FOREWIND

DOGGER BANK
TEESSIDE A & B

March
2014

Environmental Statement Chapter 18 Marine and Coastal Archaeology

Application Reference 6.18

Cover photograph: Installation of turbine foundations in the North Sea

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Forewind Approval			
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Angela Lowe</td><td colspan="2">Signature / Approval (Forewind)

Gareth Lewis</td><td>Approval Date:

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Revision History

Date	Issue No.	Remarks / Reason for Issue	Author	Checked	Approved
29 July 2013	1	Issued for 1st Technical Review	FS	AL	AMP
21 August 2013	1.2	Issued for 2nd Technical Review	FS	AL	AL
04 September 2013	2	Issued for Quality Review	FS	AL	AL
03 October 2013	2.1	Issued for Approval	GS	AL	AL
10 October 2013	3	Issued for PEI 3	GS	AL	RAH
24 January 2014	4	Pre-DCO submission review	FS	BLO	AL
13 February 2014	4.1	DCO submission	FS	BLO	AL

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1. Introduction

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

1.1.2. The marine and coastal archaeology resource occurring within Dogger Bank Teesside A & B includes sites, features and finds, and prehistoric land surfaces. Collectively these constituents are referred to as the 'historic environment' resource within this chapter.

1.1.3. Related chapters include:

- Seascape and Visual Character (considered in **Chapter 20 Seascape and Visual Character**);
- Terrestrial archaeology (considered in **Chapter 27 Terrestrial Archaeology**); and
- Marine Physical Processes (considered in **Chapter 9 Marine Physical Processes**).

1.1.4. This chapter deals with historic seascape considerations below sea level. **Chapter 20** deals with historic seascape considerations above sea level.

1.1.5. The information presented in this chapter is based on a technical report authored by Wessex Archaeology, which is available in full in **Appendix 18A Archaeology and Cultural History Technical Report**. Wessex Archaeology also conducted the impact assessment (**Appendix 18A**).

2. Guidance and Consultation

2.1. Legislation, policy and guidance

2.1.1. The assessment of potential impacts upon the historic environment resource has been made with specific reference to the relevant National Policy Statements (NPS). These are the principal decision making documents for Nationally Significant Infrastructure Projects (NSIP). Those relevant to Dogger Bank Teesside A & B are:

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

2.1.2. The specific assessment requirements for the historic environment, as detailed within the NPS, are repeated in the following paragraphs. Where any part of the NPS has not been followed within this assessment, an explanation as to why the requirement was not deemed relevant, or has been met in another manner, is provided.

2.1.3. EN-1 clearly states that "*the applicant should provide a description of the significance of the heritage assets affected by the proposed development and the contribution of their setting to that significance*."

2.1.4. EN-1 then identifies in general the requirement for undertaking investigations and development of the historic environment baseline and assessment, stating that:

> *Where a development site includes, or the available evidence suggests it has the potential to include, heritage assets with an archaeological interest, the applicant should carry out appropriate desk-based assessment and, where such desk-based research is insufficient to properly assess the interest, a field evaluation.*

2.1.5. It also clarifies that the significance of the historic environment receptors (or heritage assets) should be understood and reported on.

2.1.6. In defining the Infrastructure Planning Commissions (IPC) (now the Planning Inspectorate) requirements for considering the effects on the historic environment resource, EN-1 states that:

> *There should be a presumption in favour of the conservation of designated heritage assets and the more significant the designated heritage asset, the greater the presumption in favour of its conservation should be.*

2.1.7. Consequently, a key focus of the historic environment consideration is to avoid potentially significant impacts wherever possible, either through micro-siting or other mitigation measures. However, where historic environment receptors are affected, there is a requirement to record (preserve by record) and advance the understanding of the heritage asset before any effect arises.

2.1.8. The recommendations and statements made in EN-1 are reiterated in EN-3, with inclusion of the use of geophysical and geotechnical information to further understanding and knowledge of the known or potential historic environment resource.

2.1.9. The assessment also takes account of the UK Marine Policy Statement (MPS) (Department for Environment, Food and Rural Affairs (Defra 2011) in regard to historic environment.

2.1.10. Paragraph 2.6.6.3 of the MPS states:

> *The view shared by the UK Administrations is that heritage assets should be enjoyed for the quality of life they bring to this and future generations, and that they should be conserved through marine planning in a manner appropriate and proportionate to their significance. Opportunities should be taken to contribute to our knowledge and understanding of our past by capturing evidence from the historic environment and making this publicly available, particularly if a heritage asset is to be lost.*

2.1.11. Paragraph 2.6.6.9 of the MPS states:

> *Where the loss of the whole or a material part of a heritage asset's significance is justified, the marine plan authority should identify and require suitable mitigating actions to record and advance understanding of the significance of the heritage asset before it is lost. Requirements should be based on advice from the relevant regulator and advisors.*

2.1.12. A detailed description of all additional relevant legislation, policy and guidance is provided within the marine and coastal archaeology environmental impact assessment technical report, which is provided as **Appendix 18A**. In summary, however, further specific guidance into identifying, describing, evaluating and assessing the potential effects of the proposed development on the historic environment resource are provided in the following, and which have been considered in the development of this chapter:

- Protection of Wrecks Act (PWA) 1973;
- Ancient Monuments and Archaeological Areas Act (AMAA) 1979;
- United Nations Convention on the Laws of the Sea 1982;
- Protection of Military Remains Act (PMRA) 1986;
- Planning (Listed Buildings and Conservation Areas) Act 1990;
- European Convention on the Protection of the Archaeological Heritage (Valletta) 1992;
- Merchant Shipping Act 1995;
- ICOMOS International Charter on the Protection and Management of Underwater Cultural Heritage (Sofia Charter) 1996;
- England's coastal heritage (English Heritage 1996);
- Identifying and Protecting Palaeolithic Remains (English Heritage 1998);
- European Landscape Convention 2000;

- UNESCO Convention on the Protection of the Underwater Cultural Heritage 2001;
- Military Aircraft Crash Sites (English Heritage 2002);
- Code of Practice for Seabed Development (Joint Nautical Archaeology Policy Committee 2006);
- COWRIE Historic Environment Guidance for the Offshore Renewable Energy Sector (Wessex Archaeology 2007);
- COWRIE Guidance for Assessment of Cumulative Impacts on the Historic Environment from Offshore Renewable Energy (Oxford Archaeology 2008);
- Marine and Coastal Access Act 2009;
- North Sea Prehistory Research and Management Framework (Peeters *et al*. 2009);
- Model Clauses for Archaeological Written Schemes of Investigations (Crown Estate and Wessex Archaeology 2010);
- PPS5: Planning for the Historic Environment Practice Guide (English Heritage 2010);
- COWRIE Offshore Geotechnical Investigations and Historic Environment Analysis: Guidance for the Renewable Energy Sector (EMU 2011);
- The Setting of Heritage Assets (English Heritage 2011);
- Standard and Guidance for Historic Environment Desk-based Assessment (Institute for Archaeologists, revised 2012);
- National Planning Policy Framework (Department for Communities and Local Government 2012); and
- Other recent relevant practice and guidance documents for marine and coastal archaeology, including English Heritage's Introductions to Heritage Assets series.

2.2. Consultation

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

- A request for a Scoping Opinion submitted to the Planning Inspectorate (PINS) May 2012;
- Scoping Opinion received from PINS, including responses from the Secretary of State and English Heritage June 2012;
- A late scoping consultation response was received from the Marine Management Organisation (MMO) on 22 June 2012, but there were no references to marine and coastal archaeology within the MMO response.
- First stage of statutory consultation (in accordance with sections 42 and 47 of the Planning Act 2008) on Preliminary Environmental Information (PEI) 1 (report published May 2012); and

- Second stage of statutory consultation (in accordance with sections 42, 47 and 48 of the Planning Act 2008) on the draft ES designed to allow for comments before final application to the Planning Inspectorate.

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

2.2.3. **Table 2.1** summarises issues that have been highlighted by the consultees throughout the consultation process and indicates which sections of the ES address each issue. This table only includes the key items of consultation that have defined the assessment to date. The full record of consultation and an explanation as to how the comments have been considered have been provided alongside this ES, in the Consultation Report.

Table 2.1 Summary of consultation responses

Date and form of consultation	Raised by	Summary	Section where addressed
January 2014 (Section 42 Consultation on the draft ES)	English Heritage	Paragraph 3.2.9 - regarding an agreement with English Heritage that the appointed archaeological contractors "would only review seabed anomalies measuring 5m or greater in any one dimension, as identified by GEMS in their review of all data in support of engineering objectives." We must add that this approach does not negate action that should be taken by the developer to protect or mitigate any impact on any known, or unknown archaeological sites that might not be identified because of the resolution for interpretation that was selected. Furthermore in reference to paragraph 6.4.17, we appreciate that further identification and qualification of anomalies of potential archaeological interest will be addressed post-consent through the acquisition pre-construction geophysics data. However, survey standards to support archaeological interpretation and sufficient time for archaeological review of results must be factored into the project delivery timetable to fully inform any subsequent installation programme.	Consideration of archaeological objectives in the planning of pre-construction surveys forms part of the WSI, as does the subsequent archaeological assessment of this data. This will ensure that full consideration is given to the protection of known and unknown archaeological sites and will inform the mitigation measures required to prevent significant impacts to them from the construction, operation and decommissioning of Dogger Bank Teesside A & B. See section 8.5 of the WSI.

Date and form of consultation	Raised by	Summary	Section where addressed
January 2014 (Section 42 Consultation on the draft ES)	English Heritage	Paragraph 4.6.14 – we require further explanation regarding the statement that the sensitivity (value) of the current character was dominated by “dense industrial and shipping activity” which is considered to be “tolerant to change and able to adapt to accommodate elements associated with offshore renewables.” In particular, is a qualitative and/or quantitative judgement used to determine if a particular character “dominates” and thereby is not affected by any change in character as represented by the proposed development?	This chapter and **Appendix 18A Archaeology and Cultural History Technical Report** have been updated to remove qualitative and/or quantitative judgements in determining character while retaining descriptive text on how the character will change to inform decision making. See Section 4.6 and Sections 6 –11 of this chapter and **Appendix 18A Archaeology and Cultural History Technical Report** sections 9 and 12 – 19.
January 2014 (Section 42 Consultation on the draft ES)	English Heritage	Table 5.1 – We noted that the information provided describes an anticipated area or volume of seabed disturbed to support installation of 200 or 400 turbines plus ancillary infrastructure. However, in consideration of the site specific characteristics of archaeological and historic sites or palaeo-environment features, we require estimation of depths of seabed disturbance, so that we are in an informed position to provide advice about suitable mitigation strategies. We add that such information is necessary given the detail under the parameter “installation of wind turbine foundations” that states: “Indicative max penetration into seabed - typically due to skirts (below seabed surface): 10m” for either 200 or 400 6MW turbines gravity base foundations. This clarification is also applicable for the following parameters: “installation of offshore platform foundations” which states “Indicative skirt depth: 5m”; and “Installation of Meteorology Masts” which states “Indicative max penetration into seabed - typically due to skirts (below seabed surface): 10m”. It was also noticed that the parameter “route clearance” states that “Full route clearance and pre-lay grapnel runs to remove seabed and subsurface debris”. However, in consideration of the following: Installation of Inter-array	Maximum depth of 10m added as a worst case for sea bed preparation for foundation and 0.3m for route clearance. Cable installation to burial depth of 3m within the cable corridors is already considered. See **Table 5.1** of this chapter and **Appendix 18A Archaeology and Cultural History Technical Report** section 11.

Date and form of consultation	Raised by	Summary	Section where addressed
		cables; Installation of Inter-platform cables; and Installation of Export cables, which all have an "Indicative maximum burial depth: 3m." it would therefore seem relevant that, for the purposes of this table, that "route clearance" should be considered to have a worst case scenario whereby route clearance to support any cable installation is to a started maximum depth.	
January 2014 (Section 42 Consultation on the draft ES)	English Heritage	Paragraphs 6.3.16 to 6.3.18 – we noted the detail provided in these paragraphs regarding the application of Archaeological Exclusion Zones (AEZs). We also noted the detail of paragraph 6.3.19 that should further data support the case then further AEZs will be applied.	Comment noted
January 2014 (Section 42 Consultation on the draft ES)	English Heritage	Paragraphs 6.3.33 to 6.3.35 – we noted the attention given to the risk of encountering previously unknown archaeological materials and historic sites and we support the application of the Offshore Renewables Protocol for Archaeological Discoveries (ORPAD) system.	Comment noted
January 2014 (Section 42 Consultation on the draft ES)	English Heritage	Paragraphs 6.4.18 to 6.4.20 – we support the statements made in these paragraphs regarding the geoarchaeological assessment exercises conducted to date, and that further analysis and data gathering exercises are to be agreed and implemented as conditions of any consent granted for this proposed project.	Comment noted
January 2014 (Section 42 Consultation on the draft ES)	English Heritage	Paragraphs 7.4.12 and 7.4.14 – the attention to monitoring requirements as a component of any agreed archaeological Written Scheme of Investigation (WSI) is noted.	Comment noted
January 2014 (Section 42 Consultation on the draft ES)	English Heritage	Paragraphs 9.1.5 to 9.1.7 – in regard to the statements made about potential for fishing activities to be displaced because of the proposed Dogger Bank Teesside A & B projects, we hereby encourage the developer to continue promotion of the Fishing Industry Protocol for Archaeological Discoveries (FIPAD), as described in Forewind's Fisheries Update 2 (Issue Two, Summer/Autumn 2013) within the overall Forewind Dogger Bank Zone. We suggest that this would provide a	Comment noted

Date and form of consultation	Raised by	Summary	Section where addressed
		mechanism to determine if any displacement of fishing activity has resulted in more interaction with seabed archaeological sites.	
January 2014 (Section 42 Consultation on the draft ES)	English Heritage	Table 10.1 (potential cumulative impacts) – the detail is noted regarding “multiple impacts during construction, operation and decommissioning upon the archaeological resource (including on palaeo-environmental features (i.e. prehistoric landscape elements).”	Comment noted
January 2014 (Section 42 Consultation on the draft ES)	English Heritage	Paragraph 10.2.8 – we support the approach advocated that mitigation measures will be applicable to all Dogger Bank offshore wind farm projects. However, to address cumulative impact to identified historic environment receptors it will be necessary to ensure a consistent approach to the preparation and delivery of all WSI1 for all Forewind projects proposed within the Dogger Bank Zone. We make this point as a mechanism to ensure that the risk identified in Table 10.1 is addressed. In this regard, we do not concur with the conclusion made in paragraph 10.4.6 that determination of cumulative impact should not be made against the overall percentage of seabed that is subject to disturbance at a regional scale (undefined), but in reference to the identifiable and predictable archaeological resource, as described in Table 10.1. Furthermore, this same basis for determining impact to archaeological resources is supported by the statement made in paragraph 11.1.11 vis-à-vis any identifiable transboundary effects from impacts to palaeo-landscapes.	A consistency in approach across all WSIs for proposed wind farms in the Dogger Bank Zone has been, and will be, applied. This chapter and the Technical Report have been updated to remove the reference to overall percentage of seabed subject to disturbance and to reflect the conclusion that while cumulative effects will occur, there has been, and will continue to be, an accumulation of archaeological data representing a positive cumulative effect. See paragraphs 10.4.6 and 10.4.7 of this chapter and **Appendix 18A Archaeology and Cultural History Technical Report** paragraphs 19.3.6 and 19.3.7.
January 2014 (Section 42 Consultation on the draft ES)	English Heritage	Paragraphs 10.4.7 to 10.4.10 – we welcome the statements made in these paragraphs and the recognition that it is essential to adhere to accepted professional archaeological standards to ensure validity of the process adopted and the results produced. In addition to the policy documents quoted, we also direct your attention to National Policy Statement EN-3.	Reference to EN-3 has been included. See paragraph 10.4.9 of this chapter and **Appendix 18A Archaeology and Cultural History Technical Report** paragraphs 19.3.8 and 19.3.9.

Date and form of consultation	Raised by	Summary	Section where addressed
June 2012 (Scoping Opinion)	Planning Inspectorate	Assessment methodologies should be developed in consultation with English Heritage and the Joint Nautical Archaeological Policy Committee. The Assessment methodology takes account of current guidance and best practice.	Section 3 covers the methodology used to inform baseline characterisation and impact assessments.
June 2012 (Scoping Opinion)	Planning Inspectorate	Assessment methodologies must include an Archaeological Written Scheme of Investigation (WSI). A high level WSI has been produced for Dogger Bank Teesside A & B. Scheme specific WSIs will be produced for each project and/or project element once the design is finalised and Method Statements for specific archaeological works will be produced, as required.	Separate WSI is only referenced in this chapter (Sections 6, 7, and 8). The WSI will not form part of the submission, but is available upon request.
June 2012 (Scoping Opinion)	Planning Inspectorate	In assessing the potential impacts during the operational phase of the development, consideration should be given to the impacts associated with additional anti-scour materials in relation to the export and inter-array cabling and the turbines. Scour protection included in assessing the worst case scenario for archaeology for operational phase.	Sections 5 and 7 cover the assessments of impacts during construction and operation.
June 2012 (Scoping Opinion)	Planning Inspectorate	The ES should include a protocol based on best practice guidance that states how potential archaeological discoveries will be reported. Offshore Renewables Protocol for Archaeological Discoveries (ORPAD) included as a key mitigation strategy for potential archaeological discoveries as set out in WSI. A high level WSI has been produced for Dogger Bank Teesside A & B.	Separate WSI is only referenced in this chapter (Sections 6, 7, and 8). The WSI will not form part of the submission, but is available upon request.
June 2012 (Scoping Response)	English Heritage	During operation we consider impacts associated with additional anti-scour materials to be a relevant consideration in reference to both export and inter-array cabling and turbines. Scour protection included in assessing the worst case scenario for archaeology for operational phase.	**Chapter 9 Marine Physical Process** and Sections 5 and 7 cover the assessments of impacts during construction and operation.

Date and form of consultation	Raised by	Summary	Section where addressed
June 2012 (Scoping Response)	English Heritage	The planning of this project must be fully informed by an adequate interpretation of geophysics survey data to identify anomalies with archaeological potential. The assessment has been informed by geophysical data from Tranche A, Tranche B and the Dogger Bank Teesside A & B Export Cable Corridor.	Section 3 and **Appendix 18A Archaeology and Cultural History Technical Report** (appendices 1 to 3)
June 2012 (Scoping Response)	English Heritage	We stress the importance of the developer notifying us regarding further survey work. Commitment to archaeological involvement in future surveys is set out in the WSI to be agreed in further consultation with English Heritage. A high level WSI has been produced for Dogger Bank Teesside A & B.	Separate WSI is only referenced in this chapter (Sections 6, 7, and 8). The WSI will not form part of the submission, but is available upon request.
June 2012 (Scoping Response)	English Heritage	We will require the developer to produce, in agreement with us, an Archaeological WSI. A high level WSI has been produced for Dogger Bank Teesside A & B. Scheme specific WSIs will be produced for each project and/or project element once the design is finalised and Method Statements for specific archaeological works will be produced, as required.	Separate WSI is only referenced in this Chapter (Sections 6, 7, and 8). The WSI will not form part of the submission, but is available upon request.
June 2012 (Scoping Response)	English Heritage	The production of an archaeological WSI prior to development and in agreement with English Heritage should be prepared by a body affiliated to a professional association, such as the Institute for Archaeology. A WSI has been produced by Wessex Archaeology. Scheme specific WSIs will be produced by Wessex Archaeology. All required Method Statements will also be prepared by a body affiliated to a professional association.	Separate WSI is only referenced in this chapter (Sections 6, 7, and 8). The WSI will not form part of the submission, but is available upon request.

Date and form of consultation	Raised by	Summary	Section where addressed
June 2012 (Scoping Response)	English Heritage	Attention directed at the planning and delivery of analysis which is corroborated by information obtained from any geotechnical and geophysical surveying campaign commissioned for this project. The assessment has been informed by geophysical and geotechnical data commissioned by Forewind for Dogger Bank Teesside A & B and by palaeoenvironmental data from samples recovered through ORPAD as reported by Forewind. Commitment to archaeological involvement in future surveys set out in the WSI to be agreed with English Heritage.	Section 3 and **Appendix 18A Archaeology and Cultural History Technical Report** (Appendices 1 to 3). The WSI will not form part of the submission, but is available upon request.
June 2012 (Scoping Response)	English Heritage	Any archaeological reports produced as part of the WSI are to be agreed with English Heritage (and any relevant local authority) prior to the development commencing and the developer is also responsible for ensuring that copies of any agreed archaeological assessment reports are deposited with English Heritage. A WSI is to be submitted to English Heritage for approval. Consultation will continue with English Heritage with regard to scheme specific WSIs and Method Statements.	Separate WSI is only referenced in this chapter (Sections 6, 7, and 8). The WSI will not form part of the submission, but is available upon request.
June 2012 (Scoping Response)	English Heritage	The above requirement is completed by submitting an English Heritage OASIS (Online Access to the Index of archaeological investigations) form with a digital copy of the report. Notification of the completion of the OASIS form is to be sent, by the developer, to the relevant local authority for any aspect of this project that occurs within their area of responsibility for inclusion within any locally maintained Historic Environment Record. Requirement for OASIS submission is set out in the WSI. OASIS submission will be dealt with on completion of the project.	Separate WSI is only referenced in this chapter (Sections 6, 7, and 8). The WSI will not form part of the submission, but is available upon request.

Date and form of consultation	Raised by	Summary	Section where addressed
June 2012 (Scoping Response)	English Heritage	English Heritage supports action that delivers in situ protection and where this might not possible we must direct your attention to the UK Marine Policy Statement (published by HM Government and the Devolved Administrations in March 2011) to ensure that any to such action to disturb such sites takes full account of the historic environment. The avoidance of impacts through the application of Archaeological Exclusion Zones and through micrositing forms the primary method of mitigation set out in the ES and WSI.	Sections 5-8 cover the assessment of impacts during construction, operation and decommissioning. Separate WSI is only referenced in this chapter. The WSI will not form part of the submission, but is available upon request.
June 2012 (Scoping Response)	English Heritage	We add also that the Environmental Statement for this project must set out how a reporting protocol will be produced and we direct your attention to The Protocol for Archaeological Discoveries: offshore renewables projects published by The Crown Estate in December 2010. The Offshore Renewables Protocol for Archaeological Discoveries is included as a key mitigation strategy for potential archaeological discoveries, as set out in WSI.	Separate WSI is only referenced in this chapter (Sections 6, 7, and 8). The WSI will not form part of the submission, but is available upon request.

2.2.4. Please note that consultation with respect to Preliminary Environmental Information 3 (PEI 3) and post submission consultation (as a result of the relevant representations and the Rule 6 letter) for Dogger Bank Creyke Beck A & B has also been applied to Dogger Bank Teesside A & B.

3. Methodology

3.1. Study area

3.1.1. The study area covers the entire Dogger Bank Offshore Zone Development Envelope (ZDE)[1] and areas beyond to provide contextual information to the known and potential resource (**Figure 3.1**). This ensures that any potential constraints that may be present are assessed, particularly with regard to the significance of the heritage assets.

