FOREWIND

Dogger Bank

August 2013

Offshore Tranche, Array Boundary and In-Zone Export Cable Corridor Selection Report

Tranches C and D

Dogger Bank Teesside C & D

Offshore Tranche, Wind Farm Array Boundaries and In-Zone Export Cable Corridor Selection Report – Tranches C and D, and Dogger Bank Teesside C & D

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Overview:

This report justifies the selection of the remaining two of Forewind's four Tranches, Tranches C and D, and the offshore wind farm array boundaries for the 5th and 6th wind farm array to be developed in the Round 3 Dogger Bank Zone. The relevant environmental, engineering, commercial and consenting considerations that Forewind has taken into account in the selection of these tranches and wind farm array boundaries are explained.

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Forewind Management Meeting	August 2013	FMM 06/08/2013

Table of figures

Table of tables

1 Introduction

1.1 Forewind and the Dogger Bank Zone

1.1 In 2008, The Crown Estate announced proposals for the third round (Round 3) of offshore wind farm leasing in UK waters. Under the Round 3 process, The Crown Estate identified nine large areas of seabed around the UK which were considered the most suitable areas for development of offshore wind farms (The Crown Estate, 2012). A competitive tender process was run which awarded these Round 3 Zones to different offshore wind farm developers.

1.2 Forewind is a consortium comprised of four leading international energy companies: RWE, SSE, Statkraft and Statoil. Forewind was awarded the development rights for the Dogger Bank Round 3 Zone in January 2010. The Dogger Bank Zone comprises an area of 8660 square kilometres (km^2) located in the North Sea between 125 kilometres (km) and 290km off the coast of Yorkshire.

1.3 Forewind has a target to achieve consent for 9 gigawatts (GW) of grid connection capacity in the Dogger Bank Zone. Forewind's priority is to secure the first six offshore wind farm arrays, each with a generation capacity of up to 1.2GW, or a total installed generation capacity of 7.2GW.

1.4 The following wind farm array boundary (array boundary) selection process has utilised both desk-based and site specific survey data gathered throughout the Dogger Bank Zone Appraisal and Planning (ZAP) process and considers both environmental and engineering constraints. The process has also been informed by the results of continuing stakeholder engagement carried out during the development of the Dogger Bank Zone.

1.5 The environmental data collected through the ZAP process have been used to define the overall developable area across the Dogger Bank Zone. The engineering and economic criteria have then been used to define the tranches and array boundaries within the identified developable area.

1.6 ZAP is a non-statutory strategic planning process, which was advocated by The Crown Estate as part of the development process for the larger Round 3 Zones. One of the key objectives of this approach was to allow developers to make informed decisions on the location of projects within a Round 3 zone by providing a mechanism for the early consideration of environmental, planning and engineering constraints associated with the delivery of projects. This includes a consideration of the impacts between projects in the Dogger Bank Zone and between Round 3 Zones (known as cumulative effects). For the Dogger Bank Zone this process was termed Zonal Characterisation and provided the context for tranche selection and on-going development work. The ZAP process is described in more detail in Section 2.

1.7 This report forms part of the overall continued ZAP process and as such, Forewind welcomes any comments or further contributions that stakeholders may have on this document.

1.2 Aims of this report

1.8 Having previously identified Tranche A (Forewind, 2010) and Tranche B (Forewind, 2012a), the next stage in the tranche selection process is the identification of the final two tranches in the Dogger Bank Zone – Tranche C and Tranche D.

1.9 Forewind recognises the need to identify array boundaries within these tranches. Offshore wind projects within the Dogger Bank Zone are classified as Nationally Significant Infrastructure projects (NSIPs) under the Planning Act 2008 as amended (the Planning Act). The consent regime for NSIPs strongly encourages applicants to clearly explain all elements of the design of projects in the consent application. It also introduces a front loaded process where all consultation and important design decisions must be undertaken early in the development phase, before the application is submitted.

1.10 Identification of array boundaries is an important element of the site selection and design of the offshore wind farms. The individual array boundaries define the limits of where the offshore infrastructure (excluding export cables to shore) can be placed as well as any space between arrays. The identification of array boundaries in this manner allows the full impact of a project to be assessed in the Environmental Impact Assessment (EIA). Upon review of the Zone-wide data, it has been accepted that there is sufficient information to select Tranches C and D, and the individual wind farm array boundaries within Tranche C, known as Dogger Bank Teesside C & Dogger Bank Teesside D (together Dogger Bank Teesside C & D). Therefore, the areas for future surveys will be based on these array boundaries, as opposed to the tranche boundary.

1.11 The aim of this report is to describe the selection process undertaken to identify Tranches C and D, the individual array boundaries for Dogger Bank Teesside C & D and the associated in-Zone export cable corridors. Figure 1 shows a flow diagram of the process that has been undertaken by Forewind, which details the relevant environmental, engineering, economic and consenting considerations that Forewind has taken into account in the selection of the array boundaries for Dogger Bank Teesside C & D.

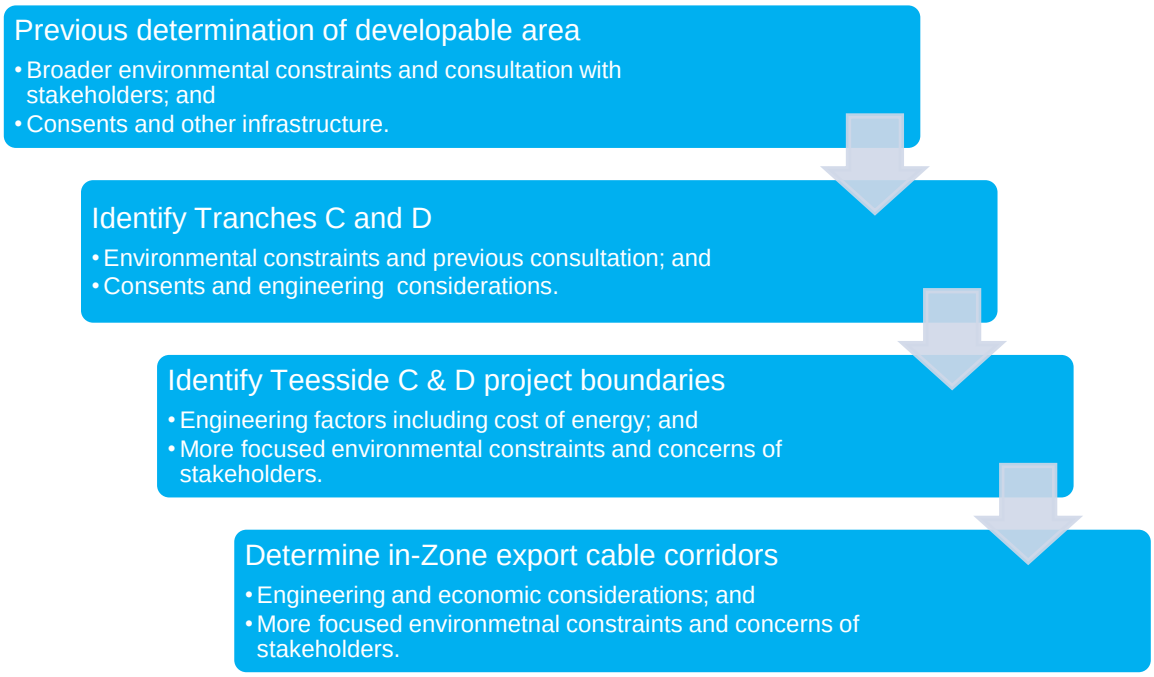


Figure 1 Selection process undertaken as described in this report

1.12 A phased approach to the development of tranches and array boundaries has been necessary to ensure a robust process. Selection has been achieved by considering the extent and complexity of the relevant environmental, engineering and consenting constraints.

1.13 The potential boundaries for the seventh and eighth wind farm arrays, as well as the previously identified array boundaries for the first four projects in the Dogger Bank Zone, Dogger Bank Creyke Beck A & Dogger Bank Creyke Beck B (together Dogger Bank Creyke Beck A & B) and Dogger Bank Teesside A & Dogger Bank Teesside B (together Dogger Bank Teesside A & B) were also considered in the context of economic viability of the whole Dogger Bank Zone and for individual wind farm arrays.

1.14 Each array boundary needs to contain all wind turbines, collector and converter stations, inter-array cables, meteorological masts (met masts) and offshore operation hubs for each project but must also allow the necessary level of flexibility in array design, as the final array design will only be confirmed after consent is granted as part of the final design process. This final design can only be confirmed once consent has been achieved and financial close reached based on the selection of appropriate and available technology at that point in time.

2 Background

2.1 Zone Appraisal and Planning

2.1 The Dogger Bank Zone is large enough to accommodate multiple projects and offers sufficient flexibility to allow the selection of the most appropriate areas within the zone to site these wind farms. Comprehensive Zone-wide data has been collected through surveys and desk-based research and sufficient information therefore exists to provide the understanding of those constraints which may influence boundary location decisions.

2.2 As described in Section 1, a phased approach has been taken to the development of the Dogger Bank Zone, which has allowed Forewind to identify potential constraints to development and therefore inform the identification of project boundaries. This commenced with individual tranches being identified for survey purposes. The original intention was to identify four tranches within the Dogger Bank Zone (A, B, C and D) with the capability of siting up to three wind farm arrays in each, which was part of the Forewind ZAP process.

2.3 Forewind identified Tranche A in 2010 (Forewind, 2010) and Tranche B in 2011 (Forewind, 2012a). These were the first and second areas respectively within the Dogger Bank Zone to be selected for offshore wind farm array development.

- Tranche A is approximately 2000km^2 in area, located in the south-west of the Dogger Bank Zone, with the majority of water depths being less than 30m below Lowest Astronomical Tide (LAT);
- Tranche B has a total area of 1500km^2 and is located in the south-east of the Dogger Bank Zone, with the majority of water depths being less than 35m LAT.

2.4 Selection of Tranche A and Tranche B was informed by information which was collated during ZAP and presented in the Zone Characterisation Document (ZoC) (Forewind, 2011a). The ZoC (now in its second edition) provides a baseline understanding of the environment across the Dogger Bank Zone.

2.5 The ZoC is supplemented by reports which outline further steps in spatial planning across the Dogger Bank Zone. It had previously been anticipated that another interim version of the ZoC would be produced to feed into this report. However, an evaluation was carried out prior to the production of this report and it was concluded that sufficient information was already available to inform the selection of Tranches C and D.

2.6 As part of the ZAP process, a ‘heat map’ was produced to provide a view of all known consenting considerations, see Figure 2. This combined information from

existing desk-based assessment work, inputs from a series of stakeholder workshops held in 2010 and early Zone wide data collected by Forewind. Simultaneously, the Forewind engineering team produced a heat map evaluating the variation in cost of energy across the Zone, which took into account the cost of foundations and export cables, strategic and health and safety implications, as well as predicted variation in wind resource. The engineering heat map is presented in Figure 3. Both heat maps were based upon the best available information at the time they were developed.

2.2 Consultation

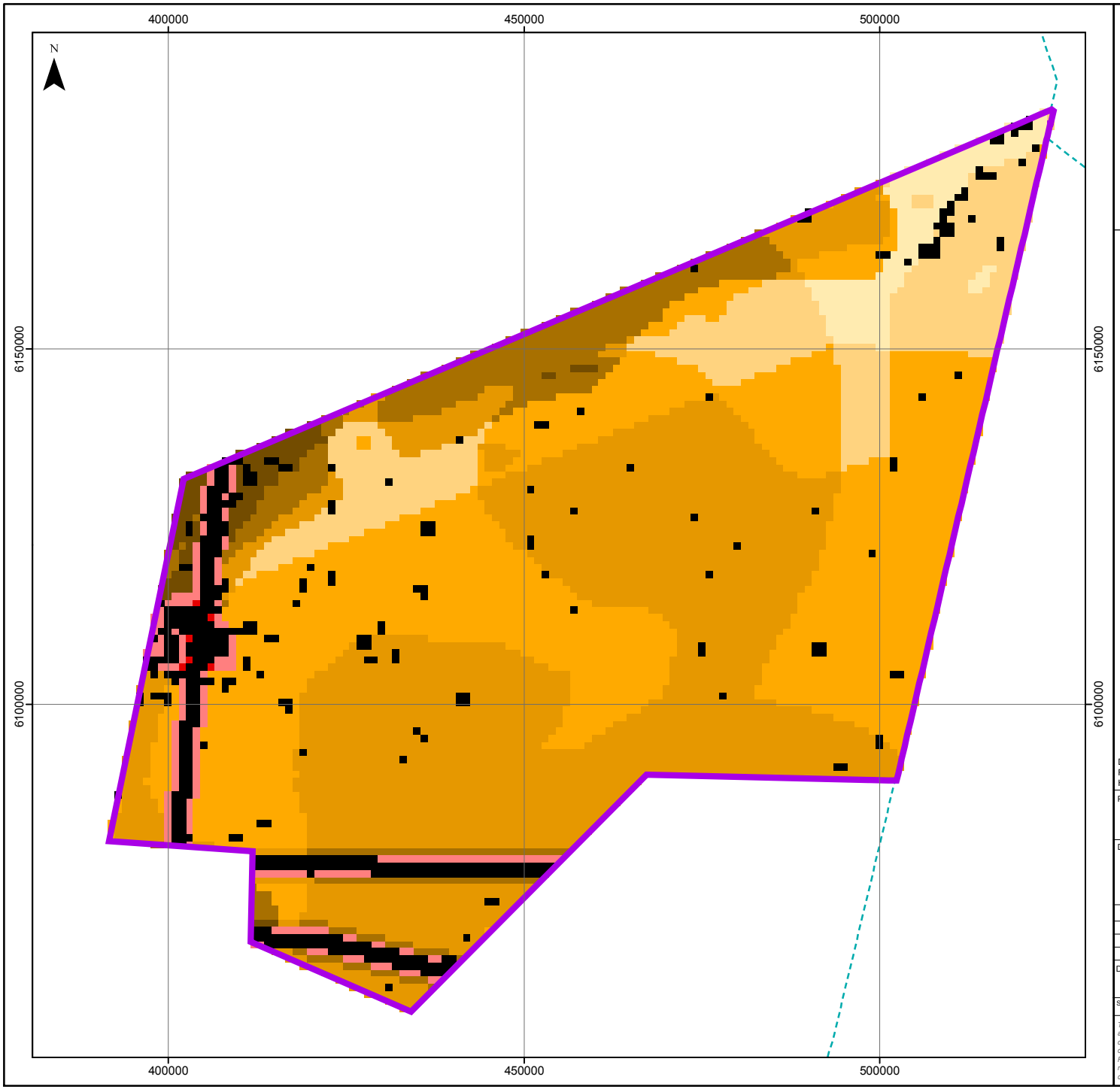
2.7 A fundamental part of Forewind's continuing development and ZAP process is consultation with stakeholders. This started with consultation on the ZAP process and the Zone as a whole in 2010 and has continued throughout Forewind's development activities to date.

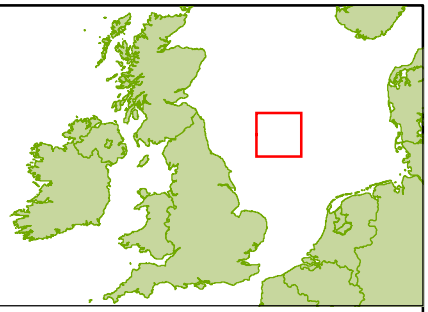
2.8 ZAP consultation included three stakeholder workshops, which were held in April 2010. Over 88 stakeholder organisations attended these workshops, including statutory bodies, UK and international fishing organisations, environmental non-governmental organisations and developers of other offshore infrastructure projects. The workshops were a success in that they ensured that stakeholders were engaged in the development of the Dogger Bank Zone from an extremely early stage, and feedback received helped shape the content of the ZoC and informed the approach to consultation.

2.9 Forewind has continued to consult with stakeholders throughout each step of the process, including on landfall and array location selection.

2.10 The array boundaries described in this report have been developed through thorough analysis and have been refined by a consideration of engineering and environmental constraints. Many of the key decisions in selecting the boundaries for Tranches C and D, and for the Dogger Bank Teesside C & D projects have been influenced by previous stakeholder feedback on both the Dogger Bank Zone and individual projects. For example, based on data collected through survey and in consultation with stakeholders, it was decided to exclude development from the western edge of the Dogger Bank Zone due to the high densities of sand eel and birds observed in this area.

2.11 Consultation will continue as the undertaking of the EIA for Dogger Bank Teesside C & D progresses and stakeholders will have the opportunity to provide input into the development of these projects.





LEGEND

- Dogger Bank Round 3 Zone
- Tranche Boundary
- International Boundary

Consentability Heat Map

- Hard Contraints
- Higher
- Lower

0 10 20

Kilometres

Data Source:
Round 3 © TCE, 2010
Heat map created by EMU Ltd 2011

PROJECT TITLE

DOGGER BANK R3 DEVELOPMENT

DRAWING TITLE

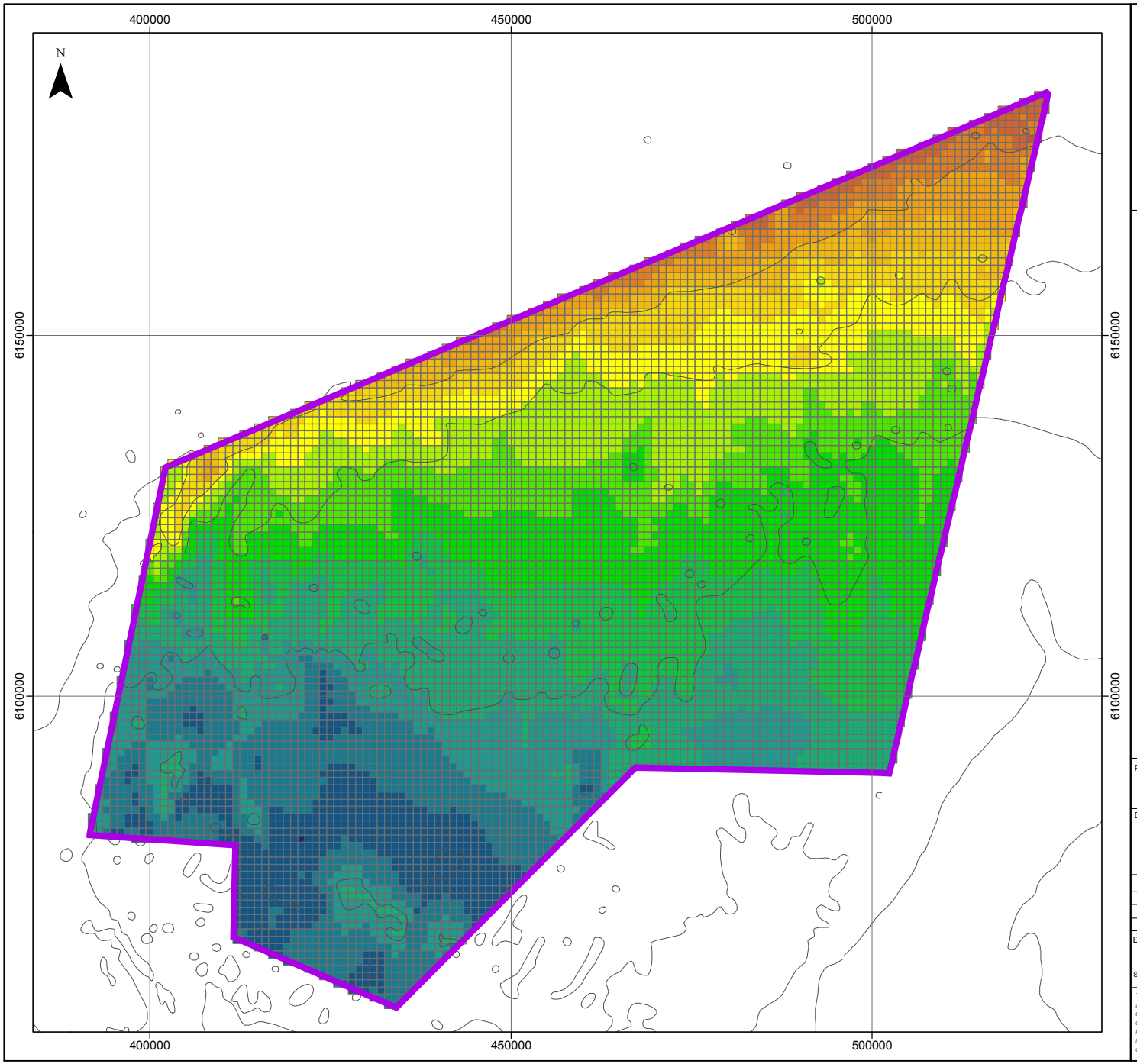
Figure 2
Dogger Bank
Consentability Heat Map

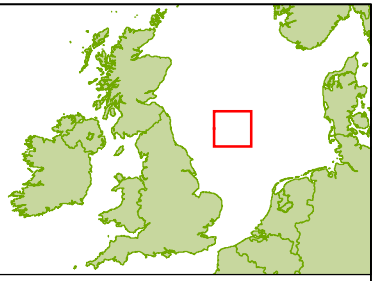
VER	DATE	REMARKS	Drawn	Checked
1	04/04/2013	First issue	AJ	MS

DRAWING NUMBER: **M-DES-0192-01**

SCALE	PLOT SIZE	DATUM	PROJECTION
1:800,000	A4	WGS84	UTM31N

FOREWIND





LEGEND

Dogger Bank Round 3 Zone

Relative Cost of Energy

Lowest

Highest

0 10 20

Kilometres

Source:
Round 3 zone boundary © The Crown Estate, 2010
Heat map created by EMU Ltd 2010

PROJECT TITLE

DOGGER BANK R3 DEVELOPMENT

DRAWING TITLE

Figure 3
Dogger Bank Zone
Relative Cost of Energy

VER	DATE	REMARKS	Drawn	Checked
1	16/05/2013	First issue	AJ	MS

DRAWING NUMBER:

M-DES-0205-01

SCALE	PLOT SIZE	DATUM	PROJECTION
1:800,000	A4	WGS84	UTM31N

FOREWIND

2.3 Previous identification of the developable area

2.12 As part of the work carried out by Forewind in identifying the boundaries for the first four wind farm arrays, a developable area was established that excluded certain areas of the Dogger Bank Zone from development and defined an area within which all projects should be located (it should be noted that there may be some small sections outside of the developable area where export cables may be installed). This boundary selection exercise was strongly driven by the ZAP process.

