communities to changes in suspended sediment concentrations and the short-term, temporary and intermittent nature of the increase levels of suspended sediment concentrations, no change to the abundance and / or species composition of the infaunal and epifaunal communities would be expected within the Doggersbank SCI.

**Physical damage (smothering) to habitat feature communities through deposition of sediment during the operation phase**

7.4.16 The sediment deposition as a result of seabed disturbance and re-suspended sediments during the operation phase for Dogger Bank Teesside A & B in-combination with other projects (see paragraph 7.4.14) are predicted to respond in a similar manner to those of Dogger Bank Teesside A & B alone (see paragraph 4.6.46). Given the very low sensitivity of the subtidal sandbanks communities to changes in sediment deposition ('smothering') and the short-term, temporary and intermittent nature of the deposited sediment, no change to the abundance and / or species composition of the infaunal and epifaunal communities would be expected within the Doggersbank SCI.

**Physical damage to subtidal sandbank communities from increased suspended sediment concentrations during decommissioning**

7.4.17 The suspended sediment concentrations generated during the decommissioning of Dogger Bank Teesside A & B in-combination with the other projects are predicted to be similar to but lesser in scale than those for the construction phase. Consequently, as described in paragraph 7.4.6, given the low sensitivity of subtidal sandbanks communities to changes in suspended sediment concentrations and the short-term, temporary and intermittent nature of the increase in levels of suspended sediment concentrations, no change to the abundance and / or species composition of the infaunal and epifaunal communities would be expected within the Doggersbank SCI.

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**Physical damage (smothering) to habitat feature communities through deposition of sediment during decommissioning**

7.4.18 The sediment deposition as a result of seabed disturbance and re-suspended sediments (see above) during the decommissioning phase for Dogger Bank Teesside A & B in-combination with the other projects are predicted to be similar to but lesser in scale than those for the construction phase. Consequently, as described in paragraph 7.4.7, given the very low sensitivity of the subtidal sandbanks communities to changes in sediment deposition ('smothering') and the short-term, temporary and intermittent nature of the deposited sediment, no change to the abundance and / or species composition of the infaunal and epifaunal communities would be expected within the Doggersbank SCI.

## Assessment against Conservation Objectives and conclusions on integrity

7.4.19 The assessment of the impacts in relation to the conservation objectives for the the subtidal sandbanks feature of the Dogger Bank cSAC (see **Table 7.10**) have been assumed to also apply to the subtidal sandbanks feature of the Doggersbank SCI.

7.4.20 No direct footprint or disturbance effects would arise within the Doggersbank SCI. The scale of the (indirect) impacts on the subtidal sandbanks feature of the Doggersbank SCI, described in paragraphs 7.4.6 to 7.4.18, would be lesser in scale and magnitude than those assessed for the subtidal sandbanks feature of the Dogger Bank cSAC, due to the spatial separation between the SCI and the location of in-combination project activities. Overall, short-term and temporary impacts that would fall within the range exhibited under natural conditions are predicted. As a consequence, it is therefore concluded that there would be no implications in respect of favourable condition and nthe achievement of the conservation objectives in relation to the physical features, processes, and communities of the subtidal sandbank feature of the Doggersbank SCI would not be compromised. The development of Dogger Bank Teesside A & B in-combination with other projects would therefore not result in an adverse effect on the integrity of the Doggersbank SCI.

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## 7.5 Assessment of in-combination effects on the integrity of supporting habitat features of the Teesmouth and Cleveland Coast SPA (and Ramsar site) and the Northumbria Coast SPA (and Ramsar site)

7.5.1 It has been concluded in paragraphs 4.9.6 to 4.9.11 that there would not be an adverse affect on the integrity of the Teesmouth and Cleveland Coast SPA (and Ramsar site) and the Northumbria Coast SPA (and Ramsar site) due to the construction, operation, and decommissioning of Dogger Bank Teesside A & B alone. Initial screening (see Section 7.1) did not identify any other plans or projects (the Blyth Demonstration Site and Teesside Offshore Wind Farm are already built and operating) within 25km of these sites (see paragraph 7.3.3) which could influence the physical, chemical, and biological parameters of the marine environment. Consequently, no other plans and projects have been considered in this in-combination assessment, and no sources of impacts that could act in concert with the small-scale effects predicted as a result of the construction, operation, and decommissioning of Dogger Bank Teesside A & B exist. Therefore, there would not be an adverse effect on the integrity of the Teesmouth and Cleveland Coast SPA (and Ramsar site) and the Northumbria Coast SPA (and Ramsar site) due to Dogger Bank Teesside A & B alone or in-combination with other projects.

## 7.6 Assessment of in-combination effects on the integrity of UK sites supporting the Annex II grey seal feature

7.6.1 This section provides an assessment of the activities and effects of Dogger Bank Teesside A & B in-combination with other plans and projects on the designated grey seal populations of the European sites (see **Table 5.1**) screened into this HRA process.

### Other projects

7.6.2 The following effects have been identified and examined in the alone assessment of Dogger Bank Teesside A & B with respect to the grey seal feature of UK and transboundary European sites:

- Changes in grey seal prey species (fish) distribution, density or quality arising from increased suspended sediment concentrations in the water column and re-deposition of sediment from the water column during construction, operation, and decommissioning;
- Direct effects on the grey seal population as a result of behavioural changes arising from barrier effect due to the presence and operation of the wind turbines;
- Indirect effects on the grey seal population as a result of behavioural changes arising from the increase in underwater noise levels due to the operation of the wind turbines;
- Direct physical damage (mortality) and indirect physical damage (avoidance) to grey seal population as a result of underwater noise due to

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pile driving and vessel movements during construction, operation, and decommissioning; and

- Direct physical damage (mortality) to grey seal population as a result of collisions with vessels during construction, operation, and decommissioning.

7.6.3 Screening of the above effects against other projects and plans has been undertaken in order to determine those projects that have the potential to interact with the effects of Dogger Bank Teesside A & B, and that have the potential to result in effects on grey seal populations within the North Sea. The list of projects screened in is presented in **Table 7.12.** These projects are located within a 'study area' which encompasses the range of the North Sea grey seal population (see **Figure 7.11**) based on their known foraging range of up to 145km from their haul out sites (Thompson *et al.* 1996) as well as known interaction between grey seal colonies in the UK, Netherlands, Belgium and likely eastern North Sea. There are a total of 63 projects identified; 24 of these relate to offshore wind farm projects (only one of which is outside the UK), and a further 14 relate to the cable elements of the same developments. The remainder comprise of 16 marine aggregate extraction projects, four oil and gas developments, and five wave and tidal developments. This means there is a total of 49 projects to be considered. The locations of the projects are shown on **Figure 7.11**.

7.6.4 Projects relating to aggregate extraction and mining are considered in the area of the southern North Sea. Potential impacts from these developments include behavioural disturbance from underwater noise and vessels, potential collision risk with vessels, and indirect impacts on prey resources.

7.6.5 All offshore wind farm developments have the potential to cause the same types of impacts that could arise during the development of Dogger Bank Teesside A & B. However, the magnitude of likely effects (impact footprints and temporal duration) on marine mammals would vary depending on the size of the developments and the existing environment in the vicinity of the proposed development. Some projects are also located in regions with different underlying marine mammal densities to those seen across the Dogger Bank Zone and wider Dogger Bank area. Densities of mobile species, such as grey seal are known to vary over space and time, so there will be a large amount of uncertainty in quantifying impacts.

7.6.6 Although there is the potential for overlap in the construction phase of all of the wind farms considered, it is likely that infrastructure constraints (such as the availability of offshore construction barges) would limit the potential for concurrent pile driving across many sites. There is also a large amount of uncertainty in respect of the date of commencement of many of the projects which are yet to be consented.

7.6.7 Oil and gas developments and pipelines under construction have the potential to cause impacts relating to disturbance via underwater noise from construction activities and vessels, collision risk with vessels and indirect impacts relating to prey resources, as well as potential disturbance from seismic surveys undertaken as part of prospecting work.

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Table 7.12 Projects that are screened in to the in-combination assessment for marine mammals (grey seal and harbour porpoise)

| Type of project | Project title | Project status | Predicted construction/ development period | Confidence in project details | Confidence in project data | Potential in-combination impact |
|---|---|---|---|---|---|---|
| Aggregate application area | Area 466/1 | Application | Uncertain | Medium | Medium | Underwater noise - disturbance, collision risk and indirect impacts on prey |
| | Area 448 (now Area 514/1) | Application | Uncertain | Medium | Medium | Underwater noise - disturbance, collision risk and indirect impacts on prey |
| | Area 449 (now Area 514/3) | Application | Uncertain | Medium | Medium | Underwater noise - disturbance, collision risk and indirect impacts on prey |
| | Area 485/1 | Application | Uncertain | Medium | Medium | Underwater noise - disturbance, collision risk and indirect impacts on prey |
| | Area 485/2 | Application | Uncertain | Medium | Medium | Underwater noise - disturbance, collision risk and indirect impacts on prey |
| | Area 483 | Application | Uncertain | Medium | Medium | Underwater noise - disturbance, collision risk and indirect impacts on prey |
| | Area 484 | Application | Uncertain | Medium | Medium | Underwater noise - disturbance, collision risk and indirect impacts on prey |
| | Area 506 | Application | Uncertain | Medium | Medium | Underwater noise - disturbance, collision risk and indirect impacts on prey |
| | Area 400 | Application | Uncertain | Medium | Medium | Underwater noise - disturbance, collision risk and indirect impacts on prey |
| | Area 439 | Application | Uncertain | Medium | Medium | Underwater noise - disturbance, collision risk and indirect impacts on prey |
| | Area 492 | Application | Uncertain | Medium | Medium | Underwater noise - disturbance, collision risk and indirect impacts on prey |
| | Area 493 | Application | Uncertain | Medium | Medium | Underwater noise - disturbance, collision risk and indirect impacts on prey |
| | Area 454 (now Area 512) | Application | Uncertain | Medium | Medium | Underwater noise - disturbance, collision risk and indirect impacts on prey |
| | Area 495/1 | Application | Uncertain | Medium | Medium | Underwater noise - disturbance, collision risk and indirect impacts on prey |
| | Area 495/2 | Application | Uncertain | Medium | Medium | Underwater noise - disturbance, collision risk and indirect impacts on prey |


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| Type of project | Project title | Project status | Predicted construction/ development period | Confidence in project details | Confidence in project data | Potential in-combination impact |
|---|---|---|---|---|---|---|
| Aggregate application area | Area 494 | Application | Uncertain | Medium | Medium | Underwater noise - disturbance, collision risk and indirect impacts on prey |
| Cables and pipelines | Breagh Pipeline | Under construction | 2012- | High | High | Underwater noise - disturbance, and collision risk. |
| | Dudgeon R2 | Consented | As offshore wind farm | N/A[3] | N/A | Underwater noise - disturbance, and collision risk. |
| | Galloper | Consented | As offshore wind farm | N/A | N/A | Underwater noise - disturbance, and collision risk. |
| | Greater Gabbard | Construction | As offshore wind farm | N/A | N/A | Underwater noise - disturbance, and collision risk. |
| | Humber Gateway | Consented | As offshore wind farm | N/A | N/A | Underwater noise - disturbance, and collision risk. |
| | Kentish Flats Extension | Consented | As offshore wind farm | N/A | N/A | Underwater noise - disturbance, and collision risk. |
| | Lincs | Construction | As offshore wind farm | N/A | N/A | Underwater noise - disturbance, and collision risk. |
| | London Array II | Consented (subject to a Grampian condition) | As offshore wind farm | N/A | High | Underwater noise - disturbance, and collision risk. |
| | R3 Wind farm projects (East coast, Phase 1) | Pre-consent | As offshore wind farm | N/A | N/A | Underwater noise - disturbance, and collision risk. |
| | Race Bank | Consented | As offshore wind farm | N/A | N/A | Underwater noise - disturbance, and collision risk. |
| | Scottish Territorial waters sites (east coast) | Pre-consent | As offshore wind farm | N/A | N/A | Underwater noise - disturbance, and collision risk. |
| | Teesside Offshore Windfarm | Construction | As offshore wind farm | N/A | N/A | Underwater noise - disturbance, and collision risk. |
| | Triton Knoll | Pre-consent | As offshore wind farm | N/A | N/A | Underwater noise - disturbance, and collision risk. |

[3] Project and data confidence for cables relating to other offshore wind farms is not assessed as they are included in the subsequent offshore wind farm confidence assessments.


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| Type of project | Project title | Project status | Predicted construction/ development period | Confidence in project details | Confidence in project data | Potential in-combination impact |
|---|---|---|---|---|---|---|
| Cables and pipelines | Westermost Rough | Consented | As offshore wind farm | N/A | N/A | Underwater noise - disturbance, and collision risk. |
| Offshore wind farm | Beatrice | Pre-consent | 2014-2017 | Medium | Medium | Underwater noise - disturbance and auditory injury, collision risk and indirect impacts on prey |
| | Blyth Demonstration Site (NaREC) | Pre-consent | 2014-2016 | Medium | Medium | Underwater noise - disturbance and auditory injury, collision risk and indirect impacts on prey |
| | Dogger Bank Creyke Beck A & B | Pre-consent | Post 2016 | High | High | Underwater noise - disturbance and auditory injury, collision risk and indirect impacts on prey |
| | Dogger Bank Teesside C & D | Pre-consent | Post 2017 | High | Medium | Underwater noise - disturbance and auditory injury, collision risk and indirect impacts on prey |
| | Dudgeon | Consented | 2016 | High | High | Underwater noise - disturbance and auditory injury, collision risk and indirect impacts on prey |
| | Firth of Forth – Project Alpha and Project Bravo | Pre-consent | Post 2015 | Medium | Medium | Underwater noise - disturbance and auditory injury, collision risk and indirect impacts on prey |
| | Galloper | Consented | 2014-2016 | Medium | Medium | Underwater noise - disturbance and auditory injury, collision risk and indirect impacts on prey |
| | Hornsea Zone – Project One | Pre-consent | Post 2015 | High | Medium | Underwater noise - disturbance and auditory injury, collision risk and indirect impacts on prey |
| | Hornsea Zone – Project Two | Pre-consent | Post 2015 | Medium | Medium | Underwater noise - disturbance and auditory injury, collision risk and indirect impacts on prey |
| | Humber Gateway | Consented | 2012-2013 | High | High | Underwater noise - disturbance and auditory injury, collision risk and indirect impacts on prey |


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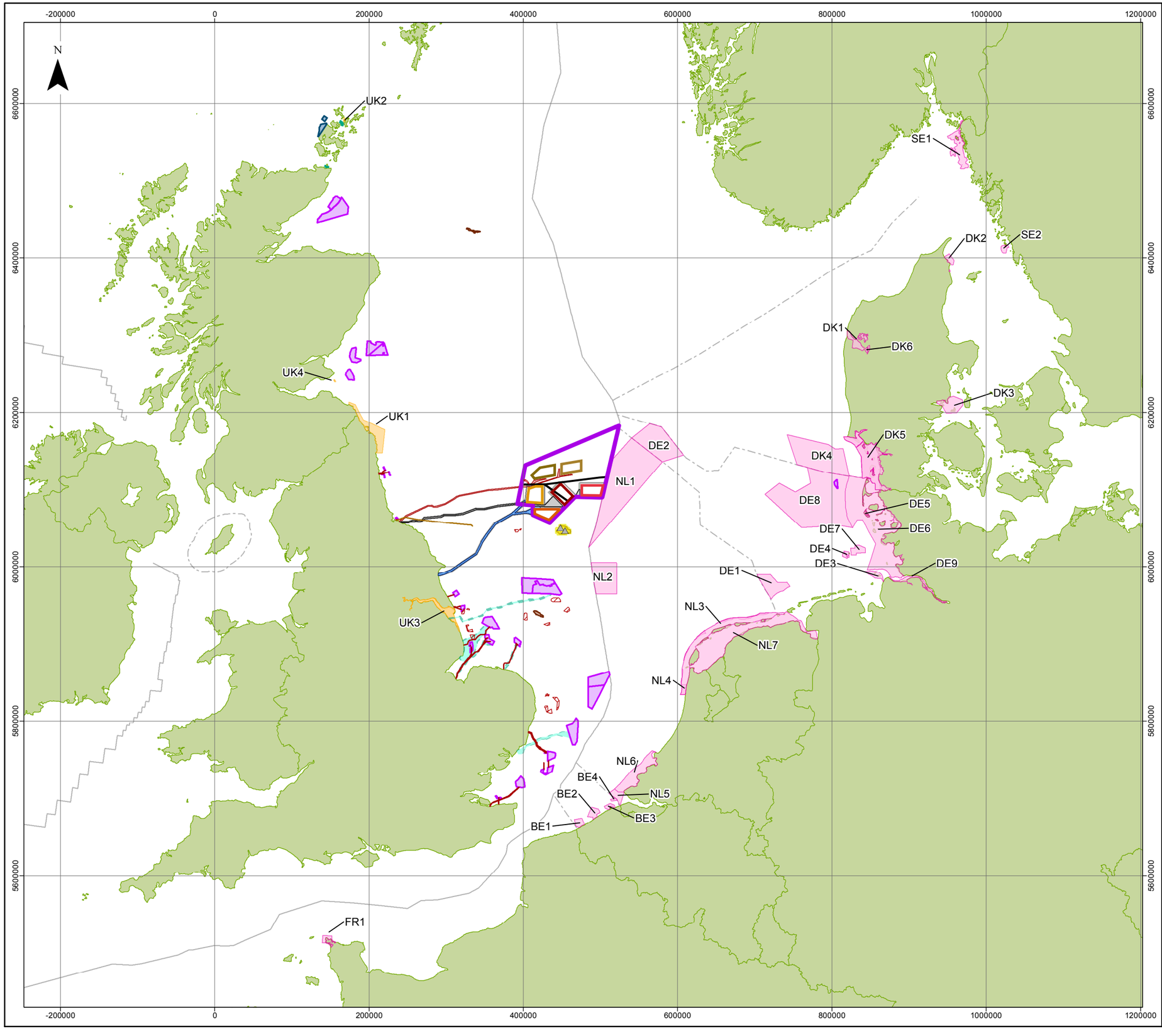
| Type of project | Project title | Project status | Predicted construction/ development period | Confidence in project details | Confidence in project data | Potential in-combination impact |
|---|---|---|---|---|---|---|
| Offshore wind farm | Inch Cape | Pre-consent | 2015-2019 | Medium | Medium | Underwater noise - disturbance and auditory injury, collision risk and indirect impacts on prey |
| | Kentish Flats Extension | Consented | 2015 | Medium | Medium | Underwater noise - disturbance and auditory injury, collision risk and indirect impacts on prey |
| | Lincs | Consented | 2011-2013 | High | High | Underwater noise - disturbance and auditory injury, collision risk and indirect impacts on prey |
| | London Array II | Consented (subject to a Grampian condition) | 2014-2015 | High | High | Underwater noise - disturbance and auditory injury, collision risk and indirect impacts on prey |
| | Moray Firth – Telford, Stevenson and MacColl | Pre-consent | 2015-2019 | Medium | Medium | Underwater noise - disturbance and auditory injury, collision risk and indirect impacts on prey |
| | Neart na Gaoithe | Pre-consent | 2014-2017 | Medium | Medium | Underwater noise - disturbance and auditory injury, collision risk and indirect impacts on prey |
| | East Anglia ONE | Pre-consent | Post 2015 | High | Medium | Underwater noise - disturbance and auditory injury, collision risk and indirect impacts on prey |
| | East Anglia THREE | Pre-consent | Post 2016 | Medium | Medium | Underwater noise - disturbance and auditory injury, collision risk and indirect impacts on prey |
| | East Anglia FOUR | Pre-consent | Post 2016 | Medium | Medium | Underwater noise - disturbance and auditory injury, collision risk and indirect impacts on prey |
| | Offshore- Bürger-windpark Butendiek (Germany) | Consented | Post 2012 | High | High | Underwater noise - disturbance and auditory injury, collision risk and indirect impacts on prey |
| | Race Bank | Consented | 2013-2014 | Medium | Medium | Underwater noise - disturbance and auditory injury, collision risk and indirect impacts on prey |

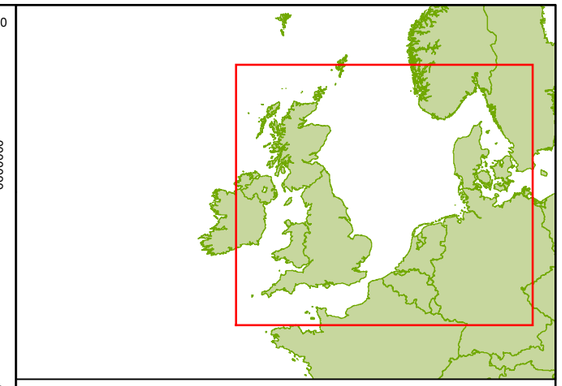

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| Type of project | Project title | Project status | Predicted construction/ development period | Confidence in project details | Confidence in project data | Potential in-combination impact |
|---|---|---|---|---|---|---|
| Offshore wind farm | Teesside Offshore Windfarm | Under construction | 2012-2013 | High | High | Underwater noise - disturbance and auditory injury, collision risk and indirect impacts on prey |
| | Triton Knoll | Consented | 2017-2021 | Medium | Medium | Underwater noise - disturbance and auditory injury, collision risk and indirect impacts on prey |
| | Westermost Rough | Consented | 2012-2014 | High | High | Underwater noise - disturbance and auditory injury, collision risk and indirect impacts on prey |
| Oil and Gas | Cygnus Alpha | In development | Post 2012 | Medium | Medium | Underwater noise - disturbance, collision risk and indirect impacts on prey |
| | Cygnus Bravo | In development | Post 2012 | Medium | Medium | Underwater noise - disturbance, collision risk and indirect impacts on prey |
| Oil/Gas Field | Ensign | In development | 2012- | Medium | Medium | Underwater noise - disturbance, collision risk and indirect impacts on prey |
| | Rochelle | In development | 2012- | Medium | Medium | Underwater noise - disturbance, collision risk and indirect impacts on prey |
| Tidal | Cantick Head | Pre-consent | Post 2013 | Medium | Medium | Underwater noise - disturbance, collision risk and indirect impacts on prey |
| | Westray South | Pre-consent | Post 2013 | Medium | Medium | Underwater noise - disturbance and collision risk |
| Wave Energy | Brough Head (Aquamarine Power) | Pre-consent | Post 2013 | Medium | Medium | Underwater noise - disturbance, collision risk and indirect impacts on prey |
| | Costa Head | Pre-consent | Post 2013 | Medium | Medium | Underwater noise - disturbance, collision risk and indirect impacts on prey |
| | Inner Sound | Pre-consent | Post 2013 | Medium | Medium | Underwater noise - disturbance, collision risk and indirect impacts on prey |


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## 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
- Offshore wind farm
- North Sea wind farm export cable route
- Indicative North Sea wind farm cable corridor
- Tidal energy project
- Wave energy project
- Aggregate application area
- Cygnus proposed subsurface infrastructure
- Cygnus gas field development
- Oil and gas field
- Breagh pipeline
- UK Special Area of Conservation (SAC)/Ramsar site
- European Sites of Community Importance (SCI)/Ramsar site

0 50 100 200
Kilometres

Data Source:
Environmental Designations © JNCC/European Environment Agency, 2014
Oil and Gas © DECC, 2014
UK energy projects and Aggregate areas © The Crown Estate, 2014
European wind farm boundary data supplied by MarineFind, 2014

PROJECT TITLE

*Dogger Bank Teesside A & B*
IfAA Report

DRAWING TITLE

**Figure 7.11 Other projects considered for in-combination assessment on grey seal and harbour porpoise Annex II species**

| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 15/10/2013 | PEI3 | LW | PT |
| 2 | 18/03/2014 | DCO Submission | JE | PT |
| | | | | |

DRAWING NUMBER:

**9Y0986/TSABHRA/55/R2**

| SCALE | PLOT SIZE | DATUM | PROJECTION |
|---|---|---|---|
| 1:5,000,000 | A3 | WGS84 | UTM31N |

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7.6.8 The remaining types of projects, relating to wave and tidal developments, have the potential for disturbance from underwater noise, during construction and operation of the device and from vessels, as well as collision risk with vessels and devices and indirect effects from impacts on prey.

## Impacts on grey seal populations

### Alteration to prey species and impact on grey seal population

7.6.9 The mobility of seals and flexibility in prey selection suggests that short-term and localised changes in fish abundance during construction and operation would not compromise the ability of grey seal populations within the North Sea to gain sufficient prey. This conclusion is reached with respect to Dogger Bank Teesside A & B and is also likely to hold true for other projects where short-term changes in habitat conditions and disturbance to prey species may occur. There is no evidence to suggest that the in-combination effects of infrastructure development / human activities within the North Sea over previous decades has resulted in any detrimental impact on the prey species of grey seal. Indeed, as reported in Section 5.5, the North Sea population of grey seal has increased significantly since the 1980's, suggesting that prey availability has not acted as a constraint to population growth. Based on this historical perspective of development, it is therefore concluded that further infrastructure development and human activities in the North Sea would be unlikely to have an effect on prey resources that would lead to an impact on grey seal populations.

### PTS and TTS (behavioural change) due to underwater noise

#### *Dogger Bank Teesside A & B construction phase*

7.6.10 Underwater noise generated by vessels associated with activities such as dredging and cable-laying would be unlikely to give rise to risk of PTS. TTS could arise locally in the vicinity of vessels, particularly in situations where vessels are slow moving (e.g. aggregate dredging), but given the intermittent, temporary and localised nature of such activities and related noise disturbance effects any impacts on grey seal would be of a similar intermittent and temporary nature.

7.6.11 In respect of the in-combination effect of wind farm development, where underwater noise effects associated with piling may be of significance, the work undertaken for Dogger Bank Teesside A & B can be used as an indicator as to the likely in-combination effect with other offshore wind farms. As concluded in **Table 5.10** and paragraph 5.6.19) only a very small percentage of the overall grey seal population would be at risk of PTS, and taking into account the proposed mitigation measures (see Section 5.9) which would minimise any potential risk of grey seal being affected, the risk of PTS is considered negligible. Similar mitigation measures would be expected for marine piling for the other wind farm projects. Consequently, Dogger Bank Teesside A & B in-combination with other projects (those listed in **Table 7.12**) is not predicted to adversely affect the grey seal populations within the North Sea as a result of PTS.

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7.6.12 Whilst Dogger Bank Teesside A & B could disturb and result in displacement through avoidance of up to 0.019% of the North Sea grey seal population, as piling would be progressive and effectively represent a sequence of localised individual disturbance events, seals that may be present in the vicinity of piling would be able to relocate to adjacent areas in order to avoid potential exposure to high underwater noise levels. Similarly, there is a significant distance between piling works that would take place within the Dogger Bank Teesside A & B development area and other projects (including Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D) such that there would be no overlap of areas affected by this disturbance effect. Given this characteristic (that there would be no overlapping convergence of noise disturbance areas) of the in-combination displacement, together with the extent of available alternative foraging area, and the low sensitivity of grey seals to underwater noise, Dogger Bank Teesside A & B in-combination with other projects (those listed in **Table 7.12**) is not predicted to compromise the grey seal populations within the North Sea as a result of TTS, and any disturbance and displacement would be short-term and temporary.

7.6.13 Noise generated by vessel traffic for Dogger Bank Teesside A & B in-combination with other projects is difficult to quantify due to the wide range of project types and the disparate locations of the other projects around the North Sea. Furthermore, projects closer to shore occur in areas in which there are high numbers of vessels and in areas of increased (in comparison to Dogger Bank) grey seal activity, as recorded by seal tagging (see Section 5.5). Given the existing high levels of vessel traffic in much of the southern North Sea (see paragraphs 5.5.32 and 5.5.33) it is considered that the in-combination effect of additional vessel traffic for spatially discreet projects would not significantly contribute to any increase in underwater noise levels above that of the baseline such that a measurable behavioural response in grey seals would arise. Subsequently, no in-combination effect is predicted in relation to the grey seal populations within the North Sea.

### *Dogger Bank Teesside A & B operation phase*

7.6.14 As empirical data exists to support a conclusion of no lasting disturbance or exclusion of seals around wind farm sites during their operation, notably Tougaard *et al.* (2005) and Scheidat *et al.* (2011), no in-combination effect between projects is predicted.

7.6.15 During the operation phase for Dogger Bank Teesside A & B the amount of vessel traffic attending to and related to the wind farm will be significantly lower than during construction. Similarly, vessel numbers for the other projects would also be lower in this phase. Consequently, noise effects (disturbance) on grey seal would be reduced (spatially and in terms of frequency) than those predicted during the construction phase. Therefore, no measurable behavioural effect is predicted, as described in paragraph 7.6.13 for the operation of Dogger Bank Teesside A & B in-combination with other projects (those listed in **Table 7.12**).

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### *Dogger Bank Teesside A & B decommissioning phase*

7.6.16 In-combination underwater noise levels generated during decommissioning activities would, in all likelihood, be lower than those generated during construction as noise generating activities (e.g. pile driving or use of explosives) for those projects considered would have ceased. Consequently, decommissioning of Dogger Bank Teesside A & B in-combination with other projects (those listed in **Table 7.12**) is not predicted to compromise the grey seal populations within the North Sea as a result of PTS or behavioural response to the limited noise disturbance.

7.6.17 Whilst detail on the number and type of vessels during decommissioning of Dogger Bank Teesside A & B and other projects is not available at this stage, it is expected that vessel numbers and subsequent noise effects would be similar to those during the construction phase. Consequently, no measurable behavioural effect is predicted on the North Sea grey seal population, as described in paragraph 7.6.13 for the duration of decommissioning for Dogger Bank Teesside A & B in-combination with the other projects (those listed in **Table 7.12**).

7.6.18 Once decommissioning is completed, no additional noise sources would be present or emanate from within Dogger Bank Teesside A & B, therefore no in-combination effect could arise.

**Physical damage as a result of vessel collisions**

### *Dogger Bank Teesside A & B construction phase*

7.6.19 In-combination impacts of collision risk are hard to quantify, and the potential for collision varies between projects, vessel types, vessel speeds, and vessel activity. Although many of the projects (those listed in **Table 7.12**) would result in an in-combination increase in the amount of vessel activity over the home range of the North Sea grey seal population, there are already large numbers of vessel movements, particularly inshore, across this area.

7.6.20 Grey seals range widely across the North Sea, with movement north and south across the whole east coast of the UK (in areas of high vessel movements) as well as between the UK and southern North Sea. Given the agility and manoeuvrability of grey seals, the relatively large size and slower speeds of construction vessels likely to be used for the majority of projects during construction, it is considered unlikely that healthy grey seals would be impacted by vessel collisions except in extreme circumstances.

7.6.21 Guidance in assessing the potential risk of corkscrew injuries has been agreed by the SNCAs (SNCAs 2012). This guidance suggests that activities at greater than 30 nautical miles (c. 55km) from seal colonies (i.e. in areas of greatest use by seals) pose a low risk of potential injury. The following projects are located within 30 nautical miles (or c. 55km) from seal colonies (e.g. Donna Nook, the Farne Islands, and Abertay):

- Aggregate Area 400 (within 55km of the Donna Nook and the Wash grey seal colonies);

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- Aggregate Area 439 (within 55km of the Donna Nook and the Wash grey seal colonies);
- Aggregate Area 448 (within 55km of the Donna Nook grey seal colony);
- Aggregate Area 449 (within 55km of the Donna Nook grey seal colony);
- Aggregate Area 493 (within 55km of the Donna Nook and the Wash grey seal colonies);
- Dudgeon offshore wind farm cable route (within 55km of the Wash grey seal colony);
- Inch Cape offshore wind farm (within 55km of the Abertay grey seal colony);
- Lincs offshore wind farm (within 55km of the Donna Nook and the Wash grey seal colonies);
- Neart na Gaoithe offshore wind farm (within 55km of the Abertay grey seal colony);
- Race Bank offshore wind farm (within 55km of the Donna Nook and the Wash grey seal colonies);
- Triton Knoll offshore wind farm or cable route (within 55km of the Donna Nook and the Wash grey seal colonies); and
- Westermost Rough offshore wind farm (within 55km of the Donna Nook grey seal colony).

7.6.22 There are already very high numbers of vessel movements in the locations around the seal colonies and, as such, the grey seal populations may display habituation to vessel movements and would therefore already display avoidance reactions. Consequently, whilst a risk is present in-combination with other projects, the risk would be temporary and is predicted to result in a negligible influence through mortality on the North Sea grey seal population. Furthermore, as noted in paragraph 5.6.29, the risk of such injuries occurring as a result of Dogger Bank Teesside A & B is considered to be low and no impact at the population level would be likely to arise due to its distance from the various colonies.

### *Dogger Bank Teesside A & B operation phase*

7.6.23 For the reasons described and assessed in paragraph 7.6.19 and given the lower numbers of vessels that would be present within the operation phase for Dogger Bank Teesside A & B in-combination with the other projects (those listed in **Table 7.12**) a negligible risk and impact on the North Sea grey seal population is predicted.

### *Dogger Bank Teesside A & B decommissioning phase*

7.6.24 Whilst detail on the number and type of vessels during decommissioning for Dogger Bank Teesside A & B and all other projects is not available at this stage, it is expected that vessel numbers and subsequently the potential in-combination impact on the North Sea grey seal population as a result of hull impacts or effects from ducted propellers is predicted to be similar to that

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identified for the construction phase (see paragraph 7.6.19). Consequently, no measurable in-combination effect is predicted on the North Sea grey seal population for the short-term duration of decommissioning.

**Alteration to behaviour due to barrier effect and impact on grey seal population**

7.6.25 The presence of Dogger Bank Teesside A & B and other wind farm projects could be seen as having the potential to create a physical barrier, preventing movement or migration of grey seals between important feeding and / or between breeding areas and populations. However, as identified for Dogger Bank Teesside A & B (see paragraph 5.7.7), surveys at existing wind farms show little evidence to suggest that marine mammals (including grey seals) avoid these areas, and tend to indicate that they may be attracted to wind farms for foraging, therefore no population level impact is predicted on grey seal.

## Assessment against Conservation Objectives and conclusions on integrity

7.6.26 The assessment of the construction phase for Dogger Bank Teesside A & B in-combination with other projects (those listed in **Table 7.12**) is based on the assessed impacts presented in paragraphs 7.6.9 to 7.6.25. This in-combination assessment relates to the Berwickshire and North Northumberland Coast SAC, Isle of May SAC, and the Humber Estuary SAC. However, given the very wide ranging nature of the North Sea grey seal population, as noted in tagging studies reported in the baseline (see Section 5.5), and the negligible use of Dogger Bank Teesside A & B by seals from the above SACs (0.15%, 0.22% and 2.74% of foraging time at sea of the grey seal population of the Berwickshire and North Northumberland Coast SAC, Isle of May SAC, and the Humber Estuary SAC (and Ramsar site), respectively), the assessment has been undertaken with regard to the southern North Sea grey seal population as a whole.

7.6.27 In-combination disturbance effects that could occur as a result of construction activity associated with Dogger Bank Teesside A & B and the other projects would be spatially dispersed, temporary, short-term, and would not be expected to influence or result in a decrease in the population of grey seals for which SACs have been designated. Furthermore, where individuals may be temporarily affected, they have a low sensitivity to disturbance effects and are known, (from tagging studies) to exploit very large areas for foraging. In circumstances where seals may be subject to disturbance effects, they have the capacity to avoid sources of disturbance in order to continue foraging. There is no evidence to indicate that prey resources would be affected to the degree that foraging success or energetics of grey seal would be adversely affected.

7.6.28 As such, it is concluded that the construction phase for Dogger Bank Teesside A & B in-combination with the other projects (those listed in **Table 7.12**) would not affect the achievement of favourable condition with respect to the criteria and targets of all the attributes related to the grey sea feature of the UK SACs under consideration.

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7.6.29 Overall, it is therefore concluded that there would not be an adverse effect on the integrity of the Berwickshire and North Northumberland Coast SAC, Faray and Holm of Faray SAC, Isle of May SAC, and Humber Estuary SAC (and Ramsar site) as a result of the construction of Dogger Bank Teesside A & B in-combination with other projects (assuming the worst case scenario) or any other scenario (i.e. Dogger Bank Teesside A or Dogger Bank Teesside B alone and in-combination with other projects).

7.6.30 For the operational phase of Dogger Bank Teesside A & B and the other projects, in-combination disturbance effects that could give rise to significant impacts on grey seal populations would not be expected. There is no available evidence to indicate that underwater noise levels generated by operational wind turbines, presence of subsea cables, or localised aggregate dredging, affect or disturb grey seals such that displacement or adverse changes in foraging behaviour would be likely to occur. Vessel noise and collision risk are assessed as being of negligible influence at the population level. Overall, in-combination disturbance effects would therefore be unlikely to result in adverse impacts on the energetics of seals from SAC colonies that may be present in the area of Dogger Bank Teesside A & B and the other sites during their operation phase. As such, it is concluded that the operational phase for Dogger Bank Teesside A & B in-combination with the other projects (those listed in **Table 7.12**) would not affect the achievement of favourable condition with respect to the criteria and targets of all the attributes and features related to the grey seal feature of the SACs.

7.6.31 Overall, it is therefore concluded that there would not be an adverse effect on the integrity of the Berwickshire and North Northumberland Coast SAC, Faray and Holm of Faray SAC, Isle of May SAC and Humber Estuary SAC (and Ramsar site) as a result of the operation of Dogger Bank Teesside A & B in-combination with other projects (assuming the worst case scenario) or any other scenario (i.e. Dogger Bank Teesside A or Dogger Bank Teesside B alone and in-combination with other projects).

7.6.32 Given that the in-combination effects of the decommissioning phase are likely to be the same, albeit smaller in magnitude and intensity, to those described and assessed for the construction phase (see paragraphs 7.6.27 to 7.6.29 above), and given that all effects would be temporary, there would not be an adverse effect on the integrity of the Berwickshire and North Northumberland Coast SAC, Faray and Holm of Faray SAC, Isle of May SAC, and Humber Estuary SAC (and Ramsar site) as a result of the decommissioning of Dogger Bank Teesside A & B in-combination with other projects (assuming the worst case scenario) or any other scenario (i.e. Dogger Bank Teesside A or Dogger Bank Teesside B alone and in-combination with other projects).

**Transboundary sites**

7.6.33 With regard to the in-combination effects of disturbance during construction and potential prey displacement, the conclusions drawn in respect of grey seals that may originate from UK SACs (see paragraphs 7.6.26 to 7.6.32 above) also apply to non-UK designated populations. Essentially, this conclusion reflects the observed data that grey seals spend the majority of their time at sea within

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relative proximity to their breeding colonies. The proportion of the grey seal population at individual colonies spending a significant amount of time foraging in offshore waters at distance from colonies is likely to be small. Grey seals are therefore more likely to be affected by projects that lie within their normal foraging range. In-combination, the contribution of foraging effort within Dogger Bank is likely to be very small in comparison to the total effort taking place close to colonies. Given this, the in-combination impact of Dogger Bank Teesside A & B on grey seal populations / colonies is considered to be no greater than that likely to arise with respect to individual projects in closer proximity to sites where this species is a designated feature.

7.6.34 Overall, it is considered that the construction, operation, and decommissioning of Dogger Bank Teesside A & B in-combination with other projects would not have an adverse effect on the integrity of the grey seal populations of the transboundary sites (listed in **Table 5.1**) assuming the worst case scenario or any other scenario (i.e. Dogger Bank Teesside A or Dogger Bank Teesside B alone and in-combination with other projects).

## 7.7 Assessment of in-combination effects on the integrity of transboundary sites supporting the Annex II harbour porpoise feature

7.7.1 This section screens the activities and effects of Dogger Bank Teesside A & B against the potential activities of other plans and projects, in order to assess the in-combination effects on the harbour porpoise population in relation to the transboundary European sites (SCIs and pSCIs) listed in **Table 5.1**. This component of the information for appropriate assessment relates only to transboundary European sites as there are no UK SACs supporting harbour porpoise that would be affected or that have been screened into this assessment. The assessment work presented below therefore relates the assessment presented in the ES to the harbour porpoise feature of the transboundary SCIs, noting the North Sea scale of the harbour porpoise population and movements.

### Other projects

7.7.2 The following effects have been identified and examined in the alone assessment of Dogger Bank Teesside A & B with respect to the harbour porpoise population in relation to the transboundary European sites:

- Changes in harbour porpoise prey species (fish) distribution, density or quality arising from increased suspended sediment concentrations in the water column and re-deposition of sediment from the water column during construction, operation, and decommissioning;
- Direct effects on the harbour porpoise population as a result of behavioural changes arising from a barrier effect due to the presence and operation of the wind turbines;
- Direct physical damage (mortality) and indirect physical damage (avoidance) to harbour porpoise population as a result of underwater noise

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due to pile driving and vessel movements during construction, operation, and decommissioning;

- Direct physical damage (mortality) to harbour porpoise population as a result of collisions with vessels during construction, operation, and decommissioning;
- Indirect physical damage to harbour porpoise as a result of behavioural changes arising from the presence of electromagnetic fields from underwater electrical cables; and
- Indirect effects on the harbour porpoise population as a result of behavioural changes arising from the increase in underwater noise levels due to the operation of the wind turbines.

7.7.3 Screening of the above effects against other projects has been undertaken in order to determine those projects that have the potential to interact with the effects of Dogger Bank Teesside A & B, and the potential to result in effects on harbour porpoise populations within the North Sea (i.e. disturbance zones overlap with the areas where harbour porpoise are present). The list of projects screened in is presented in **Table 7.12**, and the range and number of projects identified are the same as for grey seals (see paragraph 7.5.3). The list of projects has been derived from a 'study area' which encompasses the range of the North Sea harbour porpoise population (see **Figure 7.11**) based on the IAMMWG North Sea (NS) Management Unit (IAMMWG 2013).

## Impacts on harbour porpoise

### Alteration to prey species and impact on harbour porpoise population

#### *Dogger Bank Teesside A & B construction phase*

7.7.4 There is a large amount of uncertainty with regard to the potential impact of any changes in prey availability that could occur as a result of the projects listed in **Table 7.12**. However, the projects considered in the cumulative assessment of impacts for fish presented in Section 10 in **Chapter 13** of the Dogger Bank Teesside A & B ES concluded that only **minor adverse** impacts would arise, in-combination with other projects.

7.7.5 The mobility of harbour porpoise and flexibility in prey selection suggests that any short-term and localised changes in fish abundance during construction of Dogger Bank Teesside A & B in-combination with the other projects would not compromise the ability of harbour porpoise that are present within and around all projects to gain sufficient prey. In addition, any disturbance to prey species would occur within areas harbour porpoise are likely to avoid due to noise disturbance. Consequently, given the low sensitivity of harbour porpoise to small changes in prey abundance and spatial distribution, as they follow prey and take a wide range of prey depending on availability, it is concluded that there would be no discernible implications for the harbour porpoise population during the construction phase.

#### *Dogger Bank Teesside A & B operation phase*

7.7.6 Evidence from studies described in paragraph 5.17.2 indicate that there is no observable change to harbour porpoise activity and numbers at Horns Rev and

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other wind farms during their operation. It is, therefore, concluded that Dogger Bank Teesside A & B would have **no impact** on harbour porpoise during the operation phase. Therefore, no in-combination effect is predicted as a result of the operation of Dogger Bank Teesside A & B and other projects.

### *Dogger Bank Teesside A & B decommissioning phase*

7.7.7 Small-scale and temporary disturbance to the seabed would occur during decommissioning of Dogger Bank Teesside A & B, with significantly lower levels of increased suspended sediment concentrations and sediment deposition than during construction. Such changes are unlikely to give rise to any significant impact on prey species (as described in paragraph 5.16.2). Similar effects are predicted during both operation and decommissioning of other wind farms (assuming that some wind farms may still be operating when Dogger Bank Teesside A & B is decommissioned). Given the temporary nature of decommissioning impacts, the very small-scale or non-existent impact of operational activities, and the low sensitivity of harbour porpoise to minor changes in prey species abundance, no measurable in-combination impact on the harbour porpoise population is predicted.

## PTS and TTS (behavioural change) due to underwater noise

### *Dogger Bank Teesside A & B construction phase*

7.7.8 Displacement and possible mortality of harbour porpoise due to underwater piling (and other associated noise generating activities) during construction of Dogger Bank Teesside A & B and other projects, is not quantified through any supporting empirical evidence or studies, though it has been undertaken for Dogger Bank Teesside A & B alone due to the information available. Whilst harbour porpoise require food regularly, and individuals could potentially die without food for three days (Kastelein *et al*. 1997), their avoidance of any area of disturbance would be highly unlikely to lead to mortality because of the wide ranging foraging and their ability to feed on a variety of common prey species with widespread distributions.

7.7.9 **Table 7.13** presents a summary of the information available from offshore wind farm projects considered in this in-combination assessment. For many of the offshore wind farm developments there is limited quantified information on the area of displacement or the total number of harbour porpoise that could be disturbed by pile driving. Of the projects presented in **Table 7.13**, the following could take place at the same time as Dogger Bank Teesside A & B:

- Beatrice;
- Dogger Bank Creyke Beck A & B;
- Dogger Bank Teesside C & D;
- Dudgeon;
- East Anglia ONE;
- East Anglia THREE;
- East Anglia FOUR;

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- Firth of Forth (Phase 1);
- Galloper;
- Hornsea Project One;
- Hornsea Project Two;
- Humber Gateway;
- Inch Cape;
- Lincs;
- London Array II;
- Moray Firth (Moray Firth - Telford, Stevenson and MacColl).
- Neart na Gaoithe;
- Race Bank;
- Triton Knoll; and
- Westermost Rough.

7.7.10 Where impacts are not quantified within the relevant ESs for the projects in **Table 7.13**, the number of animals that potentially could be disturbed have been quantified using an approximation of impacted areas from the impact range, and average densities based on the SCANS II data (Hammond *et al.* 2013) for the relevant project area. Some operational projects have been included in order to provide an indication of pre-Dogger Bank Teesside A & B in-combination assessment.

7.7.11 **Table 7.15** presents the predicted number of harbour porpoise that may be disturbed each year due to pile driving noise for all other considered projects (notably offshore wind farms), whilst **Table 7.16** presents the predicted area of displacement each year. The quantities in the tables are presented in a timeline, along with an assessment of the relative confidence in the quantification of impacts, and a summary of the effects in relation to the population and extent in each year.

7.7.12 As shown in **Table 7.15**, in 2016 up to 21% of the North Sea population of harbour porpoise potentially could be disturbed by piling for all current and proposed (but not yet consented) offshore wind farm projects, in-combination with Dogger Bank Teesside A & B. Over 10% of the North Sea population of harbour porpoise potentially could be disturbed between 2016 and 2018, with less than 1% of the population affected before 2014 and after 2020. Given the differing assessments and the approach taken here this is considered to be a very precautionary indication of the potential magnitude of disturbance. However, determining the impact of the disturbance effect on the harbour porpoise population is fraught with uncertainty. Whilst concurrent pile driving could occur between and through the years of 2014 to 2020 this would result in a reduction of the amount of habitat available at any one time. As shown in **Table 7.16**, between 5% and 11% of the habitat available to harbour porpoise in the North Sea between 2015 and 2018 potentially could be subject to levels of underwater noise due to piling, such that this area could be actively avoided.

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However, this assumes a 100% displacement, whereas in reality it is reasonable to assume that avoidance is likely to occur in 50% to 75% of individuals.

7.7.13 As stated previously, there is significant uncertainty regarding the potential mortality impact that may arise as a result of displacement. However, the mobility and extensive range of harbour porpoise, together with their ability to take a wide range of prey species and respond to the availability of changing abundance of prey species, suggests that displacement would be unlikely to lead to any significant mortality. While it is possible that a large percentage of the population could be displaced annually for the duration of piling, the in-combination risk of mortality and subsequent impact on the population in the long-term is considered to be negligible, particularly as even in the worst case, at least 89% of the foraging available to harbour porpoise would remain unaffected at any time, and only for one year, prior to and after which a greater area of foraging area would be undisturbd and available.

7.7.14 Given the existing levels of vessel traffic (see paragraphs 5.5.32 and 5.5.33) within the area of Dogger Bank and other areas of the North Sea in which the relevant projects are located, particularly inshore areas, it is not expected that the presence and movement of vessels associated with project development and maintenance would significantly increase the underwater noise above that of the baseline. Whilst some data support the probability that small cetaceans avoid areas of intense boat activity (Thomsen *et al*. 2006) given the density and presence of harbour porpoise across the North Sea, it is likely that they are to some extent habituated to vessel movements. Furthermore, studies indicate that noise levels from large surface vessels are unlikely to cause physiological damage (Malme *et al.* 1989; Richardson *et al*. 1995). Whilst some localised disturbance may arise, it should be noted that, during construction, that vessel movements would be largely expected to be to and from areas of greater disturbance resulting from piling works for wind farms. Consequently, it is predicted that a measurable behavioural response to vessel movements and associated underwater noise would not arise on harbour porpoise from the construction of Dogger Bank Teesside A & B in-combination with other projects (particularly wind farms which are likely to result in a greater degree of vessel movements compared to other projects).