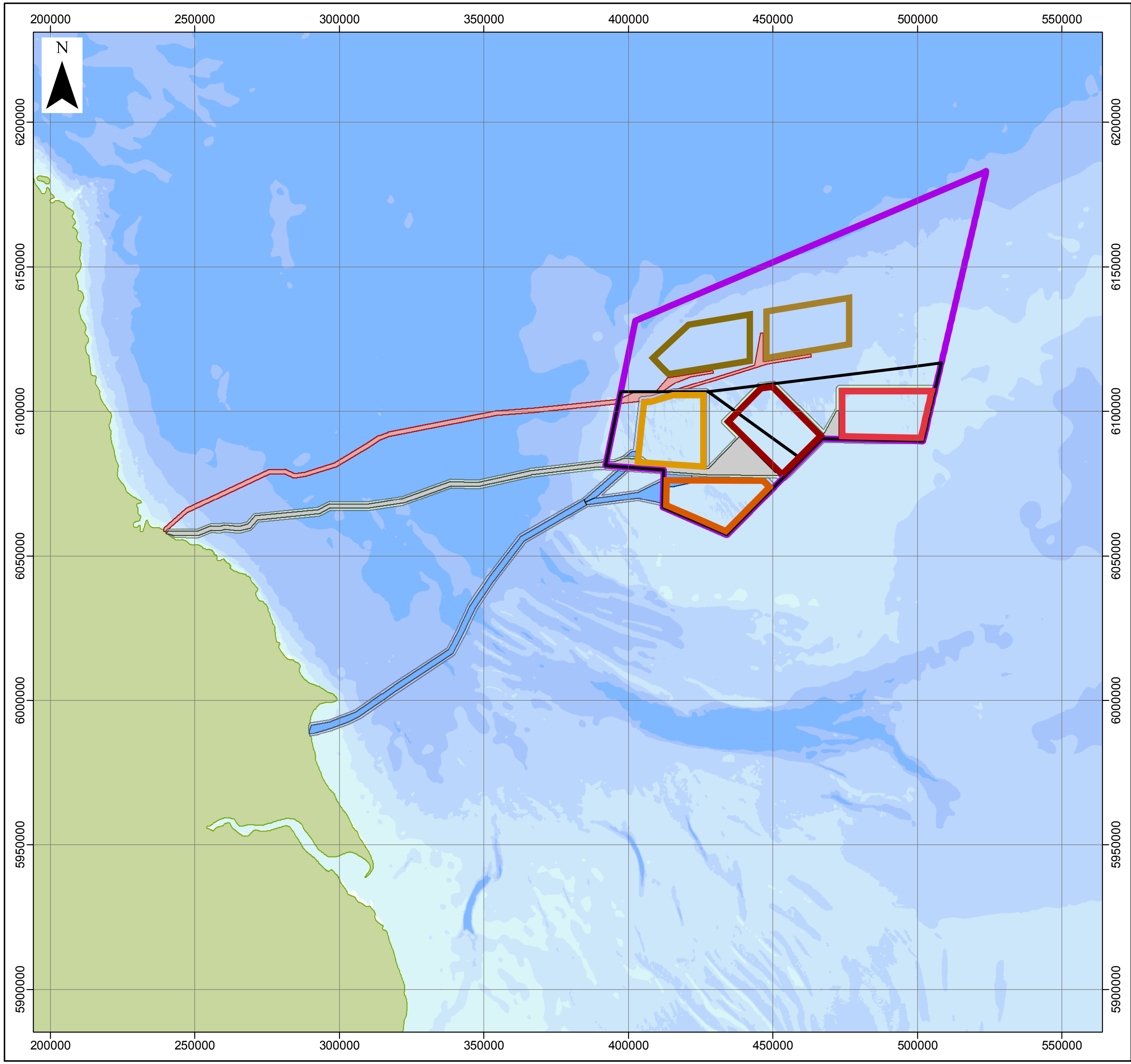
3.1.2. The baseline characterisation and impact assessment have been compiled with reference to Marine Study Areas (MSA) incorporating the project boundaries and Temporary Working Areas (TWA) defined by Forewind (**Figure 3.1**). The need for TWAs around offshore project and cable route boundaries was identified by Forewind for use during construction, within which vessels may carry out intrusive activities such as deploying anchors or jack-up legs as part of the construction process. The Dogger Bank Teesside A & B Export Cable Corridor MSA comprises the Teesside A & B Export Cable Corridor plus a 750m TWA. The Teesside A & B MSAs comprise the Teesside A & B project boundaries plus a 1km TWA.

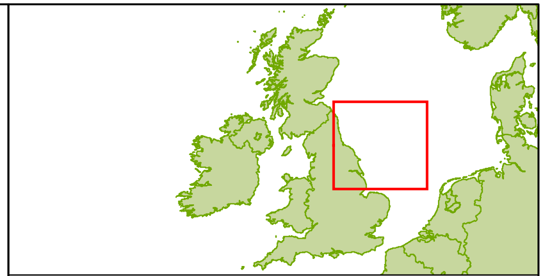
3.1.3. The westernmost limit of the Dogger Bank Teesside A & B Export Cable Corridor MSA is defined as Mean High Water incorporating the intertidal zone between Mean High Water and Mean Low Water. The Dogger Bank Teesside A & B Export Cable Corridor MSA continues offshore into the Dogger Bank Zone where it joins the project areas.

3.1.4. The historic environment resource has been divided into five categories, which are addressed in turn. These are:

- Landfall;
- Submerged prehistoric archaeology and palaeo-landscapes;
- Maritime or shipwreck archaeology;
- Aviation or aircraft archaeology; and
- Historic Seascape Character.

[1] The offshore ZDE was established as part of the Zone Appraisal and Planning process as the area encompassing the whole of the Dogger Bank Zone and the likely Dogger Bank Teesside A & B Export Cable Corridor to Mean High Water Springs.





LEGEND

- Dogger Bank Zone
- Tranche boundary
- Dogger Bank Creyke Beck A
- Dogger Bank Creyke Beck B
- Dogger Bank Teesside A
- Dogger Bank Teesside B
- Dogger Bank Teesside C
- Dogger Bank Teesside D
- Dogger Bank Creyke Beck Export Cable Corridor
- Creyke Beck temporary works area
- Dogger Bank Teesside A & B Export Cable Corridor
- Teesside A & B temporary works area
- Dogger Bank Teesside C & D Export Cable Corridor

0 20 40
Kilometres

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

PROJECT TITLE

DOGGER BANK TEESSIDE A & B

DRAWING TITLE

Figure 3.1 Marine and coastal archaeology, marine study area and cable route study area

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

DRAWING NUMBER: **F-OFL-MA-607**

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

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3.2. Characterisation of the existing environment – methodology

Archaeological desk based assessment

3.2.1. In order to identify the known and potential archaeological resource and to ascribe importance to the various heritage assets within the study area, a marine and coastal archaeology technical report (including environmental impact assessment) was produced by Wessex Archaeology (**Appendix 18A)** reflecting best practice as detailed by the Institute for Archaeologists (IfA) Standard and Guidance for Historic Environment Desk-based Assessment (IfA 1994, revised 2012). The approach also reflects the requirements of Environmental Assessment arising from European Council Directive 85/337/EEC as amended by Directive 97/11/EC. Both these directives were codified into Directive 2011/92/EU on 13 December 2011.

3.2.2. Principal data sources used to inform this chapter comprise:

- Seabed and sub-seabed geophysical survey datasets gathered for the current development;
- Geotechnical survey datasets gathered for the current development;
- Palaeoenvironmental evidence from samples of peat collected from trawls over Dogger Bank and reported through ORPAD (Wessex Archaeology 2013d);
- The United Kingdom Hydrographic Office (UKHO) records of chartered wrecks, obstructions and navigational hazards supplied by SeaZone;
- Records held by the National Record of the Historic Environment (NRHE); (formerly the National Monuments Record), including shipping and aircraft casualties and archaeological monuments and findspots;
- Records held by the Redcar and Cleveland Historic Environment Record (HER);
- Modern Admiralty and geological charts relevant to the MSAs; and
- Written secondary sources, including academic papers relating to previous archaeological and geophysical work in the region, and other offshore wind farm environmental statements in the public domain. Historic environment specific reports consulted included:
  - North East Rapid Coastal Zone Assessment (Tolan-Smith 2008);
  - North East Regional Research Framework for the Historic Environment (Petts and Gerrard 2006); and
  - England's Historic Seascapes Scarborough to Hartlepool and Adjacent Marine Zone (Val Baker *et al*. 2007).

3.2.3. The technical report obtained records of wrecks, casualties and seabed features from a variety of sources (as outlined above), which were then evaluated in terms of their importance (whether designated or undesignated, previous known or unknown). These are listed in a gazetteer and GIS (**Appendix 18A**), to which further information was added following the completion of geophysical survey and geotechnical investigations.

3.2.4. Wessex Archaeology previously undertook an archaeological assessment for the first stage of Forewind's development of the Dogger Bank Zone, comprising two potential wind farms, Dogger Bank Creyke Beck A & B (Appendix 2 to **Appendix 18A)**. Both wind farms fall within the boundary of Tranche A (**Figure 3.1**) (Appendix 2 to **Appendix 18A**). Reference has been made to this assessment where relevant to the baseline and assessment of Dogger Bank Teesside A & B.

3.2.5. Archaeological receptors have been assigned a unique number as follows:

- Within the intertidal study area: from WA1000;
- Maritime and aviation receptors within the project boundaries that were examined as part of the archaeological assessment of geophysical data have been assigned a number from WA70000;
- Additional records of receptors that were not included as part of the archaeological assessment of geophysical data have been assigned a number from WA2000. These records refer to locations within the MSAs but beyond the areas covered by geophysical survey; and
- Palaeogeographic features relevant to the assessment of submerged prehistory have been assigned a number from WA75000.

Review of geophysical and geotechnical data

3.2.6. Extensive geophysical data were collected within Tranche B by Gardline Geosurvey Limited between June and October 2011 and March and May 2012. The dataset consisted of single-beam and multibeam echo sounder, sidescan sonar, pinger sub-bottom profiler and magnetometer data.

3.2.7. As Dogger Bank Teesside B straddles both Tranche A and Tranche B, the assessment also made use of data acquired in Tranche A by GEMS Survey Limited (GEMS) between July and December 2010. This data had previously been assessed by Wessex Archaeology for the Dogger Bank Creyke Beck A & B EIA Archaeology and Cultural History Technical Report (Appendix 2 to **Appendix 18A**).

3.2.8. Due to the large area covered by Tranche A and Tranche B, and the equivalent large volume of geophysical data produced, a targeted assessment strategy was adopted for the archaeological assessment of the geophysical data.

3.2.9. Analysis of the results included the identification of seabed anomalies which were subsequently assessed (Appendix 2 to **Appendix 18A**) to determine potential archaeological properties. Additionally, the data was cross-referenced against sites of all live wrecks recorded in the UKHO database within the development area. For Tranche A, it was agreed with English Heritage that Wessex Archaeology would only review seabed anomalies measuring 5m or greater in any one dimension, as identified by GEMS in their review of all data in support of engineering objectives.

3.2.10. The systematic selection of seabed targets to be assessed by Wessex Archaeology for Dogger Bank Teesside A and Dogger Bank Teesside B was established by using approximately 20% of the total number of seabed targets identified by Gardline, this is a similar approach to that used for the Tranche A data assessment (Appendix 2 to **Appendix 18A**). In total 118 Gardline seabed anomalies were targeted to be assessed for the seabed features interpretation.

3.2.11. Wessex Archaeology assessed all Gardline targets identified to be wreck and debris remains in both magnetic and sidescan sonar data. Further to this, any, magnetic anomalies over 20nT were investigated as well as any magnetic anomalies within the vicinity of a sidescan sonar anomaly. Additionally, sidescan sonar lines were viewed at a spacing of 1km until 118 Gardline anomaly locations had been assessed. Where no targets were observed on a survey line the adjacent lines were assessed in order to give as even coverage of the development zones as possible. In addition, any recorded wrecks and obstructions in the SeaZone dataset were investigated.

3.2.12. Geophysical data was acquired in the Dogger Bank Teesside A & B Export Cable Corridor MSA by Gardline between May and July 2012 with Titan Environmental Surveys Limited (Titan) conducting the inshore operations between 8 of June and 28 July. This included single-beam and multibeam echo sounder, sidescan sonar, pinger and boomer sub-bottom profiler and magnetometer data and backscatter. All data acquired within the Dogger Bank Teesside A & B Export Cable Corridor MSA was made available for archaeological assessment. Wessex Archaeology assessed all data within the survey area for the southern Dogger Bank Teesside A & B Export Cable Corridor.

3.2.13. Geotechnical site investigations were carried out by Fugro GeoConsulting Limited (Fugro) from the geotechnical drilling vessel MV Bucentaur from 5 August 2012 to 15 August 2012.

3.2.14. The fieldwork comprised 17 boreholes (including two bumpover boreholes) with combined in situ cone penetration tests (CPT) and downhole sampling with performance of seismic CPTs and Bengt Arne Torstensson (BAT) probes (for pore-water sampling) at selected locations. The borehole locations and findings of these surveys, as relevant to the marine and coastal archaeology assessment, are reported within this ES, and provided in full in **Appendix 18A**.

3.2.15. The results of the Tranche B geoarchaeological assessment are presented in Appendix 2 to **Appendix 18A**, and are used to inform the baseline characterisation for Dogger Bank Teesside A & B. Additional geotechnical data acquired by Fugro from Tranche A, previously assessed by Wessex Archaeology (2012), were also used where relevant to the geoarchaeological interpretation of Dogger Bank Teesside B.

3.2.16. Each anomaly identified in the geophysical data was given an archaeological 'flag' in order to record the initial geophysical assessment of the anomaly (**Table 3.1**). These were based on the form, size, and / or extent of the anomaly and its likely archaeological potential.

Table 3.1 Criteria for assigning Marine and Coastal Archaeological Potential Rating to geophysical anomalies

Flag	Description
High	Ascribed only where the geophysical anomalies clearly represent a wreck site or were very near to a previously known site.
Medium	Geophysical anomalies with no directly corroborating data but being of a size, shape or amplitude such as to suggest that they possibly relate to archaeological sites or features.
Low	Small, isolated, geophysical anomalies of uncertain origin, which are likely to be 'artefacts' in the data or natural features.
Very Low	Anomalies that are known or are highly likely to be of modern origin, and which are not archaeologically interesting (e.g. moorings, etc.).

3.2.17. The anomalies for all types of survey were then overlaid to identify features recorded in more than one survey type. Each of the resulting anomaly locations was then given an identification code.

3.2.18. A discrimination "flag" was added to the record in order to discriminate against those which were not thought to be of archaeological concern (**Table 3.2**). This methodology allows for all features considered of archaeological interest to be highlighted while retaining all of the information produced during the course of the geophysical interpretation and Archaeological Desk Based Assessment (ADBA) for further evaluation should more information become available.

Table 3.2 Criteria for discriminating relevance of features to proposed schemes

Feature Type	Discrimination	Flag	Criteria
Seabed Features	Non-Archaeological	U1	Not of anthropogenic origin
		U2	Known non-archaeological feature
		U3	Non-archaeological hazard
	Archaeological	A1	Anthropogenic origin of archaeological interest
		A2	Uncertain origin of possible archaeological interest
		A3	Historic record of possible archaeological interest with no corresponding geophysical anomaly
Shallow Geological Features	Non-Archaeological	U2	Feature of non-archaeological interest
	Archaeological	P1	Feature of probable archaeological interest either because of its palaeogeography or likelihood for producing palaeoenvironmental material
		P2	Feature of possible archaeological interest

Palaeoenvironmental Evidence (ORPAD)

3.2.19. A total of 174 samples of peat have been collected from trawls and grab samples undertaken within Tranche B and Dogger Bank Teesside A & B Export Cable Corridor routes in order to inform the assessment of benthic ecology. The peat samples were recognised as being of archaeological value and were reported by Forewind through the Offshore Renewables Protocol for Archaeological Discoveries (ORPAD). Thirty one samples were selected for processing by Wessex Archaeology, provider of the ORPAD implementation service, and a detailed assessment of the waterlogged remains and preservation was carried out (Wessex Archaeology 2013d).

3.2.20. The peat was extremely compacted and the samples were broken down by hand prior to being wet-sieved through a stack of sieves 4mm, 2mm, 1mm, 0.5mm, and 0.25mm. The fractions from each mesh were then scanned under a x10 to x40 stereo-binocular microscope and the presence of waterlogged plant and insect, as well as charcoal, and other biological material was noted.

3.2.21. The majority of samples contained extremely well-preserved waterlogged plant material, including seeds, whole fruits, stems and occasionally leaf fragments (Wessex Archaeology 2013d). The results of this assessment are incorporated into the baseline characterisation of submerged prehistory in Section 4.2.

3.3. Assessment of impacts – methodology

3.3.1. The assessment of impacts for marine and coastal archaeology has been conducted, where relevant, and as far as possible, in line with the standard methodology set out in **Chapter 4 EIA Process**, which considers the following:

- The magnitude of the effect;
- The sensitivity of a receptor to an effect;
- The probability that an effect-receptor interaction will occur;
- The determination and qualification of the significance of an impact on a receptor; and
- The level of certainty at all stages.

3.3.2. For this assessment, the consideration of magnitude and sensitivity is slightly different to the approach taken in other chapters of this ES. These differences, and the reasons for them, are set out in the following sections.

3.3.3. The methodology has been developed to take account of the guidelines for environmental assessment as set out in the NPS (see Section 2).

3.3.4. Impacts are assessed with reference to the worst case scenario for archaeology in accordance with the Rochdale Envelope approach to Environmental Impact Assessment (EIA). The worst case scenario for Dogger Bank Teesside A & B is defined in Section 5.

3.3.5. As Dogger Bank Teesside A & B are the subject of one ES, the impact assessment considers both areas together. Where relevant, a distinction is made between impacts from each of the two projects and the total impact of both projects combined.

Magnitude of effect

3.3.6. Magnitude is defined (**Chapter 4**) by reference to the following:

- Extent: the area over which an effect occurs;
- Duration: the time for which the effect occurs;
- Frequency: how often the effect occurs; and
- Severity: the degree of change relative to the existing environmental conditions.

3.3.7. The assessment of impacts on marine and coastal archaeology focusses on severity alone, since the emphasis is placed entirely on whether an effect exists or not. Severity (and therefore magnitude) is either 'high' (the effect exists) or 'negligible' (no detectable effect relative to the baseline level).Receptor sensitivity and value

3.3.8. The sensitivity of a receptor is a function of its capacity to accommodate change and reflects its ability to recover if it is affected. The sensitivity of the receptor can be quantified via the following factors (**Chapter 4**):

- Adaptability: the degree to which a receptor can avoid or adapt to an effect;
- Tolerance: the ability of a receptor to accommodate temporary or permanent change without a significant adverse impact;
- Recoverability: the temporal scale over and extent to which a receptor will recover following an effect; and
- Value: a measure of the receptors importance, rarity and worth.

3.3.9. The assessment of impacts on marine and coastal archaeology focusses on value (**Table 3.3**) for the following reasons:

- In relation to adaptability, archaeological receptors are fixed in terms of their location and their inherent attributes (essential to their archaeological value) and cannot avoid or adapt to effects upon them. Once an effect has occurred, the receptor, and/or its relationship with the wider environment, will be permanently altered;
- In relation to tolerance, archaeological receptors are unable to tolerate any changes without adverse effect. All changes will be permanent; and
- In relation to recoverability, all changes to archaeological receptors are permanent therefore they will be unable to recover once an effect has occurred.

3.3.10. For this reason, the sensitivity of receptors is defined solely by their archaeological value.

3.3.11. The Marine Policy Statement (DEFRA 2011, p. 21) and National Policy Statement EN-1 (DECC 2011a, p. 90) state that the value of heritage assets, to this and future generations lie in their heritage interest, which may be archaeological, architectural, artistic or historic.

3.3.12. In accordance with this definition, the value of archaeological receptors are assessed by examining the receptor's age, type, rarity, survival and condition, fragility and vulnerability, group value, documentation, associations, scientific potential and outreach potential. These factors help to characterise a receptor and to assess how representative it is in comparison to other similar archaeological, architectural, artistic or historic heritage assets. They also enable its potential to contribute to knowledge, understanding and outreach to be assessed. In the majority of cases, statutory protection is only provided to a site or feature judged to be an above average example in regard to these factors.

3.3.13. For the purposes of this assessment the value of archaeological receptors has been determined as follows:

Table 3.3 Definition of archaeological value

Value	Definition
High	Above average example and/or high potential to contribute to knowledge and understanding and/or outreach. Receptors with a demonstrable international or national dimension to their importance are likely to fall within this category. Sites of wrecked ships and aircraft with statutory protection plus as-yet undesignated sites that are demonstrably of equivalent archaeological value. Palaeogeographic features with demonstrable potential to include artefactual and/or palaeoenvironmental material, possibly as part of a prehistoric site or landscape. All sites for which data limitations prevent an assessment of value and to which the precautionary approach applies (see para 3.3.17).
Medium	Average example and/or moderate potential to contribute to knowledge and understanding and/or outreach. Includes wrecks of ships and aircraft that do not have statutory protection or equivalent significance, but have moderate potential based on a formal assessment of their importance in terms of build, use, loss, survival and investigation. Prehistoric deposits with moderate potential to contribute to an understanding of the palaeoenvironment.
Low	Below average example and/or low potential to contribute to knowledge and understanding and/or outreach. Includes wrecks of ships and aircraft that do not have statutory protection or equivalent significance, but have low potential based on a formal assessment of their importance in terms of build, use, loss, survival and investigation. Prehistoric deposits with low potential to contribute to an understanding of the palaeoenvironment.
Negligible	Poor example and/or little or no potential to contribute to knowledge and understanding and/or outreach. Assets with little or no surviving archaeological interest.

3.3.14. As stated in the Marine Policy Statement (DEFRA 2011, p. 22) and National Policy Statement EN-1 (DECC 2011a, p. 90), some heritage assets have a level of significance that justifies official designation (Section 2.3 for relevant legislation), although both statements recognise that many heritage assets are demonstrably of equivalent significance but are not currently designated.

3.3.15. While designation indicates that a receptor has been identified as being of high value, non-designated heritage assets are not necessarily of lesser importance.

Very few offshore archaeological sites are designated due to a lack of investigation and data and due to the difficulties of identifying sites offshore. Therefore, non-designated receptors that can be demonstrated of equivalent significance to designated sites should be considered subject to the policies for designated heritage assets.

3.3.16. The nature of the archaeological resource is such that there is a high level of uncertainty concerning remains on the seabed. It is often the case that data concerning the nature and extent of sites is out of date, extremely limited or entirely lacking. As such, the precautionary principle is often necessarily applied to aspects of archaeological impact assessment.

3.3.17. Where uncertainty occurs, the precautionary approach is to assign 'high' value. Consequently, if a receptor is impacted, the resulting level of impact (without mitigation) may be overestimated. However, mitigation is possible, and the relative certainty (e.g. for archaeological exclusion zones) concerning how successful it will be in avoiding impacts means that the residual impact can be reduced.

Impact significance

3.3.18. The significance of an impact (beneficial or adverse) is determined as a combination of the measures of magnitude and archaeological value as set out in the matrix below:

Table 3.4 Impact matrix

Receptor value	Magnitude of effect			
	High	**Medium**	**Low**	**Negligible**
High	Major	Moderate	Minor	Negligible
Medium	Moderate	Moderate	Minor	Negligible
Low	Minor	Minor	Negligible	Negligible
Negligible	Minor	Negligible	Negligible	Negligible

3.3.19. Significance is also determined by the probability of that impact occurring (temporally and spatially).

3.3.20. Account is taken of the uncertainty in the data used to predict the magnitude of effects and the value of receptors judged from low to high, in accordance with the following definitions:

- Low uncertainty: Interactions are well understood and documented. Predictions are modelled and maps based on interpretations are supported by a large volume of data. Information/data has very comprehensive spatial coverage/resolution;
- Medium uncertainty: Interactions are understood with some documented evidence. Predictions are modelled but not validated and/or calibrated.

Mapped outputs are supported by a moderate degree of evidence. Information/data has relatively moderate spatial coverage/resolution; and

- High uncertainty: Interactions are poorly understood and not documented. Predictions are not modelled and maps are based on expert interpretation using little or no quantitative data. Information/data has poor spatial coverage/resolution.

3.3.21. Mitigation appropriate to archaeology will be outlined and the residual impact assessed. In accordance with the EIA regulations, only residual impacts assessed to be moderate or major will be regarded as significant.

4. Existing Environment

4.1. Landfall sites

Known archaeological receptors

4.1.1. A total of ten records[2] of known archaeological receptors have been identified that fall below high water within the intertidal section of the MSA at the landfall (**Figure 4.1**). Of these, two fall within the boundary of the Dogger Bank Teesside A & B Export Cable Corridor with the remainder within the 750m TWA (**Figure 4.1**).

4.1.2. The two sites that lie within the Dogger Bank Teesside A & B Export Cable Corridor comprise a weapons pit (WA1003) and earth trench (WA1004), both of which are recorded as destroyed. Likewise, a further seven of the records (WA1002, WA1005, WA1006, WA1007, WA1008, WA1010, WA1011) located within the TWA relate to World War II installations, again recorded as destroyed or demolished.

4.1.3. During a site visit carried out on 18 June 2013 no remains were seen at the locations of any of the above nine records.

4.1.4. However, a concrete base was observed, which may represent the remains of pillbox (WA1005), fallen from the top of the cliff as it eroded. The location of the base was recorded during the site visit using GPS, and it does not correspond to that recorded for WA1005, but allowing for errors in positioning and movement due to erosion it is possible they represent the same structure.

4.1.5. A single, concrete anti-tank cube was also observed, presumably a sole survivor of the series of obstructions that were formerly present on the beach (WA1002).

4.1.6. As none of the features noted during the site visit are located below MHWS, they do not form part of the offshore assessment. Their presence on the beach, however, is of note with regard to the current records of the demolished or destroyed World War II installations noted above.