2.13 Detailed rationale of the selection of this developable area can be found in the Offshore Project Boundary Selection Report (Forewind, 2012b); however key summary points are provided below. Figure 4 shows the developable area as identified by Forewind.

2.3.1 Removal of the northern edge

2.14 The northern edge of the Dogger Bank Zone was removed from potential development, due to the slope reef benthic habitat identified through the original Zonal characterisation work. This habitat was considered more sensitive to development than the habitats in other areas of the Dogger Bank Zone and this was a key factor in the removal of future development from this area. The second reason was a commercial consideration due to water depths. Developing offshore wind farms in deeper water increases the capital expenditure and limits optionality within the supply chain. Deeper water also provides greater engineering challenges, such as limiting foundation options, and there are few examples of offshore wind installations in water depths exceeding 50m. This decreases the commercial viability and attractiveness of the project and as such shallower water was preferred for the identification of wind farm array boundaries. Forewind aims to develop all of its projects within water depths of 50m or less and therefore the decision was made to exclude any area of the Dogger Bank Zone where water depth is greater than 50m.

2.3.2 Removal of the western edge

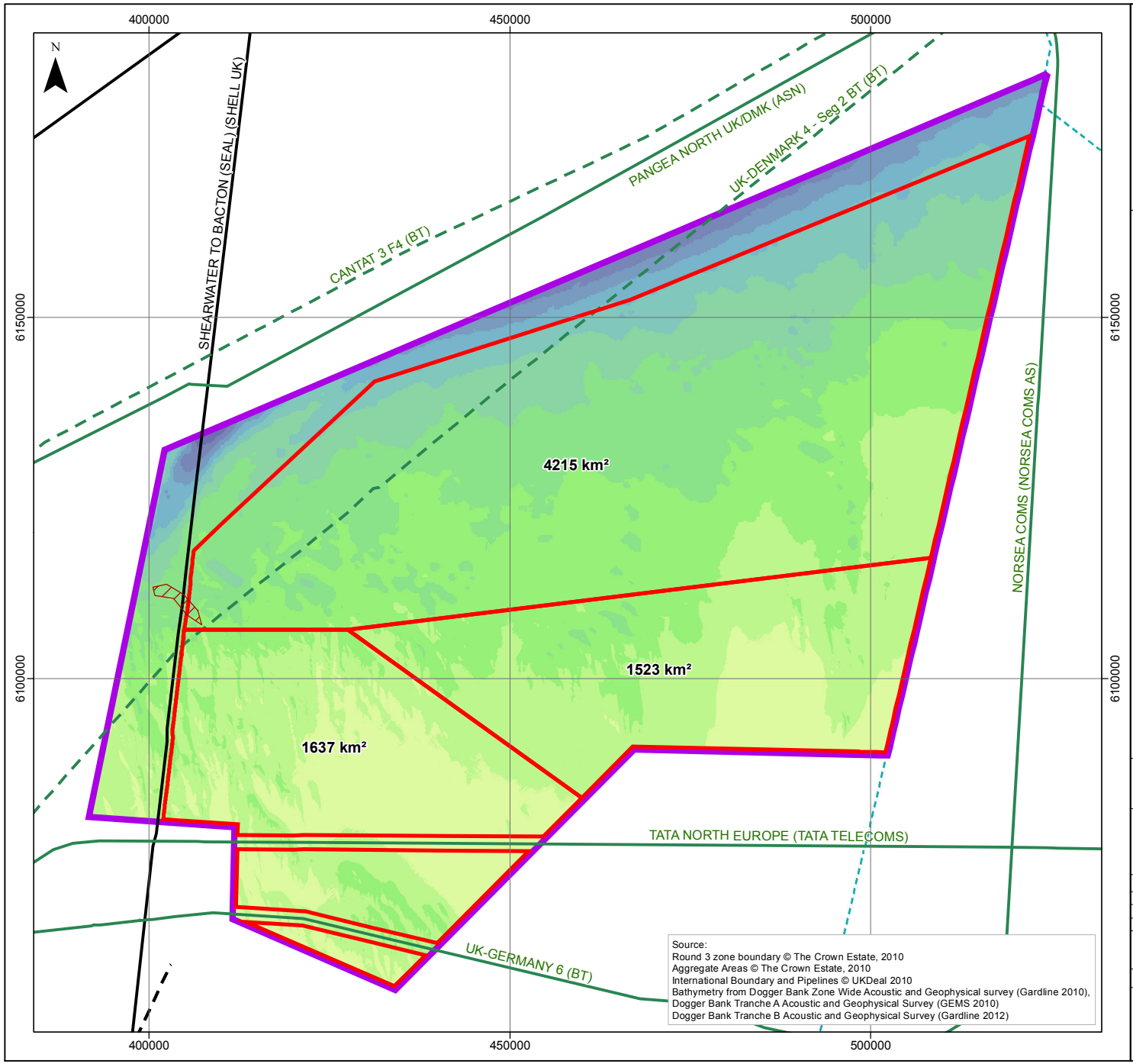
2.15 A further key factor in shaping the developable area was the exclusion of development from the western edge of the Dogger Bank Zone. The main reason for this was due to the high densities of sand eel identified through survey and the associated environmental impacts that could arise from placing projects in, or in close proximity, to these areas.

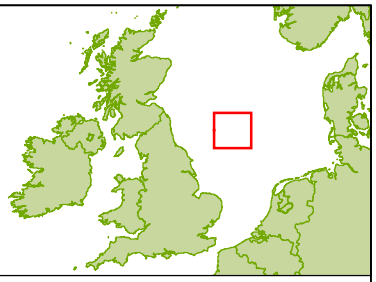
2.16 High densities of sand eel are known to attract high numbers of birds, since they are an important prey resource. Wind farms have the potential to have an impact on birds through collision, causing birds to be disturbed or displaced from their habitat, or causing migratory birds to deviate from normal flight paths. To limit the potential for these impacts, Forewind aims to site wind farm arrays away from areas of higher bird populations.

2.17 In addition, there is also a sand eel fishery associated with this area and therefore siting wind turbines here may potentially lead to an increase in vessel collision and allision risk, especially during the construction phase.

2.18 Another contributing factor was the identification of an area of complex geology to the west of the Shearwater Elgin Area Line (SEAL) pipeline which would make foundation design more problematic, thus increasing the capital expenditure and reducing the financial viability of the project.

2.19 Because of all these factors, the western edge, up to the SEAL pipeline, was removed from the developable area (although export cables may pass through this area).





LEGEND

- Dogger Bank Round 3 Zone
- Dogger Bank Developable area
- International Boundary

Aggregate Areas

- Aggregate dredging area

Cables

- Out of Service Cables
- Active Cables

Pipelines

- Not In Use Pipelines
- Active Pipelines

Bathymetry

- Less than 20m
- 20m-25m
- 25m-30m
- 30m-35m
- 35m-40m
- 40m-45m
- 45m-50m
- 50m-55m
- 55m-60m
- 60m-65m
- Greater than 65m

(relative to LAT)

0 10 20
Kilometres

PROJECT TITLE

DOGGER BANK R3 DEVELOPMENT

DRAWING TITLE

Figure 4
Dogger Bank Zone Developable Area

VER	DATE	REMARKS	Drawn	Checked
1	16/05/2013	First issue	AJ	MS

DRAWING NUMBER:

M-DES-0206-01

SCALE	1:800,000	PLOT SIZE	A4	DATUM	WGS84	PROJECTION	UTM31N

FOREWIND

2.4 Zonal development to date

2.20 The ZAP process and the subsequent identification of the developable area have led to the development of the following projects in Tranches A and B.

2.4.2 Dogger Bank Creyke Beck A & B

2.21 Forewind has secured agreement with National Grid Electricity Transmission plc (National Grid) for 2GW of connection capacity to the National Electricity Transmission System (NETS) at the Creyke Beck substation in the East Riding of Yorkshire, in the form of two 1GW connections. This connection capacity will be sufficient for two projects, each with a generating capacity of 1.2GW. The rationale for installing a greater generating capacity than onshore grid connection capacity is based on the principle of 'overplanting' – optimising the installed capacity to maximise efficiency, accounting for electrical losses, availability and the natural variability of a wind farm's output. Further detail on this can be found in the Offshore Project Boundary Selection Report (Forewind, 2012b).

2.22 Following an initial scoping exercise, Forewind identified a 2km wide offshore export cable corridor from the southern section of Tranche A to a chosen landfall on the Holderness Coast. This 187km long cable corridor will connect the offshore components of the wind farm to the shore. A 32km long, 1km wide onshore cable corridor has also been identified to connect the landfall area to the National Grid substation. A study area for the onshore direct current (DC) to alternating current (AC) converter stations has also been identified.

2.23 The rationale for selection of the components is presented in the Dogger Bank Creyke Beck A & B Preliminary Environmental Information 1 (PEI1) document (Forewind, 2011b) and has been further updated in the draft Environmental Statement (ES) which Forewind consulted on in 2013.

2.24 The Dogger Bank Creyke Beck A & B boundaries were finalised in November 2012 and the rationale for selection is presented in the Offshore Project Boundary Selection Report (Forewind, 2012b).

2.4.3 Dogger Bank Teesside projects

2.25 Forewind has secured agreement with National Grid for a grid connection capacity of 4GW at Teesside. This is enough for four projects, each with a generating capacity of 1.2GW, to be connected to the NETS. Two of these projects, Dogger Bank Teesside A & B, will be located in Tranches A and B, as described in the Offshore Project Boundary Selection Report (Forewind, 2012b) whilst the Dogger Bank Teesside C & D projects will be located in the north of the Dogger Bank Zone, as described in this report.

2.26 Forewind sought to identify areas of the Teesside coastline between the Tees Estuary and Saltburn-by-the-Sea which could accommodate a landfall for up to four export cable systems (up to eight individual cables). The landfall has been identified between Redcar and Marske-by-the-Sea.

2.27 Forewind then undertook an exercise to identify potential converter station sites within the industrial area to the south of the Tees Estuary at Teesside. A long list of sites that fitted Forewind's initial design criteria was subsequently refined to a shortlist of six potential sites. Having undertaken further site selection work and stakeholder engagement, Forewind has since identified its preferred converter stations sites from this list, both based in the Wilton Complex, near Redcar. Each converter station site could accommodate up to two converter stations. Work is still being undertaken to define the onshore cable corridors.

2.28 The rationale for selection of the components described above is set out in the Dogger Bank Teesside PEI1 documents (Forewind, 2012c).

2.4.4 Dogger Bank Teesside export cable corridor selection (Dogger Bank Zone boundary to landfall)

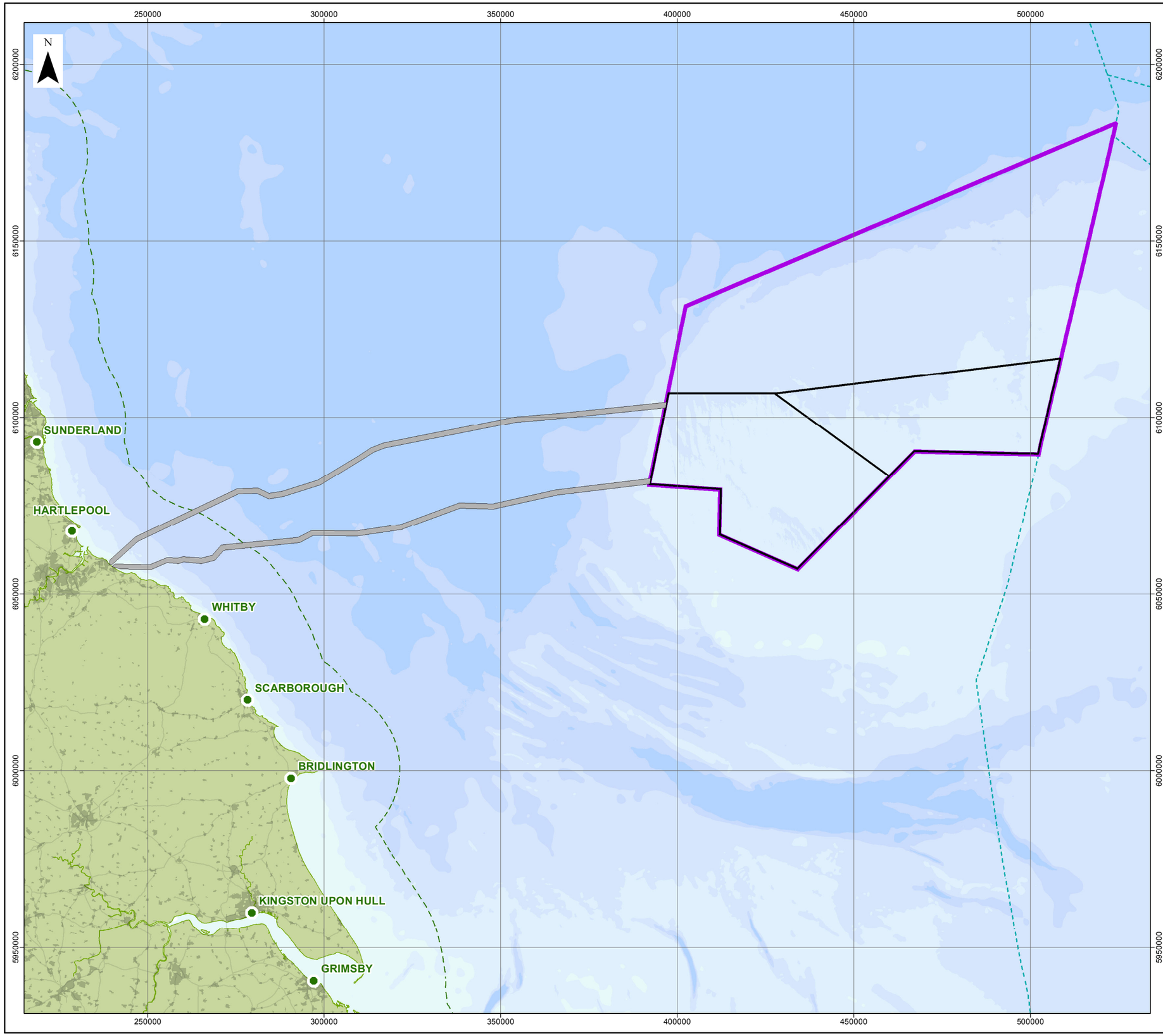
2.29 Two export cable corridors have been identified for the Dogger Bank Teesside projects; one for Dogger Bank Teesside A & B, and one for Dogger Bank Teesside C & D. Each corridor is approximately 1.5km wide, comprising two 500m wide strips for which detailed survey data has been collected to inform the EIA. Forewind intends to apply for consent for the full 1.5km width for each corridor in order to maintain flexibility for cable routing and have the ability to avoid obstacles through the micro-routing of cables. Post-consent, detailed surveys will be carried out to inform the final route before cable installation occurs.

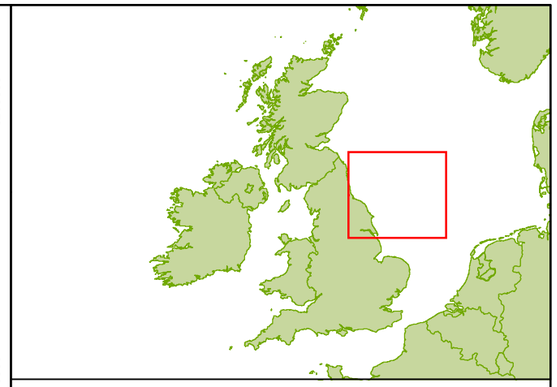
2.30 These export cable corridors were identified prior to the selection of the boundaries for the Dogger Bank Teesside C & D projects, due to the grid connections for all four Dogger Bank Teesside projects being in a similar location. This process was also driven by the decision to select a single landfall location for all four arrays, located between Redcar and Marske-by-the-Sea. Whilst the precise locations of Dogger Bank Teesside C & D had not been determined when the export cable corridor was developed, it was known that Dogger Bank Teesside C & D would be located to the north of Tranches A and B. This was sufficient to identify the exit points and the export cable corridors from the Dogger Bank Zone boundary to the landfall.

2.31 The initial selection process considered hard constraints, such as cables and pipelines, and less preferred areas where cable burial may be challenging and thus more expensive. Figure 5 shows the final export cable corridors for all Dogger Bank Teesside projects.

2.32 However, this selection process did not include the identification of the export cable corridor within the Dogger Bank Zone (in-Zone) as the final array boundaries for Dogger Bank Teesside C & D were not known when the export cable corridor was

identified. The in-Zone export cable corridor selection has now been undertaken for Dogger Bank Teesside C & D and is explained further in Section 6.





LEGEND

- Teesside export cable corridor
- Tranche boundary
- Dogger Bank Round 3 Zone
- International boundary
- 12nm Territorial boundary

0 20 40

Kilometres

Data Source:
Round 3 zone boundary © The Crown Estate, 2010
International Boundary © UKDeal, 2010
Contains UKHO Law of the Sea data © Crown copyright and database right
Ordnance Survey data © Crown copyright and database right, 2010
Background bathymetry image derived in part from TCarta data 2009

PROJECT TITLE

DOGGER BANK R3 DEVELOPMENT

DRAWING TITLE

Figure 5
Dogger Bank Teesside
Proposed Export Cable Route

VER	DATE	REMARKS	Drawn	Checked
1	09/11/2012	First Issue	AJ	GL

DRAWING NUMBER:

M-DES-0110-01

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

FOREWIND

3 Identification of Tranches C and D

3.1 Introduction

3.1 The following section explains the selection process undertaken by Forewind in identifying Tranches C and D. This process relied on the previous identification of Tranches A and B, as well as the known developable areas within the Dogger Bank Zone. In addition, the identified boundaries for Dogger Bank Creyke Beck A & B and Dogger Bank Teesside A & B have refined this process further, as described in Section 2.

3.2 This selection work identified the remaining developable area within the Dogger Bank Zone, where it was intended that Tranches C and D would be located. Tranches C and D lie to the north of Tranches A and B, constrained by the previously defined developable area affecting the western and northern edges of the Dogger Bank Zone (see Section 2.3).

3.2 Identification of Tranche C

3.3 The key considerations for the identification of Tranche C were principally engineering and commercial factors, following an extensive consideration of the wider environmental factors identified through the ZAP process, which identified the overall developable area.

3.4 A key factor in the identification of Tranche C was the requirement to allow sufficient space to develop two wind farms, based on the previous design principles applied in the identification of the boundaries for Dogger Bank Creyke Beck A & B and Dogger Bank Teesside A & B (Forewind, 2012b).

3.5 As described in Section 2.4.2, Forewind has signed a grid connection agreement with National Grid to connect to a substation based in Teesside and therefore the exit points previously selected for the Dogger Bank Teesside C & D export cable corridor (Forewind, 2012d) are located on the western edge of the Dogger Bank Zone. To minimise the length of the export cable required, reduce cost and minimise risk, it was decided that Tranche C should be located on the western side of the developable area.

3.6 Combining these two considerations allowed for Tranche C to be identified, as shown in Figure 6.

3.7 Key parameters of Tranche C are shown in Table 1 and the co-ordinates that make up the boundary are shown in Table 2.

Parameter	Value
Area of Tranche C	2519km^2
Predominant water depth range	25 – 55m below LAT
Distance from shore (closest point)	150km

Table 1 Tranche C statistics

	Easting	Northing	Longitude	Latitude
	(metres)		Decimal Degrees	
1	406194	6117689	1.52628469	55.19685977
2	407054	6118583	1.53949832	55.20505747
3	420368	6131016	1.74512368	55.31907230
4	431239	6141168	1.91391021	55.41191957
5	466662	6152472	2.47201434	55.51718599
6	481058	6158367	2.69959961	55.57092237
7	481058	6113354	2.70264791	55.16644735
8	427575	6106758	1.86489238	55.10224431
9	404879	6106758	1.50928766	55.09841154

Table 2 Tranche C boundary co-ordinates (co-ordinates presented in WGS84 UTM 31N format)

3.3 Identification of Tranche D

3.8 Upon assessing the area remaining after the identification of Tranches A, B and C, Forewind was able to confirm that there would be space for two further wind farms based on the design principles applied in the identification of the boundaries of Dogger Bank Creyke Beck A & B and Dogger Bank Teesside A & B (Forewind, 2012b). Therefore, to maintain the maximum flexibility for future wind farm development within the tranche, it was decided that Tranche D should constitute the entire area remaining within the developable area, as shown in Figure 6.

3.9 Forewind is yet to sign a grid connection agreement for projects to be located in Tranche D. Further work is also required to gather information on the economic, engineering and environmental viability of projects within this tranche.