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Table 7.13 Offshore wind farm projects included in the in-combination assessment for harbour porpoise (information has been taken from the ES chapter for each development where available or other sources as detailed, and SCANS II densities are taken from Hammond *et al*. 2013)

| Project title | Project status | Predicted construction period | Total number of turbines (foundation type) and capacity[1] | Number of pile driving events | Assessment of disturbance[2] | Assessment of pile driving in each project's ES | Data source |
|---|---|---|---|---|---|---|---|
| Teesside Offshore Windfarm | Operational | 2012-2013 | 27 (monopole) 62.1MW | 27 | Impacts are not quantified in the project ES. Impact ranges likely to be small and porpoise densities low due to site characteristics (proximity to shore). Impacts not quantified in this CIA due to limited information. | Not significant | EDF Energy (2004) |
| Lincs | Constructed | 2011-2013 | 75 (monopole) 270MW | 75 | Impacts are not quantified in the project ES. Pile driving stated as audible to marine mammals out to 20km. Average densities of porpoise in SCANS II block U are 0.598 animals per $km^2$ (CV 0.28). Estimate of up to 751 porpoise disturbed (assuming spherical impact). | Minor | Lincs Wind Farm Limited (2010) |
| Triton Knoll | Pre-consent | 2017-2021 | 288 (4-legged jackets) 400MW | 1,152 | Up to 948 disturbed porpoise per pile. Assessed as minor. | Minor | RWE Npower Renewables Limited (2012) - Chapter 5 |
| Blyth Demonstration Site (NaREC) | Pre-consent | 2014-2016 | 15 (monopole) 4MW | 15 | Impacts are not quantified in EIA, therefore not quantified in this CIA due to limited information. | N/A | NaREC (2013) |


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| Project title | Project status | Predicted construction period | Total number of turbines (foundation type) and capacity[1] | Number of pile driving events | Assessment of disturbance[2] | Assessment of pile driving in each project's ES | Data source |
|---|---|---|---|---|---|---|---|
| Inch Cape | Pre-consent | 2016-2017 | 213 (4-legged jackets) 905MW | 852 | Worst case on 556 harbour porpoise during two concurrent piling events. There is potential overlap in noise footprints between Firth of Forth, Neart na Gaoithe and Inch Cape. It is likely that non-cumulative pile driving impacts from these projects will be less than the sum of each individual project as presented here. | Minor | Inch Cape Offshore Limited (2013) |
| Neart na Gaoithe | Pre-consent | 2014-2017 | 90 (4-legged jackets) 450MW | 360 | Up to 887 per piling event. There is potential large overlap in noise footprints between Firth of Forth, Neart na Gaoithe and Inch Cape It is likely that non-cumulative pile driving impacts from these projects will be less than the sum of each individual project as presented here. | Minor | Mainstream Renewable Power (2012 - Section 13; 2013) |
| Firth of Forth (Phase 1) | Pre-consent | 2015-2016 | Phase 1 Alpha - 75 (4-legged jackets) 525 MW Phase 1 Bravo - 75 (4-legged jackets) 525MW Total 150 turbines | 600 | 2,543 porpoise based on two concurrent projects piling (Project Alpha and Project Bravo). There is potential for overlap in noise footprints between Firth of Forth, Neart na Gaoithe, and Inch Cape. It is likely that non-cumulative pile driving impacts from these projects will be less than the sum of each individual project as presented here. | Negligible | Seagreen Wind Energy (2012) |


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| Project title | Project status | Predicted construction period | Total number of turbines (foundation type) and capacity[1] | Number of pile driving events | Assessment of disturbance[2] | Assessment of pile driving in each project's ES | Data source |
|---|---|---|---|---|---|---|---|
| Bürger-windpark Butendiek | Consented | Post 2014 | 80 (monopole) 288MW | 80 | No project ES available to quantify numbers of harbour porpoise disturbed. Impacts are not quantified in this CIA due to limited information. | Intermediate risk and intermediate intensity of negative effects on harbour porpoise concluded | Offshore-Bürger-Windpark Butendiek (2002) |
| Beatrice | Pre-consent | 2014-2017 | 277 (4-legged jackets) 1,000MW | 1,108 | 4,337 individuals per piling event will experience a behavioural impact. There is potential for a small overlap in noise footprints between Beatrice and Moray Firth (Telford, Stevenson and MacColl). It is likely that non-cumulative pile driving impacts from these projects will be less than the sum of each individual project as presented here. | Minor | Arcus Renewable Energy Consulting Limited (2012) - Section 12 |
| Dogger Bank Teesside A & B | Pre-consent | Post 2016 | Dogger Bank Teesside A - 200 (6-legged jackets) 1,200MW. Dogger Bank Teesside B – 200 (6-legged jackets) 1,200MW. Total 400 turbines | 2,400 | 11,437 (possible avoidance) based on modelling for Dogger Bank Teesside A & B, Dogger Bank Teesside C & D and Dogger Bank Creyke Beck A & B (based on monopole impact areas). | Moderate (cumulatively) | See **Table 7.14** |


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| Project title | Project status | Predicted construction period | Total number of turbines (foundation type) and capacity[1] | Number of pile driving events | Assessment of disturbance[2] | Assessment of pile driving in each project's ES | Data source |
|---|---|---|---|---|---|---|---|
| Dogger Bank Teesside C & D | Pre-consent | Post 2016 | Dogger Bank Teesside C - 200 (6-legged jackets) 1,200MW, based on Dogger Bank Teesside A.<br>Dogger Bank Teesside D - 200 (6-legged jackets) 1,200MW, based on Dogger Bank Teesside A.<br>Total 400 turbines | 2,400 | Included in Dogger Bank Teesside A & B total above. | Moderate (cumulatively) | See **Table 7.14** |
| Dogger Bank Creyke Beck A & B | Pre-consent | Post 2016 | Dogger Bank Creyke Beck A - 300 4MW devices (4-legged jackets) 1,200MW.<br>Dogger Bank Creyke Beck B - 300 4MW devices (4-legged jackets) 1,200MW. | 2,400 | Included in Dogger Bank Teesside A & B total above. | Moderate (cumulatively) | See **Table 7.14** |
| Moray Firth - Telford, Stevenson and MacColl | Pre-consent | 2015-2019 | Telford - 113 (4-legged jackets) 500MW<br>Stevenson - 113 (4-legged jackets) 500MW<br>MacColl - 113 (4-legged jackets) 500MW<br>Total 339 turbines | 1,356 | 5,149 individuals based on the three projects piling concurrently.<br>There is potential for a small overlap in noise footprints between Beatrice and Moray Firth. It is likely that non-cumulative pile driving impacts from these projects will be less than the sum of each individual project as presented here. | Minor | Moray Offshore Renewables Limited (2013) |


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| Project title | Project status | Predicted construction period | Total number of turbines (foundation type) and capacity[1] | Number of pile driving events | Assessment of disturbance[2] | Assessment of pile driving in each project's ES | Data source |
|---|---|---|---|---|---|---|---|
| Galloper | Consented | 2014-2016 | 140 (4-legged jackets) 504MW | 560 | Up to 1,780 porpoise per piling event. | Minor | Royal Haskoning (2011) - Chapter 14 |
| Hornsea (Project One) | Pre-consent | 2015- up to five years (30 months pile driving) | 322 turbines. A total of 339 (8.5m) monopoles 1.2GW | 339 | Draft ES details ranges of likely disturbance to 46.6km for maximium hammer energy. Disturbance of up to 6,849 harbour porpoise based on concurrent pile driving and visual density estimates. | Draft ES available. Moderate adverse in medium term, minor adverse in long term | SMart Wind Limited (2013) |
| Hornsea (Project Two) | Pre-consent | Post 2015 | Up to 360 (monopole) 1.8GW | 360 | No project ES available. Impacts are likely to be comparable to Hornsea One. | No Project ES | SMart Wind Limited (2012) |
| Humber Gateway | Consented | 2013-2014 | 73 (monopole) 219MW | 73 | Disturbance to 11.4km range, but numbers impacted not quantified in the ES. Average densities of porpoise in SCANS II block U are 0.598 animals per $km^2$ (CV 0.28). Estimate of 244 porpoise disturbed (assuming spherical impact). | Minor | ERM (2008) - Section 11 |
| Dudgeon | Consented | 2016 | 75 (4-legged jackets) 560MW | 308 | Up to 2,166 porpoise per piling event. | Minor | Dudgeon Offshore Wind Farm (2013) |


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| Project title | Project status | Predicted construction period | Total number of turbines (foundation type) and capacity[1] | Number of pile driving events | Assessment of disturbance[2] | Assessment of pile driving in each project's ES | Data source |
|---|---|---|---|---|---|---|---|
| London Array II | Consented (subject to a Grampian condition) | 2014-2015 | 65 (monopole) 370MW | 65 | Strong avoidance to 7.7km. Impacted numbers not quantified in the ES. Average densities of porpoise in SCANS II block B are 0.331 animals per $km^2$ (CV 0.38). Estimate of up to 62 porpoise disturbed (assuming spherical impact). | Minor-moderate | RPS (2005) |
| Race Bank | Consented | 2017 | 116 (undecided) 580MW | 116 | Disturbance out to 12km, but numbers of individuals impacted not quantified in the ES. Average densities of porpoise in SCANS II block U are 0.598 animals per $km^2$ (CV 0.28). Estimate of 271porpoise disturbed (assuming spherical impact). | Minor to moderate. | AMEC (2009) |
| Westermost Rough | Consented | 2014-2015 | 35 (4-legged jackets) 220MW | 140 | Impacted numbers not quantified in the ES, but ranges of likely disturbance are estimated at 10km. Average densities of porpoise in SCANS II block U are 0.598 animals per $km^2$ (CV 0.28). Estimate of 188 porpoise disturbed (assuming spherical impact). | Minor adverse. | Dong Energy (2009) |
| East Anglia ONE | Pre-consent | 2015-2017 | 325 (4-legged jackets) 1,200MW | 1,300 | Possible avoidance over 1,433km2 Disturbance of: 1,433 animals (maximum SCANS II densities, 1 animals per $km^2$) 2,006 animals (based on site specific aerial surveys, 1.4 animals per $km^2$). It should be noted that JCP surveys suggest densities may be higher than this in the zone. | Not significant | East Anglia Offshore Wind Limited (2012a) |


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| Project title | Project status | Predicted construction period | Total number of turbines (foundation type) and capacity[1] | Number of pile driving events | Assessment of disturbance[2] | Assessment of pile driving in each project's ES | Data source |
|---|---|---|---|---|---|---|---|
| East Anglia THREE | Pre-consent | Post 2015 | 240 (4-legged jackets) 1,200MW | 960 | ES not available. Impacts may be comparable to East Anglia ONE. There is the potential for overlap in noise footprint between the East Anglia projects. It is likely that non-cumulative pile driving impacts from these projects will be less than the sum of each individual project as presented here. | No project ES | East Anglia Offshore Wind Limited |
| East Anglia FOUR | Pre-consent | Post 2015 | 240 (4-legged jackets) 1,200MW | 960 | ES not available. Impacts may be comparable to East Anglia ONE. There is the potential for overlap in noise footprint between the East Anglia projects. It is likely that non-cumulative pile driving impacts from these projects will be less than the sum of each individual project as presented here. | No project ES | East Anglia Offshore Wind Limited |

[1] Data source http://www.4coffshore.com/offshorewind/
[2] It should be noted that not all assessments use the same metric for assessing behavioural disturbance during noise propagation modelling.
[3] The footprint approach to calculating impacts has been used in the assessment of Dogger Bank Teesside A & B but has not generally been used in the assessment for other projects, and therefore represents a precautionary assessment of the numbers of harbour porpoise possibly disturbed by other projects.


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Table 7.14 Areas ($km^2$) of behavioural impact (based on two pile driving events at each project with maximum distances between vessels, with 3,000kJ maximum hammer energy), number of individuals impacted (and uncertainty based on 95% confidence interval around density estimates), and percentage of reference population impacted by concurrent pile driving across Dogger Bank Teesside A & B, Dogger Bank Teesside C & D, and Dogger Bank Creyke Beck A & B

| Species (reference population) | Likely avoidance | | | Possible avoidance | | |
|---|---|---|---|---|---|---|
| | Impact area | Impacted number | Percentage of reference population | Impact area | Impacted number | Percentage of reference population |
| Harbour porpoise (227,298) | 940$km^2$ | 602 (543 to 671) | 0.26% | 18,780$km^2$ | 12,030 (10,847 to 13,400) | 5.29% |
| Harbour porpoise and potential harbour porpoise combined (227,298) | | 673 (491 to 915) | 0.30% | | 13,449 (9,819 to 18,279) | 5.92% |


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Table 7.15 Timeline for magnitude of effect (number of harbour porpoise possibly disturbed) for offshore wind farm projects included in the in-combination assessment for harbour porpoise

| Project title | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | Relative confidence in quantitative assessment |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lincs | 751 | | | | | | | | | | Low |
| Triton Knoll[1] | | | | | | 948 | 948 | 948 | 948 | 948 | High |
| Inch Cape[2] | | | | | 556 | 556 | | | | | High |
| Neart na Gaoithe[1] | | | 887 | 887 | 887 | 887 | | | | | High |
| Firth of Forth (Phase 1 Projects Alpha and Bravo) | | | | 2,543 | 2,543 | | | | | | High |
| Beatrice | | | 4,337 | 4,337 | 4,337 | 4,337 | | | | | High |
| Dogger Bank Teesside A & B, Dogger Bank Teesside C & D, and Dogger Bank Creyke Beck A & B | | | | | 13,449 | 13,449 | 13,449 | 13,449 | 13,449 | | High |
| Moray Firth - Telford, Stevenson and MacColl | | | | 5,149 | 5,149 | 5,149 | 5,149 | 5,149 | | | High |
| Galloper | | | 1,780 | 1,780 | 1,780 | | | | | | High |
| Hornsea (Project One)[3] | | | | | 6,849 | 6,849 | 6,849 | | | | Medium |
| Hornsea (Project Two) | | | | | 6,849 | 6,849 | 6,849 | | | | Low |
| Humber Gateway[1] | | 244 | 244 | | | | | | | | Low |
| Dudgeon[1] | | | | | 368 | | | | | | Low |
| London Array II[1] (subject to a Grampian condition) | | | 62 | 62 | | | | | | | Low |
| Race Bank | | | | | | 271 | | | | | Low |
| Westermost Rough | | | 188 | 188 | | | | | | | Low |
| East Anglia ONE[3] | | | | 2,006 | 2,006 | 2,006 | | | | | High |
| East Anglia THREE | | | | | 2,006 | 2,006 | 2,006 | | | | Low |
| East Anglia FOUR | | | | | 2,006 | 2,006 | 2,006 | | | | Low |
| **TOTAL** | **751** | **244** | **7,254** | **16,764** | **48,417** | **45,042** | **37,256** | **19,546** | **14,397** | **948** | |
| **Percent of reference population** | **0.3** | **0.1** | **3.2** | **7.4** | **21** | **19.8** | **16.4** | **8.6** | **6.3** | **0.4** | |
| **Magnitude of effect** | **Neg.** | **Neg.** | **Low** | **Medium** | **High** | **High** | **High** | **Medium** | **Medium** | **Neg.** | **Medium** |

[1] - Area of impact not quantified in ES, assumed to be similar to Firth of Forth Project Alpha single piling event.
[2] - Area of impact not presented in ES, assumed to be similar to Beatrice.
[3] - Areas of impact are not presented in the draft ES, these provide a maximum approximation.


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Table 7.16 Timeline for magnitude of effect (area of habitat excluded in km$^2$) for offshore wind farm projects included in the in-combination assessment for harbour porpoise

| Project title | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | Relative confidence in quantitative assessment |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lincs | 1,257 | | | | | | | | | | Low |
| Triton Knoll[1] | | | | | | 863 | 863 | 863 | 863 | 863 | High |
| Inch Cape[2] | | | | | 7,174 | 7,174 | | | | | Low |
| Neart na Gaoithe | | | 4,668 | 4,668 | 4,668 | 4,668 | | | | | High |
| Firth of Forth (Phase 1 Projects Alpha and Bravo) | | | | 10,386 | 10,386 | | | | | | High |
| Beatrice | | | 8,053 | 8,053 | 8,053 | 8,053 | | | | | High |
| Dogger Bank Teesside A & B, Dogger Bank Teesside C & D, and Dogger Bank Creyke Beck A & B | | | | | 15,971 | 15,971 | 15,971 | 15,971 | 15,971 | 15,971 | High |
| Moray Firth - Telford, Stevenson and MacColl[3] | | | | 8,053 | 8,053 | 8,053 | 8,053 | 8,053 | | | Low |
| Galloper | | | 2,967 | 2,967 | 2,967 | | | | | | High |
| Hornsea Project One[1] | | | | | 8,825 | 8,825 | 8,825 | | | | Medium |
| Hornsea Project Two | | | | | 8,825 | 8,825 | 8,825 | | | | Low |
| Humber Gateway[1] | | 408 | 408 | | | | | | | | Low |
| Dudgeon[1] | | | | | 3,622 | | | | | | Low |
| London Array II[1] | | | 186 | 186 | | | | | | | Low |
| Race Bank | | | | | | 452 | | | | | Low |
| Westermost Rough | | | 314 | 314 | | | | | | | Low |
| East Anglia ONE[4] | | | | 1,433 | 1,433 | 1,433 | | | | | High |
| East Anglia THREE[5] | | | | | 1,433 | 1,433 | 1,433 | | | | Low |
| East Anglia FOUR[4] | | | | | 1,433 | 1,433 | 1,433 | | | | Low |
| **TOTAL (km$^2$)** | **1,257** | **408** | **16,596** | **36,060** | **82,843** | **67,183** | **45,403** | **24,887** | **16,834** | **16,834** | **Medium** |
| **Percent of North Sea habitat** | **0.17** | **0.05** | **2.22** | **4.81** | **11.05** | **8.96** | **6.05** | **3.32** | **2.24** | **2.24** | |

[1] Areas of impact are not presented in the draft ES, these provide a maximum approximation.
[2] Area of impact not quantified in ES, assumed to be similar to Firth of Forth Project Alpha single piling event.
[3] Area of impact not presented in ES, assumed to be similar to Beatrice.
[4] Numbers disturbed are based on site specific survey data.
[5] Areas are assumed to approximate East Anglia ONE.


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### *Dogger Bank Teesside A & B operation phase*

7.7.15 Overall, given the low levels of underwater noise from wind farms and localised aggregate dredging relative to the PTS and TTS thresholds, there is no indication that anything other than a localised response, similar to that reported in Tougaard *et al. (*2009) and McConnell *et al.* (2012) would occur. Furthermore, on the basis of the monitoring studies (see paragraphs 5.17.4, 5.17.5, and 5.17.7), it is considered that evidence indicates that no noticeable effect would occur with regard to harbour porpoise behaviour as a result of the operation of wind farms. Consequently, it is considered that no in-combination effect would arise due to disturbance during the operation phase for Dogger Bank Teesside A & B in-combination with other projects.

7.7.16 During the operation phase of Dogger Bank Teesside A & B the amount of vessel traffic attending to and related to the wind farm will be significantly lower than during construction. Similarly, vessel numbers for the other projects would also be lower in this phase if they are operating. Consequently, noise effects (disturbance) on harbour porpoise would be smaller (spatially and in terms of frequency) than those during the construction phase. Therefore, no measurable behavioural effect is predicted, as described in paragraph 7.7.14 in relation to the construction phase, for the operation of Dogger Bank Teesside A & B in-combination with other projects (those listed in **Table 7.12**).

### *Dogger Bank Teesside A & B decommissioning phase*

7.7.17 It is not possible, at this stage, to forecast the scale of potential project development at the time of decommissioning of Dogger Bank Teesside A & B. However, it is considered unlikely that development would be as intense as that predicted to occur over the forthcoming decade and it is more likely that that underwater noise levels (and consequent disturbance effects) generated during decommissioning activities would be lower than those generated during construction. Consequently, decommissioning of Dogger Bank Teesside A & B in-combination with the continued operation and decommissioning of projects (those listed in **Table 7.12**) or potential construction of other projects is not predicted to compromise the harbour porpoise populations within the North Sea as a result of PTS or behavioural response to noise disturbance.

7.7.18 Whilst detail on the number and type of vessels during decommissioning of Dogger Bank Teesside A & B and other projects is not available at this stage, it is expected that vessel numbers and subsequent noise effects would be similar to those during the construction phase. Consequently, no measurable behavioural effect is predicted on the North Sea harbour porpoise population, as described in paragraph 7.7.14 in relation to the construction phase, for the duration of decommissioning for Dogger Bank Teesside A & B in-combination with the other projects (those listed in **Table 7.12**).

7.7.19 Once decommissioning is completed, no additional noise sources would be present or emanate from within Dogger Bank Teesside A & B, therefore no in-combination effect could arise.

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**Physical damage as a result of vessel collisions**

***Dogger Bank Teesside A & B construction phase***

7.7.20 In-combination impacts of collision risk are hard to quantify, and the potential for collision varies between projects, vessel types, vessel speeds, vessel activity and species. Although all projects will increase the amount of vessel activity over the home range of harbour porpoise, there are already large numbers of commercial vessel movements across the inshore area and large numbers of fishing vessel movements across the Dogger Bank Zone. Given that there is a negligible risk of collision predicted for Dogger Bank Teesside A & B, similarly collision risk is considered to be low for the other projects considered in this in-combination assessment. Furthermore, given that harbour porpoise would be able to detect vessels and avoid them, it is considered unlikely that healthy harbour porpoise would be impacted by vessel collisions during construction in-combination with other projects listed in **Table 7.12**.

***Dogger Bank Teesside A & B operation phase***

7.7.21 Given the negligible risk of collision predicted in respect of the lower numbers of vessels that would be present or travelling to and from Dogger Bank Teesside A & B during the operation phase, a similar level of risk is also considered likely for other operational wind farms (or those under construction) within the North Sea. No measurable effect on mortality and subsequent impact on the North Sea harbour porpoise population is predicted in-combination with the other projects listed in **Table 7.12**.

***Dogger Bank Teesside A & B decommissioning phase***

7.7.22 Whilst detail on the number and type of vessels during decommissioning for Dogger Bank Teesside A & B and the other projects listed in **Table 7.12** is not available at this stage, it is expected that vessel numbers and subsequent potential for physical damage to harbour porpoise as a result of hull impacts would be similar to those during the construction phase. Consequently, no measurable population effect is predicted for the temporary duration of decommissioning in-combination with the other projects listed in **Table 7.12**.

**Indirect physical damage as a result of behavioural change due to electro-magnetic fields**

7.7.23 The presence of Dogger Bank Teesside A & B and other wind farm projects could affect harbour porpoise such that they exhibit behavioural changes, including displacement, due to the presence of electromagnetic fields (EMF) around inter-array cables. However, as identified for Dogger Bank Teesside A & B alone (see paragraphs 5.17.10 and 5.17.12), existing cables under the Baltic have not been shown to influence harbour porpoise migration and movement into and out of the Baltic (see paragraph 5.17.11), and given the shielding used as an industry standard, no population level impact is predicted on harbour porpoise in the North Sea.

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### Physical damage as a result of behavioural change due to barrier effect

7.7.24 The presence of Dogger Bank Teesside A & B and other wind farm projects could be seen as having the potential to create a physical barrier, preventing movement or migration of harbour porpoise between or to feeding and / or breeding areas. However, as identified for Dogger Bank Teesside A & B (see paragraph 5.17.13), evidence from the Egmond aan Zee offshore wind farm (Lindeboom *et al.* 2011) suggests that marine mammals (including harbour porpoise) may be attracted to the site for foraging, therefore no population level impact is predicted on the North Sea population of harbour porpoise.

## Conclusions on integrity of transboundary European sites

7.7.25 The assessment work detailed in Sections 5.16, 5.17, and 5.18, and concluded in Section 5.20 show that only a small percentage of the harbour porpoise population for the North Sea would be affected (see **Table 5.19**) as a result of for the construction of Dogger Bank Teesside A & B alone, with limited if any population level effect. Negligible if any population effects would occur during the operation and decommissioning phases.

7.7.26 As identified in paragraphs 5.16.2 to 5.16.4 for the construction of Dogger Bank Teesside A & B, no measurable effects on the harbour porpoise population are expected to arise from alteration of prey species abundance. Disturbance to prey species is not predicted to extend to areas outside of the area that harbour porpoise are predicted to avoid due to piling for the duration of construction. Furthermore, collision risk is considered to be low due to the likelihood that harbour porpoise can detect and avoid vessels. Consequently, no in-combination effect is predicted.

7.7.27 The key potential impact during construction is PTS and TTS (fleeing response and avoidance) arising from underwater noise from piling and to a significantly lesser extent vessel movements. It is considered that the use of soft-start would prevent potential mortality arising to harbour porpoise either directly or indirectly from PTS. Therefore, no population-level impact (i.e. mortality) is predicted on the North Sea harbour porpoise population in-combination with other projects.

7.7.28 The total potential area of avoidance by harbour porpoise that is predicted to occur with all projects being constructed at the same time (the extreme worst case scenario) is predicted to result in potential displacement of up to 1% (assuming 100% displacement) of the North Sea harbour porpoise population in the worst year (2016), with a lower impact predicted either prior to and afterwards, and less than 1% of the population prior to 2014 and after 2020. Given the mobility of the species, its use of a wide range of prey species, the fact that the largest extent of areas likely to be affected by many of the wind farm projects are inshore, where high densities of harbour porpoise are rarely recorded (see **Figure 5.28**), and that mortality effects are of low probability, no measurable effect is predicted on the North Sea harbour porpoise population during the construction phase for Dogger Bank Teesside A & B in-combination with the other projects (those listed in **Table 7.12**).

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7.7.29 For transboundary sites, it is assumed that in respect of the potential impacts identified, that the relevant conservation objectives relate to the maintenance of designated population levels. In this respect, the findings of the assessment work, as discussed above, would not compromise the conservation objectives and achievement of favourable condition for the harbour porpoise feature of the transboundary European sites listed in **Table 5.1.**).

7.7.30 Overall, it is concluded that there would not be an adverse effect on the integrity of the transboundary European sites (SCIs and pSCIs) listed in **Table 5.1** as a result of the construction of Dogger Bank Teesside A & B in-combination with other projects (assuming the worst case scenario) or Dogger Bank Teesside A or Dogger Bank Teesside B alone and in-combination with other projects.

7.7.31 For the operational phase of wind farms, disturbance effects that could give rise to significant impacts on harbour porpoise populations would not be expected, as studies (see paragraphs 5.17.4, 5.17.5, and 5.17.7) indicate that there is no evidence of a reduction in harbour porpoise use of existing wind farms. These studies actually indicate that potentially there may even be an increase in the use of wind farms by harbour porpoise due to the reduction in fishing activities, even taking into account the underwater noise derived from the turbines operation, maintenance vessel movements, alteration to prey species, or collision risk. It is, therefore, concluded that the operation phase for Dogger Bank Teesside A & B in-combination with the other projects (those listed in **Table 7.12**) would not affect the achievement of favourable condition with respect to the conservation objectives related to the harbour porpoise feature of the transboundary European sites (SCIs and pSCIs).

7.7.32 Overall, it is concluded that there would not be an adverse effect on the integrity of the transboundary European sites (SCIs and pSCIs) listed **Table 5.1** as a result of the operation of Dogger Bank Teesside A & B in-combination with other projects (assuming the worst case scenario) or Dogger Bank Teesside A or Dogger Bank Teesside B alone and in-combination with other projects.

7.7.33 The effects of the decommissioning phase are likely to be the same, albeit smaller in magnitude and intensity, to those described and assessed for the construction phase (see paragraphs 7.7.7, 7.7.17, 7.7.18, and 7.7.22). Given that all decommissioning phase effects would be smaller in magnitude and temporary, it is therefore concluded that there would not be an adverse effect on the integrity of the transboundary European sites (SCIs and pSCIs) listed in **Table 5.1** as a result of the decommissioning of Dogger Bank Teesside A & B in-combination with other projects (assuminh the worst case scenario) or Dogger Bank Teesside A or Dogger Bank Teesside B alone and in-combination with other projects.

7.7.34 In conclusion, it is considered that the construction, operation, and decommissioning of Dogger Bank Teesside A & B would not affect the favourable achievement of the sites' conservation objectives with regard to harbour porpoise and it is, therefore, concluded that there would not be an adverse effect on the integrity of the harbour porpoise populations of the transboundary sites listed in **Table 5.1**.

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# 7.8 Assessment of in-combination effects on SPA bird populations

## Introduction and methodology

7.8.1 As discussed at the beginning of this section, the determination of those projects to be included in the in-combination assessment has been defined through a set of criteria relating to confidence in data and assessment outcomes. Following the overall Forewind Cumulative Impact Assessment strategy (see **Chapter 33** of the Dogger Bank Teesside A & B ES), consideration has been given to whether in-combination impacts on a receptor could occur between projects and, from this, the overall magnitude/significance of the impact has been determined.

7.8.2 The assessment methodology follows a number of steps, as set out below:

- Determine which project types could have the potential to interact with the effects of Dogger Bank Teesside A & B and lead to the generation of additive or synergistic impacts on ornithological receptors. In respect of this step, only bird species that may form part of designated European site or Ramsar site populations are of relevance;
- Identify those receptors assessed for Dogger Bank Teesside A & B, for which potential in-combination impacts could arise;
- On the basis of available information, determine which projects (of those types screened into the assessment) should be considered and determine whether combined impacts could arise for those receptors identified as relevant to the assessment. Relevant impacts include: disturbance and displacement (during construction and operation), mortality and potential direct impacts on population levels and habitat loss/alteration;
- Identify whether specific attribution of individual species to designated European and Ramsar sites has been undertaken for relevant projects to determine the overall effect on designated site populations; and
- Provide a final view on whether in-combination impacts on individual designated populations/sites are significant in the context of the applicable conservation objectives.

## Relevant project types for consideration in the in-combination assessment

7.8.3 The CIA identified a long-list of plans and projects in the wider area that, on the basis of likely effects, could have implications in-combination with the effects of Dogger Bank Teesside A & B. As discussed at the beginning of this section of the report, projects that generate similar and potentially interactive effects with the proposed wind farm development include; other offshore wind farms, oil and gas exploration and production activities, aggregate extraction and dredging, and the installation of pipelines and cables. The above project types all relate to potential interactions in the offshore, marine environment. There may potentially also be some projects that may influence ornithological interests in the vicinity of the export cable landfall location.

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**Relevant project types for the offshore environment**

### *Oil and gas installations*

7.8.4 As discussed in the introduction to this section, the effects associated with oil and gas development in the southern North Sea are relatively limited with respect to ornithological interests. Some localised disturbance and displacement could occur during exploration activities, but such effects would be expected to be temporary and of no consequence at the population level.

7.8.5 As most of the new facilities likely to be developed in the southern North Sea will be for gas, the potential for significant oil pollution events is considered to be very low.

7.8.6 The potential for significant interaction of effects to arise with proposed oil and gas developments is, therefore, considered to be negligible negligible and no such projects are considered herein.

### *Aggregate extraction and dredging*

7.8.7 The main effects generated by aggregate extraction relate to the disturbance to benthic communities, loss/alteration of seabed habitat and the production of increased suspended sediment concentrations in the water column during extraction activities. Potentially, vessel movements during extraction may generate some disturbance and displacement effects, however, any such effects would be very localised and confined to the immediate vicinity of the vessel. It is also likely that such activity would act as an attractant for many species of seabird, as dredging can increase potential food/prey availability in the water column.

7.8.8 Both seabed habitat degradation and increase in suspended sediment concentrations in the water column may impact upon fish communities that may form part of the foraging resource of seabirds. Recovery of seabed communities following aggregate extraction is generally relatively rapid (<2 years) and the effects of suspended sediment increases in the water column are localised, intermittent and temporary (see Section 10 in **Chapter 12**, of the ES), with longer term impacts on fish communities (i.e. prey availability) highly unlikely to occur.

7.8.9 The localised and temporary nature of the impacts associated with aggregate extraction, even if potential effects were to interact with those generated during the construction and/or operation of Dogger Bank Teesside A & B, effectively preclude the likelihood of any significant in-combination impacts from arising, particularly when considered in the context of the extensive foraging areas available to seabirds in the offshore marine environment.

7.8.10 The potential for significant interaction of effects to arise with proposed aggregate extraction and dredging projects is, therefore, considered to be negligible and no such projects are considered herein.

### *Installation of pipelines and cables*

7.8.11 As with the impacts associated with the installation of the export cable for Dogger Bank Teesside A & B, any impacts associated with the installation of pipelines and cables would be expected to be localised and temporary.

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Disturbance and displacement of seabirds in the vicinity of vessels undertaking installation activities may occur, but such effects are considered to be insignificant at the population level. No long term loss of habitat resource and, therefore, prey availability for seabirds would be anticipated.

7.8.12 The potential for significant interaction of effects to arise with pipeline and cabling projects is, therefore, considered negligible and no such projects are considered herein.

### *Other offshore wind farms*

7.8.13 Of all of the potential project types that generate effects that could interact with those of Dogger Bank Teesside A & B, clearly those associated with other offshore wind farms have the greatest potential for interaction and for in-combination impacts to arise. The key impacts are: disturbance and displacement, particularly during the operation phase, barrier effects, mortality arising from collision during the operation phase, and habitat loss / modification (during the construction and operation phases).

7.8.14 Given the spatial scale over which the assessment for Dogger Bank Teesside A & B has been undertaken, potentially a significant number of offshore wind farm projects could be included in the in-combination assessment. However, the need to include certain projects can be refined through consideration of both the receptors for which a potentially significant impact arising from Dogger Bank Teesside A & B has been identified and the nature of the data availability and assessment outputs for other projects. Both of these aspects are discussed in the next sections and the methodology adopted for undertaking the in-combination assessment for each of the key impacts listed above is described.

### *Summary*

7.8.15 Based on the spatial extent, duration and magnitude of the types of effects associated with a range of project types that occur in the offshore marine environment, it is clear that, in the case of Dogger Bank Teesside A & B, the only project type that presents any significant potential for the interaction of effects is other offshore wind farm projects. Therefore, the remainder of the in-combination assessment presented here focuses solely on the determination of the significance of potential interactions in respect of this project type.

## Relevant projects for consideration of interactions at the export cable landfall location

7.8.16 The CIA work undertaken for the project (see **Appendix 11A** of the Dogger Bank Teesside A & B ES) indicates that there are only a limited number of projects in the vicinity of the landfall location that could influence ornithological interests. As assessed in Section 6, the potential for any significant impacts on designated bird populations as a result of proposed works at the location of the export cable landfall is considered to be very low given the very limited use of the foreshore by waterbirds. Thus, the potential for significant in-combination impacts to arise is also considered to be low.

7.8.17 Three other plans and projects were considered relevant, in terms of distance and activities, during screening in relation to the export cable installation and

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landfall construction activities (see **Chapter 11** of the Dogger Bank Teesside A & B ES). These are considered below.

7.8.18 No data is available regarding the Underground Coal Gasification (UCG) project, therefore, no reasonable assessment of potential interactions can be undertaken. The Yorkshire and Humber Carbon Capture and Storage (CCS) project is located a significant distance from the landfall works and it is not expected that the construction phase of this project would overlap with the construction work associated with the cable landfall installation. The recommended Runswick Bay Marine Conservation Zone (rMCZ) is located approximately 12km to the east of the proposed landfall location. Although MCZs do not have bird receptors listed as designated features, the designation of the MCZ and its associated management measures could have indirect benefits for birds.

7.8.19 As the UCG project and the CCS project are in the early stages of development and / or project effects would be unlikely to interact, and the rMCZ may benefit waterbirds, it is concluded that no adverse in-combination impacts would arise in respect of the export cable landfall works.

## Identification of receptors for in combination assessment

7.8.20 The assessment of potential impacts on seabirds, waterbirds and migrant birds detailed in Section 6 of this report, indicates that the nature and magnitude of the potential impact likely to arise from the proposed wind farm development varies according to bird groups and individual species.

7.8.21 A brief summary of the predicted impacts of Dogger Bank Teesside A & B in respect of the relevant species and bird groups is provided here in order to determine for which of these the potential for in-combination impacts needs to be considered. As discussed above, given that no in-combination impacts on designated SPA and Ramsar bird populations are identified in respect of the export cable landfall, the subsequent description and assessment of impacts is restricted solely to those that could arise in the offshore zone.

### Disturbance and displacement

7.8.22 The disturbance and displacement analysis presented in Section 6.6 reveals that this impact would be of relevance and of potential significance for the following species of seabirds:

- Common guillemot;
- Razorbill; and
- Atlantic puffin.

7.8.23 Although no displacement impact is predicted for northern gannet from Dogger Bank Teesside A & B alone, it is recognised that there is the possibility that displacement from a number of offshore wind farms could be of potential concern. The potential in-combination displacement impact on northern gannet is, therefore, also considered and assessed.

7.8.24 For all other seabird species and migrants, as there would be no significant disturbance and displacement impacts during either the construction or

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operation of Dogger Bank Teesside A & B, in-combination assessment is not considered to be necessary.

**Barrier effects**

7.8.25 Analysis of potential barrier effects was presented for a number of breeding seabird species deriving from SPAs for which Dogger Bank Teesside A & B could act as a barrier to them reaching potential foraging grounds. The assessment concluded that small barrier effects could arise for:

- Northern fulmar;
- Northern gannet;
- Black-legged kittiwake;
- Common guillemot; and
- Razorbill.

7.8.26 Apart for northern fulmar and black-legged kittiwake originating from Flamborough and Filey Coast pSPA, where over 1% of the breeding population of these species could be affected, for all SPA designated populations of the above species the barrier effect posed by Dogger Bank Teesside A & B was assessed as being not significant. This suggests that in-combination effects would be unlikely to arise. However, consideration is given to the potential combined effect that other wind farm projects may have on foraging birds of the species listed above. For all other species of seabirds it is considered that in-combination barrier effects would not arise.

7.8.27 The methodology to determine the potential barrier effect on migratory bird species used for Dogger Bank Teesside A & B has been applied with respect to other offshore wind farm projects, where relevant data is available.

**Collision risk and mortality**

7.8.28 Collision risk modelling for Dogger Bank Teesside A & B has demonstrated that potential impacts that would be significant at designated site populations would only arise with respect to a few species of seabirds. A summary of the predicted annual collision totals for the key seabird species present in the project area is provided in **Table 7.17**.

7.8.29 For the purposes of the in-combination assessment of collision risk, the species considered are therefore restricted to the following: northern gannet, black-legged kittiwake, lesser black-backed gull and great black-backed gull. For all other species of seabird, the annual collision losses predicted for Dogger Bank Teesside A & B are deemed to be insignificant and therefore in-combination assessment is not considered to be necessary.

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Table 7.17 Predicted seasonal collision risk estimates (with 90% confidence limits) for study species within Dogger Bank Teesside A & B using a 98% avoidance rate (99% for northern gannet)

| Species | Mean | | Considered for in-combination assessment |
|---|---|---|---|
| | Breeding | Non-breeding | |
| Northern fulmar | 1 (1-1) | 0 (0-1) | No |
| Northern gannet | 34 (28-40) | 34 (28-40) | Yes |
| Arctic skua | 0 (0-19) | 0 (0-168) | No |
| Great skua | 0 (0-1) | 0 (0-1) | No |
| Black-legged kittiwake | 87 (77-98) | 48 (42-54) | Yes |
| Lesser black-backed gull | 20 (13-31) | 12 (7-22) | Yes |
| Great black-backed gull | 17 (11-27) | 41 (29-59) | Yes |
| Common guillemot | 0 (0-0) | 0 (0-0) | No |
| Razorbill | 0 (0-0) | 2 (1-3) | No |
| Atlantic puffin | 0 (0-0) | 0 (0-0) | No |

7.8.30 Collision risk modelling for migrant bird species that may pass through Dogger Bank Teesside A & B revealed that, at the Great Britain population level, the overall predicted annual losses would be insignificant. It is therefore not expected that, in-combination with other projects, collision losses of migrants during the operation phase for Dogger Bank Teesside A & B would be significant. No specific species sensitivities were identified through the assessment work. Therefore, if information on collision losses from other projects is available, all of the species analysed for the project by itself will be considered in respect of potential in-combination impacts.

## Screening of relevant offshore wind farm projects

7.8.31 While the majority of marine birds that occur in Dogger Bank Teesside A & B during the breeding season may originate from a restricted number of protected sites, those that are present outwith the defined breeding seasons or during the breeding season as non-breeders, and migrants that pass through the area in autumn and spring, are not constrained to particular protected sites and could potentially originate from sites in a wider geographical area. Therefore, the populations potentially impacted by Dogger Bank Teesside A & B could also be impacted by many other projects across a wide area. A full list of the offshore wind farms in the wider North Sea region that were initially considered for the ornithological cumulative impact assessment is provided in Appendix 8 in **Appendix 11A** of the Dogger Bank Teesside A & B ES. The appendix also states which of these projects are within foraging range of the protected sites identified to be of relevance to Dogger Bank Teesside A & B.

7.8.32 Further screening was undertaken to refine this list based on the criteria set out at the beginning of this section of the report. The results of this further screening, along with justification for the exclusion of particular projects from the in-combination assessment, are provided in **Table 7.18**.

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Table 7.18 Offshore wind farm projects included in the in in-combination assessment and impacts considered in available project assessment materials

| Project | UK Round | Status | Collision | Disturbance / displacement | Reference |
|---|---|---|---|---|---|
| Beatrice | Scottish | Consent Application Submitted | Yes | Yes | Arcus Renewable Energy Consulting Limited (2012) Section 12; and 2013 |
| Blyth Demonstration Site | - | Consent Application Submitted | Yes | | Narec (2012) |
| Breeveertien II | | Consent Authorised | Yes | | Airtricity (2007) |
| Dogger Bank Creyke Beck A & B | 3 | Consent Application Submitted | Yes | Yes | Forewind (2013b) |
| Dogger Bank Teesside C & D | 3 | Concept / Early Planning | Yes | Yes | Forewind |
| Dudgeon | 2 | Consent Authorised | Yes | | ECON (2010) |
| East Anglia ONE | 3 | Consent Application Submitted | Yes | Yes | East Anglia Offshore Wind Limited (2012a) |
| European Offshore Wind Development Centre (EOWDC) | | Consent Authorised | Yes | Yes | Technip (2012) |
| Firth of Forth (Alpha and Bravo) | Scottish | Consent Application Submitted | Yes | Yes | Seagreen (2013) |
| Galloper | 2 - extension | Consent Authorised | Yes | Yes | Royal Haskoning (2011) - Chapter 11 |
| Greater Gabbard | 2 | Fully Commissioned | Yes | | Banks *et al*. (2006) |
| Hornsea Project One | 3 | Consent Application Submitted | Yes | Yes | SMart Wind (2013) |
| Humber Gateway | 2 | Consent Authorised | Yes | | ERM (2008) |
| Inch Cape | Scottish | Consent Application Submitted | Yes | Yes | Inch Cape Offshore Ltd 2013; RPS (2013) |
| Lincs | 2 | Partial Generation/Under Construction | Yes | | Centrica Energy (2007) |
| London Array II | 2 | Fully Commissioned | Yes | Yes | RPS (2005) |
| Moray | Scottish | Consent Application Submitted | Yes | Yes | Moray Offshore Renewables Ltd 2013 |
| Neart na Gaoithe | Scottish | Consent Application Submitted | Yes | Yes | Mainstream Renewable Power 2013a and 2013b |
| Race Bank | 2 | Consent Authorised | Yes | | AMEC (2009) |
| Sheringham Shoal | 2 | Fully Commissioned | Yes | | Scira Offshore Energy Limited (2006) |


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| Project | UK Round | Status | Collision | Disturbance / displacement | Reference |
|---|---|---|---|---|---|
| Teesside Offshore Windfarm | 1 | Partial Generation / Under Construction | Yes | | EDF Energy (Northern Offshore Wind) Limited (2004) |
| Thanet | 2 | Fully Commissioned | Yes | Yes | Royal Haskoning (2005) |
| Triton Knoll | 2 | Consent Authorised | Yes | | RWE Npower Renewables (2012; 2013) |
| Westermost Rough | 2 | Consent Authorised | Yes | | RPS (2009) |


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7.8.33 Review of the available assessment information for these projects in the form of environmental statements and appropriate assessments has been undertaken to obtain the relevant data to enable in-combination assessment. In some cases information is unavailable for particular projects to inform the in-combination assessment for one or more specific impacts (see **Table 7.18** and **7.19**), and this is reflected in the assessment work presented in subsequent sections.

7.8.34 For the in-combination assessment no attempt has been made to standardise estimates using the same assumptions as presented in this assessment as, based on the information presented for other assessments, this would have only been possible in some cases. In addition the values/assumptions used in other assessments may have been agreed with statutory advisors and/or be specific to those projects and thus it would not be appropriate to convert these results to achieve standardised estimates here. The assumptions used in deriving displacement and collision risk estimates in other assessments are highlighted where these differ from those used in this assessment.

## Impacts on breeding sea bird populations

### Habitat loss and alteration

7.8.35 Available data and evidence indicates that benthic habitat loss as a result of the installation of wind turbines and other structures in the development footprint for Dogger Bank Teesside A & B would not affect the overall prey resource available to foraging seabirds. No significant impact on designated seabird populations is therefore predicted. The same conclusion is drawn with regard to the other projects screened into the assessment. In particular, the widely dispersed and small-scale nature of habitat loss and alteration would be highly unlikely to have an in-combination effect with regard to the foraging resource of individual breeding colonies.

7.8.36 Seabird prey resources (specifically fish) within Dogger Bank Teesside A & B could be temporarily affected by increased underwater noise levels during construction. However, this effect would be localised to the immediate area of piling works, would not cumulate and temporary displacement of the resource is predicted rather than loss or decrease in availability. A similar conclusion is reached in relation to the in-combination impact with other projects (i.e. temporary, intermittent and localised). In relation to habitat loss and alteration, no significant impact on designated seabird populations is therefore predicted and no adverse effect on the integrity of designated populations of the SPAs screened into the assessment for their seabird species is predicted.

### Disturbance and displacement to breeding sea bird populations

7.8.37 The assessment of disturbance and displacement has been carried out as one for the construction, operation, and decommissioning phases, as at any one time there is likely to be a combination of wind farms under construction or already in operation, and ultimately being decommissioned. This approach also better reflects the view, taken here, that displacement represents effective habitat loss and, therefore, can be treated as a single (albeit long term) impact on the population levels of affected species.

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## Table 7.19 Offshore wind farm projects excluded from the in-combination assessment and reasons for exclusion

| Project | UK Round | Status | Developer | Reason for Exclusion from in-combination assessment |
|---|---|---|---|---|
| Blyth | 1 | Fully Commissioned 2000 | E.ON | Site became operational prior to bird survey period for Dogger Bank. |
| East Anglia THREE | 3 | Concept/Early planning | East Anglia Offshore Wind | A scoping study for the project has been produced submitted in 2012 (East Anglia Offshore Wind Limited 2012b) as part of the East Anglia THREE submission documentation. East Anglia Offshore Wind Limited (2013a) in their HRA Report for East Anglia ONE does not consider East Anglia THREE as the consent application has not been submitted. Given that no quantifiable data is yet published the project has been screened out. |
| East Anglia FOUR | 3 | Concept/Early planning | East Anglia Offshore Wind | A scoping study for the project has been produced submitted in 2012 (East Anglia Offshore Wind Limited 2012c) as part of the East Anglia THREE submission documentation. East Anglia Offshore Wind Limited (2013a) in their HRA Report for East Anglia ONE does not consider East Anglia THREE as the consent application has not been submitted. Given that no quantifiable data is yet published the project has been screened out. |
| Gunfleet Sands I and II | 1 | Fully Commissioned 2009 | Dong Energy | Site became operational prior to bird survey period for Dogger Bank. |
| Kentish Flats | 1 | Fully Commissioned 2005 | Vatenfall | Site became operational prior to bird survey period for Dogger Bank. |
| Lynn and Inner Dowsing | 1 | Fully Commissioned 2009 | Centrica | Site became operational prior to bird survey period for Dogger Bank. |
| Scroby Sands | 1 | Fully Commissioned 2004 | E.ON | Site became operational prior to bird survey period for Dogger Bank. |
| Hornsea Project Two | 3 | Concept/Early planning | SMart Wind | A scoping study for the project has been produced and initial assessment data are available as part of the Hornsea Project One submission documentation. SMart Wind (2013) in the HRA Report for Hornsea Project One place the assessment data for Hornsea Project Two in a Low Confidence category, reflecting the status of the assessment outcomes. The same position is taken here with regard to the use of the preliminary data from this project and the project has been screened out. |


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7.8.38 Guidance on the assessment of disturbance/displacement at the cumulative scale is provided in King *et al.* (2009). In the absence of resource competition, the effect of cumulative displacement would be negligible. However, such an assumption may not be correct given that areas used by seabirds for foraging may be close to carrying capacity. Since there is currently no simple method to determine carrying capacity, King *et al.* (2009) recommend that cumulative displacement should be calculated by summing displacement effects from each of the contributing developments.