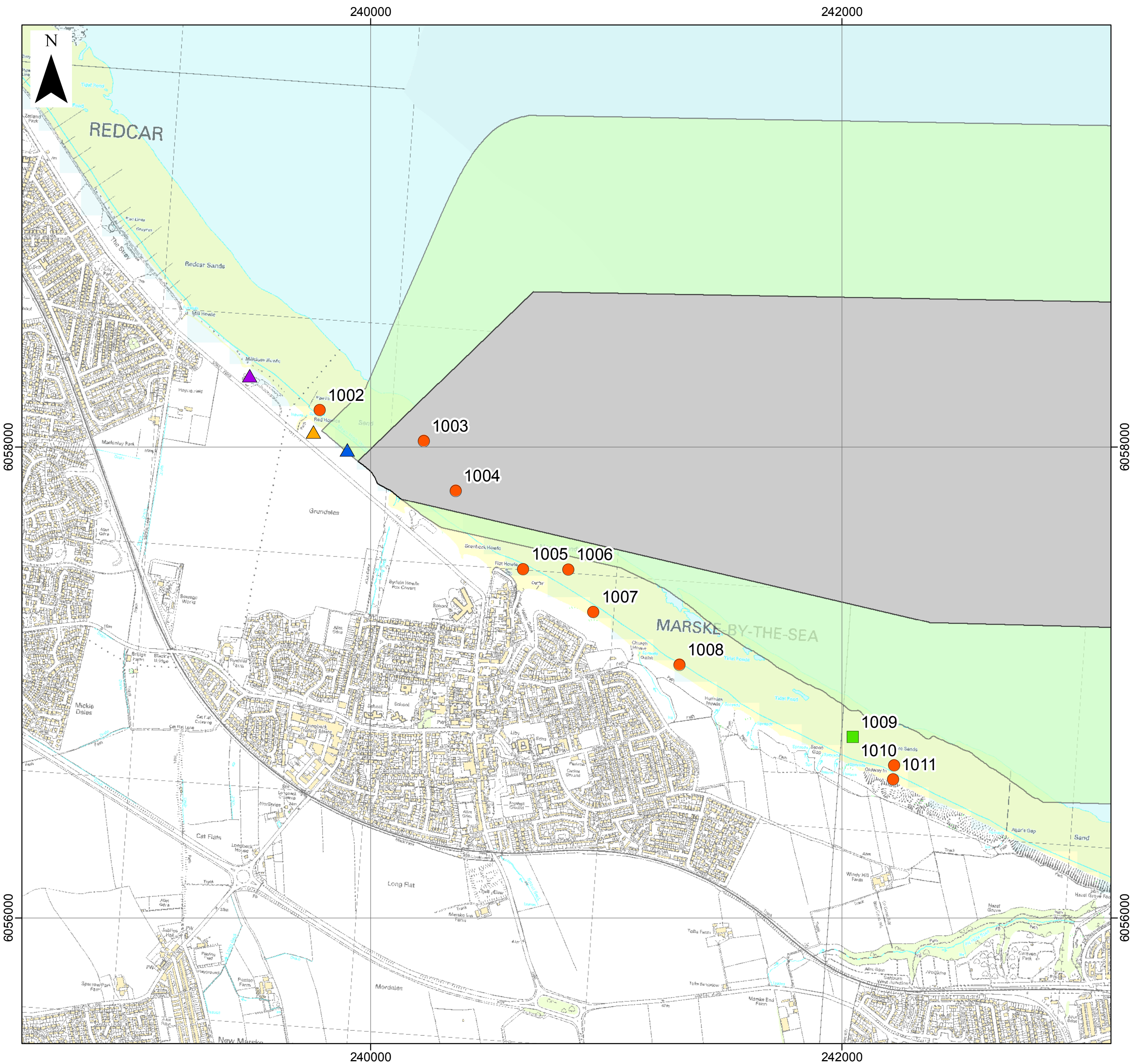
4.1.7. The tenth relates to the isolated discovery of a Neolithic-Bronze Age domesticated cattle bone from the beach east of Marske (WA1009). There are an additional two findspots to the north west beyond the boundary of the TWA relating to an Edward I (1272-1307 AD) silver penny found on Redcar Beach (WA1000) and Post-medieval human remains from the cliffs east of Redcar (WA1001).

4.1.8. As findspots, these records represent isolated discoveries only. They do serve to demonstrate, however, the diversity of as yet undiscovered artefacts that may be present within the MSA at the landfall.

[2] The record reference numbers given in Section 4 (e.g. WA1003) correspond with the Wessex Archaeology technical report, available at **Appendix 18A**).

4.1.9. While records of findspots are of value for understanding the cultural heritage of the study area the locations are, themselves, not of archaeological value.

4.1.10. All of the WWII installations are recorded as demolished or destroyed and no evidence for remains at this location was observed during the site visit. No in situ remains were observed although fragmentary and eroded remains of former structures and anti-tank obstacles were observed above MHWS, outside the scope of this assessment. It is possible that further debris or intact structural components from these installations may still be present buried in beach deposits. If present, these may be considered of medium value as isolated discoveries.



LEGEND

- Dogger Bank Teesside A & B Export Cable Corridor
- Temporary works area
- Records of sites
- Records of findspots
- Anti-tank cube
- Concrete base
- Possible anti-tank obstruction

0 0.5 1
Kilometres

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

PROJECT TITLE

DOGGER BANK TEESSIDE A & B

DRAWING TITLE

Figure 4.1 Archaeological sites and findspots in the landfalll area

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

DRAWING NUMBER: **F-OFL-MA-608**

SCALE	1:25,000	PLOT SIZE	A4	DATUM	OSGB36	PROJECTION	BNG

FOREWIND

Potential archaeological receptors

4.1.11. There are a limited number of known marine and coastal archaeological assets within the intertidal zone associated with the landfall.

4.1.12. The records of sites and findspots described above do however indicate potential for further archaeological remains to be present within the intertidal zone at the landfall.

4.1.13. Debris associated with the destroyed World War II installations may be buried within the beach sand, as evidenced by the worn brick and tile fragments observed along the beach. It is possible that intact structural elements may survive.

4.1.14. The findspots represent isolated discoveries only but serve to demonstrate the diversity of as yet undiscovered artefacts that may be present within the MSA at the landfall. These may include remains from the Palaeolithic onwards and, while derived material is more likely in reworked beach deposits, there may also be potential for the presence of in situ Prehistoric features beneath the sand.

4.1.15. This Prehistoric potential is discussed further as part of the baseline discussions below.

4.1.16. Isolated discoveries of material of Prehistoric or later date are more limited than in situ material in terms of their research value. However, a number of artefacts from a given location have potential to contribute to a more detailed archaeological understanding of that area and, as such, any isolated discoveries of archaeological material during constructions activities at the landfall, should be considered of medium archaeological value.

4.2. Submerged prehistory

4.2.1. The discussion of submerged prehistory below is based upon current interpretations of the palaeolandscape and palaeoenvironment within the study areas during Pleistocene and Holocene phases of hominin settlement. This is informed by the results of the Tranche B geoarchaeological assessment (Appendix 3 to **Appendix 18A**), the results of the palaeoenvironmental assessment of peat samples reported through ORPAD (Wessex Archaeology 2013d) and the assessment of geophysical data as set out in Appendix 3 to **Appendix 18A** and associated appendices. Following completion of the assessments it is noted that none of the assessed boreholes correspond to palaeogeographic features seen in the sub-bottom profiler data (**Figure 4.2**).

Known archaeological receptors

4.2.2. There are no known prehistoric sites or finds from offshore (marine) contexts within the MSAs. This sparsity of records from offshore (marine) contexts is typical across the UK and is understood to be primarily associated with the difficulties of identifying and investigating prehistoric sites. See **Appendix 18A** for further details.

Potential archaeological receptors (Pleistocene)

4.2.3. A summary is provided in this section, for a more detailed account see **Appendix 18A**.

4.2.4. A number of the deeper 50m boreholes reviewed as part of the geoarchaeological assessment of Tranche B geotechnical data, were seen to contain marine sediments which may form part of the Yarmouth Roads formation (including BH1246, BH1282 and BH1291) (Appendix 3 to **Appendix 18A**).

4.2.5. Although the Yarmouth Roads formation is postulated to be extant in some discrete areas, the Pleistocene sediments across the Dogger Bank Zone are thought to comprise predominantly glacial, Middle Pleistocene infilled channels, including tunnel valleys of the Anglian Swarte Bank Formation (c.475,000 to 420,000BP) and Wolstonian Cleaver Bank Formation (c.303,000 to 130,000 BP (Before Present)) (Wessex Archaeology 2012). The interglacial deposits of the Hoxnian Egmond Ground Formation (c.423,000 to 280,000) and Ipswichian Eem formation (c.130,000 to 110,000 BP) are thought to be present across the wider Dogger Bank Zone.

4.2.6. Thus, although the predominant Pleistocene deposits underlying the Dogger Bank correlate to glacial periods of human absence, there is some potential for pre-Devensian archaeological remains to be present where discrete areas of interglacial deposits are identified.

4.2.7. The deepest sediments assessed for the geoarchaeological investigation are from borehole BH1282 within Dogger Bank Teesside B between 37.62 and 38.10m below seabed (Appendix 3 to **Appendix 18A**). The sediments are overlain by glacial deposits of the Dogger Bank Formation. The foraminifera (*Haynesina orbiculare*) from these levels indicate a cold, shallow marine, nearshore environment typical of a transitional temperate to cold Pleistocene stage (Funnell 1989). Surrounding environment of marsh and birch woodland was indicated by the waterlogged plants recovered. A post-temperate boreal forest pollen flora recovered from these levels, dominated by Pinus (pine), Betula (birch) and Picea (spruce) is similar to Late Ipswichian/Early Devensian (MIS 5e/5d) assemblages previously recorded (Turner 2000).

4.2.8. All of the boreholes assessed in the geoarchaeological study contained Pleistocene sediments comprising stiff grey/brown clays and sands of up to c.35 metres in thickness, interpreted as belonging to the Dogger Bank Formation (Appendix 2 to **Appendix 18A**). Despite the formation of Dogger Bank under mainly terrestrial conditions the Devensian climate and conditions precluded human occupation during this phase of the later Pleistocene. During the Devensian glacial phase the ice reached its maximum extent at c.18,000 BP, extending as far south as the Midlands, and the MSAs would have been entirely covered by ice.

4.2.9. Radiocarbon dates from boreholes BH1257 (Dogger Bank Teesside B) and BH1279, (Dogger Bank Teesside A) obtained as part of the geoarchaeological assessment, provided ages of c.43 to 45ka cal. (calibrated Radio Carbon Years) BC (Before Christ) (SUERC-43885 and SUERC-43886) within the Devensian glacial phase (Appendix 2 to **Appendix 18A**). There is, however, recent research which indicates that beyond c.38ka cal. BC all conventionally pre-treated radiocarbon ages should be treated with extreme caution (Hijma *et al*. 2012). During the study, in the eastern North Sea, a mixed assemblage of terrestrial and marine mammal species produced a similar wide range of radiocarbon ages between c.45 and 30ka 14C BP, although surprisingly few around the radiocarbon measurable limit of c.50ka 14C BP. As marine conditions were absent from the area between c.80 and 8ka cal. BC a significant number of the dated remains were expected to have true ages beyond the radio-carbon dating-limit, especially from marine mammals, termed *ghostdates*.

4.2.10. The radiocarbon dates from BH1257 and BH1279, therefore, should be treated with some caution. Foraminifera and ostracods from the boreholes indicate that they are both derived from shallow marine and brackish coastal environments which are not expected at these dates and depths (c.35 to 38m below present levels). Lisiecki and Raymo (2005) have calculated that sea levels were at least 50m below this level during this period.

4.2.11. The radiocarbon dates derived from BH1275 and BH1279 may, therefore, also be ghostdates and have true dates beyond the measurable radiocarbon timescale (50ka BP) within pre-Devensian phases with the potential for hominin presence. It is also possible that the dates may be the result of reworked carbon within younger sediments. The boreholes do not correspond to the locations of any of the palaeogeographic features identified in the sub-bottom data and it is not possible to conclude with certainty the origin of the date, although reworked carbon is considered the most likely explanation.

4.2.12. Upper organic sediments sampled from 2.00 to 3.48m, overlying the glacial Dogger Bank sediments within borehole BH1282 have the earliest dated (post Devensian Glacial maximum c.18,000 BP) organic deposits in the Dogger Bank area (Appendix 3 to **Appendix 18A**): see Ward *et al*. 2006; Shennan *et al*. 2000). A radiocarbon date at 3.48m below seabed of 14890-14010 cal. BP (SUERC-43891) correlates to the early Windermere (continental Bølling) interstadial and the Upper Palaeolithic archaeological period.

4.2.13. The on-site environment at these levels as evidenced by the preserved waterlogged plants and pollen remains (e.g. sedges and rushes) was predominantly a freshwater wet marshland and bog environment surrounded by drier areas of ground with low growing shrubs (including dwarf birch) and small trees (Appendix 3 to **Appendix 18A**). Small amounts of charcoal were recorded at this level although it is not possible to tell whether it formed as a result of natural causes (e.g. lightning strike) or due to anthropogenic burning.

4.2.14. At 2.24m below seabed, a date of 13810-13480 cal. BP (SUERC-43887) correlates to the middle Windermere (continental Allerød) interstadial period. The on-site environment was similar to that the underlying sediments, a cold, wet marshland and (indicated by the presence of plants such as sedges, rushes and bogbean) and again surrounded by drier areas with low growing shrubs (including dwarf birch).

4.2.15. The date of the earliest post-glacial reoccupation of Britain precedes the radiocarbon dates from BH1282 (Appendix 3 to **Appendix 18A**). This is thought to have occurred during the Upper Palaeolithic after 14,700BP proven by the radiocarbon dating of human remains from Gough's Cave, Cheddar, Somerset (Jacobi and Higham 2009). Archaeological evidence for this period is sparse, especially offshore, however a late Upper Palaeolithic flint artefact was recovered from an offshore BGS borehole c400km north of the Dogger Bank on the Viking Bank (Long *et al*. 1986).

4.2.16. By 13,000 BP the Devensian ice had receded, leaving only the highest uplands covered by ice. During this phase, prior to the subsequent marine transgression, the top of the Dogger Bank will have formed a terrestrial land surface and a broad outline of this terrestrial surface was identified in the geophysical data assessed for Tranche A (Appendix 2 to **Appendix 18A**).

4.2.17. In Tranche B a large, lacustrine 'Clay Basin' has been identified by RPS at the very top of the 'Dogger Bank' sediments and could either be late-glacial or post-glacial in age. The location of this feature within the stratigraphy suggests it could be of archaeological potential. However, geotechnical testing has shown that the clay from within this basin has a relatively high shear strength, suggesting compressional forces from ice, either vertically or horizontally, may have been applied to the basin post-deposition. Moreover, there are clearly defined later fluvial features cutting into the 'Clay Basin' deposits. Both of these factors suggest the feature is of glacial rather than postglacial origin, and therefore not considered to be of archaeological potential.

Known archaeological receptors (Holocene)

4.2.18. With rising temperatures and sea level at c.12,000 BP 'Doggerland' would have offered an increasingly attractive environment for human settlement. Periglacial tundra was replaced by more temperate grassland which was in turn colonised by trees (birch, willow and hazel followed by pine, oak, alder and elm) (Val Baker *et al.* 2007, p. 208). As the climate and environment changed so did the animal resources as the big game of open grassland (mammoth, auroch, red deer and wild horse) that may have attracted Late Palaeolithic hunters, were replaced by a wide range of animals, fish and wild fowl as the temperatures rose and new river systems and wetlands developed.

4.2.19. These climatic and environmental changes are evidenced in the ORPAD peat samples (Wessex Archaeology 2013d). The initial assessment indicates that the range of environments demonstrated by the palaeoenvironmental evidence from these samples, grouped into seven main habitat types, reflect post-Devensian climatic change and rising sea levels:

- Sphagnum/moss bog;
- Wooded fen, dominated by birch and, in one sample, aspen;
- Phragmites reed marshland/fen;
- Sedge marshland/bog;
- Set marshland dominated by bogbean (*Menyanthes trifoliata*);
- Coastal habitats; and
- Aquatic environments.

4.2.20. A number of the peat samples were found to contain species representative of one or more habitat groups indicating formation in proximity to a number of different environments or that water input may also have carried in material from nearby habitats. For example, one sample (OT40.1) contained evidence for *Sphagnum* bog, birch forest sedge marsh and aquatic environments. Due to the smaller size of the sample it is unlikely that this variation is indicative of changing environments over time. It is more likely that that the peat formed within an environment that had bog-moss growing within it, along with sedges and bogbean, with open birch forest or isolated trees nearby.

4.2.21. The ORPAD peat samples, therefore, indicate both the evolution of climate and environment during this phase of rapid sea level rise as well as the widely available and varied resources accessible by prehistoric settlers at any given time. As a high point in the landscape at this time Dogger Bank is likely to have been an occupied island that survived for several centuries after being isolated by rising sea levels (Coles 1998, pp. 68-9).

4.2.22. Previous studies have demonstrated the importance of fluvial features as key indicators of archaeological potential. Water sources provided a focus for activity and the greatest potential for the survival of early Holocene archaeological remains is frequently associated with the palaeochannels of these former watercourses and the adjacent land surfaces. A recent offshore example is the recovery and subsequent investigation of lithic artefacts dredged from a gravel floodplain during aggregate extraction within Area 240 off the coast of Norfolk (Tizzard *et al*. 2011, Wessex Archaeology 2011a, Wessex Archaeology 2011b). The evidence from Hartlepool bay also indicates that occupation and settlement may have focused around watercourse and around the palaeochannels flowing through the bay (Waughman *et al*. 2005, p.142).

4.2.23. While the palaeochannels are not in themselves archaeological, mapping of these palaeogeographic features can assist assessments of where prehistoric populations may have been active while artefacts are often discovered in association with river infill and floodplain deposits.

4.2.24. Palaeogeographic assessment of sub-bottom profiler data from Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor has revealed a number of such features. The results of the assessment carried out by Wessex Archaeology within Tranche B and the Dogger Bank Teesside A & B Export Cable Corridor are summarised below and presented in full in **Appendix 18A** and associated appendices respectively. Reference is also made to the assessment of data from Tranche A where relevant to the palaeogeographic interpretation of Dogger Bank Teesside B. All features seen in the data are described in **Appendix 18A** and associated appendices.

4.2.25. These features were divided into three Phases based on their morphology, type of fill and interpreted relative age, with Phase I being the earliest and Phase III the most recent. A full description of these features in included in Appendix 3 to **Appendix 18A**.

Phase I

4.2.26. In Dogger Bank Teesside A, Phase Ia features have been grouped into two areas. To the west of the centre are two approximately N-S trending channel features WA75316 and WA75318. The Sands Map created by RPS indicates that these are both part of the same channel. A number of smaller, similar features (WA75310, WA75311, WA75312, WA75313, WA75319 and WA75332) have also been identified in this area to the west of the centre of Dogger Bank Teesside A. These could have originally been part of the same channel system, though this is uncertain.

4.2.27. The second area of Phase Ia features is located to the east of the centre of Dogger Bank Teesside A, where a curving, approximately NE-SW alignment of features (WA75343, WA75348, WA75350, WA75353) has been identified. Feature 75343 can be split into two sections. The southern part is a long, distinct channel and towards the north, this spreads out laterally to form an extensive deposit interpreted as a possible lake. A second possible lake (75357) has also been identified approximately 5.5km to the southeast.

4.2.28. Features WA75348, WA75350 and WA75353 extend NE from this lake deposit, and probably represent the remains of a single channel complex that has been separated into sections by subsequent erosion. This series of features appears to continue eastwards beyond the boundary of Dogger Bank Teesside A, where it potentially joins with another large channel, WA75266. This channel runs approximately E-W outside the northern edge of Dogger Bank Teesside A, exhibiting two distinct phases of development, and is likely to have been a major palaeolandscape feature within the post-LGM landscape.

4.2.29. Phase Ib in Dogger Bank Teesside A is represented by a small number of relatively small features (WA75317, WA75331, WA75334, WA75349 and WA75351). These are all associated with previously described channels, and are possibly related overbank deposits.

4.2.30. Dogger Bank Teesside B is dominated by two large, approximately NNW-SSE trending Phase Ia channels (WA75105 and WA75106) (**Figure 4.3**). This also correlates with an 'Early Holocene' channel observed during the NSPP (Fitch *et al*. 2005, Gaffney *et al*. 2007).

4.2.31. Channel WA75184 is located towards the north-eastern end of the development area comprising a main channel with numerous tributaries. Occasional limited areas of acoustic blanking, interpreted as shallow gas, have been identified, suggesting some organic material is present. Towards the south east the feature becomes less well-defined, and is possibly a braided system at this point.

4.2.32. Channel WA75178 is located at the north-western edge of Dogger Bank Teesside B and appears different in character to the other Phase Ia features identified within Tranche B. Its origins are less certain, and it could have originally been a sub-glacial feature with later infill.

4.2.33. This feature most closely resembles WA75111 identified in Tranche A (Appendix 2 to **Appendix 18A**) in fill and basal reflector characteristics. This feature was interpreted as a possible Pingo lake, though WA75178 appears more fluvial than lacustrine in form. At present this feature is classed as part of Phase Ia, though further work would need to be undertaken to further understand the feature.

4.2.34. In the south eastern section of Dogger Bank Teesside B are two areas of small cut and fill features (WA75192 and WA75193) that cannot be traced as coherent channels with any confidence. These are all characterised by a single phase of fill, and radiocarbon dating of peat layers obtained from BH 1282 returned dates of 12940 - 12060 cal. BC and 11860 - 11530 cal. BC (Appendix 3 to **Appendix 18A**), indicating they are Upper Late Palaeolithic in age, immediately post-dating the LGM. A third, younger peat layer was not radiocarbon dated, and could potentially be Early Mesolithic in age.

4.2.35. There is some suggestion that the uppermost section of peat which was not radiocarbon dated (from c.2.00 to 2.12m below seabed) within borehole BH1282 is potentially Holocene in age (Appendix 3 to **Appendix 18A**). It is possible that this area was a large wetland associated with channel WA75184.

4.2.36. As with Dogger Bank Teesside A, the Phase Ib features identified within Dogger Bank Teesside B are relatively few in number and are associated with the larger channel features. The more extensive deposits are associated with WA75106 and WA75178, while a number of small deposits are associated with WA75184. No ground truthing has been carried out from within these features and so their nature cannot be definitively determined at present, but, as with Teesside A, these are interpreted as being possible overbank deposits directly associated with the Phase Ia channels.

Phase II

4.2.37. Phase II of the evolution of the post-LGM Dogger Bank landscape shows a less extensive fluvial system overlying the silted up remains of the Phase Ia channel complexes. These Phase II features may correspond with the 'Later Holocene' channels identified during the NSPP (Fitch *et al*. 2005, Gaffney *et al*. 2007), which are described as being a later dendritic fluvial system which cuts across the 'Early Holocene' channels.

4.2.38. The Phase II features are considered to be of medium archaeological potential. Although they are interpreted as being terrestrial features likely to have been created during a period of human occupation, their interpretation is less certain and their sandier fill is less likely to preserve palaeoenvironmental material. However, they still potentially contain some material, possibly both in-situ and derived, of both archaeological and palaeoenvironmental interest.

4.2.39. Phase II in Dogger Bank Teesside A is represented by a relatively large number of features compared with Tranche A and the rest of Tranche B. The main concentration of these features is in an approximately north to south trending strip through the centre of Dogger Bank Teesside A.

4.2.40. Very few Phase II features are present within Dogger Bank Teesside B compared with Dogger Bank Teesside A. These are generally fairly isolated areas of cut and fills (or individual channels in the case of WA75195).

Phase III

4.2.41. Phase III in Dogger Bank Teesside A is represented by two very large, deep, erosive features cutting through the centre of the development area (WA75431 and WA75432). These features truncate the western end of WA75266 and appear to have removed a number of Phase II features.

4.2.42. These features contain a single phase of fill, found by ground truthing (CPT 1292, CPT 1278, CPT 1274 and BH 1291) to comprise dense sand. This is interpreted as the same Holocene sand that covers a large portion of Tranche B.

4.2.43. The origin of these features is currently uncertain. In Tranche A, similar but much smaller features were interpreted as being possible scours created during the Holocene marine transgression. However, the features identified within Dogger Bank Teesside A seem far too large for this. It is possible that they are relict sub-glacial valleys that remained unfilled until the deposition of sand during the Holocene marine transgression. In this scenario, the features would have been large valleys during the Mesolithic, with channel WA75266 possibly entering the eastern edge of WA75432 as a hanging valley. This is difficult to determine without high resolution seismic imaging of the base of WA75431 and WA75432. Additionally, an ice sheet would have to have been present on top of Dogger Bank for these features to have been created, yet there does not appear to be a tabular lodgement till at the top of the Dogger Bank sediments to indicate that this was the case.

4.2.44. Also present in Dogger Bank Teesside A & B are a number of isolated cut and fill features (**Appendix 18A** and associated appendices for full list) that could not be connected together to form larger features. These are generally shallow and laterally limited, and, due to their limited lateral extents, their interrelationships and positions within the Phase system cannot be determined. However, these are likely to represent the remains of eroded channel systems, kettle lakes and even erosive features from a combination of the four Phases.

4.2.45. Phase III is not represented within Dogger Bank Teesside B, as no features of this type have been identified.

Dogger Bank Teesside A & B Export Cable Corridor

4.2.46. Along the Dogger Bank Teesside A & B Export Cable Corridor there is also potential for prehistoric archaeological sites to be present on the now submerged land surface. However, due to variable present day water depths within this area of the North Sea, the potential for the existence of such sites will vary along the Dogger Bank Teesside A & B Export Cable Corridor. Potential is likely to be highest in those areas that were sub-aerially exposed for the longest period of time, such as near the present day coast and on the edge of Dogger Bank. This is particularly the case for sites dating to the Mesolithic Period when this area would have been part of 'Doggerland'.