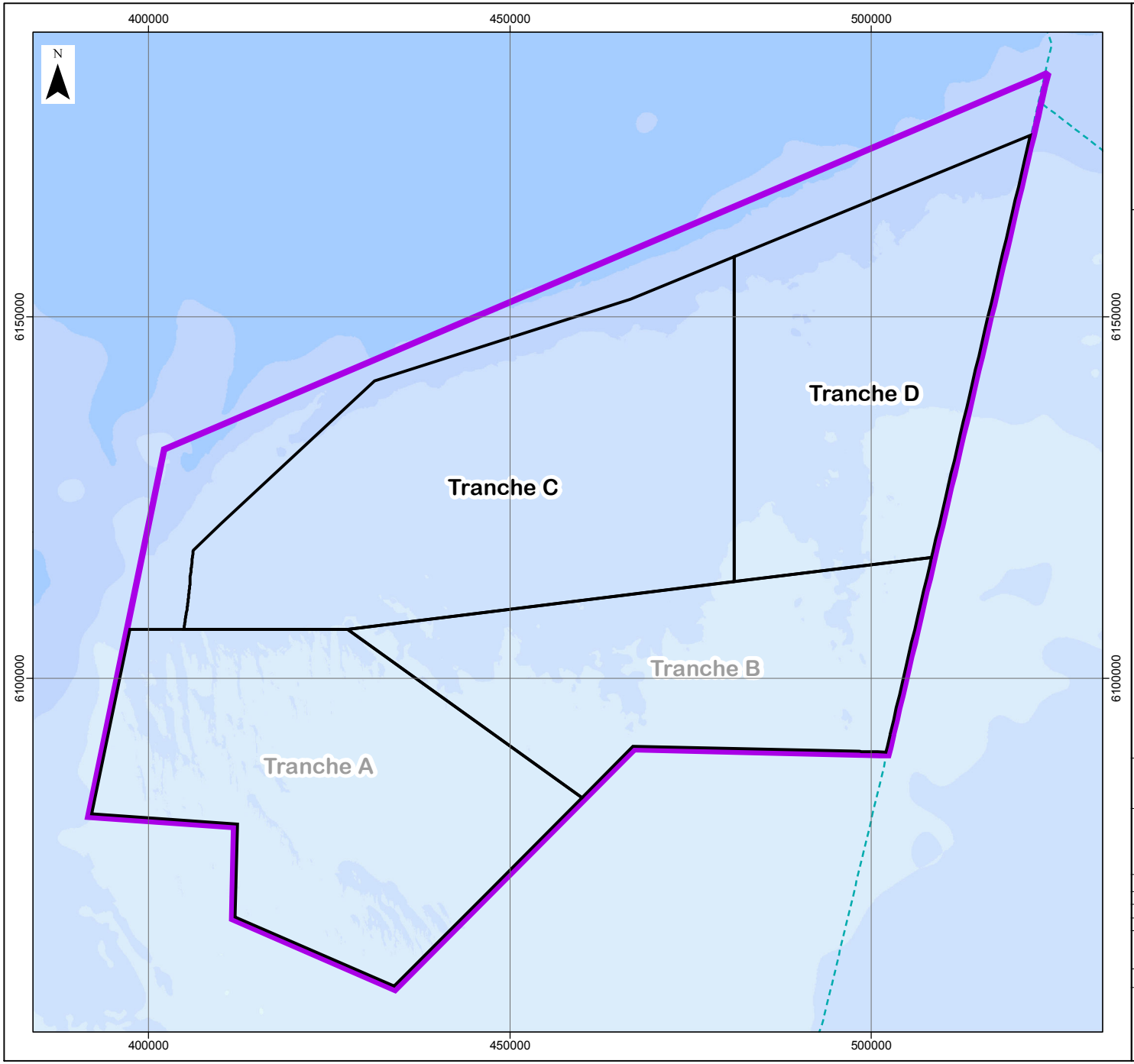
3.10 Key parameters of Tranche D are shown in Table 3 and co-ordinates that make up the boundary are shown in Table 4.

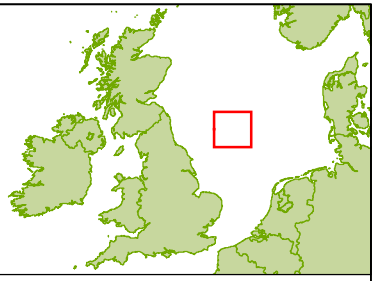
Parameter	Value
Area of Tranche D	1696km^2
Predominant water depth range	25 – 55m below LAT
Distance from shore (closest point)	215km

Table 3 Tranche D statistics

	Easting	Northing	Longitude	Longitude
	(metres)		Decimal Degrees	
1	481058	6158367	2.69959961	55.57092237
2	522026	6175142	3.35065416	55.72152078
3	508351	6116720	3.13118496	55.19698942
4	481058	6113354	2.70264791	55.16644735

Table 4 Tranche D boundary co-ordinates (co-ordinates presented in WGS84 UTM 31N format)





LEGEND

- Tranche boundary
- Dogger Bank Round 3 Zone
- International boundary

0 10 20
Kilometres

Source:
Round 3 © TCE, 2010
International Boundary © UKDeal, 2010
Background bathymetry image derived in part from TCarta data © 2009

PROJECT TITLE

DOGGER BANK R3 DEVELOPMENT

DRAWING TITLE

Figure 6
Dogger Bank
Tranche C and D Boundaries

VER	DATE	REMARKS	Drawn	Checked
1	20/03/2013	First Issue	AJ	MS

DRAWING NUMBER:

M-DES-0180-01

SCALE	PLOT SIZE	DATUM	PROJECTION
1:800,000	A4	WGS84	UTM31N

FOREWIND

4 Key considerations for Teesside C & D array boundary identification

4.1 Introduction

4.1 This section describes the key considerations that have influenced the offshore boundary identification of the Dogger Bank Teesside C & D projects.

4.2 Identification of the boundaries for individual wind farms within the Dogger Bank Zone is complicated by the lack of certainty on the precise technology and engineering solutions likely to be available at the time of construction. In addition the Dogger Bank Zone is much further offshore and in deeper waters than previous offshore wind licensing rounds (known as Round 1 and Round 2). Together this results in higher development, construction and operational costs which present new challenges to meeting cost reduction targets and keeping the cost of energy low.

4.3 Low cost of energy is essential in order to ensure continued expansion and development in supply chains, encourage on going investment in the industry and to reduce costs to the consumer. The Dogger Bank Zone and the size and capacity of wind farm arrays are much increased in scale compared to Round 2 projects.

4.4 The economics and potential environmental effects of the Dogger Bank Zone development need to be considered for each project individually and between all projects when defining the boundaries of the individual projects. Therefore, the economic impacts of the first wind farm to be developed must be considered cumulatively[1] with the impacts of wind farms developed later and vice versa. The environmental impacts will be assessed differently due to the timeframes involved with wind farm boundary identification.

4.5 All projects within the Dogger Bank Zone will consider the cumulative environmental impacts of the previously identified projects. However, for future projects, only those with array boundaries identified at the point of assessment will be considered as part of the cumulative assessment. Therefore, Dogger Bank Creyke Beck A & B has not assessed potential cumulative effects with Dogger Bank Teesside C & D, as there was not enough certainty surrounding the location of the Dogger Bank Teesside C & D projects at the time of the assessment.

[1] Throughout this document, the term cumulative is used to describe potential effects of projects within the Dogger Bank Zone, and between the zone and other plans or projects (such as other offshore wind farms, aggregate extraction areas and marine conservation zones (MCZ) for example). The term in-combination is not used, as this is a term that specifically relates to a Habitats Regulations Assessment (HRA) under The Conservation of Habitats and Species Regulations 2010.

4.6 This approach has allowed later projects to fully consider the work undertaken to inform the ES for previous projects through the incorporation of survey and assessment work. The lessons learnt from Dogger Bank Creyke Beck A & B and Dogger Bank Teesside A & B have been used to strengthen the EIA and CIA processes for Dogger Bank Teesside C & D, which has ensured that the avoidance of significant impacts has been at the forefront of Forewind's site development activities.

4.7 The consideration of cumulative effects in the development of array boundaries is described further in Section 4.4.

4.2 Engineering and economic considerations

4.8 As previously described in the Offshore Project Boundary Selection Report (Forewind, 2012b), Forewind identified the potential for a maximum generating capacity of 9.6GW (equivalent to eight 1.2GW projects) for the Dogger Bank Zone. This conclusion was reached through modelling and analysis, taking into account the unique, far from shore location of the Dogger Bank Zone, and varying different parameters from the potential number projects within the zone, to spacing between wind turbines to minimise wake effects. A more detailed breakdown of the approach taken can be found in the Offshore Project Boundary Selection Report (Forewind, 2012b). The results of the analysis are presented in Table 5.

Parameter	Optimum Value
Total Dogger Bank Zone capacity	9.6GW
Number of wind farm arrays	8 (1.2GW capacity each)
Spacing between wind turbines	Approximately 11 x rotor diameter
Area of each array	558km^2

Table 5 Optimum parameters of the Zone

4.2.1 Offshore project description

4.9 The boundaries identified for individual projects will need to accommodate a number of different offshore components that comprise the offshore wind farm. Each project will comprise the elements described below:

- Up to 200 wind turbines and their supporting tower structures. The wind turbines convert the kinetic energy in the wind into electrical energy. Each wind turbine will be mounted on a foundation to secure the structure vertically whilst withstanding loads from the wind and the marine environment;

- Up to four offshore collector stations and their foundations. The offshore collector stations receive power from the wind turbines and step up voltage for export to a high voltage direct current (HVDC) converter station;
- A single offshore converter station and foundation. The offshore convertor station converts alternating current (AC) to direct current (DC);
- Subsea inter-array cables will be installed. The inter-array cables transmit power between the wind turbines and the offshore collector platforms;
- Inter-platform cables will be installed. The inter-platform cabling transmits power between offshore collector stations and between offshore collector stations and the offshore converter station;
- Offshore export cable systems, carrying power from the offshore HVDC converter station to the landfall and possibly to other wind farm arrays or offshore connection nodes;
- Up to five met masts may be installed within each project. The data collected by these masts will be used to monitor the power performances of each wind farm. It should be noted that these met masts are in addition to the two met masts which are being installed in 2013 within the Dogger Bank Zone. These met masts will provide essential meteorological and oceanographic data, which will be utilised to optimise the design of the wind farms prior to installation;
- Up to ten pre-installed permanent vessel mooring buoys will be installed at intervals around the array area. The mooring buoys will allow vessels to moor within the array for a variety of reasons including at night, during lulls in work, to save fuel while station keeping, or in the event of machinery failures;
- If required, scour protection will be installed around the offshore structures. Scour protection can be achieved by a number of different methods, either individually or in combination, including but not limited to: rock placement, frond mats or concrete mattresses;
- Cable protection measures where necessary. Cable protection may be achieved by a number of different methods (noting that more than one may be used in one area) including but not limited to: rock or gravel burial, bagged solutions, protective aprons, frond mats or concrete mattresses; and
- Up to two offshore accommodation or helicopter platforms and their associated foundations may be installed within each project. These will help facilitate operation and maintenance activities for each wind farm.

4.10 An indication of the numbers of the above components that are expected to be sited within individual projects is given in Table 6.

Parameter	Quantity
Wind turbines and foundations	Up to 200
Collector substations	1 to 4
Converter substations	1
Meteorological masts	Up to 5
Mooring buoys	Up to 10
Accommodation/helicopter platforms	Up to 2

Table 6 Key elements of each project

4.11 The final array design, including the layout of the wind turbines and other components, will depend on a number of factors including: stakeholder feedback, seabed obstructions, ground conditions, further environmental information, water depth, wind dynamics, economic factors, and the type of wind turbine chosen. This will be finalised following consent award and can only be confirmed once financial close has been reached based on the selection of appropriate and available technology at that point in time.

4.2.2 Health and Safety Issues

4.12 Health and safety is of primary importance to Forewind and these considerations have been integral in the design of wind farm boundaries. Some of the key considerations are:

- Projects need to include collector and converter stations, as well as helicopter and accommodation platforms. The development of the boundary should allow these structures, so far as practicable, to be arranged in an easily understandable pattern with the wind turbines. This will help to minimise navigation risk;
- Array boundaries need to be designed to prevent wind turbines being positioned in a way that results in any asset being isolated outside of an array, as this could pose a hazard to navigation;
- Array boundaries must make allowance for safe operations and maintenance of existing assets (such as cables and pipelines) which are not part of the project;
- During the construction phases of Dogger Bank Teesside C & D, Forewind may apply for an additional buffer of up to 1km around each site boundary, and 750m around cable route boundaries, for temporary work areas. These temporary work areas would be used for the placement of anchors or other intrusive construction activities. No wind farm structures (e.g. wind turbine, offshore platform, or cables)

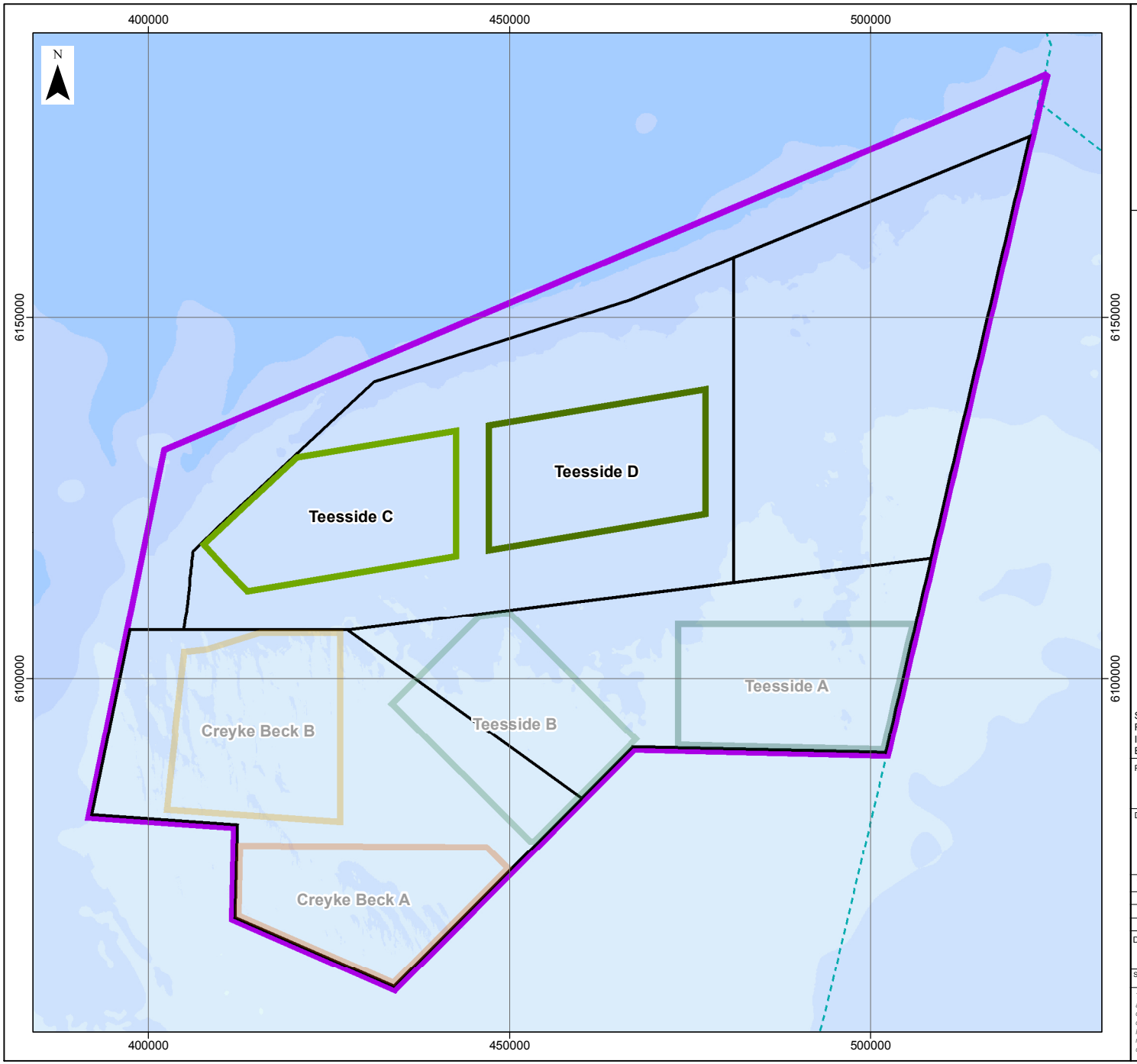
will be placed within a temporary work area. Should this buffer be required, Forewind shall provide further details and clarification within the ES; and

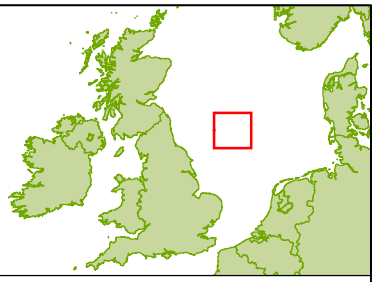
- Forewind and the lead operators of the projects also have legal responsibilities pertaining to health and safety. These include, but are not limited to, application of the Construction Design and Management (CDM) Regulations 2007 (CDM Regulations) throughout all stages of the project, application of UK Health and Safety Legislation to all phases of construction, operation and decommissioning with regard to Health and Safety at Work, and application of UK Merchant Shipping Act 1995 (Merchant Shipping Act) and subsidiary regulations.

4.2.3 Economic modelling

4.13 When identifying the array boundaries for Dogger Bank Teesside C & D, economic modelling was undertaken, which assessed a variety of possible array boundaries for Dogger Bank Teesside C & D, along with the previously identified boundaries for Dogger Bank Creyke Beck A & B and Dogger Bank Teesside A & B. The purpose of this modelling was to identify the effect that the different boundaries would have on project economics. The aim of this was to ensure that the proposed locations would give optimum array economics as well as optimum economics for the Dogger Bank Zone.

4.14 Having modelled a variety of different possibilities, the optimum array boundaries, shown in Figure 7, were then assessed for any further environmental or consenting considerations (given that environmental and survey considerations had already had a strong bearing on the identification of the developable area within the Dogger Bank Zone) to see if there were any significant reasons to amend the optimum identified boundaries.





LEGEND

- Tranche Boundary
- Dogger Bank Round 3 Zone
- International Boundary

Project Boundaries

- Creyke Beck A
- Creyke Beck B
- Teesside A
- Teesside B
- Teesside C
- Teesside D

0 10 20
Kilometres

Source:
Round 3 © TCE, 2010
International Boundary © UKDeal, 2010
Background bathymetry image derived in part from TCarta data © 2009

PROJECT TITLE

DOGGER BANK R3 DEVELOPMENT

DRAWING TITLE

Figure 7
Dogger Bank
Optimum Teesside C & D Project Boundaries

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1	22/03/2013	First Issue	AJ	MS

DRAWING NUMBER:

M-DES-0189-01

SCALE	PLOT SIZE	DATUM	PROJECTION
1:800,000	A4	WGS84	UTM31N

FOREWIND

4.3 Environmental and other consenting considerations

4.15 The following broad categories were investigated initially to assist with identification of both Tranches A and B as described in the ZoC (Forewind, 2011a), and then following more recent environmental information from continued survey work, used to further refine the developable area.

Environmental and other consenting considerations	
Geology and physical environment	Navigation and shipping
Benthic ecology	Commercial fisheries
Fish resource and ecology	Oil and gas
Birds	Military, aviation and radar
Marine mammals	Marine aggregates and disposal
Nature conservation	Pipeline and cables
Archaeology and cultural heritage	Other marine users

Table 7 Environmental and other consenting considerations

4.16 From the data collated in the ZoC, surveys undertaken to support the consent applications for Dogger Bank Creyke Beck A & B and Dogger Bank Teesside A & B (and in the absence of a full EIA for Dogger Bank Teesside C & D), the following parameters were identified as having the potential to influence the array boundary selection within Tranche C:

- Geological and physical environment;
- Commercial fisheries;
- Marine mammals;
- Birds;
- Benthic ecology (including the candidate Special Area of Conservation (cSAC) designated under European Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora (the Habitats Directive));
- Marine aggregates;
- Shipping and navigation;
- Pipelines and cables and other third party infrastructure; and
- Cumulative effects.

4.17 Factors not included in the list above but listed in Table 7, whilst considered within the EIA, were not deemed to affect boundary selection.

4.3.2 Geological and physical environment

4.18 Before an offshore wind farm can be built, water depth, sediment types and seabed ecology and archaeology need to be understood. Wind farms in deeper water generally result in higher foundation costs, whilst different sediment types pose varying degrees of challenge for cable and foundation installation, resulting in higher costs in more challenging areas.

4.19 At the time of boundary selection, site specific geophysical and geotechnical survey data had not been collected. However, the Zone-wide data previously collected, along with desk-based data, were judged to be sufficient to inform any decision on the influence of the geological and physical environment on the location of the wind farm boundaries.

4.20 As described previously, the identification of the developable area had already excluded areas with dense populations of sand eel and ornithological interest to the west of the Dogger Bank Zone, as well as avoiding sensitive habitats and deeper water (>50m LAT) to the north of the Zone. Other than these factors, assessment of the available data did not provide any key drivers to site the array boundaries in a particular area. This was primarily because the ZAP process had identified barriers to development and allowed the identification of developable areas.

4.21 Forewind has commissioned a further geophysical survey to understand the ground conditions in Tranche C in more detail. As the project boundaries had not been finalised at the time of the survey starting, and to keep costs lower, an area that encompassed the boundaries identified on known engineering and environmental parameters was used (Figure 7). This survey area also included the region in between the two preliminary boundaries to allow for some flexibility in the location of the wind farm array boundaries, if further environmental drivers indicated a change was necessary.

4.22 As described in the following sections, more detailed analysis has since been carried out and has shown there to be no significant environmental drivers identified that have indicated a need to adjust these optimum wind farm array boundaries. As such, this survey area has accommodated all the relevant areas for the final wind farm array boundaries. At the time of writing, this geophysical survey is on-going.

4.3.3 Commercial fisheries

4.23 Forewind strongly believes that commercial fisheries can co-exist alongside offshore wind farms. Since the award of the Dogger Bank Zone to Forewind, extensive consultation with the fishing community (including the National Federation of Fishermen's Organisations (NFFO) and the local Fish Producers' Organisation (FPO)) has been conducted to discuss how co-existence might be best achieved. It

is acknowledged that the construction of an offshore wind farm could prevent fishing continuing within the wind farm, should wind turbines be too close together for vessels engaged in fishing activity to manoeuvre between them. In addition, structures associated with an offshore wind farm may present an increased health and safety risk (i.e. risk of snagging on unprotected and unburied cables). On-going consultation has provided information on the types and levels of fishing occurring in the Dogger Bank Zone, and this information has been used to inform the identification of array boundaries. More specific work relating to the impacts of the proposed detailed parameters for each project will then form part of the EIAs for each individual wind farm.

4.24 Consultation with national and international fishing parties concerning commercial fishing in the Dogger Bank Zone is on-going and commercial fish and fish ecology surveys have been informed by consultation with The Marine Management Organisation (MMO), The Centre for Environment, Fisheries and Aquaculture Science (Cefas), the Joint Nature Conservation Committee (JNCC) and Natural England.