7.8.39 In assessing the potential impacts of displacement, estimates are required both of the numbers of birds predicted to be displaced and then of the numbers of these that might be expected to die following displacement. Following the overall Forewind Cumulative Impact Assessment strategy, information regarding the potential impacts of displacement was taken from impact assessments or environmental statements where available, and no attempt has been made to estimate values in other cases.

7.8.40 Estimates of numbers of displaced birds were obtained by reviewing environmental statements for planned offshore wind farms in the North Sea. In some cases, while population estimates may have been provided, specific displacement estimates were not available. Thus the sites for which data were available represent a subset of those considered in the assessment in the North Sea region as a whole.

7.8.41 The assessment presented here considers only those projects for which estimates were provided of the numbers of displaced birds that might then be expected to die (see paragraph 7.8.30 and **Table 7.20**). In many instances, while predictions were provided of the numbers of birds that might be expected to be displaced, no information was provided on the likely mortality rates of these birds (often, as mortality was considered as part of the sensitivity of species to this effect – see Maclean *et al.* (2009)). As with displacement rates, mortality rates considered varied between projects, some providing results for a range of rates and carrying through either a worst case or 'realistic' value into the assessment. Additionally, some of the Scottish projects have assessed displacement impacts in respect of breeding failure and determined the significance of this impact with reference to population viability analysis, as summarised below.

7.8.42 For the Moray Firth Round 3 Zone 1 (Moray Offshore Wind Ltd 2013), two scenarios are considered: a worst case scenario of 100% displacement for gannet, fulmar and auks and 50% for kittiwake and gulls; and a realistic scenario of 50% for gannet, fulmar and auks and 10% for kittiwake and gulls. The displacement analysis considers only birds recorded on the sea or, in the case of aerial foragers, using the sea, and excludes birds in flight. It is assumed under the worst case scenario that all displaced birds would fail to breed; the same assumption is made under the realistic scenario for all species except for fulmar and gannet where 50% breeding failure is predicted because of the greater foraging ranges of these species. The significance of the potential impacts under different scenarios is assessed with reference to population

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viability analysis, considering the change in likelihood of population decline associated with the different displacement scenarios.

7.8.43 For the Beatrice Offshore Wind Farm (Arcus 2013) displacement impacts on breeding seabirds are assessed through population modelling, assuming 100% displacement and that each displaced breeding adult is part of a pair that fails to reproduce.

7.8.44 For the Firth of Forth Phase 1 (Seagreen 2013) displacement is assessed using the NE/JNCC (2012) guidance using the mean of the annual peak populations for the defined breeding season of each species. Displacement values used in the assessment are based on figures proposed by SNH and range from 0 - 60%. Mortality following displacement was considered to be difficult to determine (although a 1% mortality rate during the breeding season is applied in the ES) and instead PBR is used to set a threshold by which the level of mortality required at the specific level of displacement for a species can be determined in order for an effect to be realised. Where an unfeasibly high level of mortality would be required in order to exceed the PBR threshold it is concluded that no significant impact would arise.

7.8.45 For the Neart na Gaoithe development, assessment of displacement impacts has been undertaken with reference to one and two kilometre buffers around the wind farm development area. Displacement and mortality rates of 90% / 10% for gannet, and 40% / 10% for auks are utilised in the HRA. No displacement impacts for black-legged kittiwake and lesser black-backed gull are assessed (Mainstream 2013a).

7.8.46 For the Inch Cape development it is considered that a proportion of displaced birds fail to breed, this proportion depending on the species. Consideration is given to whether this is likely to result in population level effects by assessing the predicted change in productivity against available information on breeding success. The reduction in productivity is premised on the assumption that birds which are displaced from foraging areas within the proposed project area cannot be accommodated in alternative areas of equivalent quality outside the project area, and are therefore forced to use sub-optimal areas and/or travel increased distances to feed and therefore do not reproduce successfully. For four species (kittiwake, guillemot, razorbill and puffin) where the impacts of displacement were considered to have the potential for population level effects, population viability analysis was carried out (Inch Cape Offshore Ltd. 2013).

7.8.47 Where estimates are available for other projects and have been apportioned to protected sites, these have been added to respective apportioned estimates for Dogger Bank Teesside A & B to assess potential impacts at the European site level.

7.8.48 It should be noted that East Anglia Offshore Wind Ltd has recently stated that it will be reducing the number of proposed turbines for the development from 325 to 240 (EAOL 2013). Without any further assessment work of the implications of this reduction in turbine numbers, has been is assumed that (in respect of displacement impacts) the area occupied by the turbines would remain the same and, therefore, that displacement impacts as assessed for the current wind farm layout would remain the same.

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### *Northern gannet*

7.8.49 While northern gannet is likely to display a high displacement rate (assigned as 75%) it is considered, on the basis of habitat flexibility, to have a very high tolerance to this effect. For Dogger Bank Teesside A & B by itself, a 0% mortality rate as a result of displacement was assigned to this species. However, it is recognised that cumulatively the habitat loss resulting from a number of large offshore wind farm projects could reach a habitat availability threshold that becomes significant. Therefore, a precautionary 5% mortality rate (see Section 6.6), which reflects the potential for the loss of relatively large areas of available foraging habitat, has been assumed for displaced birds for the in-combination assessment.

Table 7.20 Predictions of the numbers of displaced birds obtained for additional offshore wind farm sites in the North Sea for which quantitative displacement data has been presented

| Wind farm development | Season | Northern gannet | Common guillemot | Razorbill | Atlantic puffin |
|---|---|---|---|---|---|
| Dogger Bank Teesside A & B | Breeding | 192 | 1,072 | 88 | 31 |
| | Winter | 390 | 4,502 | 1,604 | 166 |
| Dogger Bank Creyke Beck A & B | Breeding | 229 | 3,947 | 193 | 51 |
| | Winter | 502 | 9,445 | 3,127 | 244 |
| Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Teesside C & D combined (mean) | Breeding | 1,002 | 7,741 | 784 | 137 |
| | Winter | 1,438 | 19,814 | 6,405 | 605 |
| **Other wind farms** | | | | | |
| Beatrice | | | 3,112 | 528 | 641 |
| East Anglia ONE | Spring | 65 | 430 | 120 | |
| | Breeding | 43 | | | |
| | Autumn | 1,870 | | | |
| | Winter | 64 | 820 | 200 | |
| European Offshore Wind Development Centre (EOWDC) | | 32 | 386 | 129 | 62 |
| Galloper[1] | Breeding[2] | | | | |
| | Winter[2] | | 3,219 | 342 | |
| Hornsea Project One | Breeding | 239 | 1,037 | 366 | 428 |
| | Post-breeding | | 5,705 | 2,926 | |
| | Winter | 237 | 4,609 | 2,628 | 503 |
| London Array | | 162 | 2,500 | 250 | |
| Thanet | | 37 | 193[3] | 193[3] | 193[3] |
| Firth of Forth Alpha | Breeding | 761 | 2,858 | 604 | 790 |
| Firth of Forth Bravo | Breeding | 512 | 3,215 | 232 | 1,002 |
| Inch Cape | Breeding | 1,001 | 2,185 | 819 | 1,800 |
| Moray (Telford, Stevenson and MacColl) | Breeding | 119 | 5,738 | 1,320 | 1,588 |
| Neart na Gaoithe | Breeding | 1,715 | 1,095 | 117 | 3,450 |
| **Total** | | **9,297** | **64,557** | **17,962** | **11,119** |

[1] No specific displacement rates were presented; hence, it is assumed that all birds in the areas of the respective projects were displaced; [2] A total displacement estimate was obtained following the methodology used in the Dogger Bank Teesside A & B assessment, assuming that breeding populations were separate to non-breeding (post-breeding/migration/wintering) populations; [3] Impacts of displacement were predicted for all auks combined; a worst case was assumed by applying the combined estimate to each species

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7.8.50 Only three SPAs are within mean maximum foraging range of Dogger Bank Teesside A & B, as shown in **Figure 7.12**, which defines the spatial limits for the inclusion of other projects that potentially could also affect breeding birds deriving from these two SPAs.

7.8.51 Predictions of the numbers of gannet potentially displaced were available for the projects listed in **Table 7.20**. The cumulative number of birds estimated to be displaced across these projects was 9,297 (summing estimates from different seasons where provided, following the assumption used in this assessment that these would be different birds).

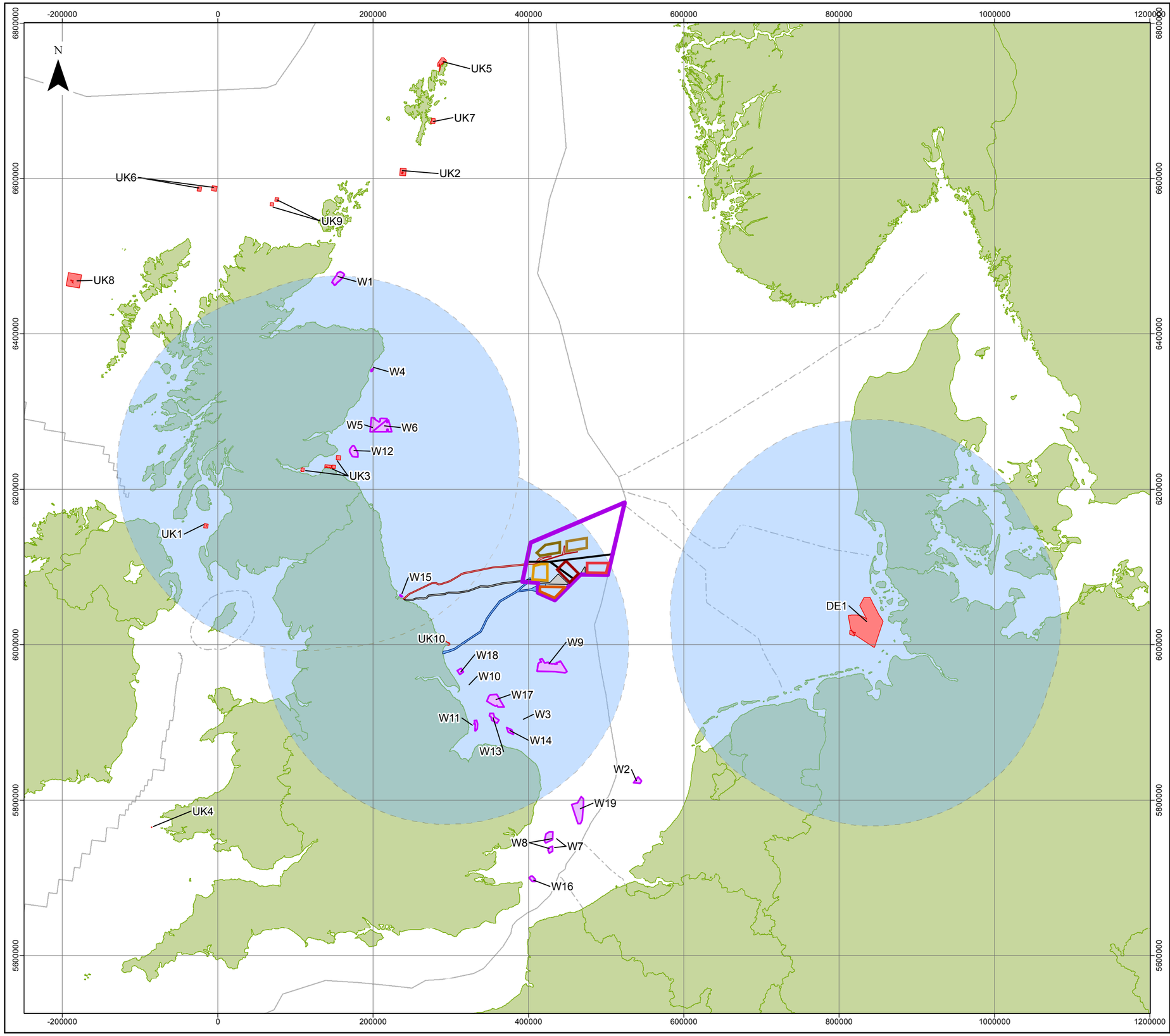
7.8.52 Total mortality losses following displacement have been calculated for seven projects (Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B, Dogger Bank Teesside C & D, East Anglia ONE, Hornsea Project One, Firth of Forth Alpha and Firth of Forth Bravo and Neart na Gaoithe). A combined total of 122 birds are predicted to be lost through mortality following displacement from Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D (75% displacement and 5% mortality). For East Anglia ONE (see East Anglia Offshore Wind Limited, 2013a) a maximum loss of 30 birds is calculated (based on 70% displacement and 10% mortality) and for Hornsea Project One (70% displacement and 2% mortality during the breeding season and 1% mortality during the non-breeding season) a maximum loss of seven birds (SMart Wind, 2013).

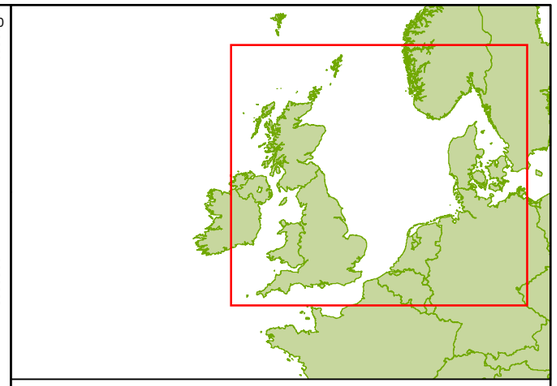
7.8.53 For the purposes of HRA, a displacement rate of 90% and a mortality rate of 2% are used to calculate the displacement impact of the Neart na Gaoithe project on gannet. This gives rise to a total predicted mortality of 34 breeding adults (Mainstream 2013a), all of which are apportioned to the Forth Islands SPA.

7.8.54 For the Inch Cape project, it is assumed that 50% of displaced adult gannets will suffer breeding failure and all birds are from different breeding pairs. Thus 487 pairs are predicted to fail because of displacement, equating to a loss of 375 chicks and a 0.8 % increase in annual breeding failure for the Bass Rock (Forth Islands SPA) colony. Based on potential foraging range of gannet from Bass Rock, it is calculated that the Inch Cape development (including a 2km buffer) would result in the loss of approximately 0.1% of the available foraging area for gannet originating from Bass Rock. The small predicted increase in annual breeding failure is considered to be offset by the very large foraging range of gannet, its flexibility in exploiting a multitude of food resources, the population's relative insensitivity to small changes in reproduction rates, and the limited spatial extent over which displacement is likely to occur. The assessment for the Inch Cape development concludes that the impact on the regional gannet breeding population through displacement would be negligible as it represents a slight change from baseline conditions, with any effects likely to fall within fluctuations of natural variation (RPS 2013). As a consequence of this approach to determining the impact of displacement it is not possible to reconcile the assessment output with that of the other projects considered here.

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## 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 Creyke Beck Export Cable Corridor
- Dogger Bank Teesside C & D Export Cable Corridor
- Offshore wind farm
- Special Protection Area (SPA)
- Northern gannet mean maximum range - 230km

0 50 100 200

Kilometres

Data Source:
Environmental Designations © JNCC/European Environment Agency, 2014
UK offshore wind farm © The Crown Estate, 2014
European wind farm boundary data supplied by MarineFind, 2014

PROJECT TITLE

*Dogger Bank Teesside A & B*
IfAA Report

DRAWING TITLE

**Figure 7.12 Northern gannet foraging ranges and other projects**

| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 15/10/2013 | PEI3 | LW | PT |
| 2 | 18/03/2014 | DCO Submission | JE | PT |
| | | | | |

DRAWING NUMBER:

**9Y0986/TSABHRA/56/R2**

| SCALE | PLOT SIZE | DATUM | PROJECTION |
|---|---|---|---|
| 1:5,000,000 | A3 | WGS84 | UTM31N |

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7.8.55 For the Firth of Forth Alpha and Bravo (Seagreen) development, a total of 1,818 adult birds would be displaced (assuming 60% displacement). In the context of the calculated PBR for the Forth Islands SPA (Bass Rock), it is determined that in order to exceed the PBR that a mortality rate of 60% would be required. A negligible quantity, <0.3%, of the potential foraging habitat from the SPA would be lost to the development. On this basis, a 1% mortality rate has been assumed, resulting in the loss of 19 adult birds from the Forth Islands SPA during the breeding season.

7.8.56 The Moray wind farm project did not apportion any predicted displacement impact for gannet to either the Flamborough and Filey Coast pSPA or the Forth Islands SPA.

7.8.57 For Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D, apportioning of the affected birds to individual SPAs is presented in **Table 7.21**. For the SPAs that are within the mean maximum foraging range of Dogger Bank Teesside A & B, the population affected by Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D is 0.09% (comprising 11 breeding adult birds and six non-breeding birds) for the Flamborough and Filey Coast pSPA and 0.04% (comprising 20 breeding adult birds and 40 non-breeding birds) for the Forth Islands SPA. The full apportioning breakdown of the SPA populations affected by Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D is presented in Table A9.48d in Appendix 9 of **Appendix 11A** of the Dogger Bank Teesside A & B ES.

Table 7.21 Apportioning of displacement and mortality impact for northern gannet to European sites predicted as a result of in-combination displacement during the operation phase for Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D

| Site name | Breeding | | Non-breeding | | Total | |
|---|---|---|---|---|---|---|
| | No. | % population | No. | % population | No. | % population |
| Fair Isle | 0 | 0 | 3 | 0.02 | 3 | 0.02 |
| Forth Islands | 20 | 0.02 | 40 | 0.02 | 60 | 0.04 |
| Flamborough Head and Bempton Cliffs | 11 | 0.06 | 6 | 0.02 | 17 | 0.09 |
| Hermaness, Saxa Vord and Valla Field | 0 | 0 | 18 | 0.02 | 18 | 0.02 |
| Noss | 0 | 0 | 7 | 0.02 | 7 | 0.02 |
| Sule Skerry and Sule Stack | 0 | 0 | 3 | 0.02 | 3 | 0.02 |
| **Transboundary sites** | | | | | | |
| Cote de Granit Rose-Sept Iles | 0 | 0 | 14 | 0.02 | 14 | 0.02 |
| Seevogelschutzgebiet Helgoland | 0.03 | 0.01 | 0.1 | 0.02 | 0.05 | 0.04 |

7.8.58 Calculated mortality losses from the East Anglia ONE are not attributed to any specific SPA, but instead the overall change in background mortality rate for the North Sea population across differing seasons is considered (East Anglia Offshore Wind Limited 2013a). In this respect, no in-combination contribution to

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the potential impact on the Flamborough and Filey Coast pSPA from East Anglia ONE can be defined.

7.8.59 For Hornsea Project One, during the breeding season, a total of three adult bird mortalities resulting from displacement were apportioned to the Flamborough and Filey Coast pSPA. Of the two predicted mortalities that could arise during the non-breeding period none were apportioned to the Flamborough and Filey Coast pSPA. No mortality losses were apportioned to other SPAs.

### *Flamborough and Filey Coast pSPA*

7.8.60 For Hornsea Project One, during the breeding season, a total of three adult bird mortalities resulting from displacement were apportioned to the Flamborough and Filey Coast pSPA. Of the two predicted mortalities that could arise during the non-breeding period none were apportioned to the Flamborough and Filey Coast pSPA. No mortality losses were apportioned to other SPAs.

7.8.61 Combining the predicted mortality losses for Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B, Dogger Bank Teesside C & D and Hornsea Project One, a total of 14 adult birds during the breeding season would be lost from the Flamborough and Filey Coast pSPA population (0.08% of the population). Of the six non-breeding birds apportioned to the SPA from Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D, as a minimum it is assumed that four of these are adult birds. In total, therefore, displacement losses would equate to 18 adult birds from the designated breeding population of the Flamborough and Filey Coast pSPA. This would represent 0.1% of the designated population.

7.8.62 As discussed in Section 6.6, PBR analysis for the Flamborough and Filey Coast pSPA northern gannet population is provided as part of the Consolidated Ornithological Addendum for Dogger Bank Creyke Beck (Forewind 2014). This PBR work takes into account the recent increase in the breeding population of gannet at Flamborough. Based on the revised population level and the status of the population (i.e. considered to be of least concern and increasing), an *f* value of 0.5 is considered to be appropriate and a PBR value of 503 (for adult breeding gannet) is calculated. The HRA Report for Hornsea Project One (SMart Wind 2013) also provides PBR modelling for Northern Gannet from the Flamborough and Filey Coast pSPA. The results of this work indicate that the loss of more than 452 northern gannet per year would be unsustainable (based on a recovery factor of 0.5) – see Annex J, SMart Wind (2013). These PBR values suggest that the mortality of 18 adult birds through displacement would therefore not represent an unsustainable population loss. This is particularly so as the PBR represents an annual loss from the population and the calculated displacement impact effectively represents habitat loss that could support 18 adult birds (i.e. it is not an annual loss, but a long-term reduction in the population). If an annual loss of 500 adult birds represents a critical threshold for this species at which population sustainability is threatened, then clearly the 'one-off' loss of habitat that supports 18 adult birds would not result in an effect that would lead to a significant population impact.

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7.8.63 Given the small population effect for all SPA populations assessed, the overall conclusion is that Dogger Bank Teesside A & B, in-combination with other projects, would not result in a displacement impact that would constitute an adverse effect on the integrity of the screened in SPAs designated for their northern gannet populations.

### *Forth Islands SPA*

7.8.64 For the purposes of HRA assessment, and in line with SNH/JNCC guidance for Scottish projects, only impacts during the breeding season are assessed by Scottish projects with respect to Scottish SPAs. For the Forth Islands SPA, 20 adult birds are predicted to be lost from the breeding population as a result of displacement from Dogger Bank Teesside A & B, Dogger Bank Creyke Beck and Dogger Bank Teesside C & D combined. Together with the 19 adult birds apportioned to this SPA from the Firth of Forth Alpha and Bravo development and 34 adults from the Neart na Gaoithe project, the total loss is 73 adult breeding birds. This equates to 0.065% of the designated SPA population. On the basis of the small percentage of the breeding population that would be affected it is concluded that Dogger Bank Teesside A & B, in combination with other projects, would not result in a displacement impact that would constitute an adverse effect on the integrity of the designated northern gannet population of the Forth Islands SPA.

### *Common guillemot*

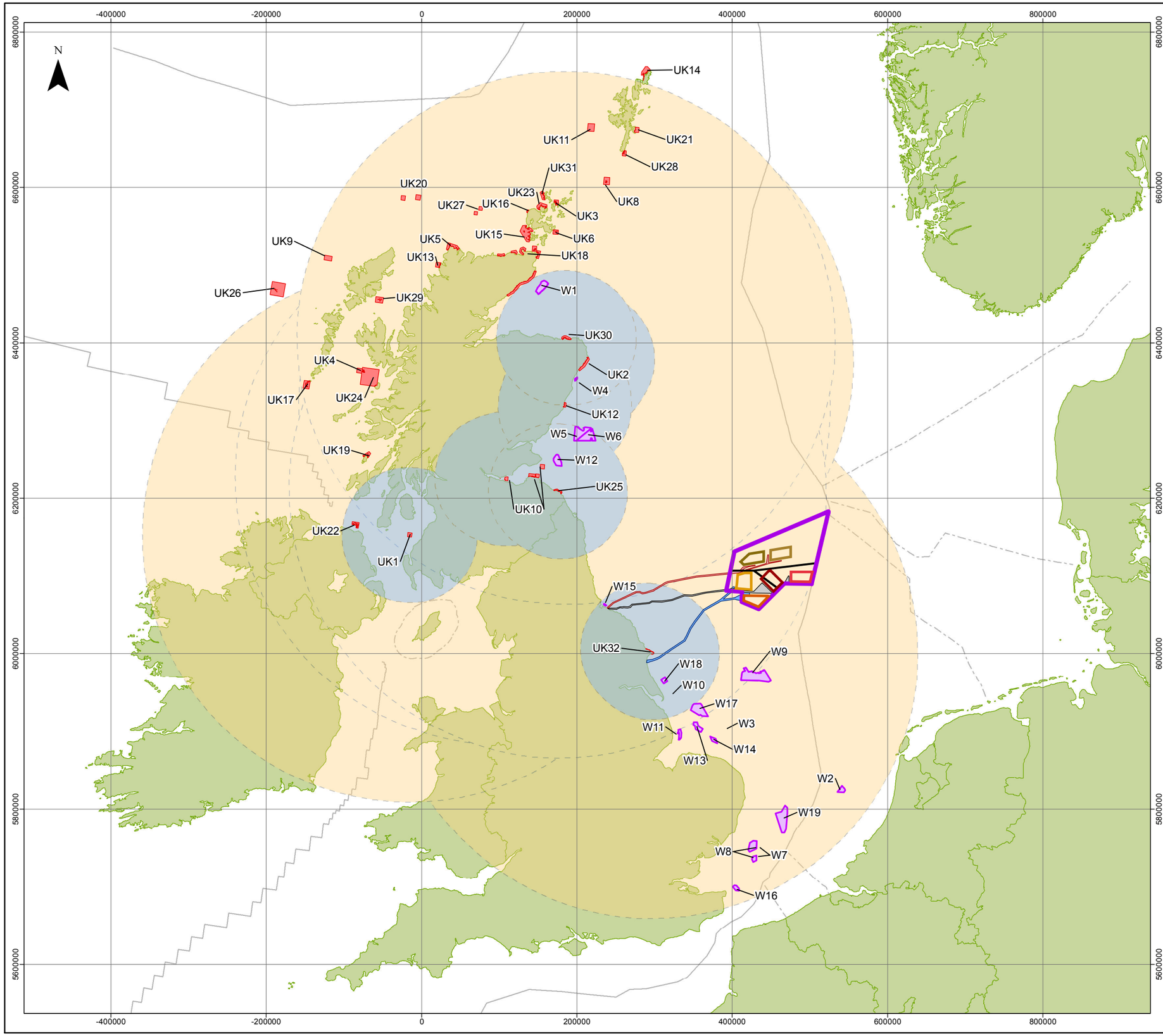
7.8.65 The common guillemot exhibits a medium vulnerability to activities in the marine environment and, therefore, is likely to show a disturbance response. It has a medium sensitivity to the effects of displacement (i.e. effective habitat loss) and, therefore, is considered to have some tolerance to this effect. A precautionary 50% displacement rate during the operation phase for Dogger Bank Teesside A & B has been assumed and a mortality rate of 5% following displacement assigned across both the breeding and non-breeding seasons. The mortality rate is based on knowledge of the foraging ecology of this species and the magnitude of the habitat loss that could occur as a result of displacement from the wind farm development area. As discussed in Section 6.3 and in Furness (2013) (see **Appendix 11B** of the Dogger Bank Teesside A & B ES) this is viewed as a precautionary mortality rate and it is anticipated that the actual rate would be lower than this.

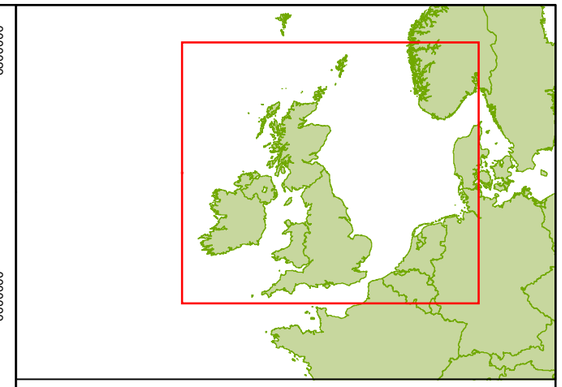
7.8.66 Predictions of the numbers of birds potentially displaced were available for the other projects set out in **Table 7.20**. The total number of birds estimated to be displaced across these projects is 64,557 (summing estimates from different seasons where provided, following the assumption used in this assessment that these would be different birds).

7.8.67 Six SPAs are within the maximum foraging range of Dogger Bank Teesside A & B, as shown in **Figure 7.13**, which defines the spatial limits for the inclusion of other projects that could potentially also affect breeding birds deriving from these SPAs.

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## 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 Creyke Beck Export Cable Corridor
- Dogger Bank Teesside C & D Export Cable Corridor
- Offshore wind farm
- Special Protection Area (SPA)
- Common guillemot mean maximum range - 84km
- Common guillemot maximum range - 340km

0 50 100 200

Kilometres

Data Source:
Environmental Designations © JNCC, 2014
UK offshore wind farm © The Crown Estate, 2014
European wind farm boundary data supplied by MarineFind, 2014

PROJECT TITLE

*Dogger Bank Teesside A & B*
IfAA Report

DRAWING TITLE

**Figure 7.13 Common guillemot foraging ranges and other projects**

| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 15/10/2013 | PEI3 | LW | PT |
| 2 | 18/03/2014 | DCO Submission | JE | PT |
| | | | | |

DRAWING NUMBER:

**9Y0986/TSABHRA/57/R2**

| SCALE | PLOT SIZE | DATUM | PROJECTION |
|---|---|---|---|
| 1:5,000,000 | A3 | WGS84 | UTM31N |

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7.8.68 Estimates of mortality for the numbers of displaced birds were available for Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B, Dogger Bank Teesside C & D, East Anglia ONE, the EOWDC project, Hornsea Project One, Firth of Forth Alpha and Bravo (Seagreen), and Neart na Gaoithe. While displacement values were provided for the Inch Cape and Moray projects, the assessments did not assign any specific mortality impact, **Table 7.22** sets out the displacement and mortality rates and predicted mortalities for each of the above projects.

Table 7.22 Predicted numbers of common guillemot subject to displacement and mortality for relevant wind farm developments

| Wind farm development | Season | Displacement rate | Number of birds displaced | Mortality rate | Number of mortalities |
|---|---|---|---|---|---|
| Dogger Bank Teesside A & B | Breeding | 50% | 1,072 | 5% | 54 |
| | Winter | 50% | 4,502 | 5% | 225 |
| Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D combined | Breeding | 50% | 7,741 | 5% | 387 |
| | Winter | 50% | 19,814 | 5% | 991 |
| East Anglia ONE | Spring | 30% | 430 | 10% | 43 |
| | Winter | 30% | 820 | 10% | 82 |
| EOWDC | | | 386 | 100% | 386 |
| Hornsea Project One | Breeding | 30% | 1,037 | 10% | 104 |
| | Post-breeding | 30% | 5,705 | 2% | 114 |
| | Winter | 30% | 4,609 | 1% | 46 |
| Firth of Forth Alpha and Bravo (Seagreen) | Breeding | 60% | 5,496 | 1% | 55 |
| Neart na Gaoithe | Breeding | 40% | 1,095 | 10% | 110 |
| Total | | | **38,544** | | **1,888** |

7.8.69 For the EOWDC, a range of rates was presented, but no specific rate advocated, so a worst case (386 birds displaced and 100% mortality) was considered herein as presented in the assessment. Combining these project estimates provided an estimated total of displaced birds that might be expected to die of 1,888.

7.8.70 In terms of the apportioning totals to individual SPAs, combined losses for Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D would be 0.17% of the designated breeding common guillemot population of the Flamborough and Filey Coast pSPA. For the other SPAs that are within the maximum foraging range of Dogger Bank Teesside A & B, the total population affected by Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D is 0.11% or less. The full apportioning breakdown of the SPA populations affected by Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D is presented in **Table 7.23** (also see Tables A9.56a-d in Appendix 9 of **Appendix 11A** of the Dogger Bank Teesside A & B ES for annual breakdown of data).

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Table 7.23 Apportioning of displacement and mortality impact for common guillemot to European sites as a result of in-combination displacement during the operation phase for Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D (figures provided show the percentage of the designated SPA breeding population affected and, in brackets, the number of individual mortalities)

| Site name | Dogger Bank Teesside A & B | | | Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D | | | EOWDC | Hornsea Project One[2] | Firth of Forth Alpha and Bravo (Seagreen)[1] | Neart na Gaoithe | All projects total % of population |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Breeding | Non-breeding[1] | Total | Breeding | Non-breeding[1] | Total | | | | | |
| Buchan Ness to Collieston Coast SPA | 0 | 0.02 (7) | 0.02 (7) | 0.02 (6) | 0.09 (33) | 0.11 (39) | 1.5 (299) | 0 | <0.01 (2) | 0 | 1.61 (340) |
| Cape Wrath SPA | 0 | 0.02 (8) | 0.02 (8) | 0 | 0.09 (38) | 0.09 (38) | 0 | 0 | 0 | 0 | 0.09 (38) |
| Calf of Eday SPA | 0 | 0.02 (1) | 0.02 (1) | 0 | 0.09 (2) | 0.09 (2) | 0 | 0 | 0 | 0 | 0.09 (2) |
| Copinsay SPA | 0 | 0.02 (5) | 0.02 (5) | 0 | 0.09 (24) | 0.09 (24) | 0 | 0 | 0 | 0 | 0.09 (24) |
| East Caithness Cliffs SPA | 0 | 0.02 (58) | 0.02 (58) | 0 | 0.09 (273) | 0.09 (273) | 0 | 0 | 0 | 0 | 0.09 (273) |
| Fair Isle SPA | 0 | 0.02 (7) | 0.02 (7) | 0 | 0.09 (34) | 0.09 (34) | 0 | 0 | 0 | 0 | 0.09 (34) |
| Farne Islands SPA | 0.05 (8) | 0.02 (18) | 0.025 (26) | 0.08 (49) | 0.09 (83) | 0.17 (132) | 0 | 0 | 0 | 0.01(5) | 0.18 (137) Br. 0.09 (54) |
| Forth Islands SPA | 0.01 (2) | 0.02 (8) | 0.03 (10) | 0.04(13) | 0.09 (37) | 0.13 (50) | 0 | 0 | 0.02 (7) | 0.2 (46) | 0.35 (103) Br. 0.26 (66) |
| Flamborough and Filey Coast pSPA | 0.02 (20) | 0.02 (23) | 0.04(43) | 0.16 (137) | 0.09 (107) | 0.25 (244) | 0 | 0.15 (127) | 0 | 0 | 0.4 (371) |
| Foula SPA | 0 | 0.02 (8) | 0.02 (8) | 0 | 0.09 (39) | 0.09 (39) | 0 | 0 | 0 | 0 | 0.09 (39) |
| Fowlsheugh SPA | 0.004 (2) | 0.02 (16) | 0.02 (18) | 0.03 (21) | 0.09 (77) | 0.12 (98) | 0.15 (89) | 0 | 0.07 (40) | 0.01 (8) | 0.36 (235) Br. 0.27 (158) |
| Hermaness, Saxa Vord and Valla Field SPA | 0 | 0.02 (3) | 0.02 (3) | 0 | 0.09 (13) | 0.09 (13) | 0 | 0 | 0 | 0 | 0.09 (13) |
| Hoy SPA | 0 | 0.02 (3) | 0.02 (3) | 0 | 0.09 (16) | 0.09 (16) | 0 | 0 | 0 | 0 | 0.09 (16) |


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| Site name | Dogger Bank Teesside A & B | | | Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D | | | EOWDC | Hornsea Project One[2] | Firth of Forth Alpha and Bravo (Seagreen)[1] | Neart na Gaoithe | All projects total % of population |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Breeding | Non-breeding[1] | Total | Breeding | Non-breeding[1] | Total | | | | | |
| Marwick Head SPA | 0 | 0.02 (7) | 0.02 (7) | 0 | 0.09 (31) | 0.09 (31) | 0 | 0 | 0 | 0 | 0.09 (31) |
| North Caithness Cliffs SPA | 0 | 0.02 (26) | 0.02 (26) | 0 | 0.09 (121) | 0.09 (121 | 0 | 0 | 0 | 0 | 0.09 (121 |
| Noss SPA | 0 | 0.02 (8) | 0.02 (8) | 0 | 0.09 (38) | 0.09 (38) | 0 | 0 | 0 | 0 | 0.09 (38) |
| Rousay SPA | 0 | 0.02 (1) | 0.02 (1) | 0 | 0.09 (5) | 0.09 (5) | 0 | 0 | 0 | 0 | 0.09 (5) |
| St Abb's Head to Fast Castle SPA | 0.01 (5) | 0.02 (16) | 0.026 (21) | 0.05 (32) | 0.09 (75) | 0.14 (107) | 0 | 0 | <0.01 (5) | 0.03 (17) | 0.18 (129) Br. 0.09 (54) |
| Sule Skerry and Sule Stack SPA | 0 | 0.02 (2) | 0.02 (2) | 0 | 0.09 (11) | 0.09 (11) | 0 | 0 | 0 | 0 | 0.09 (11) |
| Sumburgh Head SPA | 0 | 0.02 (2) | 0.02 (2) | 0 | 0.09 (9) | 0.09 (9) | 0 | 0 | 0 | 0 | 0.09 (9) |
| Troup, Pennan and Lions Heads SPA | 0 | 0.02 (6) | 0.02 (6) | 0 | 0.09 (28) | 0.09 (28) | 0 | 0 | 0 | 0 | 0.09 (28) |
| West Westray SPA | 0 | 0.02 (4) | 0.02 (4) | 0 | 0.09 (21) | 0.09 (21) | 0 | 0 | 0 | 0 | 0.09 (21) |
| **Transboundary sites** | | | | | | | | | | | |
| Cap d'Erquy – Cap Frehel SPA | 0 | 0.02 (0.1) | 0.02 (0.1) | 0 | 0.09 (0.6) | 0.09 (0.6) | 0 | 0 | 0 | 0 | 0.09 (0.6) |
| Cote de Granit Rose-Sept Iles SPA | 0 | 0.02 (0.01) | 0.02 (0.01) | 0 | 0.09 (0.03) | 0.09 (0.03) | 0 | 0 | 0 | 0 | 0.09 (0.03) |
| Seevogelschutzgebiet Helgoland SPA | 0 | 0.02 (1) | 0.02 (1) | 0 | 0.09 (7) | 0.09 (7) | 0 | 0 | 0 | 0 | 0.09 (7) |
| Hallands Vardero SPA | 0 | 0.02 (0) | 0.02 (0) | 0 | 0.09 (0.02) | 0.09 (0.02) | 0 | 0 | 0 | 0 | 0.09 (0.02) |

1 – The total number of birds (provided in brackets) is for all birds (i.e. adults and immature). It is assumed that two thirds (67%) of these non-breeding birds are adults.
2 – Adult birds only.


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7.8.71 For Hornsea Project One, displacement mortalities that may occur during the breeding season have been attributed to the Flamborough and Filey Coast pSPA as this is the closest SPA and is within the maximum foraging range of guillemot reported in Thaxter *et al*. (2012). At other times of the year, birds from a number of possible east coast and potentially further afield colonies may be present in the Hornsea Zone and therefore mortalities could potentially be apportioned to a number of SPAs. The assessment work presented in the Hornsea Project One HRA assumes that a certain percentage (in direct proportion to the colony size) of the birds present could derive from the Flamborough and Filey Coast pSPA and therefore some of the mortalities can be apportioned to this SPA. The remaining mortalities are not apportioned to any other SPAs.

7.8.72 The calculated mortalities for East Anglia ONE are considered in the context of increase in mortality relative to the baseline mortality rate for the national population of common guillemot and no apportioning of losses to specific SPAs is provided (East Anglia Offshore Wind Limited 2013b). Calculated mortalities for this project have therefore not been considered in the apportioned in-combination totals presented here.

7.8.73 Birds affected by the EOWDC were apportioned to two SPAs – Buchan Ness to Collieston and Fowlsheugh (Technip 2012). Both of these SPAs are at the furthest extent of the foraging range of this species from Dogger Bank Teesside A & B (330km and 305km respectively to the nearest part of the development area).

7.8.74 For the Neart na Gaoithe project, the assessment of displacement impact (766 adult birds within the development area + 2km buffer) concludes that 76 adult birds may suffer mortality, based on a 10% mortality rate. This predicted loss has been apportioned to the breeding populations present in the Forth Islands SPA, St Abb's Head SPA, Fowlsheugh SPA, and the Farne Islands SPA, all of which are within the mean maximum foraging range (plus one standard deviation) of this species during the breeding period and may therefore occur within the Neart na Gaoithe offshore site during this time (Mainstream 2013a).

7.8.75 For the Inch Cape project, it is assumed that 50% of breeding adult birds present within the development area + buffer could be displaced, giving a total of 1,827 birds subject to displacement during operation. It is assumed that 100% of displaced birds would fail to breed successfully and that all are from separate breeding pairs. This would potentially reduce the overall breeding success of the regional population by 1,206 chicks, representing a 1.4% increase in breeding failure. Based on the potential foraging range of guillemot (mean maxiumum plus 1 standard deviation = 134km), it is calculated that the development area + 2km buffer is equivalent to a loss of about 0.2% of potential foraging habitat for the regional population, if all areas within foraging range provide suitable habitat. No specific mortality rates are applied to the displacement total. However, population viability analysis is used to investigate the impacts of displacement for guillemot. The PVA predicts that displacement (50% of birds displaced and 100% breeding failure) would have a negligible effect on increasing the chance of population decline up to 25%, whilst the

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increased likelihood of larger declines (50% and 75%) resulting from displacement is only 2% - 3% (see RPS 2013 Appendix 15A). Apportioning of the displacement losses, as a predicted reduction in breeding success, is undertaken in respect of four SPAs (Forth Islands, Buchan Ness to Collieston Coast SPA, Fowlsheugh and St Abb's Head to Fast Castle) and this impact assessed in respect of PVA analysis (ICOL 2013).

7.8.76 For the Moray Firth Round 3 Zone 1 projects, displacement impacts for guillemot were assessed in relation to the designated breeding populations of the East Caithness Cliffs SPA and North Caithness Cliffs SPA. No breeding season impacts on these designated populations are predicted to arise from Dogger Bank Teesside A & B and therefore, for the purposes of HRA assessment, no in-combination impacts with the Moray development would occur.

7.8.77 Adult guillemot predicted to be displaced by the Firth of Forth Alpha and Bravo (Seagreen) development were apportioned to four SPAs, all within mean maximum foraging range of the project area: Forth Islands SPA, Fowlsheugh SPA, St Abb's Head to Fast Castle SPA, and Buchan Ness to Collieston Coast SPA. Breeding season displacement impacts are apportioned to these SPAs from Dogger Bank Teesside A & B and, therefore, potential in-combination impacts are considered in the following sections.

### Flamborough and Filey Coast pSPA

7.8.78 For Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D, the combined displacement impact would affect 0.25% of the breeding common guillemot population at the Flamborough and Filey Coast pSPA. For Hornsea Project One, the predicted losses for this SPA are 127 adult birds, which equates to 0.15% of the SPA population. Together these projects would therefore result in the loss of 0.4% of the designated common guillemot population. No attempt has been made here to normalise the approach to calculating overall mortality losses (i.e. applying the same displacement and mortality rates used for Dogger Bank Teesside A & B to the Hornsea Project One data) and the overall total is therefore derived from two approaches using different values.

7.8.79 As discussed in Section 6.3, the location of Dogger Bank Teesside A & B in relation to available good quality sandeel foraging habitat indicates that the overall loss of foraging resource to common guillemot deriving from Flamborough Head and Bempton Cliffs would be negligible.

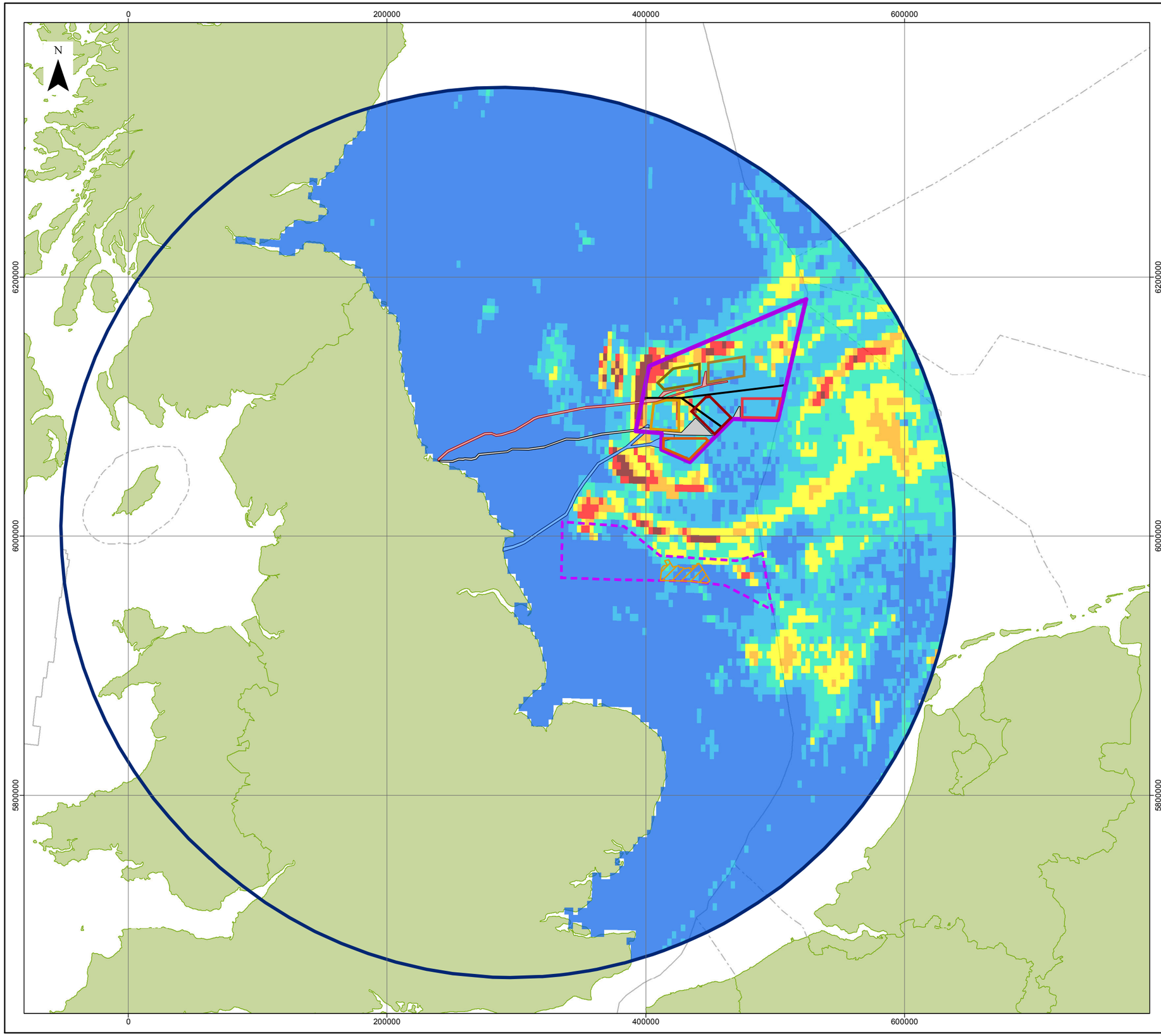
7.8.80 Using data from the Danish Vessel Monitoring System (VMS), see Section 6.3, as a proxy for sandeel habitat (i.e. foraging resources), it is calculated that the percentage loss of good quality habitat via displacement from Dogger Bank Teesside A & B would represent a total of 0.5% of available habitat within the maximum foraging area, giving, with Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D, a combined total loss of 4.4% of habitat see **Table 7.24** (see **Figure 7.14**).