4.2.47. The Quaternary sedimentary sequence along the proposed Cable Route is generally relatively thin. Close to the landfall, a thin layer of Holocene marine sediments directly overlie the Jurassic bedrock (Cameron *et al*. 1992). Further offshore, a blanket deposit of Weichselian till (Bolders Bank Formation) is present between the bedrock and overlying superficial sand. Older, pre-Weichselian sediments become visible within the sequence as the route approaches Dogger Bank (Cameron *et al*. 1992). These sediments are not considered of archaeological interest although features have been identified cutting into the bedrock and till that are of possible archaeological potential (**Figure 4.4**)

4.2.48. The features of highest archaeological potential (WA75451 and WA75452) have been identified close to the landfall at Redcar, and are small channel features cut directly into the bedrock. These are distinct features with a single phase of fill, and are possibly the original offshore courses of waterways during periods of relatively lower sea level. It is most likely that they originally related to Skelton Beck, which flows into the North Sea a little further along the coast at Saltburn-by-the-Sea.

4.2.49. These channels have the potential to contain both in-situ and derived archaeological and palaeoenvironmental material and as such are deemed to be of relatively high archaeological potential.

4.2.50. A number of cut and fill features (WA75450, WA75453, WA75454, WA75455, WA75456, WA75457, WA75458 and WA75459) have been identified along the proposed route which are generally too small or indistinct to be classified as channels. Feature 75455 is an exception and is a large feature which crosses the entire proposed route. The fill is interpreted as being recent Holocene sand, and so is not considered of archaeological potential. However, the feature itself is interpreted as being a possible glacial scour, which would have created a significant landscape feature during periods of lower sea level. Because of this, the base of the feature may contain both in-situ and derived archaeological material, although this is uncertain.

4.2.51. Features WA75457, WA75458 and WA75459, located towards the edge of the Dogger Bank Zone, have been identified on a number of survey lines but are very poorly defined. These are potentially fluvial features belonging to Phase Ia identified from within Tranche B, though due to their poorly defined nature this is uncertain.

4.2.52. There is the potential for Holocene prehistoric material to be present within the study area with the earliest evidence submerged by rising sea levels during the Mesolithic. By the Neolithic an isolated island formed by Dogger Bank and the near shore zone is expected to have remained exposed and there is extensive evidence from the area to indicate a range of coastal and marine exploitation during this period. This is also demonstrated by the discovery of Neolithic or Bronze Age domesticated cattle bone from the beach to the east of Marske recorded at the cable landfall (WA1009).

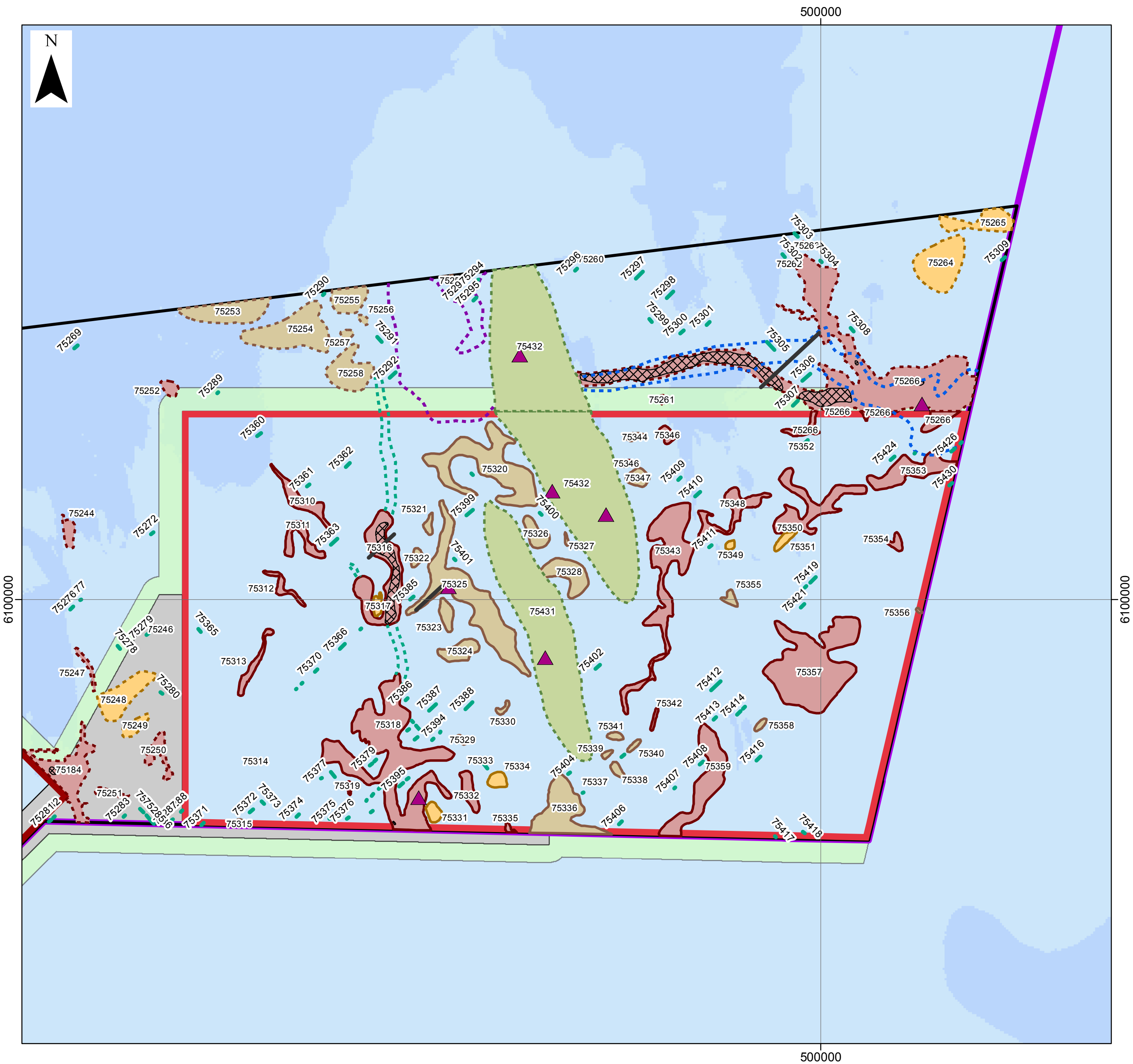
4.2.53. As the sea level fluctuations ceased towards the end of the Bronze Age a final period of a positive sea-level tendency is marked by marine inundation during the Iron Age. After this date the potential for archaeological evidence may be restricted to that of a maritime nature only.

4.2.54. On the basis of their age and rarity in a marine context, all Palaeolithic and Mesolithic material, if present within the study areas, will be of high archaeological value (**Table 3.3**). In the event that prehistoric archaeological material discovered offshore is found in situ it should be considered of high archaeological value.

4.2.55. Isolated discoveries of prehistoric archaeological artefacts may, in themselves, be of more limited value. Multiple discoveries from an area or region, however, have the potential to provide valuable information on patterns of human land use and demography in a field of study which is still little understood and rapidly evolving (Hosfield & Chambers 2007). Isolated prehistoric artefacts, therefore, should be regarded as medium value receptors for the purpose of impact assessment.

4.2.56. Features and deposits, such as those identified within the MSAs by the palaeogeographic assessment, are of medium value as indicators of submerged prehistoric landscapes. These features and deposits have not yet been demonstrated to contain archaeological material, although they do correspond to periods of prehistoric archaeological interest and represent the most likely contexts for such material to be discovered.

4.2.57. Palaeoenvironmental evidence in the context of an in situ Prehistoric site will be of high value although isolated discoveries of palaeoenvironmental material should be considered of medium value for the purpose of impact assessment.



LEGEND

- Dogger Bank Zone
- Tranche boundary
- Dogger Bank Teesside A
- Dogger Bank Teesside B
- Dogger Bank Teesside A & B Export Cable Corridor
- Temporary works area
- Boreholes
- Isolated cut and fill features
- Transects

Features from RPS sands map

- Lowlands
- Old Channel
- Phase I

Palaeolandscape features

- Phase II
- Phase III
- Phase Ia
- Phase Ib
- Acoustic blanking

0 3 6
Kilometres

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

PROJECT TITLE

DOGGER BANK TEESSIDE A & B

DRAWING TITLE

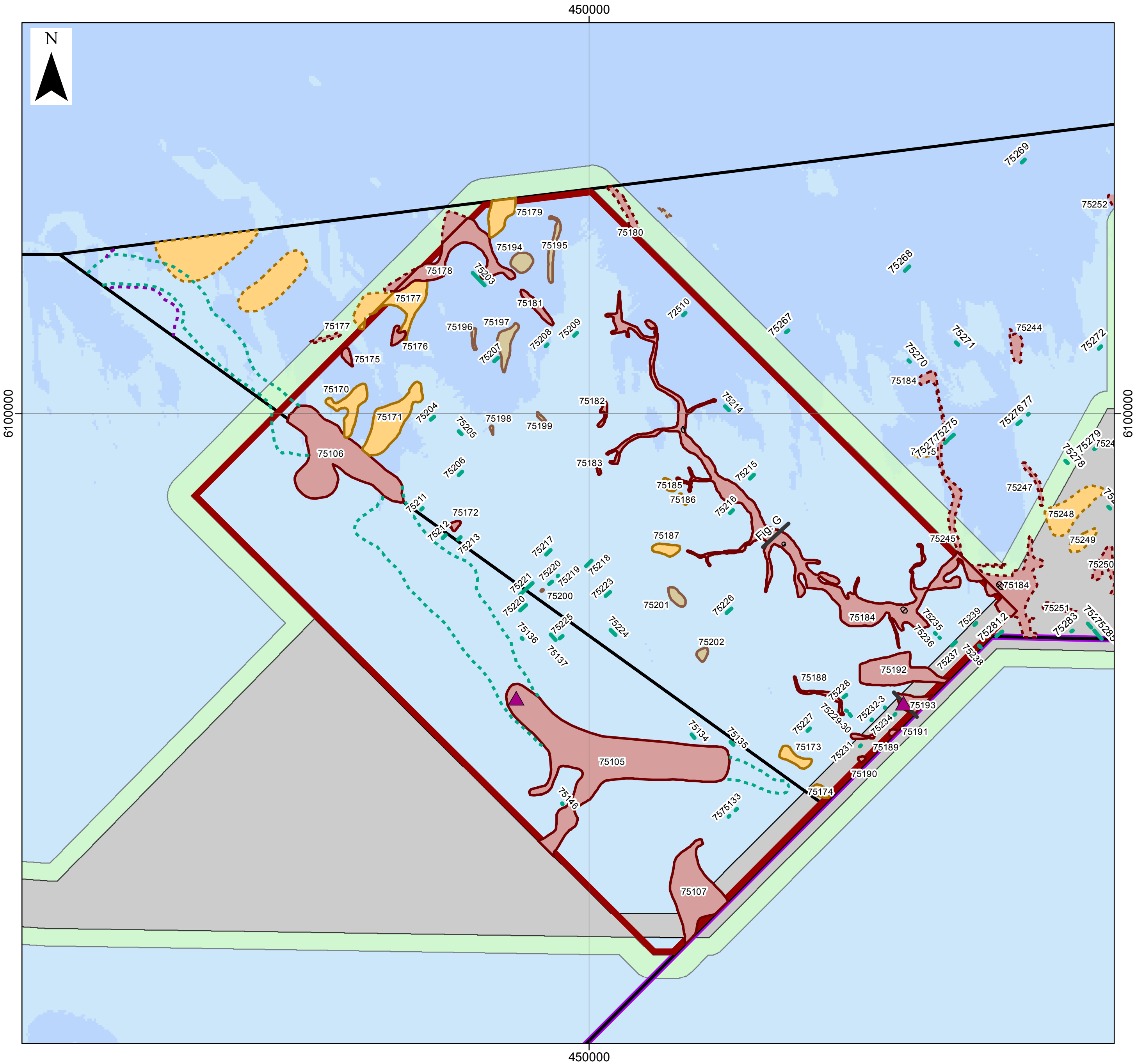
Figure 4.2 Palaeolandscape features identified within Dogger Bank Teesside A

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

DRAWING NUMBER: **F-OFL-MA-609**

SCALE	1:250,000	PLOT SIZE	A4	DATUM	WGS84	PROJECTION	UTM31N

FOREWIND



LEGEND

- Dogger Bank Zone
- Tranche boundary
- Dogger Bank Teesside A
- Dogger Bank Teesside B
- Dogger Bank Teesside A & B Export Cable Corridor
- Temporary works area
- Boreholes
- Transects
- Isolated cut and fill features

Features from RPS sands map

- Lowlands
- Old Channel
- Phase I

Palaeolandscape features

- Phase II
- Phase III
- Phase Ia
- Phase Ib
- Acoustic blanking

0 3 6
Kilometres

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

PROJECT TITLE

DOGGER BANK TEESSIDE A & B

DRAWING TITLE

Figure 4.3 Palaeolandscape features identified within Dogger Bank Teesside B

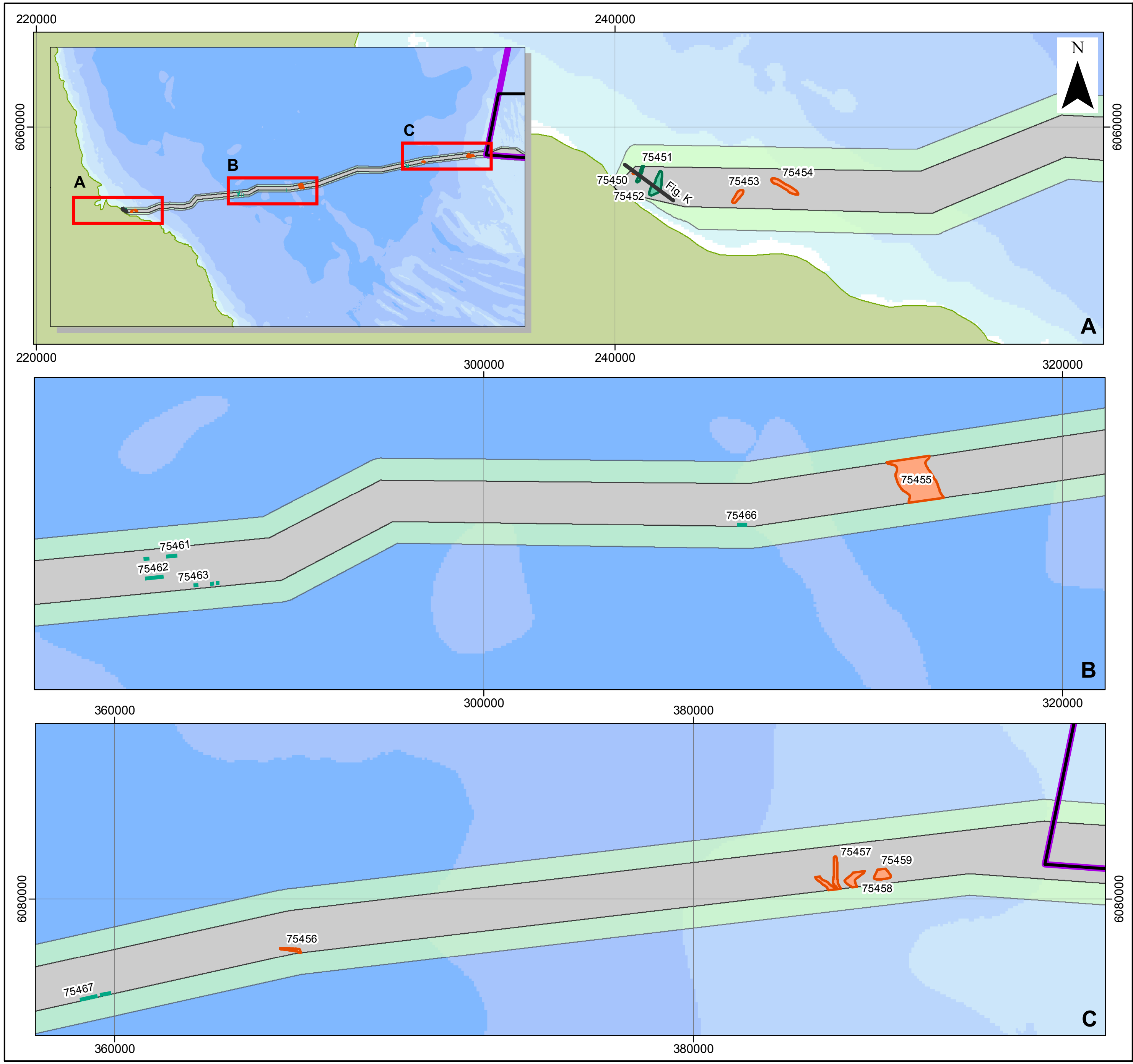
VER	DATE	REMARKS	Drawn	Checked
1	02/10/2013	PEI3	GC	FS
2	07/02/2014	DCO Submission	GC	FS

DRAWING NUMBER:

F-OFL-MA-610

SCALE	1:250,000	PLOT SIZE	A4	DATUM	WGS84	PROJECTION	UTM31N

FOREWIND



LEGEND

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

Palaeolandscape features

- Channel
- Cut & fill

0 3 6
Kilometres

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

PROJECT TITLE

DOGGER BANK TEESSIDE A & B

DRAWING TITLE

Figure 4.4 Palaeolandscape features identified along the cable route

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

DRAWING NUMBER: **F-OFL-MA-611**

SCALE	1:200,000	PLOT SIZE	A4	DATUM	WGS84	PROJECTION	UTM31N

FOREWIND

4.3. Maritime or shipwreck archaeology

4.3.1. This section outlines the known and potential maritime resource within the MSAs including Dogger Bank Teesside A & B Export Cable Corridor the Dogger Bank Teesside A & B Export Cable Corridor, and incorporating project boundaries and TWAs, as defined by Forewind (**Figure 3.1**). A more detailed characterisation of the known maritime heritage resource is provided in **Appendix 18A**.

Known archaeological receptors

4.3.2. The known maritime resource is considered to consist of known records of wrecks and obstructions, including those charted by the UKHO and recorded in the NRHE and HER, and additional wrecks identified during the assessment of geophysical data for which no corresponding record exists. The NRHE and HER do not record archaeology beyond the 12nm limit of British waters so for the majority of the MSAs only UKHO data were available.

Dogger Bank Teesside A

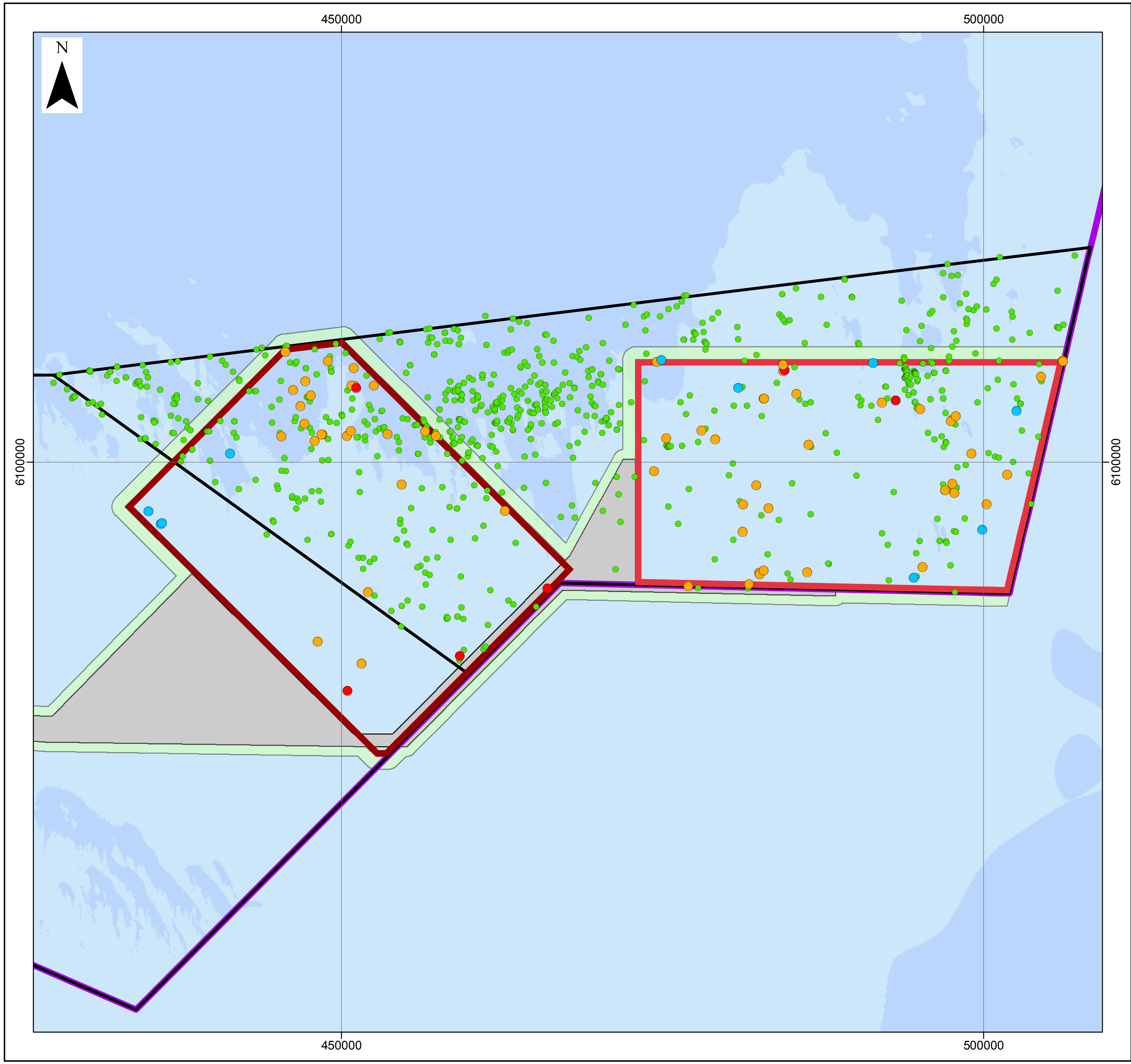
4.3.3. The UKHO records five wrecks (four live and one dead) within the Teesside A MSA and one live obstruction. All of these are located within the project area and there are no records of receptors within the TWA.

4.3.4. No anomalies were seen by Wessex Archaeology within the geophysical data that correspond to these records.

4.3.5. The five wrecks and obstruction were classified as A3 (historic record of possible archaeological interest with no corresponding geophysical anomaly). They are discussed in full in the technical report and associated appendices (**Appendix 18A**), and are illustrated in **Figure 4.5**. Of these six maritime sites, three are considered of low archaeological value or no archaeological interest (WA70616, WA70617 and WA70619).

4.3.6. Two of the remaining three records relate to unidentified wrecks charted as live by the UKHO (WA70618, WA70620)

4.3.7. The third wreck (WA70621) is charted as dead and appears to relate to a record of loss only and not actual remains on the seabed.



LEGEND

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

Wessex archaeology Anomalies

- A1: Anthropogenic origin of archaeological interest
- A2: Uncertain origin of possible archaeological interest
- A3: Historic record of possible archaeological interest

0 5 10
Kilometres

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

PROJECT TITLE

DOGGER BANK TEESSIDE A & B

DRAWING TITLE

Figure 4.5 Seabed features within Teesside A & B

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

DRAWING NUMBER: **F-OFL-MA-612**

SCALE	1:450,000	PLOT SIZE	A4	DATUM	WGS84	PROJECTION	UTM31N

FOREWIND

4.3.8. Two of the anomalies assessed by Wessex Archaeology were classified as A1 (anthropogenic origin of archaeological interest) and are discussed in full in the technical report and associated appendices (**Appendix 18A**) and are illustrated on Wreck Sheets 1 and 2, and **Figure 4.5**.

4.3.9. Wreck WA70587 (Gardline ID BW005) is located in the northern extent of the Teesside A area of the development (Wreck Sheet 1). The wreck measures 34.5m x 10m x 0.7m and is associated with a large magnetic anomaly measuring 1159nT which suggests a ferrous construction. The wreck looks to be wholly intact and a possible piece of associated debris (WA70586) has been identified 123m southwest of the wrecks location. The hull, bow and stern of the wreck appear to be well preserved and intact as well as some standing structures still surviving.

4.3.10. Anomaly WA70590 has been identified as a possible wreck in the northern extent of Teesside A (Wreck Sheet 2). The possible wreck has dimensions of 40m x 14m x 0.4m and a strong curvilinear edge consistent with wreck remains. There is no associated magnetic anomaly associated with this possible wreck, although it does sit on an area of the seabed that is highly affected by magnetic fluctuations likely resulting from geological noise.

4.3.11. Of the anomalies assessed by Wessex Archaeology 35 were classified as A2 (uncertain origin of possible archaeological interest). These are discussed in full in the technical report and associated appendices (**Appendix 18A**) and illustrated in **Figure 4.5**. They are also summarised in **Table 4.1**.

Table 4.1 A2 anomalies of uncertain origin of possible archaeological interest (Dogger Bank Teesside A)

Anomaly classification	Number of anomalies
Debris	10
Dark Reflector	4
Depression	5
Magnetic	16
Total	**35**

4.3.12. Of the ten A2 anomalies identified as debris, one (WA70586) has been tentatively associated with wreck WA70587. Two (WA70583 and WA70593) are associated with magnetic anomalies and are interpreted as being at least partially ferrous in nature. The largest piece of debris is WA70591 (10.7m x 4.4m x 0.3m high) and the smallest is WA70579 (Gardline ID BB490) (1.7m x 0.6m x 0.1m high).