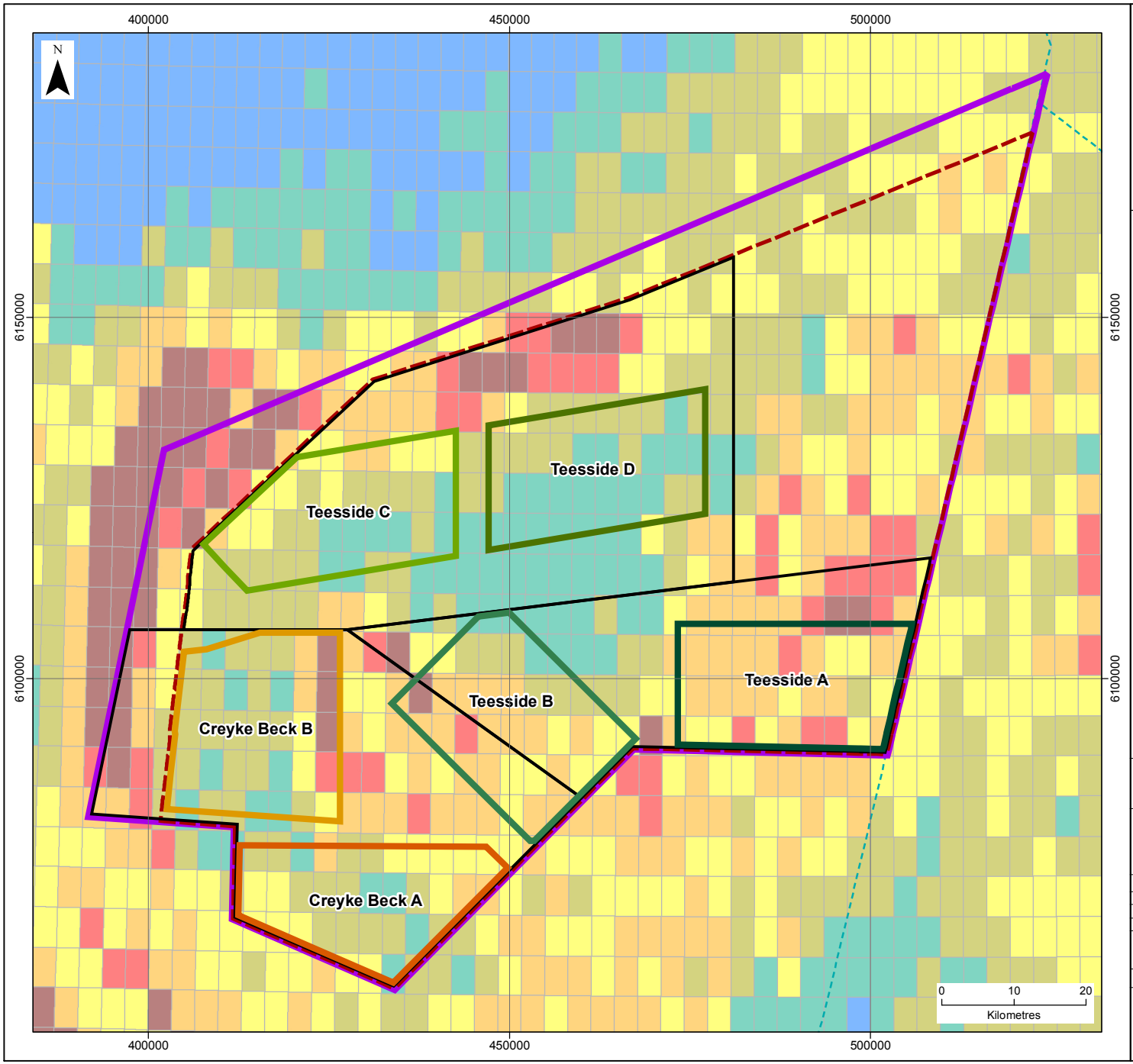
4.25 The nationalities of fishing vessels operating across Dogger Bank are principally Danish, Dutch, Belgian, British, Swedish, Norwegian, German and French. The sand eel fishery is predominantly fished by Danish, Swedish and Norwegian vessels (Figure 8). This has been important in influencing array boundary selection, having already been a key driver in shaping the developable area of the Dogger Bank Zone (as described in Section 2). However, Figure 8 also shows that fishing activity within the identified array boundaries is low, in comparison to adjacent areas.

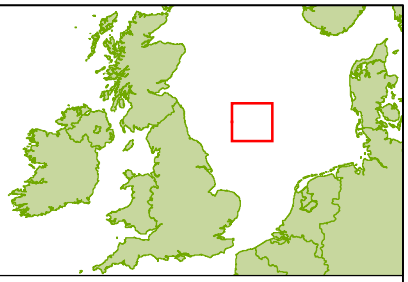
4.26 Shipping density surveys were undertaken across the Dogger Bank Zone between April 2010 and May 2012 and included AIS (Automatic Identification System) and satellite tracking. In addition, a desk-based review of existing data has also been undertaken. These shipping surveys established that 44% of traffic in the Dogger Bank Zone was due to commercial fishing.

4.27 Surveys have found that in addition to the sand eel fishery, fishing activity is dominated by beam trawling year round for plaice, lemon sole, turbot, skate and rays and Dover sole on a seasonal basis. Demersal seine netting and demersal trawling also occurs.

4.28 Based on the data obtained to date, Forewind believes that, apart from in the west of the Dogger Bank Zone where development has already been excluded, the density of fishing across the zone is relatively low.

4.29 Forewind has received proposals from the fishing industry regarding co-existence of fishing and renewables and these will be discussed further prior to submission. However, it is not anticipated that this will lead to changes in the boundaries identified in this report. Forewind is keen to ensure co-existence with the commercial fishing community and remains committed to maintaining active dialogue.





LEGEND

- Dogger Bank Round 3 Zone
- Tranche Boundary
- Dogger Bank Developable Area
- International Boundary

Project Boundaries

- Creyke Beck A
- Creyke Beck B
- Teesside A
- Teesside B
- Teesside C
- Teesside D

Danish Satellite (VMS) Density

August 2007 to 2011

- 0 to 2
- 2 to 5
- 5 to 10
- 10 to 20
- 20 to 40
- 40 to 80
- Over 80

Source:
Round 3 © TCE, 2010
International Boundary © UKDeal, 2010
Danish Satellite (VMS) Density data received from Brown & May Marine Ltd.
Ordnance Survey data © Crown copyright and database right, 2010

PROJECT TITLE

DOGGER BANK R3 DEVELOPMENT

DRAWING TITLE

Figure 8
Teesside C & D Site Selection
Commercial Fisheries Activity

VER	DATE	REMARKS	Drawn	Checked
1	22/03/2013	First Issue	PR	MS

DRAWING NUMBER: **M-DES-0135-01**

SCALE	PLOT SIZE	DATUM	PROJECTION
1:800,000	A4	WGS84	UTM31N

FOREWIND

4.30 While the United Kingdom Fishing Information Mapping Project (UKFIM) data have not been used for array boundary selection, Forewind hopes to make use of it during the undertaking of the EIA (subject to data use restrictions).

4.3.4 Marine mammals

4.31 Wind farm construction activities such as foundation installation (particularly monopile installation using percussive piling) can result in elevated noise levels through the water column. At its most severe, excess underwater noise may cause marine mammal mortality, or harm, through to the disturbance of the normal behaviour of the animal. This range of effects will be due to a number of variables including the size of the piling equipment, the substrate the foundation is being built in and the distance of the marine mammal from the noise source.

4.32 An increase in vessel activity may lead to an increase in the risk of collisions with marine mammals, while wind turbines have the potential to cause barriers to marine mammal movement. The potential also exists for the electromagnetic fields (EMF) produced from export and inter-array cables to interfere with the navigational ability of some marine mammal species, though there is currently limited information on this and any effect is considered negligible. Key prey species for marine mammals in the Dogger Bank Zone include a number of flatfish and sand eel species. Should any significant loss of these prey sources occur this could result in indirect effects on marine mammals.

4.33 Forewind has undertaken continuous marine mammal surveys across the Dogger Bank Zone since 2010, with a combination of boat and aerial-based surveys used. These surveys gathered information on the numbers of species and distribution of marine mammals present in the Dogger Bank Zone. Forewind has discussed methodology and preliminary survey findings with the JNCC and a number of non-government organisations including Whale and Dolphin Conservation Society (WDCS), World Wildlife Fund (WWF) and Greenpeace.

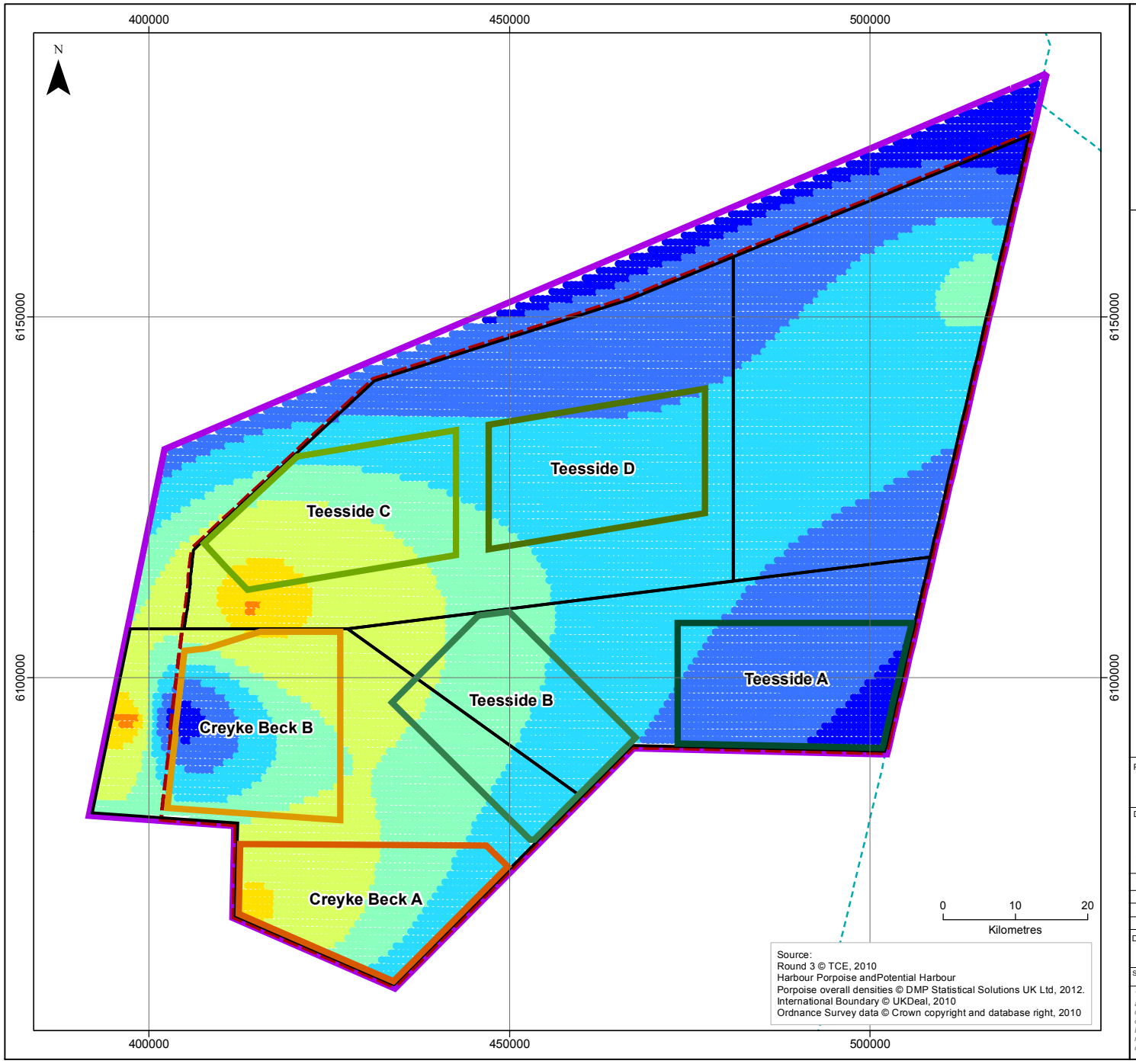
4.34 Bird and marine mammal surveys have covered the entire Dogger Bank Zone, and are still on-going. Both the aerial and boat surveys follow a series of transect lines evenly spread out over the whole Dogger Bank Zone. Surveys have revealed that minke whale, white beaked dolphin, harbour porpoise and grey seal are present in the Dogger Bank Zone. Harbour porpoise, being the most commonly recorded, have been identified throughout the Dogger Bank Zone. Other species, in addition to those listed above, have been recorded but at too low numbers to undertake sufficient density plots. Further detailed marine mammal surveys of the wind farm array boundary areas will be undertaken in order to support the EIA.

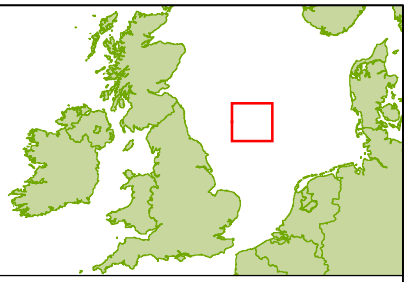
4.35 Figure 9 shows the results of the surveys of the entire Dogger Bank Zone, showing densities of harbour porpoise and ‘unidentified small cetaceans’ which have been included as ‘potential harbour porpoise’ as a precautionary measure. The figure shows that whilst there are certain areas across the Dogger Bank Zone where

densities are higher than others, harbour porpoise are present throughout the whole Dogger Bank Zone and the variance between the highest density and most of the developable area is approximately two harbour porpoise per km^2. As such, it was considered that nowhere was there a high enough density of harbour porpoise within the Dogger Bank Zone to require array boundary amendments.

4.36 The Dogger Bank geological feature extends into Dutch, Danish and German waters. The Dutch Doggersbank Site of Community Importance (SCI) and Klaverbank SCI, as well as the German Dogger Bank SCI lie on the eastern borders of the Dogger Bank Zone. These non-UK areas have included harbour porpoise and harbour seal as designated features, while the Dutch sites also include grey seal as a qualifying feature. However, as the proposed boundaries for the Dogger Bank Teesside C & D projects are located towards the west of the Dogger Bank Zone, this has not provided a strong enough influence to amend the proposed boundaries.

4.37 JNCC considers harbour porpoise to be a generally ubiquitous and highly mobile species within the North Sea and therefore these mammals are not considered as a qualifying feature of the cSAC in the UK sector.





LEGEND

- Dogger Bank Round 3 Zone
- Tranche Boundary
- Dogger Bank Developable Area
- International Boundary

Project Boundaries

- Creyke Beck A
- Creyke Beck B
- Teesside A
- Teesside B
- Teesside C
- Teesside D

Absolute Mean Density (km²)

- ≤ 0.4
- 0.41 - 0.60
- 0.61 - 0.80
- 0.81 - 1.0
- 1.01 - 1.5
- 1.51 - 2.0
- 2.01 - 2.5
- ≥ 2.51

Absolute Mean Densities (in km²) of Harbour Porpoise and Potential Harbour Porpoise Adjusted for Availability

PROJECT TITLE

DOGGER BANK R3 DEVELOPMENT

DRAWING TITLE

Figure 9
Teesside C & D Site Selection Marine Mammals - Harbour Porpoise and Potential Harbour Porpoise

VER	DATE	REMARKS	Drawn	Checked
1	22/03/2013	First Issue	PR	MS
2	16/05/2013	Legend presentation amended	AJ	MS

DRAWING NUMBER: **M-DES-0144-02**

SCALE	PLOT SIZE	DATUM	PROJECTION
1:800,000	A4	WGS84	UTM31N

FOREWIND

4.3.5 Birds

4.39 The construction and operation of an offshore wind farm poses a number of potential risks to birds. The primary risks are thought to be from collision with wind turbine blades or other offshore structures, as well as the displacement of seabirds from within the area of the wind farm.

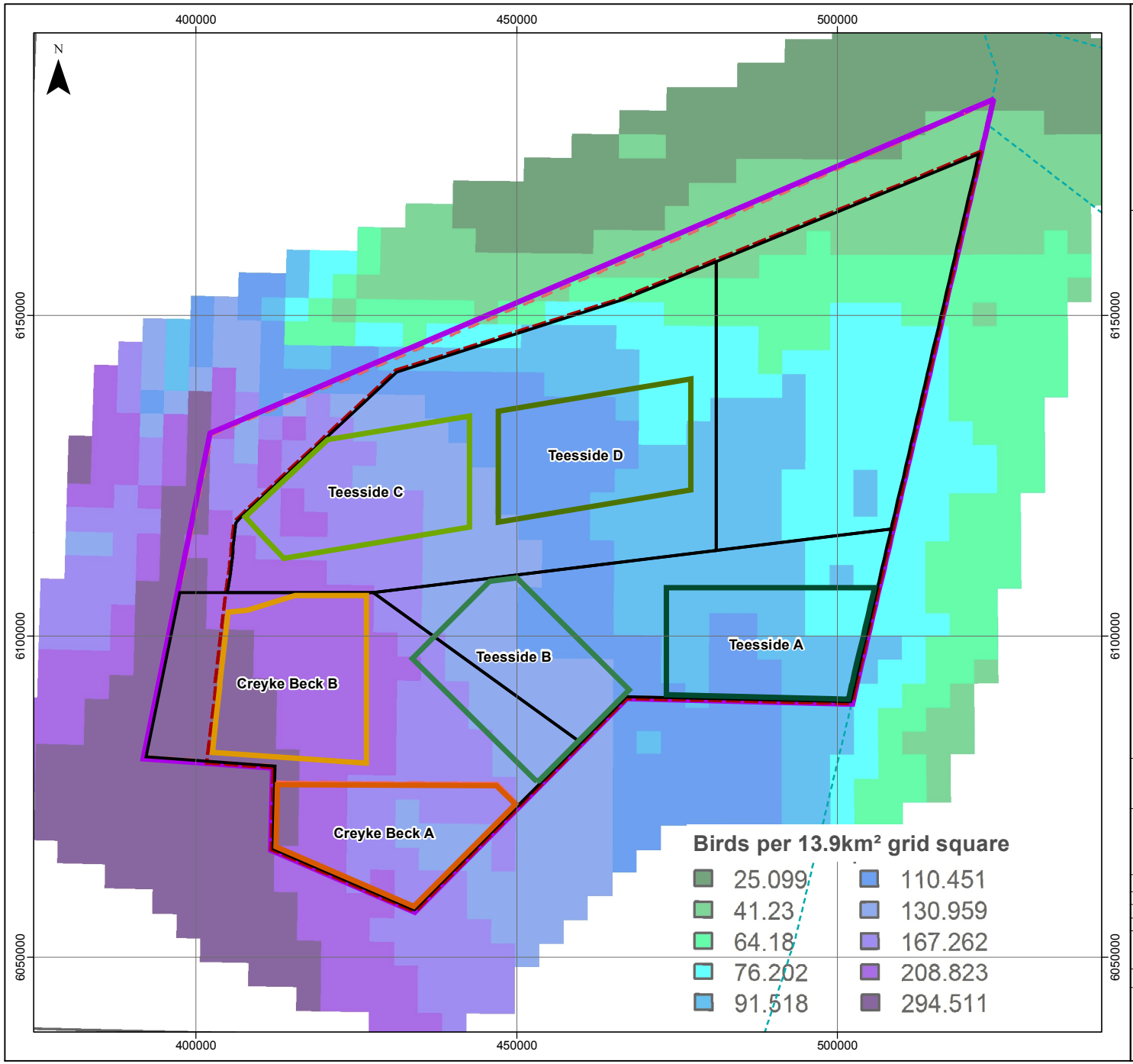
4.40 Wind turbines may be physical barriers to birds feeding within or migrating through the Dogger Bank Zone. The construction and operation phases will bring increased noise and human presence, which has the potential to disturb and displace bird species and their prey and provide foraging opportunities for other opportunistic species of birds, resulting in competition and displacement of existing species in the Dogger Bank Zone. Other species may actively avoid the wind farm, displacing them to other locations where they would have to compete for prey resource or expend additional energy on feeding and could lead to increased mortality or a failure in their breeding success.

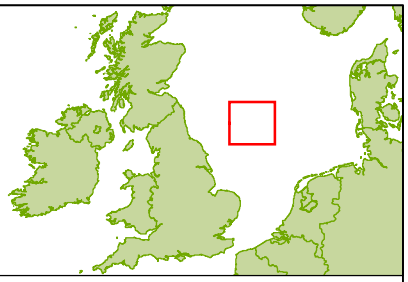
4.41 Forewind has undertaken continuous ornithological surveys of the Dogger Bank Zone, and areas of concentrated effort, since 2010 and these are still on-going. Two different survey techniques have been used across the Dogger Bank Zone, aerial and boat-based survey. Aerial surveys have utilised high definition digital video camera technology, whilst the boat based surveys have relied on visual observation techniques to count and identify species and spatially reference the records. Surveys have covered the entire Dogger Bank Zone.

4.42 As discussed previously, the data collected from the Dogger Bank Zone-wide surveys have highlighted the high density of bird species along the western boundary of the site, in close proximity to the areas of dense sand eel. This area coincides with the identified commercial sand eel fishing ground and is closest to the main breeding colonies along the east coast of England and Scotland. This has led to the exclusion of development from this area, to mitigate the potential impacts of the project on ornithological communities.

4.43 A more intensive aerial survey effort is planned for Tranche C, now that it has been defined, the results of which will feed directly into the EIA for Dogger Bank Teesside C & D.

4.44 Surveys of the Dogger Bank Zone have identified significant concentrations of species that may be affected by displacement such as guillemot, razorbill, little auk and puffin. The species considered to be the most sensitive to collisions in the Dogger Bank Zone are black-legged kittiwake, northern gannet, lesser black-backed gull, and great black-backed gull. Figures 10 – 16 show population densities of these species within the Dogger Bank Zone.