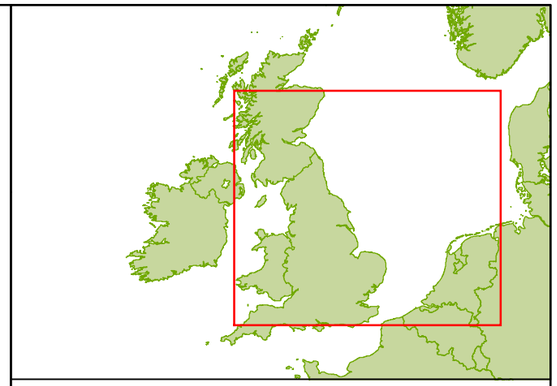
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Table 7.24 Calculation of effective loss of foraging habitat for common guillemot and razorbill due to the combined effect of Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D (Danish VMS data used as a proxy for sandeel habitat)

| VMS density | Area $km^2$ | Area ($km^2$) in Dogger Bank Teesside A & B +buffer | Area ($km^2$) in Dogger Bank Creyke Beck A & B + buffer | Area ($km^2$) in Dogger Bank Teesside C & D +buffer | Combined total area ($km^2$) of VMS density classes | Combined total percentage of total VMS density classes |
|---|---|---|---|---|---|---|
| **Common guillemot – foraging area = 196,496$km^2$ based on 340km maximum range** | | | | | | |
| VMS Density 10 to 20 | 657 | 2 | 6 | 14 | 22 | 3.3 |
| VMS Density 20 to 40 | 201 | 1 | 5 | 6 | 12 | 6.0 |
| VMS Density 40 to 80 | 99 | 1 | 2 | 4 | 7 | 7.1 |
| VMS Density >80 | 63 | 1 | 2 | 1 | 4 | 6.3 |
| **Total** | **1,020** | **5** | **14** | **25** | **45** | **4.4** |
| **% of VMS Density class** | | **0.5%** | **1.4%** | **2.5%** | **4.4%** | |
| **Razorbill – foraging area = 166,801$km^2$ based on 312km maximum range** | | | | | | |
| VMS Density 10 to 20 | 598 | 2 | 6 | 14 | 22 | 3.7 |
| VMS Density 20 to 40 | 185 | 1 | 5 | 6 | 12 | 6.5 |
| VMS Density 40 to 80 | 97 | 1 | 2 | 4 | 7 | 7.2 |
| VMS Density >80 | 63 | 1 | 2 | 1 | 4 | 6.3 |
| **Total** | **943** | **5** | **14** | **25** | **45** | **4.8** |
| **% of VMS Density class** | | **0.53%** | **1.5%** | **2.7%** | **4.8%** | |


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**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 Creyke Beck Export Cable Corridor
- Dogger Bank Teesside C & D Export Cable Corridor
- Hornsea Round 3 Zone
- Hornsea Project One
- Common guillemot maximum range - 340km

Danish sandeel satellite (VMS) density

- 0 to 2
- 2 to 5
- 5 to 10
- 10 to 20
- 20 to 40
- 40 to 80
- Over 80

0 25 50 100
Kilometres

Data Source:
VMS © Ministeriet for Fødevarer, Landbrug og Fiskeri, 2013,
Offshore wind farm © The Crown Estate, 2014

PROJECT TITLE

*Dogger Bank Teesside A & B*
IfAA Report

DRAWING TITLE

**Figure 7.14 VMS data overlay for common guillemot foraging range from Flamborough Head and Bempton Cliffs SPA**

| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 15/10/2013 | PEI3 | LW | PT |
| 2 | 18/03/2014 | DCO Submission | JE | PT |
| | | | | |

DRAWING NUMBER:

**9Y0986/TSABHRA/58/R2**

| SCALE | 1:3,000,000 | PLOT SIZE | A3 | DATUM | WGS84 | PROJECTION | UTM31N |
|---|---|---|---|---|---|---|---|

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7.8.81 The very small area of resource affected by the proposed development indicates that, should displacement occur, that there are extensive areas of good quality foraging habitat available to breeding common guillemot outside of the development area. For non-breeding common guillemot the area available for them to re-distribute into is even greater (i.e. much of the North Sea).

7.8.82 The calculations of percentage loss given in **Table 7.24** take into account habitat quality and the overall percentage loss of total available foraging habitat within the total available foraging area would be much less. However, it is possible that the better quality habitat, as defined by the higher density VMS data, provides a greater proportion of the overall prey resource taken by birds and therefore potential loss would have greater consequences than the loss of other areas. Without knowledge of whether the habitat used within the foraging range is at carrying capacity, it is not possible to determine if there is likely to be a direct proportional relationship between the area of good quality habitat lost and potential effect on populations. A precautionary mortality rate of 5% (applicable to birds throughout the year) was therefore selected in order to reflect this uncertainty, and to take account of other potential factors that may play a role in the overall availability of prey resources (e.g. fluctuations in sandeel stocks).

7.8.83 It is notable that similar mortality rates have been used in determining the displacement impact of the Hornsea One Offshore Wind Farm (SMart Wind 2013). Applying the VMS data to the footprint of Hornsea Project One (see **Figure 7.14**) it can be seen that there is very limited overlap with any areas of defined high quality sandeel / foraging habitat for auks and, therefore, that the cumulative foraging habitat loss is unlikely to be significantly greater than that for Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D. This suggests that the selected mortality rate of 5% is also sufficient to allow for potential cumulative displacement effects from a number of offshore wind farms and that the cumulative displacement effect would not lead to any significant decline in breeding productivity and, therefore, the population level of the SPA.

### Farne Islands SPA

7.8.84 A cumulative impact of 54 adult birds lost through mortality following displacement is calculated for the Farne Islands SPA, representing 0.09% of the population of this site (see Appendix 13 in **Appendix 11A** of the Dogger Bank Teesside A & B ES).

7.8.85 For the Neart na Gaoithe project, five of the total 76 predicted guillemot mortalities resulting from displacement are apportioned to the Farne Islands SPA.

7.8.86 The contribution of Dogger Bank Teesside A & B to the cumulative total is 7 breeding birds <0.01% of the breeding population.

7.8.87 No breeding season impacts were apportioned to this SPA from other projects.

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7.8.88 On the basis of the small percentage of the breeding population that would be affected, it is concluded that Dogger Bank Teesside A & B, in combination with other projects, would not result in a displacement impact that would constitute an adverse effect on the integrity of the designated common guillemot population of the Farne Islands SPA.

### Buchan Ness to Collieston Coast SPA

7.8.89 A total of 338 birds lost through mortality following displacement was calculated for the Buchan Ness to Collieston Coast SPA, representing 1.6% of the population of this site (see Appendix 13 in **Appendix 11A** of the Dogger Bank Teesside A & B ES). The contribution from Dogger Bank Teesside A & B to this overall total is 0.02% (7 birds) and for Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D combined, 0.09% (39 birds) indicating that by far the greater impact would be from the EOWDC (based on the data as presented in the assessment). It should also be noted that of the seven predicted mortalities for Dogger Bank Teesside A & B, all would be of non-breeding birds which reflects the location of Dogger Bank Teesside A & B outside of the maximum foraging range of common guillemot from Buchan Ness to Collieston Coast SPA.

7.8.90 The assumption of a 100% mortality rate for common guillemot displaced by the EOWDC project is considered to be a significant overestimate. Based on adopting a mortality rate similar to that applied to other projects, a rate of 5-10% is considered more likely, in which case mortalities attributable to this project would be between 15-30 birds (i.e. 0.07-14% of the population). The in-combination population effect would therefore be in the region of 0.15%.

7.8.91 For the Firth of Forth Alpha and Bravo (Seagreen) project, the number of guillemot attributed to the Buchan Ness to Collieston Coast SPA and affected assuming a 60% displacement rate is 206 birds. PBR analysis indicates the threshold of loss that could not be sustained by the breeding colony is 1.75% of the population per annum. This level of loss would not be reached at any rate of displacement and mortality. It was calculated that 1.9% of the available foraging habitat would be lost as a result of the development. Taking these factors into account, and using a 1% mortality rate, it is concluded in the ES that two adult birds would be lost from the breeding population.

7.8.92 No breeding season mortality impacts for common guillemot were apportioned to this SPA from the Neart na Gaoithe project.

7.8.93 The calculated percentage of the population affected suggests that the overall potential contribution to any in-combination impact on the breeding population of common guillemot from Dogger Bank Teesside A & B is unlikely to be significant, particularly as only non-breeding birds would be affected by the development.

7.8.94 On the basis of the small percentage of the non-breeding population that would be affected, it is concluded that Dogger Bank Teesside A & B, in combination with other projects, would not result in a displacement impact that would constitute an adverse effect on the integrity of the designated common guillemot population of the Buchan Ness to Collieston Coast SPA.

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### Fowlsheugh SPA

7.8.95 A cumulative impact of 158 breeding birds lost through mortality following displacement is calculated for the Fowlsheugh SPA, representing 0.27% of the population of this SPA.

7.8.96 The majority of the breeding season displacement loss (89 adult birds) is derived from the EOWDC project. However, this is likely to be a significant over estimate as 100% mortality of displaced birds has been assumed.

7.8.97 For the Firth of Forth Alpha and Bravo (Seagreen) project, the number of guillemot attributed to the Fowlsheugh SPA and affected assuming a 60% displacement rate is 4,031 birds. PBR analysis indicates the threshold of loss that could not be sustained by the breeding colony is 1.75% of the population per annum. On this basis, a mortality rate in excess of 19% would need to be applied to achieve this level of impact. It is calculated that 1.9% of the available foraging habitat would be lost as a result of the development. Taking these factors into account, and using a 1% mortality rate, it is concluded in the ES that 40 adult birds would be lost from the breeding population.

7.8.98 The contribution of Dogger Bank Teesside A & B to the cumulative total is 2.3 adult birds during the breeding season and the constribution of Dogger Bank Creyke Beck and Dogger Bank Teesside C & D combined to the cumulative total is 18.4 breeding birds <0.03% of the breeding population.

7.8.99 For the Neart na Gaoithe project, eight of the total 76 predicted guillemot mortalities are apportioned to the Fowlsheugh SPA.

7.8.100 The PVA undertaken for the displacement impact from the Inch Cape project on the regional population includes birds during the breeding season that derive from the Fowlsheugh SPA. The displacement impact for Inch Cape is assessed in relation to potential breeding failure and no mortality figures are provided. A 3.28% reduction in breeding success is predicted for this SPA population. The conclusions of this PVA work, in respect of the regional population, also apply to the designated population of the SPA.

7.8.101 The cumulative level of predicted impact (0.27% of the SPA breeding population) is significantly below the PBR value of 1.75% of the population calculated for the Firth of Forth Alpha and Bravo (Seagreen) project. This suggests that the predicted displacement impact would not have a significant effect on increasing the chance of population decline.

7.8.102 On the basis of the small percentage of the breeding population that would be affected, it is concluded that Dogger Bank Teesside A & B, in combination with other projects, would not result in a displacement impact that would constitute an adverse effect on the integrity of the designated common guillemot population of the Fowlsheugh SPA.

### Forth Islands SPA

7.8.103 A cumulative impact of 66 breeding birds lost through mortality following displacement is calculated for the Forth Islands SPA, representing 0.27% of the population of this SPA.

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7.8.104 For the Firth of Forth Alpha and Bravo (Seagreen) project, the number of guillemot attributed to the Forth Islands SPA and affected assuming a 60% displacement rate is 717 birds. PBR analysis indicates the threshold of loss that could not be sustained by the breeding colony is 1.75% of the population per annum. On this basis, a mortality rate in excess of 53% would need to be applied to achieve this level of impact. It is calculated that 2.3% of the available foraging habitat would be lost as a result of the development. Taking these factors into account, and using a 1% mortality rate, it is concluded in the ES that seven adult birds would be lost from the breeding population.

7.8.105 The contribution of Dogger Bank Teesside A & B to the cumulative total is two breeding birds (<0.01% of the breeding population) and from Dogger Bank Creyke Beck and Dogger Bank Teesside C & D combined, 11 birds, representing 0.03% of the breeding population.

7.8.106 For the Neart na Gaoithe project, 46 of the total 76 predicted guillemot mortalities are apportioned to the Forth Islands SPA.

7.8.107 The PVA undertaken for the displacement impact from the Inch Cape project on the regional population includes birds during the breeding season that derive from the Forth Islands SPA. The displacement impact for Inch Cape is assessed in relation to potential breeding failure and no mortality figures are provided. A 1.37% reduction in breeding success is predicted for this SPA population. The conclusions of this PVA work, in respect of the regional population, also apply to the designated population of the SPA.

7.8.108 The cumulative level of predicted impact (0.27% of the SPA breeding population) is small and well below the PBR value of 1.75% of the population calculated for the Firth of Forth Alpha and Bravo (Seagreen) project. This suggests that the predicted displacement impact would not have a significant effect on increasing the chance of population decline.

7.8.109 On the basis of the small percentage of the breeding population that would be affected, it is concluded that Dogger Bank Teesside A & B, in combination with other projects, would not result in a displacement impact that would constitute an adverse effect on the integrity of the designated common guillemot population of the Farne Islands SPA.

### St Abb's Head to Fast Castle SPA

7.8.110 A cumulative impact of 54 breeding birds lost through mortality following displacement is calculated for the St Abb's Head to Fast Castle SPA, representing 0.09% of the population of this SPA.

7.8.111 For the Firth of Forth Alpha and Bravo (Seagreen) project, the number of guillemot attributed to the St Abb's Head to Fast Castle SPA and affected assuming a 60% displacement rate is 542 birds. PBR analysis indicates the threshold of loss that could not be sustained by the breeding colony is 1.75% of the population per annum. This level of loss would not be reached at any rate of displacement and mortality. It is calculated that 1.7% of the available foraging habitat would be lost as a result of the development. Taking these factors into account, and using a 1% mortality rate, it is concluded in the ES that five adult birds would be lost from the breeding population.

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7.8.112 The contribution of Dogger Bank Teesside A & B to the cumulative total is five breeding birds (0.01% of the breeding population) and from Dogger Bank Creyke Beck and Dogger Bank Teesside C & D combined, 27 birds, representing 0.04% of the breeding population.

7.8.113 For the Neart na Gaoithe project, 17 of the total 76 predicted guillemot mortalities are apportioned to the St Abb's Head to Fast Castle SPA.

7.8.114 The PVA undertaken for the displacement impact from the Inch Cape project on the regional population includes birds during the breeding season that derive from the Forth Islands SPA. The displacement impact for Inch Cape is assessed in relation to potential breeding failure and no mortality figures are provided. A 0.82% reduction in breeding success is predicted for this SPA population. The conclusions of this PVA work, in respect of the regional population, also apply to the designated population of the SPA.

7.8.115 The cumulative level of predicted impact (0.09% of the SPA breeding population) is small and well below the PBR value of 1.75% of the population calculated for the Firth of Forth Alpha and Bravo (Seagreen) project. This suggests that the predicted displacement impact would not have a significant effect on increasing the chance of population decline.

7.8.116 On the basis of the small percentage of the breeding population that would be affected it is concluded that Dogger Bank Teesside A & B, in combination with other projects, would not result in a displacement impact that would constitute an adverse effect on the integrity of the designated common guillemot population of the St Abb's Head to Fast Castle SPA.

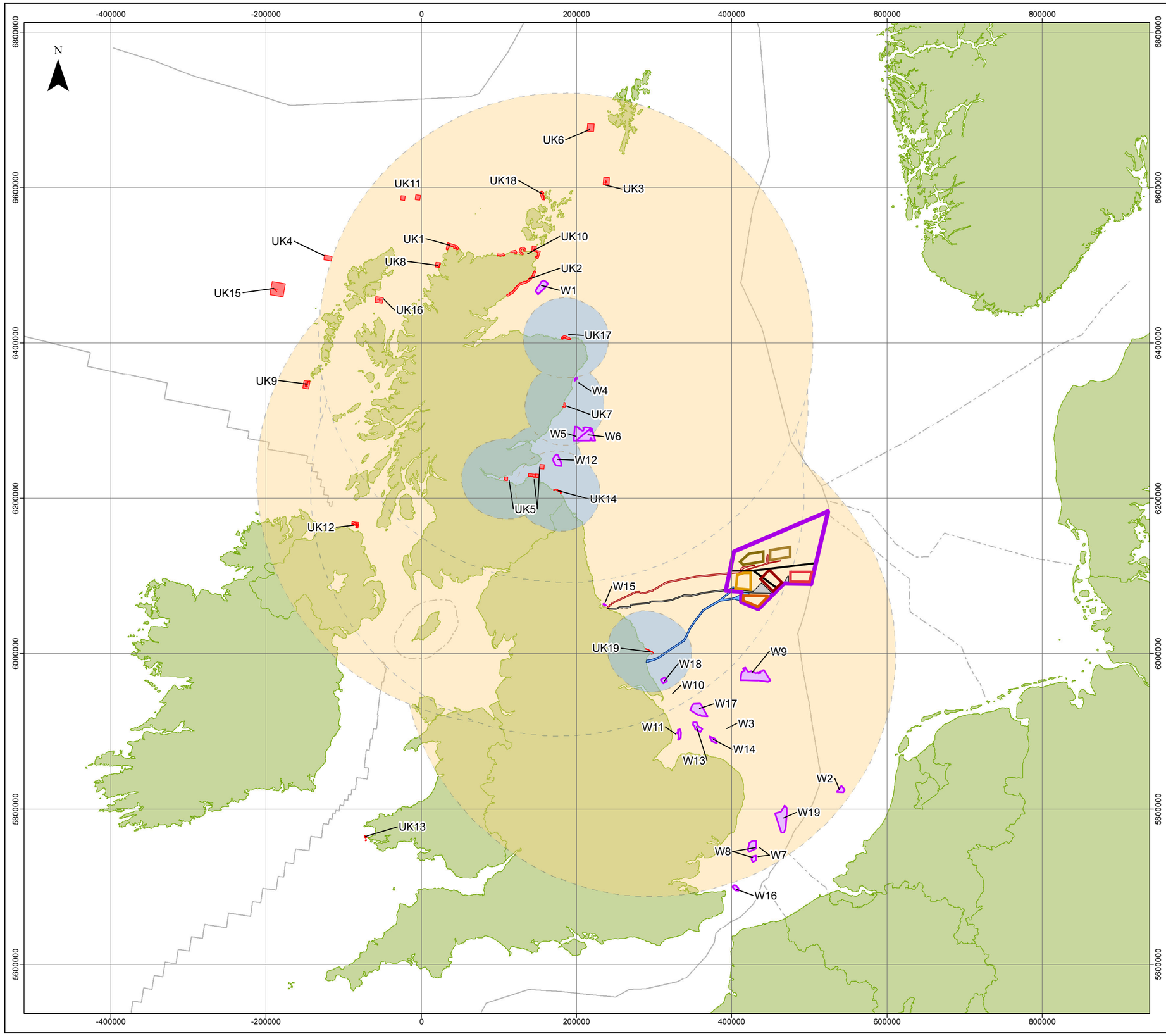
### *Razorbill*

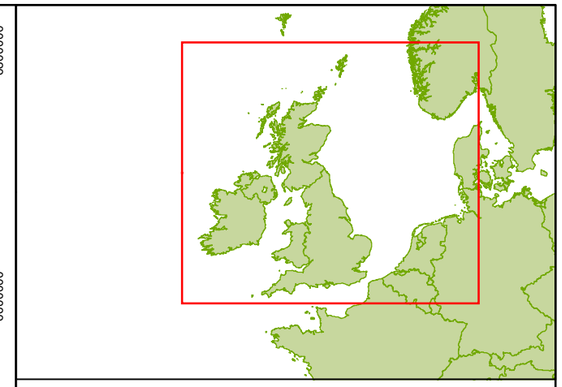
7.8.117 Razorbill exhibits a medium vulnerability to activities in the marine environment and, therefore, is likely to show a disturbance response. It has a medium sensitivity to the effects of displacement (i.e. effective habitat loss), and hence is considered to have some tolerance to this effect. A precautionary 50% displacement rate during the operation phase for Dogger Bank Teesside A & B has been assumed and a mortality rate of 5% following displacement assigned across both the breeding and non-breeding seasons. The mortality rate is based on knowledge of the foraging ecology of this species and the magnitude of the habitat loss that could occur as a result of displacement from the wind farm development area. As discussed in Section 6.3 and in Furness (2013) (see **Appendix 11B** of the Dogger Bank Teesside A & B ES) this is viewed as a precautionary mortality rate and it is anticipated that the actual rate would be lower than this.

7.8.118 Five SPAs are within the maximum foraging range of Dogger Bank Teesside A & B, as shown in **Figure 7.15**, which defines the spatial limits for the inclusion of other projects that potentially could also affect breeding birds deriving from these SPAs.

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## 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 Creyke Beck Export Cable Corridor
- Dogger Bank Teesside C & D Export Cable Corridor
- Offshore wind farm
- Special Protection Area (SPA)
- Razorbill mean maximum range - 49km
- Razorbill maximum range - 312km

0 50 100 200
Kilometres

Data Source:
Environmental Designations © JNCC, 2014
UK offshore wind farm © The Crown Estate, 2014
European wind farm boundary data supplied by MarineFind, 2014

PROJECT TITLE

*Dogger Bank Teesside A & B*
IfAA Report

DRAWING TITLE

**Figure 7.15 Razorbill foraging ranges and other projects**

| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 15/10/2013 | PEI3 | LW | PT |
| 2 | 18/03/2014 | DCO Submission | JE | PT |
| | | | | |

DRAWING NUMBER:

**9Y0986/TSABHRA/59/R2**

| SCALE | 1:5,000,000 | PLOT SIZE | A3 | DATUM | WGS84 | PROJECTION | UTM31N |
|---|---|---|---|---|---|---|---|

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7.8.120 Predictions of the numbers of birds potentially displaced by other projects were available for the projects shown in **Table 7.20**. The total number of birds estimated to be displaced across these projects was 17,962 (summing estimates from different seasons where provided, following the assumption used in this assessment that these would be different birds).

7.8.121 Estimates of the numbers of displaced birds for which mortality may result were available for the projects listed in for **Table 7.25**, which also sets out the displacement and mortality rates and predicted mortalities for each of the projects. Apportioning of the affected birds to individual SPAs is presented in **Table 7.26**.

Table 7.25 Predicted numbers of razorbill subject to displacement and mortality for relevant wind farm developments

| Wind farm development | Season | Displacement rate | Number of birds displaced | Mortality rate | Number of mortalities |
|---|---|---|---|---|---|
| Dogger Bank Teesside A & B | Breeding | 50% | 88 | 5% | 5 |
| | Winter | 50% | 1,604 | 5% | 80 |
| Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D | Breeding | 50% | 784 | 5% | 39 |
| | Winter | 50% | 6,405 | 5% | 320 |
| East Anglia ONE | Spring | 30% | 120 | 10% | 12 |
| | Winter | 30% | 200 | 10% | 20 |
| EOWDC | | | 129 | 100% | 129 |
| Hornsea Project One | Breeding | 40% | 366 | 10% | 37 |
| | Post-breeding | 40% | 2,926 | 2% | 59 |
| | Winter | 40% | 2,628 | 1% | 26 |
| Firth of Forth Alpha and Bravo (Seagreen) | Breeding | 60% | 836 | 1% | 84 |
| Neart na Gaoithe | Breeding | 40% | 117 | 10% | 12 |
| **Total** | | | **14,511** | | **743** |

7.8.122 For Hornsea Project One, displacement mortalities that may occur during the breeding season have been attributed to the Flamborough and Filey Coast pSPA as this is the closest SPA, although it is at a distance greater than the maximum foraging range of razorbill reported in Thaxter *et al*. (2012). At other times of the year, birds from a number of possible east coast and potentially further afield colonies may be present in the Hornsea Zone and therefore mortalities could potentially be apportioned to a number of SPAs. The assessment work presented in the Hornsea Project One HRA assumes that a certain percentage (in direct proportion to the colony size) of the birds present could derive from the Flamborough and Filey Coast pSPA and therefore some of the mortalities can be apportioned to this SPA (SMart Wind 2013). The remaining mortalities are not apportioned to any other SPAs.

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Table 7.26 Apportioning of displacement and mortality impact for razorbill to European sites as a result of in-combination displacement during the operation phase for Dogger Bank Teesside A & B and other projects (figures provided show the percentage of the designated SPA breeding population affected and, in brackets, the number of individual mortalities)

| Site name | Dogger Bank Teesside A & B | | | Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D | | | EOWDC | Firth of Forth Alpha and Bravo | Hornsea Project One[2] | Neart na Gaoithe | All projects total % of population |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Breeding | Non-breeding[1] | Total | Breeding | Non-breeding[1] | Total | | | | | |
| Cape Wrath SPA | 0 | 0.03 (1.8) | 0.03 (1.8) | 0 | 0.14 (7) | 0.14 (7) | 0 | 0 | 0 | 0 | 0.14 (7) |
| East Caithness Cliffs SPA | 0 | 0.03 (13) | 0.03 (13 | 0 | 0.14 (51) | 0.14 (51) | 0 | 0 | 0 | 0 | 0.14 (51) |
| Fair Isle SPA | 0 | 0.03 (1) | 0.03 (1) | 0 | 0.14 (4) | 0.14 (4) | 0 | 0 | 0 | 0 | 0.14 (4) |
| Farne Islands SPA | 0.01 (0.1) | 0.03 (0.4) | 0.04 (0.5) | 0.04 (0.3) | 0.14 (1.7) | 0.18 (2) | 0 | 0 | 0 | 0 | 0.18 (2) |
| Forth Islands SPA | 0.01 (0.2) | 0.03 (3.4) | 0.04 (3.6) | 0.02 (1.2) | 0.14 (14) | 0.16 (15) | 0 | <0.01 (1) | 0 | 0.11 (7) | 0.36 (23) |
| Flamborough and Filey Coast pSPA | 0.01 (4.4) | 0.03 (11.4) | 0.04 (15.8) | 0.08 (18) | 0.14 (45) | 0.23 (63) | 0 | 0 | 0.4 (79)[2] | 0 | 0.63 (142) |
| Foula SPA | 0 | 0.03 (2.5) | 0.03 (2.5) | 0 | 0.14 (10) | 0.14 (10) | 0 | 0 | 0 | 0 | 0.14 (10) |
| Fowlsheugh SPA | >0 (0) | 0.03 (3.8) | 0.03 (3.8) | 0.01 (0.6) | 0.14 (15) | 0.15 (16) | 0.6 (30)[3] | 0.03 (4) | 0 | <0.01 (1) | 0.78 (50) |
| North Caithness Cliffs SPA | 0 | 0.03 (1.8) | 0.03 (1.8) | 0 | 0.14 (7) | 0.14 (7) | 0 | 0 | 0 | 0 | 0.14 (7) |
| St Abb's Head to Fast Castle SPA | <0.01 (0.3) | 0.03 (2.3) | 0.03 (2.6) | 0.03 (1.1) | 0.14 (9) | 0.17 (10) | 0 | 0 | 0 | 0.04 (1) | 0.21 (11) |
| Troup, Pennan and Lions Heads SPA | 0 | 0.03 (1.9) | 0.03 (1.9) | 0 | 0.14 (7) | 0.14 (7) | 0 | 0 | 0 | 0 | 0.14 (7) |
| West Westray SPA | 0 | 0.03 (0.7) | 0.03 (0.7) | 0 | 0.14 (3) | 0.14 (3) | 0 | 0 | 0 | 0 | 0.14 (3) |
| **Transboundary sites** | | | | | | | | | | | |
| Cap d'Erquy – Cap Frehel SPA | 0 | 0.03 (0.01) | 0.03 (0.01) | 0 | 0.14 (0.04) | 0.14 (0.04) | 0 | 0 | 0 | 0 | 0.14 (0.04) |
| Chausay SPA | 0 | 0.03 (0.02) | 0.03 (0.02) | 0 | 0.14 (0.06) | 0.14 (0.06) | 0 | 0 | 0 | 0 | 0.14 (0.06) |
| Cote de Granit Rose-Sept Iles SPA | 0 | 0.03 (0.02) | 0.03 (0.02) | 0 | 0.14 (0.1) | 0.14 (0.1) | 0 | 0 | 0 | 0 | 0.14 (0.1) |
| Ouessant-Molene SPA | 0 | 0.03 (0) | 0.03 (0) | 0 | 0.14 (0.02) | 0.14 (0.02) | 0 | 0 | 0 | 0 | 0.14 (0.02) |


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| Site name | Dogger Bank Teesside A & B | | | Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D | | | EOWDC | Firth of Forth Alpha and Bravo | Hornsea Project One[2] | Neart na Gaoithe | All projects total % of population |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Breeding | Non-breeding[1] | Total | Breeding | Non-breeding[1] | Total | | | | | |
| Seevogelschutzgebiet Helgoland SPA | 0 | 0.03 (0.02) | 0.03 (0.02) | 0 | 0.14 (0.1) | 0.14 (0.1) | 0 | 0 | 0 | 0 | 0.14 (0.1) |

1 – The total number of birds (provided in brackets) is for all birds (i.e. adults and immature). It is assumed that two thirds (67%) of these non-breeding birds are adults.
2 – Adult birds only.
3 – Assumption of 100% mortality of apportioned birds. A 10% mortality of 3 birds is also quoted in the HRA for the EOWDC (Technip 2012).


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7.8.123 The calculated mortalities for East Anglia ONE are considered in the context of increase in mortality relative to the baseline mortality rate for the national population of common guillemot and no apportioning of losses to specific SPAs is provided (East Anglia Offshore Wind Limited 2013b). Calculated mortalities for this project have therefore not been considered in the apportioned in-combination totals presented here.

7.8.124 Birds affected by the EOWDC were considered to potentially derive from two SPAs – Fowlsheugh and Buchan Ness to Collieston. However, apportioning was only undertaken with respect to the Fowlsheugh SPA (a total of 30 birds at 100% mortality) as it was stated that although razorbill breeds at the Buchan Ness to Collieston Coast SPA it is not a qualifying species.

7.8.125 For the Neart na Gaoithe project, the assessment of displacement impact (124 adult birds within the development area + 1km buffer) concludes that as only 1.3% of the foraging habitat available to the regional population would be affected that there would be no significant impact. (Mainstream 2013a). Despite this conclusion, the impact of displacement on the designated breeding populations of two SPAs (Forth Islands and St. Abb's Head to Fast Castle), both of which are within mean maximum foraging range of Neart na Gaoithe, is assessed.

7.8.126 For the Inch Cape project, it is assumed that 50% of breeding adult birds present within the development area + buffer could be displaced, giving a total of 718 birds subject to displacement during operation. It is assumed that 100% of displaced birds would fail to breed successfully and that all are from separate breeding pairs. This would potentially reduce the overall breeding success of the regional population by 431 chicks, representing a 5.3% increase in breeding failure. Based on the potential foraging range of razorbill (83km), it is calculated that the development area + 2km buffer is equivalent to a loss of about 0.4% of potential foraging habitat for the regional population, if all areas within foraging range provide suitable habitat. No specific mortality rates are applied to the displacement total. However, population viability analysis is used to investigate the impacts of displacement for razorbill. Using a range of displacement (50% and 25%) and breeding failure scenarios (25%, 50% and 100%), PVA predicts that even under the most precautionary assumptions the impact of breeding season displacement is not predicted to lead to a decline in the razorbill population, but rather to limit population growth (decreasing the likelihood of this by at most 6% - 10%).

7.8.127 For the Moray Firth projects, displacement impacts for razorbill were assessed in relation to the designated breeding populations of the East Caithness Cliffs SPA and North Caithness Cliffs SPA. No breeding season impacts on the designated populations are predicted to arise from Dogger Bank Teesside A & B and, therefore, for the purposes of HRA assessment, no in-combination impacts with the Moray Firth projects would occur.

7.8.128 Adult razorbill predicted to be displaced by the Firth of Forth Alpha and Bravo (Seagreen) development were apportioned to four SPAs, all within mean maximum foraging range of the project area: Forth Islands SPA, Fowlsheugh SPA, St Abb's Head to Fast Castle SPA, and Buchan Ness to Collieston Coast

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SPA. Apart from Buchan Ness to Collieston Coast SPA, breeding season displacement impacts are apportioned to these SPAs from Dogger Bank Teesside A & B and, the potential in-combination impacts are considered in the following sections.

### Flamborough and Filey Coast pSPA

7.8.129 For Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D, the combined displacement impact would affect 63 birds (0.23% of the SPA population). Of these, a total of 18 birds (0.08% of the SPA population) would be breeding adult birds. For Hornsea Project One, the predicted losses for this SPA are 79 adult birds, which equates to 0.4% of the SPA population. Together these projects would therefore result in the loss of 0.63% of the designated breeding razorbill population. No attempt has been made here to normalise the approach to calculating overall mortality losses (i.e. applying the same displacement and mortality rates used for Dogger Bank Teesside A & B to the Hornsea Project One data) and the overall total is therefore derived from two approaches using different values.

7.8.130 As discussed in Section 6.3, the location of Dogger Bank Teesside A & B in relation to available good quality sandeel foraging habitat indicates that the overall loss of foraging resource to razorbill deriving from Flamborough Head and Bempton Cliffs would be negligible. Using data from the Danish Vessel Monitoring System (VMS), see Section 6.3, as a proxy for sandeel habitat (i.e. foraging resources), it is calculated that the percentage loss of good quality habitat via displacement from Dogger Bank Teesside A & B would represent a total of 0.5% of available habitat within the maximum foraging area. With Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D this gives a combined total loss of 4.8% of habitat.

### Fowlsheugh SPA

7.8.131 A cumulative impact of 35 breeding birds lost through mortality following displacement is calculated for the Fowlsheugh SPA, representing 0.65% of the population of this SPA.

7.8.132 The majority of the breeding season displacement loss (30 adult birds) is derived from the EOWDC project. However, this is likely to be a significant over estimate as 100% mortality of displaced birds has been assumed.

7.8.133 For the Neart na Gaoithe project, less than one of the total eight predicted adult guillemot mortalities is apportioned to the Fowlsheugh SPA.

7.8.134 For the Firth of Forth Alpha and Bravo (Seagreen) Project, the number of razorbill attributed to the Fowlsheugh SPA, assuming a 60% displacement rate, is 388 birds. PBR analysis indicates the threshold of loss that could not be sustained by the breeding colony is 1.9% of the population per annum. On this basis, a mortality rate in excess of 25% would need to be applied to achieve this level of impact, which is considered unlikely to arise. It is calculated that 1.95% of the available foraging habitat would be lost as a result of the development. Taking these factors into account, and using a 1% mortality rate, it is concluded in the ES that four adult birds would be lost from the breeding population.

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7.8.135 The contribution of Dogger Bank Teesside A & B combined with Dogger Bank Creyke Beck and Dogger Bank Teesside C & D to the cumulative total is less than one breeding bird (<0.01%) of the breeding population.

7.8.136 The PVA undertaken for the displacement impact from the Inch Cape project on the regional population includes birds during the breeding season that derive from the Fowlsheugh SPA. The conclusions of this PVA work, as set out above, therefore, also apply to the designated population of the SPA.

7.8.137 The cumulative level of predicted impact (0.65% of the SPA breeding population) is well below the PBR value of 1.9% of the population calculated for the Firth of Forth Alpha and Bravo (Seagreen) project. As indicated it is likely that the impact significance attributed to the EOWDC project is significantly overstated. This suggests that the predicted displacement impact would not have a significant effect on increasing the chance of population decline.

7.8.138 On the basis of the small percentage of the breeding population that would be affected it is concluded that Dogger Bank Teesside A & B, in combination with other projects, would not result in a displacement impact that would constitute an adverse effect on the integrity of the designated razorbill of the Fowlsheugh SPA.

### Forth Islands SPA

7.8.139 A cumulative impact of 9.2 breeding birds lost through mortality following displacement is calculated for the Forth Islands SPA, representing 0.13% of the population of this SPA.

7.8.140 For the Neart na Gaoithe project, seven of the total eight predicted adult guillemot mortalities are apportioned to the Forth Islands SPA.

7.8.141 For the Firth of Forth Alpha and Bravo (Seagreen) Project, the number of razorbill attributed to the Forth Islands SPA, assuming a 60% displacement rate, is 127 birds. PBR analysis indicates the threshold of loss that could not be sustained by the breeding colony is 2.38% of the population per annum. On this basis, a mortality rate of 87% would need to be applied to achieve this level of impact. It is calculated that 2.4% of the available foraging habitat would be lost as a result of the development. Taking these factors into account, and using a 1% mortality rate, it is concluded in the ES that 1 adult bird would be lost from the breeding population.

7.8.142 The contribution of Dogger Bank Teesside A & B combined with Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D to the cumulative total is one breeding bird (<0.01% of the breeding population).

7.8.143 The PVA undertaken for the displacement impact from the Inch Cape project on the regional population includes birds during the breeding season that derive from the Forth Islands SPA. The conclusions of this PVA work, as set out above, therefore, also apply to the designated population of the SPA.

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7.8.144 The cumulative level of predicted impact (0.22% of the SPA breeding population) is small and well below the PBR value of 2.38% of the population calculated for the Firth of Forth Alpha and Bravo (Seagreen) project. This suggests that the predicted displacement impact would not have a significant effect on increasing the chance of population decline.

7.8.145 On the basis of the small percentage of the breeding population that would be affected it is concluded that Dogger Bank Teesside A & B, in combination with other projects, would not result in a displacement impact that would constitute an adverse effect on the integrity of the designated razorbill of the Forth Islands SPA.

### St Abb's Head to Fast Castle SPA

7.8.146 A cumulative impact of 2.1 breeding birds lost through mortality following displacement is calculated for the St Abb's Head to Fast Castle SPA, representing 0.07% of the population of this SPA.

7.8.147 For the Neart na Gaoithe project, one of the total eight predicted adult guillemot mortalities is apportioned to the St Abb's Head to Fast Castle SPA.

7.8.148 For the Firth of Forth Alpha and Bravo (Seagreen) project, the number of guillemot attributed to the St Abb's Head to Fast Castle SPA and affected assuming a 60% displacement rate is 24 birds. PBR analysis indicates that no level of displacement and mortality could result in unsustainable losses. Using a 1% mortality rate, it is concluded in the ES that less than one adult bird would be lost from the breeding population.

7.8.149 The contribution of Dogger Bank Teesside A & B combined with Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D to the cumulative total is one breeding bird (0.03% of the breeding population).

7.8.150 The PVA undertaken for the displacement impact from the Inch Cape project on the regional population includes birds during the breeding season that derive from the Forth Islands SPA. The conclusions of this PVA work, as set out above, therefore, also apply to the designated population of the SPA.

7.8.151 The cumulative level of predicted impact (0.06% of the SPA breeding population) is small and well below the PBR value for the population calculated for the Firth of Forth Alpha and Bravo (Seagreen) project. This suggests that the predicted displacement impact would not have a significant effect on increasing the chance of population decline.

7.8.152 On the basis of the small percentage of the breeding population that would be affected it is concluded that Dogger Bank Teesside A & B, in combination with other projects, would not result in a displacement impact that would constitute an adverse effect on the integrity of the designated razorbill of the St Abb's to Fast Castle SPA.

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### *Atlantic puffin*

7.8.153 Atlantic puffin exhibits a low vulnerability to activities in the marine environment and, therefore, is likely to show a limited disturbance response. It has a medium sensitivity to the effects of displacement (i.e. effective habitat loss) and, therefore, is considered to have some tolerance to this effect.

7.8.154 Predictions of the numbers of birds potentially displaced by other projects were available for the projects shown in **Table 7.20**. The total number of birds estimated to be displaced across these projects is 11,119 (summing estimates from different seasons where provided, following the assumption used in this assessment that these would be different birds). Estimates of mortality for the numbers of displaced birds were, apart from Thanet, available for all of the other projects listed (see **Table 7.27**).

Table 7.27 Predicted numbers of Atlantic puffin subject to displacement and mortality for relevant wind farm developments

| Wind farm development | Season | Displacement rate | Number of birds displaced | Mortality rate | Number of mortalities |
|---|---|---|---|---|---|
| Dogger Bank Teesside A & B | Breeding | 50% | 31 | 5% | 2 |
| | Winter | 50% | 166 | 5% | 8 |
| Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D | Breeding | 50% | 137 | 5% | 7 |
| | Winter | 50% | 605 | 5% | 30 |
| EOWDC | | | 62 | 100% | 62 |
| Hornsea Project One | Breeding | 40% | 428 | 10% | 43 |
| | Post-breeding | 40% | | 2% | |
| | Winter | 40% | 503 | 1% | 5 |
| Firth of Forth Alpha and Bravo (Seagreen) | Breeding | 60% | 2,322 | 1% | 23 |
| Neart na Gaoithe | Breeding | 40% | 3,445 | 10% | 344 |
| **Total** | | | **7,502** | | **524** |

7.8.155 As Dogger Bank Teesside A & B is not within the maximum foraging range of any puffin breeding colonies, no in-combination impacts with breeding puffin populations affected by proposed wind farm developments in Scottish waters would arise. For the purposes of HRA assessment no further consideration is therefore given to the impact of these projects on Atlantic puffin populations. None of the Scottish projects apportion displacement mortalities to any of the SPAs in English waters, although the possibility of some displacement to puffin from the Farne Islands SPA that may be present within the proposed development area for the Neart na Gaoithe project is recognised (Mainstream 2013a) although not assessed.

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7.8.156 Apportioning of the affected birds to individual SPAs was not undertaken for EOWDC and, therefore, is only available for Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D (see Tables A9.62a-d in Appendix 9 of **Appendix 11A** of the Dogger Bank Teesside A & B ES) and the Hornsea Project One. It should be noted that Dogger Bank Teesside A & B is not within the maximum foraging range of any SPA designated breeding populations and therefore the attributed losses relate to non-breeding birds only (see **Figure 7.16**). Hornsea Project One is within the maximum foraging range of Atlantic puffin from the Flamborough and Filey Coast pSPA.

7.8.157 The relatively small number (37) of puffin affected by Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D result in a near zero percentage impact on relevant SPA populations screened into the assessment (see Table A9.62d in Appendix 9 of **Appendix 11A** of the Dogger Bank Teesside A & B ES).

7.8.158 In respect of Hornsea Project One, during the breeding season, affected adult Atlantic puffin are apportioned to three SPAs – Flamborough Head and Bempton Cliffs, Coquet Island and the Farne Islands. Coquet Island and the Farne Islands are located at a distance from the Hornsea Project One development area that is greater than the mean maximum foraging range of Atlantic puffin. However, apportioning to these SPAs has been undertaken on the basis that during the breeding season the Hornsea Project One area supports numbers of Atlantic puffin significantly higher than the total population of the Flamborough and Filey Coast pSPA (980 individuals) indicating that either non-breeding birds are present or that breeding birds from other SPAs are using the area. Based on the breeding population size, the distance of each colony from the Hornsea Project One development area and the proportion of the total area within the species' foraging range, a mortality loss of three adult birds is attributed to the Flamborough and Filey Coast pSPA, nine adult birds to the Coquet Island SPA and 18 adult birds to the Farne Islands SPA.

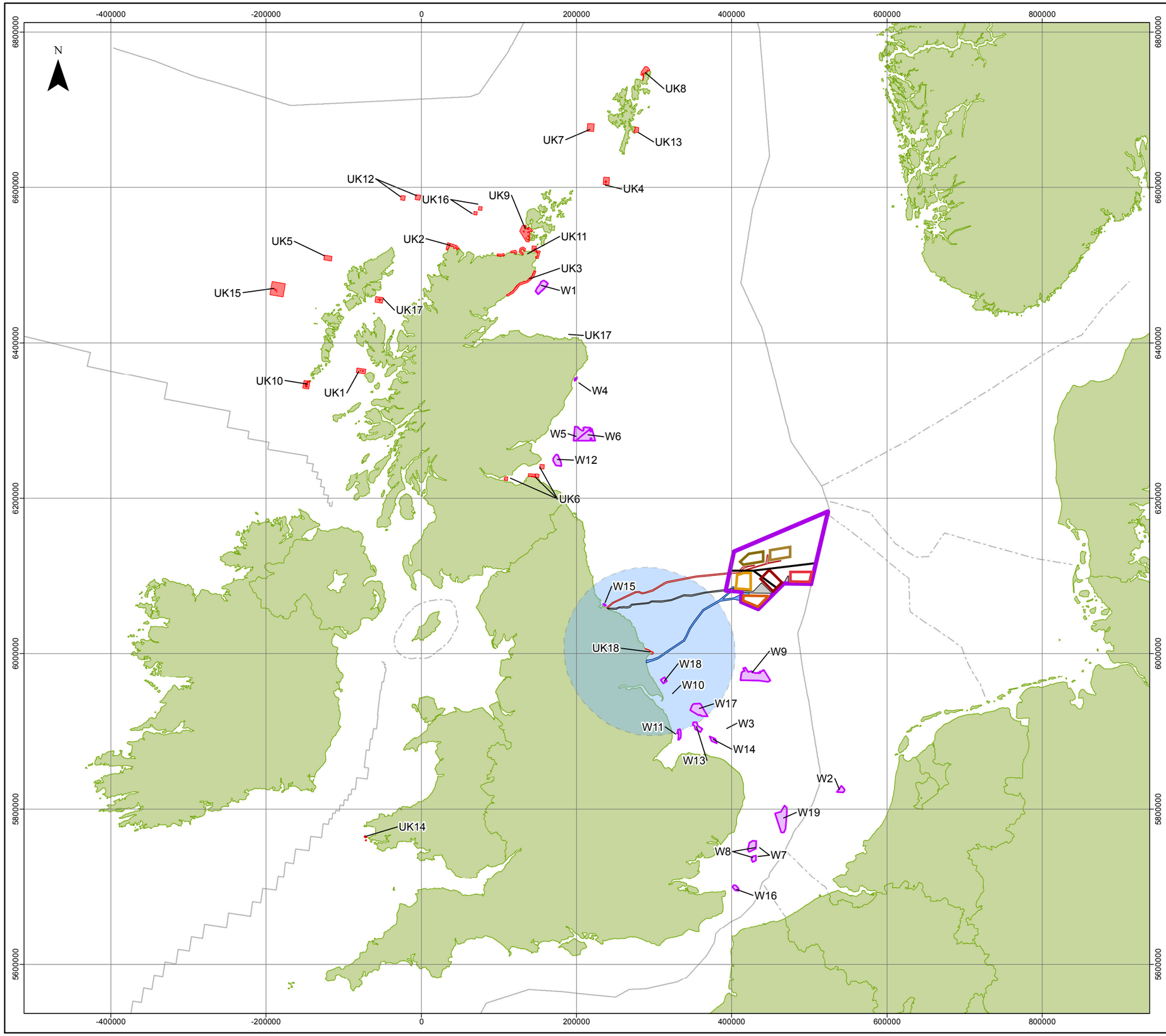
7.8.159 The combined impact of all of the projects considered here, at the population level for each of these SPAs, is provided in **Table 7.28**.

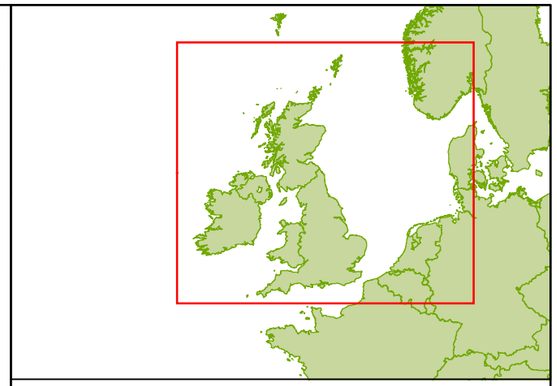
Table 7.28 Apportioning to SPAs of predicted Atlantic puffin mortalities arising from displacement (percentage of the designated SPA breeding population affected shown and, in brackets, the number of individual mortalities)

| SPA | Season | Dogger Bank Teesside A & B | Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D | Hornsea Project One | Totals (number and % of population) |
|---|---|---|---|---|---|
| Flamborough Head and Bempton Cliffs | Breeding | 0 (0) | 0 (0) | 3 | 3 (0.3) |
| | Non-breeding | 0.02 (<0.01) | 0.1 (0.01) | 0 | 0.1 (0.01) |
| Coquet Island | Breeding | 0 (0) | 0 (0) | 9 | 9 (0.05) |
| | Non-breeding | 0.7 (<0.01) | 3 (0.01) | N/C | 3 (0.01) |
| Farne Islands | Breeding | 0 (0) | 0 (0) | 18 | 18 (0.04) |
| | Non-breeding | 1.6 (<0.01) | 7 (0.01) | N/C | 7 (0.01) |

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## 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 Creyke Beck Export Cable Corridor
- Dogger Bank Teesside C & D Export Cable Corridor
- Offshore wind farm
- Special Protection Area (SPA)
- Atlantic puffin mean maximum range - 105km

0 50 100 200

Kilometres

Data Source:
Environmental Designations © JNCC, 2014
UK offshore wind farm © The Crown Estate, 2014
European wind farm boundary data supplied by MarineFind, 2014

PROJECT TITLE

*Dogger Bank Teesside A & B*
IfAA Report

DRAWING TITLE

**Figure 7.16 Atlantic puffin foraging ranges and other projects**

| VER | DATE | REMARKS | Drawn | Checked |
|---|---|---|---|---|
| 1 | 15/10/2013 | PEI3 | LW | PT |
| 2 | 18/03/2014 | DCO Submission | JE | PT |
| | | | | |

DRAWING NUMBER:

**9Y0986/TSABHRA/60/R2**

| SCALE | PLOT SIZE | DATUM | PROJECTION |
|---|---|---|---|
| 1:5,000,000 | A3 | WGS84 | UTM31N |

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7.8.160 As shown in **Table 7.28**, the greatest population impact (0.3%) is the predicted loss of three breeding adult birds from the Flamborough and Filey Coast pSPA as a result of displacement during the operation phase for Hornsea Project One. The combined contribution of Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D to the overall population loss at Flamborough and Filey Coast pSPA is 0.1 indiviudal bird or 3.3% of the total predicted loss of 0.31% of the adult breeding population. For Dogger Bank Teesside A & B, the predicted loss of 0.02 of a bird (non-breeding) is not considered to be significant, as it represents substantially less than 0.002% of the population.

7.8.161 The HRA Report for Hornsea Project One (SMart Wind 2013) provides PBR modelling for Atlantic puffin from the Flamborough and Filey Coast pSPA. The results of this work indicate that the loss of more than 7.6 puffins per year would be unsustainable (based on a precautionary recovery factor of 0.2) – see Annex J, SMart Wind (2013). This analysis suggests that the mortality of three adult birds through displacement would therefore not represent an unsustainable population loss. This is particularly so as the PBR represents an annual loss from the population and the calculated displacement impact effectively represents habitat loss that could support three adult birds (i.e. it is not an annual loss, but a long-term reduction in the population of three birds). If an annual loss of 7.6 adult birds represents a critical threshold for this species at which population sustainability is threatened, then clearly the 'one-off' loss of habitat that supports three adult birds would not result in an effect that would lead to a significant population impact.