4.3.13. The four dark reflectors are all small/medium sized anomalies with height and all but one (WA70584) are large enough to be visible in the bathymetry data. Two of the five depressions (WA70597 and WA70598) are located within 55m of one another and could be related although they look to be separate anomalies. There is a large magnetic anomaly of 144nT associated with these two depressions which may indicate buried ferrous debris remains, are not visible on the seabed.

4.3.14. There are 16 magnetic anomalies of possible anthropogenic interest with no associated sidescan sonar or multibeam bathymetry anomalies associated. These could potentially be buried ferrous material and objects. Of particular interest are three very large magnetic anomalies that potentially represent large pieces of buried ferrous debris. WA70606 (Gardline ID BM284) has a magnetic value of 649nT, WA70600 (Gardline ID BM189) has a magnetic value of 241nT and WA70601 (Gardline ID BM228) has a magnetic value of 163nT.

4.3.15. With further investigation it may be possible to reinterpret these 35 A2 anomalies as non-archaeological. Likewise, further survey may confirm their anthropological origin and maritime archaeological interest.

Dogger Bank Teesside B

4.3.16. The UKHO records three wrecks (one live and two dead) within the Teesside B MSA. All of these are located within the project area and there are no records of receptors within the TWA.

4.3.17. No anomalies were seen by Wessex Archaeology within the geophysical data that correspond to these records.

4.3.18. The three wrecks were classified as A3 (historic record of possible archaeological interest with no corresponding geophysical anomaly). They are discussed in full in the technical report and associated appendices (**Appendix 18A**), and illustrated in **Figure 4.5**.

4.3.19. Two of these (WA70535 submarine U 66 lost in 1917 and WA70536 William and John lost in 1648) appear to be recorded losses only and may not relate to actual remains on the seabed. The third (WA70533) is an unknown wreck charted in 1920 and deleted in 1927 and, likewise, may not correspond to archaeological remains.

4.3.20. Four of the anomalies assessed by Wessex Archaeology were classified as A1 (anthropogenic origin of archaeological interest). They are discussed in full in the technical report and associated appendices (**Appendix 18A**), and illustrated in **Figure 4.5** and Wreck Sheets 3 to 6.

4.3.21. Wreck WA70636 (Gardline ID BW002) is located in the Teesside B area of the development (Wreck Sheet 3). The wreck site appears partially buried and has a large magnetic anomaly associated with it measuring 144nT which would indicate part ferrous construction or cargo debris associated with the wreck. The entire wreck has dimensions of 15m x 13m x 0.9m and may be the remains of a small fishing vessel. Overall the wreck remains look to be poorly preserved.

4.3.22. Wreck WA70637 (Gardline ID BW003) is located on the north eastern corner of the Teesside B area of the development (Wreck Sheet 4). The wreck remains have a very high magnetic anomaly associated with them measuring 1999nT which suggests a predominantly ferrous structure. The wreck has dimensions of 29m x 9m x 0.7m height and appears to be mostly intact and well-preserved with superstructure visible in the data.

4.3.23. Wreck WA70505 (GEMS ID DBA_S1099) was identified in the Tranche A assessment and lies within Teesside B (**Appendix 18A**) (Wreck Sheet 5). This is a relatively small but well-defined anomaly associated with a well-defined 60nT magnetic anomaly and measuring approximately 16.8m x 10.3m x 1.8m. No coherent structure seems to remain, though it could represent the remains of a small, badly degraded, partially ferrous vessel. The feature appears similar in appearance to a well-head, though correlation with the locations of known well-heads across Dogger Bank has ruled out this possibility.

4.3.24. Wreck WA70640 is located in the northern corner of Teesside B (Wreck Sheet 6). This possible wreck has dimensions of 34.5m x 13.5m x 0.4m.

4.3.25. 25 of the anomalies assessed by Wessex Archaeology were classified as A2 (uncertain origin of possible archaeological interest). These are discussed in full in the technical report and associated appendices (**Appendix 18A**), illustrated in **Figure 4.5** and summarised in **Table 4.2**.

Table 4.2 A2 anomalies of uncertain origin of possible archaeological interest (Dogger Bank Teesside B)

Anomaly classification	Number of anomalies
Debris	14
Debris Field	2
Dark Reflector	2
Magnetic	7
Total	**25**

4.3.26. Of the 14 A2 anomalies identified as debris, two (WA70506 and WA70507) were previously identified in the Tranche A assessment within Dogger Bank Teesside B (Appendix 2 to **Appendix 18A**). The largest piece of debris is WA70628 (Gardline ID BB082) (7.3m x 2.8m x 0.1m) and the smallest is WA70633 (Gardline ID BB145) (1.8m x 1.2m x 0.2m high).

4.3.27. WA70638 (Gardline ID BB135) is interpreted as a debris field with total dimensions of 15m x 4.4m x 0.8m height and associated with a magnetic anomaly of 7nT which suggests a small amount of ferrous material is present. The second debris field is visible as an object in a depression WA70627 (Gardline ID BB089 and BB090). There are small scour marks visible orientated south in the sandy sediments next to the debris and possible smaller buried pieces visible in the sidescan sonar imagery.

4.3.28. The two dark reflectors recorded in Teesside B, WA70622 (Gardline ID BB096) and WA70625 (Gardline ID BB118) are also both visible in the multibeam bathymetry data as depressions. No magnetic anomalies are located within the vicinity of these targets which indicates they are not ferrous material.

4.3.29. There are seven magnetic anomalies of possible anthropogenic interest without associated sidescan sonar or multibeam bathymetry anomalies. These could potentially be buried ferrous material and objects and are generally small to medium in size (50nT).

Dogger Bank Teesside A & B Export Cable Corridor

4.3.30. Following searches, a large number of records of wrecks, obstructions and reported losses were identified below MHWS within the Dogger Bank Teesside A & B Export Cable Corridor MSA:

- 63 maritime records from Redcar and Cleveland HER;
- 105 maritime records from the NRHE; and
- 24 UKHO records of wrecks and obstructions (via SeaZone).

4.3.31. Following comparison and grouping of the data from the three datasets, 39 recorded wrecks and obstructions were identified within the geophysical survey area, 38 of which were not seen in the geophysical data and are classified as A3 (historic record of possible archaeological interest with no corresponding geophysical anomaly). These 38 records comprise six wrecks, one foul and 31 fishermen's fasteners (unidentified seabed obstructions).

4.3.32. The record recorded as a foul (WA70867) has previously been identified as an area of rock ledges and is not expected to be of archaeological interest.

4.3.33. The six wrecks comprise three unknown wrecks recorded by the HER (WA70855, WA70860 and WA70866), two unknown wrecks recorded as dead by the UKHO (WA70830 and WA78031) and the wreck of *Afrique* recorded by the HER (WA70853). It has, however, been concluded that the *Afrique* has been recorded at this location in error.

4.3.34. The wrecks WA70855 and WA70866 are recorded by the HER only with reference to Hydrographic Office (HO) print outs. As nothing was seen at these locations in the geophysical data it is considered likely that this wreck has been recorded at this location in error. Moreover, WA70866 is located in the vicinity of UKHO 6348 (WA70867) recorded as an area of rock ledges.

4.3.35. The location of wreck WA70860 corresponds to the location of a fishermen's fastener recorded by the NRHE (WA70863). As this record references a different HER record (WA2061), and as nothing was seen in the geophysical data, it is also concluded that this wreck has been recorded at this location in error.

4.3.36. The two dead wrecks, WA70830 and WA70831, are recorded as bad obstructions (wrecks) by the UKHO. The source for both records is the Kingfisher Book of Tows which suggests that these may be better classified as fishermen's fasteners rather than wrecks. Nothing was seen at these positions during survey in 1993 and nothing was seen in the data for Dogger Bank Teesside A & B. It is thus considered likely that there are no archaeological remains present at these locations.

4.3.37. The 31 records identified as fishermen's fasteners were not seen in the geophysical data and it is considered likely that any obstructions, of either natural or anthropogenic origin that may once have been present, are now absent or that the co-ordinates reported by fishermen may have been inaccurate or uncertain.

4.3.38. Only one of the anomalies assessed by Wessex Archaeology was classified as A1 (anthropogenic origin of archaeological interest). Wreck WA70657 is recorded by the UKHO to be the HMS Ruthin Castle (UKHO 6058) a British steam trawler ship built in 1916 and sunk off the coast of Yorkshire in 1917 by a mine laid by the German Submarine UC-50.

4.3.39. The vessel lies in quite shallow water in the nearshore area of the cable route and in the backscatter geophysical dataset the wreck appears as a discreet large anomaly covered by sands and gravels. The skeleton of the vessel is subtly visible with some structure of the hull or stern area present and somewhat intact. The wreck looks to be in a poor state of preservation, consistent with the UKHO diver survey report which records the wreck as very broken up and abraded. The wreck is visible in the multibeam bathymetry data although it is not distinguishable as a wreck. As the magnetometer fish could not be towed in this area of the cable route there is no evidence for a magnetic anomaly.

4.3.40. 177 of the anomalies assessed by Wessex Archaeology were classified as A2 (uncertain origin of possible archaeological interest). These are discussed in full in the technical report and associated appendices (**Appendix 18A**) and illustrated in **Figure 4.6a- Figure 4.6i**. They are also summarised in **Table 4.3.**

Table 4.3 A2 Anomalies of uncertain origin of possible archaeological interest (Dogger Bank Teesside A & B Export Cable Corridor)

Anomaly classification	Number of anomalies
Debris	45
Debris Field	10
Mound	7
Rope/chain	4
Seafloor Disturbance	2
Dark Reflector	60
Magnetic	49
Total	**177**

4.3.41. Of the A2 anomalies 45 have been identified as possible pieces of anthropogenic debris. The largest object (15.7m x 1.8m x 0.9m high) comprises two pieces of debris that look to have originally been one (WA70730). The smallest object (2m x 0.8m with no measurable height) (WA70791) was identified in the backscatter data. The interpretation of many of the targets identified in the backscatter data is tentative as the data resolution is much poorer and identification and interpretation is more difficult, particularly as the backscatter lacks a corresponding magnetometer dataset.

4.3.42. There are ten possible debris fields. Only one has a corresponding magnetic anomaly (WA70673) indicating a non-ferrous origin for the remainder. Debris field WA70673 has a magnetic anomaly value of 52nT which indicates it is in part made up of ferrous material, appearing as a mound of uneven rubble material. The largest debris field (WA70699) is dispersed across the seabed covering an area of 37.6m x 6.9m and maximum height of 0.5m. The smallest debris field (WA70732) has dimensions of 7.2m x 5.4m x 1.5m height.

4.3.43. There are seven mounds identified in the multibeam bathymetry data. The largest mound (WA70759) is irregular shaped with dimensions of 98m x 56m x 1.4m height and a magnetic anomaly value of 18nT. The smallest mound (WA70782) has dimensions of 5.1m x 4m x 0.2m height.

4.3.44. Four rope and chain remains have been identified and flagged as an A2 archaeological potential rating (WA70655, WA70719, WA70728 and WA70825). The longest of these (63.5m) is WA70655.

4.3.45. There are two recorded seafloor disturbances (WA70693 and WA70801). WA70693 is diamond shaped with geophysical dimensions of 5.6m x 3.8m and no measurable height. The second (WA70801) was seen in the backscatter data with dimensions of 26.6m x 4.4m and no measurable height.

4.3.46. There are 60 dark reflectors categorised as A2. The smallest (WA70794) was seen in the backscatter data with dimensions of 0.7m x 0.5m. The largest dark reflector (WA70820) has dimensions of 10.8m x 7.5m x 1m.

4.3.47. Finally, there are 49 magnetic anomalies without corresponding bathymetry or sidescan anomalies ranging in size from 35nT to 5nt, the smallest anomaly value selected for assessment. The presence of these anomalies in areas categorised as sand, thin sands and gravels indicates that, even where there is little sediment cover, there is potential for buried material to be present. A very small number of magnetic anomalies were identified on patches of till which could be resultant of geological changes.

4.3.48. With further investigation it may be possible to reinterpret these 177 A2 anomalies as non-archaeological. Likewise, further survey may confirm their anthropological origin and maritime archaeological interest.

4.3.49. In addition to the records and anomalies identified within the geophysical survey area there are 106 further records located within the Dogger Bank Teesside A & B Export Cable Corridor MSA, outside the geophysical survey area, and within the TWA.

4.3.50. Of these 80 have been categorised as Fishermen's Fasteners. 20 have been identified as duplicates leaving 60 individual locations. Due to the disparity in referencing between the NRHE and HER datasets it is possible that further of these 60 are also duplicates although it is not possible to conclude this with certainty this from the recorded data.

4.3.51. Six further records relate to fouls recorded by the UKHO and obstructions positively identified during previous surveys as geological features.

4.3.52. Of the remaining 18 records, seven relate to six unknown wrecks three are charted as live by the UKHO (WA2014, WA2017 and WA2110) with WA2110 also recorded (at the same location) by the NRHE. Only the presence of a wreck is recorded for WA2104 and WA2017 while WA2110 is described as an iron-hulled wreck observed by divers in 1995, well decayed but with identifiable features indicating a steamship.

4.3.53. Wreck WA2024 was reported in 1972 but has not been observed since and is considered dead by the UKHO. Wreck WA2092 is recorded by the HER only, referencing an HO (Hydrographic Office) print out. As there is no corresponding UKHO record at or near this location this may be a recording error. Wreck WA2094 is recorded by the HER as a wreck marked on an admiralty chart. In line with the precautionary principle, as these three locations are not covered by the geophysical data for Dogger Bank Teesside A & B their presence should be considered possible.

4.3.54. The remaining ten records refer to six individual, named wrecks. These additional records are detailed in full in the technical report and associated appendices (**Appendix 18A**).

Value of known maritime receptors

4.3.55. The value assigned to individual wrecks is site specific and individual vessels may be considered to be of archaeological value by reference to any number of interrelating integral and relative factors. Those regarded of special interest may further be designated under the Protection of Wrecks Act 1973 or the Protection of Military Remains Act 1986.

4.3.56. Within Teesside A & B there are six A1 anomalies identified as wrecks, two within Teesside A (WA70587 and WA70590) and four within Teesside B (WA70636, WA70637, WA70505 and WA70640). Each of these is unidentified and, as such, there is insufficient data to assess their individual value and, in accordance with the precautionary approach, each will be considered of high archaeological value.

4.3.57. There is one A1 anomaly within the Dogger Bank Teesside A & B Export Cable Corridor identified as the HMS *Ruthin Castle* (WA70657). This wreck is of high value as a World War I loss although the wreck is not in a good state of preservation.

4.3.58. Within Teesside A there are six A3 recorded wrecks and obstructions that have not been seen in geophysical data. Two are considered to be of low archaeological value (WA70616 and WA70617) as modern losses while WA70619 is considered to be of no archaeological value relating to the recent loss of equipment.

4.3.59. Two of the remaining three records relate to unidentified wrecks charted as live by the UKHO (WA70618, WA70620). As these are unidentified and as there is insufficient data to assess their value, in accordance with the precautionary approach, each will be considered of high archaeological value.

4.3.60. The third wreck *Membland* (WA70621), a British steamship lost after striking a mine in 1915, is charted as dead and is suspected to relate to a record of loss only and not actual remains on the seabed. Although this cannot be confirmed, the absence of remains is considered likely and this record is considered of low archaeological value.

4.3.61. Within Dogger Bank Teesside B there are three A3 recorded wrecks that have not been seen in geophysical data. Two of these (WA70535 and WA70536) appear to be recorded losses only while the third (WA70533) is an unknown wreck charted in 1920 and deleted in 1927 and, likewise, may not correspond to archaeological remains. As with the *Membland* the absence of remains is considered likely and this record is considered of low archaeological value.

4.3.62. Within the Dogger Bank Teesside A & B Export Cable Corridor MSA, within the geophysical survey area, 39 records of wrecks and obstructions were not seen in the data and classified as A3s.

4.3.63. The 33 Fishermen's Fasteners that were not seen in the geophysical data are considered to be either absent or inaccurately positioned. Without clear evidence of archaeological material having been present in the past, or seen within the geophysical data, these records are considered of low archaeological value.

4.3.64. Similarly, the four wrecks that have not been seen in the geophysical data (WA70855, WA70860, WA70866 and *Afrique* WA70853) are considered to be either absent or inaccurately recorded. These are also considered to be of low archaeological value. The foul identified as rock ledges (WA70867) is of no archaeological interest.

4.3.65. Within the Dogger Bank Teesside A & B Export Cable Corridor MSA, outside the geophysical survey area, there are 106 additional records of wrecks and obstructions at positions that are not covered by geophysical data.

4.3.66. One of the records was conclusively identified as a positional error (WA2149) and is not considered further.

4.3.67. Five of the records are not of archaeological interest:

- Modern equipment losses (WA2012 and WA2013); and
- Features positively identified as geological features (WA2136, WA2045 and WA2052).

4.3.68. These records are not considered further as part of this assessment.

4.3.69. The precautionary approach is outlined in Section 3 and states that when uncertainty occurs archaeological receptors should be assigned high value. For this reason the 80 Fishermen's Fasteners, not covered by geophysical survey, should be considered high value. If further data becomes available to confirm the absence or non-anthropogenic origin of these obstructions, as for the 31 fastener's not seen in the data for Dogger Bank Teesside A & B, this value judgment may be revised down. The same applies to the three UKHO unidentified seabed obstructions WA2016, WA2020 and WA2018).

4.3.70. The six unknown wrecks (WA2014, WA2017, WA2110, WA2024, WA2092 and WA2094) should also be considered as being of high value unless further data becomes available. Even where recorded errors are suspected (WA2092 and WA2094) records are of high value until further information, such as geophysical survey, can confirm their absence. Likewise, the records relating to the vessels *Moorwood* (WA2095) and HMS *Ruthin Castle* (WA2148) should be considered of high archaeological value as World War losses until the suspected recording inaccuracies can be confirmed.

4.3.71. The remaining maritime receptors relate to four individual, named wrecks:

- *Rema* (WA2022): low archaeological value as a modern loss;
- *Anboto Mendi* (WA2114): high archaeological value as a World War I loss with substantial structure remaining;
- *Early Percy* (WA2126): medium archaeological value as a late 19th century merchant steamer with broken up structural remains; and
- *Hartley* (WA2147): high archaeological value as a World War I loss with substantial structure remaining.

Potential maritime archaeological receptors

4.3.72. Teesside and the Yorkshire coast are geographically isolated by the North York Moors and it may have been more natural for past communities to look to the sea rather than landwards for transport (Val Baker *et al*. 2007). This isolation also led to the intensive exploitation of the coastal strip and there is potential within the MSAs for the presence of archaeological material relating to both these maritime and exploitative activities.

4.3.73. The potential maritime resource relates to vessels which have been lost in the past but for which no remains have yet been located. This may comprise vessels for which a record of that loss exists (e.g. in the Lloyds of London list of shipping casualties, in newspaper accounts, in historic records of eyewitness accounts) and vessels for which no account of its loss is known (e.g. prehistoric or early historic losses, loss of smaller local craft). Discussions of potential rely upon the characterisation of known maritime activity (e.g. shipping routes, fishing grounds, maritime battles) to identify the likelihood of as yet undiscovered remains being present within a given area.

4.3.74. The NRHE groups documented losses (historical records of vessels lost at sea) at arbitrary points on the seabed called Named Locations (NLOs). These points represent general loss locations and do not (except by chance) relate to actual seabed remains. There are five NLOs that fall within, or adjacent to the boundary of the Dogger Bank Teesside A & B Export Cable Corridor MSA (**Figure 4.7**).

4.3.75. The NRHE records 52 shipping losses at these NLOs ranging in date from 1313 to 1939 (**Table 4.4**). Due to the arbitrary nature of these grouped loss locations it is possible that the actual remains of these vessels may lie some distance from the recorded location, possibly within the MSAs. As new data becomes available, these records may become linked to charted wrecks of unknown identity or to newly discovered maritime receptors.

Table 4.4 Summary of Named Locations (NLOs) within, or adjacent to the boundary of the Dogger Bank Teesside A & B Export Cable Corridor MSA

Associated Named Location	Easting	Northing	NLO Area (HA)	No of wrecks	Date of Loss Range
Marske Sands	241527	6057289	Point	1	1860
			0.030901	7	1758-1819
			77.25423	18	1807-1904
Saltburn Sands	243617	6056057	77.25424	5	1822-1861
Satlburn Scar	245252	6056331	77.25421	1	1880
Hunt Cliff	246305	6055905	77.25424	6	1801-1899
Off Redcar	250305	6059954	77.25423	13	1808-1939
			78.39142	1	1313

4.3.76. The distribution of dates and vessel types recorded at these locations reflects a general trend off Teesside and North Yorkshire in the dominance of early modern wrecks involved in coastal trade and fishing (Val Baker 2007, p. 43).

4.3.77. There are also two further recorded losses identified from a UKHO record (UKHO 6052, *John Miles* lost 1917) and HER record (HER 3055, Farmers Increase lost 1808) (**Figure 4.7**). These are both records from documentary evidence without any evidence for corresponding remains. Other records suspected to be recorded losses only have been included in the maritime gazetteer as the absence of remains is not conclusive (WA2005, WA2007 and WA2008). The wreck of the John Miles, however, has been identified elsewhere beyond the MSA (UKHO 6063), while no evidence for the wreck Farmer's Increase has been found in supporting documentation.

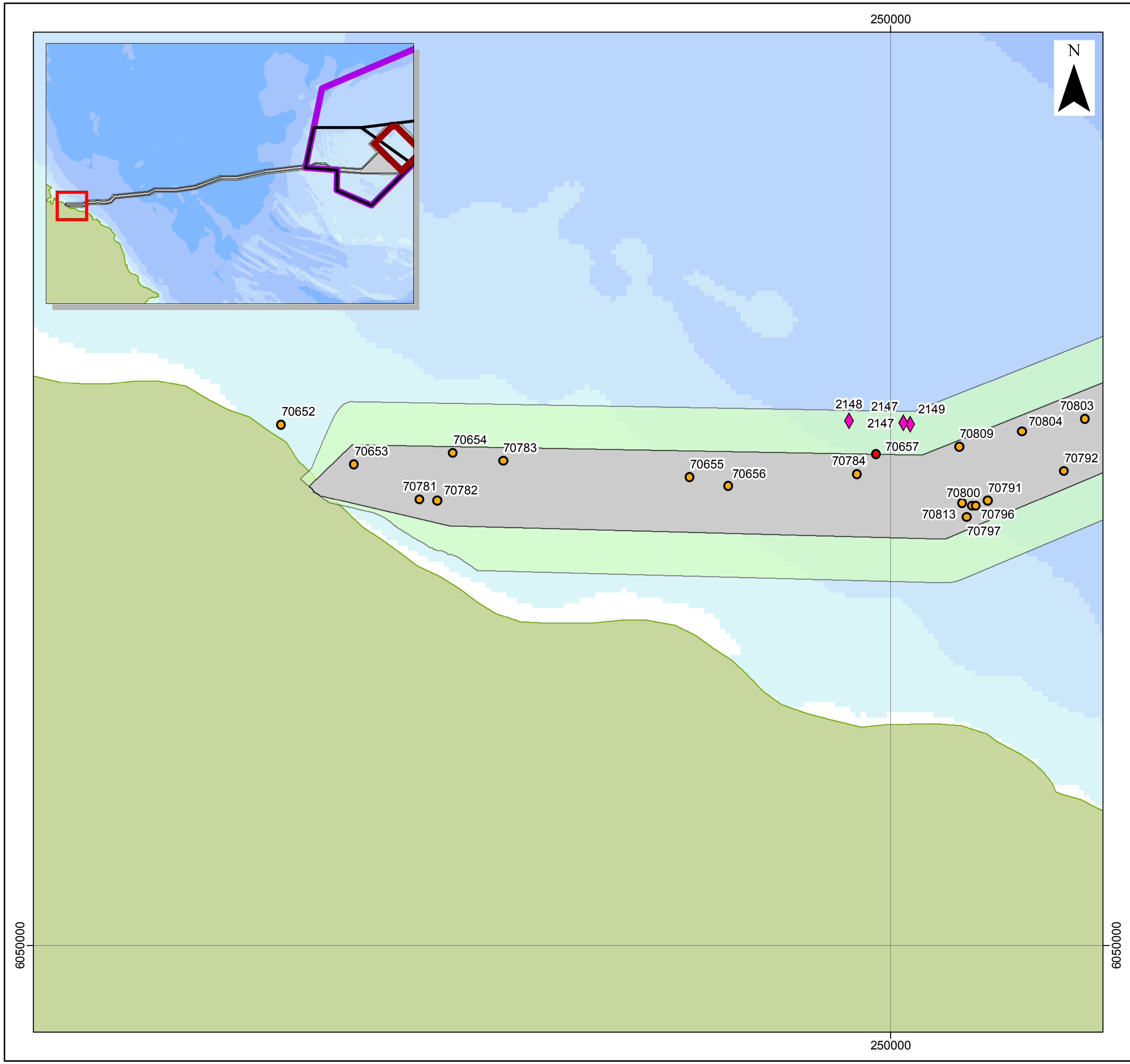
4.3.78. These losses are key indicators of the potential for further wrecks to be identified within the study areas. This potential spans a wider prehistoric to modern period, as indicated by a strong history of maritime tradition in the area.