LEGEND

- Dogger Bank Round 3 Zone
- Tranche Boundary
- Dogger Bank Developable Area
- International Boundary

Project Boundaries

- Creyke Beck A
- Creyke Beck B
- Teesside A
- Teesside B
- Teesside C
- Teesside D

0 10 20
Kilometres

Source:
Round 3 © TCE, 2010
International Boundary © UKDeal, 2010
Bird Population Densities from BTO, 2013
Ordnance Survey data © Crown copyright and database right, 2010

PROJECT TITLE

DOGGER BANK R3 DEVELOPMENT

DRAWING TITLE

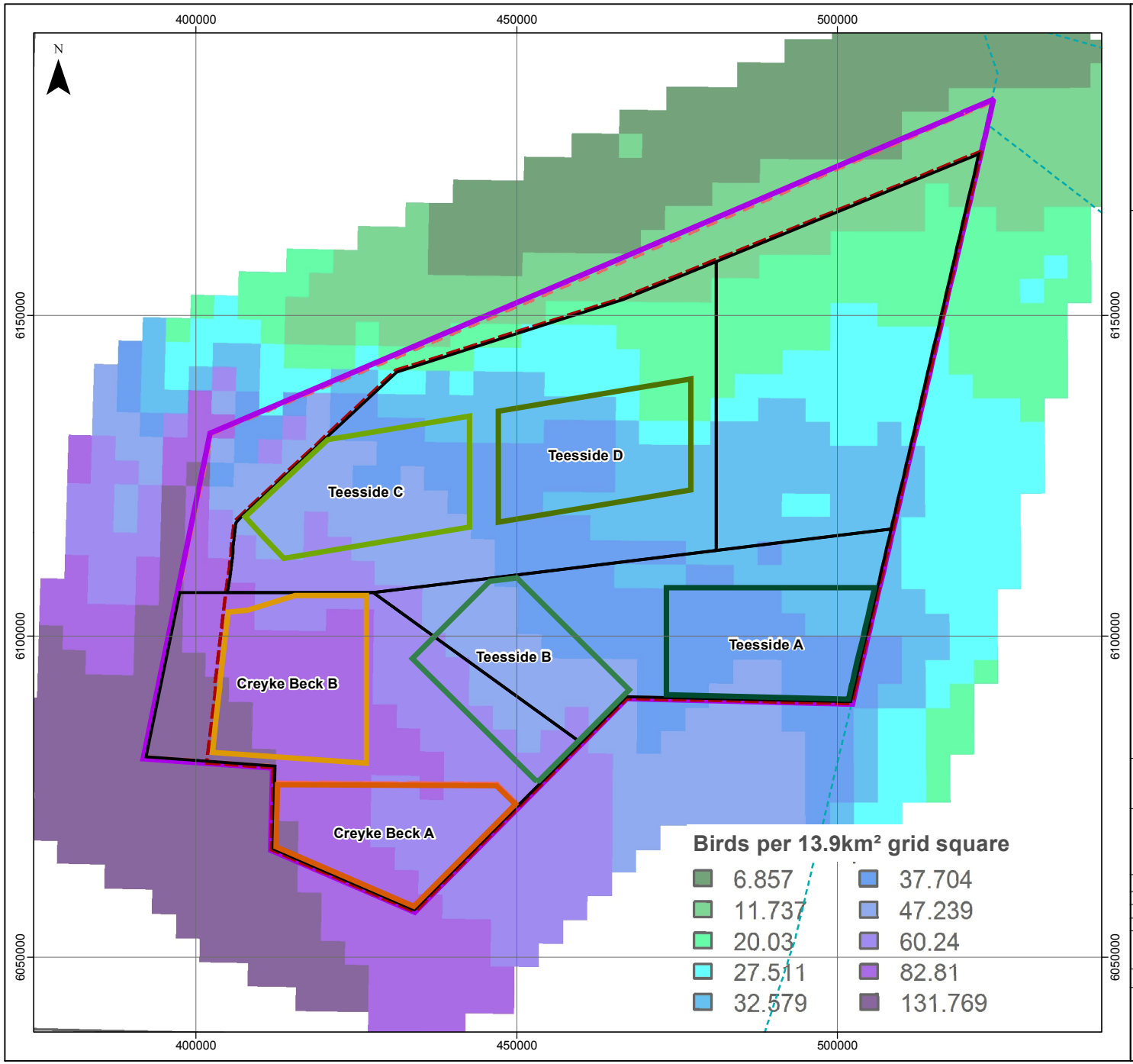
Figure 10
Teesside C & D Site Selection
Guillemot Population Densities

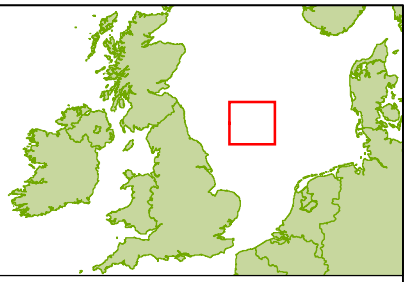
VER	DATE	REMARKS	Drawn	Checked
1	22/03/2013	First Issue	AJ	MS
2	06/08/2013	Bird density data updated	AJ	KH

DRAWING NUMBER: **M-DES-0131-02**

SCALE	PLOT SIZE	DATUM	PROJECTION
1:900,000	A4	WGS84	UTM31N

FOREWIND





LEGEND

- Dogger Bank Round 3 Zone
- Tranche Boundary
- Dogger Bank Developable Area
- International Boundary

Project Boundaries

- Creyke Beck A
- Creyke Beck B
- Teesside A
- Teesside B
- Teesside C
- Teesside D

0 10 20
Kilometres

Source:
Round 3 © TCE, 2010
International Boundary © UKDeal, 2010
Bird Population Densities from BTO, 2013
Ordnance Survey data © Crown copyright and database right, 2010

PROJECT TITLE

DOGGER BANK R3 DEVELOPMENT

DRAWING TITLE

Figure 11
Teesside C & D Site Selection
Razorbill Population Densities

VER	DATE	REMARKS	Drawn	Checked
1	22/03/2013	First Issue	AJ	MS
2	06/08/2013	Bird density data updated	AJ	KH

DRAWING NUMBER: **M-DES-0130-02**

SCALE	PLOT SIZE	DATUM	PROJECTION
1:900,000	A4	WGS84	UTM31N

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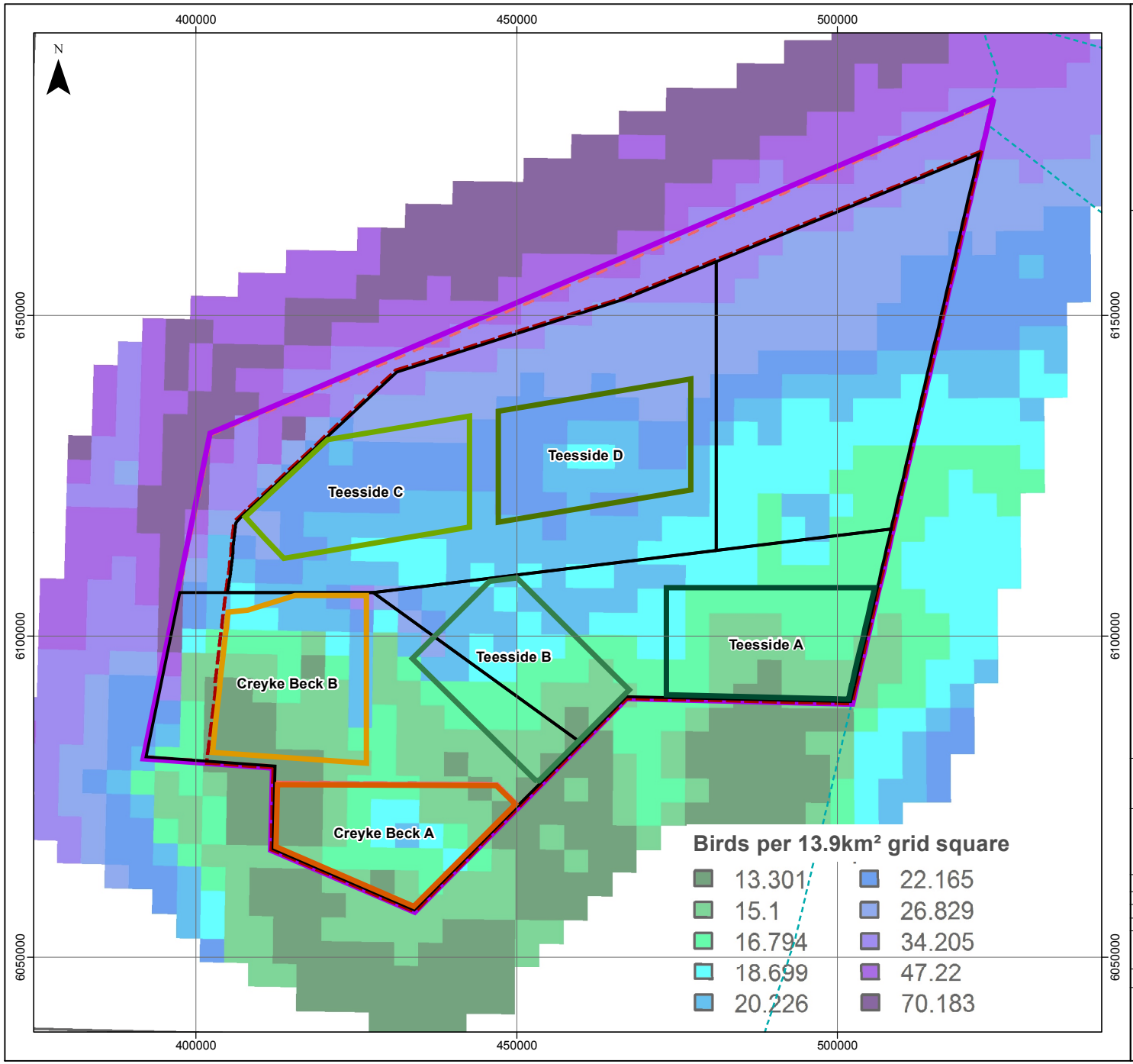

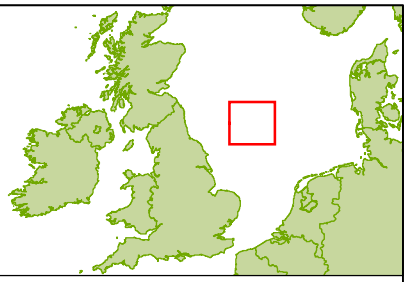

LEGEND

- Dogger Bank Round 3 Zone
- Tranche Boundary
- Dogger Bank Developable Area
- International Boundary

Project Boundaries

- Creyke Beck A
- Creyke Beck B
- Teesside A
- Teesside B
- Teesside C
- Teesside D

0 10 20
Kilometres

Source:
Round 3 © TCE, 2010
International Boundary © UKDeal, 2010
Bird Population Densities from BTO, 2013
Ordnance Survey data © Crown copyright and database right, 2010

PROJECT TITLE

DOGGER BANK R3 DEVELOPMENT

DRAWING TITLE

Figure 12
Teesside C & D Site Selection
Little Auk Population Densities

VER	DATE	REMARKS	Drawn	Checked
1	22/03/2013	First Issue	AJ	MS
2	06/08/2013	Bird density data updated	AJ	KH

DRAWING NUMBER: **M-DES-0127-02**

SCALE	PLOT SIZE	DATUM	PROJECTION
1:900,000	A4	WGS84	UTM31N

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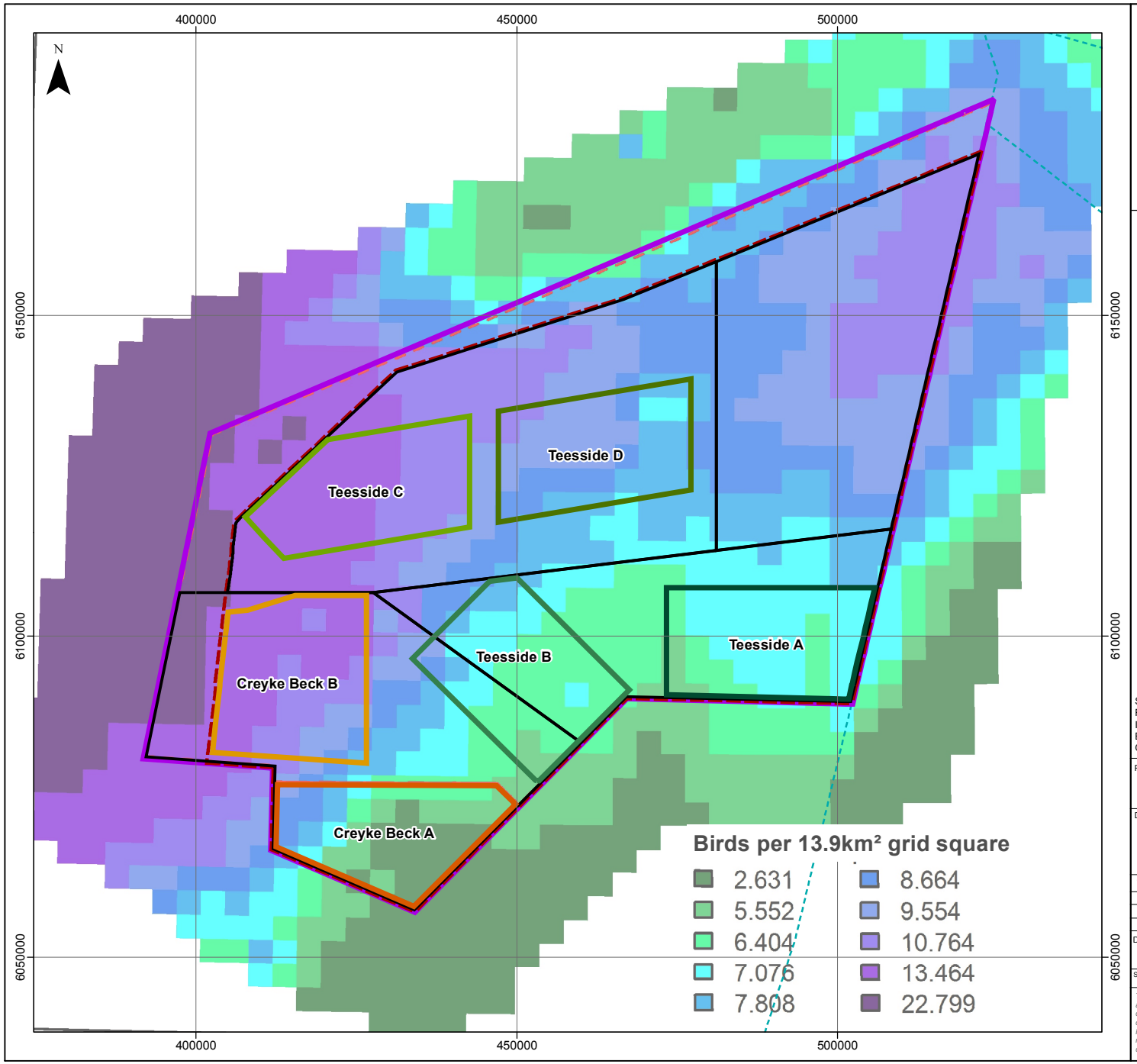

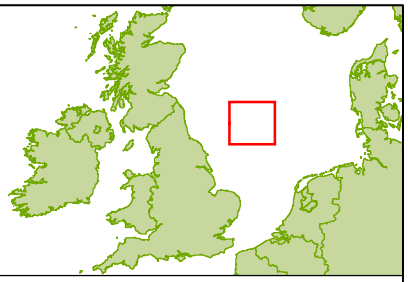

LEGEND

- Dogger Bank Round 3 Zone
- Tranche Boundary
- Dogger Bank Developable Area
- International Boundary

Project Boundaries

- Creyke Beck A
- Creyke Beck B
- Teesside A
- Teesside B
- Teesside C
- Teesside D

0 10 20
Kilometres

Source:
Round 3 © TCE, 2010
International Boundary © UKDeal, 2010
Bird Population Densities from BTO, 2013
Ordnance Survey data © Crown copyright and database right, 2010

PROJECT TITLE

DOGGER BANK R3 DEVELOPMENT

DRAWING TITLE

Figure 13
Teesside C & D Site Selection
Puffin Population Densities

VER	DATE	REMARKS	Drawn	Checked
1	22/03/2013	First Issue	AJ	MS
2	06/08/2013	Bird density data updated	AJ	KH

DRAWING NUMBER: **M-DES-0132-02**

SCALE	PLOT SIZE	DATUM	PROJECTION
1:900,000	A4	WGS84	UTM31N

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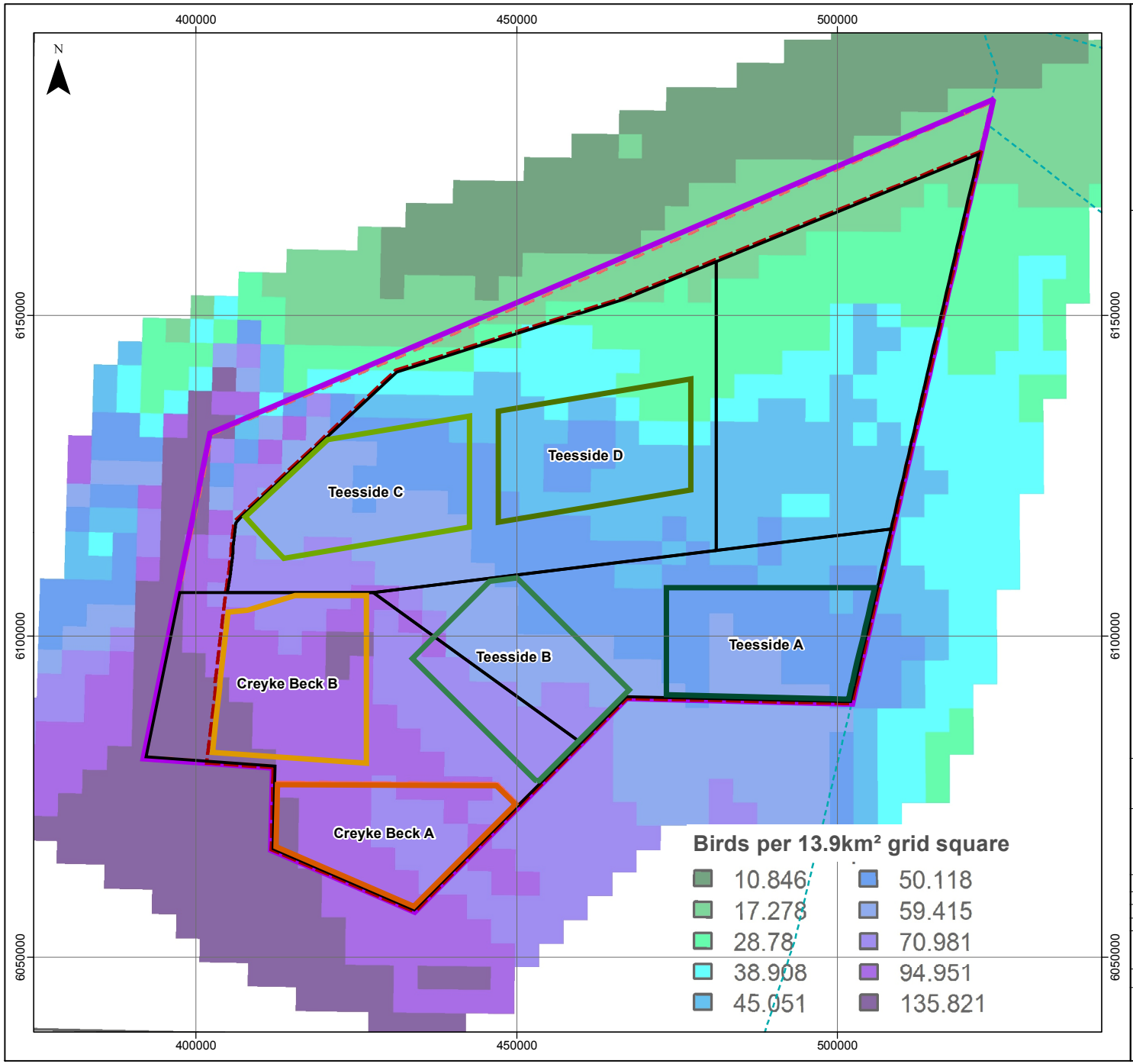

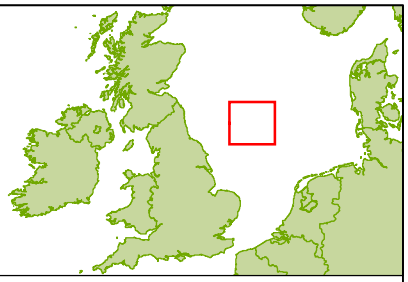

LEGEND

- Dogger Bank Round 3 Zone
- Tranche Boundary
- Dogger Bank Developable Area
- International Boundary

Project Boundaries

- Creyke Beck A
- Creyke Beck B
- Teesside A
- Teesside B
- Teesside C
- Teesside D

0 10 20
Kilometres

Source:
Round 3 © TCE, 2010
International Boundary © UKDeal, 2010
Bird Population Densities from BTO, 2013
Ordnance Survey data © Crown copyright and database right, 2010

PROJECT TITLE

DOGGER BANK R3 DEVELOPMENT

DRAWING TITLE

Figure 14
Teesside C & D Site Selection
Kittiwake Population Densities

VER	DATE	REMARKS	Drawn	Checked
1	22/03/2013	First Issue	AJ	MS
2	06/08/2013	Bird density data updated	AJ	KH