7.8.162 The very small impact of Dogger Bank Teesside A & B at the population level (0.002%) also indicates that for the Flamborough and Filey Coast pSPA the effective contribution of the mortality loss predicted for this project is insignificant in-combination with other projects. This conclusion also applies with regard to the other SPAs to which calculated mortality losses have been apportioned (see Table A9.45d in Appendix 9 of **Appendix 11A** of the Dogger Bank Teesside A & B ES).

7.8.163 It is therefore concluded that, in-combination with other projects, Dogger Bank Teesside A & B would not result in a displacement impact that would constitute an adverse effect on the integrity of the screened in SPAs designated for their Atlantic puffin populations.

**Collision risk to sea bird populations**

7.8.164 Collision estimates for the four species under consideration (northern gannet, black-legged kittiwake, lesser black-backed gull and great black-backed gull) were obtained from the ESs and HRAs for the offshore wind farms in the North Sea as listed in **Table 7.20**. It should be noted that for some of the projects, notably the latest Round 3 and Scottish projects, collision risk estimates based on a range of avoidance rates and Band model options are presented in the assessment materials (ES and HRA). The mortality figures derived by individual projects are presented in **Table 7.29** and used for the purposes of the in-combination assessment presented here. Unless stated in the footnotes to **Table 7.29**, all of the collision mortality estimates provided are for a 98%

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avoidance rate. It should be noted that the collision estimates for Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D are based on the mean of the three years of available data (2010, 2010/2011 and 2011/2012).

Table 7.29 Annual collision estimates for marine seabirds for Dogger Bank Teesside A & B and other projects

| Project | Model used | Northern gannet | Black-legged kittiwake | Lesser black-backed gull | Great black-backed gull |
|---|---|---|---|---|---|
| Dogger Bank Teesside A & B | Band (2012) Option 3 | 68[1] | 134 | 33 | 58 |
| Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D | Band (2012) Option 3 | 217[1] | 553 | 88 | 163 |
| Beatrice | Band (2012) Option 3 | 42 | 44 | | 239 |
| Blyth Demonstrator | Band (2012) Option 3 | 15[2] | 10[2] | | 33[2] |
| Breeveerten II | Band *et al.* (2007) | 137 | | 548 | 40 |
| Dudgeon | Band (2000) | 597[3] | | 153[1] | |
| East Anglia ONE[1] | Band (2012) Option 1 | 314 | 780 | 291 | 115 |
| European Offshore Wind Development Centre | Band (2012) Option 2 | 17 | 34 | | 12 |
| Firth of Forth Aplha and Bravo (Seagreen) | Band (2012) Option 3 | 719 | 252 | 12 | 267 (Option 1 total) |
| Galloper | Band *et al.* (2007) | 112 | 148 | 661 | 104 |
| Greater Gabbard | Band (2000) | | | 252[4] | |
| Hornsea Project One | Band (2012) Option 4 | 54[1] | 31 | 22 | 127 |
| Humber Gateway | Band (2000) | 18[5] | 34[5] | 13[5] | 64[5] |
| Inch Cape | Band 2012 Option 1 | 675 | 547 | - | 147 |
| London Array I/II | Band (2000) | 10 | | | |
| Lincs | Band (2000) | 9 | | 34 | |
| Moray (Telford, Stevenson and MacColl) | Band (2012) Option 3 | 53 | 96 | - | 89 |
| Neart na Gaoithe | Band (2012) Option 1 | 377 | 86 | 3 | 21 |
| Race Bank | Band (2000) | 494[5] | 241[5] | 296 | 96 |
| Sheringham Shoal | Band (2000) | 31 | | 33 | |
| Teesside | Band (2000) | 2[6] | 28[6] | | 33[6] |
| Thanet | Band (2000) | 1 | 1 | 32 | 1 |
| Triton Knoll[1] | Band (2000) | 129 | 158 | 85 | 487 |
| Westermost Rough | Band (2000) | 1 | 1 | 1 | 1 |
| **Total** | | **1,998** | **2,157** | **2,536** | **1,633** |

[1]Avoidance rate of 99%; [2]Avoidance rate of 88% used; [3]Avoidance rate of 97% used – due to capacity reduction, overall collision total likely to be significantly lower; [4]Avoidance rate of 99.82% used; [5]Avoidance rate of 95% used; [6]Avoidance rate of 99.62% used. Figures based on median population estimates are used for consistency across projects.

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7.8.165 The following sections deal with the predicted impact of the estimated collision losses on individual species and specific designated SPA populations where apportioning from the projects listed in **Table 7.29** has been undertaken.

### *Northern gannet*

7.8.166 Data on predicted collision estimates for northern gannet is available for 18 additional projects, with the total annual collision mortality estimated as 1,998 birds per year from these projects (see **Table 7.29**). It should be noted that this figure comprises estimates derived from a range of collision risk modelling considerations including variations in the type of model used (i.e. options of the basic Band model) and avoidance rates.

7.8.167 Dogger Bank Teesside A & B is within mean maximum foraging range of one designated SPA where the species is a designated feature - Flamborough and Filey Coast pSPA. Evidence from tracking studies (Wakefield *et al*. 2013) also indicates that birds from the Forth Islands SPA may also forage within Dogger Bank and this SPA is therefore also included as being within foraging range of birds during the breeding season. Birds occurring outwith the breeding season may originate from a wider suite of designated sites (see Table A9.33d in Appendix 9 of **Appendix 11A** of the Dogger Bank Teesside A & B ES).

7.8.168 Attribution of northern gannet collision mortalities during the breeding season from Hornsea Project One is undertaken with respect to the Flamborough and Filey Coast pSPA only. However, consideration is also given to the impact of the loss of 10 non-breeding birds attributed to the Forth Islands SPA.

7.8.169 Attribution of northern gannet collision mortalities from the East Anglia ONE project is undertaken with respect to the Flamborough and Filey Coast pSPA and with other wind farm projects in respect of the populations of the North Sea and East Coast colonies (many of which are designated SPAs). However, as only specific attributed data is available for the Flamborough and Filey Coast pSPA, assessment in respect of East Anglia ONE is restricted to consideration of this SPA only. It should be noted that East Anglia Offshore Wind Ltd has recently stated that it will be reducing the number of proposed turbines for the development from 325 to 240 (EAOL 2013). The annual collision estimate for northern gannet would therefore reduce by approximately 25% from 425 birds to 314 (using Option 1 of the Band model and an avoidance rate of 98%). Consequently, the number of collisions attributed to the Flamborough and Filey Coast pSPA will decrease in proportion to 24 birds.

7.8.170 In line with guidance from SNH and JNCC (see Natural England and JNCC Relevant Representation, Section 4.11 - 4.12 – NE/JNCC (2013)), apportioning of predicted collision mortality from proposed Scottish projects is confined to SPAs within mean maximum foraging range of project sites and is also restricted to the breeding season only. Based on mean maximum foraging ranges, the only seabird species that could derive from SPA designated breeding populations in England and be impacted through collision by wind farm projects in Scottish waters is fulmar. However, on the basis of SNH / JNCC advice no SPA designated populations of this species in England were included in the HRAs for Scottish projects (Seagreen 2013). As a result, no apportioning of collision losses to SPAs outside of Scottish waters has been undertaken.

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There is, however, some potential for in-combination impact with Dogger Bank Teesside A & B to arise during the breeding season for northern gannet, based on evidence from tracking studies that breeding birds from the Forth Islands SPA may forage at times within the Dogger Bank Zone. All of the Scottish projects under consideration have apportioned some collision losses of northern gannet to the Forth Islands SPA.

7.8.171 The following sections provide an analysis of in-combination collision losses at both of these designated sites.

### Flamborough and Filey Coast pSPA

7.8.172 Out of the total of 68 annual collision losses calculated for Dogger Bank Teesside A & B, 10 mortalities (seven breeding adults, two non-breeding adults and immature) were attributed to the Flamborough and Filey Coast pSPA.

7.8.173 In addition to the apportioning undertaken for Dogger Bank Teesside A & B, collision estimates have been attributed to the Flamborough and Filey Coast pSPA from the other projects included in **Table 7.30** (adapted from RWE Npower Renewables (2013)).

Table 7.30 Annual collision estimates (mortalities) for northern gannet and black-legged kittiwake attributed to Flamborough and Filey Coast pSPA for offshore wind farm projects in the Greater Wash and Dogger Bank (figures in brackets are for adult birds)

| Project | Northern gannet – adult losses at 98% | Northern gannet – adult losses at 99% | Black-legged kittiwake |
|---|---|---|---|
| Dogger Bank Teesside A & B | 14 | 7 | 67 (62) |
| Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D | 62 | 31 | 285 (267) |
| Dudgeon[1] | 40 | 20 | - |
| East Anglia ONE[2] | 48 | 24 | 80 |
| Hornsea Project One | 12 | 6 | 17 (15) |
| Humber Gateway | 3 | 2 | 14 |
| Lincs | 1 | 1 | - |
| Race Bank[1] | 24 | 12 | 12 (7) |
| Sheringham Shoal | 4 | 2 | - |
| Triton Knoll[3] | 45-67 (89) | 23-34 (45) | 79-118 (52-78) (158 (104)) |
| Westermost Rough | 1 | 0.5 | 1 |
| **Total** | **239-261** | **119-130** | **487-529 (436-462)** |

[1] Avoidance rate of 99%. Figures for Dudgeon, Humber Gateway, Lincs, Race Bank, Sheringham Shoal, Triton Knoll and Westermost Rough are derived from the Triton Knoll HRA where collision estimates from other projects were normalised to a 98% avoidance rate.

7.8.174 Based on figures provided in the respective project ESs and appropriate assessments / HRA Reports, the total collision estimate for northern gannet for all projects for the Flamborough and Filey Coast pSPA amounts to239-261 adult breeding birds. The calculated loss equates to up to 1.5% of the breeding

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population using a 98% avoidance rate (22.5% increase in background mortality) or 0.75% at a 99% avoidance rate (11.3% increase in background mortality), which suggests that the total number of annual collisions could be significant.

7.8.175 As discussed in Section 6.6 of the Dogger Bank Creyke Beck IfAA Report, the PBR model/calculation developed for the Triton Knoll development indicates that the PBR for northern gannet at Flamborough Head and Bempton Cliffs lies between 286 to 393 adult birds, depending on the population growth rate used and whether a correction factor is applied to the population count.

7.8.176 A revised PBR analysis has been undertaken specifically to provide an update to the Triton Knoll work. This takes into account the recent increase in the breeding population of gannet at Flamborough Head, with a recent (2012) count undertaken by the RSPB revealing a total of 11,061 pairs (http://www.rspb.org.uk/news/326575-shining-a-light-on-gannet-numbers-at-rspb-bempton-cliffs). This work is presented in **Appendix E** of the **HRA Report**. Based on the revised population level and the status of the population (i.e. considered to be of least concern and increasing), a PBR of 503 for adult breeding gannet is calculated.

7.8.177 Based on this analysis, the cumulative annual loss of an estimated 239-261 adult birds (i.e. at a 98% avoidance rate) from the population is significantly below the revised (and previous) PBR limit (representing a maximum of 52% of the PBR total). Using an avoidance rate of 99%, which may be more realistic and takes into account the very strong macro-avoidance response of gannet (Krijsveld *et al.* 2011), the cumulative annual loss would be an estimated 119-130 breeding adults, representing up to 26% of the PBR. It should also be noted that the comparatively high collision estimates determined for Triton Knoll, Race Bank and Dudgeon are based on the use of Option 1 of the Band collision risk model and these values would be significantly decreased in adopting Option 3 of the model.

7.8.178 Additionally, for Race Bank and Dudgeon attribution to the Flamborough and Filey Coast pSPA was not undertaken at the time of the individual assessments. For the Triton Knoll in-combination assessment work, the calculated annual mortality losses attributable to the SPA from the Race Bank project were based on the calculated density of gannet within the project area. The Environmental Statement for Race Bank notes that peaks in northern gannet abundance were recorded from July through to October (i.e. outside of the breeding season), suggesting that many of the birds observed at Race Bank represented birds moving through the area following breeding from colonies further to the north. This point is also noted in the Hornsea Project One HRA Report, with the conclusion that "*the proportion of the 494 collisions attributable to breeding Flamborough and Filey Coast pSPA birds will be low, particularly if converted to a 99% avoidance rate*" (Smart Wind 2013). The analysis of satellite-tracking data presented in Wakefield et al. (2013) also indicates that Race Bank (and Dudgeon wind farm) are both outside of the regular foraging range of northern gannet from Flamborough Head and Bempton Cliffs.

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7.8.179 The appropriate assessment undertaken for the Dudgeon wind farm did not consider the impact of northern gannet collision losses on the Flamborough and Filey Coast pSPA, indicating that it was considered not to represent a likely significant effect on the designated population. The Dudgeon scheme has recently been revised with a reduction in the number of wind turbines from 178 to 78 and capacity from 520MW to 400MW. Further supplementary environmental information (SEI) has been provided by Dudgeon Offshore Wind Limited to DECC and the MMO to determine whether this change alters any of the original assessment findings (Royal Haskoning 2013). With regard to potential collision risk estimates for northern gannet, the SEI report does not update the position with regard to the original assessment and notes that *"mortalities at Dudgeon have potential to impact local populations, although there is little evidence of these birds using the site to forage other than sporadically during summer"*.

7.8.180 The population of northern gannet at the Flamborough and Filey Coast pSPA is, given the significant increase in size since designation (see Appendix 1 in Appendix 11A of the Dogger Bank Teesside A & B ES), in favourable condition. Based on the estimated adult mortalities that could arise from the combined impact of collision (using either a 98% or 99% avoidance rate) for all wind farm projects considered, it is apparent that the combined loss would be significantly below the PBR threshold calculated for the gannet population of the Flamborough and Filey Coast pSPA. It is therefore concluded that the predicted cumulative collision losses would not have an adverse effect on the designated northern gannet population of the Flamborough and Filey Coast pSPA.

### Forth Islands SPA

7.8.181 Dogger Bank lies beyond the mean maximum foraging range (230km) of this SPA and therefore attribution during the breeding season is based on tagging data (Wakefield *et al*. 2013) which indicates potential use of the area by gannet from the Firth of Forth colonies (i.e. Bass Rock).

7.8.182 Several proposed Scottish wind farm projects lie within mean maximum foraging range of the Forth Islands SPA and predicted gannet collision mortalities have been largely apportioned to this SPA, as shown in **Table 7.31**. Cumulatively, the number of adult mortalities at a 98% avoidance rate is high with a total of 2,247 adult mortalities predicted. This level of collision mortality reflects the relatively close proximity of these wind farms to the large breeding colony at Bass Rock, which supports over 110,000 northern gannet.

7.8.183 A PBR analysis undertaken for the Seagreen project indicates that a sustainable additional mortality of 2.26% of the population per annum could apply. This equates to 2,511 individuals. The SoSS-04 gannet PVA work (WWT 2012) provided a PBR for the Forth Islands SPA equivalent to 2.08% of the population (2000 individuals). This estimate was based on a smaller colony size (96,130 individuals, as of 2004) rather than the current population size of 110,964 birds.

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Table 7.31 Predicted collision estimates for the designated Forth Islands SPA breeding northern gannet population from Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B, Dogger Bank Teesside C & D and Scottish projects (estimates are for Option 3 of the Band model, apart from Neart na Gaoithe and Inch Cape for which Option 1 figures are provided)

| Total | Dogger Bank Teesside A & B | Dogger Bank Creyke Beck, Dogger Bank Teesside A & B and Dogger Bank Teesside C & D | Neart na Gaoithe | Firth of Forth Alpha and Bravo (Seagreen) | Inch Cape |
|---|---|---|---|---|---|
| 1,803 (98%)<br>899 (99%) | 28 (98%)<br>14 (99%) | 81 (98%)<br>40 (99%) | 377 (98%)<br>188 (99%) | 719 (98%)<br>358 (99%) | 626 (98%)<br>313 (99%) |

7.8.184 An in-combination analysis (based on the calculation of mean density of gannet in flight across all of the relevant project areas) undertaken as part of the Seagreen assessment work predicted that a total collision mortality of 1,814 gannets originating from Bass Rock (Forth Islands SPA) from all development sites. This was based on using Option 2 of the Band Model. The figure using Option 3 was calculated as 1,972 mortalities. The Option 2 values represent 1.64% of the population of the SPA and the Option 3 values 1.78%.

7.8.185 The predicted collision mortality associated within Dogger Bank Teesside A & B is 28 adult birds (based on a 98% avoidance rate using Option 3 of the Band model). When combined with the predicted losses from the Scottish projects this gives a total of 1,750 birds (see **Table 7.30**) or 2,000 using the Seagreen approach. With the inclusion of predicted losses from Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D the respective totals are 1,803 and 2,053 birds. The Dogger Bank Teesside A & B contribution to the total breeding adult mortality is 1.5%. Based on the revised PBR of 2,511 birds (Seagreen 2013), the in-combination total falls below the likely threshold of mortality increase at which a decline in the population of northern gannet at the Forth Islands SPA would be likely to occur. Based on this, it is concluded that the predicted cumulative collision losses would not have an adverse effect on the designated northern gannet population of the Forth Islands SPA.

### *Black-legged kittiwake*

7.8.186 Data on predicted collision estimates for black-legged kittiwake are available for the projects listed in **Table 7.29**. The total collision estimate for black-legged kittiwake from these projects is calculated as 2,157 birds per year.

7.8.187 Dogger Bank Teesside A & B is within foraging range of one SPA where the species is a designated feature - Flamborough and Filey Coast pSPA. Birds occurring outwith the breeding season may originate from a wider suite of sites (see Table A9.35d in Appendix 9 of **Appendix 11A** of the Dogger Bank Teesside A & B ES).

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7.8.188 Attribution of black-legged kittiwake collision mortalities determined for the East Anglia ONE is undertaken with respect to the Flamborough and Filey Coast pSPA only. For Hornsea Project One attribution is to a total of 21 SPAs, although collisions during the breeding season are attributed solely to the Flamborough and Filey Coast pSPA, as this is the only site within mean maximum foraging range of the wind farm development. The small number of non-breeding collision mortalities attributed to other SPAs is not significant at the population level (see Table B2 in Annex B of the Hornsea Project One HRA Report – SMart Wind (2013)).

7.8.189 All proposed Scottish wind farm developments are located outside of the mean maximum foraging distance of kittiwake from Flamborough and Filey Coast pSPA and therefore no breeding season collision impacts have been attributed to the SPA from these projects. In line with guidance from SNH/JNCC, no assessment of potential impacts on birds outside of the breeding season is presented for the Scottish projects and therefore, for the purposes of HRA assessment, no impact on kittiwake that may originate from the Flamborough and Filey Coast pSPA breeding colony is assumed.

### Flamborough and Filey Coast pSPA

7.8.190 Out of the total annual collision losses calculated for Dogger Bank Teesside A & B, 67 birds (55 breeding adults, seven non-breeding adults and five immature) were attributed to the Flamborough and Filey Coast pSPA – see Table A9.35d in Appendix 9 of **Appendix 11A** of the Dogger Bank Teesside A & B ES.

7.8.191 For Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D, the combined collision losses apportioned to this SPA are 285 birds (238 breeding adults, 29 non-breeding adults and 18 immature) – see Table A9.52d in Appendix 9 of **Appendix 11A** of the Dogger Bank Teesside A & B ES.

7.8.192 In addition to the apportioning undertaken for Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D collision estimates have been attributed to the Flamborough and Filey Coast pSPA from a number of other offshore wind farm developments (see **Table 7.30**).

7.8.193 The annual collision estimate for black-legged kittiwake for all projects for the Flamborough and Filey Coast pSPA amounts to 487-529 individual birds (or 436-462 adults). The calculated loss equates to up to 0.59% of the population (all birds) or 0.52% of the adult breeding population at this site. The increase in background mortality is 10.6% (see Table A9 52d in Appendix 9 of **Appendix 11A** of the Dogger Bank Teesside A & B ES), which suggests that the total could be significant.

7.8.194 A PBR analysis for the kittiwake population of the Flamborough and Filey Coast pSPA has been undertaken (see **Appendix E** of the **HRA Report**). This work provides a suggested PBR value of 1,718 adult birds, based on an *f* value of 0.3 and a breeding population of 89,040 birds (the latter figure is based on the latest population estimate provided by Natural England – Natural England (2013)). The reasoning for the use of an *f* value of 0.3 is presented in **Appendix E** of the **HRA Report** but essentially relates to the fact that the kittiwake population of

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Flamborough and Filey Coast pSPA is not threatened and is open to immigration (i.e. it is not a closed, endangered population). It should also be stated that, following the original arguments presented by Dillingham and Fletcher (2008) on the attribution of *f* values to threatened populations, the use of an *f* value of 0.3 is considered to be precautionary (see **Appendix E** of the **HRA Report**). For illustration purposes PBR values using other *f* values are presented in **Appendix E** of the **HRA Report**.

7.8.195 The cumulative total of 436-462 collision losses of adult kittiwake from the Flamborough and Filey Coast pSPA would therefore represent 25-27% of the calculated PBR. It should also be noted that the estimated collision losses would fall below PBR values calculated using *f* values below 0.3. This analysis indicates that the predicted cumulative collision losses for the Flamborough and Filey Coast pSPA black-legged kittiwake population would be below a threshold at which adverse population effects would be expected to occur.

7.8.196 Based on this, the predicted in-combination collision losses would not have an adverse effect on the designated black-legged kittiwake population of the Flamborough and Filey Coast pSPA.

### *Lesser black-backed gull*

7.8.197 **Table 7.30** shows that a total of 2,536 annual collision losses are predicted for lesser black-backed gull from the projects screened into the in-combination assessment.

7.8.198 No SPAs supporting breeding populations of lesser black-backed gull are within mean maximum foraging range of Dogger Bank Teesside A & B. Therefore, any potential in-combination collision impact relates solely to non-breeding birds, which potentially could derive from a number of SPAs (18 screened into the assessment) situated around the North Sea.

7.8.199 A total of 394 collision mortalities (including a total of 45 breeding adult birds) are predicted for the East Anglia ONE project and 22 (18 during the breeding season) for Hornsea Project One.

7.8.200 For East Anglia ONE, the loss of 45 adult birds during the breeding season was assessed in relation to the regional breeding population, resulting in an increase relative to the baseline mortality rate of 5.08%, considered to be a negligible magnitude impact on the regional breeding population (EAOW 2013c). Mortality of birds during the winter is assessed as leading to a 0.34% increase in the baseline mortality of the international wintering population resulting in a negligible magnitude impact. East Anglia ONE is within mean maximum foraging range of the lesser black-backed gull population of the Alde-Ore Estuary SPA. Apportioning of collision mortalities during the breeding season to this SPA indicates that 14 adult birds could be lost from this population. Inclusive of birds outside of the breeding season, a total of 20 birds (16 adults) were apportioned to the SPA (EAOW 2013c). A PVA model developed for the project determined that an additional mortality of 20 adult lesser black-backed gulls would result in a negligible effect on the number of breeding pairs of lesser black-backed gulls expected to be present at the Alde-Ore Estuary SPA after 25 years under the medium scenario. The assessment work for East Anglia ONE

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therefore concluded that there would not be an adverse effect on breeding lesser black-backed gulls or the integrity of the Alde-Ore Estuary SPA due to collision mortality arising from the operation of East Anglia ONE. It should be noted that East Anglia Offshore Ltd has recently stated that it will be reducing the number of proposed turbines for the development from 325 to 240 (EAOL 2013). While no consequential decrease in collision numbers for lesser black-backed gull is reported in EAOL (2013) it is expected, based on figures provided for northern gannet and black-legged kittiwake, that this change would result in an approximate 25% decrease in the number of collisions per year from those originally predicted (i.e. from 394 to 291).

7.8.201 Hornsea Project One is beyond maximum foraging range of any SPAs and impacts during the breeding season were not apportioned to any SPAs. Outwith the breeding season five adult birds are apportioned to two non-UK SPAs (see Table B.3 of the Hornsea Project One HRA Report – SMart Wind (2013)). No birds were apportioned to the Alde-Ore Estuary SPA.

7.8.202 Of the Scottish projects considered in this in-combination assessment, breeding season impacts on the designated lesser black-backed gull population of the Forth Islands SPA are assessed for the Neart na Gaoithe and Firth of Forth Alpha and Bravo (Seagreen) projects. However, no non-breeding season impacts to the SPA population are assessed in line with SNH/JNCC guidance. As a consequence, for the purposes of HRA, no in-combination impact with Dogger Bank Teesside A & B is determined.

7.8.203 For Dogger Bank Teesside A & B, for all SPAs combined, the total number of predicted collision losses is 33 birds (see Table A9.36d in Appendix 9 of **Appendix 11A** of the Dogger Bank Teesside A & B ES). Apportioned across the relevant SPAs, this total number of collision losses represents 0.01% of individual SPA populations, including the Alde-Ore Estuary SPA (predicted loss of 1.2 non-breeding birds) and a background increase in mortality of 0.12%. This very small impact indicates that any contribution of collision losses due to the operation of Dogger Bank Teesside A & B would not be significant when combined with collision losses attributed to other projects.

7.8.204 Consequently, it is concluded that no adverse in-combination effect on the integrity of lesser black-backed gull populations of the SPAs screened into the assessment would arise.

### *Great black-backed gull*

7.8.205 **Table 7.30** shows that a total of 1,633 annual collision losses are predicted for great black-backed gull from the projects screened into the in-combination assessment.

7.8.206 No SPAs supporting breeding populations of great black-backed gull are within mean maximum foraging range of Dogger Bank Teesside A & B. Therefore, any potential in-combination collision impact relates solely to non-breeding birds, which could potentially derive from a number of SPAs (17 screened into the assessment) situated around the North Sea.

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7.8.207 A total of 115 collision mortalities (using option 3 of the Band model) are predicted for the East Anglia ONE project. These losses are not attributed to any specific SPAs, but considered in relation to the North Sea population, for which it is calculated that the collision losses would result in a change in the baseline mortality rate from 7% to 7.08%. It is considered that this level of additional mortality would have little impact on the current population trends of the North Sea greater black-backed gull population and less on the total flyway population (EAOW 2013d).

7.8.208 Hornsea Project One is beyond maximum foraging range of any SPAs and although 15 collision mortalities during this period were considered to be of SPA designated birds no impacts on designated SPAs were concluded. Outwith the breeding season 27 collision mortalities are predicted for birds belonging to SPA designated populations (see Table B.5 of the Hornsea Project One HRA Report – SMart Wind (2013)).

7.8.209 Of the Scottish projects considered in this in-combination assessment, breeding season impacts on the designated great black-backed gull population of the East Caithness Cliffs SPA are assessed for the Moray and Beatrice projects. However, no non-breeding season impacts to the SPA population are assessed in line with SNH/JNCC guidance. As a consequence, for the purposes of HRA, no in-combination impact with Dogger Bank Teesside A & B is determined.

7.8.210 For all SPAs combined, the total number of predicted collision losses is nine birds (see Table A9.37d in Appendix 9 of **Appendix 11A** of the Dogger Bank Teesside A & B ES). Apportioned across the relevant SPAs, this total number of collision losses represents 0.09% of individual SPA populations and a background increase in mortality of 0.35%. This very small impact indicates that any contribution of collision losses due to the operation of Dogger Bank Teesside A & B would not be significant when combined with collision losses attributed to other projects.

7.8.211 Consequently, it is concluded that no adverse in-combination effect on the integrity of great black-backed gull populations of the SPAs screened into the assessment would arise.

**Barrier effect on foraging sea birds (breeding populations)**

7.8.212 There is considerable uncertainty regarding the assessment of barrier effects posed by offshore wind farms. Assessment of the potential in-combination effects for seabirds from their breeding colonies has not been attempted for the following reasons:

- The difficulties in assessing the magnitude of the potential impacts of this effect;
- The complexities associcted with the numbers of potential projects affecting birds foraging from different colonies (see Appendix 9 in **Appendix 11A** of the Dogger Bank Teesside A & B ES); and
- The potential in-combination impacts of barrier effects from multiple wind farms are not likely to be additive (King *et al*. 2009), and thus are problematic to quantify.

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7.8.213 Consideration of the in-combination impact of barrier effects is, therefore, confined to assessment of wind farm development within the confines of the Dogger Bank Zone (i.e. the in-combination impact for Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D). The species considered and the data used for the in-combination analysis is presented in **Table 7.32**.

Table 7.32 Estimates of the numbers of breeding adult birds of breeding seabird species potentially affected by barrier effects in flight in Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D using mean data

| Species | Breeding season | Mean (2010; 2010/2011 and 2011/2012 |
|---|---|---|
| Northern fulmar | Mar-Sep | 446 (360-540) |
| Northern gannet | Apr-Sep | 482 (540-572) |
| Black-legged kittiwake | Mar-Sep | 3,877 (614-4,307) |
| Common guillemot | May-Jul | 1,179 (1,003-1,292) |
| Razorbill | May-Jul | 228 (278-278) |

### *Northern fulmar*

7.8.214 The increase in flight distance for northern fulmar due to the barrier presented by Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D is unlikely to be more than that presented by the individual wind farm projects on their own, and is predicted to be approximately 25km (6.25% of the northern fulmars' mean maximum foraging range of 400km). This increase might prevent birds from two sites (Troup, Pennan and Lions Heads SPA and Seevogelschutzgebiet Helgoland SPA) from reaching foraging areas beyond the projects (see Appendix 1 in **Appendix 11A** of the Dogger Bank Teesside A & B ES).

7.8.215 The apportionment of the numbers of breeding northern fulmar predicted to be affected by the potential barrier effect posed by Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D is presented in Table A9.46 in Appendix 9 of **Appendix 11A** of the Dogger Bank Teesside A & B ES and summarised in **Table 7.33**.

Table 7.33 Apportioning to European sites of the population of northern fulmar predicted to be influenced by potential barrier effect due to the concurrent operation of Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D

| Site | Percentage of site's population influenced by barrier effect |
|---|---|
| Buchan Ness to Collieston Coast SPA | 1.92 |
| Firth of Forth SPA | 2.47 |
| Flamborough and Filey Coast pSPA | 15.6 |
| Forth Islands SPA | 2.5 |
| Fowlsheugh SPA | 1.33 |
| Troup, Pennan and Lions Heads SPA | 2.06 |
| Seevogelschutzgebiet Helgoland SPA | 0.99 |

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### *Northern gannet*

7.8.216 The increase in flight distance for northern gannet due to the barrier presented by Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D is unlikely to be more than that presented by the individual projects on their own, and is predicted to be approximately 25km (10% of the northern gannets' mean maximum foraging range of 230km). This increase would not prevent birds from SPAs within foraging range of Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D from reaching foraging grounds beyond the development areas (see Appendix 1 in **Appendix 11A** of the Dogger Bank Teesside A & B ES).

7.8.217 The apportionment of the numbers of breeding northern gannet predicted to be affected by the barrier resulting from Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D to European sites is presented in Table A9.49 in Appendix 9 of **Appendix 11A** of the Dogger Bank Teesside A & B ES and summarised in **Table 7.34**.

Table 7.34 Apportioning to European sites of the population of northern gannet predicted to be influenced by potential barrier effect due to the concurrent operation of Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D

| Site name | Percentage of site's population influenced by barrier effect |
|---|---|
| Flamborough and Filey Coast pSPA | 1.07 |
| Forth Islands SPA | 0.28 |
| Seevogelschutzgebiet Helgoland SPA | 0.22 |

### *Black-legged kittiwake*

7.8.218 The increase in flight distance for black-legged kittiwake due to the barrier presented by Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D is unlikely to be more than that presented by the individual projects on their own, and is predicted to be approximately 25km (up to 10.8% of the black-legged kittiwakes' maximum foraging range of 231km).

7.8.219 The apportionment of the numbers of black-legged kittiwake predicted to be affected by the barrier resulting from Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D to European sites is presented in Table A9.51 in Appendix 9 of **Appendix 11A** of the Dogger Bank Teesside A & B ES and summarised in **Table 7.35**.

Table 7.35 Apportioning to European sites of the population of black-legged kittiwake predicted to be influenced by potential barrier effect due to the concurrent operation of Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D

| Site name | Percentage of site's population influenced by barrier effect |
|---|---|
| Farne Islands SPA | 0.91 |
| Flamborough and Filey Coast pSPA | 4.85 |

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### *Common guillemot*

7.8.220 The increase in flight distance for common guillemot due to the barrier presented by Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D is unlikely to be greater than that presented by the individual projects on their own, and is predicted to be approximately 25km (7.4% of the species' maximum foraging range of 340km). This increase might prevent common guillemot from four sites (Buchan Ness to Collieston Coast SPA, Forth Islands SPA, Fowlsheugh SPA, and St Abb's Head to Fast Castle) from reaching foraging areas beyond the development areas (see Appendix 1 in **Appendix 11A** of the Dogger Bank Teesside A & B ES).

7.8.221 The apportionment of the numbers of common guillemot predicted to be affected by the barrier resulting from Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D to European sites is presented in Table A9.57 in Appendix 9 of **Appendix 11A** of the Dogger Bank Teesside A & B ES and summarised in **Table 7.36**.

Table 7.36 Apportioning to European sites of the population of common guillemot predicted to be influenced by potential barrier effect due to the concurrent operation of Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D

| Site name | Percentage of site's population influenced by barrier effect |
|---|---|
| Buchan Ness to Collieston Coast | 0.07 |
| Farne Islands | 0.36 |
| Forth Islands | 0.21 |
| Flamborough Head and Bempton Cliffs | 0.52 |
| Fowlsheugh | 0.13 |
| St Abb's Head to Fast Castle | 0.35 |
| Seevogelschutzgebiet Helgoland | 0.05 |

### *Razorbill*

7.8.222 The increase in flight distance for razorbill due to the barrier presented by Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D is unlikely to be greater than that presented by the individual projects on their own, and is predicted to be approximately 25km (8.0% of the species' maximum foraging range of 312km). This increase might prevent razorbill from three sites (Farne Islands SPA, Firth of Forth Islands SPA and St Abbs Head to Fast Castle SPA) from reaching foraging areas beyond the development areas (see Appendix 1 in **Appendix 11A** of the Dogger Bank Teesside A & B ES).

7.8.223 The apportionment of the numbers of razorbill predicted to be affected by the barrier resulting from Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D to European sites is presented in Table A9.60 in Appendix 9 in **Appendix 11A** of the Dogger Bank Teesside A & B ES and summarised in **Table 7.37**.

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Table 7.37 Apportioning to European sites of the population of razorbill predicted to be influenced by potential barrier effect due to the concurrent operation of Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D

| Site name | Percentage of site's population influenced by barrier effect |
|---|---|
| Farne Islands SPA | 0.45 |
| Forth Islands SPA | 0.29 |
| Flamborough and Filey Coast pSPA | 0.64 |
| Fowlsheugh SPA | 0.08 |
| St Abb's Head to Fast Castle SPA | 0.61 |

### Conclusions on impact of barrier effects on breeding seabirds

7.8.224 As stated, there are considerable uncertainties and difficulties in assessing the barrier effects posed by offshore wind farms. This in-combination assessment has, therefore, been limited to determining the combined impact of Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D located within the Dogger Bank Zone.

7.8.225 For the five species with SPA designated breeding colonies within the foraging range of Dogger Bank, only two species (northern fulmar and black-legged kittiwake) were identified where greater than 1% of the breeding population at individual SPAs could potentially be affected.

7.8.226 While the percentage of the overall breeding population affected of each of the species listed above would be greater than for Dogger Bank Teesside A & B itself, the estimated deviation to flight distance posed by the combined projects would be essentially the same. Discussion of the potential impact of the increase in flight distance on the relevant breeding seabird populations is provided in Section 6.6. Hence the conclusions reached for Dogger Bank Teesside A & B alone in respect of breeding northern fulmar and black-legged kittiwake populations also apply to the potential combined effect of Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D combined.

7.8.227 The overall conclusion is that, for breeding seabirds, the combined development of Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D would not exert an appreciable barrier effect, such that detrimental impacts on designated populations at individual SPAs would arise. No adverse effect on the integrity of those designated populations for which a barrier effect has been identified would therefore arise.

## Impacts on migrant bird populations

### Collision risk

7.8.228 As reported in Section 6.6, predicted collision loss estimates for migrant bird populations that may pass through Dogger Bank Teesside A & B indicate that, for all of the species examined, the losses are negligible at the Great Britain population level and therefore also at the SPA suite level (which is just a subset

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of the Great Britain population and therefore the same proportional impact applies).

7.8.229 The very small collision losses demonstrate that the contribution to any in-combination impact that could arise from Dogger Bank Teesside A & B would not be significant.

7.8.230 Examination of data available from the other wind farm projects screened into the in-combination assessment revealed that consideration of this potential impact is generally lacking. Data is available from the Dogger Bank Creyke Beck A & B, Dogger Bank Teesside C & D, Beatrice, Breeveertien II, the European Offshore Wind Development Centre, Hornsea Project One, Inch Cape, Lincs, and Teesside Offshore Windfarm.

7.8.231 For Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D combined (see **Table 7.38**) for all species for which their migratory routes potentially overlap with Dogger Bank, the potential impact would represent less than 0.1% (significantly less than 0.1% for many species) of the reference populations. This indicates that the collision losses of Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D would not be significant for all SPAs supporting the listed migratory species.

7.8.232 For Hornsea Project One, potential collision risk and mortality estimates were calculated for twelve selected species of waterbird (seven waders and five waterfowl) based on a relatively high proportion of birds occurring within the regional SPAs close to the proposed Hornsea Project One wind farm development.

7.8.233 For each of the twelve species assessed the migration model, Migropath, was used to calculate the proportion of the population likely to pass through the Hornsea Project One development site (APEM 2012). Of the species assessed, the greatest percentage of the Great Britain and Ireland population predicted to pass through the Hornsea Project One development site is that of the taiga bean goose (13.9% of the Great Britain and Ireland population) although no collisions were predicted. For the remaining eleven species, the percentage of the Great Britain and Ireland populations passing through the Hornsea Project One development site were estimated as being less than 10%. The collision risk modelling predicted low numbers of collisions for most of the species, with the highest mortalities predicted for wigeon (20 birds) and lapwing (48 birds). Assessment of these losses against reference populations is not provided in the APEM (2012) report. The calculated collision mortalities for the selected species assessed for Hornsea Project One project are included in **Table 7.38** and the combined impact with respect to the percentage of the Great Britain and Great Britain /Ireland population provided. The inclusion of the estimated collision losses for the migratory species assessed for Hornsea Project One project does not lead to any changes in the conclusions reached regarding the combined impact of the Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D and for all of the species examined the total collision losses would represent significantly less than 0.1% of the relevant Great Britain and Great Britain and Ireland populations.

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Table 7.38 Assessment of in-combination collision risk for migrant birds during the operation phase for Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B, Dogger Bank Teesside C & D, Hornsea Project One, and Inch Cape

| Species | Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D estimated annual collisions | Hornsea Project One estimated annual collisions | Inch Cape | % Great Britain or Great Britain / Ireland population |
|---|---|---|---|---|
| Bean goose | 0.10 | 0 | - | <0.1% |
| Barnacle goose (Svalbard population) | 0.08 | - | - | <0.1% |
| Light-bellied brent goose (Svalbard population) | 0.25 | - | - | <0.1% |
| Common shelduck | 3.93 | 2 | 1 | <0.1% |
| Eurasian wigeon | 22.25 | 20 | - | <0.1% |
| Gadwall | 0.36 | - | - | <0.1% |
| Eurasian teal | 5.27 | - | - | <0.1% |
| Mallard | 16.19 | - | - | <0.1% |
| Northern pintail | 0.71 | - | - | <0.1% |
| Northern shoveler | 0.54 | - | - | <0.1% |
| Common pochard | 2.12 | - | - | <0.1% |
| Tufted duck | 4.03 | - | 1 | <0.1% |
| Greater scaup | 0.02 | - | - | <0.1% |
| Common scoter | 0.19 | - | 1 | <0.1% |
| Velvet scoter | 0.12 | - | - | <0.1% |
| Common goldeneye | 1.38 | - | <1 | <0.1% |
| Red-breasted merganser | 0.01 | - | - | <0.1% |
| Goosander (breeding males) | 0.003 | - | - | <0.1% |
| Goosander (non-breeding) | 0.18 | - | - | <0.1% |
| Great bittern | 0.02 | - | - | <0.1% |
| Great crested grebe | 0.53 | - | - | <0.1% |
| Slavonian grebe | 0.02 | - | - | <0.1% |
| Hen harrier (breeding) | 0.003 | - | - | <0.1% |
| Hen harrier (non-breeding) | 0.07 | - | - | <0.1% |
| Eurasian coot | 0.84 | - | - | <0.1% |
| Eurasian oystercatcher (non-breeding) | 7.53 | - | 3 | <0.1% |


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| Species | Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D estimated annual collisions | Hornsea Project One estimated annual collisions | Inch Cape | % Great Britain or Great Britain / Ireland population |
|---|---|---|---|---|
| Common ringed plover (non-breeding) | 1.30 | - | - | <0.1% |
| Golden plover (non-breeding) | 13.45 | 16 | 36 | <0.1% |
| Grey plover | 3.73 | 2 | - | <0.1% |
| Northern lapwing | 34.52 | 48 | - | <0.1% |
| Red knot | 11.51 | 12 | 5 | <0.1% |
| Sanderling | 2.95 | - | - | <0.1% |
| Dunlin *Calidris alpine schinzii* & *C. a. arctica* (passage) | 0.24 | - | - | <0.1% |
| Dunlin *Calidris alpina alpine* (passage & winter) | 26.27 | 10 | 8 | <0.1% |
| Ruff | 0.19 | - | - | <0.1% |
| Common snipe | 33.91 | - | - | <0.1% |
| Black-tailed godwit | 0.20 | 0 | - | <0.1% |
| Bar-tailed godwit | 4.47 | 2 | - | <0.1% |
| Whimbrel | 0.85 | - | - | <0.1% |
| Eurasian curlew (non-breeding) | 6.83 | - | 2 | <0.1% |
| Greenshank | 0.002 | - | - | <0.1% |
| Common redshank (breeding) | 0.22 | - | - | <0.1% |
| Common redshank Icelandic population (non-breeding) | 9.11 | - | - | <0.1% |
| Common redshank mainland Europe population (non-breeding) | 2.01 | - | - | <0.1% |
| Ruddy turnstone | 1.62 | - | - | <0.1% |
| Short-eared owl | 0.07 | - | - | <0.1% |
| European nightjar | 0.06 | - | - | <0.1% |


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7.8.234 For the Neart na Gaoithe project, collision risk modelling was undertaken for 15 species of geese and waders based on an assumed population of 1,000 birds of each species passing through the offshore site twice per year, on spring and autumn passage, with all birds flying at rotor height (Mainstream 2013b). The predicted number of collisions per year is provided based on a selection of avoidance rates. For all species it was determined that collision mortality would affect 0.7% - 0.8% of the assumed populations. The assessment outputs using this methodology are not compatible with those derived from the Wright *et al*. (2012) methodology and it is therefore not possible to determine any potential contribution from the project to in-combination impacts.

7.8.235 A descriptive assessment of the potential risks to migrant bird populations is provided for the Moray Firth wind farm projects (MORL 2013). On the basis of consideration of likely migratory routes and potential protected sites that could be affected for the species concerned, a judgement of potential impact risk is provided, but no quantitative assessment of population impacts are provided. For two species, pink-footed goose and greylag goose, the potential risk is determined as being of minor significance and collision risk modelling with respect to these two species was undertaken. This provided results of annual collisions of 2.8 greylag (99% avoidance rate) and 20 pink-footed goose. Neither of these species have migratory routes that overlap with the Dogger Bank Zone and therefore no in-combination impacts would arise.

7.8.236 The Seagreen Phase 1 offshore HRA (Seagreen 2013) does not provide any specific (quantified) assessment of the impact of the project on designated migratory waterbird populations.

7.8.237 The Inch Cape project assessed potential collision risk for 13 migratory species using the approach set out in Wright et al. (2012). The species selected were those most likely to migrate through the wind farm. Of these species, the migratory pathways of nine, could potentially overlap with the Dogger Bank and therefore in-combination impacts at the migratory population level could arise (see **Table 7.38**). The predicted annual mortality for each of the 13 species assessed would represent less than 0.01 per cent of the source population (the British wintering population or the passage population from which birds are likely to derive). The project also assessed potential collision impact to the designated migratory taiga bean goose population of the Slamannan Plateau SPA and the Svalbard barnacle goose population of the Upper Solway Flats and Marshes SPA.

7.8.238 The calculated collision mortalities for the selected species assessed for Hornsea Project One project and Inch Cape are included in **Table 7.38** and the combined impact with respect to the percentage of the Great Britain and Great Britain /Ireland population provided. The inclusion of the estimated collision losses for the migratory species assessed for Hornsea Project One and Inch Cape does not lead to any changes in the conclusions reached regarding the combined impact of the Dogger Bank Creyke Beck and Dogger Bank Teesside A & B projects and for all of the species examined the total collision losses would represent significantly less than 0.1% of the relevant Great Britain and Great Britain and Ireland populations.

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7.8.239 For the other projects for which quantitative data is available, collision losses were only presented for two species, barnacle goose and common scoter, for which the migratory routes overlap with Dogger Bank Teesside A & B. For both species the estimated collision losses when combined with those for Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B, Dogger Bank Teesside C & D and Hornsea Project One would be less than 0.1% of the reference populations (see Table 6.5 in **Appendix 11A** of the Dogger Bank Teesside A & B ES).

7.8.240 Consequently, it is concluded that no adverse in-combination effect on the integrity of designated migratory SPA populations screened into the assessment would arise as a result of collision losses during the operation phase for Dogger Bank Teesside A & B.

**Barrier effect on migrant bird populations**

7.8.241 For similar reasons to those discussed previously in respect of breeding seabirds, no attempt has been made to assess in a quantified manner the in-combination effect of the potential barrier effects posed by offshore wind farms lying outside of the Dogger Bank Zone on the 47 migratory populations of terrestrial or waterbird migrants that are UK SPA features whose migration zones (defined by Wright *et al*. 2012) overlap with Dogger Bank Teesside A & B. It should also be noted that there is considerable uncertainty regarding the assessment of barrier effects to migratory birds posed by offshore wind farms. This is due to:

- Uncertainty regarding the numbers of birds passing through each project area;
- Whether birds fly directly to or from the protected sites that they are features of;
- Whether birds fly close to the coastline or further offshore;
- The extent to which the wind farm poses a barrier effect; and
- The consequences for survival from the increase in energy expenditure that could be associated with the increases in flight distance for those birds exposed to barrier effects.

7.8.242 Consideration of the in-combination effect of barrier effects is, therefore, confined to assessment of wind farm development within the Dogger Bank Zone (i.e. the in-combination impact for Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D only).

7.8.243 The results of modelling the potential barrier effect for the migrant species that potentially could interact with the Dogger Bank Zone during the concurrent operation of Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D are summarised in **Table 7.39**.