4.3.79. As the value of potential wrecks cannot be evaluated until they are discovered, potential wrecks of all periods should be expected to be of high value.

4.3.80. On the basis of their age and rarity prehistoric maritime material will be of high archaeological value. In the event that prehistoric maritime remains discovered offshore are found in situ they should also be considered of high archaeological value.

4.3.81. Derived artefacts are likely to be of limited archaeological value as individual discoveries. However, the occurrence of a number of seemingly isolated artefacts within a particular area have the potential to indicate historical shipping routes or maritime battlegrounds, for example, or may indicate the presence of a hitherto unknown wreck site. Isolated maritime finds are, therefore, of medium archaeological value.

4.3.82. The archaeological value of these maritime receptors and other archaeological receptors is summarised in **Table 4.6**.



LEGEND

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

Wessex Archaeology Anomalies

- A1: Anthropogenic origin of archaeological interest
- A2: Uncertain origin of possible archaeological interest
- A3: Historic record of possible archaeological interest
- Additional records

0 1 2
Kilometres

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

PROJECT TITLE

DOGGER BANK TEESSIDE A & B

DRAWING TITLE

Figure 4.6a Seabed features within export cable corridor

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

DRAWING NUMBER: **F-OFL-MA-613**

SCALE	PLOT SIZE	DATUM	PROJECTION
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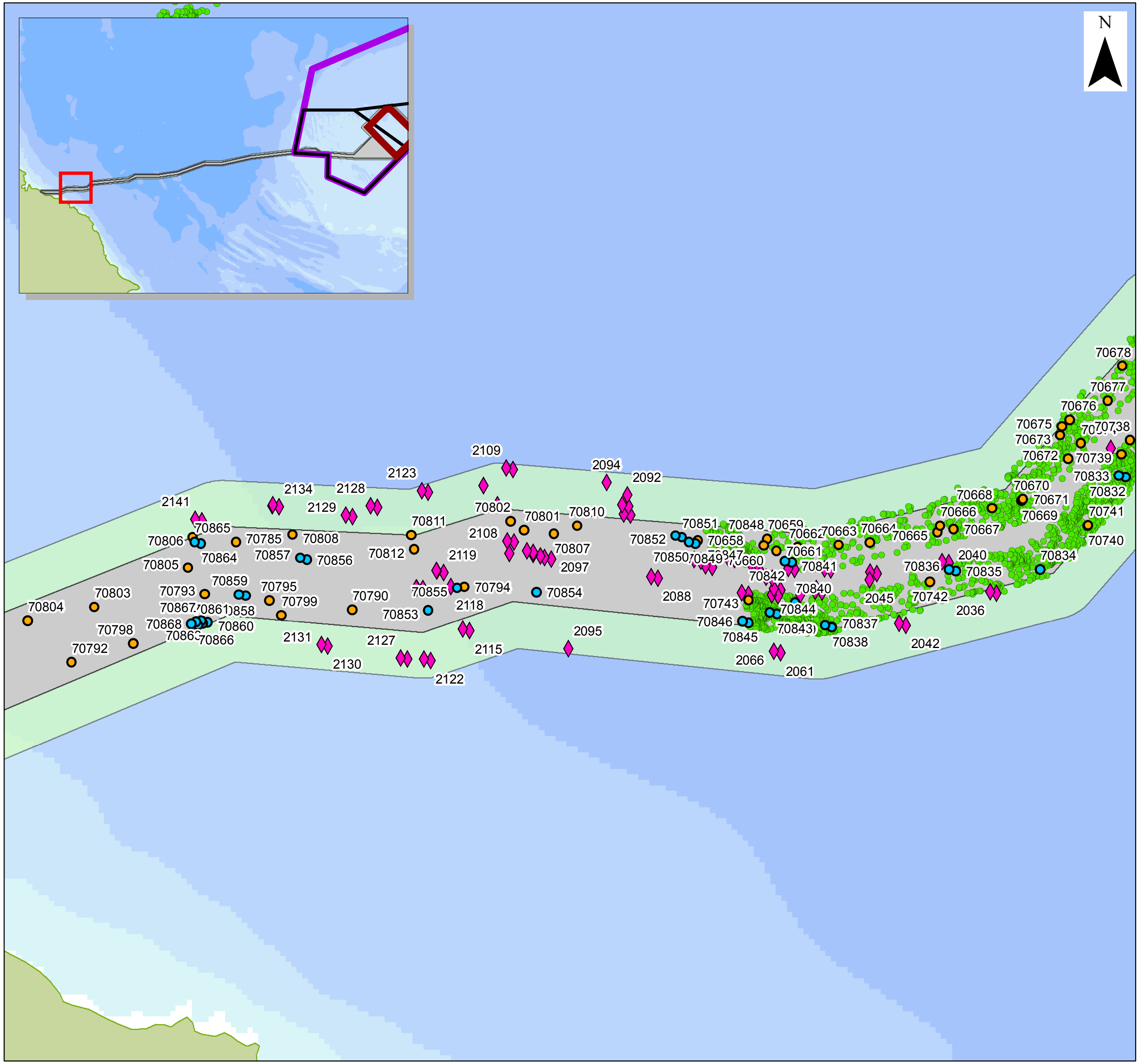
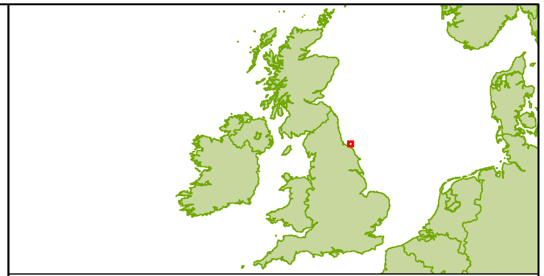




LEGEND

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

Wessex Archaeology Anomalies

- A1: Anthropogenic origin of archaeological interest
- A2: Uncertain origin of possible archaeological interest
- A3: Historic record of possible archaeological interest
- Additional records

0 1 2
Kilometres

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

PROJECT TITLE

DOGGER BANK TEESSIDE A & B

DRAWING TITLE

Figure 4.6b Seabed features within export cable corridor

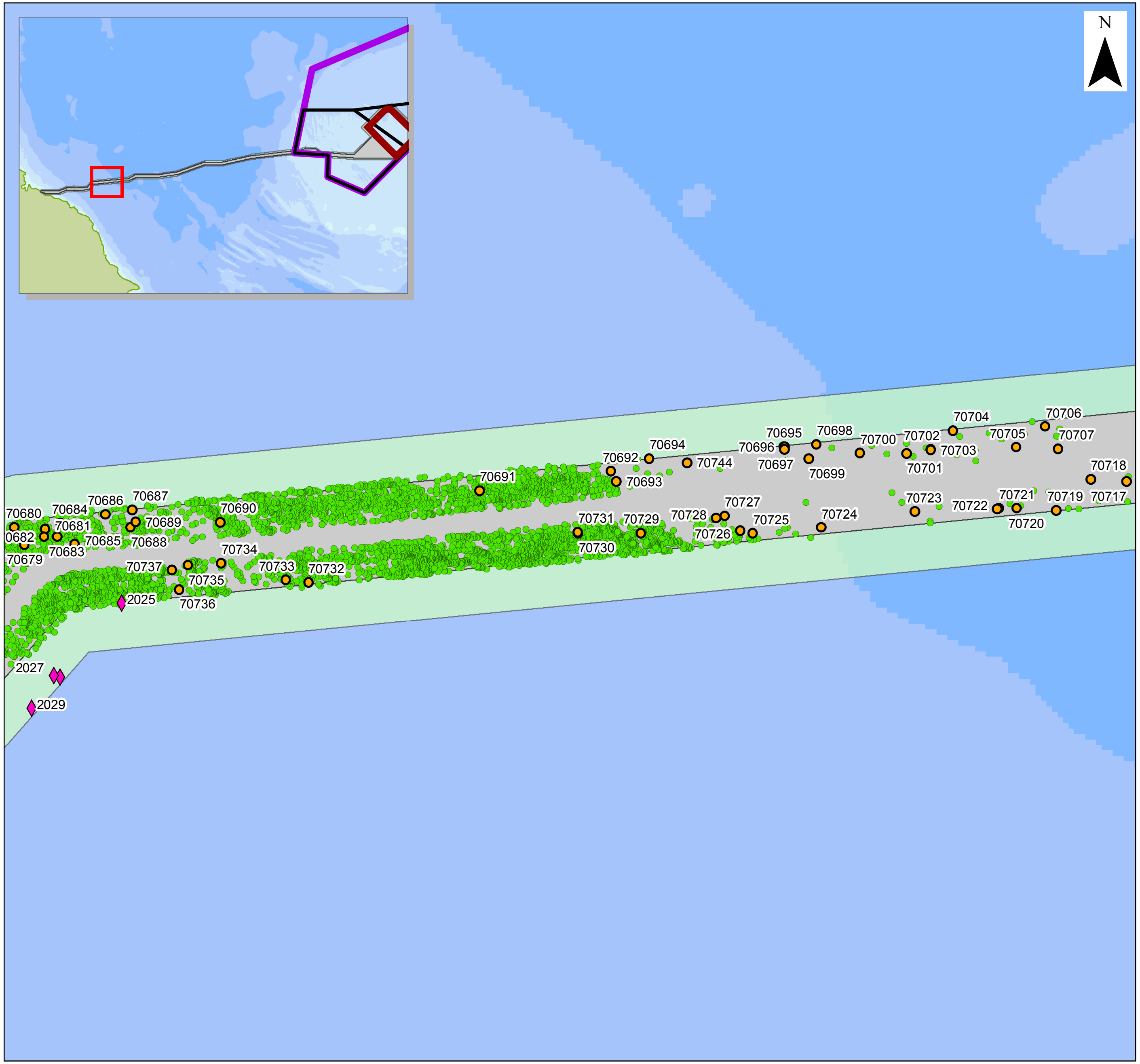
VER	DATE	REMARKS	Drawn	Checked
1	02/10/2013	PEI3	GC	FS
2	07/02/2014	DCO Submission	GC	FS

DRAWING NUMBER:

F-OFL-MA-614

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

FOREWIND



LEGEND

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

Wessex Archaeology Anomalies

- A1: Anthropogenic origin of archaeological interest
- A2: Uncertain origin of possible archaeological interest
- A3: Historic record of possible archaeological interest
- Additional records

0 1 2
Kilometres

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

PROJECT TITLE

DOGGER BANK TEESSIDE A & B

DRAWING TITLE

Figure 4.6c Seabed features within export cable corridor

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

DRAWING NUMBER: **F-OFL-MA-615**

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

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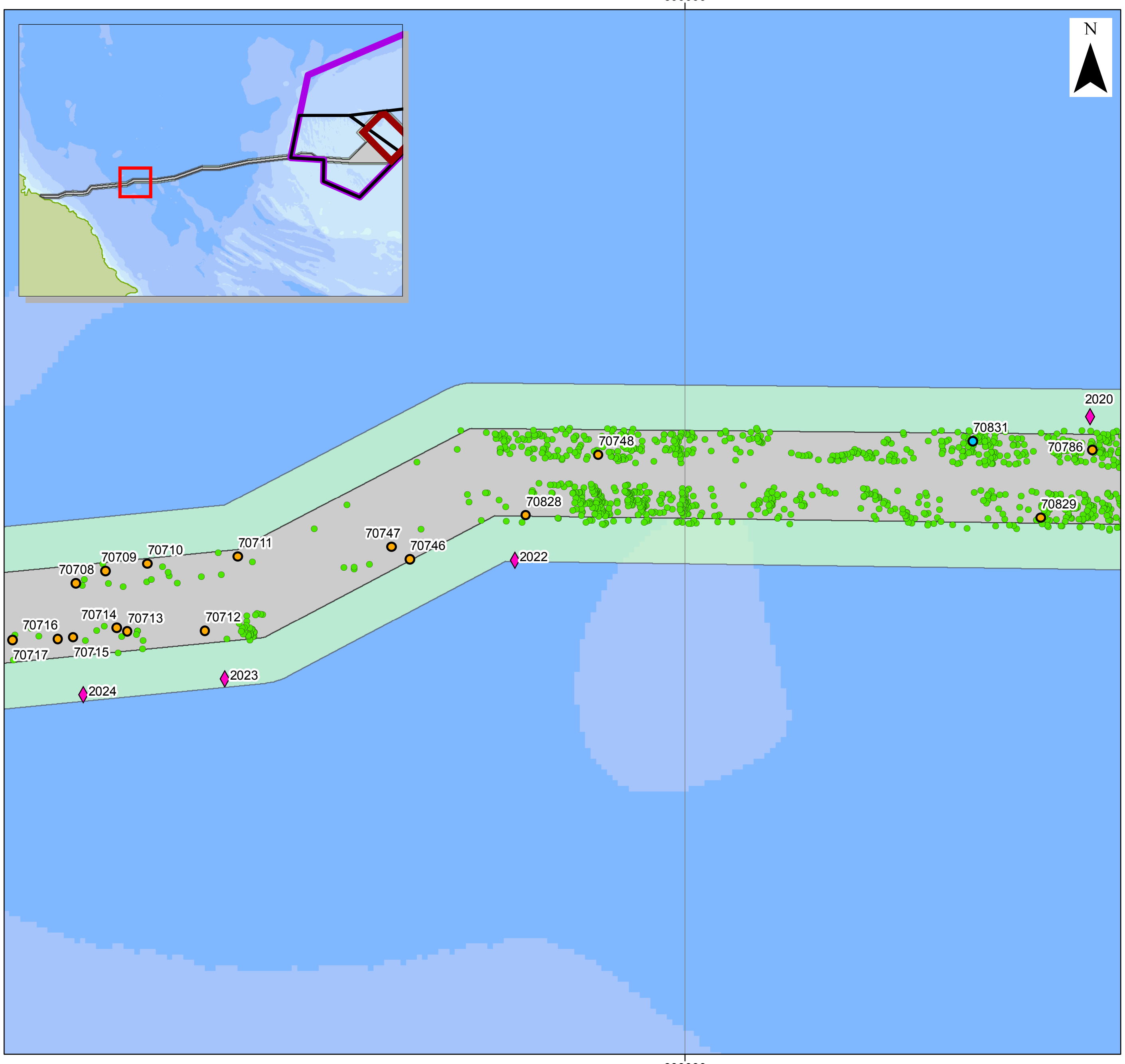


LEGEND

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

Wessex Archaeology Anomalies

- A1: Anthropogenic origin of archaeological interest
- A2: Uncertain origin of possible archaeological interest
- A3: Historic record of possible archaeological interest
- Additional records

0 1 2
Kilometres

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

PROJECT TITLE

DOGGER BANK TEESSIDE A & B

DRAWING TITLE

Figure 4.6d Seabed features within export cable corridor

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

DRAWING NUMBER: **F-OFL-MA-616**

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

FOREWIND

LEGEND

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

Wessex Archaeology Anomalies

- A1: Anthropogenic origin of archaeological interest
- A2: Uncertain origin of possible archaeological interest
- A3: Historic record of possible archaeological interest
- Additional records

0 1 2
Kilometres

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

PROJECT TITLE

DOGGER BANK TEESSIDE A & B

DRAWING TITLE

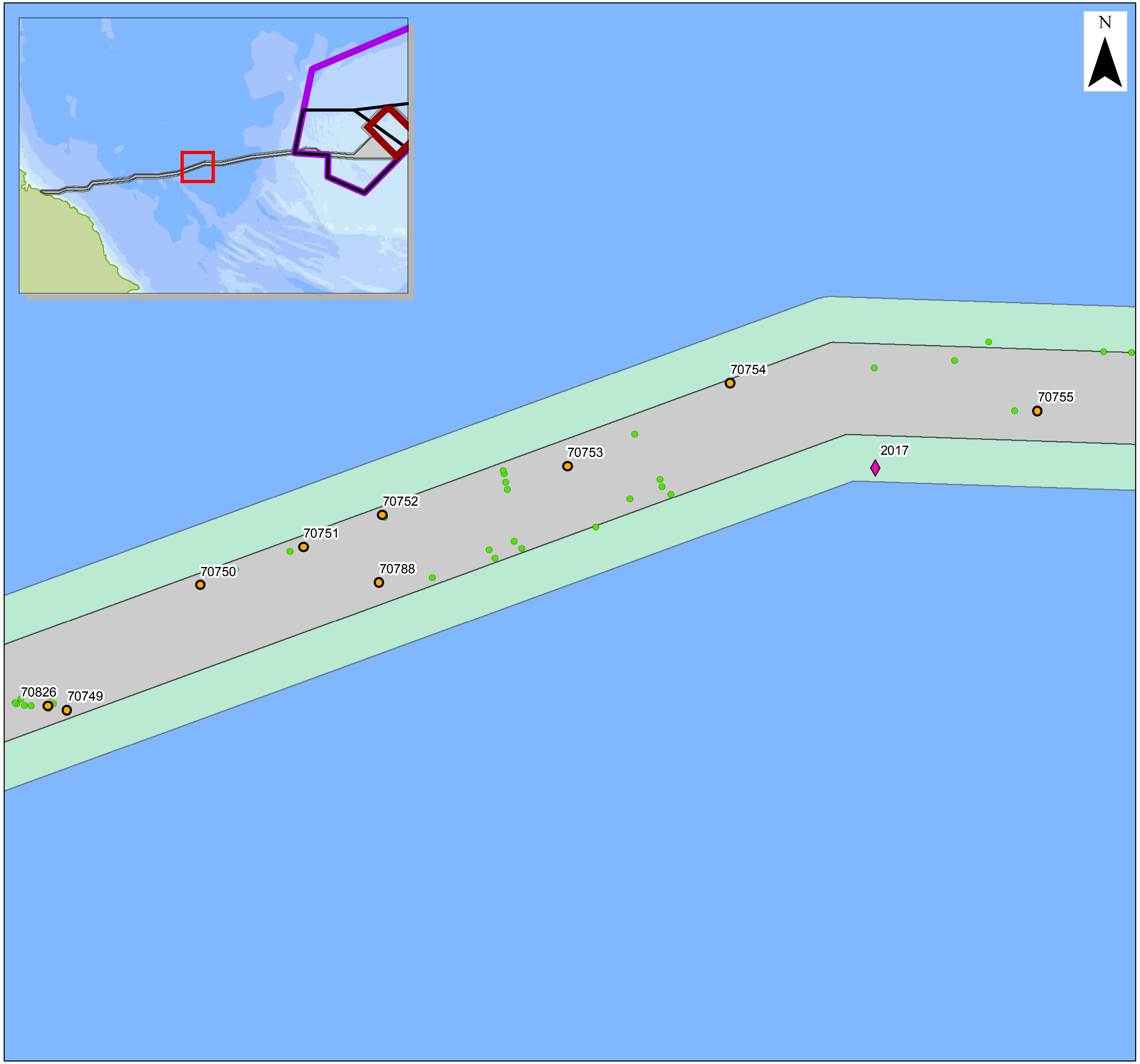
Figure 4.6e Seabed features within export cable corridor

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

DRAWING NUMBER: **F-OFL-MA-617**

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

FOREWIND



LEGEND

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

Wessex Archaeology Anomalies

- A1: Anthropogenic origin of archaeological interest
- A2: Uncertain origin of possible archaeological interest
- A3: Historic record of possible archaeological interest
- Additional records

0 1 2
Kilometres

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

PROJECT TITLE

DOGGER BANK TEESSIDE A & B

DRAWING TITLE

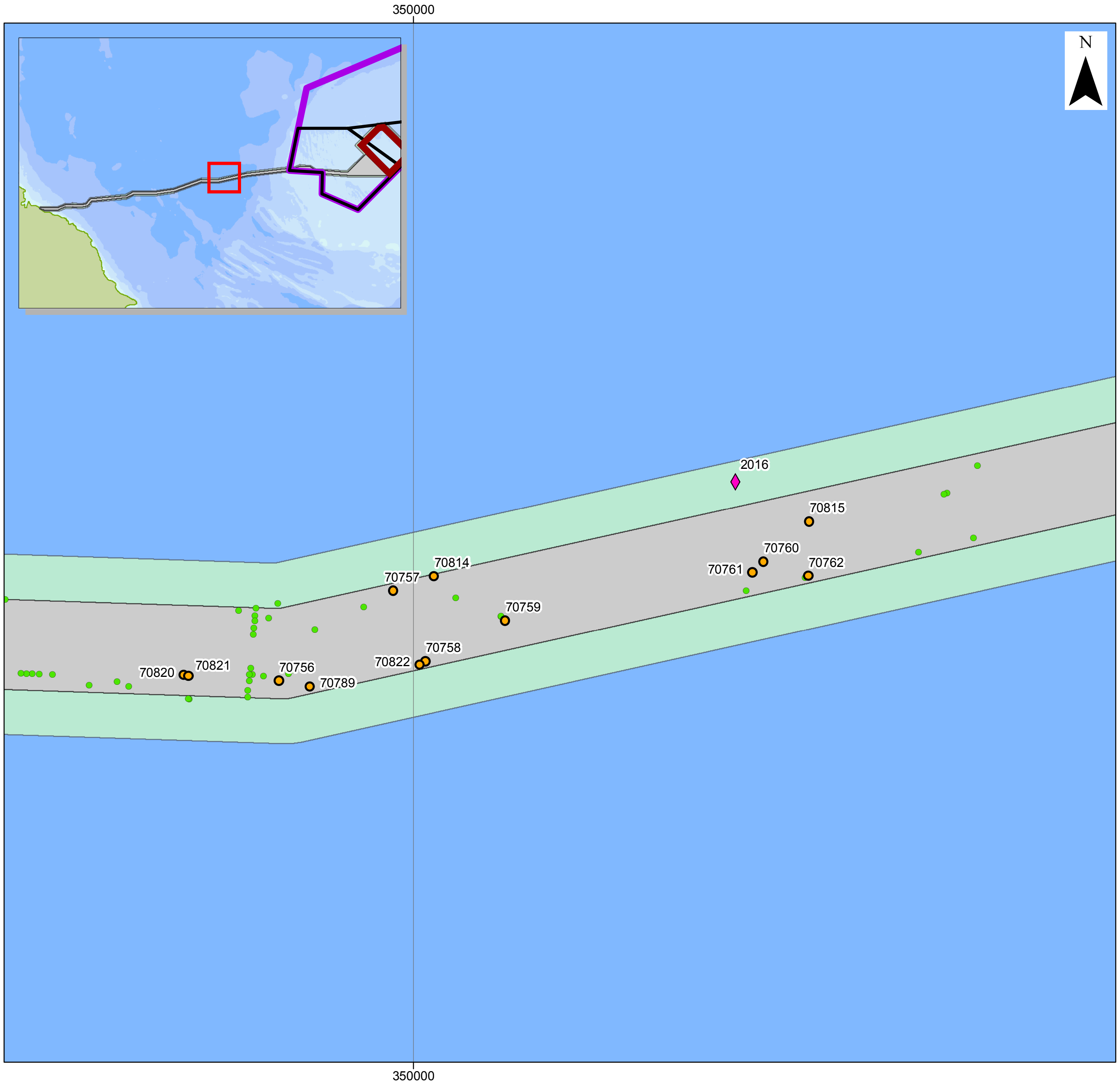
Figure 4.6f Seabed features within export cable corridor

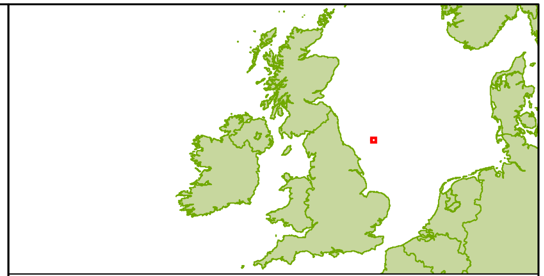
VER	DATE	REMARKS	Drawn	Checked
1	02/10/2013	PEI3	GC	FS
2	07/02/2014	DCO Submission	GC	FS

DRAWING NUMBER: **F-OFL-MA-618**

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

FOREWIND





LEGEND

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

Wessex Archaeology Anomalies

- A1: Anthropogenic origin of archaeological interest
- A2: Uncertain origin of possible archaeological interest
- A3: Historic record of possible archaeological interest
- Additional records