DRAWING NUMBER: **M-DES-0129-02**

SCALE	PLOT SIZE	DATUM	PROJECTION
1:900,000	A4	WGS84	UTM31N

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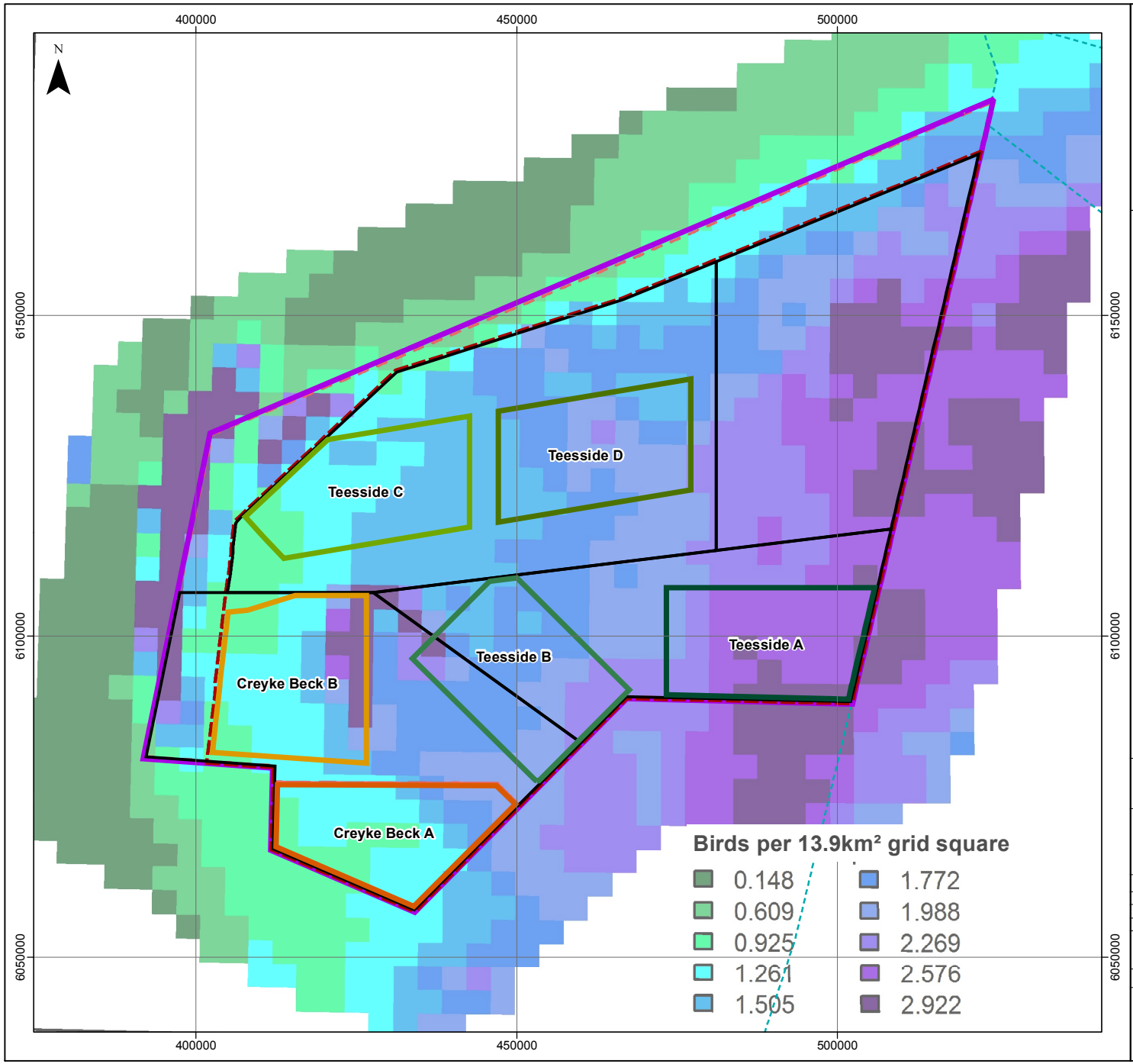
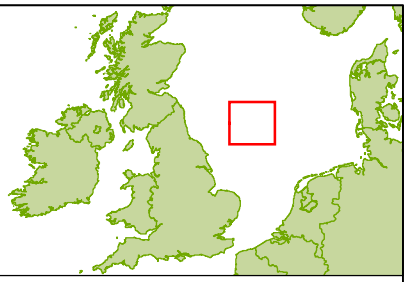




LEGEND

- Dogger Bank Round 3 Zone
- Tranche Boundary
- Dogger Bank Developable Area
- International Boundary

Project Boundaries

- Creyke Beck A
- Creyke Beck B
- Teesside A
- Teesside B
- Teesside C
- Teesside D

0 10 20
Kilometres

Source:
Round 3 © TCE, 2010
International Boundary © UKDeal, 2010
Bird Population Densities from BTO, 2013
Ordnance Survey data © Crown copyright and database right, 2010

PROJECT TITLE

DOGGER BANK R3 DEVELOPMENT

DRAWING TITLE

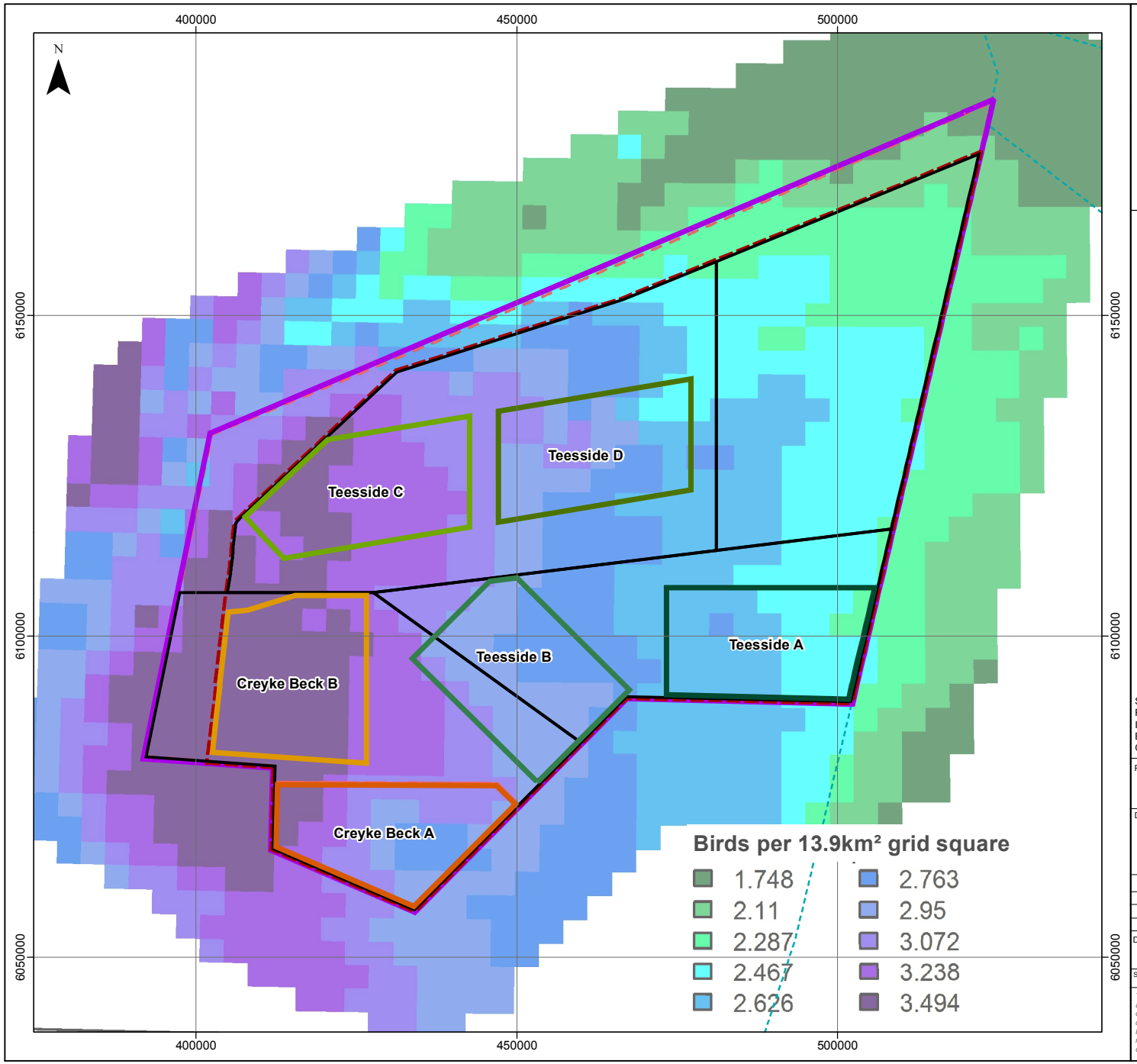
Figure 15
Teesside C & D Site Selection Lesser Black Backed Gull Population Densities

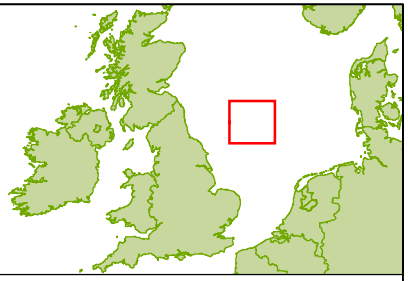
VER	DATE	REMARKS	Drawn	Checked
1	22/03/2013	First Issue	AJ	MS
2	06/08/2013	Bird density data updated	AJ	KH

DRAWING NUMBER: **M-DES-0128-02**

SCALE	1:900,000	PLOT SIZE	A4	DATUM	WGS84	PROJECTION	UTM31N

FOREWIND





LEGEND

- Dogger Bank Round 3 Zone
- Tranche Boundary
- Dogger Bank Developable Area
- International Boundary

Project Boundaries

- Creyke Beck A
- Creyke Beck B
- Teesside A
- Teesside B
- Teesside C
- Teesside D

0 10 20
Kilometres

Source:
Round 3 © TCE, 2010
International Boundary © UKDeal, 2010
Bird Population Densities from BTO, 2013
Ordnance Survey data © Crown copyright and database right, 2010

PROJECT TITLE

DOGGER BANK R3 DEVELOPMENT

DRAWING TITLE

Figure 16
Teesside C & D Site Selection Great Black-Backed Gull Population Densities

VER	DATE	REMARKS	Drawn	Checked
1	22/03/2013	First Issue	AJ	MS
2	06/08/2013	Bird density data updated	AJ	KH

DRAWING NUMBER: **M-DES-0133-02**

SCALE	1:900,000	PLOT SIZE	A4	DATUM	WGS84	PROJECTION	UTM31N

FOREWIND

4.45 The wind farm boundaries for Dogger Bank Teesside C & D have been developed to avoid the higher bird densities observed within the west of the Dogger Bank Zone. This has been a key consideration in the development of the boundary of Tranche C.

4.3.6 Benthic ecology

4.46 Dogger Bank is an area of raised seabed that falls into Dutch, Danish, British and German waters of the North Sea. As discussed in Section 4.3.4, part of the UK section of the Dogger Bank is designated as a cSAC, which is due to the presence of the Habitats Directive Annex 1 Habitat 'sandbanks which are slightly covered by seawater all the time' (Joint Nature Conservation Committee, 2012).

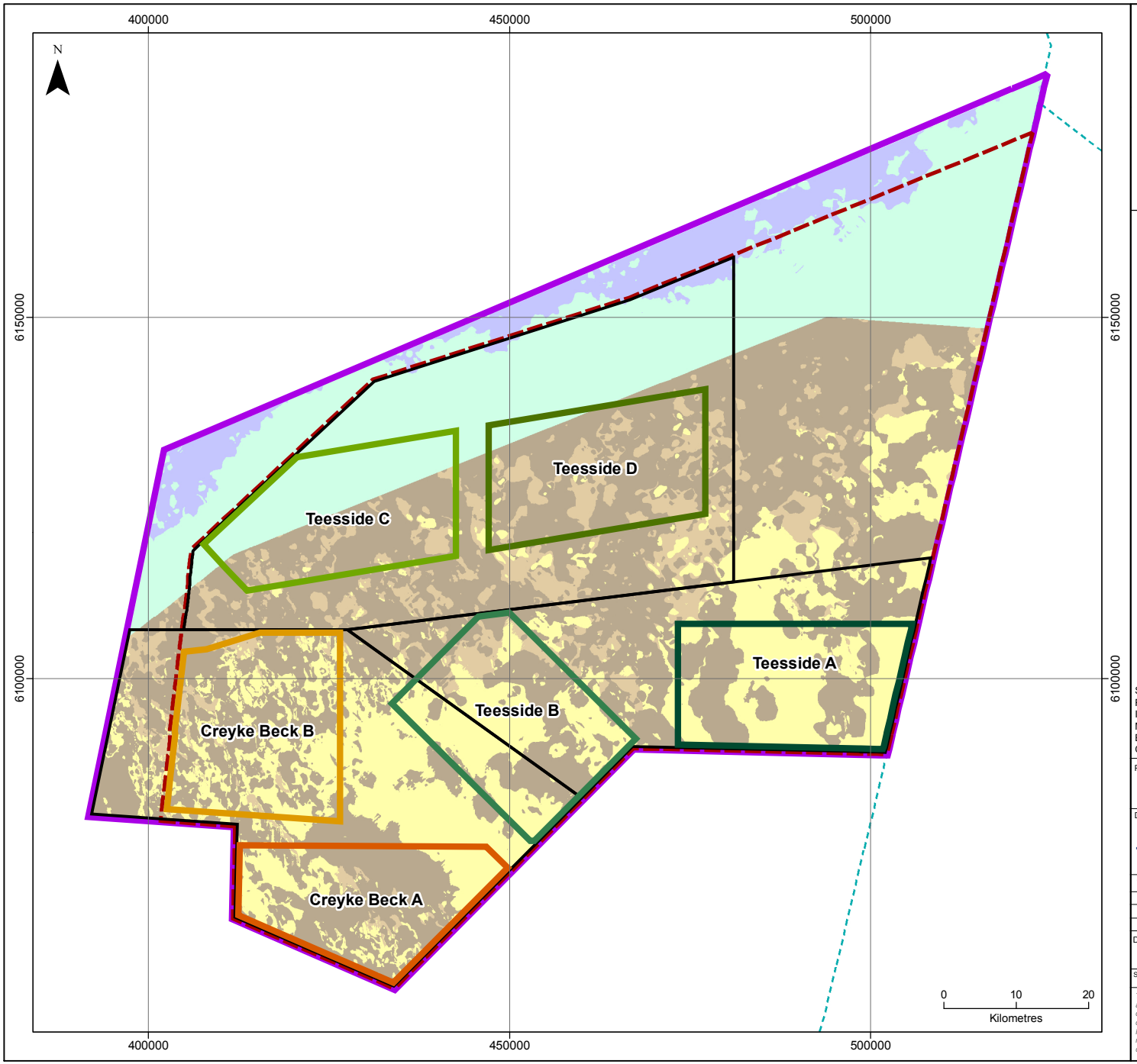
4.47 The installation of foundations, cables and other structures can cause direct physical loss and/or disturbance of the seabed and to those organisms which live on or below the seabed. Other effects arising from the construction, operation and decommissioning of an offshore wind farm, such as an increase in suspended sediment in the water column can also impact benthic communities. The footprint of foundation and cable installation can lead to a loss of habitat during the lifetime of an offshore wind project.

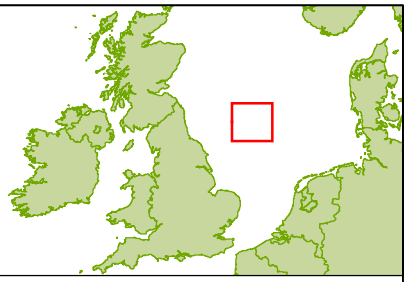
4.48 From the data collected from the initial Zone-wide coarse resolution geophysical survey and in conjunction with ZAP work, the northern edge of the Dogger Bank Zone was deemed more sensitive from a benthic habitat perspective due to the presence of slope reef habitat. This more sensitive area is shown in purple in Figure 17 and, as can be seen, the boundaries proposed for the Dogger Bank Teesside C & D projects avoid this area.

4.49 As described in Section 4.3.2, Forewind has commissioned and is undertaking a more focused geophysics survey on a selected area in Tranche C to provide finer scale data. These data will be used to identify the potential presence of Annex 1 of habitat within Tranche C for further location specific survey.

4.50 The proposed boundaries for Dogger Bank Teesside C & D overlap the cSAC. Previous surveys within Tranches A and B have observed that the majority of benthic habitats and species present are those that are considered to be generally tolerant to disturbance and have high recoverability; it is therefore assumed that these habitats and species will also be present in Tranches C and D based on the Zone-wide data previously collected. Therefore, there was no limit on boundary selection resulting from either benthic features or the presence of the cSAC.

4.51 Forewind has recently commissioned a benthic ecology survey in Tranche C to establish, at a finer resolution, the benthic communities present within the Dogger Bank Zone and within the array boundaries. The aim of the survey was to identify the baseline benthic communities, especially those of conservation interest and in particular those listed in Annex 1 of the Habitats Directive. At the time of writing, the survey has been completed and work is on-going to analyse and identify the samples.





LEGEND

- Dogger Bank Round 3 Zone
- Tranche Boundary
- Dogger Bank Developable Area
- International Boundary

Project Boundaries

- Creyke Beck A
- Creyke Beck B
- Teesside A
- Teesside B
- Teesside C
- Teesside D

Marine Ecology

Biotope Sensitivity

- Low-moderate sensitivity; outside SAC
- Moderate sensitivity; outside SAC
- Very low sensitivity; inside SAC
- Low sensitivity; inside SAC
- Low-moderate sensitivity; inside SAC

Source:
Round 3 © TCE, 2010
International Boundary © UKDeal, 2010
Marine Ecology data from Envision Mapping Ltd., 2012
Background bathymetry image derived in part from TCarta data © 2009
Ordnance Survey data © Crown copyright and database right, 2010

PROJECT TITLE

DOGGER BANK R3 DEVELOPMENT

DRAWING TITLE

Figure 17
Teesside C & D Site Selection Marine Ecology

VER	DATE	REMARKS	Drawn	Checked
1	22/03/2013	First Issue	PR	MS

DRAWING NUMBER: **M-DES-0138-01**

SCALE	1:800,000	PLOT SIZE	A4	DATUM	WGS84	PROJECTION	UTM31N

FOREWIND

4.3.7 Marine aggregates

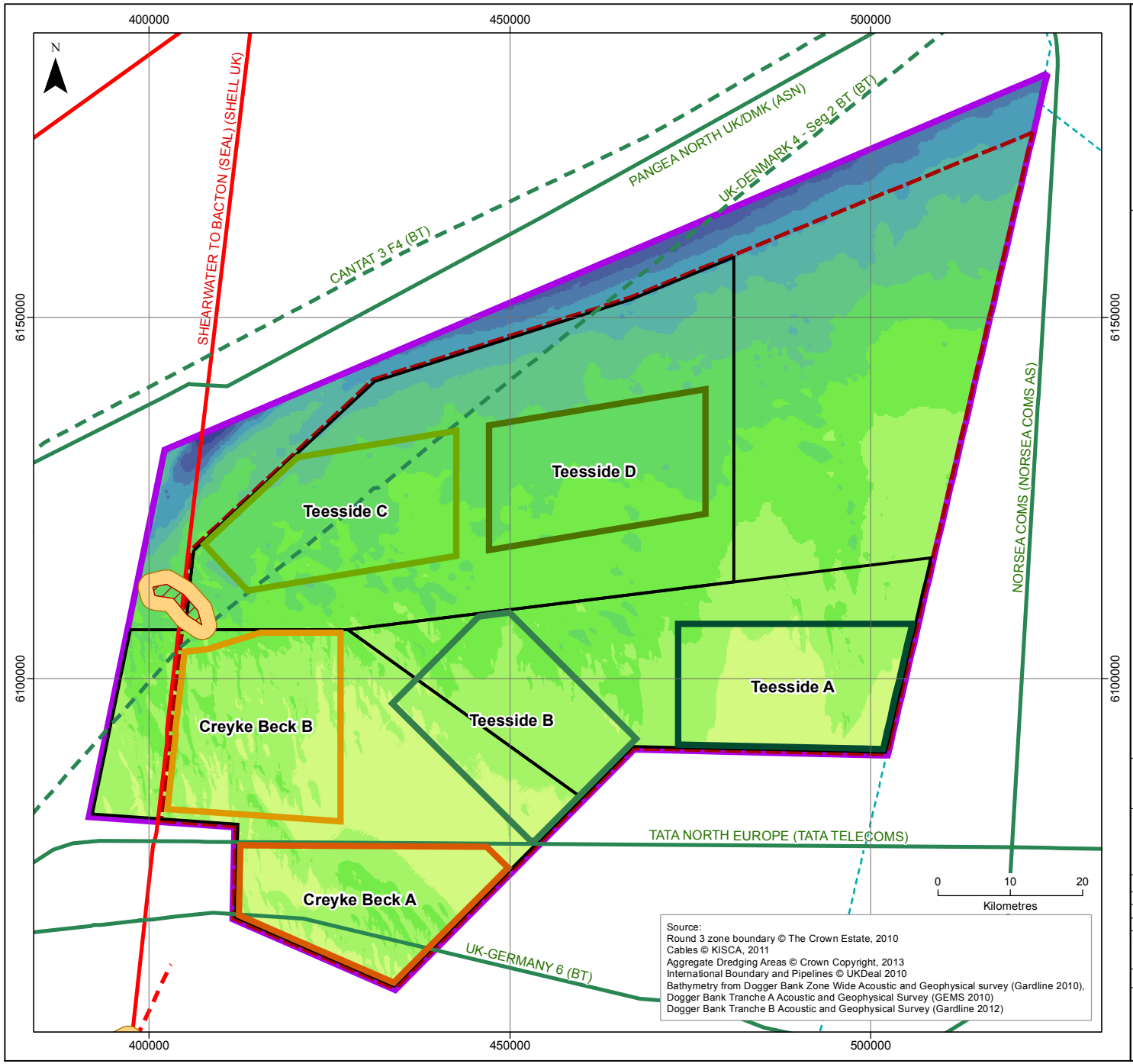
4.52 Marine aggregate extraction is generally not possible within offshore wind farms since anchoring of dredging vessels close to cables and dredging near to buried cables could result in the risk of damage to both vessels and cables.

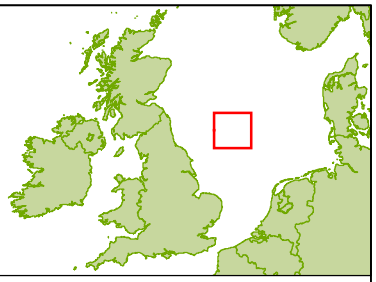
4.53 At present there are no licensed aggregate areas within the Dogger Bank Zone itself. However, there is currently an application for an aggregate dredging ground approximately 600m northwest of Tranche A (see Figure 18), covering an area of approximately 11.13km^2. Consultation with Cemex, the applicant, has confirmed that a buffer zone of 2km is currently industry best practice between proposed aggregates area and any offshore wind farm structures. Currently this area has been avoided and no other factors related to marine aggregates, other than consideration of the possible presence of vessels associated with this dredging site have been considered as influencing boundary selection.

4.3.8 Shipping and navigation

4.54 The introduction of an offshore wind farm to an area currently devoid of offshore installations and structures has the potential to increase the navigational risk for mariners within the area. The main hazard to mariners from the presence of offshore wind farms is an increased risk of collision or allision with both vessels and wind farm structures. This risk is created by transit deviations, structures creating visual confusion, structure presence impairing small vessel detection (visual or radar) systems, and the potential to impact emergency response capability. As a result, it is necessary to assess the baseline environment including the identification of navigational features, defining existing users such as fishing operators and determining historical commercial shipping routes (both regular operators and densely used routes).

4.55 Marine traffic data, charted information and consultation feedback were used to identify the baseline level of shipping activity of the Dogger Bank Zone. The marine traffic survey data used for the baseline navigation review of the assessment area included two datasets of AIS data (21 days in spring/summer 2011 and 28 days in autumn/winter 2011/2012) and one dataset of radar data (28 days across August, September and October 2010). These data were recorded from survey vessels working at the site during the given periods and form part of a large data set of over 500 days' data collected by Forewind. Further AIS and radar data is being collected at the same time as other surveys taking place within Tranche C throughout 2013.