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Table 7.39 Assessment of barrier effect posed by Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D on relevant bird species with migratory routes across the North Sea that overlap with the project areas

| Species | Number recorded by boat surveys in 20101 | Number recorded by boat surveys in 20111 | Estimated number crossing project areas | % Great Britain or Great Britain / Ireland population |
|---|---|---|---|---|
| Bean goose | 0 | 1 | 27 | 3.74 |
| Barnacle goose (Svalbard population) | 0 | 4 | 23 | 0.07 |
| Light-bellied Brent Goose (Svalbard population) | 0 | 30 | 75 | 2.22 |
| Common shelduck | 0 | 0 | 1166 | 1.54 |
| Eurasian wigeon | 0 | 8 | 7132 | 1.37 |
| Gadwall | 0 | 0 | 114 | 0.52 |
| Eurasian teal | 0 | 1 | 1799 | 0.72 |
| Mallard | 2 | 3 | 4960 | 1.08 |
| Northern pintail | 2 | 1 | 218 | 0.72 |
| Northern shoveler | 0 | 0 | 174 | 0.92 |
| Common pochard | 0 | 3 | 687 | 0.92 |
| Tufted duck | 2 | 0 | 1321 | 1.28 |
| Greater scaup | 0 | 0 | 6 | 0.06 |
| Common scoter | 113 | 191 | 59 | 0.05 |
| Velvet scoter | 4 | 9 | 38 | 1.52 |
| Common goldeneye | 2 | 0 | 450 | 1.54 |
| Red-breasted merganser | 0 | 0 | 3 | 0.11 |
| Goosander (breeding males) | 5 | 0 | 1 | 0.02 |
| Goosander (non-breeding) | 5 | 0 | 54 | 1.67 |
| Great bittern | 0 | 0 | 6 | 1.46 |
| Great crested grebe | 0 | 0 | 167 | 0.69 |
| Slavonian grebe | 0 | 0 | 5 | 0.48 |
| Hen harrier (breeding) | 0 | 0 | 1 | 0.24 |
| Hen harrier (non-breeding) | 0 | 0 | 17 | 4.51 |
| Eurasian coot | 0 | 0 | 281 | 0.27 |
| Eurasian oystercatcher (non-breeding) | 2 | 8 | 2403 | 1.20 |
| Common ringed plover (non-breeding) | 4 | 4 | 948 | 1.30 |


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| Species | Number recorded by boat surveys in 20101 | Number recorded by boat surveys in 20111 | Estimated number crossing project areas | % Great Britain or Great Britain / Ireland population |
|---|---|---|---|---|
| Golden plover (non-breeding) | 0 | 5 | 4602 | 1.15 |
| Grey plover | 0 | 0 | 1268 | 2.57 |
| Northern lapwing | 0 | 19 | 11548 | 2.57 |
| Red knot | 3 | 15 | 4063 | 1.20 |
| Sanderling | 6 | 0 | 1079 | 1.80 |
| Dunlin *Calidris alpine schinzii & C. a. arctica (passage)* | 16 | 18 | 89 | 2.40 |
| Dunlin *Calidris alpina alpine* (passage & winter) | 16 | 0 | 9729 | 2.22 |
| Ruff | 0 | 3 | 66 | 2.77 |
| Common snipe | 1 | 0 | 12015 | 1.20 |
| Black-tailed godwit | 0 | 0 | 128 | 2.27 |
| Bar-tailed godwit | 0 | 0 | 1462 | 2.69 |
| Whimbrel | 6 | 27 | 273 | 1.18 |
| Eurasian curlew (non-breeding) | 51 | 4 | 2052 | 2.51 |
| Greenshank | 0 | 1 | 1 | 0.19 |
| Common redshank (breeding) | 0 | 0 | 75 | 0.25 |
| Common redshank Icelandic population (non-breeding) | 0 | 0 | 3152 | 1.15 |
| Common redshank mainland Europe population (non-breeding) | 0 | 0 | 697 | 2.79 |
| Ruddy turnstone | 7 | 12 | 576 | 1.20 |
| Short-eared owl | 2 | 23 | 18 | 1.74 |
| European nightjar | 0 | 0 | 18 | 0.15 |


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7.8.244 The increase in flight distance depends on the direction of flight, and for the shortest east-west route would result in an increase of up to 25km (4% of the 575km route). This postulated increase in flight distance is precautionary in that it assumes that deviation in flight line would occur rather than birds altering their flight height to avoid wind farm development and the need to deviate from their flight path.

7.8.245 Considering both the small percentage of migrating bird populations likely to be involved and the relative increase in flight distance that the combined wind farm developments could exert, it is concluded that the potential barrier posed by wind farm development would be unlikely to have a detrimental impact upon the energetics of migratory birds such that an effect at either the population or individual protected site level would arise. As a result of the methodology used, the results of this analysis apply to all SPAs in Great Britain and Ireland designated for their migratory bird populations and for which potential overlap of routes with the Dogger Bank Zone have been identified, and not just those SPAs originally screened into the HRA.

7.8.246 The migration routes and information presented in Wright *et al*. (2012) demonstrate that for many species there is significant movement of migratory birds between continental sites (from and to the Netherlands in particular) and the UK. Important sites are designated as SPAs/Ramsar sites (e.g. the Waddenzee). Many of the migratory birds on passage and wintering at SPAs in the Netherlands and Germany would arrive via routes that would not impinge upon the Dogger Bank Zone. However, given interchange and/or onward movement of birds to the UK, part of the populations that are present at these continental sites could be subject to a barrier effect. As such, the results of the analysis also apply to SPAs used by birds on return migration from the UK.

7.8.247 Consequently, it is concluded that no adverse effect on the integrity of those designated migratory SPA populations for which potential in-combination barrier effects are identified would arise.

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# 8 Summary and Conclusions

## 8.1 Introduction

8.1.1 This document has been produced to inform the Habitat Regulations Assessment (HRA) process for Dogger Bank Teesside A & B offshore wind farm development. It provides the relevant information required by the Competent Authority to undertake an appropriate assessment of the project with respect to its potential implications for European sites of nature conservation importance screened into this stage of the HRA process. This step in the HRA process is further described in Section 1.4 and Section 3 of this report.

## 8.2 Likely significant effect

8.2.1 An HRA Screening Report for Dogger Bank Teesside A & B (presented as **Appendix A** of the **HRA Report**) was prepared and circulated for consultation in July 2013. The Screening Report set out the steps taken to determine the designated SPAs, SACs, SCIs, and Ramsar sites that could be affected by the proposed wind farm development and for which a likely significant effect (LSE) could arise.

8.2.2 At an early stage in the Dogger Bank Teesside A & B development process it was recognised that sequential wind farm development of the Dogger Bank Zone would lead to potential in-combination impacts on a range of receptors, including habitats and species of designated European sites. Therefore, in order to facilitate the HRA process, screening was undertaken at both the Zone level (i.e. the entirety of the Dogger Bank Zone) and for Dogger Bank Teesside A & B. This followed the process set out for the first of the Dogger Bank Zone wind farm projects – Dogger Bank Creyke Beck. The Screening Report concluded whether development, either at the Zone level or within Dogger Bank Teesside A & B would constitute LSE, with respect to the European sites screened into the HRA process.

8.2.3 This stage essentially represented a site-identification / selection process which, while it formed part of the overall LSE determination stage of HRA, was separated out to refine the need to undertake more detailed consideration of LSE across all of the possible sites and features that could be influenced by wind farm development within the Dogger Bank Zone and Dogger Bank Teesside A & B. For those sites and designated features identified as having the potential to be affected by wind farm development (at the Zone and individual project level) further screening to determine LSE was undertaken (see Section 3.3).

8.2.4 For those designated sites and features where it was apparent during screening that information was insufficient to enable a firm decision on LSE to be made, a precautionary approach was adopted and a conclusion of potential LSE reached. If, on the basis of further detailed assessment of the relevant information, as presented in this IfAA Report, it is apparent that the effects of the

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project would not constitute LSE with respect to designated features/sites, then this has been stated and no additional assessment has been undertaken. If, on the other hand, the assessment indicates that LSE could arise then the assessment process required to determine whether an adverse effect on site integrity has been followed and a conclusion in respect of this provided.

8.2.5 The findings of the screening report and the additional work presented in this report with regard to LSE for the designated sites and features screened into the assessment process are as follows and are fully detailed in **Appendix D** of the **HRA Report**.

## Terrestrial SACs and SPAs

8.2.6 No terrestrial SACs or SPAs / Ramsar sites would be directly or indirectly affected by proposed works within the export cable route from the landfall location or the proposed substation location (see Figure 5.1 in **Appendix A** of the **HRA Report**).

## Marine and coastal SAC Annex I habitats and supporting habitats of SPAs

8.2.7 Screening identified that the only designated site where direct effects would manifest is the Dogger Bank cSAC, as Dogger Bank Teesside A & B overlaps with the boundary of this site (see **Figure 3.1**).

8.2.8 Hydrodynamic and sediment transport effects would be localised and their potential influence during construction, operation and decommissioning would be restricted to the Dogger Bank cSAC, and the Doggersbank SCI and Doggerbank SCI in Dutch and German waters respectively. The potential for a LSE to arise was determined for these sites.

8.2.9 Due to cable installation techniques and the proposed design of the cable protection, potentially significant adverse effects on the intertidal and subtidal habitats of SACs, SPAs and Ramsar sites located within the zone of potential influence of the export cable (due to changes in hydrodynamic processes and sediment transport) are not anticipated (see Section 4.6, 4.7 and 4.8). Given this, a conclusion of no LSE on the supporting habitats of the Teesmouth and Cleveland Coast SPA (and Ramsar site) located 2km to the north-west, and the Northumbria Coast SPA (and Ramsar site) located 20km to the north of the export cable landfall has been determined.

## Annex II migratory fish populations

8.2.10 All sites around the North Sea supporting Annex II populations of diadromous fish (Atlantic salmon, twaite shad, allis shad, and sea lamprey) were screened into the assessment process due to the potential for works in the marine environment to have an adverse effect upon the migratory behaviour of these species.

8.2.11 Based on consideration of the distribution and likely behaviour of the relevant migratory fish species in relation to the location of the Dogger Bank Zone and the likely effects of development, it was concluded that the works would not have a LSE with respect to SACs around the North Sea designated for their

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Annex II migratory fish populations. The key reasons for this conclusion are as follows:

- There are no designated riverine/estuarine SACs for twaite shad or allis shad in UK North Sea waters, both species exhibiting a western seaboard distribution in the UK (Maitland and Hatton-Ellis, 2003). While some continental European SACs with estuarine links to the North Sea have been designated for twaite shad, available information indicates that migratory adults are likely to use coastal waters of the southern North Sea. The Dogger Bank Zone is located in the central North Sea and, therefore, outside of coastal waters in which twaite shad and allis shad are likely to be present during the marine phase of their life-cycle (Maitland and Hatton-Ellis, 2003). Given this, migratory behaviour would not be influenced by wind farm development works (including cable installation) for Dogger Bank Teesside A & B or within the Dogger Bank Zone;
- Available evidence indicates that the majority of Atlantic salmon return to Scottish rivers from winter feeding grounds off the Faroes and West Greenland. It is therefore highly unlikely that salmon returning to these rivers would migrate through the Dogger Bank Zone or northwards via coastal waters along the eastern UK coast. The exposure risk for designated populations in Scottish rivers to effects that potentially could influence migratory behaviour (e.g. turbine installation, cable-laying) is, therefore, considered to be extremely low. There are no important salmon rivers located in the vicinity of the potential influence of works for the Dogger Bank Teesside A & B Export Cable Corridor landfall;
- Given that the migratory distribution of Atlantic salmon and both shad species would appear to preclude any significant presence within the Dogger Bank Zone or the Dogger Bank Teesside A & B Export Cable Corridor, it is considered highly unlikely that construction or operational effects associated with wind farm development would have any significant influence, such that an adverse effect on designated migratory populations would arise;
- Sea lamprey is a solitary, dispersive species. Individuals from designated populations could be present within the Dogger Bank Zone and, therefore, could be affected by some aspects of the works, notably disturbance and displacement associated with increased underwater noise levels. However, mortality effects are considered unlikely, particularly as host species are predicted to be largely unaffected by the development. There is no evidence to indicate that adults undertake migration from offshore waters along specific routes. Works in the marine environment, therefore, would be unlikely to disrupt the migratory behaviour of fish along specific routes to and from designated rivers for this species; and
- River lamprey tend to remain in coastal, nearshore, and estuarine waters and their presence in offshore waters, where they may be subject to potentially adverse effects of wind farm development, is considered to be highly unlikely.

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## Annex II marine mammal populations

8.2.12 Survey work has revealed that significant numbers of harbour porpoise may be present in Dogger Bank Teesside A & B and the Dogger Bank Zone and that the area is also used by grey seal and small numbers of harbour seal. The Dogger Bank cSAC is not designated for any Annex II marine mammal populations.

8.2.13 Screening identified that the main effects on marine mammals resulting from development of Dogger Bank Teesside A & B would relate to potential disturbance and displacement as a result of increased noise levels generated during construction work, reduction in prey availability, again due to disturbance and displacement of fish during construction, and increased collision risk with vessels during construction and operation. Of these effects, an increase in underwater noise levels during construction, specifically linked to piling works, is considered to pose the greatest potential for impact at the population level. Modelling of underwater noise levels has been undertaken to inform the assessment of potential behavioural responses of marine mammals during the construction phase for the wind farm.

8.2.14 While there is the potential for collision of mammals with vessels operating within and transiting to/from the project area, the overall risk of such collision is considered to be low.

8.2.15 On the basis of the very low numbers of harbour seal observed within the Dogger Bank Zone (see **Chapter 14** of the Dogger Bank Teesside A & B ES and the HRA Screening Report presented in **Appendix A** of the **HRA Report**) data from available tagging studies showing a very limited use of the area and the low risk of collision related mortality. It is concluded that wind farm development within Dogger Bank Teesside A & B would not have any implications for designated sites supporting harbour seal populations. Hence, no LSE was concluded for SACs / SCIs for which harbour seal is a designated feature.

8.2.16 Given the greater observed usage of the Dogger Bank Zone by grey seal and tagging data which demonstrates that individuals appear to make active use of the Dogger Bank Zone for foraging (or transit between colonies), there is an increased potential (in comparison to that for harbour seal) for development effects to impact upon grey seal populations.

8.2.17 It is highly likely that harbour porpoise observed within Dogger Bank Teesside A & B form part of the overall mobile southern North Sea population. The effects of wind farm development, particularly increased underwater noise levels during construction (see **Chapter 14** of the Dogger Bank Teesside A & B ES and Section 5.6 of this report), are known to have potential adverse effects on individual cetaceans and, therefore, development within Dogger Bank Teesside A & B and could have implications for the status of this species within European sites for which it is a designated feature.

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8.2.18 At the screening stage it was not possible to discount the potential for a LSE to arise with regard to European sites designated for their grey seal and harbour porpoise populations. All sites supporting designated Annex II grey seal and harbour porpoise populations initially identified at the screening stage were considered at risk of LSE.

## Designated SPA bird populations

8.2.19 Survey data and previous studies show that the Dogger Bank Zone may at times support nationally and internationally important numbers of seabirds. Potentially, the Dogger Bank Zone and Dogger Bank Teesside A & B are on the flyway of a significant number of migratory birds moving to and from breeding and wintering grounds. As such, wind farm development within the Dogger Bank Zone and Dogger Bank Teesside A & B could have significant implications for a large number of designated SPAs and Ramsar sites around the North Sea and potentially further afield (see **Figure 3.4**).

8.2.20 There would be no terrestrial SACs or SPAs / Ramsar sites that would be directly or indirectly affected by proposed works within the export cable route from the landfall location or the proposed substation location (see Figure 5.1 in **Appendix A** of the **HRA Report**).

8.2.21 The site screening exercise initially identified that the following species populations and relevant designated sites should be included in the assessment process:

- SPAs and Ramsar sites designated for breeding seabird populations of the following species: northern fulmar, northern gannet, great skua, Arctic skua, black-legged kittiwake, lesser black-backed gull, great black-backed gull, common guillemot, razorbill, and Atlantic puffin. Unless specific tracking data was available, mean maximum foraging ranges were used to determine the sites from which birds observed within Dogger Bank Teesside A & B during the breeding season could derive. However, seabirds present within the development area and Dogger Bank Zone at other times of the year (e.g. wintering / passage) could also derive from these breeding sites as birds would not be constrained to their colonies post-breeding and, therefore, it is not possible to screen sites out solely on the use of foraging range during the breeding season;
- SPAs and Ramsar sites designated for wintering / passage seabird populations for the above seabird species, also including little gull, across the North Sea and the east coast of the UK; and
- SPAs and Ramsar sites that support designated populations of migratory species (including species that may form part of internationally important assemblages of waterbirds) that could pass through Dogger Bank Teesside A & B and the Dogger Bank Zone.

8.2.22 While a reasoned argument to discount potential LSE for designated SPAs supporting breeding seabird populations located at distances greater than appropriate foraging ranges of the species populations could be made, it was noted that seabirds from sites at a distance greater than these foraging ranges could pass through or overwinter within the Dogger Bank Zone. Consequently,

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it was determined that, for all sites around the greater North Sea that support the key seabird species, the potential for LSE could arise as a result of wind farm development within the Dogger Bank Zone, including Dogger Bank Teesside A & B.

8.2.23 A number of seabird species were screened out with respect to LSE (see **Appendix A** of the **HRA Report**) on the basis of very low numbers present within the Dogger Bank Zone (both during the breeding and non-breeding seasons) and the fact the development site lies well outside of the foraging range of the majority of breeding seabirds. Species falling into this category include: great cormorant, European shag, pomarine skua, European storm petrel, and Leach's storm-petrel.

8.2.24 With regard to herring gull, this species was screened out with respect to LSE (see paragraphs 6.3.73 and 6.3.74 in **Appendix A** of the **HRA Report**) due to the very low numbers present (also see **Table 6.9**) and the proposed development area being significantly outside the mean maximum foraging range for the herring gull populations at any European sites around the North Sea.

8.2.25 Arctic tern and common tern were screened out with respect to LSE (see paragraphs 6.3.75 to 6.3.82 in **Appendix A** of the **HRA Report**) due to the very low numbers present within the Dogger Bank Zone as a whole (see **Table 6.9**) and the fact that their key migration routes being predominantly coastal, in the context of the projects significant distance offshore.

8.2.26 The HRA Screening Report (see **Appendix A** of the **HRA Report**), concluded that, due to the numerous migratory populations that could be at risk from wind farm development, a LSE could arise with respect to all SPAs / Ramsar sites around the greater North Sea that support migratory species that pass through the Dogger Bank Zone and Dogger Bank Teesside A & B.

## 8.3 Appropriate assessment of Dogger Bank Teesside A & B alone and in-combination with other projects

### Dogger Bank cSAC, Doggersbank SCI (Netherlands) and Doggerbank SCI (Germany) – subtidal sandbanks

8.3.1 The Screening Stage identified three European sites designated for the subtidal sandbanks feature where a potential LSE could arise as a result of the construction, operation or decommissioning of Dogger Bank Teesside A & B. These sites comprise one site in UK waters, namely Dogger Bank cSAC, one site in Dutch waters (Doggersbank SCI) and one site in German waters (Doggerbank SCI).

8.3.2 For the Dogger Bank cSAC, assessment concludes that effects during construction (and decommissioning) would be temporary, short-term and negligible in magnitude. In particular, increases in suspended sediment concentrations and subsequent re-deposition, while potentially extensive under a worst case scenario, are predicted to remain within the range of conditions currently experienced over Dogger Bank. The species and communities of the subtidal sandbank feature are adapted to such intermittent and relatively rapid changes in suspended sediment concentrations and re-deposition. A total area

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of 0.29% of the cSAC could be exposed to disturbance during construction (see **Table 4.14**). Relatively rapid recovery of benthic communities is predicted in areas where disturbance to fine-grained sediment occurs.

8.3.3 Localised changes to the morphology and structure of the sandbanks feature and the processes that maintain sedimentary features would arise in the immediate vicinity of works to install individual structures during construction, or from removal of structures during decommissioning. These changes effectively can be considered as temporary during the construction and decommissioning phases, but potentially could lead to localised and longer-term alteration in habitat structure. It is, therefore, concluded that, under the worst case scenario investigated, there would not be an adverse effect on the integrity of the Dogger Bank cSAC during construction and decommissioning. Furthermore, any alternative scenario would result in a smaller disturbance 'footprint' and reduction in the spatial extent of any effects (e.g. sediment mobilisation and transport) during installation of the offshore wind farm structures.

8.3.4 During the operation phase, under the worst case scenario for development a long-term reduction in the extent of subtidal sandbank habitat of 0.08% of the total within the cSAC would occur (see **Table 4.20**). This very small, long-term reduction in area is not predicted to compromise the coherence of the ecological structure and function of the cSAC, including the morphology of the sandbank feature itself. Apart from long-term habitat loss, the majority of the effects associated with the operation of Dogger Bank Teesside A & B (e.g. intermittent, temporary disturbance to seabed habitat during maintenance activities) that could affect the Dogger Bank cSAC subtidal sandbanks feature would be temporary, short-term, negligible in magnitude, and remain within the range of variation experienced and to which the species and communities of the subtidal sandbank feature are adapted. It is, therefore, concluded that, under the worst case scenario investigated, there would not be an adverse effect on the integrity of the Dogger Bank cSAC during the operational phase. Furthermore, any alternative scenario (i.e. the use of piled structures as opposed to gravity base structures) would result in a reduction in the extent of subtidal sandbank habitat affected by comparison to that assessed.

8.3.5 During construction and decommissioning there would be no direct disturbance effects, or changes in hydrodynamic conditions, that would affect the Doggersbank SCI (Netherlands) or the Doggerbank SCI (Germany). Modelled maximum and average suspended sediment concentrations and sediment deposition depths would not increase above background levels within the Doggerbank SCI (Germany). Short-term and temporary increases in suspended sediment concentrations within the Doggersbank SCI (Netherlands) could occur during installation of wind turbines in the easternmost part of Dogger Bank Teesside A, as well as during removal of any structures and cables. Temporary deposition of sediment (see paragraph 4.6.45) may occur up to a few tens of kilometres into the Doggersbank SCI (Netherlands) for construction and decommissioning works undertaken within 20km of the SCI boundary; outside of this distance no sediment deposition would occur within the site. Given the very low sensitivity of the sandbanks communities to changes in sediment deposition ('smothering') and the short-term, temporary and intermittent nature of the

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deposited sediment, no change to the abundance and / or species composition of the infaunal and epifaunal communities would be expected within the Doggersbank SCI (Netherlands). Consequently, it is concluded that there would not be an adverse effect on the integrity of the Doggersbank SCI (Netherlands) and Doggerbank SCI (Germany) as a result of the construction and decommissioning of Dogger Bank Teesside A & B in the worst case scenario and, therefore, any other scenario.

8.3.6 During the operation phase, the modelled small changes to the hydrodynamic regime (current velocities and wave heights) that could occur over the Dogger Bank cSAC would not be discernible in relation to existing variation in these parameters within the adjacent Doggersbank SCI (Netherlands) and Doggerbank SCI (Germany). Assessment also identified that no other operation phase effects (direct or indirect) would extend to the Doggersbank SCI and Doggerbank SCI (Germany) and, therefore, no impact would arise on the sandbank feature as a result of physical disturbance, increased suspended sediment concentrations or sediment deposition. Consequently, it is concluded that there would not be an adverse effect on the integrity of the Doggersbank SCI (Netherlands) and Doggerbank SCI (Germany)as a result of the operation of Dogger Bank Teesside A & B in the worst case scenario and, therefore, any other scenario. Given this, no in-combination effects are predicted in this context.

## Teesmouth and Cleveland Coast SPA (and Ramsar)

8.3.7 Assessment of the effects of the construction, operation and decommissioning of Dogger Bank Teesside A & B, including the export cable and landfall, with respect to the supporting habitat features of the Teesmouth and Cleveland Coast SPA (and Ramsar site) identified that no change to the features would arise outside of the existing range of variability of the physical and chemical processes and, subsequently, no change to the morphology and structural integrity of the supporting habitat features would occur. No change has been identified with respect to the communities associated with the supporting habitat features. Consequently, Dogger Bank Teesside A & B would not affect the achievement of favourable condition with respect to the maintenance and restoration of the conservation objectives (listed in paragraph 4.2.20) of the supporting habitat features of the Teesmouth and Cleveland Coast SPA (and Ramsar site), alone or in-combination with other projects.

## Northumbria Coast SPA (and Ramsar)

8.3.8 The assessment of the effects of the construction, operation and decommissioning of Dogger Bank Teesside A & B, including the export cable and landfall, with respect to the supporting habitat features of the Northumbria Coast SPA (and Ramsar site) identified that no change to the features would arise outside of the existing range of variability of the physical and chemical processes and, subsequently, no change to the morphology and structural integrity of the supporting habitat features would occur. No change has been identified with respect to the communities associated with the supporting habitat features. Consequently, Dogger Bank Teesside A & B would not affect the achievement of favourable condition with respect to the maintenance and

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restoration of the conservation objectives (listed in paragraph 4.2.11) of the supporting habitat features of the Northumbria Coast SPA (and Ramsar site) alone or in-combination with other projects.

## Marine Annex I habitats – in-combination

### Dogger Bank cSAC – subtidal sandbanks

8.3.9 Screening identified a number of other projects (see **Table 7.1** and **Figure 7.1**) that have the potential to generate effects which could overlap spatially or temporally with those identified for Dogger Bank Teesside A & B.

8.3.10 Identified impact pathways through which interactions between projects could occur, include direct physical loss, direct disturbance, influence of hydrodynamic changes and increases in suspended sediment (including consequential deposition).

8.3.11 For the worst case in-combination effect of disturbance to subtidal sandbank communities, 0.89% of the cSAC feature could be affected during the construction (and decommissioning) phase for Dogger Bank Teesside A & B, assuming that Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D were constructed concurrently and that relevant aggregate extraction areas were in operation. This figure represents the total area that could be disturbed over the duration of the construction period. Given that this period extends over several years, recovery of communities in areas subject to initial disturbance would be expected during this period.

8.3.12 The worst case in-combination impact of direct habitat loss (due to the presence of GBS foundations) would affect 0.21% of the cSAC feature during the operation phase (see paragraph 7.3.24) for Dogger Bank Teesside A & B, assuming that Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D have been constructed.

8.3.13 Direct physical loss of habitat in the cSAC effectively would be restricted to the footprints of the Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D projects as no other projects or developments would take place within the site. Based on a worst case scenario, the loss attributed to Dogger Bank Teesside A & B is 0.08%, for Dogger Bank Creyke Beck A & B is 0.06%, and for Dogger Bank Teesside C & D is 0.08%, giving a total, worst case loss of 0.21% (rounding of individual amounts results in the total based on extents being slightly lower than individual percentages combined) of the subtidal sandbank feature of the cSAC (see **Table 7.4**).

8.3.14 Taken together, the in-combination effect of increased suspended sediment concentrations from aggregate extraction, and the construction of Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D is predicted to be negligible in scale, short-term though intermittent in nature, and temporary. Given the very low sensitivity of the subtidal sandbank communities to short-term and temporary increases in suspended sediment concentrations and ability to rapidly recover from such effects, no significant in-combination impact to the subtidal sandbank communities from this effect is predicted.

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8.3.15 Given the very small-scalepredicted changes to the hydrodynamic regime and morphology of the sandbank feature attributable to Dogger Bank Teesside A & B, potentially significant in-combination impacts are considered unlikely to arise. In respect of the combined effect with Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D, changes in the hydrodynamic regime would be very localised (to the immediate areas of turbine structures) and, therefore, the potential for interaction extremely limited. In effect the same impacts as forecast for Dogger Bank Teesside A & B by itself could arise, albeit over a wider area of Dogger Bank. Modelling work indicates that physical parameters would remain within the range of variability currently experienced across Dogger Bank, such that no alteration in the species composition of benthic communities that characterise the subtidal sandbanks feature of the cSAC is predicted to occur.

8.3.16 Consequently, it is predicted that there would not be an adverse effect on the integrity of the Dogger Bank cSAC as a result of the construction, operation or decommissioning of Dogger Bank Teesside A & B in-combination with other projects.

### Teesmouth and Cleveland Coast SPA (and Ramsar)

8.3.17 No other projects were identified that were considered to act upon or influence the supporting habitats of the Teesmouth and Cleveland Coast SPA and Ramsar site. Consequently, it is concluded that there would not be an adverse effect on the integrity of the Teesmouth and Cleveland Coast SPA (and Ramsar site), in relation to its supporting habitat features, as a result of the construction, operation or decommissioning of Dogger Bank Teesside A & B in-combination with other projects.

### Northumbria Coast SPA (and Ramsar)

8.3.18 No other projects were identified that were considered to act upon or influence the supporting habitats of the Northumbria Coast SPA and Ramsar site. Consequently, it is concluded that there would not be an adverse effect on the integrity of the Northumbria Coast SPA (and Ramsar site), in relation to its supporting habitat features, as a result of the construction, operation or decommissioning of Dogger Bank Teesside A & B in-combination with other projects.

## Annex II marine mammal populations – project alone

### Grey seal populations

8.3.19 The Screening Stage (see Section 3 and **Table 5.1**) identified four European sites (in UK waters) and 25 transboundary sites for which grey seal is a feature and where a potential LSE could arise as a result of the construction, operation or decommissioning of Dogger Bank Teesside A & B. There would be no direct or indirect effects arising from Dogger Bank Teesside A & B that would impact upon habitats used by grey seal within the designated boundaries of relevant European sites (SACs and SCIs).

8.3.20 Tagging data shows that grey seal is a mobile species that undertakes significant movements between colonies and foraging areas. It shows that some use of the Dogger Bank area is made by grey seal from UK colonies and

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that it is also used by seals from continental sites. As seals that may be present within the development area cannot be attributed to any one particular SAC, assessment has been undertaken with respect to the southern North Sea grey seal population as a whole.

8.3.21 Disturbance effects that could occur as a result of construction activity, particularly increased underwater noise levels, would be temporary, short-term, and negligible for individuals and would not be expected to influence or result in a decrease in the population of grey seals for which SACs have been designated. Furthermore, where individuals may be temporarily affected, they have a low sensitivity to disturbance impacts and are known to exploit the area in which disturbance effects may be present for only a small percentage of their foraging time. In the limited instance where seals may be subject to disturbance, they would be able to move away from the source of disturbance in order to continue foraging. There is no evidence to indicate that prey resources would be affected to the degree that foraging success or energetics of grey seal would be adversely affected.

8.3.22 As such, it is concluded that the construction phase for the project would not affect the achievement of favourable condition with respect to the criteria and targets of all the attributes related to the conservation objectives for the grey seal feature of the UK SACs screened into the assessment.

8.3.23 For the operational phase of Dogger Bank Teesside A & B, disturbance effects that could give rise to significant impacts on grey seal populations would not be expected. There is no available evidence to indicate that underwater noise levels generated by operational wind turbines affect or disturb grey seal such that displacement or adverse changes in foraging behaviour would be likely to occur (see paragraph 5.7.4). Vessel noise and collision risk are assessed as being of negligible influence at the population level (see paragraph 5.7.5). Again, observational and tagging data shows that usage of the Dogger Bank Zone by grey seals is limited and individuals from SAC designated colonies are unlikely to spend a significant percentage of their time at sea within Dogger Bank Teesside A & B. As such, it is concluded that the operational phase for the project would not affect the achievement of favourable condition with respect to the criteria and targets of all the attributes related to the conservation objectives for the grey seal feature of the UK SACs screened into the assessment.

8.3.24 Overall, it is therefore concluded that there would not be an adverse effect on the integrity of the grey seal populations of the: Berwickshire and North Northumberland Coast SAC, the Faray and Holm of Faray SAC, the Humber Estuary SAC (and Ramsar site), and the Isle of May SAC (see **Tables 5.13** and **5.14**) as a result of the construction, operation or decommissioning of Dogger Bank Teesside A & B.

8.3.25 As with the UK designated SACs, development for Dogger Bank Teesside A & B would have no direct impacts upon designated supporting habitats for grey seals within transboundary SACs / SCIs (i.e. those sites listed in **Table 5.1**). With regard to indirect effects (notably disturbance during construction and potential prey displacement) the same conclusions drawn in respect of grey seals that

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may originate from UK SACs also apply to non-UK designated populations. Essentially, this conclusion reflects observational and other data that grey seals spend the majority of their time at sea in relative proximity to their breeding colonies and, therefore, it is unlikely that significant numbers of seals from designated populations would be subject to the potential effects associated with development. Additionally, seals that may be present within Dogger Bank could potentially originate from both UK and continental European sites, or potentially be in transit between them. Consequently, making any distinction between UK and continental derived individuals in respect of potential exposure to development effects within Dogger Bank Teesside A & B is, in reality, meaningless and impacts are best considered at the overall North Sea population level.

8.3.26 Given this, as a result of the construction, operation or decommissioning of Dogger Bank Teesside A & B it is concluded that there would not be an adverse effect on the integrity of the grey seal populations of the transboundary sites screened into the assessment (see Section 3) and listed in **Table 5.1**.

**Harbour porpoise populations**

8.3.27 The assessment work detailed in Sections 5.16 to Section 5.20, and also presented in **Chapter 14** of the Dogger Bank Teesside A & B ES, shows that only an extremely small percentage of the harbour porpoise population for the North Sea would be affected (see **Table 5.19** and paragraph 5.17.7) by Dogger Bank Teesside A & B, during construction, operation or decommissioning.

8.3.28 As identified in SCANS-II (2008) and other studies, there are three key harbour porpoise populations that are likely to be present in the Dogger Bank Zone. However, during construction, no measurable effects on harbour porpoise are expected to arise from the alteration of prey species abundance. Furthermore, given the mitigation measures to be implemented (see Section 5.19) no instantaneous injury is predicted for harbour porpoise populations.

8.3.29 The key potential impact during construction is TTS (fleeing response and avoidance) arising from underwater noise from piling and, to a significantly lesser extent, vessel movements. Based on a worst case scenario (multiple, sequential piling), the total area of likely avoidance by harbour porpoise is predicted to affect up to 3.6% of the harbour porpoise and potential harbour porpoise population within the North Sea (see **Table 5.19**). Given their mobility, and the wide range of prey species that are taken, it is considered that displacement, even if it were to occur at the maximum predicted level, would not result in any significant mortality. Based on the worst case scenario and a comparison with mortality arising from fisheries by-catch, it is calculated that a mortality rate exceeding 48% of displaced individuals would need to be achieved (in the worst case construction scenario) in order for a significant impact at the population level to arise. It is considered highly unlikely that such a level of mortality would occur given the temporary nature of the displacement effect and the habitat flexibility exhibited by harbour porpoise. No significant impact is, therefore, predicted on the harbour porpoise population as a result of the construction phase for Dogger Bank Teesside A & B (or Dogger Bank Teesside A or Dogger Bank Teesside B alone). Consequently, the achievement

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of favourable condition with respect to the conservation objectives related to the harbour porpoise feature of the transboundary European sites (SCIs and pSCIs) would not be affected.

8.3.30 Overall, it is concluded that there would not be an adverse effect on the integrity of the transboundary European sites (SCIs and pSCIs) listed in **Table 5.1** as a result of the construction (and decommissioning) of Dogger Bank Teesside A & B (assuming the worst case scenario) or, therefore, for any other scenario.

8.3.31 For the operational phase of Dogger Bank Teesside A & B, disturbance effects (e.g. from underwater noise levels) that could give rise to significant impacts on harbour porpoise populations would not be expected. Studies indicate that there is no evidence of a reduction in harbour porpoise use of existing wind farms (see paragraph 5.17.7). Noise modelling work for Dogger Bank Teesside A & B indicates that noise from wind turbines would not be significant and would not be expected to result in an avoidance response. As such, it is concluded that the operation phase for Dogger Bank Teesside A & B would not affect the achievement of favourable condition with respect to the conservation objectives related to the harbour porpoise feature of the transboundary European sites (SCIs and pSCIs).

8.3.32 Overall, it is concluded that there would not be an adverse effect on the integrity of the transboundary European sites (SCIs and pSCIs) listed in **Table 5.1** as a result of the operation of Dogger Bank Teesside A & B.

## Annex II marine mammal populations – in-combination

### Grey seal populations

8.3.33 Screening of effects that could influence the southern North Sea population of grey seal revealed a total of 63 projects that could interact with the effects of Dogger Bank Teesside A & B. These included offshore wind farms, marine aggregate extraction sites and oil and gas developments (see **Table 7.12**). The locations of the projects are shown on **Figure 7.11**.

8.3.34 The assessment work concluded that in-combination disturbance effects that could occur as a result of construction activity associated with Dogger Bank Teesside A & B and other relevant projects would be spatially dispersed, temporary, short-term, and negligible for individuals and would not be expected to influence or result in a decrease in the population of grey seals for which SACs have been designated (see paragraph 7.6.27). Furthermore, where individuals may be temporarily affected, they have a low sensitivity to disturbance effects and are known to exploit very large areas for foraging. In the instance where seals may be subject to disturbance effects, they have the capacity to avoid sources of disturbance in order to continue foraging. There is no evidence to indicate that prey resources would be affected to the degree that foraging success or the energetics of grey seal would be adversely affected (see paragraph 7.6.9).

8.3.35 Underwater noise levels generated by operational wind turbines and other activities (e.g. vessel movements) are considered unlikely to have any long-term disturbance and displacement effects on grey seal such that adverse changes in

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foraging behaviour and impacts at the population level would be likely to occur (see paragraphs 7.6.14 and 7.6.15).

8.3.36 As such, it is concluded that Dogger Bank Teesside A & B in-combination with other relevant projects would not affect the achievement of favourable condition with respect to the criteria and targets of all the attributes related to the conservation objectives for the grey seal feature of the UK SACs under consideration. No adverse effect on the integrity of SAC designated populations is predicted.

8.3.37 The same conclusions drawn in respect of grey seals that may originate from UK SACs also apply to non-UK designated populations. There would not be an adverse effect on the integrity of the designated populations of grey seal of transboundary European sites (SCIs and pSCIs) listed in **Table 5.1** as a result of the in-combination impacts of Dogger Bank Teesside A & B.

**Harbour porpoise populations**

8.3.38 A range of other projects with similar effects to those that could occur during the construction and operation of Dogger Bank Teesside A & B have been identified. These are similar to those screened with respect to grey seal populations, with effects including prey resource alteration, disturbance effects due to underwater noise levels and vessel collision risk.

8.3.39 For the construction of Dogger Bank Teesside A & B, no measurable effects on harbour porpoise populations are expected to arise from alteration of prey species abundance. Collision risk is considered to be low due to the likelihood that harbour porpoise can detect and avoid vessels. Consequently, no in-combination effect is predicted.

8.3.40 The key potential impact during construction is PTS and TTS (fleeing response and avoidance) arising from underwater noise from piling and, to a significantly lesser extent, vessel movements. It is considered that the use of soft-start would prevent potential mortality arising to harbour porpoise either directly or indirectly from PTS. Therefore, no impact is predicted on the North Sea harbour porpoise population in-combination with other projects.

8.3.41 The total potential area of avoidance by harbour porpoise that is predicted to occur should all projects be constructed at the same time (the extreme worst case scenario) is predicted to result in the potential displacement of up to 11.05% of the North Sea harbour porpoise population in the worst year (2016), and decreasing percentages of the population thereafter (see **Table 7.16**). Given the mobility of the species and the wide range of prey species that it takes, and that there is no indication that avoidance results in mortality, their sensitivity to displacement is considered to be low. Consequently, given that all effects would be temporary and that mortality as a result of displacement has a low probability, no measurable effect is predicted for the North Sea harbour porpoise population during the construction phase for Dogger Bank Teesside A & B in-combination with other projects.

8.3.42 For transboundary sites, it is assumed that in respect of the potential impacts identified, the relevant conservation objectives would relate to the avoidance of decline of the population. In this respect, the findings of the assessment work,

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as discussed above, identify that the short-term and spatially distributed impacts would not compromise the conservation objectives and achievement of favourable condition for the harbour porpoise feature of the transboundary European sites that were screened in to this assessment. Overall, it is concluded that there would not be an adverse effect on the integrity of the transboundary European sites (SCIs and pSCIs) identified in **Table 5.1** as a result of the construction of Dogger Bank Teesside A & B in-combination with other projects (assuming the worst case scenario) or any other scenario (i.e. Dogger Bank Teesside A or Dogger Bank Teesside B alone and in-combination with other projects).

8.3.43 For the operational phase of wind farms, disturbance effects that could give rise to significant impacts on harbour porpoise populations would not be expected, as studies indicate that there is no evidence of a reduction in harbour porpoise use of existing wind farms. It is therefore concluded that the operation phase for Dogger Bank Teesside A & B in-combination with the other projects would not affect the achievement of favourable condition with respect to the conservation objectives related to the harbour porpoise feature of the transboundary European sites (SCIs and pSCIs).

8.3.44 Overall, it is therefore concluded that there would not be an adverse effect on the integrity of the transboundary European sites (SCIs and pSCIs) identified in **Table 5.1** as a result of the operation of Dogger Bank Teesside A & B in-combination with other projects (assuming the worst case scenario) or any other scenario (i.e. Dogger Bank Teesside A or Dogger Bank Teesside B alone and in-combination with other projects).

## SPA and Ramsar designated bird populations

### Habitat loss and alteration – project alone

8.3.45 There would be no direct or indirect loss or alteration of supporting habitat from within any designated SPA or Ramsar site screened into the assessment.

8.3.46 Available data and evidence indicates that benthic habitat loss in the offshore marine environment as a result of the installation and decommissioning of wind turbines and other structures in the wind farm would not affect the overall prey resource available to foraging seabirds (see Section 6.5 and **Chapter 13** of the Dogger Bank Teesside A & B ES). No significant impact on designated seabird populations is therefore predicted due to benthic habitat loss or alteration.

8.3.47 Seabird prey resources (specifically fish) within the development area could be temporarily affected by increased underwater noise levels during construction. However, this effect would be localised to the immediate area of piling works and temporary displacement of the resource is predicted rather than loss or decrease in availability.

8.3.48 During the operation phase, there is some evidence to indicate that prey resources may increase within wind farms as a result of the introduction of novel substrates and reduced fishing activity (e.g. Stenberg *et al*., 2011). This increase in prey resources may be of benefit to those species of seabird that show no or limited avoidance of wind farms and that are, therefore, able to exploit any such increase.

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### Habitat loss and alteration – in-combination

8.3.49 As with Dogger Bank Teesside A & B, impacts on prey resources could be affected by increased underwater noise levels during construction works for other projects. However, this effect would be localised to the immediate area of works (e.g. piling) and would be unlikely to be temporally cumulative across projects. Overall temporary displacement of the resource is predicted rather than loss or decrease in availability.

8.3.50 Widely dispersed and small-scale benthic habitat loss / alteration across a number of projects during their operational phases would be highly unlikely to have an in-combination effect with regard to the foraging resources available to individual seabird breeding colonies. Combined operational effects on habitat resources potentially could be of a positive nature for some species of seabird, as subsea structures may be used as nursery and spawning areas and/or provide shelter and increased feeding opportunities to some fish, thus potentially increasing the overall availability of prey to seabirds. However, it is not possible to quantify this potential effect across all project development areas and for all species of seabird and, overall, no net-loss in resource is assumed. As such, no adverse in-combination impacts on habitat resources utilised by marine seabird populations are predicted.

8.3.51 Overall, it is therefore concluded that habitat loss and alteration resulting from the construction, operation or decommissioning of Dogger Bank Teesside A & B either alone or in-combination with other projects would not have a detrimental impact on seabird populations such that an adverse effect on the integrity of the SPAs and Ramsar sites screened into this assessment would arise.

### Seabirds disturbance and displacement effects – project alone

8.3.52 Existing sensitivity classifications for disturbance and habitat use, together with available evidence on the potential ecological consequences of displacement have been used in defining project-appropriate displacement and mortality values for seabird species that may be affected by disturbance during construction and operation of the wind farm. Using the assigned values, the number of birds that could be affected, based on the estimated populations (mean of survey years) within the development area, has been calculated and these numbers apportioned to relevant SPAs to determine impacts on designated populations (see Appendix 9 of **Appendix 11A** of the Dogger Bank Teesside A & B ES).

8.3.53 In the context of wind farm development, displacement can be viewed as an alteration in effective habitat availability. For those species that are sensitive to the presence of wind farms and for which avoidance occurs, overall availability of habitat resources, notably for foraging, may decrease. Information from a range of ecological studies dealing with seabird foraging ecology and prey resource fluctuations, together with determination of the area of high quality foraging resource (using sandeel fisheries data as a proxy for habitat quality) that birds may be displaced from within Dogger Bank Teesside A & B, has been used to determine appropriate mortality rates for the project (see Section 6.6 and **Appendix 11B** of the Dogger Bank Teesside A & B ES).

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8.3.54 The assessment of displacement effects in respect of designated SPA populations for the operation phase also incorporates the assessment with respect to the construction phase. This approach reflects the fact that the displacement impact is not confined to any one phase of the project and occurs throughout the entire project lifecycle. Assessment of the potential disturbance and displacement effects that might occur during cable laying operations concluded that any effects would be temporary, very localised and therefore would not have any implications at population levels.

8.3.55 For northern fulmar, northern gannet, Arctic skua, great skua, black-legged kittiwake, lesser black-backed gull and great black-backed gull, the assigned displacement or mortality value is taken as 0%. For these species, no displacement impact would arise. Displacement associated mortality is therefore only predicted to occur for common guillemot, razorbill and Atlantic puffin.

### *Common guillemot*

8.3.56 Adopting a 50% displacement rate and a 5% mortality rate it is calculated that approximately 0.02% of the total population of the suite of protected sites (26 SPAs) around the North Sea for which common guillemot is a feature would be affected.

8.3.57 The greatest effect would be on the designated population of Flamborough and Filey Coast pSPA, where an estimated 0.04% reduction in the SPA population could occur as a result of displacement and mortality. For the other four SPAs within maximum foraging range the estimated reduction in the designated populations would be 0.02% to 0.03%. For SPA populations outside of the foraging range the calculated displacement-mortality impact is less than 0.02% (see **Table 6.19**).

8.3.58 Analysis of the availability of good quality foraging habitat within range of colonies on the east coast of the UK indicates that approximately 0.5% of available habitat would be 'lost' as a foraging resource. It is considered unlikely that this 0.5% loss would directly translate into a 5% mortality of displaced birds and, therefore, the impact is likely to be less than that determined.

8.3.59 These calculated displacement-mortality losses for the common guillemot populations at the various SPAs examined are not considered to be significant. This is particularly so given that precautionary displacement and mortality rates have been used in assessing the potential impact at the population level.

8.3.60 On the basis of the information presented in this report, it is concluded that the predicted displacement impacts during construction, operation or decommissioning of Dogger Bank Teesside A & B would not result in an adverse effect on the integrity of SPAs designated for their common guillemot populations.

### *Razorbill*

8.3.61 Adopting a 50% displacement rate and a 5% mortality rate it is calculated that approximately 0.04% of the total population of the suite of protected sites (17 SPAs) around the North Sea at which the species is a feature would be affected.

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8.3.62 The greatest effect would be on the designated population of Flamborough and Filey Coast pSPA, where an estimated 0.06% reduction in the SPA population could occur as a result of displacement and mortality effects. For the other three SPAs within maximum foraging range the estimated reduction in the designated populations would be between 0.04% and 0.05%. For SPA populations outside of the foraging range the calculated displacement-mortality impact is less than 0.04% (see **Table 6.21**). These calculated displacement-mortality losses for the razorbill populations at the various SPAs examined are not considered to be significant. The same foraging habitat losses calculated for common guillemot and conclusions reached also apply with respect to razorbill populations within maximum foraging range of Dogger Bank Teesside A & B.

8.3.63 On the basis of the information presented in this report, it is concluded that the predicted displacement impacts during construction, operation or decommissioning of Dogger Bank Teesside A & B would not result in an adverse effect on the integrity of SPAs designated for their razorbill populations.

### *Atlantic puffin*

8.3.64 Dogger Bank Teesside A & B is outside the mean maximum foraging range during the breeding season of any SPAs supporting qualifying populations of this species. Displacement-led mortality would affect less than 0.01% of the total population of the suite of protected sites around the North Sea for which the species is a feature.

8.3.65 These calculated displacement-mortality losses to the Atlantic puffin populations at the various SPAs examined are not considered to be significant.

8.3.66 On the basis of the information presented in this report, it is concluded that the displacement impacts during construction, operation or decommissioning of Dogger Bank Teesside A & B would not result in an adverse effect on the integrity of SPAs designated for their Atlantic puffin populations.

### Seabirds disturbance and displacement effects – in-combination

8.3.67 For northern fulmar, Arctic skua, great skua, black-legged kittiwake, lesser black-backed gull and greater black-backed gull, the assigned displacement or mortality value is taken as 0% for Dogger Bank Teesside A & B. This means that, for these species, no in-combination displacement impacts would arise.

8.3.68 Although a 0% mortality rate was assumed for northern gannet for Dogger Bank Teesside A & B by itself, it is recognised that across a number of projects that effective habitat loss could arise and mortality result. A 5% mortality rate for this species, therefore, has been used for the in-combination assessment. Hence, the only species for which in-combination displacement effects are assessed are: northern gannet, common guillemot, razorbill and Atlantic puffin.

8.3.69 The in-combination assessment considers only those projects for which estimates of bird mortalities were provided for the numbers of displaced birds (see paragraph 7.8.30 and **Table 7.20**). In many instances, while predictions were provided of the numbers of birds that might be expected to be displaced, no information was provided on the likely mortality rates of these birds (often, as mortality was considered as part of the sensitivity of species to this effect – see

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Maclean *et al.* (2009)). As with displacement rates, mortality rates considered varied between projects, some providing results for a range of rates and carrying through either a worst case or 'realistic' value into the assessment. Additionally, some of the Scottish projects have assessed displacement impacts in respect of breeding failure and determined the significance of this impact with reference to population viability analysis. The in-combination assessment has not sought to 'normalise' all other project assessment outcomes by using the values used for the Dogger Bank Teesside A & B displacement analysis, but has simply combined outputs from the various projects where these are available.

### *Northern gannet*

8.3.70 Based on predicted displacement associated mortality losses available from other projects (see Section 7.8), apportioning of the combined total of 125 birds to individual SPAs shows that the greatest impact would be to the Flamborough and Filey Coast pSPA gannet population, where an estimated 18 adult birds (0.09% of the population) could be lost through displacement and mortality (see Section 7.8 and **Table 7.21**). A PBR value of 503 adult birds has been calculated (see **Appendix E**) ). This PBR value suggests that the mortality of 18 adult birds through displacement, therefore, would not represent an unsustainable population loss. This is particularly so as the PBR represents an annual loss from the population and the calculated displacement impact effectively represents habitat loss that could support 18 adult birds.