0 1 2
Kilometres

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

PROJECT TITLE

DOGGER BANK TEESSIDE A & B

DRAWING TITLE

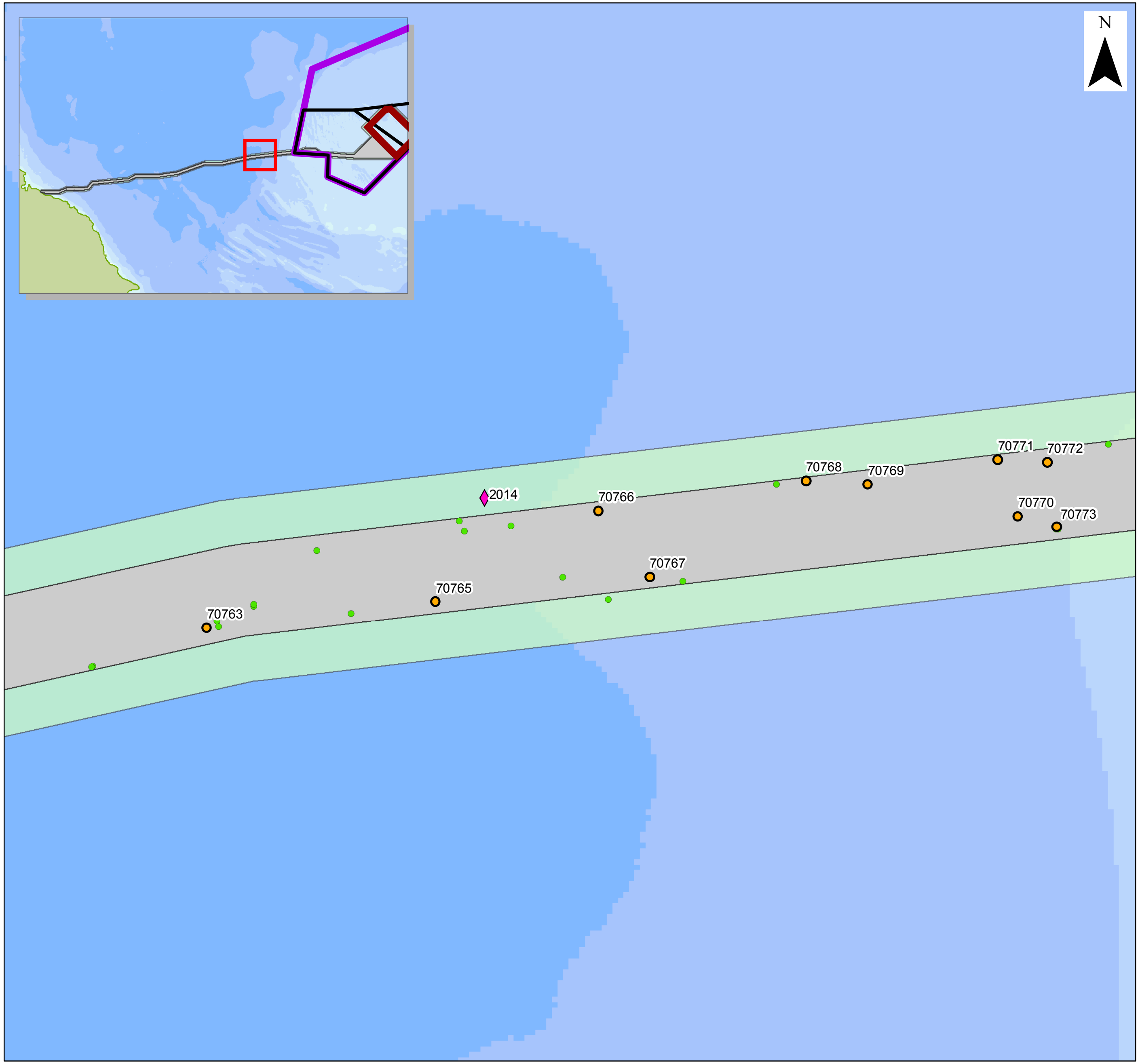
Figure 4.6g Seabed features within export cable corridor

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

DRAWING NUMBER: **F-OFL-MA-619**

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

FOREWIND



LEGEND

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

Wessex Archaeology Anomalies

- A1: Anthropogenic origin of archaeological interest
- A2: Uncertain origin of possible archaeological interest
- A3: Historic record of possible archaeological interest
- Additional records

0 1 2
Kilometres

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

PROJECT TITLE

DOGGER BANK TEESSIDE A & B

DRAWING TITLE

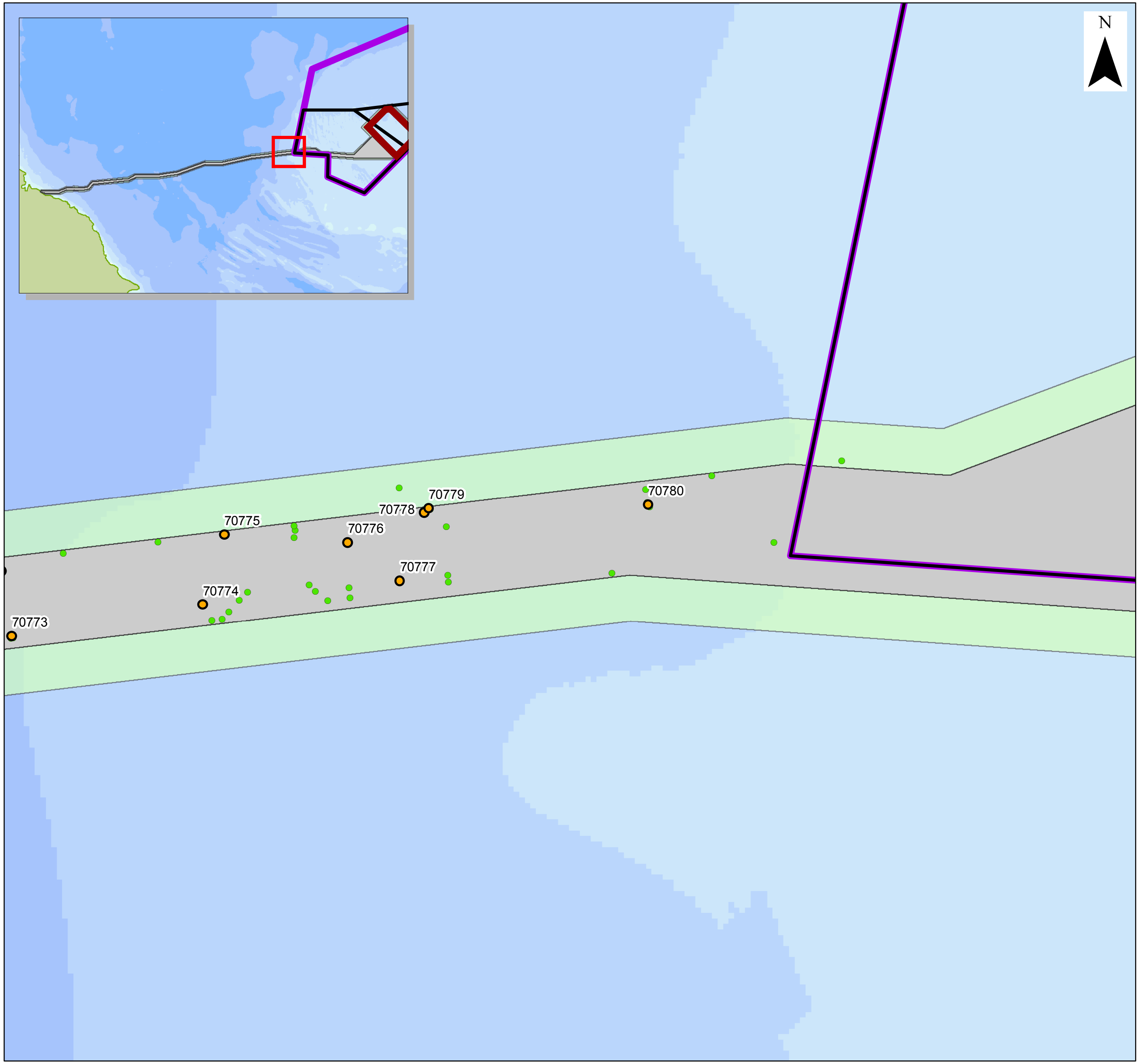
Figure 4.6h Seabed features within export cable corridor

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

DRAWING NUMBER: **F-OFL-MA-620**

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

FOREWIND



LEGEND

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

Wessex Archaeology Anomalies

- A1: Anthropogenic origin of archaeological interest
- A2: Uncertain origin of possible archaeological interest
- A3: Historic record of possible archaeological interest
- Additional records

0 1 2
Kilometres

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

PROJECT TITLE

DOGGER BANK TEESSIDE A & B

DRAWING TITLE

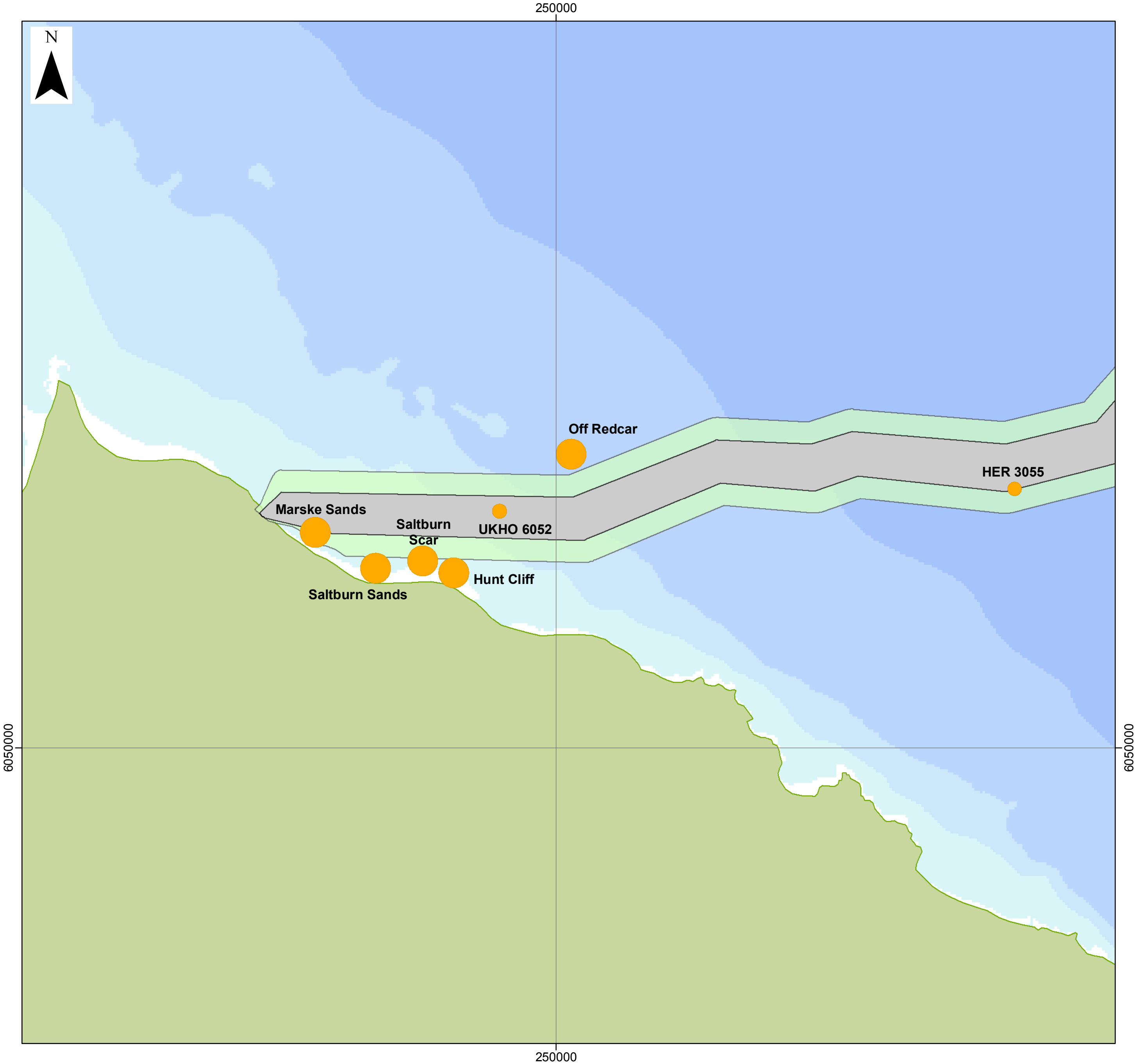
Figure 4.6i Seabed features within export cable corridor

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

DRAWING NUMBER: **F-OFL-MA-621**

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

FOREWIND



LEGEND

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

0 2.5 5
Kilometres

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

PROJECT TITLE

DOGGER BANK TEESSIDE A & B

DRAWING TITLE

Figure 4.7 Recorded Losses

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

DRAWING NUMBER: **F-OFL-MA-622**

SCALE	1:200,000	PLOT SIZE	A4	DATUM	WGS84	PROJECTION	UTM31N

FOREWIND

4.4. Aviation or aircraft archaeology

Known archaeological receptors

4.4.1. There are two records relating to aviation remains in the study areas.

4.4.2. The first (WA70651) is a UKHO live obstruction located within the Teesside B project area and described as a foul (**Figure 4.5**). The record indicates a possible aircraft although there is insufficient information in the description to ascertain the origin of this suggestion. No anomaly was observed at this location in the geophysical data and this record is classed A3. However, due to the limited availability of information the receptor should be regarded as being of high value.

4.4.3. The second (WA70834) is a UKHO record of a dead wreck located within the cable route MSA, c.25km from the landfall, relating to a lightning aircraft that crashed in 1986 (**Figure 4.6b**). The description indicates that it probably broke up on impact and remains have not subsequently been located by survey. No anomaly was observed at this location in the geophysical data and this record is classed A3. The receptor is considered to be of low value.

4.4.4. There are no further records of aircraft although there is potential for such remains to be present within the MSAs.

Potential archaeological receptors

4.4.5. Fixed wing-aviation first began in the early 1900s in the UK, with the first flight across the English Channel in 1909 and there is potential for the presence of aviation remains associated with crashed aircraft from this date. Further details are presented in **Appendix 18A**.

4.4.6. While there have been relatively few aircraft losses since the end of World War II, there were a large number of aircraft lost at sea during World War II itself and losses are also known from World War I. The majority of these aircraft are yet to be located and there is demonstrable potential for the presence of crashed aircraft within the MSAs, predominantly associated with World War II. The importance of aircraft crash sites is outlined in Military Aircraft Crash Sites (English Heritage 2002) which recognises the implicit heritage value of crashed aircraft as historic artefacts. The remains of aircraft lost while in military service attain additional significance insofar as they are warranted automatic designation under the Protection of Military Remains Act 1986. On this basis, all potential aircraft sites are to be considered as high value receptors.

4.4.7. As with isolated maritime finds discussed above, the archaeological potential for isolated aircraft finds to provide insight into patterns of historical aviation across the study areas or to indicate the presence of a recorded but uncharted aircraft crash site should not be disregarded. Nonetheless, as derived finds, isolated aircraft remains should be considered as medium value receptors.

4.5. Additional anomalies

4.5.1. There are 35 A2 anomalies of uncertain origin within Dogger Bank Teesside A, 25 within Dogger Bank Teesside B and 177 within the Dogger Bank Teesside A & B Export Cable Corridor.

4.5.2. Based on the interpretation of geophysical data, it is not clear if these anomalies are archaeological, although the precautionary approach is to assume that they are and to assign high archaeological value.

4.5.3. With further investigation it may be possible to determine the archaeological (or non-archaeological) characteristics of the anomalies with greater certainty and the archaeological value may be confirmed or reduced.

4.6. Historic seascape character

4.6.1. A national programme of Historic Seascape Characterisation (HSC) was commissioned by English Heritage in order to map an understanding of the cultural processes shaping the present landscape in coastal and marine areas. Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor fall within the pilot HSC from Scarborough to Hartlepool undertaken by Cornwall County Council (Val Baker *et al*. 2007).

4.6.2. The project characterises the historic seascape at four tiered levels, the seabed, seafloor, water column and surface. The data is presented for GIS using fine gridded cells, with tiered attributes, to record the present and dominant historic character for each marine layer. Using the GIS data, the key characteristics for Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor has been identified and are summarised below.

4.6.3. The known and potential prehistoric, maritime and aviation receptors that form part of the Historic Seascape Character have been discussed at length in the existing environment descriptions above. The character descriptions below, therefore, refer only to the cultural processes which have shaped the historic seascape.

4.6.4. The surface character only is additionally discussed as part of the baseline presented in **Chapter 20** of the ES. Details of the assessment were available to Wessex Archaeology in the technical report authored by LUC (2013) and produced to inform the drafting of the Dogger Bank Teesside A & B ES. The assessment covers a wider study area than presented here as defined for the purposes of the seascape visual impact assessment.

4.6.5. The assessment below applies to the MSAs as defined in Section 3.1.

4.6.6. Dogger Bank Teesside A & B lie within the Character Area Dogger Bank:

> *The Dogger Bank is a very large shoal area in the central southern North Sea, with water depths less than 30m. It is shallowest in the south-west where depths are only 10-15m and areas of natural swell are common (Val Baker et al. 2007, p. 287).*

4.6.7. The historic character is primarily one of palaeolandscapes and fishing, as outlined above. Specific historic associations include recognition as a sea area from BBC Radio 4's shipping forecast, the association of Dogger Bank with the First World War naval battle and Dogger Bank as the sites of the UK's strongest earthquake in 1931 measuring 6.1 on the Richter scale (Val Baker *et al*. 2007, p. 214).

4.6.8. The primary cultural processes which characterise Dogger Bank Teesside A comprise:

Industry

- Extractive Industry (Hydrocarbon)

Fishing and Mariculture

- Fishery (Beam Trawling)

Navigation

- Navigation Area/Route Shipping Lane

4.6.9. The primary cultural processes which characterise Dogger Bank Teesside B comprise:

Communication

- Telecommunications

Fishing and Mariculture

- Fishery (Beam Trawling)

4.6.10. The Dogger Bank Teesside A & B Export Cable Corridor lies within the following Character Areas (from East to West):

- Dogger Bank

  As above.

- Dogger Flanks

  The Dogger Flanks skirt the Dogger Bank, encompassing the area between the 20-50m contours (Val Baker et al. 2007, p. 286). The historic character is primarily one of palaeolandscapes, particularly associated with Mesolithic Coastal settlements.

- Whitby and Hartlepool Ground

  This character area covers the deeper offshore waters between the coast and the Dogger Bank (Val Baker et al. 2007, p. 287). The historic character is primarily one of fishing and navigation.

- Skinningrove to Ravenscar

  From the crumbling shale cliffs of Staithes to the 200m high cliffs at Boulby (the highest cliffs on England's east coast), the coastline exhibits a wide variety of rock types and coastal features associated with them (Val Baker et al. 2007, p. 273). The historic character is primarily one of fishing ports and activities, transport and navigation, coastal settlement and the alum, ironstone and jet industries. The dominant industry in the area is now *tourism and this stretch of coastline (with the exception of Whitby) is designated as a heritage coast.*

- Tees Estuary and Bay

  The River Tees enters the North Sea between Hartlepool and Redcar where the coast is low and flat. Formerly extensive tidal sand flats have now been reclaimed to create a vast industrial complex (Val Baker et al. 2007, p. 262). The historic character is primarily one of transport and navigation, ports and industrialisation.

4.6.11. The primary cultural processes which characterise the Dogger Bank Teesside A & B Export Cable Corridor:

Communication

- Telecommunications

Industry

- Extractive Industry (Hydrocarbon)

Fishing and Mariculture

- Fishery (Beam Trawling)
- Fishery (Netting and Lining)
- Fishery (Potting/Trunking)
- Fishery (Seine Netting)

Navigation

- Navigation Area/Route

4.6.12. In summary, the historic seascape character of Dogger Bank Teesside A & B and the export cable route is predominantly one of palaeolandscapes (although largely unrecognised), fishing, navigation with submarine cables and extractive industry installations (although in decline)(**Appendix 18A** Section 9).

4.6.13. The installation of Dogger Bank Teesside A & B, and further offshore wind farms comprising Dogger Bank Creyke Beck and Dogger Bank Teesside C & D, will result in a change to the historic seascape character to include a character associated with offshore renewables.

4.6.14. However, it is also important to note that, since the above historic seascape assessment was carried out, 27 wind turbines have recently (January 2012 to May 2013) been installed immediately offshore from Redcar for the Teesside Offshore Wind Farm. Thus the historic character of the nearshore area of the cable route must also now be considered to already include an offshore renewables character.

4.7. Setting

4.7.1. The National Planning Policy Framework (NPPF) (Department for Communities and Local Government 2012, p. 30) states that in determining planning applications authorities should require an applicant to describe the significance of any heritage assets affected, including any contribution to the significance made by the assets setting. The advice within the NPPF is usefully detailed and hence reference is made to it here within this section of this chapter.

4.7.2. In *Guidance for Assessment of Cumulative Impacts on the Historic Environment from Offshore Renewable Energy*, 'perception' is defined as the different ways people value historic features and their setting (Oxford Archaeology 2008).

4.7.3. More recently, the English Heritage guidance on managing change within the setting of heritage assets refers to the definition of setting as, *'the surroundings in which an asset is experienced'* (English Heritage 2011, p. 2). The guidance notes:

> *The extent and importance of setting is often expressed by reference to visual considerations. Although views of or from an asset will play an important part, the way in which we experience an asset in its setting is also influenced by other environmental factors such as noise, dust and vibration; by spatial associations; and by our understanding of the historic relationship between places* (English Heritage 2011, p. 5).

4.7.4. In the marine environment, archaeological sites can only be 'experienced' in their surroundings by those individuals with access to the seafloor. This may include, for example, divers or maritime specialists with remote cameras or geophysical equipment. Assets on the seabed, therefore, are not 'experienced' in the same way as an asset located above the water, either onshore, on the coast or only partially submerged.

4.7.5. None of the archaeological sites identified in the baseline characterisation are considered to have a 'setting' that forms a significant component of their archaeological value. Impacts to the setting of offshore archaeology are not considered further within this assessment.

4.7.6. The visual impacts from Dogger Bank Teesside A & B are summarised within **Chapter 20**. Impacts to the setting of onshore heritage assets are assessed within **Chapter 25 Terrestrial Archaeology**.

4.7.7. Both assessments demonstrate that once built, the visible components of the wind farm, the wind turbines and ancillary structures, will not be visible from the shore. Only the onshore components of the development are thus considered with regard to onshore heritage assets, within the above chapters and not dealt with here.

4.7.8. As construction activities will be temporary in nature mitigation to reduce the effects of works upon the landscape/seascape is not considered practical or necessary.

4.8. Baseline characterisation summary

4.8.1. **Table 4.5** presents a summary of the baseline characteristics described above that will inform the impact assessment for Dogger Bank Teesside A and B.

Table 4.5 Summary of archaeological receptors identified in the baseline characterisation

Area	Receptor summary	
Theme: Archaeology at the Landfall		
Known Sites		
Dogger Bank Teesside A & B Export Cable Corridor	Ten records of sites and findspots within the intertidal zone (all destroyed)	
	Dogger Bank Teesside A & B Export Cable Corridor	Two sites (WA1003, WA1004)
	Temporary Works Area	Seven sites (WA1002, WA1005, WA1006, WA1007, WA1008, WA1010, WA1011) and one findspot (WA1009)
Potential sites		
Dogger Bank Teesside A & B Export Cable Corridor	Debris and structural remains associated with destroyed World War II installations	
	Isolated discoveries of material (Prehistoric onwards)	
	In situ Prehistoric sites (if relevant deposits survive below the beach)	
Theme: Submerged Prehistory		
Known sites		
All areas	No records of known receptors	
Potential sites		
Dogger Bank Teesside A and B	Minimal potential for Pleistocene archaeological remains within discrete areas of Yarmouth Roads Formation, Egmond Ground Formation and Eem Formation if present	
	Palaeoenvironmental potential, particularly associated with organic deposits in BH1282, the earliest known from the Dogger Bank area and post-dating earliest known re-occupation of Britain following the last ice age.	
	Potential for Late Pleistocene/Holocene archaeological remains (in situ sites and isolated artefacts). Highest potential associated with features identified in geophysical survey (Phase Ia, Phase Ib, Phase II and Phase III)	
Dogger Bank Teesside A & B Export Cable Corridor	Potential for Holocene archaeological remains (in situ sites and isolated artefacts). Highest potential associated with features identified in geophysical survey	
	Potential for Holocene palaeoenvironmental data	
Theme: Maritime		
Known sites		
Dogger Bank Teesside A	Two (A1) wrecks seen in geophysical data (WA70586, WA70587)	
	Five (A3) UKHO wrecks and one UKHO recorded obstruction not seen in the geophysical data (WA70616 to WA70621)	
Dogger Bank Teesside B	Four (A1) wrecks seen in geophysical data (WA70636, WA70637, WA70505, WA70640)	
	Three (A3) UKHO wrecks not seen in the geophysical data (WA70533, WA70535, WA70536)	
Dogger Bank Teesside A & B Export Cable Corridor	One (A1) wreck seen in geophysical data (WA70657)	
	38 (A3) wrecks and obstructions not seen in geophysical data (WA70830 to WA70833, WA70835 to WA70868)	
	106 additional records of Fishermen's Fasteners, wrecks, fouls and obstructions outside the geophysical survey area	
Known anomalies of potential archaeological value		

Area	Receptor summary
Dogger Bank Teesside A	35 (A2) additional anomalies seen in the geophysical data
Dogger Bank Teesside B	25 (A2) additional anomalies seen in the geophysical data
Dogger Bank Teesside A & B Export Cable Corridor	177 (A2) additional anomalies seen in the geophysical data
Potential sites	
All	Early Holocene maritime remains associated with seabed features (e.g. palaeochannels) sealed beneath transgression alluvium
	Post-transgression maritime remains (Prehistoric to Modern wrecks) on the seabed or buried within seabed deposits (fine grained)
	Isolated discoveries of maritime artefacts
Theme: Aviation	
Known sites	
Dogger Bank Teesside A	No records of known receptors
Dogger Bank Teesside B	1 (A3) aircraft not seen in geophysical data (WA70651)
Dogger Bank Teesside A & B Export Cable Corridor	1 (A3) aircraft not seen in geophysical data (WA70834)
Potential sites	
All	Aircraft crash sites on the seabed or buried within seabed deposits (fine grained)
	Isolated discoveries of aviation artefacts

4.9. Receptor value summary

4.9.1. **Table 4.6** presents a summary of the value of archaeological receptors that will inform the impact assessment for Dogger Bank Teesside A & B.