LEGEND

- Dogger Bank Round 3 Zone
- Tranche Boundary
- Dogger Bank Developable Area
- International Boundary

Project Boundaries

- Creyke Beck A
- Creyke Beck B
- Teesside A
- Teesside B
- Teesside C
- Teesside D

Bathymetry

- Less than 25m
- 25m-30m
- 30m-35m
- 35m-40m
- 40m-45m
- 45m-50m
- 50m-55m
- 55m-60m
- 60m-65m
- Greater than 65m

(relative to LAT)

Aggregate Areas

- Aggregate dredging area
- 2km buffer around aggregate dredging area

Cables

- Out of Service Cables
- Active Cables

Pipelines

- Not In Use Pipelines
- Active Pipelines

PROJECT TITLE

DOGGER BANK R3 DEVELOPMENT

DRAWING TITLE

Figure 18
Dogger Bank Zone Marine Aggregate Licence Applications

VER	DATE	REMARKS	Drawn	Checked
1	09/11/2012	First issue	AJ	GL
2	22/03/2013	Project Boundaries added	AJ	MS

DRAWING NUMBER:

M-DES-0092-02

SCALE	1:800,000	PLOT SIZE	A4	DATUM	WGS84	PROJECTION	UTM31N

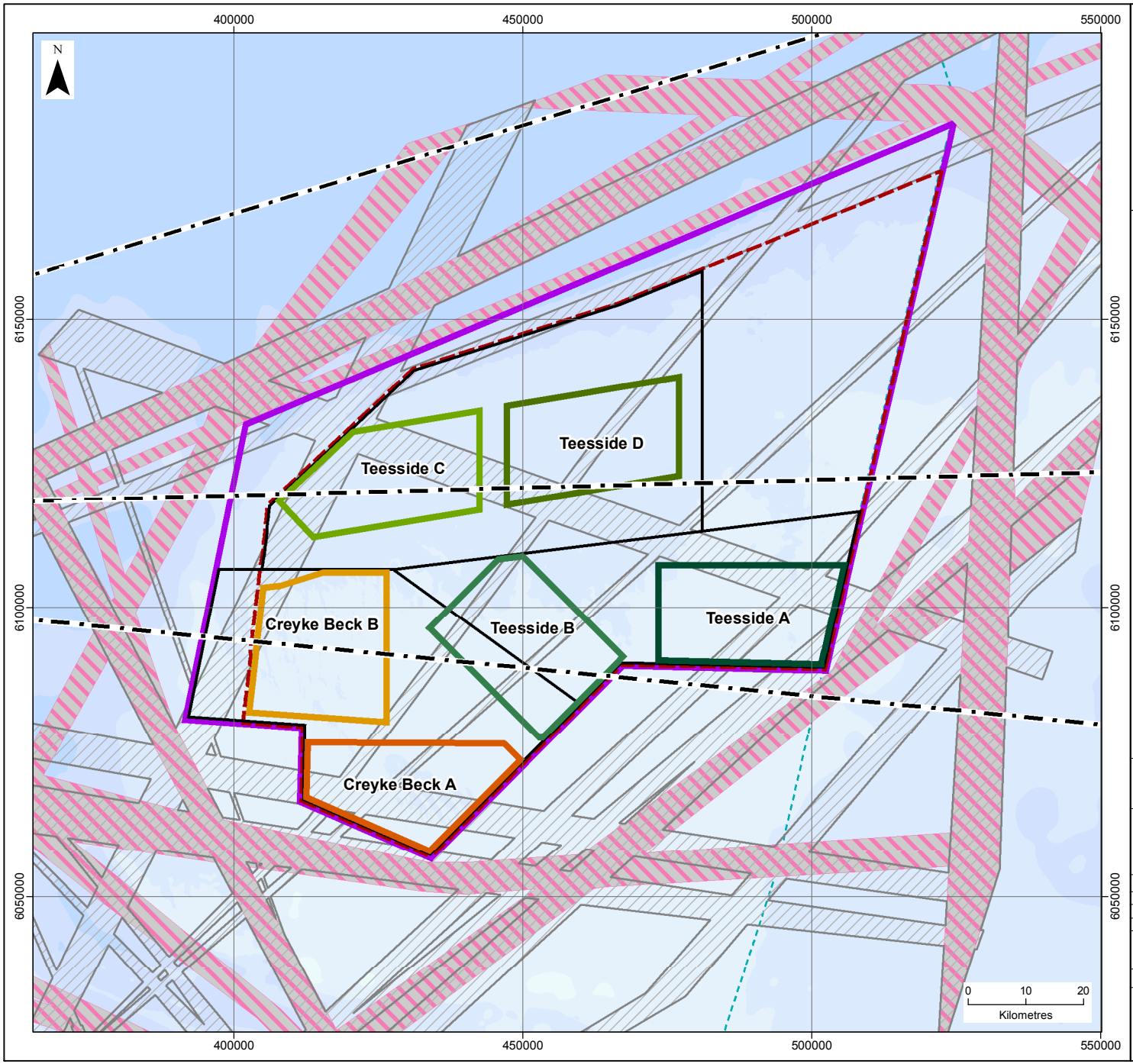
FOREWIND

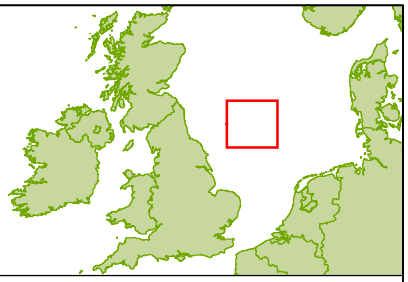
4.49 Discussions with the Maritime and Coastguard Agency (MCA) in particular have focused on Forewind's findings regarding how comparatively light the shipping activity is in the Dogger Bank Zone compared to elsewhere in the North Sea. Thus there is no evidence that "areas to be avoided" or similar area restrictions would be required. Whilst Forewind is carrying out impact assessment work in relation to navigational risk, it is considered that the greatest influence of the outcomes of this work on the wind farms will be on layout and aids to navigation such as lighting and markings rather than the boundaries.

4.50 Data analysis has shown that the Dogger Bank Zone has relatively few vessel transits through the zone in relation to both its size and other North Sea Round 3 Zones. Due to the Dogger Bank Zone's distance offshore, use for recreational sailing is also low. However, as discussed above, there is a strong commercial fishing presence at the western edge of the Dogger Bank Zone, in particular sand eel fishery, which has in contributed to the exclusion of development from that area.

4.51 In order to address the cumulative issues arising from multiple large offshore wind farm developments in the Southern North Sea, Forewind joined the developers of the Hornsea and East Anglia Round 3 Zones in forming the Southern North Sea Offshore Wind Forum (SNSOWF). The group recognised that the cumulative impacts of all three Round 3 Zones should be accounted for when considering selection of suitable wind farm array areas and commissioned a report into the effects entitled "Navigational Assessment into Cumulative Issues" (Anatec Limited, 2012). Additionally consultation was also undertaken with UK and transboundary regulators.

4.52 Although vessels may be displaced by the presence of offshore projects within the Dogger Bank Zone, a maximum increase in transit time for any vessel would be about twenty-two minutes, or 1.2% of total journey distance for the average route. This was calculated within the Navigational Risk Assessment (NRA) for the Dogger Bank Creyke Beck A & B, and is derived from proposed rerouted shipping lanes (Figure 19). Consequently, no areas of the Dogger Bank Zone were identified at this stage as being unsuitable for wind farm development as a result of shipping activity and hence no areas were ruled out on this basis. It was noted that site design, including presence of peripheral structures, lighting and marking, needed to be considered to ensure that the projects do not pose additional risk to shipping.





LEGEND

- Dogger Bank Round 3 Zone
- Tranche Boundary
- Dogger Bank Developable Area
- UK International Boundary

Project Boundaries

- Creyke Beck A
- Creyke Beck B
- Teesside A
- Teesside B
- Teesside C
- Teesside D

UK Cruising Routes

- Medium Recreational Use

Shipping

- Deviated 90th Percentile Shipping Routes
- Existing 90th Percentile Shipping Routes

Source:
Round 3 © TCE, 2010
UK International Boundary supplied by UKHO, 2013
UK Cruising Routes © Royal Yachting Association (RYA),2012
Shipping Routes data from Anatec, 2013
Background bathymetry image derived in part from TCarta data © 2009
Ordnance Survey data © Crown copyright and database right, 2010

PROJECT TITLE

DOGGER BANK R3 DEVELOPMENT

DRAWING TITLE

Figure 19
Teesside C & D Site Selection
Shipping Routes

VER	DATE	REMARKS	Drawn	Checked
1	22/03/2013	First Issue	PR	MS
2	16/07/2013	Existing shipping routes added	AJ	KH

DRAWING NUMBER:

M-DES-0136-02

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

FOREWIND

4.3.10 Pipelines, cables and other third party infrastructure

4.54 Operational pipelines and cables are considered hard constraints to wind farms, as wind farm structures cannot be sited directly on to these structures, with the exception of inter-array or export cables, which would need to be subject to cable or pipeline crossing agreements. Buffer zones are provided to ensure the safety of the existing infrastructure during the construction operations associated with the wind farm. For example, anchor spreads or jack-up feet from vessels engaged in the construction of the wind farm will only be permitted to encroach up to a certain buffer from the cable or pipeline to ensure they do not damage the existing infrastructure. Additionally, during operation, buffers are required to ensure the safety of vessels working on repair or maintenance operations in close proximity to the surface wind farm structures and to ensure adequate space for the repair and maintenance of the cable or pipeline is provided.

4.55 On-going consultation with asset owners has indicated that the buffers required for out of service cables and pipelines are either not necessary or significantly smaller than for operational assets. This is because the same level of maintenance and hence access to the cable or pipeline is not expected or required. However, where these are charted, note is still made of out of service cables and pipelines to ensure that consultation captures any concerns relating to these assets.

4.56 Early data collection from published sources and the output of conflict checks from The Crown Estate identified active and inactive cables and pipelines within proximity to the Dogger Bank Zone. The assets that could potentially influence the boundaries of Dogger Bank Teesside C & D are shown in Table 8 and Figure 20. Whilst UK-Denmark 4 does interact directly with the proposed location for the Teesside C project, it is inactive and as such can be removed in full or in part prior to construction of an offshore wind farm on this site, subject to an agreement with the asset owner.

Cable	Operator	Active or Inactive Cable/Pipeline	Interaction with Tranches
SEAL	SHELL UK	Active	Potential to influence wind farm development located to the west of the Dogger Bank Zone
UK – Denmark 4	BT / TDC	Inactive	Crosses proposed boundary for Teesside C and is in close proximity to north west corner of Teesside D but first 12nm of cable removed and the rest is left inactive

Table 8 Cable and pipelines in proximity to Dogger Bank Zone

4.57 On-going dialogue between Forewind and the operators of these pipelines and cables has helped to inform the boundary design of Dogger Bank Teesside C & D. A

dialogue on crossing and proximity agreements is currently in progress with operators.

4.58 There are no active oil or gas fields located within the north of the Dogger Bank Zone. Numerous exploration wells have been drilled, but have been plugged and abandoned, or released as dry holes.

4.59 There are no oil and gas blocks currently licensed for oil and gas exploration within the boundaries of Dogger Bank Teesside C & D and as such have not had an influence on the determination of array boundaries.

4.3.11 Consideration of cumulative effects

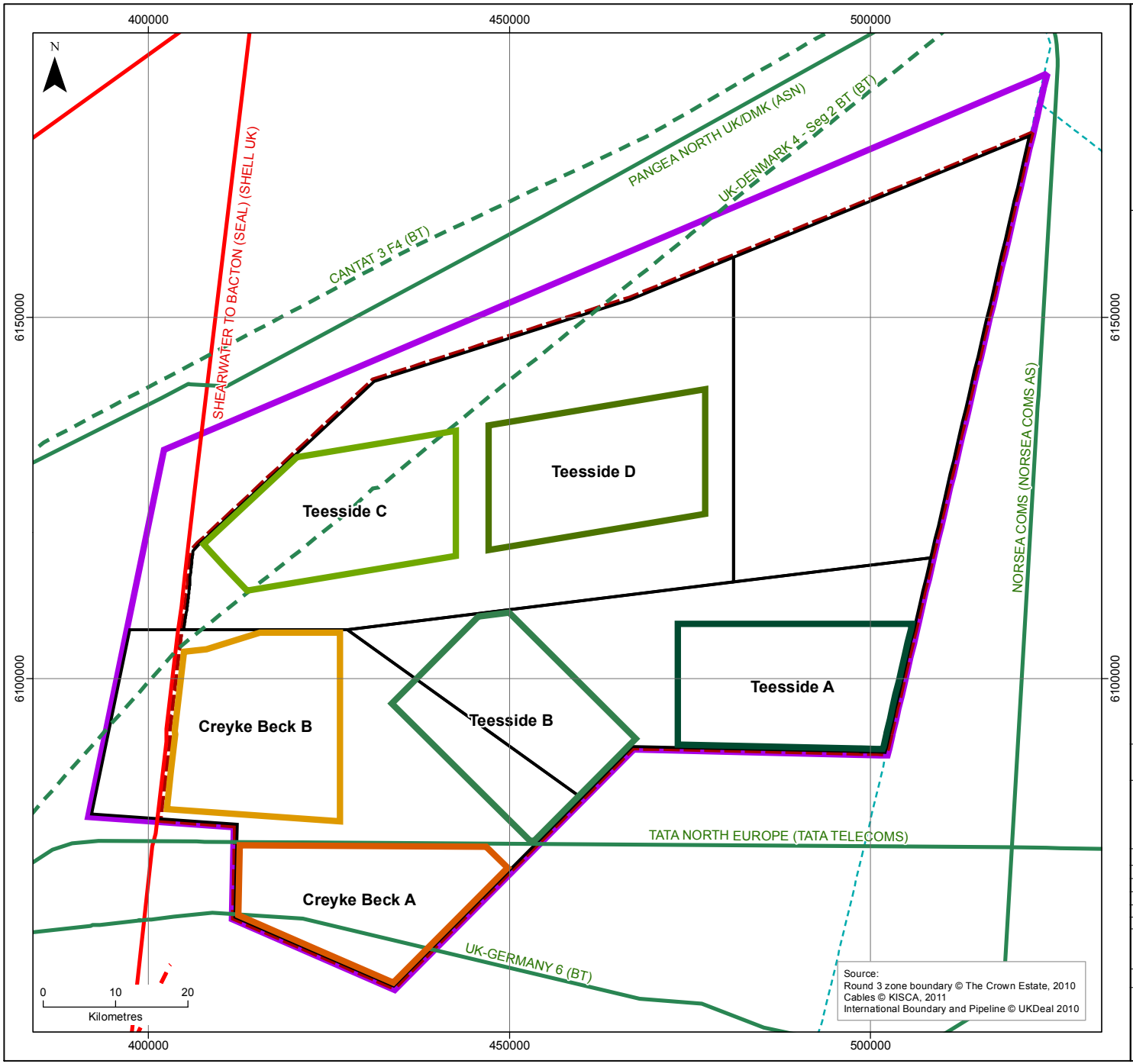
4.60 The consideration of cumulative effects (both between projects within the Dogger Bank Zone and between the zone and other Round 3 Zones) has been a key driver in the selection of development area and project boundaries.

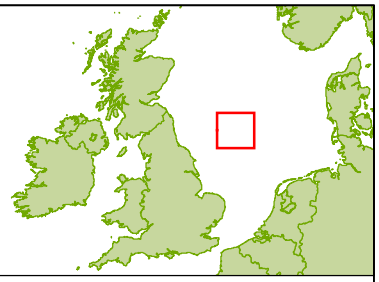
4.61 The ZAP process identified a number of potential constraints to development, such as the high densities of birds, marine mammals and fishing activity within the west of the Dogger Bank Zone, due to the presence of high numbers of sand eel in this area. This led to a decision to exclude development from this area, to ensure that the cumulative effects of the Dogger Bank Zone could be reduced on a number of key receptors.

4.62 Data collected from the ZAP studies, as well as work undertaken to inform the ES for Dogger Bank Creyke Beck A & B and Dogger Bank Teesside A & B has highlighted higher densities of key bird species in certain areas of the Dogger Bank Zone, as shown in Figures 10 – 16. The siting of the Teesside C & D projects in areas of lower density, will, by design reduce the potential for cumulative effects.

4.63 Forewind has also taken part in regional initiatives, such as the commissioning of the Navigational Assessment into Cumulative Issues report (Anatec Limited, 2012) to further understand the intra-project and inter-project potential for cumulative effects. By seeking to deviate shipping routes around the Dogger Bank Zone, rather than on an individual project basis, Forewind has been able to reduce the cumulative effects of the project on shipping and navigation. This approach to Zonal development has demonstrated that the consideration of cumulative effects has been paramount in the identification of the first six projects across the Dogger Bank Zone.

The detailed consideration already given to the consideration of cumulative effects through the ZAP phase has ensured that cumulative effects have been identified which have resulted in the array boundaries to be further amended in order to reduce impacts on a number of receptors. Going forward, assessment of potential cumulative effects will form an integral part of the project-level assessment, incorporating learning from the assessment work conducted for the Dogger Bank Creyke Beck A & B and Dogger Bank Teesside A & B projects.





LEGEND

- Dogger Bank Round 3 Zone
- Dogger Bank Developable Area
- Tranche Boundary
- International Boundary

Project Boundaries

- Creyke Beck A
- Creyke Beck B
- Teesside A
- Teesside B
- Teesside C
- Teesside D

Pipelines

- Not In Use Pipelines
- Active Pipelines

Cables

- Out of Service Cables
- Active Cables

PROJECT TITLE

DOGGER BANK R3 DEVELOPMENT

DRAWING TITLE

Figure 20
Dogger Bank Zone
Existing Cables and Pipelines

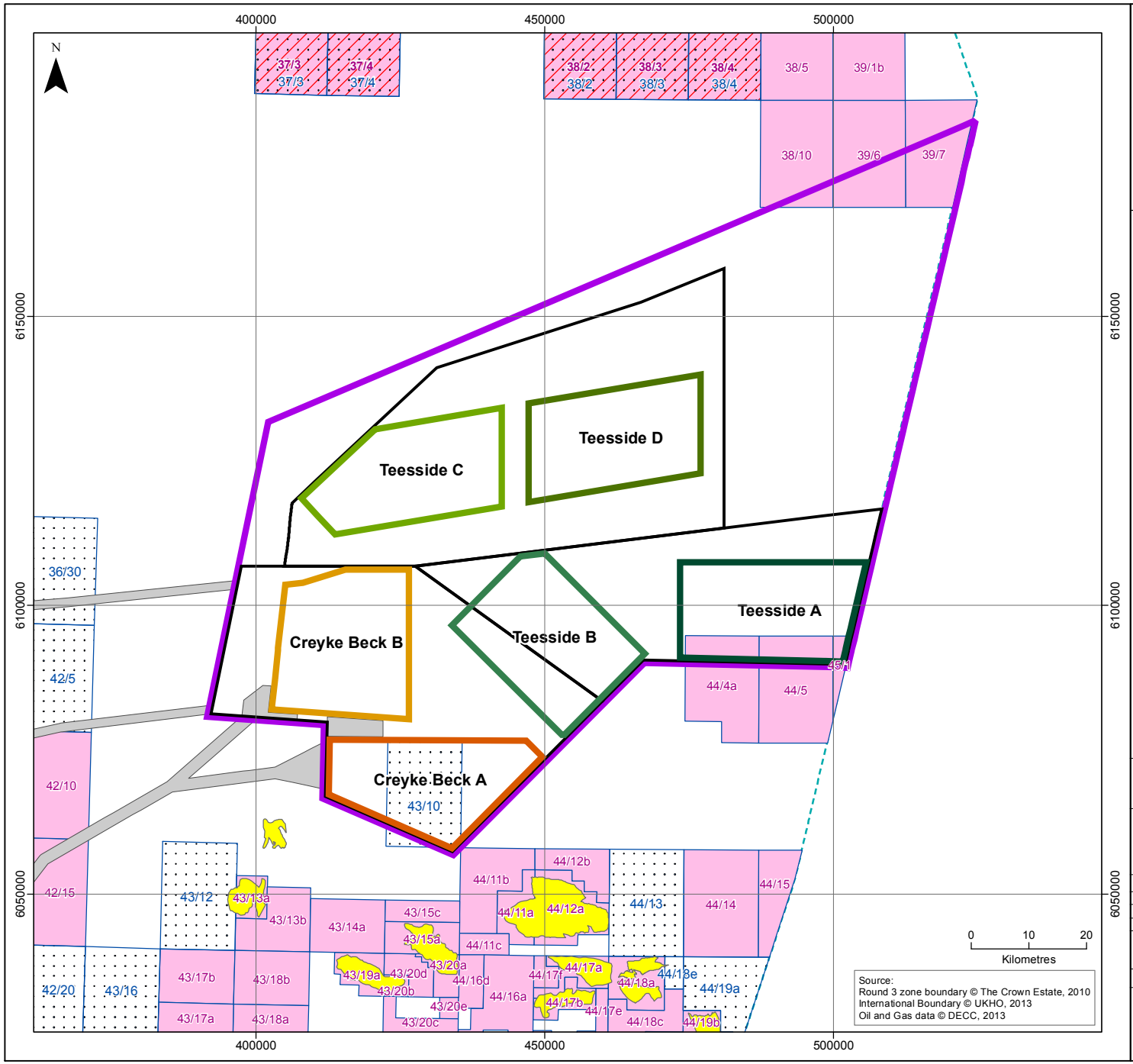
VER	DATE	REMARKS	Drawn	Checked
1	22/03/2013	First issue	AJ	MS
2	02/05/2013	Teesside AB Inzone cable corridor amended	AJ	MS
3	04/07/2013	Teesside CD Inzone cable corridor added	AJ	MS
4	31/07/2013	Tranche C and D boundary added	AJ	KH
5	06/08/2013	Teesside C & D cable corridor removed	AJ	KH

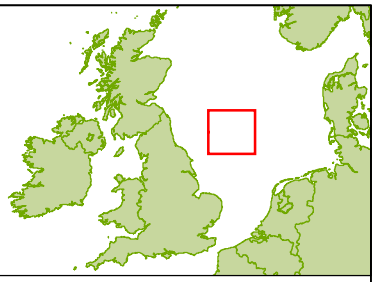
DRAWING NUMBER:

M-DES-0190-05

SCALE	PLOT SIZE	DATUM	PROJECTION
1:800,000	A4	WGS84	UTM31N

FOREWIND





LEGEND

- Dogger Bank Round 3 Zone
- Tranche Boundary
- Export Cable Corridor
- International Boundary

Project Boundaries

- Creyke Beck A
- Creyke Beck B
- Teesside A
- Teesside B
- Teesside C
- Teesside D

Oil and Gas blocks

- Field Boundaries
- 27th Round Provisional Awards
- HRA Screening blocks
- Oil and Gas Current Licenced Blocks

PROJECT TITLE

DOGGER BANK R3 DEVELOPMENT

DRAWING TITLE

Figure 21
Oil and Gas Blocks in the Vicinity of Dogger Bank

VER	DATE	REMARKS	Drawn	Checked
1	22/03/2013	First issue	AJ	MS
2	08/05/2013	HRA Screening Blocks added	AJ	MS

DRAWING NUMBER:

M-SOC-0029-02

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

FOREWIND

4.4 Summary of boundary identification

4.64 Forewind has identified the developable area within the Dogger Bank Zone in an iterative manner, based on broad environmental and consenting considerations informed by desk-based assessment and offshore survey. This process was driven by an understanding of the key constraints on development and a desire to reduce the effects of all projects, both alone and cumulatively. This has led to the identification of Tranche C, the third tranche in the Dogger Bank Zone, where Dogger Bank Teesside C & D is planned to be located.