8.3.71 For the purposes of HRA assessment, and in line with SNH/JNCC guidance for Scottish projects, only impacts during the breeding season are assessed by Scottish projects with respect to Scottish SPAs. For the Forth Islands SPA, 20 adult birds are predicted to be lost from the breeding population as a result of displacement from Dogger Bank Teesside A & B, Dogger Bank Creyke Beck and Dogger Bank Teesside C & D combined. Together with the 19 adult birds apportioned to this SPA from the Firth of Forth Alpha and Bravo development and 34 adults from the Neart na Gaoithe project, the total loss is 73 adult breeding birds. This equates to 0.065% of the designated SPA population.

8.3.72 Given the small population effect for all SPA populations assessed, the overall conclusion is that in-combination with other projects Dogger Bank Teesside A & B would not result in a displacement impact that would constitute an adverse effect on the integrity of the screened SPAs designated for their northern gannet populations.

### *Common guillemot*

8.3.73 Six SPAs are within mean maximum foraging range of Dogger Bank Teesside A & B, as shown in **Figure 7.13**, which defines the spatial limits for the inclusion of other projects that could potentially also affect breeding birds deriving from these SPAs. Estimated mortality losses resulting from displacement were available for six projects from those included in the assessment (see **Table 7.23**).

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### Flamborough and FIley Coast pSPA

8.3.74 An estimated 371 birds (0.4%) from the the Flamborough and Filey Coast pSPA common guillemot population could be lost through displacement and mortality (see Section 7.8, **Table 7.23**), of which an estimated 0.04% (43 birds) is attributed to Dogger Bank Teesside A & B. A PBR threshold of 1,293 birds has been calculated for the Hornsea One Project (Smart Wind 2013) as representing a value over which an adverse impact on the common guillemot population of the Flamborough and Filey Coast pSPA could occur. While this value represents an annual loss, rather than the impact of a longer-term reduction in foraging habitat extent that the displacement effect represents, the calculated PBR value clearly indicates that the estimated total loss of 371 birds would not have an adverse effect on the sustainability of the common guillemot population.

### Farne Islands SPA

8.3.75 A cumulative impact of 54 adult birds lost through mortality following displacement is calculated for the Farne Islands SPA, representing 0.09% of the population of this site (see **Appendix 13** in **Appendix 11A** of the Dogger Bank Teesside A & B ES). Five of the total 76 predicted guillemot mortalities resulting from displacement by the Neart na Gaoithe wind farm development are apportioned to the Farne Islands SPA.

### Buchan Ness to Collieston Coast SPA

8.3.76 A total of 338 birds lost through mortality following displacement was calculated for the Buchan Ness to Collieston Coast SPA, representing 1.6% of the population of this site (see **Appendix 13** in **Appendix 11A** of the Dogger Bank Teesside A & B ES). Of the seven predicted mortalities from the Dogger Bank Teesside A & B project, all would be of non-breeding birds which reflects the location of Dogger Bank Teesside A & B outside of the maximum foraging range of common guillemot from Buchan Ness to Collieston Coast SPA.

8.3.77 The 1.6% loss is considered to represent a significant overestimate as a 100% mortality rate for common guillemot displaced by the EOWDC project is assumed. Based on adopting a mortality rate similar to that applied to other projects, a rate of 5-10% is considered more likely, in which case mortalities attributable to this project would be between 15-30 birds (i.e. 0.07-14% of the population). The in-combination population effect would therefore be in the region of 0.15%. PBR analysis undertaken for the Seagreen project indicates that the threshold of loss that could not be sustained by the breeding colony is 1.75% of the population per annum.

### Fowlsheugh SPA

8.3.78 A cumulative impact of 158 breeding birds lost through mortality following displacement is calculated for the Fowlsheugh SPA, representing 0.27% of the population of this SPA. The majority of the breeding season displacement loss (89 adult birds) is derived from the EOWDC project. However, this is likely to be a significant over estimate as 100% mortality of displaced birds has been assumed.

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8.3.79 The contribution of Dogger Bank Teesside A & B to the cumulative total is 2.3 adult birds during the breeding season and the contribution of Dogger Bank Creyke Beck and Dogger Bank Teesside C & D combined to the cumulative total is 18.4 breeding birds <0.03% of the breeding population.

8.3.80 The cumulative level of predicted impact (0.27% of the SPA breeding population) is significantly below the PBR value of 1.75% of the population calculated by the Firth of Forth Alpha and Bravo (Seagreen) project. This suggests that the predicted displacement impact would not have a significant effect on increasing the chance of population decline.

### Forth Islands SPA

8.3.81 A cumulative impact of 66 breeding birds lost through mortality following displacement is calculated for the Forth Islands SPA, representing 0.27% of the population of this SPA.

8.3.82 The contribution of Dogger Bank Teesside A & B to the cumulative total is two breeding birds (<0.01% of the breeding population) and from Dogger Bank Creyke Beck and Dogger Bank Teesside C & D combined, 11 birds, representing 0.03% of the breeding population.

8.3.83 The cumulative level of predicted impact (0.27% of the SPA breeding population) is small and well below the PBR value of 1.75% of the population calculated by the Firth of Forth Alpha and Bravo (Seagreen) project. This suggests that the predicted displacement impact would not have a significant effect on increasing the chance of population decline.

### St Abb's Head to Fastcastle

8.3.84 A cumulative impact of 54 breeding birds lost through mortality following displacement is calculated for the St Abb's Head to Fast Castle SPA, representing 0.09% of the population of this SPA.

8.3.85 The contribution of Dogger Bank Teesside A & B to the cumulative total is five breeding birds (0.01% of the breeding population) and from Dogger Bank Creyke Beck and Dogger Bank Teesside C & D combined, 27 birds, representing 0.04% of the breeding population.

8.3.86 The cumulative level of predicted impact (0.09% of the SPA breeding population) is small and well below the PBR value of 1.75% of the population calculated by the Firth of Forth Alpha and Bravo (Seagreen) project. This suggests that the predicted displacement impact would not have a significant effect on increasing the chance of population decline.

8.3.87 Based on the displacement and mortality rates and, given the relatively small population impact for all SPA populations assessed, it is concluded that in-combination with other projects displacement of common guillemot from Dogger Bank Teesside A & B would not constitute an adverse effect on the integrity of the screened SPAs designated for their common guillemot populations.

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### *Razorbill*

8.3.88 Five SPAs are within mean maximum foraging range of Dogger Bank Teesside A & B, as shown in **Figure 7.15**, which defines the spatial limits for the inclusion of other projects that potentially could also affect breeding birds deriving from these SPAs. Estimated mortality losses resulting from displacement were available for seven other projects (see **Table 7.25**).

#### Flamborough and Filey Coast pSPA

8.3.89 An estimated 142 birds (0.63%) from the the Flamborough and Filey Coast pSPA razorbill population could be lost through displacement and mortality (see Section 7.8, **Table 7.26**), of which an estimated 0.04% (16 birds) is attributed to Dogger Bank Teesside A & B. A PBR threshold of 607 birds has been calculated for the Hornsea One Project (Smart Wind 2013) as representing a value over which an adverse impact on the razorbill population of the Flamborough and Filey Coast pSPA could occur. While this value represents an annual loss, rather than the impact of a longer-term reduction in foraging habitat extent that the displacement effect represents, the calculated PBR value clearly indicates that the estimated total loss of 142 birds would not have an adverse effect on the sustainability of the common guillemot population.

#### Fowlsheugh SPA

8.3.90 A cumulative impact of 35 breeding birds lost through mortality following displacement is calculated for the Fowlsheugh SPA, representing 0.7% of the population of this SPA.

8.3.91 The contribution of Dogger Bank Teesside A & B combined with Dogger Bank Creyke Beck and Dogger Bank Teesside C & D to the cumulative total is less than one breeding bird (<0.01%) of the breeding population.

8.3.92 The majority of the breeding season displacement loss (30 adult birds) is derived from the EOWDC project. However, this is likely to be a significant over estimate as 100% mortality of displaced birds has been assumed.

8.3.93 The cumulative level of predicted impact (0.7% of the SPA breeding population) is well below the PBR value of 1.9% of the population calculated for the Firth of Forth Alpha and Bravo (Seagreen) project. This suggests that the predicted displacement impact would not have a significant effect on increasing the chance of population decline.

#### Forth Islands SPA

8.3.94 A cumulative impact of 9.2 breeding birds lost through mortality following displacement is calculated for the Forth Islands SPA, representing 0.02% of the population of this SPA.

8.3.95 The contribution of Dogger Bank Teesside A & B combined with Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D to the cumulative total is one breeding bird (<0.01% of the breeding population).

8.3.96 Breeding season displacement losses to this SPA are also apportioned from the Neart na Gaoithe project and Firth of Forth Alpha and Bravo (Seagreen) Project.

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8.3.97 The cumulative level of predicted impact (0.22% of the SPA breeding population) is small and well below the PBR value of 2.38% of the population calculated for the Firth of Forth Alpha and Bravo (Seagreen) project. This suggests that the predicted displacement impact would not have a significant effect on increasing the chance of population decline.

### St Abb's Head to Fast Castle SPA

8.3.98 A cumulative impact of 2.1 breeding birds lost through mortality following displacement is calculated for the St Abb's Head to Fast Castle SPA, representing 0.06% of the population of this SPA.

8.3.99 The contribution of Dogger Bank Teesside A & B combined with Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D to the cumulative total is one breeding bird (0.03% of the breeding population).

8.3.100 Breeding season displacement losses to this SPA are also apportioned from the Neart na Gaoithe project and Firth of Forth Alpha and Bravo (Seagreen) Project.

8.3.101 The cumulative level of predicted impact (0.06% of the SPA breeding population) is small and well below the PBR value for the population calculated for the Firth of Forth Alpha and Bravo (Seagreen) project. This suggests that the predicted displacement impact would not have a significant effect on increasing the chance of population decline.

8.3.102 Based on the displacement and mortality rates and, given the relatively small population impact for all SPA populations assessed, it is concluded that in-combination with other projects displacement of razorbill from Dogger Bank Teesside A & B would not constitute an adverse effect on the integrity of the screened SPAs designated for their razorbill populations.

### *Atlantic puffin*

8.3.103 Dogger Bank Teesside A & B is not within the maximum foraging range of any puffin breeding colonies

8.3.104 No in-combination impacts with breeding puffin populations affected by proposed wind farm developments in Scottish waters would arise. For the purposes of HRA assessment no consideration has therefore been given to the impact of these projects on Atlantic puffin populations. None of the Scottish projects apportion displacement mortalities to any of the SPAs in English waters, although the possibility of some displacement to puffin from the Farne Islands SPA that may be present within the proposed development area for the Neart na Gaoithe project is recognised (Mainstream 2013a) although not assessed.

8.3.105 Estimated mortality losses resulting from displacement were available for four other projects (see **Table 7.27**) not including the other Dogger Bank projects. Dogger Bank Teesside A & B is not within the mean maximum foraging range of any SPA designated breeding populations and, therefore, the attributed losses relate to non-breeding birds only. The relatively small number (37) of Atlantic puffin affected by Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D results in a predicted 0.01% impact on relevant SPA populations.

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8.3.106 An estimated 3.1 birds (0.3%) from the the Flamborough and Filey Coast pSPA population could be lost through displacement and mortality (see Section 7.8, **Table 7.28**), of which less than 0.01% (0.02 birds) is attributed to Dogger Bank Teesside A & B, indicating that the contribution of Dogger Bank Teesside A & B to the combined total is effectively insignificant. A PBR threshold of 7.6 birds has been calculated for the Hornsea One Project (Smart Wind 2013) as representing a value over which an adverse impact on the Atlantic puffin population of the Flamborough and Filey Coast pSPA could occur. While this value represents an annual loss, rather than the impact of a longer-term reduction in foraging habitat extent that the displacement effect represents, the calculated PBR value indicates that the estimated total loss of 3.1 birds would not have an adverse effect on the sustainability of the Atlantic puffin population.

8.3.107 Based on the predicted displacement and mortality rates and, given the relatively small population impact for all SPA populations assessed, it is concluded that, in-combination with other projects displacement of Atlantic puffin from Dogger Bank Teesside A & B would not constitute an adverse effect on the integrity of the screened SPAs designated for their Atlantic puffin populations.

**Seabirds - collision impacts**

8.3.108 Collision risk analyses for the operational phase of Dogger Bank Teesside A & B have been run using the Band model (Option 3), updated for the offshore environment (Band 2012).

8.3.109 Collision risk modelling has been undertaken for all seabird species for which sufficient population data were available – northern gannet, northern fulmar, Arctic skua, great skua, lesser black-backed gull, great black-backed gull, black-legged kittiwake, common guillemot, razorbill, and Atlantic puffin, using monthly population estimates for each species. A precautionary avoidance rate of 98% (SNH 2010; Cook *et al*. 2012) was utilised in the assessment for all species except gannet, for which a 99% avoidance rate was utilised (see Section 6.6).

8.3.110 The number of northern fulmar, Arctic skua, great skua, common guillemot and Atlantic puffin colliding with turbines is predicted to be less than one bird per year. Razorbill similarly has a predicted low risk, with 2 collisions per year predicted. It is considered that the predicted very low number of annual collisions for these species would be highly unlikely to have a discernible effect at the population level, either with regard to individual designated site-based populations or wider North Sea populations. On the basis of the modelling undertaken, it is concluded that collision mortality during the operation phase for Dogger Bank Teesside A & B would not result in an adverse effect on the integrity of SPAs designated for their northern fulmar, Arctic skua, great skua, common guillemot, razorbill and Atlantic puffin populations.

8.3.111 As the predicted collision losses for northern fulmar, Arctic skua, common guillemot, razorbill and Atlantic puffin are all extremely low, no assessment of in-combination collision impacts for these species is considered necessary and the conclusion for Dogger Bank Teesside A & B alone therefore also applies to any potential in-combination considerations of collision impact.

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### *Lesser black-backed gull*

8.3.112 **Table 7.30** shows that a total of 2,536 annual collision losses are predicted for lesser black-backed gull from the projects screened into the in-combination assessment.

8.3.113 Dogger Bank Teesside A & B is outside the foraging range of any protected sites designated for breeding populations of lesser black-backed gull. Predicted losses of lesser black-backed gull (33 birds) from SPAs screened into the assessment process would represent less than 0.01% of designated populations and less than a 0.1% increase in the background mortality for this species.

8.3.114 The calculated small population impact for those SPAs examined indicates that any contribution of collision losses due to operation of Dogger Bank Teesside A & B would be negligible in-combination with collision losses attributed to any other projects. Consequently, it is concluded that, either alone or in-combination with other projects, Dogger Bank Teesside A & B would not have an adverse effect on the integrity of lesser black-backed gull populations of the SPAs screened into the assessment.

### *Great black-backed gull*

8.3.115 Table 7.30 shows that a total of 1,633 annual collision losses are predicted for great black-backed gull from the projects screened into the in-combination assessment.

8.3.116 All SPAs, screened into the HRA process supporting great-black backed gull populations are located outside the maximum foraging range of this species. The collision risk analysis provided an estimate of 9 birds being lost from the suite of SPAs, representing 0.09% of populations at individual sites and a 0.35% increase in the background mortality for this species.

8.3.117 From an in-combination perspective, the calculated small population impact for those SPAs examined indicates that any contribution of collision losses due to operation of Dogger Bank Teesside A & B would be negligible when taken into account with collision losses attributed to any other projects. Consequently, it is concluded that, either alone or in-combination with other projects, Dogger Bank Teesside A & B would not have an adverse effect on the integrity of great black-backed gull populations of the SPAs screened into the assessment.

### *Northern gannet*

8.3.118 Dogger Bank Teesside A & B is within the mean maximum foraging range of one SPA (Flamborough and Filey Coast pSPA), although there is evidence from tagging studies that birds from the Forth Islands SPA may also forage within the area during the breeding season. Using a 99% avoidance rate, collision risk modelling provided an estimate of 68 collisions per year (34 breeding birds and 34 non-breeding birds).

#### Flamborough and Filey Coast pSPA

8.3.119 The greatest impact is predicted for the northern gannet population at Flamborough and Filey Coast pSPA, where up to 0.05% of the population, 8 adult birds (representing a 0.79% increase in background mortality), could be impacted on an annual basis (see Section 6, **Table 6.27**). A PBR value of 503

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adult birds is calculated for the northern gannet at the Flamborough and Filey Coast pSPA (see Appendix E). Use of this PBR indicates that the predicted level of collision losses are significantly below mortality thresholds at which a population decline for this species at Flamborough and Filey Coast pSPA might occur.

8.3.120 The total collision estimate for northern gannet for all projects screened into the assessment for the Flamborough and Filey Coast pSPA amounts to 239 to 261 adults using a 98% avoidance rate or 119 to 130 adults using a 99% avoidance rate (see **Table 7.30**). The calculated loss for all birds equates to 1.5% of the breeding population using a 98% avoidance rate (22.5% increase in background mortality) or 0.75% at a 99% avoidance rate (11.3% increase in background mortality). This in-combination loss represents up to 52% of the PBR (using a 98% avoidance rate) or 26% (using a 99% avoidance rate).

### Forth Islands SPA

8.3.121 Dogger Bank lies beyond the mean maximum foraging range (230km) of this SPA and therefore attribution during the breeding season is based on tagging data (Wakefield *et al*. 2013) which indicates potential use of the area by gannet from the Firth of Forth colonies (i.e. Bass Rock).

8.3.122 In respect of the Forth Islands SPA, 14 adult birds were apportioned to the site, representing 0.03% of the SPA population at 99 avoidance rate (see **Table 6.27**). A threshold mortality that could be sustained for the Bass Rock gannet colony (part of the Forth Islands SPA) was calculated as part of the WWT (2012) PVA analysis for this species. This mortality threshold was calculated as 2,000 birds. On the basis of this PVA work, the loss of up to 14 adult birds per year is significantly below the likely threshold of mortality increase at which a decline in the population of northern gannet at the Forth Islands SPA would be likely to be significant.

8.3.123 Several proposed Scottish wind farm projects are located within the mean maximum foraging range of the Forth Islands SPA and predicted gannet collision mortalities have been largely apportioned to this SPA, as shown in **Table 7.31**. Cumulatively, the number of adult mortalities at a 98% avoidance rate is 1,803 and at 99% 900 mortalities. This level of collision mortality reflects the relatively close proximity of these wind farms to the large breeding colony at Bass Rock, which supports over 110,000 northern gannet.

8.3.124 A PBR analysis undertaken for the Seagreen project indicates that a sustainable additional mortality of 2.26% of the population per annum could apply. This equates to 2,511 individuals. The Dogger Bank Teesside A & B contribution to the total breeding adult mortality is 1.5%. Based on the revised PBR of 2,511 birds (Seagreen 2013), the in-combination total falls below the likely threshold of mortality increase at which a decline in the population of northern gannet at the Forth Islands SPA would be likely to occur.

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8.3.125 For all of the SPAs examined, the conclusion is therefore reached that the losses of northern gannet that could occur as a result of collision would not have any consequences at population levels, both for Dogger Bank Teesside A & B, alone and in-combination with other assessed projects, such that an adverse effect on the integrity of the screened SPAs designated for this species would arise.

### *Black-legged kittiwake*

8.3.126 Dogger Bank Teesside A & B is within maximum foraging range of one SPA for this species, Flamborough and Filey Coast pSPA. Using a 98% avoidance rate, collision risk modelling analysis provides an estimate of 134 (87 breeding birds and 48 non-breeding birds) collisions per year attributable to SPA designated populations of this species.

8.3.127 The greatest impact is predicted for the black-legged kittiwake population of Flamborough and Filey Coast pSPA. Here, just over 55 adult birds during the breeding season and 12 birds during the non-breeding season (of which 7 would be adults, assuming 60% of non-breeders are adults) could be lost annually as a result of collision (see paragraph 6.6.124 and *Table A9.35d* in *Appendix 9* of **Appendix 11A** of the Dogger Bank Teesside A & B ES).

8.3.128 The collision estimate for black-legged kittiwake for all projects for the Flamborough and Filey Coast pSPA amounts to 487 to 529 individual birds (or 436 to 462 adults), see paragraph 7.8.193. The calculated loss equates to 0.52% of the adult breeding population at this site, an increase in background mortality of 10.6%.

8.3.129 A PBR analysis for the kittiwake population of the Flamborough and Filey Coast pSPA has been undertaken (see **Appendix E** of the HRA Report). This work provides a suggested PBR value of 1,718 adult birds, based on an f value of 0.3 and a breeding population of 89,040 birds.

8.3.130 The cumulative total of 436 - 462 collision losses of adult kittiwake from the Flamborough and Filey Coast pSPA would therefore represent 25% - 27% of the calculated PBR. This analysis indicates that the predicted cumulative collision losses for the Flamborough and Filey Coast pSPA black-legged kittiwake population would be below a threshold at which adverse population effects would be expected to occur.

8.3.131 For SPAs located outside of the maximum foraging range of Dogger Bank Teesside A & B, the apportioned collision losses (involving non-breeding birds only) would represent 0.01% (0.17% increase in background mortality) of the designated populations.

8.3.132 For all of the SPAs examined, the conclusion is therefore reached that the losses of black-legged kittiwake that could occur as a result of collision from operation of Dogger Bank Teesside A & B, alone and in-combination with other assessed projects, would not result in an adverse effect on the integrity of the SPA designated populations of this species screened into the assessment.

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### Migratory birds

8.3.133 For migratory birds, the migration zones (defined by Wright *et al*. 2012) of 45 species' populations of terrestrial or waterbird migrants that are UK SPA features overlap with the development area for Dogger Bank Teesside A & B. Estimated numbers of potential collisions for these 45 species of migrants were modelled based on the numbers of birds predicted to pass through the wind farm area, a 98% avoidance rate and expert judgement to determine the proportion of individuals likely to be flying at a height which places them at risk of collision.

8.3.134 Collision risk estimates suggest that on an annual basis, the potential mortality associated with Dogger Bank Teesside A & B is likely to represent significantly less than 0.1% of the Great Britain or Great Britain and Ireland population of each of the populations considered (see **Table 6.28**).

8.3.135 Examination of data available from the other wind farm projects screened into the in-combination assessment revealed that consideration of this potential impact is generally lacking. For all species for which migratory routes potentially overlap with Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B, Dogger Bank Teesside C & D, Hornsea Project One, and Inch Cape, the potential in-combination impact would represent less than 0.1% (significantly less than 0.1% for many species – see **Table 7.38**) of the reference populations. This indicates that in-combination collision losses would not be significant for all SPAs supporting the relevant migratory species.

8.3.136 For many species there is significant movement of migratory birds between continental sites (in the Netherlands in particular) and the UK. Many of these sites are designated SPAs (e.g. the Waddenzee). As such, the results of the analysis also apply to SPAs that form staging posts for onward migration to the UK or sites used by birds on return migration from the UK.

8.3.137 Consequently, it is therefore concluded that Teesside A & B either alone or in-combination with other projects would not have an adverse effect on the integrity of those designated migratory SPA populations for which potential collision risk has been identified.

### Barrier effects

#### *Seabirds*

8.3.138 It is unlikely that Dogger Bank Teesside A & B would act as a significant barrier to the foraging movements of breeding seabirds. For all species with SPA designated breeding colonies within foraging range of Dogger Bank Teesside A & B, only two species (northern fulmar and black-legged kittiwake) were identified where greater than 1% of the breeding population at individual SPAs could potentially be affected.

8.3.139 For northern fulmar, up to 5% of the population at the Flamborough and Filey Coast pSPA might be potentially influenced by the barrier posed by Dogger Bank Teesside A & B (see paragraph 6.6.77). On the basis of the mean maximum foraging range of this species, the potential deviation to the direct flight line would represent 6.3%.

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8.3.140 Breeding black-legged kittiwake from Flamborough and Filey Coast pSPA could be subject to a barrier effect, with an estimated 1.1% of the population being affected (see paragraph 6.6.83). On the basis of the maximum foraging range (230km) of this species, the deviation to the direct flight line would represent 10.8%.

8.3.141 For both species it is considered unlikely that the relatively small increases in flight distance that could be incurred by birds flying in a direct line from the breeding colony would adversely affect the energetics of individuals, such that an effect at the population level would arise. This is particularly so given:

- Birds may be able to alter their flight routes from the colony to take account of the presence of the wind farm and, therefore, avoid the additional energetic cost that flying around the wind farm would incur;
- For accomplished and effective fliers the small increase in flight distance may not equate to equivalent energy losses; and
- Birds may combine shorter foraging flights with longer ones that extend beyond the wind farm. In this respect, it is notable that the average foraging range for fulmar is 48km and for black-legged kittiwake is 25km.

8.3.142 Thus, not all foraging flights would be subject to a barrier effect and the deviation to the flight line posed by Dogger Bank Teesside A & B is, therefore, likely to be significantly less than 6.3% and 10.8% respectively for fulmar and black-legged kittiwake of the total distance of all flights.

8.3.143 Given the above, it is considered unlikely that the potential barrier effect posed by Dogger Bank Teesside A & B would adversely affect the energetics of individual birds originating from Flamborough and Filey Coast pSPA, such that an effect at the population level would arise.

8.3.144 There are considerable uncertainties and difficulties in assessing the in-combination barrier effects posed by offshore wind farms. The in-combination assessment has, therefore, been limited to determining the combined impact of Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D. For the five species with SPA designated breeding colonies within foraging range of Dogger Bank, only two species (northern fulmar and black-legged kittiwake) were identified where greater than 1% of the breeding population at individual SPAs potentially could be affected.

8.3.145 While the percentage of the overall breeding population affected of each of the species listed above would be greater than for Dogger Bank Teesside A & B by itself (see **Table 7.33**, **Table 7.34**, and **Table 7.35**), the estimated deviation to flight distance posed by the combined projects is the same. The conclusions reached for Dogger Bank Teesside A & B alone in respect of breeding northern fulmar and black-legged kittiwake populations, therefore, also apply to Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D in-combination.

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8.3.146 For all other species, where the barrier effect has been determined to affect less than 1% of the breeding populations at individual sites, it is considered that the barrier effect posed by Dogger Bank Teesside A & B by itself or in-combination with Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D would not have any discernible impact upon seabird populations (see **Table 7.36** and **Table 7.37**). This is particularly so given that, for many breeding colonies/sites, Dogger Bank is located at the extreme edge of the maximum foraging range (and well beyond the mean maximum distance) for the seabird species within foraging range. This suggests that, even for the small percentage of birds from these SPAs that may make use of the area for foraging, the increase in energetics that the presence of wind farm development may cause would be negligible in the context of the total distance of all foraging flights undertaken.

8.3.147 The overall conclusion is that, for breeding seabirds, wind farm development within Dogger Bank Teesside A & B would not, by itself or in-combination with other projects in the Dogger Bank Zone, exert an appreciable barrier effect, such that detrimental impacts on designated populations at individual SPAs would arise. No adverse effect on the integrity of those SPAs and their designated populations for which a barrier effect has been identified is, therefore, predicted.

### *Migratory birds*

8.3.148 An assessment of the potential barrier effects posed by Dogger Bank Teesside A & B based on overlap with the migration zones (defined by Wright *et al*. 2012) of 45 species' populations of terrestrial and waterbird migrants that are UK SPA features has been undertaken.

8.3.149 The percentages of Great Britain or Great Britain and Ireland populations estimated to pass through the project area at risk height (following Wright *et al*. 2012) and thus exposed to potential barrier effects were less than 1% for most species considered, between 1% and 2% for 15 species' populations, and between 2% and 3% for two species' populations (see **Table 6.25**).

8.3.150 The increase in flight distance due to the barrier presented by Dogger Bank Teesside A & B varies by direction of flight. The shortest approximately east-west route across the North Sea passing through the project area, equates to a maximum of approximately 25km (an increase of 4% on the ca. 575km route) in order for birds to circumvent it. For all other routes, the potential percentage increase in the migration route would be less than 4%. This postulated increase in flight distance is precautionary in that it assumes that deviation in the flight line would occur rather than birds increasing their flight height and, therefore, avoiding the need to deviate.

8.3.151 There are significant difficulties in assessing the in-combination barrier effect of a number of offshore wind farms on migratory birds. The in-combination assessment was, therefore, limited to considering the impact of Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D. In-combination, the increase in flight distance due to the barrier presented by the developments is estimated as being similar to that for Dogger Bank Teesside A & B by itself.

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8.3.152 This conclusion also applies to all SPAs in Great Britain and Ireland designated for their migratory bird populations and for which potential overlap of routes with the Dogger Bank Zone have been identified. Similarly, given significant movement of migratory birds between continental sites (from and to the Netherlands in particular) and the UK, part of the populations that are present at these continental sites could be affected by barrier effects. As such, the results also apply to SPAs used by birds on return migration from the UK.

8.3.153 Considering both the small percentage of migrating bird populations likely to be involved and the relative increase in flight distance that Dogger Bank Teesside A & B by itself and in-combination with other proposed wind farm development in the Dogger Bank zone could exert, it is concluded that the potential barrier posed by wind farm development would be unlikely to have a detrimental impact upon the energetics of migratory birds. Consequently, it is concluded that there would not be an adverse effect on the integrity of designated SPA migratory bird populations as a result of the potential barrier posed by Dogger Bank Teesside A & B alone or in-combination with other projects.

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# 9 References

Airtricity (2007). *Offshore Windpark "Breeveertien II" Mileu Effect Rapport - Addendum*.

AMEC (2009). *Race Bank Offshore Wind Farm Environmental Statement. Volume 1: Offshore Works*. On behalf of Centrica Ltd.

Andersson, M.H., Berggren, M, Wilhelmsson, D. and Ohman, M.C. (2009). Epibenthic colonization of concrete and steel pilings in a cold-temperate embayment: a field experiment. *Helgoland Marine Research* **63** (3): 249-260.

APEM (2011). *Red-throated divers & offshore wind farms in the Outer Thames: historic data review*. APEM Scientific Report 411134. London Array Ltd., June 2011 v2 Final.

APEM (2012). *Migration Modelling and Collision Risk Modelling in Relation to Hornsea Subzone 1 Development – DRAFT. Appendix D to the Hornsea Project One Ornithology Technical Report*.

Appleby, J.P. and Scarratt, D.J. (1989). *Physical effects of suspended solids on marine an estuarine fish and shellfish with special reference to ocean dumping: a literature review*. Canadian Technical Report of Fisheries and Aquatic Science No.1681.

Arcus Renewable Energy Consulting Limited (2012). *Beatrice Offshore Wind Farm Environmental Statement*.

Arcus Renewable Energy Consulting Limited (2013). *Beatrice Offshore Wind Farm – Environmental Statement Addendum. Annex 3B – Report to Inform and Appropriate Assessment*.

ASCOBANS (2012). *Convention on Migratory Species*. Available at http://www.cms.int/species/ascobans/asc_bkrd.htm

Babtie (1997). *Redcar Beach Study*. Report to Redcar & Cleveland Borough Council, August 1997.

Babtie (1999). *Seaham Harbour to Saltburn Shoreline Management Plan*. Report to Easington District Council, Hartlepool Borough Council and Redcar & Cleveland Borough Council, March 1999.

Bäcklin, B-M., Moraeus, C., Roos, A., Eklof, E., and Lind, Y. (2011). Health and age and sex distributions of Baltic grey seals (Halichoerus grypus) collected from by-catch and hunt in the Gulf of Bothnia. *ICES Journal of Marine Science*, **68**(1); 183–188.

Bailey, H., Senior, B., Simmons, D., Rusin, J., Picken, G., and Thompson, P. M. (2010). Assessing underwater noise levels during pile-driving at an offshore wind farm and its potential effects on marine mammals. *Marine Pollution Bulletin*, **60**; 888-897.

 © 2014 Forewind

Band, W. (2012). *Using a collision risk model to assess bird collision risks for offshore windfarms*. Strategic Ornithological Support Services Project SOSS-02.

Band, W., Madders, M., & Whitfield, D.P. (2007). Developing field and analytical methods to assess avian collision risk at wind farms. In: de Lucas, M., Janss, G.F.E. and Ferrer, M. (eds.) *Birds and Wind Farms: Risk Assessment and Mitigation*, pp. 259-275. Quercus Edicions, Madrid, Spain.

Banks, A.N., Maclean, I.M.D., Burton, N.H.K., Austin, G.E., Carter, N., Chamberlain, D.E., Holt, C., Rehfisch M.M., Pinder, S., Batty, A., Wakefield, E. & Gill, P. (2006). The Potential Effects on Birds of the Greater Gabbard Offshore Wind Farm Report for February 2004 to April 2006. *BTO Research Report* No. **440**. BTO & ESS on behalf of Greater Gabbard Offshore Winds Limited.

Bellefleur, D., Lee, P. & Ronconi, R.A. (2009). The impact of recreational boat traffic on marbled murrelets (*Brachyramphus mamoratus*). *Journal of Environmental Management* **90**, 531-538.

BERR (Department for Business, Enterprise and Regulatory Reform) (2008). *Atlas of UK Marine Renewable Energy Resources: Atlas Pages*. A Strategic Environmental Assessment Report, March 2008, 19pp.

Birtwell, I.K. (1999). *The Effects of Sediment on Fish and their Habitat. Fisheries and Oceans Canada*. Canadian Stock Assessment Secretariat. Research Document 99/139.

Brandt, M. J., Diederichs, A., and Nehls, G. (2009). *Investigations into the effects of pile driving at the offshore wind farm Horns Rev II and the FINO III research platform*. Report to DONG Energy.

Brandt, M., Diederichs, A., Betke, K., and Nehls, G. (2011). Responses of harbour porpoises to pile driving at the Horns Rev II offshore wind farm in the Danish North Sea. *Marine Ecology Progress Series*, **421**; 205-215.

Brasseur, S., van Polanen Petel, T., Aarts, G., Meesters, E., Dijkman, E., and Reijnders, P., (2010). *Grey seals (Halichoerus grypus) in the Dutch North Sea: population ecology and effects of wind farms*. In: we@sea (Ed.), IMARES Report number C137/10. http://www.we-at-sea.org/leden/docs/reports/RL2-2 2005-006 Effect of wind farms on grey seals in the Dutch North Sea.pdf

Brasseur, S., Aarts, G., Meesters, E., Van Polanen Petel, T., Dijkman, E., Cremer, J., and Reijnders, P. (2012). *Habitat preferences of harbour seals in the Dutch coastal area: analysis and estimate of effects of offshore wind farms*. IMARES report C043/10.

Brazier, D. P., Davies, J., Holt, R. H. F., and Murray, E. (1998). *Marine Nature Conservation Review Sector 5. South-east Scotland and north-east England: area summaries*. JNCC, Peterborough. Coasts and seas of the United Kingdom MNCR series.

British Geological Survey (BGS) (1998). *Guisborough. Sheet 34. Solid and Drift Geology*.

 © 2014 Forewind

Budd, G.C. (2008). *Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand. *Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme.* [On-line]. Plymouth: Marine Biological Association of the United Kingdom.

Bundesamt für Naturschutz (2008). Erhaltungsziele für das FFH-Gebiet "Doggerbank" (DE 1003-301) in der deutschen AWZ der Nordsee. Available at: http://www.bfn.de/habitatmare/en/schutzgebiet-doggerbank.php [accessed 14 August 2013]

Burthe, S., Daunt, F., Butler, A., Elston, D.A., Frederiksen, M., Johns, D., Newell, M., Thackeray, S.J. and Wanless, S. (2012). Phenological trends and trophic mismatch across multiple levels of a North Sea pelagic food web. Mar*ine Ecology Progress Series* **454**: 119-133.

Burton, N.H.K., Armitage, M.J.S., Musgrove, A.J., and Rehfisch, M.M. (2002). Impacts of Man-Made landscape Features on Numbers of Estuarine Waterbirds at Low Tide. *Environmental Management* 30(6): 857-864.

Burton, N.H.K., Rehfisch, M.M., Clark, N.A. and Dodd, S.G. (2006). Impacts of sudden winter habitat loss on the body condition and survival of Redshank *Tringa totanus*. *Journal of Applied Ecology* 43: 464-473.

Cairns, D.K. (1987). Seabirds as indicators of marine food supplies. *Biological Oceanography* **5**: 261–271.

Camphuysen C.J. and van de Meer J. (2005). Wintering seabirds in West Africa: foraging hotspots off Western Sahara and Mauritania driven by upwelling and fisheries. *African Journal of Marine Science* **27**: 427-437

Camphuysen, C.J. & Siemensma, M.L. (2011). *Conservation plan for the Harbour Porpoise Phocoena phocoena in The Netherlands: towards a favourable conservation status*. NIOZ Report 2011-07, Royal Netherlands Institute for Sea Research, Texel.

Canadian Council of Ministers of the Environment (2002). *Canadian sediment quality guidelines for the protection of aquatic life: Summary tables*. Update. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

Cefas (2000). The impact of Disposal of Marine Dredged Material on the Flamborough Head Candidate Special Area of Conservation (SAC). November 2000.

Cefas (2009). *Strategic review of offshore wind farm monitoring data associated with FEPA licence conditions. Fish*. Contract ME1117.

Centrica Energy (2007). *Lincs offshore windfarm: Environmental Statement Volume One: Offshore Chapters 1 to 8*. In association with RES.

Chung-Davidson, Y. Bryan, M.B. Teeter, J. Bedore, C.N. and Li, W. (2008). Neuroendocrine and behavioural responses to weak electric fields in adult sea lampreys (Petromyzon marinus). *Hormones and Behaviour*. **54** (1), pp. 34-40.

 © 2014 Forewind

Clarke, K. R. and Gorley, R. N. (2006). *Primer v6: User Manual/Tutorial*. Plymouth Marine Laboratory.

Clarke, K. R. and Warwick, R. M. (2001). *Change in marine communities: an approach to statistical analysis and interpretation*. Natural Environment Research Council. Second edition.

Connor, D.W., Allen, J.H., Golding, N., Howell, K.I., Lieberknecht, L.M., Northern, N., and Reker, J.B. (2004). [Online]. *The Marine Habitat Classification for Britain and Ireland.* Version 04.05. Available at: www.jncc.gov.uk/MarineHabitatClassification. [Accessed 22 October 2012].

Connor, D.W., Gilliland, P.M., Golding, N., Robinson, P., Todd, D., and Verling, E. (2006). *UKSeaMap: the mapping of seabed and water column features of UK seas*. Joint Nature Conservation Committee, Peterborough, 104pp.

Cook, A.S.C.P., Wright, L.J., and Burton, N.H.K. (2012). *A review of flight heights and avoidance rates in relation to offshore wind farms*. Strategic Ornithological Support Services Project SOSS-02. BTO Research Report 618. BTO, Thetford.

Cooper, N.J., Rowe, S., Parsons, A. and Cooper, T. (2009). *Cell 1 Regional Coastal Monitoring Programme*. Proceedings of the Flood and Erosion Risk Management Conference, Telford.

Cork Ecology. (2009). *Seabird and marine mammal surveys in the North Sea between February 2008 and March 2009*. A report to DECC. DECC (Department of Energy and Climate Change), 2011. UK Offshore Energy. Available at http://www.offshore-sea.org.uk/site/scripts/book_info.php?consultationID=16&bookID=11

Cury, P.M., Boyd, I.L., Bonhommeau, S., Anker-Nilssen, T., Crawford, R.J.M., Furness, R.W., Mills, J.A., Murphy, E.J., österblom, H., Paleczny, M., Piatt, J.F., Roux, J-P., Shannon, L. and Sydeman, W.J. (2011). Global seabird response to forage fish depletion – one-third for the birds. *Science* **334**: 1703-1706.

Cutts, N. and Allen, J. D. (1999). *Avifaunal Disturbance Assessment, Flood Defence Work, Saltend*. Report to the Environment Agency.

Cutts, N., Phelps A. and Burdon, D. (2009). *Construction and waterfowl: Defining sensitivity, response, impacts and guidance*. Report to Humber INCA. Institute of Estuarine and Coastal Studes (IECS), University of Hull.

Daunt, F., Wanless, S., Peters, G., Benvenuti, S., Sharples, J., Gremillet, D., & Scott, B. (2006). Impacts of oceanography on the foraging dynamics of seabirds in the North Sea. In: *Top predators in marine ecosystems: their role in monitoring and management*. (eds I.L. Boyd, S. Wanless & K. Camphuysen). Cambridge University Press, Cambridge, pp177-190.

Delaney, S., Scott, D., Dodman, T., and Stroud, D. (eds) (2009). *An atlas of wader populations in Africa and Western Eurasia*. Wetlands International, Wageningen, The Netherlands.

 © 2014 Forewind

Department of Energy & Climate Change (DECC) (2002). *Strategic Environmental Assessment (SEA) 3*. Available at http://www.offshore-sea.org.uk/site/index.php

Department of Energy & Climate Change (DECC) (2009). *UK Offshore Energy Strategic Environmental Assessment. Future Leasing for Offshore Wind Farms and Licensing for Offshore Oil & Gas Storage*. Appendix A3a.7 (Marine Mammals).

Department for Environment, Food and Rural Affairs (Defra) (2012). *Report of the Habitats and Wild Birds Directives Implementation Review*. March 2012.

Desholm, M. & Kahlert, J. (2005). Avian collision risk at an offshore wind farm. *Biology Letters* 1, 296-298.

Desprez, M. (2000). Physical and biological impact of marine aggregate extraction along the French coast of the Eastern English Channel: short and long-term post-dredging restoration. *ICES Journal of Marine Science*, **57**: 1428–1438. 2000.

Diederichs, A, Nehls, G., Dähne, M., Adler, S., Koschinski, S., and Verfuß, U. (2008). *Methodologies for measuring and assessing potential changes in marine mammal behaviour, abundance or distribution arising from the construction, operation and decommissioning of offshore wind farms*. COWRIE ENG-01-2007.

Diesing, M., Ware, S., Foster-Smith, R., Stewart, H., Long, D., Vanstaen, K., Forster, R. and Morando, A. (2009). *Understanding the marine environment - sea bed habitat investigations of the Dogger Bank offshore draft SAC*. Joint Nature Conservation Committee Report 429, JNCC, Peterborough, 127pp.

Dietz, R., Henriksen, O. D., Laidre, K., and Teilman, J. (2003). *Movements of seals from Rodsand seal sanctuary monitored by satellite telemetry: Relative importance of the Nysted Offshore Wind Farm area to the seals*. NERI Technical Report No. 429: 2003.

Dillingham, P.W. and Fletcher, D. (2008). Estimating the ability of birds to sustain additional human-caused mortalities using a simple decision rule and allometric relationships. *Biological Conservation*, **141**, pp. 1783-1792.

Doerffer, R., and Fisher, J., (1994). Concentrations of chlorophyll, suspended matter, and data with inverse modelling methods in case II waters derived from satellite coastal zone colour scanner. *Journal of Geophysical Research*, **99**: 7457-7466.

Dong Energy (2009). Westermost Rough Offshore Wind Farm Environmental Statement.

Drewitt, A.L. and Langston R.H.W (2006). Assessing the impacts of wind farms on birds. *Ibis*, **148**: 29-42.

DTU (National Institute of Aquatic Resources) Aqua (2011). *Effect of the Horns Rev 1 Offshore Wind Farm on Fish Communities Follow-up Seven Years after Construction*. DTU Aqua Report No 246-2011: By Simon B. Leonhard, Claus Stenberg and Josianne Støttrup (eds.).

 © 2014 Forewind

Duck, C. D. (1995). Chapter 5.14 Seals. *In: Coasts and seas of the United Kingdom. Region 6 Eastern England: Flamborough Head to Great Yarmouth*. Ed. By Barne, J.H., Robson, C.F., Kaznowska, S.S., Doody, J.P. and Davidson, N.C. 129-133. Peterborough, Joint Nature Conservation Committee.

Dwyer, R. (2010). *Ecological and anthropogenic constraints on waterbirds of the Forth Estuary: population and behavioural responses to disturbance*. Unpublished PhD Thesis. University of Exeter.

East Anglia Offshore Wind Limited (2012a). *East Anglia ONE Environmental Statement*.

East Anglia Offshore Wind Limited (2012b). *East Anglia THREE Offshore Windfarm: Environmental Impact Assessment Scoping Report*.

East Anglia Offshore Wind Limited (2012c). *East Anglia FOUR Offshore Windfarm: Environmental Impact Assessment Scoping Report*.

East Anglia Offshore Wind Limited (2013a). *Deadline II, Appendix C: Update at the Interested Parties Deadline II stage of the assessment of potential impacts on gannet (V2)*.

East Anglia Offshore Wind Limited (2013b). Part 2. *Appendix 2P. Auk displacement note*.

ECON (2010). *Update to the ornithological assessment of the Dudgeon Offshore Wind Farm with 2009 survey data: Technical Report*.

EDF Energy (Northern Offshore Wind) Limited (2004). *Teesside Offshore Wind Farm Environmental Statement*.

Eisma, D. (1981). Supply and deposition of suspended matter in the North Sea. In Holocene Marine Sedimentation in the North Sea Basin (ed. Nio, S.-D. et al). *Special Publication of the International Association of Sedimentologists*, **5**, 415-428.

Eisma, D. and Kalf, J. (1987). Dispersal, concentration and deposition of suspended matter in the North Sea. *Journal of the Geological Society of London*, **144**, 161-178.

Eleveld, A., Pasterkamp, R., Van der Woerd, H.J., and Pietrzak, J. (2006). *Suspended Particulate Matter from SeaWiFS Data: Statistical Validation and Verification against the Physical Oceanography of the Southern North Sea*. Available at: promise.klimaatvoorruimte.nl/pro1/.../show_publication.asp?..[Accessed April 2013].

Elliott, K.H., Woo, K.J., Gaston, A.J., Benvenuti, S., Dall, Antonia, L. and Davoren, G.K. (2009). Central-place foraging in an Arctic seabird provides evidence for Storer-Ashmole's halo. *Auk* **126**: 613-625.

EMU Limited (2010). *Dogger Bank Zonal Characterisation Interim Report for Forewind Ltd*. Report no. 10/J/1/06/1587/1028.

EMU Limited (2011). *Dogger Bank Zonal Characterisation – 2nd Edition*.

 © 2014 Forewind

English Nature (2000a). *Northumbria Coast European marine site - English Nature's advice given under Regulation 33(2) of the Conservation (Natural Habitats &c.) Regulations 1994*.

English Nature (2000b). *Teesmouth and Cleveland Coast European marine site - English Nature's advice given under Regulation 33(2) of the Conservation (Natural Habitats &c.) Regulations 1994*.

English Nature (2003a). *The Humber Estuary: A comprehensive review of its nature conservation interest*. English Nature Research Report Number 547.

English Nature (2003b). *The Humber Estuary European Marine Site comprising: Humber Estuary possible Special Area of Conservation, Humber Flats, Marshes and Coast Special Protection Area & potential Special Protection Area, Humber Flats, Marshes and Coast Ramsar Site & proposed Ramsar Site. English Nature's advice given under Regulation 33(2) of the Conservation (Natural Habitats &c.) Regulations 1994*.

English Nature and Scottish Natural Heritage (2000). *Berwickshire and North Northumberland Coast European Marine Site: English Nature's and Scottish Natural Heritage's advice given in compliance with Regulation 33 (2) and in support of the implementation of The Conservation (Natural Habitats &c.) Regulations 1994*.

Enstipp, M.R., Daunt, F., Wanless, S., Humphreys, E., Hamer, K.C., Benvenuti, S. & Gremillet, D. (2006). Foraging energetics of North Sea birds confronted with fluctuating prey availability. In: *Top predators in marine ecosystems: their role in monitoring and management*. (Eds I.L. Boyd, S. Wanless & K. Camphuysen). Cambridge University Press, Cambridge, pp191-210.

ERM (2008). *Humber Gateway Offshore Wind Farm: Offshore ES: The Biological Environment – Assessment of Impacts*. On behalf of Humber Wind Limited (a company of E.ON UK plc).

European Commission (2000). *Managing Natura 2000 sites: The Provisions of Article 6 of the Habitats Directive 92/43/EEC*.

European Commission (2001). *Methodological guidance on the provisions of Article 6(3) and (4) of the Habitats Directive 92/43/EEC*.

Evans, P. (1995). Chapter 5.15 Whales, dolphins and porpoises. *In: Coasts and seas of the United Kingdom. Region 6 Eastern England: Flamborough Head to Great Yarmouth*. Ed. By Barne, J.H., Robson, C.F., Kaznowska, S.S., Doody, J.P. and Davidson, N.C. 129-133. Peterborough, Joint Nature Conservation Committee.

Evans, P. G. H., Andersen, L. W., Bjorge, A., Fontaine, M., Galatius, A., Kinze, C. C., Lockyer, C., Luna, C. De., Pierce, G. J., Sveegaard, S., Teilmann, J., Tiedmann, R., and Walton, M. (2009). *Harbour porpoise Phocoena phocoena. Report of ASCOBANS/HELCOM small cetacean population structure workshop*. 8–10 October 2007, UN Campus, Hermann-Ehlers-Str. 10, 53113 Bonn, Germany, p. 61–85.

 © 2014 Forewind

Forewind (2011). *Dogger Bank Zonal Characterisation (2nd Edition)*. Prepared by Emu Limited, December 2011.

Forewind (2013a). *Dogger Bank Teesside A & B draft Environmental Statement for PEI3 Consultation*.

Forewind (2013b). *Dogger Bank Creyke Beck Development Consent Order Application: Supporting Documents*.

Forewind (2014). *Dogger Bank Creyke Beck Consolidated Ornithological Addendum*.

Fort, J., Pettex, E., Tremblay, Y., Lorentsen, S.H., Garthe, S., Votier, S., Pons, J.B., Siorat, F., Furness, R.W., Grecian, W.J., Bearhop, S., Montevecchi, W.A., and Gremillet, D. (2012). Meta-population evidence of oriented chain migration in northern gannets (*Morus bassanus*). *Frontiers in Ecology and the Environment* 10, 237--242.

Frederiksen, M., Moe, B., Daunt, F., Phillips, R.A., Barrett, R.T., Bodganova, M.I., Boulinier, T., Chardine, J.W., Chastel, O., Chivers, L.S., Christensen-Dalsgaard, S., Clément-Chastel, C., Colhoun, K., Freeman, R., Gaston, A.J., Gonzalez-Solis, J., Goutte, A., Grémillet, D., Guilford, T., Jensen, G.H., Krasnov, Y., Lorentsen, S-H., Mallory, M.L., Newell, M., Olsen, B., Shaw, D., Steen, H., Strøm, H., Systad, G.H., Thórarinsson, T., and Anker-Nilssen, T. (2012). Multi-colony tracking reveals the winter distribution of a pelagic seabird on an ocean basin scale. *Diversity and Distributions* **18**, 530-542.

Fugro (2011). *Geotechnical Report, Laboratory and In-situ Data: Dogger Bank Wind Farm Site Investigation UKCS, North Sea*.

Furness R.W. (2013). *Extent of displacement and mortality implications of displacement of seabirds by offshore wind farms*.

Furness, R.W. & Tasker, M.L. (2000). Seabird-fishery interactions: quantifying the sensitivity of seabirds to reductions in sandeel abundance, and identification of key areas for sensitive seabirds in the North Sea. *Marine Ecology Progress Series* 202: 253-264.

Furness, R.W. & Wade, H. (2012). *Vulnerability of Scottish Seabirds to Offshore wind turbines*. Report to Marine Scotland.

Future of the Atlantic Marine Environment (FAME) (2012). *A marathon for a kittiwake recorded using GPS tags* [Online]. Available at: http://www.fameproject.eu/en/results/united-kingdom/ [Accessed 9 January 2013].

Gage, J.D. (2001). Deep-sea benthic community and environmental impact assessment at the Atlantic Frontier. *Continental Shelf Research*, **21**: 957-986

Gardline Environmental Limited (2011a). Dogger Bank Zone Wide Acoustic and Geophysical Survey May to August 2010. Survey Report to Forewind, January 2011.

Gardline Environmental Limited (2011b). *Dogger Bank Tranche A and Associated Export Route Benthic Survey, May-Aug 2011*. Environmental Field Report to Forewind, August 2011.

 © 2014 Forewind

Gardline Environmental Limited (2011c). *Dogger Bank Geophysical Survey. Geophysical Survey of Tranche A Project 1 Cable Corridor*. May to June 2011. Results Report to Forewind, December 2011.

Gardline Environmental Limited (2012). *Dogger Bank Tranche B Benthic Survey 2012*. UKCS 38/27. Field Survey Report to Forewind, July 2012.

Gardline Environmental Limited (2012c). *Ornithological Survey Monthly Field Report Forewind Dogger Bank Wind Farm Project*. Dogger Bank, January 2012.

Gardline Environmental Limited (2013a). *Dogger Bank Geophysical Survey Tranche B Project Areas 1A, 1B, 2A and 2B*. June 2011 to May 2012. Results Report to Forewind, March 2013.

Gardline Environmental Limited (2013b). *Dogger Bank Geophysical Survey of Teesside Export Cable Corridor, May-July 2012*. Report to Forewind, February 2013.

Gardline Environmental Limited (2013c). *Dogger Bank Offshore Wind Farm (Tranche B and Teesside Cable Corridor) Benthic Survey*. A report to Forewind. Date 01/03/2013.

Garthe, S. & Hüppop, O. (2004). Scaling possible adverse effects of marine wind farms on seabirds: developing and applying a vulnerability index. *Journal of Applied Ecology* 41: 724-734.

GEMS (2011). *Geophysics Results Report. Volume 4 of 9. Dogger Bank Tranche A Acoustic and Geophysical Survey*. Report (Revision: 01) to Forewind, September 2011, 73pp.

Gill, A.B., Gloyne-Phillips, I., Neal, K.J. and Kimber, J.A. (2005). COWRIE 1.5 Electromagnetic Fields Review. *The potential effects of electromagnetic fields generated by sub-sea power cables associated with offshore wind farm developments on electrically and magnetically sensitive marine organisms – a review*. Commissioned by COWRIE. Available at URL: http://www.offshorewindfarms.co.uk/Assets/COWRIE_Final_compiled.pdf.

Gilles, A., Peschko, V., Scheidat, M., and Siebert, U. (2012). *Survey for small cetaceans over the Dogger Bank and adjacent areas in summer 2011*. 19th ASCOBANS Advisory Committee Meeting.

Gilles, A., Peschko, V., Scheidat, M., and Siebert, U. (2011b). *A Visuelle Erfassung von Schweinswalen und akustische Erfassung im Seegebie*t. In DoggerbankMonitoringbericht 2010-2011 Marine Säugetiere und Seevögel in der deutschen AWZ von Nordund Ostsee.

Gilles, A., Peschko, V., Scheidat, M., and Siebert, U. (2011b). *A Visuelle Erfassung von Schweinswalen und akustische Erfassung im Seegebiet*. In DoggerbankMonitoringbericht 2010-2011 Marine Säugetiere und Seevögel in der deutschen AWZ von Nordund Ostsee.

Gilles, A., Peschko, V., Scheidat, M., and Siebert, U. (2012). *Survey for small cetaceans over the Dogger Bank and adjacent areas in summer 2011*. 19th ASCOBANS Advisory Committee Meeting.

 © 2014 Forewind

Goss-Custard, J.D. (1985). Foraging behaviour of wading birds and the carrying capacity of estuaries. In: Sibly, R.M. & Smith, R.H. (eds) *Behavioural Ecology: Ecological Consequences of Adaptive Behaviour*, pp. 169–188. Blackwell Scientific Publications, Oxford, UK.

Goss-Custard, J.D., Stillman, R.A., West, A.D., Caldow, R.W.G. & McGrorty, S. (2002). Carrying capacity in overwintering migratory birds. *Biological Conservation* **105**, 27–41.

Götz, T. Janik V.M. (2010). Averseness of sounds in phocid seals: psychophysiological factors, learning processes and motivation. *J Exp Biol* **2010, 213**:1536-1548.

Götz, T. and Janik V.M. (2011). Repeated elicitation of the acoustic startle reflex leads to sensitisation in subsequent avoidance behaviour and induces fear conditioning. *Neuroscience* **2011, 12**:30.

Gubbay. S. & Knapman, P.A. (1999). *A review of the effects of fishing within UK European marine sites*. Peterborough: English Nature (UK Marine SACs Project). 134 pages.

Hall A.J. (2002). *Grey seal in: The Encyclopedia of Marine Mammals*. Eds CA.Perrin, W. F., B. G. Wursig, and J. G. M. Thewissen Academic Press: San Diego.

Hamer, K.C., Phillips, R.A., Wanless, S., Harris, M.P. & Wood, A.G. (2000). Foraging ranges, diets and feeding locations of Gannets *Morus bassanus* in the North Sea: evidence from satellite telemetry. *Marine Ecology Progress Series* **200**, 257-264.

Hamer, K.C., Phillips, R.A., Hill, J.K., Wanless, S. & Wood, A.G. (2001). Contrasting foraging strategies of gannets Morus bassanus at two North Atlantic colonies: foraging trip duration and foraging area fidelity. *Marine Ecology Progress Series* **224**, 283-290.

Hammond, P. S., Benke, H., Borchers, D.L., Buckand, S.T., Collet, A., Heide-Jørgensen, M-P., Heimlich-Boran, S., Hiby, A.R., Leopold, M. F., and Øien, N. (2002). Distribution and abundance of the harbour porpoise and other small cetaceans in the North Sea and Adjacent Waters. *Journal of Applied Ecology*, **39(2)**; 361-376.

Hammond, P. S., Macleod, K., Berggren, P., Borchers, D.L., Burt, L., Cañadas, A., Desportes, G., Donovan, G. P., Gilles, A., Gillespie, D., Gordon, J., Hiby, L., Kuklik, I., Leaper, R., Lehnert, K., Leopold, M., Lovell, P., Øienm, N., Paxton, C. G. M., Ridoux, V., Rogan, E., Samarra, F., Scheidat, M., Sequeira, M., Siebert, U., Skov, H., Swift, R., Tasker, M. L., Teilmann, J., Van Canneyt, O., and Vázquez, J. A. (2013). Cetacean abundance and distribution in European Atlantic shelf waters to inform conservation and management. *Biological Conservation*, **164**; 107-122

Hammond, P.S. and Grellier, K. (2006). *Grey seal diet composition and prey consumption in the North Sea*. Final report to Department for Environment Food and Rural Affairs on project MF0319.

Harding, K.C., M. Fujiwara, T., Härkönen, and Y. Axberg. (2005). Mass dependent energetics and survival in harbour seal pups. *Functional Ecology*, **19**; 129-135.

 © 2014 Forewind

Harkonen, T., Brasseur, S., Vincent, C., Dietz, R., Abt, K., and Reijnders, P. (2007). Status of grey seals along mainland Europe from the Southwestern Baltic to France. *NAMMCO Sci. Publ*. **6**: 57-68.

Harris, M.P., Newell, M., Leitch, A., Bruce, B. & Hunt, J. (2009). Dramatic decline in numbers of Atlantic Puffins in the Firth of Forth. *Scottish Birds,* **29**: 132-134.

Hassel, A., Knutsen, T., Dalen, J., Løkkeborg, S., Skaar, K.,Østensen, Ø., Haugland, E. K., Fonn, M., Høines, A . and Misund, O. A. (2003). *Reaction of sandeel to seismic shooting: a field experiment and fishery statistics study*. Institute of Marine Research, Fisken og Havet, 4: 63 pp.

Hassel.,A, Knutsen, T., Dalen, J., Skaar, K., Løkkeborg, S., Misund, O.A., Oivind, O., Fonn, M. and Haugland, E.K. (2004). Influence of seismis shooting on the lesser sandeel (Ammodytes marinus), ICES *Journal of Marine Science*, **61**, pp.1165-1173.

Hartnoll, R.G., (1998). Volume VIII. *Circalittoral faunal turf biotopes: An overview of dynamics and sensitivity characteristics for conservation management of marine SACs*. Scottish Association of Marine Sciences, Oban, Scotland. [UK Marine SAC Project. Natura 2000 reports.]

Hiscock, K., Langmead, O., Warwick, R. and Smith, A. (2005). *Identification of seabed indicator species to support implementation of the EU Habitats and Water Framework Directives*. Second edition. Report to the Joint Nature Conservation Committee and the Environment Agency from the Marine Biological Association. Plymouth: Marine Biological Association. JNCC Contract F90-01-705. 77 pp

HM Treasury & Infrastructure UK (2011). *National Infrastructure Plan 2011*.

Humber Management Scheme (2010). *2008-2009 Combined Annual Reports: Humber Management Scheme*. Access by: http://humberems.co.uk/downloads/Annual%20Report%2020082009.pdf

Hüppop, O., Dierschke, J., Exo, K.M., Fredrich, E., and Hill, R. (2006). Bird migration studies and potential collision risk with offshore wind turbines. *Ibis* 148 (Suppl. 1): 90–109.

Hvidt, C.B., Kaustrup, M., Leonhard, S.B., and Pedersen, J. (2005). *Fish along the Cable Trace. Nysted Offshore Wind Farm*. Final Report 2004.

IAMMWG (2013). *Management Units for marine mammals in UK waters*.

ICES (2010). *Report of the Benchmark Workshop on Sandeel (WKSAN)*. ICES CM2010/ACOM: 57 Annex 12. ICES, Copenhagen.

IMARES (2009). *Conservation objectives for Natura 2000 sites (SACs and SPAs) in the Dutch sector of the North Sea*. Report number C065/09.

Inch Cape Offshore Limited (ICOL) (2013). *Inch Cape Offshore Wind Farm Environmental Statement*.

 © 2014 Forewind

Inter-agency Marine Mammal Working Group (IAMMWG) (2013). Management Units for marine mammals in UK waters (June 2013)

Jackson, A. & Hiscock, K. (2008). Erect sponges, *Eunicella verrucosa* and *Pentapora fascialis* on slightly tide swept moderately exposed circalittoral rock. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme.

Jak R.G., Bos O.G., Witbaard R. and Lindeboom H.J. (2009). *Instandhoudingsdoelen Natura 2000-gebieden Noordzee* (Conservation targets for Natura 2000 sites in the North Sea). IMARES - Institute for Marine Resources & Ecosystem Studies.

Joint Nature Conservation Committee (JNCC) (2009). *Threshold for designation of Special Areas of Conservation for harbour porpoise and other highly mobile, wide-ranging marine species*. Annex 1 to JNCC Committee paper P10 Sept 08, amended 13 February 2009.

Joint Nature Conservation Committee (JNCC) (2010). *Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise*. JNCC, Aberdeen.

Joint Nature Conservation Committee (JNCC) (2011). *Offshore Special Area of Conservation: Dogger Bank SAC Selection Assessment Document*. Version 9.0, August 2011. Available at: http://www.jncc.gov.uk/page-4535 [Accessed 22 October 2012].

Joint Nature Conservation Committee (JNCC) (2012a). *Offshore Special Area of Conservation: Dogger Bank - Conservation Objectives and Advice on Operations*. Version 6.0 (March 2012). Available at: http://jncc.defra.gov.uk/pdf/DoggerBank_ConservationObjectivesAdviceonOperations_6.0.pdf [Accessed October 2012]

JNCC (2012b). Seabird Monitoring Programme Online Database (http://jncc.defra.gov.uk/page-4460) – Seabird Colony Data.

JNCC (2012c). Seabird Population Trends and Causes of Change: 2012 Report (http://www.jncc.defra.gov.uk/page-3201). JNCC, Aberdeen.

Joint Nature Conservation Committee (JNCC) & Natural England (NE) (2012). *Joint Natural England and JNCC Interim Advice Note: Presenting information to inform assessment of the potential magnitude and consequences of displacement of seabirds in relation of Offshore Windfarm Developments*. NE/JNCC.

Joint Nature Conservation Committee (JNCC) & Natural England (NE) (2013a). *Natural England and JNCC advice on Habitats Regulations Assessment (HRA) screening for seabirds in the breeding season*. February 2013.

Joint Nature Conservation Committee (JNCC) & Natural England (NE) (2013b). *JNCC and Natural England interim advice on Habitats Regulations Assessment (HRA) screening for seabirds in the non-breeding season*. February 2013.

 © 2014 Forewind

Jones, E., McConnell, B., Sparling, C., and Matthiopoulos, J. (2013). Grey and harbour seal density maps. Marine Mammal Scientific Support. Research Programme MMSS/001/11. Available at: http://www.scotland.gov.uk/Resource/0041/00416981.pdf

Kaiser, M. J., Galanidi, M., Showler, D. A., Elliot, A. J., Caldow, R. W. G., Rees, E. I S., Stillman, R. A., Sutherland, W. J. (2006). Distribution and behaviour of Common Scoter *Melanitta nigra* relative to prey resources and environmental parameters. *Ibis* **148**: 110-128.

Kastak, D., Southall, B. L., Schusterman, R. J., and Reichmuth, C. (2005). Underwater temporary threshold shift in pinnipeds: Effects of noise level and duration. *J. Acoust. Soc. Am.*, **118**, pp. 3154-3163.

Kastelein, R.A., Hardemann, J., and Boer, H. (1997). Food consumption and body weight of harbour porpoises (Phocoena phocoena). In T*he biology of the harbour porpoise*; Read, A.J., Wiepkema, P.R., Nachtigall, P.E. (Eds.) (1997), pp. 217–234. Woerden, The Netherlands:De Spil Publishers.

King, S., Maclean, I., Norman, T., and Prior, A. (2009). *Developing guidance on ornithological cumulative impact assessment for offshore wind farm developers*. Report commissioned by COWRIE. Available at http://www.offshorewind farms.co.uk/

Kirschvink, J. L., A. E. Dizon, and J. A. Westphal. (1986). Evidence from strandings for geomagnetic sensitivity in Cetaceans. *J. Exp. Biol*. **120**, 1–24.

Klein, H., Konig, P., and Frohse, A. (1999). Currents and near-bottom suspended matter dynamics in the central North Sea during stormy weather - Results of the PIPE'98 field experiment. *Deutsche HydrographischeZeitschrift*, **51**, p47-66.

Klinowska, M. (1985). Cetacean live stranding sites related to geomagnetic topography. *Aquatic Mammals* (**1**):27-32.

Kober, K., Webb, A., Win, I., Lewis, M., O'Brien, S., Wilson, L.J., and Reid, J.B. (2010). *An analysis of the numbers and distribution of seabirds within the British Fishery Limit aimed at identifying areas that qualify as possible marine SPAs*. JNCC report No. 431.

Krijgsveld, K. L., Fijn, R.C., Heunks, C., van Horssen, P.W., de Fouw, J., Collier, M. P., Poot, M. J. M., Beuker, D., and Dirksen, S. (2010). *Effect Studies Offshore Wind Farm Egmond aan Zee. Progress report on fluxes and behaviour of flying birds covering 2007 & 2008*. Bureau Waardenburg report 09-023. Bureau Waardenburg, Culemborg, Netherlands.

Krijgsveld, K.L., Fijn, R.C., Japink, M., van Horssen, P.W., Heunks, C., Collier, M.P., Poot, M.J.M., Beuker, D., and Dirksen, S. (2011). *Effect Studies Offshore Wind Farm Egmond aan Zee. Final report on fluxes, flight altitudes and behaviour of flying birds.* Bureau Waardenburg report 10-219. Bureau Waardenburg, Culemborg, Netherlands.

Kubetzki, U., Garthe, S., Fifield, D., Mendel, B., and Furness, R.W. (2009). Individual migratory schedules and wintering areas of northern gannets. *Marine Ecology Progress Series* 391, 257–65.

 © 2014 Forewind

Laist D. W., Knowlton A. R., Mead J. G., Collet A. S. and Podesta M. (2001). Collisions between ships and whales. *Marine Mammal Science*, **vol. 17**, no 1, pp. 35-75.

Langston. R.H.W. (2010). *Offshore wind farms and birds: Round 3 zones, extensions to Round 1 and 2 sites and Scottish Territorial Waters*. RSPB Research Report No. 39.

Langston, R.H.W. & Boggio, S. (2011). *Foraging ranges of northern gannets Morus bassanus in relation to proposed offshore wind farms in the UK*. RSPB Report to DECC [Online]. Available at: http://www.offshore-sea.org.uk/site/scripts/consultation_download_info.php?downloadID=284 [Accessed 9 January 2013].

Langston, R.H.W. & Teuten, E. (2012). *Foraging ranges of northern gannets Morus bassanus in relation to proposed offshore wind farms in the UK: 2011*. Report to DECC.

Larsen, J.K. and Guillemette, M. (2007). Effects of wind turbines on flight behaviour of wintering common eiders: implications for habitat use and collision risk. *Journal of Applied Ecology*, **44**: 516–522.

Leonhard, S.B and Pedersen, J. (2005). *Hard Bottom Substrate Monitoring Horns Rev Offshore Wind Farm*. Annual Status Report 2004.

Leonhard, S.B. and Pedersen, J. (2006). *Benthic communities at Horns Rev before, during and after Construction of Horn Rev Offshore Wind Farm*. Vattenfall Report Number: Final. Report/Annual report 2005, p 134.

Leopold, M.F. & Camphuysen, C.J. (2007). *Did the pile driving during the construction of the Offshore Wind Farm Egmond aan Zee, the Netherlands, impact local seabirds?* Report CO62/07. Wageningen IMARES Institute for Marine Resources & Ecosystem Studies.

Leopold, M.F., Camphuysen, C.J., Verdaat, H., Dijkman, E.M., Meesters, H.W.G., Aarts, G.M., Poot, M. and Fijn, R. (2010). *Local Birds in and around the Offshore Wind Park Egmond aan Zee (OWEZ) (T_0 & T_1)*. Report for NoordzeeWind.

Lewis, S., Sherratt, T.N., Hamer, K.C. and Wanless, S. (2001). Evidence of intra-specific competition for food in a pelagic seabird. *Nature* **412**: 816-819.

Lincs Wind Farm Limited (2010). *LID6 Environmental Statement*. On Behalf of Lincs Wind Farm Limited. Centric Energy, Dong Energy, and Siemens.

Lindeboom, H. J., Kouwenhoven, H. J., Bergman, M. J. N., Bouma, S., Brasseur, S., Daan, R., Fijn, R. C., de Haan, Dirksen S.D., van Hal, R., Hille Ris Lambers, R., ter Hofstede, R., Krijgsveld, K.L., Leopold, M., and Scheidat. M (2011). Short-term ecological effects of an offshore wind farm in the Dutch coastal zone; a compilation. *Environ. Res. Lett*. **6** 035101.

Longcore, T., & Rich, C., (2004). Ecological light pollution. *Frontiers in Ecology and the Environment*, **2**(4), pp. 191-198.

 © 2014 Forewind

Lucke, K., Siebert, U., Lepper, P. A. and Blanchet, M. A. (2009). Temporary shift in masked hearing thresholds in a harbor porpoise (Phocoena phocoena) after exposure to seismic airgun stimuli. J*. Acoust. Soc. Am*., **125 (6),** pp. 4060-4070.

Maclean I.M.D, Wright L.J., Showler D.A., and Rehfisch M.M. (2009). *A Review of Assessment Methodologies for Offshore Windfarms*. BTO Report commissioned by Cowrie Ltd.

Madsen, P. T., Wahlberg, M., Tougaard, J., Lucke, K., and Tyack, P. (2006). Wind turbine underwater noise and marine mammals: implications of current knowledge and data needs. *Mar Ecol Prog Ser*, **309**; 279-295.

Magnusdottir, E., Leat, E.H.K., Bourgeon, S., Strøm, H., Petersen, A., Phillips, R.A., Hanssen, S.A., Bustnes, J.O., Hersteinsson, P. & Furness, R.W. (2012). Wintering areas of Great Skuas Stercorarius skua breeding in Scotland, Iceland and Norway. *Bird Study*, **59**, 1-9.

Mainstream Renewable Power (2012). Neart na Gaoithe Offshore Wind Farm Environmental Statement.

Mainstream Renewable Power (2013). *Neart na Gaoithe Offshore Wind Farm Addendum of Supplementary Environmental Information*. June 2013.

Maitland, P. S. (2003). Ecology of the River, Brook and Sea Lamprey. *Conserving Natura 2000 Rivers Ecology Series* No. **5**. English Nature, Peterborough.

Maitland, P. S., and Hatton-Ellis T. W. (2003). Ecology of the Allis and Twaite Shad. *Conserving Natura 2000 Rivers Ecology Series* No. **3**. English Nature, Peterborough.

Malme, C. I., Miles, P. R., Miller, G. W., Richardson, W. J., Reseneau, D. G., Thomson, D. H., and Greene, C. R. (1989). *Analysis and ranking of the acoustic disturbance potential of petroleum industry activities and other sources of noise in the environment of marine mammals*. In Alaska, Malme, C. I, Miles, P. R., Miller, G. W., Richardson, W. J., Roseneau, D. G., Thomson, D. H., and Greene, C. R., BBN Report No. 6945 OCS Study MMS 89-0005. Reb. From BBN Labs Inc., Cambridge, MA, for U.S. Minerals Managements Service, Anchorage, AK. NTIS PB90-188673.

Mander, L. & Cutts, N. (2003). *Ornithological Monitoring, Thorngumbald: Annual Report #1 January to December 2002*. Institute of Estuarine & Coastal Studies, University of Hull.

Mander, L. & Cutts, N (2004). *Ornithological Monitoring, Thorngumbald: Annual Report #2 January to December 2003*. Institute of Estuarine & Coastal Studies, University of Hull

Masden, E.A., Haydon, D.T., Fox, A.D., Furness, R.W., Bullman, R., and Desholm, M. (2009). Barriers to movement: impacts of wind farms on migrating birds. *ICES Journal of Marine Science* 66: 746-753.

Masden, E., Haydon, D.T., Fox, A.D., and Furness, R.W. (2010). Barriers to movement: Modelling energetic costs of avoiding marine wind farms amongst breeding seabirds. *Marine Pollution Bulletin* 60: 1085-1091.

 © 2014 Forewind

Mathiesen, M. and Nygaard, E. (2010). *Dogger Bank Wind Power Sites Metocean Design Basis*. Statoil Report PTM MMG MGE RA 63, Rev no 1, June 2010, 129pp.

Mathiesen, M., Nygaard, E. and Andersen, O. J. (2011). *Dogger Bank Wind Power Sites Metocean Design Basis*. Statoil Report PTM MMG MGE RA 63, Rev no 3, October, 2011, 129pp.

McConnell, B. J., Cahmbers, C., Nicholas, K. S., Fedak, M. A. (1992). Satellite tracking of grey seal (*Halichoerus grypus*). *Journal of Zoology*, **226** 271-282.

McConnell B.J., Fedak M.A., Lovell P., and Hammond P.S. (1999). Movements and foraging areas of grey seals in the North Sea. *Journal of Applied Ecology*, **36**: 573-590.

McConnell, B., Lonergan, M., and Dietz, R. (2012). *Interactions between seals and offshore wind farms*. The Crown Estate, 41 pages. ISBN: 978-1-906410-34-5.

Mitchell, P.I., Newton, S.F., Ratcliffe, N., and Dunn, T.E. (2004). *Seabird Populations of Britain and Ireland*. Poyser, London.

Moray Offshore Renewables Limited (2012). *Telford, Stevenson and MacColl Offshore Wind Farms and Transmission Infrastructure: Environmental Statement*,

NaREC (2012). *Blyth Environmental Statement, Offshore Demonstration Project: Section 7, The Biological Environment*.

NaREC (2013). *Blyth Offshore Demonstration Project Supplementary Environmental Information, Non-technical summary*.

National Grid (2012). Carbon Capture and Storage (CCS). Available at: http://www.nationalgrid.com/NR/rdonlyres/1692CFEF-C694-4A62-ABAE-97DFF35F5938/53826/CarbonCapture.pdf

Natural England (2013). *Population Figures for the Proposed Extension to the Flamborough SPA*. Email correspondence received from Natural England in response to the Dogger Bank Creyke Beck HRA Screening Report.

Nedwell J R, Langworthy J and Howell D. (2003). *Assessment of sub-sea acoustic noise and vibration from offshore wind turbines and its impact on marine wildlife; initial measurements of underwater noise during construction of offshore wind farms, and comparison with background noise*. Subacoustech Report ref: 544R0423, published by COWRIE, May 2003.

Nedwell, J. R. and D. Howell (2004). A review of offshore windfarm related underwater noise sources. *COWRIE* report No**. 544** R 0308, 57 pp.

Nedwell, J.R, Parvin, S.J, Edwards, B, Workman, R, Brooker, A.G. and Kynoch ,J.E. (2007). *Measurements and interpretation of underwater noise during construction and operation of offshore wind farms in UK waters*. Subacoustech Report No. 544R0738 to COWRIE ltd. ISBN: 978-0-9554279-5-4.

 © 2014 Forewind

Normandeau Associates, Tricas, T. and Gill A. (2011). *Effects of EMFs from undersea power cables on elasmobranchs and other marine species*. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Regulation, and Enforcement, Pacific OCS Region, Camarillo, CA. OCS Study BOEMRE 2011-09.

Northridge, S. (2011). *An overview of the state of bycatch monitoring and mitigation measures being implemented in European fisheries*. IWC Publication, SC/63/SM1.

Northridge (2012). *MS Offshore Renewables Research: Work Package C2: Request for advice on the populations of cetaceans that might be involved in significant interactions with marine renewable energy developments in Scottish marine waters*.

Offshore-Bürger-Windpark Butendiek (2002). *Environmental Impact Assessment June 2002 English Summary*. Offshore-Bürger-Windpark Butendiek GmbH & Co. KG.

OSPAR (2008). *Background Document on Potential Problems associated with Power Cables other than those for Oil and Gas Activities*. OSPAR Commission. Biodiversity Series.

OSPAR (2009). *Assessment of the environmental impacts of cables*. A Biodiversity Series Report.

Otani, S., Naito, Y., Kato, A. and Kawamura, A. (2000). Diving behaviour and swimming speed for free-ranging harbour porpoise, *Phocean phocena*. *Marine Mammal Science*, **l6**(4), pp. 811-814.

Parvin S J., Nedwell J. R. and Workman R. (2006). *Underwater noise impact modelling in support of the London Array, Greater Gabbard and Thanet offshore wind farm developments*. Report to CORE Ltd by Subacoustech Ltd Report No. 710R0517, 2006.

Peak Ecology Limited (2012). *Dogger Bank Creyke Beck Winter Birds Surveys November 2011-March 2012*. Commissioned by Forewind.

Perrow, M. R., Gilroy, J. J., Skeate, E. R. & Tomlinson, M. L. (2011). Effects of the construction of Scroby Sands offshore wind farm on the prey base of little tern Sternula albifrons at its most important UK colony. *Marine Pollution Bulletin* **8**:1661-1670.

Petersen, I.K., Clausager, I. & Christensen, T.K. 2004. Bird Numbers and Distribution in the Horns Rev Offshore Wind Farm Area. NERI report. Available at http://www.hornsrev.dk/Miljoeforhold/miljoerapporter/Bird_numbers_2003%20status_report.pdf.

Petersen, I.K., Christensen, T.K., Kahlert, J., Desholm, M., and Fox, A.D. (2006). *Final results of bird studies at the offshore wind farms at Nysted and Horns Rev, Denmark*. National Environmental Research Institute, Denmark.

Petersen, I.K. & Fox, A.D. (2007). *Changes in bird habitat utilisation around the Horns Rev 1 offshore wind farm, with particular emphasis on Common Scoter*. NERI report to Vattenfall A/S.

 © 2014 Forewind

Petersen, I.K., MacKenzie, M.L., Rexstad, E., Wisz, M.S. & Fox, A.D. (2011). *Comparing pre- and post-construction distributions of long-tailed ducks Clangula hyemalis in and around the Nysted offshore wind farm, Denmark: a quasi-designed experiment accounting for imperfect detection, local surface features and autocorrelation*. CREEM Technical Report, no. 2011-1, University of St Andrews.

Pettersson, J. & Stalin, T. (2003). *Influence of Offshore Windmills on Migration Birds in Southeast Coast of Sweden*. Report to GE Wind Energy.

Pettersson, J. (2005). The impact of Offshore Wind Farms on bird life in southern Kalmar Sound, Sweden: A final report based on studies 1999-2003. For the Swedish Energy Agency.

Planning Inspectorate (2012). *Habitats Regulations Assessment. Advice Note 10: Habitat Regulations Assessment relevant to nationally significant infrastructure projects*.

Platteeuw, M. & Beekman, J. H. (1994). Disturbance of waterbirds by ships on lakes Ketelmeer and Ijsselmeer. *Limosa* **67**: 27-33.

Rayment, W.J. (2008). *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves in infralittoral compacted fine sand. *Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme*.

Rees, H. L., Eggleton, J. D., Rachor, E., and Vanden Berghe, E. eds. (2007). *Structure and dynamics of the North Sea benthos*. Cooperative Research Report, 288, Denmark: ICES.

Reid, J.B., Evans, P.G.H., and Northridge, S.P. (2003). *Atlas of cetacean distribution in North-west European waters*. JNCC, Peterborough.

Rexstad, E. & Buckland, S. (2012). *Displacement analysis boat surveys Kentish Flats*. Strategic Ornithological Support Services Project SOSS-01. University of St. Andrews.

Richardson, W. J., Greene, C. R. J., Malme, C. I., and Thomson D. D. (1995). *Marine mammals and noise*. San Diego: Academic Press, 1994.

Robinson, S. P., Theobald, P. D. and Lepper, P. A. (2011). *The noise radiated by marine piling for the construction of offshore wind farms*. Proceedings of the 4th International Conference & Exhibition on "Underwater Acoustic Measurements: Technologies & Results", Kos, Greece, 2011.

Ronconi, R.A. & St. Clair, C.C. (2002). Management options to reduce boat disturbance on foraging black guillemots (Cepphus grylle) in the Bay of Fundy. *Biological Conservation* **108**: p265-271.

Rosen, D.A. & Renouf, D. (1997). Seasonal changes in the blubber distribution in Atlantic harbour seals: indications of thermodynamic considerations. *Marine Mammal Science*, **13**, 229–240.

Royal Haskoning (2005). *Thanet Offshore Wind Farm Environmental Statement*.

 © 2014 Forewind

Royal Haskoning (2011). *Galloper Wind Farm Project Environmental Statement*. On behalf of Galloper Wind Farm Limited (a company of RWE Npower Renewables and SSE Renewables).

Royal Haskoning (2012). *Dudgeon Offshore Wind Farm: Environmental Statement*.

Royal Haskoning DHV (2013). *Dudgeon Offshore Wind Farm. Supplementary Environmental Information. Appendix 3.1 - information to support appropriate assessment*.

Royal Society for the Protection of Birds (RSPB) (2011). *Future of the Atlantic Marine Environment (FAME)*. [Online]: Available at: http://www.rspb.org.uk/ourwork/projects/details.aspx?view=print&id=tcm:9-255106 [Accessed 9 January 2013].

RPS (2005). *Environmental Statement Volume 1: Offshore Works London Array Limited*.

RPS (2009). *Westermost Rough Offshore Windfarm Environmental Statement*.

RWE Npower Renewables Limited (2012). *Triton Knoll Offshore Wind Farm Limited Environmental Statement Volume 2*.

RWE Npower Renewables (2013). *Statement of Common Ground between Triton Knoll Offshore Wind Farm Ltd, The Joint Nature Conservation Committee and Natural England regarding Ornithology for the proposed Triton Knoll Offshore Wind Farm Order*. PINS Reference EN 10005.

Santos, M.B., and Pierce, G.J. ( 2003). The diet of harbour porpoise (Phocoena phocoena) in the north-east Atlantic. *Oceanography and Marine Biology: an Annual Review 2003*, **41**, 355–390.

SCANS-II (2008). *Small cetaceans in the European Atlantic and North Sea*. Final Report submitted to the European Commission under project LIFE04NAT/GB/000245, SMRU, St Andrews.

Scheidat, M., Tougaard, J., Brasseur, S., Carstensen, J., van Polanen Petel, T., Teilmann, J., and Reijnders, P. (2011). Harbour porpoises (*Phocoena phocoena*) and wind farms: a case study in the Dutch NorthSea. *Environ. Res. Lett*. **6** (April-June 2011) 025102.

Schwemmer, P., B. Mendel, N. Sonntag, V. Dierschke and S. Garthe. (2011). Effects of ship traffic on seabirds in offshore waters: implications for marine conservation and spatial planning. *Ecological Applications* **21**: p1851–1860.

Scira Offshore Energy Limited (2006). *Sheringham Shoal Environmental Statement*.

SCOS (2010). *Scientific Advice on Matters Related to the Management of Seal Populations: 2010*. Available at http://www.smru.st-and.ac.uk

SCOS (2011). SCOS Report. *Scientific advice on matters related to the management of seal populations: 2010*. Available at www.smru.st-and.ac.uk

 © 2014 Forewind

Scottish Natural Heritage (2006a). *Faray & Holm of Faray Special Area of Conservation Advice under Regulation 33(2) of The Conservation (Natural Habitats, &c.) Regulations 1994 (as amended)*.

Scottish Natural Heritage (2006b). *Isle of May Special Area of Conservation Advice under Regulation 33(2) of The Conservation (Natural Habitats, &c.) Regulations 1994 (as amended)*.

Scottish Natural Heritage (2010). *SNH Avoidance Rate Information & Guidance Note: Use of Avoidance Rates in the SNH Wind Farm Collision Risk Model*.

Seagreen Wind Energy (2012). *Firth of Forth Phase 1 Environmental Statement Volume 1*.

Sewell, J. & Hiscock, K. (2005). *Effects of fishing within UK European Marine Sites: guidance for nature conservation agencies*. Report to the Countryside Council for Wales, English Nature and Scottish Natural Heritage from the Marine Biological Association. Plymouth: Marine Biological Association. CCW Contract FC 73-03-214A.

Seys, J., Offringa, H., van Waeyenberge, J., Meire, P., Vincx, M., and Kuijken, E. (2001). Distribution patterns of seabirds in Belgian marine waters. Pp. 22-39 in: Seys J. *Sea- and coastal bird data as tools in the policy and management of Belgian marine waters*. PhD Thesis, University of Gent, Gent, Belgium.

Sharples R. J., Matthiopoulos and J., and Hammond, P. S. (2008). *Distribution and movements of harbour seals around the coast of Britain: Outer Hebrides, Shetland, Orkney, the Moray Firth, St Andrews Bay, The Wash and The Thames*. Report to DTI, July 2008.

Skov, H., Durinck, J., Leopold, M.F., and Tasker, M.L. (1995). Important Bird Areas for seabirds in the North Sea. RSPB, Sandy, UK.

SMart Wind Limited (2012). *Hornsea Project Two Environmental Impact Assessment Scoping Report*.

SMart Wind Limited (2013). *Hornsea Offshore Wind Farm Project One Draft Environmental Statement Volume 2*.

Smit, C.J. & Visser, J.M. (1993). Effects of disturbance on shore-birds: a summary of existing knowledge from the Dutch Wadden Sea and Delta area. In Davids, N & Rothwel, P (Eds.); *Wader Study Group Bulletin* 68, Special Issues, 6-19.

SMRU Ltd (2013). *Grey and harbour seal density maps*. Marine Mammal Scientific Support Research Programme MMSS/001/11. Available at: http://www.scotland.gov.uk/Resource/0041/00416981.pdf

SNCAs (Statutory Nature Conservation Agencies) (2012). *Guidance for staff advising on the potential risk of seal corkscrew injuries*. April 2012.

 © 2014 Forewind

Southall, B. L., Bowles, A. E., Ellison, W. T., Finneran, J. J., Gentry, R. L., Greene Jr., C. R., Kastak, David, Ketten, D. R., Miller, J. H., Nachtigall, P. E., Richardson, W. J., Thomas, J. A., and Tyack, P. L. (2007). Marine mammal noise exposure criteria: initial scientific recommendations. *Aquatic Mammals*, **33** (4), pp. 411-509.

Speakman, J., Gray, H., and Furness, L. (2009). *Effects of offshore wind farms on the energy demands on seabirds*. University of Aberdeen report to DECC. URN 09D/800.

Stanev, E.V., Dobrynin, M., Pleskachevsky, A., Grayek, S., and Gunther, H. (2008). Bed shear stress in the southern North Sea as an important driver for suspended sediment dynamics. *Ocean Dynamics*, **59**, 183-194.

Stenberg, C., van Deurs, M., Stottrup, J., Mosegaard, H, Grome, T., Dinesen, G., Christensen, A., Jensen, H, Kaspersen, M., Berg, C.W., Leonhard, S.B., Skov, H., Pedersen, J., Hvidt, C.B. and Kaustrup, M. (2011). *Effect of the Hors Rev 1 Offshore Wind Farm on Fish Communities. Follow-up Seven Years after Construction*. DTU Aqua Report NO 246-2011.

Stone, C.J., Webb, A., Barton, C., Ratcliffe, N., Reed, T.C., Tasker, M.L., Camphuysen, C.J., and Pienkowski, M.W. (1995). *An atlas of seabird distribution in north-west European waters*. JNCC, Peterborough.

Stroud, D.A., Chambers, D., Cook, S., Buxton, N., Fraser, B., Clement, P., Lewis, P., McLean, I., Baker, H., and Whitehead, S. (eds) (2001). *The UK SPA network: its scope and content.* JNCC, Peterborough [Online]. Available at: http://jncc.defra.gov.uk/page-1412 [Accessed 9 January 2013].

Stroud, D.A., Davidson, N.C., West, R., Scott, D.A., Haanstra, L., Thorup, O., Ganter, B., and Delany, S. (compilers) on behalf of the International Wader Study Group (2004). Status of migratory wader populations in Africa and Western Eurasia in the 1990s. *International Wader Studies* 15: 1-259.

Tasker, M.L., Hope Jones, P., Blake, B.F., Dixon, T.J. & Wallis, A.W. (1986). Seabirds associated with oil production platforms in the North Sea. *Ringing and Migration* **7**: p7-14.

Technip (2012). *Aberdeen Offshore Wind Farm Ornithological Baseline and Impact Assessment Addendum*.

Teesmouth Bird Club (2011). Cleveland Bird Report 2011.

Thaxter, C.B., Lascelles, B., Sugar, K., Cook, A.S.C.P., Roos, S., Bolton, M., Langston, R.H.W., and Burton, N.H.K. (2012). Seabird foraging ranges as a preliminary tool for identifying candidate Marine Protected Areas. *Biological Conservation* doi:10.1016/j.biocon.2011.12.009.

Thompson, P.M., McConnell, B.J., Tollit, D.J., Mackay, A., Hunter, C., and Racey, P.A. (1996). Comparative distribution, movements and diet of harbour and grey seals from the Moray Firth, N.E. Scotland. *Journal of Applied Ecology*. **33**: 1572-1584.

 © 2014 Forewind

Thompson, P.M. & Hastie, G. D. (2011). *Proposed revision of noise exposure criteria for auditory injury in pinnipeds 2nd Draft*. 11th October 2011.

Thompson, C., Bexton, S., Brownlow, A., Wood, S., Patterson, T. Pye, K., Lonergan, M. and Milne, R. (2010). *Report on recent seal mortalities in UK waters caused by extensive lacerations, October 2010*. Sea Mammal Research Unit.

Thompson, P.M., Hastie G. D., Nedwell, J., Barham, R., Brookes, K., Cordes, L., Bailey, H., & McLean, N. (2012). *Framework for assessing the impacts of pile-driving noise from offshore wind farm construction on the Moray Firth harbour seal population*. Seal assessment Framework Technical Summary, 6th June 2012.

Thompson, P. M. and Miller, D. (1990). Summer foraging activity and movements of radio-tagged common seals (*Phoca vitulina*) in the Moray Firth, Scotland. *Journal of Applied Ecology*, **63**, 24-30.

Thomsen, F., Lüdemann, K., Kafemann, R., and Piper, W. (2006). *Effects of offshore wind farm noise on marine mammals and fish*. On behalf of COWRIE Ltd.

Topping, C. & Petersen, I.K. (2011). *Report on a red-throated diver agent-based model to assess the cumulative impact from offshore wind farms*. Report commissioned by Vattenfall A/S. Aarhus University, DCE – Danish Centre for Environment and Energy.

Tougaard, J, Carstensen, J, Wisz, M.S, Teilmann, J, Bech, N.I, Skov, H. & Henriksen, O.D. (2005). *Harbour Porpoises on Horns Rev – Effects of the Horns Rev Wind Farm. Annual Status*. Report 2004 to Elsam Engineering A/S. NERI Technical Report July 2005.

Tougaard, J., Henriksen, O.D., and Miller. L.A. (2009). Underwater noise from three types of offshore wind turbines: estimation of impact zones for harbour porpoise and harbour seals. *Journal of the Acoustic Society of America*, **125**(6): 3766.

Trilateral Seal Expert Group (TSEG) (2011). *Grey seals in the Wadden Sea 2011*. Available at http://www.waddensea-secretariat.org/news/news/Seals/Annual-reports/Grey%20Seals/greyseals2011.html

Trapp, J. L. (1998). *Bird kills at towers and other man-made structures: an annotated partial bibliography (1960-1998)*. U. S. Fish and Wildlife Service web report.

Trilateral Seal Expert Group (TSEG) (2012). Aerial surveys of Grey seals in the Wadden Sea in the season of 2011-2012. Available at: http://www.waddensea-secretariat.org/sites/default/files/downloads/final_report_aerial_surveys_of_grey_seals_in_the_wadden_sea_in_2012.pdf

Turnpenny, A.W.H. and Nedwell, J.R. (1994). T*he Effects on Marine Fish, Diving Mammals and Birds of Underwater Sound Generated by Seismic Sur*veys. Subacoustech Ltd.

 © 2014 Forewind

Tulp, I., Schekkerman, J. K., Larsen, J. K., van der Winden, J., van de Haterd, R. J. W., van Horssen, P., Dirksen, S., and Spaans, A. L. (1999). *Nocturnal flight activity of sea ducks near the wind farm Tuno Knob in the Kattegat*. Bureau Waardenburg bv, Report 99.64, Culemborg, the Netherlands.

Van Hoey, G., Degraer, S., Vinex, M. (2004). Macrobenthic community structure of soft-bottom sediments at the Belgian Continental Shelf. *Estuarine, Coastal and Shelf Science*, **59**: p599-613.

Van Hoey, G., Guilini, K., Rabaut, M., Vincx, M. and Degraer, S. (2008). Ecological implications of the presence of the tube-building polychaete *Lanice conchilega* on soft-bottom benthic ecosystems. *Marine Biology*, **154**: p1009-1019

Van der Molen (2002). The influence of tides, wind and waves on the net sand transport in the North Sea. *Continental Shelf Research*, **22**, 2739-2762.

Wahlberg, M., and Westerberg, H. (2005). Hearing in fish and their reactions to sounds from offshore wind farms. *Marine Ecology Progress Series*, vol. **288**, pp295–309.

Walker, T.I., (2001). *Basslink Project Review of Impacts of High Voltage Direct Current Sea Cables and Electrodes on Chondrichthyan Fauna and Other Marine Life*. Report to NSR Environmental Consultants Pty Ltd, No. 20: 77p.

Wakefield, E.D., Bodey, T.W., Bearhop, S. et al. (2013). Space partitioning without territoriality in gannets. *Science*.1236077.

Westerberg, H. and Lagenfelt, I. (2008). Sub-Sea Power Cables and the Migration Behaviour of the European Eel. *Fisheries Management and Ecology*, **15** (1-5), pp. 369-375.

Wieking, G. & Kröncke, I. (2001). Decadal changes in macrofauna communities on the Dogger Bank caused by large-scale climate variability. *Senckenbergiana marit*., **31**(2): 125-141.

Wiese, F., Montevechi, W.A., Davoren, G.K., Huettmann, F., Diamond, A.W., Linke, J. (2001). Seabirds at risk around offshore oil platforms in the North-west Atlantic. *Marine Pollution Bulletin* **42**: 1285-1290.

Wildfowl and Wetland Trust (WWT) (2009). *Distributions of cetaceans, seals, turtles, sharks and ocean sunfish recorded from aerial surveys 2001-2008*. WWT Consulting. Report to Department of Energy and Climate Change.

Wildfowl and Wetlands Trust (WWT) Consulting (2012). *Gannet population viability analysis: Demographic data, population model and outputs*. The Crown Estate SoSS-04.

Wilson, B., Batty, R. S., Daunt, F., and Carter, C. (2007). *Collision risks between marine renewable energy devices and mammals, fish and diving birds*. Report to the Scottish Executive. Scottish Association for Marine Science, Oban, Scotland, PA37 1QA

 © 2014 Forewind

Winship, A. J. (2009). *Estimating the impact of bycatch and calculating bycatch limits to achieve conservation objectives as applied to harbour porpoise in the North Sea*. PhD Thesis, University of St Andrews.

Wright, L.J., Ross-Smith, V.H., Austin, G.E., Massimino, D., Dadam, D., Cook, A.S.C.P., Calbrade, N.A., and Burton, N.H.K. (2012). *Assessing the risk of offshore wind farm development to migratory birds designated as features of UK Special Protection Areas (and other Annex 1 species)*. Strategic Ornithological Support Services Project SOSS-05. BTO Research Report No. 592. BTO, Thetford.

Wursig B, Greene C R and Jefferson T A. (2000). Development of an air bubble curtain to reduce underwater noise of percussive piling. *Mar.Environ.Res*. **49**, pp 79 – 93.

Wyn G. and Brazier P. (2001). *Procedural Guideline No. 3-1 In situ intertidal biotope recording*. JNCC Marine Monitoring Handbook.

Yelverton, J. T., Richmond, D. R., Hicks, W., Saunders, K. and Fletcher, E. R. (1975). *The relationship between fish size and their response to underwater blast*. DNA 3677T, Lovelace Foundation for Medical.

Zucco, C., Wende, W., Merck, T., Kochling, I. & Koppel, J. (2006). *Ecological research on Offshore Wind Farms: International Exchange of Experiences*. Part B: Literature Review of Ecological Impacts. BfN-Skripten 186, 2006.

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