4.65 In identifying the boundaries for Dogger Bank Teesside C & D, Forewind produced optimum array boundaries based on the design principles applied in the identification of the first four wind farm projects.

4.66 Following this, an assessment was carried out to determine whether there were any key environmental or consenting considerations that would cause Forewind to reconsider the boundaries.

4.67 Forewind's understanding of the environmental, consenting and spatial issues within the developable area, and in the absence of the full results of any wind farm array specific EIA, is as follows:

- Zone-wide data and desk based studies have not shown any significant geological issues and the wind farm array boundaries have been located in areas where the water depth does not exceed 50m below LAT;
- Overall, fishing activity across the Dogger Bank Zone is relatively low, with the exception of the sand eel fishery on the western edge. This area has been previously removed from the development area and was a key driver in the identification of the location for Dogger Bank Teesside C & D projects;
- Having undertaken Zone-wide boat-based and aerial marine mammal and bird surveys, Forewind has identified that the most abundant species across the Dogger Bank Zone is harbour porpoise. However, there are no areas where the population is sufficiently dense to require boundary amendment;
- The Zone-wide boat-based and aerial marine mammal and bird surveys have revealed high numbers of birds throughout the Dogger Bank Zone, albeit with greater densities in certain areas. A careful consideration of the observed densities has led to the exclusion of development from the western edge of the Dogger Bank Zone. This exclusion area has also served to reduce the potential cumulative effects on birds of the Dogger Bank Zone and individual projects within the zone;
- The optimum array boundaries are located partially within a cSAC. Whilst detailed surveys for Tranche C have only just been completed and the data not yet

analysed, previous surveys of the same cSAC, within Tranches A and B, have shown that the habitats and species present are generally those considered to be tolerant to disturbance and have high recoverability. Whilst a less developable area to the north of the Dogger Bank Zone has been identified as part of the Zone-wide surveys, this has been avoided by the exclusion of this area from development. Further analysis of the survey data obtained from the Tranche C surveys will help verify these assumptions and inform the EIA for Dogger Bank Teesside C & D, which may include proposals to micro-site foundations or micro-route cables if any sensitive benthic features are identified;

- There is an aggregates application area within the Dogger Bank Zone; however, with a 2km buffer applied, there is anticipated to be no interaction with the proposed array boundaries and this was not therefore a limiting factor for boundary development;
- The Dogger Bank Zone has a comparatively low shipping density relative to both its size and other North Sea Round 3 Zones. As such, route deviations caused by developing offshore wind farms within the Dogger Bank Zone are not anticipated to induce a significant increase in transit time for vessels. Therefore, it was not considered that any area of the zone should be avoided from a navigational risk perspective and therefore would there was no need to amend the boundaries;
- Early data collection and conflict checks from The Crown Estate have identified cables and pipelines in proximity to the Dogger Bank Zone. When considering the array boundaries for Dogger Bank Teesside C & D, one cable and one pipeline were identified as having potential to influence array boundaries. The SEAL pipeline to the west of the Dogger Bank Zone is avoided by the optimum wind farm array boundaries, as this area has previously been identified as a constraint of the developable area. The decommissioned UK-Denmark 4 telecoms cable interacts directly with the proposed wind farm array boundary for Teesside C. However, as this cable is now registered as inactive, this cable can be removed in full or in part prior to construction and as such did not require a change of the proposed wind farm array boundaries, subject to an agreement with the asset owner;
- A consideration of cumulative effects has also been a key driver in the development of the array boundaries for Dogger Bank Teesside C & D. By ensuring that the projects are located in an area where constraints are lower than other areas, the potential for cumulative effects has been reduced. This has been particularly important for the consideration of cumulative effects on birds, fish, marine mammals, commercial fishing and shipping and navigation.

5 Final Teesside C & D array boundaries

5.1 Overview

5.1 After assessing the developable area and identifying Tranche C, optimum array boundaries were modelled to maximise the economics of the wind farm arrays. These array boundaries were then assessed against a variety of environmental and consenting considerations which are well understood due to the extensive work already undertaken by Forewind during the ZAP process and the undertaking of surveys to inform the EIA for the first four projects in the Dogger Bank Zone. By considering all available information, the boundaries have been optimised to avoid significant constraints, as described in Section 3. This assessment has identified no significant environmental drivers to amend the optimum wind farm array boundaries of Dogger Bank Teesside C & D, and as such the final locations of these boundaries are shown in Figure 22.

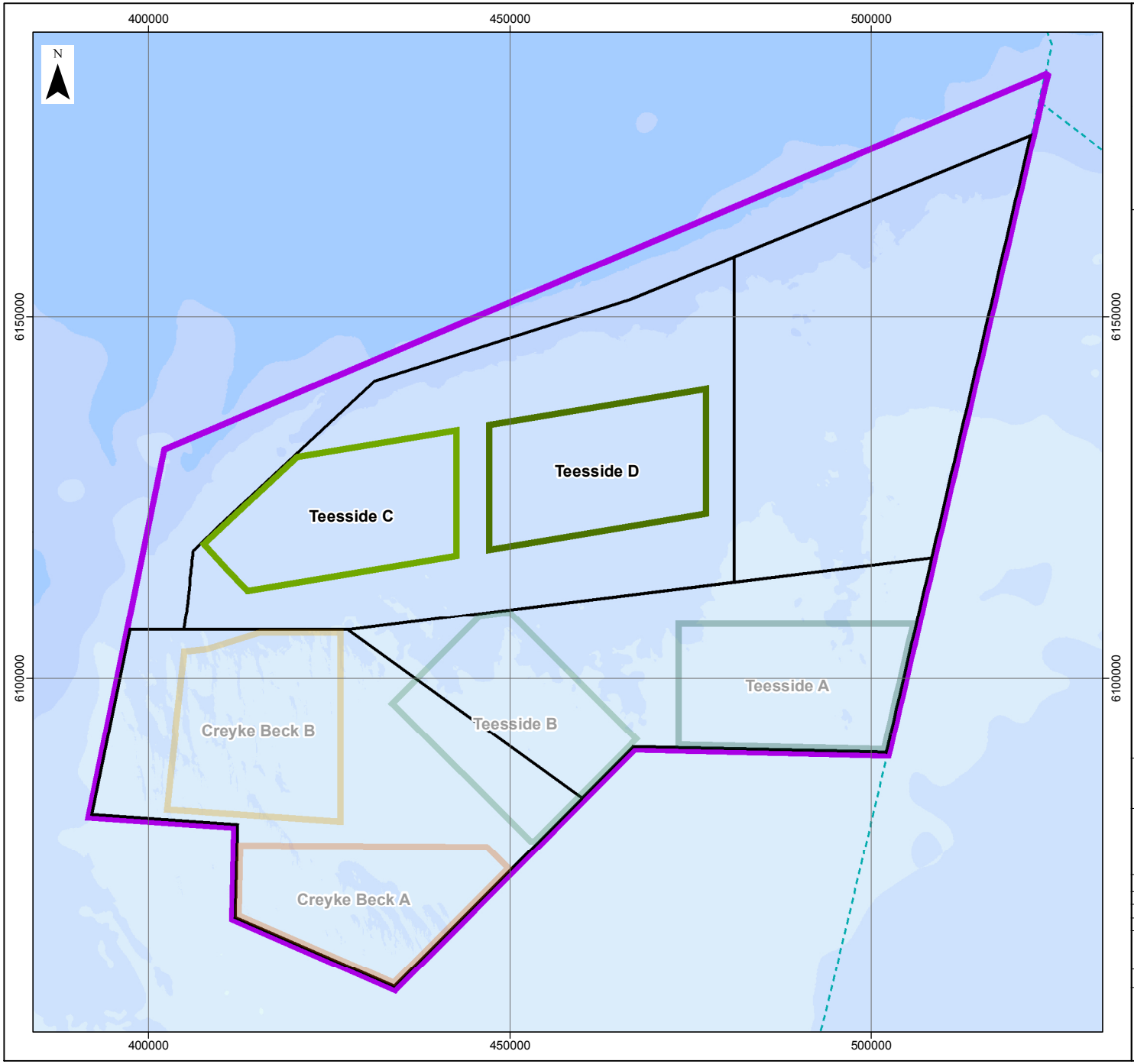
5.2 The parameters and technical details of the boundaries of Dogger Bank Teesside C & D are described in the following sections.

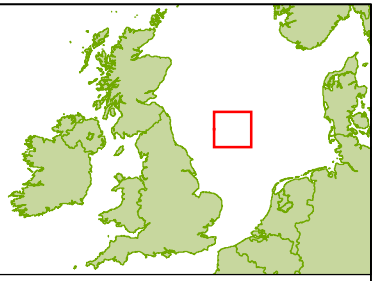
5.2 Dogger Bank Teesside C

5.3 Dogger Bank Teesside C is located within the northern portion of the Dogger Bank Zone in Tranche C. The key characteristics are listed in Table 9.

Parameter	Value
Wind farm array size	560km^2
Wind farm array Capacity	Up to 1200MW
Grid Connection Point	Tod Point
Distance from shore (closest point)	157km
Predominant water depth range	29 – 44m below LAT

Table 9 Dogger Bank Teesside C wind farm characteristics





LEGEND

- Tranche Boundary
- Dogger Bank Round 3 Zone
- International Boundary

Project Boundaries

- Creyke Beck A
- Creyke Beck B
- Teesside A
- Teesside B
- Teesside C
- Teesside D

0 10 20
Kilometres

Source:
Round 3 © TCE, 2010
International Boundary © UKDeal, 2010
Background bathymetry image derived in part from TCarta data © 2009

PROJECT TITLE

DOGGER BANK R3 DEVELOPMENT

DRAWING TITLE

Figure 22
Dogger Bank
Final Teesside C & D Project Boundaries

VER	DATE	REMARKS	Drawn	Checked
1	22/03/2013	First Issue	AJ	MS

DRAWING NUMBER: **M-DES-0218-01**

SCALE	PLOT SIZE	DATUM	PROJECTION
1:800,000	A4	WGS84	UTM31N

FOREWIND

5.4 The area for Dogger Bank Teesside C is 560km^2, which is greater than the optimum area identified previously in Section 4.2. The additional area is to provide the wind farm array with greater flexibility for environmental and engineering issues. Additional wind farm array area will give flexibility to reposition wind turbines and other offshore assets.

5.5 The boundary coordinates of the Dogger Bank Teesside C are shown in Table 10.

	Easting	Northing	Longitude	Latitude
	(metres)		(Decimal Degrees)	
1	420367.91	6131015.56	1.74512368	55.31907230
2	443031.76	6134805.80	2.10144099	55.35627291
3	443031.76	6116639.17	2.10511907	55.19304727
4	413484.25	6111697.72	1.64260449	55.14436752
5	407054.43	6118583.29	1.53949832	55.20505747

Table 10 Dogger Bank Teesside C boundary coordinates (co-ordinates presented in WGS84 UTM 31N format)

5.3 Dogger Bank Teesside D

5.6 Dogger Bank Teesside D is located within the northern portion of the developable area, in Tranche C. The key characteristics are listed in Table 11.

Parameter	Value
Wind farm array size	560km^2
Wind farm array Capacity	Up to 1200MW
Grid Connection Point	Tod Point
Distance from shore (closest point)	192km
Predominant water depth range	32 – 42m below LAT

Table 11 Dogger Bank Teesside D wind farm characteristics

5.7 The area for Dogger Bank Teesside D is 560km^2 which is greater than the optimum area identified previously in Section 4.2. The additional area is to provide the wind farm array with greater flexibility for environmental and engineering issues. Additional

wind farm array area will give flexibility to reposition wind turbines and other offshore assets.

5.8 The relative coordinates of the Dogger Bank Teesside D are shown in Table 12.

	Easting	Northing	Longitude	Latitude
	(metres)		(Decimal Degrees)	
1	446674.90	6135415.08	2.69959961	55.57092237
2	477510.46	6140571.94	3.35065416	55.72152078
3	477510.46	6122405.30	3.13118496	55.19698942
4	446674.90	6117248.44	2.70264791	55.16644735

Table 12 Dogger Bank Teesside D boundary coordinates (co-ordinates presented in WGS84 UTM 31N format)

6 Teesside C & D in-Zone export cable corridor identification

6.1 Introduction

6.1 Once the final array boundaries for Dogger Bank Teesside C & D were decided, Forewind undertook an assessment to identify the export cable corridor from the array boundaries to the previously identified export cable exit points on the edge of the Dogger Bank Zone. These exit points had been defined by the selection process for the export cable corridor from the Dogger Bank Zone boundary to the landfall for the Dogger Bank Teesside projects, as described in the Dogger Bank Teesside Export Cable Corridor Selection Report (Forewind, 2012d).

6.2 The process for this identification reflected the process undertaken in selecting the array boundaries for Dogger Bank Teesside C & D. The cable corridor was then assessed against a range of detailed environmental and consenting constraints to evaluate whether there were any significant drivers to amend or move this cable corridor.

6.3 A more detailed breakdown of the engineering and economic considerations and the environmental and consenting considerations is provided in the following sections.

6.2 Engineering and economic considerations

6.4 When selecting the in-Zone export cable corridor, a key driver was the potential economics of the proposed corridor, with the aim to minimise cable installation costs.

6.5 The first factor was to try and adopt the shortest point-to-point route as reasonably practicable, whilst considering the other constraints to be applied. In doing this, Forewind aims to minimise the length of cable required thus reducing installation time and cost. This approach also delivers environmental benefit by minimising the area of disturbance to the seabed and subsequent impact on benthic communities.

6.6 Although the width of seabed required to bury or protect the export cable will not exceed 20m, ideally in most places the corridor should be 1km wide. The justification for this is to allow for flexibility and obstacle avoidance when routing and installing the export cable, whilst balancing this against the cost of surveying the area.

6.7 A further engineering consideration was related to the potential layout of the collector and converter platforms within the wind farm array boundaries. Each of Dogger Bank Teesside C & D will have up to four collector platforms and up to one converter platform. To mitigate the risk to navigational safety, these will be located in symmetrical positions. The export cables will therefore be likely to exit the array

boundary approximately half way along either of the two sides closest to the western edge of each project.

6.8 Other considerations included avoiding crossing the other boundaries of the other projects in the Dogger Bank Zone where possible. Whilst the proposed cable corridor crosses the wind farm array boundary for Dogger Bank Creyke Beck B, this has been balanced with maintaining flexibility for routing the cable during installation.

6.9 Consideration was also given to the aggregates application area within the Dogger Bank Zone. Forewind has incorporated a 2km buffer, as agreed with Cemex, the developer of this area, into the design of the in-Zone cable corridor. However, Forewind has also allowed some extra width to extend the survey area of the corridor into this 2km buffer. The rationale for this is that as the aggregate area is at the application stage, should it not be granted permission then there would be additional flexibility for the routing of the export cable. If the aggregates application area is consented, Forewind will maintain a 2km buffer from this area when finalising the route of the export cable.

6.10 The proposed in-Zone export cable corridor has also been selected in order to avoid having no more than two sets of export cables in proximity to one another – the in-Zone export cable corridor for Dogger Bank Teesside C & D will not be in proximity to the proposed in-Zone export cable corridors for Dogger Bank Teesside A & B or Dogger Bank Creyke Beck A & B. The principle reason for this is to reduce the risk of loss or damage to all export cable from a single incident.

6.11 In order to access the exit points on the western edge of the Dogger Bank Zone, the export cable will have to cross the SEAL pipeline. Forewind took this into account when identifying the in-Zone cable corridor, with a view to ensuring flexibility with this crossing and keeping time and cost of crossing this pipeline to a minimum. There is also an out-of-service cable operated by BT, UK-Denmark 4, which intersects the Dogger Bank Zone. As this cable is out-of-service, it can be removed in full or in part if necessary, subject to an agreement with the asset owner and is therefore unlikely to need to be considered for a potential crossing. Forewind is currently undertaking consultation with the relevant cable and pipeline operators with a view to agreeing proximity and crossing agreements prior to construction.

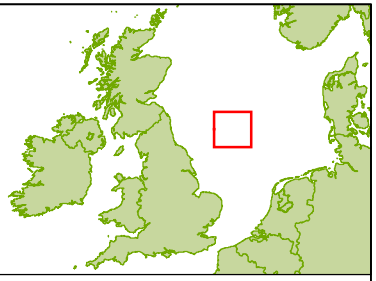
6.12 A final consideration when identifying the in-Zone export cable corridor is the future identification of the export cable exit points for the final two wind farm arrays within Tranche D. By allowing space north of the boundaries for Dogger Bank Teesside C & D, for the exit points and in-Zone export cable corridor for future wind farm arrays, the overall Dogger Bank Zone development costs can be reduced.

6.13 Applying all these considerations to the identification process produced an optimum in-Zone export cable corridor, as shown in Figure 23.

6.3 Environmental and other consenting considerations

6.14 Upon producing an optimum in-Zone export cable corridor, Forewind undertook an assessment of environmental and consenting considerations that may influence route development. This process identified constraints and ensured that the selected route minimised the environmental impact from the installation and operation of the export cable.

6.15 The constraints considered in this process were in line with those applied to the selection of the wind farm array boundaries. The assessment was based on desk-based and survey data and demonstrated that no significant environmental factors existed that required an adjustment to the optimum in-Zone export cable corridor. Therefore, the final layout taken through for assessment and surveying is that shown in Figure 23.



LEGEND

- Dogger Bank Round 3 Zone
- Dogger Bank Developable Area
- Tranche Boundary
- Teesside C and D in-zone cable corridor
- Teesside C and D cable corridor outside of zone
- International Boundary

Project Boundaries

- Creyke Beck A
- Creyke Beck B
- Teesside A
- Teesside B
- Teesside C
- Teesside D

0 10 20
Kilometres

Source:
Round 3 zone boundary © The Crown Estate, 2010
International Boundary © UKDeal 2010

PROJECT TITLE
DOGGER BANK R3 DEVELOPMENT

DRAWING TITLE
Figure 23
Optimum in-Zone export cable corridor for Teesside C & D

VER	DATE	REMARKS	Drawn	Checked
1	06/08/2013	First issue	AJ	KH

DRAWING NUMBER:
M-DES-0222-01

SCALE	PLOT SIZE	DATUM	PROJECTION
1:800,000	A4	WGS84	UTM31N

FOREWIND

7 Conclusion

7.1 Summary of identification process

7.1 Forewind undertook an iterative selection process to identify the final two tranches, Tranche C and Tranche D, the array boundaries for Dogger Bank Teesside C & D and the in-Zone export cable corridor for those wind farm array boundaries.

7.2 This selection process has utilised both desk-based and site specific survey data gathered as part of the ZAP process. The environmental data have had the biggest effect on defining the overall developable area across the Dogger Bank Zone, as Forewind has sought to take forward projects which have the smallest environmental impact, both individually and cumulatively. Engineering and economic criteria were then used to identify the tranches, array boundaries and in-Zone export cable corridor, based on the environmental parameters previously identified.

7.3 The developable area has previously been identified with environmental constraints such as sand eel, birds and commercial fisheries, and engineering constraints such as water depth, influencing where projects can be located.

7.4 Tranche selection followed on from the work identifying the developable area, and used engineering principles such as optimum wind farm array areas and distance to shore to identify Tranches C and D.

7.5 Having identified Tranche C, a range of wind farm array boundaries for Dogger Bank Teesside C & D was modelled to identify the optimum locations considering engineering constraints and the economics of each wind farm array. These were then tested against a wide range of environmental and consenting constraints, particularly those of potential importance to a future EIA. Using the data available, no significant drivers were identified which had the potential to change the optimum array boundaries and these locations were therefore taken forward.

7.6 Finally, once the boundaries for Dogger Bank Teesside C & D had been selected, the in-Zone export cable corridor selection process was progressed, using the same process identified for the array boundaries. Again, the data available was used to define the most appropriate export cable route based upon known environmental and engineering constraints.

7.1 Next steps

7.7 The array boundaries and in-Zone export cable corridor identified within this report will be taken forwards for the purposes of EIA. Where possible, further site specific data will be used to optimise wind turbine and array layouts and minimise environmental impacts wherever possible.

7.8 Forewind is continuing to commission and undertake offshore surveys, such as fish ecology, benthic ecology, bird and marine mammal surveys, the scope of which have been agreed with the relevant Government agencies and other stakeholders prior to survey work being undertaken. These data will inform the EIA for Dogger Bank Teesside C & D and allow the prediction of the effects arising from the construction, operation and decommissioning of the Dogger Bank Teesside C & D projects on the environment.

7.9 As a responsible developer, Forewind intends to continue consultation with all stakeholders throughout and after the undertaking and submission of the EIA. This will include the methodologies to be used for undertaking the EIA and the draft findings from the EIA process before an application for consent occurs. Forewind will also seek to consult all stakeholders who may either be affected by the Teesside C & D projects, or who may have an interest in them.

7.10 With respect to Tranche D, whilst this area had been identified for two further projects, at the time of writing no grid connections have been identified as available. Until such connections are secured, Forewind's development activities will focus on the first six projects, totalling 7.2GW.

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For more information

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