Table 4.6 Summary of value of archaeological receptors

Theme	Receptor/area			Value
Landfall	Isolated discoveries of artefacts or structural debris			Medium
Submerged Prehistory	In situ prehistoric sites			High
	Isolated discoveries of prehistoric finds			Medium
	Prehistoric features and deposits			Medium
	Palaeoenvironmental data			Medium
Maritime	A1 wrecks	Dogger Bank Teesside A (WA70587, WA70590)		High
		Dogger Bank Teesside B (WA70636, WA70637, WA70505, WA70640)		High
		Dogger Bank Teesside A & B Export Cable Corridor (WA70657)		High
	A3 wrecks	Dogger Bank Teesside A	Modern vessel losses (WA70616, WA70617)	Low
			Modern equipment losses (WA70619)	None
			Unidentified live wrecks (WA70618, WA70620)	High
			Recorded losses/Dead wrecks (WA70621)	Low
		Dogger Bank Teesside B	Recorded loss/Dead wreck (WA70533, WA70535, WA70536)	Low
		Dogger Bank Teesside A & B Export Cable Corridor	All Fishermen's Fasteners	Low
			Geological feature (WA70867)	None
			Wrecks not seen and considered absent or inaccurately recorded (WA70855, WA70860, WA70866, WA70853)	Low
	Additional Records	Dogger Bank Teesside A & B Export Cable Corridor	Modern equipment losses (WA2012, WA2013)	None
			Geological features (WA2136, WA2045, WA2052)	None
			All Fishermen's Fasteners	High

Theme	Receptor/area			Value
			UKHO Unidentified seabed obstructions (WA2016, WA2020, WA2018)	High
			Unknown wrecks (WA2014, WA2017, WA2110, WA2024, WA2092, WA2094)	High
			Wrecks considered absent or inaccurately recorded (*Moorwood* WA2095, HMS *Ruthin Castle* WA2148)	Low
			Modern vessel (*Rema* WA2022)	Low
			World War I wrecks (*Anboto Mendi* WA2114, Hartley WA2147)	High
			Merchant steamer wreck (*Early Percy* WA2126)	Medium
	Potential maritime sites			High
	Isolated discoveries of maritime artefacts			Medium
Aviation	A3 aircraft	Possible aircraft (WA7061)		High
		Modern aircraft (WA70834)		Low
	Potential aircraft crash sites (Military Crash Sites protected by law)			High
	Isolated discoveries of aviation artefacts			Medium
Additional Anomalies	Dogger Bank Teesside A	35 A2 anomalies		High
	Dogger Bank Teesside B	25 A2 anomalies		High
	Dogger Bank Teesside A & B Export Cable Corridor	177 A2 anomalies		High
Historic Seascape Character	Dogger Bank Teesside A			Low (Sensitivity)
	Dogger Bank Teesside B			Low (Sensitivity)
	Dogger Bank Teesside A & B Export Cable Corridor			Low (Sensitivity)

5. Assessment of Impacts – Worst Case Definition

5.1. General

5.1.1. This section establishes the realistic worst case scenario for each category of impact as a basis for the subsequent impact assessment. For this assessment this involves both a consideration of the construction scenarios (i.e. the manner in which Dogger Bank Teesside A and Dogger Bank Teesside B will be built out), as well as the particular design parameters of each project (such as the maximum construction footprint at the landfall) that define the Rochdale Envelope[3] (defined in **Chapter 5 Project Description**).

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

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

5.1.4. The realistic worst case scenarios identified here are also applied to the Cumulative Impact Assessment. When the worst case scenarios for the project in isolation do not result in the worst case for cumulative impacts, this is addressed within the cumulative section of this chapter (see Section 10) and summarised in **Chapter 33 Cumulative Impact Assessment**.

5.2. Construction scenarios

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

- The two projects may be constructed at the same time, or at different times;
- If built at different times, either project could be built first;
- If built at different times, the duration of the gap between the end of the first project to be built, and the start of the second project to be built may vary from overlapping, occurring in series or having a gap between projects;
- Offshore construction will commence no sooner than 18 months post consent, but must start within seven years of consent (as an anticipated condition of the development consent order); and

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

- Assuming a maximum construction period per project of six years, and taking the above into account, the maximum construction period over which the construction of Dogger Bank Teesside A and Dogger Bank Teesside B could take place is 11 years and six months.

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

- Maximum duration effects; and
- Maximum peak effects.

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

i) Build A or Build B in isolation;

ii) Build A and B concurrently – provides the worst 'peak' impact and maximum working footprint; and

iii) Build A, overlapping, occurring in series or having a gap between projects, Build B (sequential) – provides the worst 'duration' of impact.

5.2.4. The assessment considers any differences between the two projects, or differences that could result from the manner in which the first and the second projects are built (concurrent or sequential and the length of any gap). In the case of marine and coastal archaeology, both projects are considered to have the same impact during construction, and so a single assessment is presented.

5.3. Operation scenarios

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

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

5.3.2. For the marine and coastal archaeology assessment there is not considered to be a material difference between either Dogger Bank Teesside A or Dogger Bank Teesside B operating on its own. As such, only one assessment is presented and is considered representative for whichever project is operating in isolation.

5.4. Decommissioning scenarios

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

5.5. Realistic worst case scenarios

5.5.1. The key design parameters that form the realistic worst case scenarios for each category of impact are set out in **Table 5.1**.

Table 5.1 Key design parameters that form the realistic worst case scenarios for the assessment of impacts on marine and coastal archaeology

Parameter	Worst case (per project)	Worst case (Teesside A & B)	Rationale
Direct Impacts – CONSTRUCTION			
Seabed preparation for Wind Turbines	Shallow excavation (Option 3) for 200 x 6MW turbines: • Maximum prepared seabed area per foundation: 4,225m² • Maximum total project prepared seabed area: 845,000m² • Maximum seabed volume disturbed per foundation: 3,169m³ • Maximum spoil volume per project: 633,750m³ • Maximum depth 10m	Shallow excavation (Option 3) for 400 x 6MW turbines: • Maximum prepared seabed area per foundation: 4,225m² • Maximum total prepared seabed area: 1,690,000m² • Maximum seabed volume disturbed per foundation: 3,169m³ • Maximum spoil volume: 1,267,500m³ • Maximum depth 10m	Maximum potential disturbance of seabed across the widest area (greatest potential for direct impacts to occur)
Seabed preparation for Offshore Platforms	Shallow excavation (Option 3) for 4 collector platforms, 1 converter platform and 2 accommodation platforms: • Maximum total project prepared seabed area (combined): 80,700m² (32,400m² + 16,100m² + 32,200m²) • Maximum total project spoil volume for all platforms: 60,525m³ • Maximum depth 10m	Shallow excavation (Option 3) for 8 collector platforms, 2 converter platforms and 4 accommodation platforms: • Maximum total prepared seabed area (combined): 161,400m² (64,800m² + 32,200 m² +64,400) • Maximum total spoil volume for all platforms: 121,050m • Maximum depth 10m	Maximum potential disturbance of seabed at the greatest number of locations (greatest potential for direct impacts to occur)
Seabed preparation for Meteorology Masts	Shallow excavation (Option 3) for 5 Meteorology Masts: • Maximum prepared seabed area per foundation: 3,844m² • Maximum total project prepared	Shallow excavation (Option 3) for 10 Meteorology Masts: • Maximum prepared seabed area per foundation: 3,844m² • Maximum total prepared seabed	Maximum potential disturbance of seabed across the widest area (greatest potential for direct impacts to occur)

Parameter	Worst case (per project)	Worst case (Teesside A & B)	Rationale
	seabed area: 19,220m² • Maximum seabed volume disturbed per foundation: 2,883m³ • Maximum spoil volume per project: 14,415m³ • Maximum depth 10m	area: 38,440m² • Maximum seabed volume disturbed per foundation: 2,883m³ • Maximum spoil volume: 28,830m³ • Maximum depth 10m	
Installation of Wind turbine foundations	200 x 6MW wind turbines on gravity base foundations: • Maximum base footprint area per foundation: 1,963m² • Maximum project base footprint area: 392,699m² • Maximum foundation footprint area including scour protection per foundation: 5,027m² • Maximum foundation footprint including scour protection: 1,005,310m² • Indicative max penetration into seabed - typically due to skirts (below seabed surface): 10m	400 x 6MW wind turbines on conical gravity base foundations: • Maximum base footprint area per foundation: 1,963m² • Maximum base footprint area: 785,398m² • Maximum foundation footprint area including scour protection : 5,027m² • Maximum foundation footprint including scour protection: 2,010,620m² • Indicative max penetration into seabed - typically due to skirts (below seabed surface): 10m	Maximum potential disturbance of seabed at the greatest number of locations (greatest potential for direct impacts to occur)
Wind turbine layout and spacing	Only applicable if locations of individual wind turbines coincident with positions of known receptors		Maximum number of foundations corresponding to the locations of known archaeological receptors
Installation of Offshore Platform Foundations	4 collector platforms, 1 converter platform and 2 accommodation platforms on semi-submersible gravity base foundations: • Footprint area per project for each substation type (combined): 60,000m² (22,500m² + 12,500m² + 5,000m²) • Maximum scour protection area for site (combined): 88,300m² (36,100m² + 17,400m² +	8 collector platforms, 2 converter platforms and 4 accommodation platforms on semi-submersible gravity base foundations: • Footprint area for each substation type (combined): 120,000m² (45,000m² + 25,000m² + 10,000m²) • Maximum scour protection area (combined): 176,600m² (72,200m² + 34,800m² + 69,600m²) • Indicative skirt depth:5m	Maximum potential disturbance of seabed at the greatest number of locations (greatest potential for direct impacts to occur)

Parameter	Worst case (per project)	Worst case (Teesside A & B)	Rationale
	34,800m²) • Indicative skirt depth:5m		
Installation of Meteorology Masts	5 x meteorological masts on gravity base foundations: • Maximum project base footprint area: 1,735m² • Maximum foundation footprint area: 8,675m² • Max foundation footprint area including scour protection: 4,657m² • Max foundation footprint including scour protection: 23,285m² • Indicative max penetration into seabed - typically due to skirts (below seabed surface): 10m	10 x meteorological masts on gravity base foundations: • Maximum project base footprint area: 1,735m² • Maximum foundation footprint area: 17,350m² • Max foundation footprint area including scour protection: 4,657m² • Max foundation footprint including scour protection: 46,570m² • Indicative max penetration into seabed - typically due to skirts (below seabed surface): 10m	Maximum potential disturbance of seabed at the greatest number of locations (greatest potential for direct impacts to occur)
Installation of Vessel Moorings	10 permanent mooring buoys using drag embedment anchor • Maximum impact footprint of all buoys on sea floor: 33,600m² • Maximum seabed volume disturbed by all buoys: 201,600m³	20 permanent mooring buoys using drag embedment anchor • Maximum impact footprint of all buoys on sea floor: 67,200m² • Maximum seabed volume disturbed by all buoys: 403,200m³	Maximum potential disturbance of seabed at the greatest number of locations (greatest potential for direct impacts to occur)
Installation of Inter-array cables	950km buried cable: • Indicative maximum burial depth: 3m. • Width of disturbance from jetting: 10m • Area of disturbance from jetting: 9.5km²	1900km buried cable: • Indicative maximum burial depth: 3m. • Width of disturbance from jetting: 10m • Area of disturbance from jetting: 9.5km²	Maximum potential disturbance of seabed along the greatest distance (greatest potential for direct impacts to occur)
Installation of Inter-platform cables	320km buried cable: • Indicative maximum burial depth: 3m. • Indicative width of disturbance from jetting: 10m • Indicative area of disturbance from	640km buried cable: • Indicative maximum burial depth: 3m. • Indicative width of disturbance from jetting: 10m • Indicative area of disturbance from	Maximum potential disturbance of seabed along the greatest distance (greatest potential for direct impacts)

Parameter	Worst case (per project)	Worst case (Teesside A & B)	Rationale
	jetting: 3.2km²	jetting: 6.4km²	
	24 x cable crossings: • Length of crossings: 400m • Total footprint of crossing protection material per project: 147,134m²	48 x cable crossings: • Length of crossings: 400m • Total footprint of crossing protection material per project: 294,268m²	Maximum potential disturbance of seabed along the greatest distance (greatest potential for direct impacts)
Installation of Export cables	Teesside A: 573km buried cable: • Indicative maximum burial depth: 3m • Indicative width of disturbance from jetting: 10m • Indicative area of disturbance from jetting: 5.73km² • Teesside B: 484km buried cable: • Indicative maximum burial depth: 3m. • Indicative width of disturbance from jetting: 10m • Indicative area of disturbance from jetting: 4.84km² • 16 x cable/pipeline crossings: • Length of crossings: 400m • Total footprint of crossing protection material per project: 98,089m²	1057km buried cable: • Indicative maximum burial depth: 3m • Indicative width of disturbance from jetting: 10m • Indicative area of disturbance from jetting: 10.57km² • 32 x cable/pipeline crossings: • Length of crossings: 400m • Total footprint of crossing protection material per project: 196,178m²	Maximum potential disturbance of seabed along the greatest distance (greatest potential for direct impacts to occur)
Route clearance	Full route clearance and pre-lay grapnel runs to remove seabed and sub-surface debris (maximum depth 0.3m)		Maximum potential disturbance of seabed along the greatest distance (greatest potential for direct impacts to occur)
Landfall options	HDD • HDD Horizontal length: 700m • Equipment size: 5m long x 1.4m wide x 1.7m high • Joint transition bay: 12m x 4m	HDD • HDD Horizontal length: 700m • Equipment size: 5m long x 1.4m wide x 1.7m high • Joint transition bay: 2 x 12m x 4m	Maximum potential disturbance of intertidal deposits across the widest area (greatest potential for direct impacts to occur)

Parameter	Worst case (per project)	Worst case (Teesside A & B)	Rationale
	• Two small cofferdams: 10m x 10m x 3m • Maximum width of beach open trenching to bury cables: 10m • Working width of beach: 250m	• Four small cofferdams: 10m x 10m x 3m • Maximum width of beach open trenching to bury cables: 20m • Working width of beach: 250m	
	Open Trench • Indicative depth: 2m • Indicative length: 30m Indicative width: 1.5m		
Vessel anchors/jack-ups	• Total indicative construction vessels: 66 • Total construction vessels round trips to port per project (6MW WTGs): 5,150 Jack-up Footprint: • Individual leg footprint of 260m² • 6 x legs per jack-up • 26.4m leg penetration • 6 jacking operations per wind turbine • Project total impacted area during construction period of 1,008,000m²	• Total indicative construction vessels: 132 • Total construction vessels round trips to port per project (6MW WTGs): 103,000 Jack-up Footprint: • Individual leg footprint of 260m² • 6 x legs per jack-up • 26.4m leg penetration • 6 jacking operations per wind turbine • Project total impacted area during construction period of 2,016,000m²	Maximum potential disturbance of seabed at the greatest number of locations (greatest potential for direct impacts to occur)
	Anchor Footprint (Installation of Foundations and Topside): • Number of anchors for assumed representative construction vessel: 8 • Individual anchor footprint area per deployment and recovery: 116m² • Indicative anchor penetration depth: 4m • Impacted anchor area per deployment: 466m² • Impacted volume per deployment: 1,862m³		
	Installation of Foundations: • Number of anchors used during the activity: 4 • Assumed number of anchoring operations: 4	Installation of Foundations: • Number of anchors used during the activity: 4 • Assumed number of anchoring operations: 4	

Parameter	Worst case (per project)	Worst case (Teesside A & B)	Rationale
	• Total impacted area per wind turbine 1,862m² • Total impacted volume per wind turbine: 7,450m³ • Project Total Impacted Area: 372,480m² • Project Total Impacted Volume: 1,489,920m³	• Total impacted area per wind turbine 1,862m² • Total impacted volume per wind turbine: 7,450m³ • Project Total Impacted Area: 744,960m² • Project Total Impacted Volume: 2,979,840m³	
	Installation of Topside: • Number of anchors used during the activity: 4 • Assumed number of anchoring operations: 1 • Total impacted area per wind turbine 466m² • Total impacted volume per wind turbine: 1,862m³ • Project Total Impacted Area: 93,120m² • Project Total Impacted Volume: 372,480m³	Installation of Topside: • Number of anchors used during the activity: 4 • Assumed number of anchoring operations: 1 • Total impacted area per wind turbine 466m² • Total impacted volume per wind turbine: 1,862m³ • Project Total Impacted Area: 186,240m² • Project Total Impacted Volume: 744,960m³	
	Anchor Footprint (Installation of Export Cable): • Number of anchors for assumed representative construction vessel: 8 • Number of anchors used during the activity: 8 • Individual anchor footprint area per deployment and recovery: 61m² • *Indicative anchor penetration depth: 1.5m* • *Impacted anchor area per deployment: 485m²* • *Impacted volume per deployment:*	Anchor Footprint (Installation of Export Cable): • Number of anchors for assumed representative construction vessel: 8 • Number of anchors used during the activity: 8 • Individual anchor footprint area per deployment and recovery: 61m² • *Indicative anchor penetration depth: 1.5m* • *Impacted anchor area per deployment: 485m²* • *Impacted volume per deployment:*	

Parameter	Worst case (per project)	Worst case (Teesside A & B)	Rationale
	728m^3 • *Total number of vessel moves: 364* • *Project Total Impacted Area: 176,489.19m^2* • *Project Total Impacted Volume: 264,733.8m^3*	*728m^3* • *Total number of vessel moves: 728* • *Project Total Impacted Area: 352,978.38m^2* • *Project Total Impacted Volume: 529,467.6m^3*	
Indirect Impacts - CONSTRUCTION (Appendix 9A)			
Installation of Foundations	Release of scoured sediment • 10MW conical GBS#1 foundation Seabed preparation: • 3,675m^3 for a conical gravity base foundations • sediment cast aside close to the foundation and is available for dispersion Drill arisings: • 6,220m^3 for a 12m piled concrete foundation • 2,765m^3 for a 8m piled steel foundation Equilibrium scour volume: • 365m^3 to 756m^3 for a 12m monopile foundation • 2,933m^3 to 5,810m^3 for a conical GBS#1		Maximum potential volume of suspended sediment (greatest potential for indirect impacts from increased sediment
Installation of Cables	Inter-array cables: • Excavation: 2.5m max depth, 1.5m max width • c.3,750 m^3 sediment released per km excavated Export cable: • Excavation:3m max depth, 1.5m max width • c.4,500m^3 sediment released per km excavated (1,344m^3 per hour or trenching) • 971,000m^3 sediment released over 216km length		Maximum potential volume of suspended sediment (greatest potential for indirect impacts from increased sediment cover)
Installation Process	Installation process: • 24 x 12m-diameter monopole foundations, a set of inter-array cables connecting them and one export cable installed together over a 30-day period	Maximum effect on sediment transport (greatest potential for indirect impacts to occur)	Installation Process

Parameter	Worst case (per project)	Worst case (Teesside A & B)	Rationale
	• foundations installed on a daily basis • after each daily installation of the first eight foundations, the drill arisings are dispersed by typical wave and tidal current conditions • after installation of the eighth foundation, a one-year storm event takes place and equilibrium scour is reached at each foundation releasing the full sediment load through scour • at day 25, no more foundations are installed; • each foundation is connected to an adjacent foundation by an inter-array cable after all 24 foundations have been installed; and • excavation of the export cable is assumed continuous over the 30-day period and takes place simultaneously with the installation of the 24 foundations		
Landfall options	Four small cofferdams: • Cofferdam dimensions: 10m x 10m x 3m • Installation over 8 weeks • Total excavated volume: 1,200m^3	Maximum effect on sediment transport processes of any cross-shore position (greatest potential for indirect impacts to occur)	Landfall options
Historic Seascape Character – CONSTRUCTION			
Activities associated with construction	Maximum duration of construction phase and maximum intensity of activities: • Maximum duration of construction activities: 6 years	Maximum duration of construction phase and maximum intensity of activities: Projects A and B built in parallel (maximum peak scenario):	Maximum change to historic seascape character

Parameter	Worst case (per project)	Worst case (Teesside A & B)	Rationale
	• Maximum period of landfall HDD and construction activities: up to 24 weeks • Maximum duration of intertidal and shallow sub-tidal works: 8 weeks; • Total number of vessels present offshore during peak construction year: 66	• Maximum duration of construction activities: 6 years • Maximum period of landfall HDD and construction activities: up to 38 weeks • Maximum duration of intertidal and shallow sub-tidal works: 14 weeks • Total number of vessels present offshore during peak construction year: 132 (66 per project) Project A and B built sequentially with 6 months overlap (maximum duration scenario): • Maximum duration of construction activities: 11.5 years • Maximum period of landfall HDD and construction activities: up to 48 weeks (two discrete periods of 24 weeks per project) • Maximum duration of intertidal and shallow sub-tidal works: two discrete periods of 8 weeks with up to 5 years gap • Total number of vessels present offshore during peak construction years: 66 per project at two intervals	
Indirect Impacts - OPERATION (Appendix 9A)			
Vessel anchors/jack-ups	• Total indicative operations and maintenance vessels per year (6MW WTGs): 26 • Total operations and maintenance vessels round trips to port per project (6MW WTGs): 730		Maximum potential disturbance of seabed at the greatest number of locations (greatest potential for direct impacts to occur)

<table>
<tr><th>Parameter</th><th>Worst case (per project)</th><th>Worst case (Teesside A & B)</th><th>Rationale</th></tr>
<tr><td></td><td>Jack-up footprint:
• Individual leg footprint of 260m^2
• 6 x legs per jack-up
• 26.4m leg penetration
• 6 jacking operations per wind turbine
Project total impacted area during operation period of 904,000m^2</td><td>Jack-up footprint:
• Individual leg footprint of 260m^2
• 6 x legs per jack-up
• 26.4m leg penetration
• 6 jacking operations per wind turbine
Project total impacted area during operation period of 1,808,000m^2</td><td></td></tr>
<tr><td>Vessel Moorings</td><td>10x mooring buoy chains dragging on sea floor:
• Maximum impact footprint of all buoy chains on sea floor: 472,000m^2
• Approximate seabed volume disturbed by all buoys during operation: 0m^3</td><td>20x mooring buoy chains dragging on sea floor:
• Maximum impact footprint of all buoy chains on sea floor: 944,000m^2
• Approximate seabed volume disturbed by all buoys during operation: 0m^3</td><td>Maximum potential disturbance of seabed at the greatest number of locations (greatest potential for direct impacts to occur)</td></tr>
<tr><td>Scour</td><td colspan="2">Worst case operational scour volumes for conical GBS#1 foundations:
• 0-21m3 for typical conditions;
• 0-709m3 for a one-year storm; and
• 0-2,843m3 for a 50-year storm
Worst case operational scour plan areas (including the base plate area itself) for conical gravity base foundations:
• 1,964-2,073m2 for typical conditions;
• 1,964-2,625m2 for a one-year storm; and
• 1,964-3,350m2 for a 50-year storm
Worst case operational scour depths for conical gravity base foundations are:
• 0-0.39m for typical conditions;
• 0-2.2m for a one-year storm; and
• 0-4.3m for a 50-year storm</td><td>Maximum potential disturbance of seabed without scour protection (greatest potential for indirect impacts from increased scouring)</td></tr>
<tr><td rowspan="2">Turbine array and foundations</td><td colspan="2">6MW conical GBS#1 foundations:
• 400 foundations across Dogger Bank Teesside A & B, spaced 750m apart around their perimeters with a wider internal spacing</td><td>Maximum physical blocking effect to waves and tidal currents (greatest potential for indirect impacts to occur)</td></tr>
<tr><td colspan="2">6MW conical GBS#1 foundations:
• 400 foundations across Dogger Bank Teesside A & B, comprising a perimeter of foundations at their minimum spacing (750m) with a wider</td><td>Maximum effect on sediment transport (greatest potential for indirect impacts to occur)</td></tr>
</table>

Parameter	Worst case (per project)	Worst case (Teesside A & B)	Rationale
	spaced grid of foundations across the bulk of each project		
Nearshore cable protection	Rock armour: • 15m wide • 1.5m above surrounding seabed		Maximum effect on sediment transport (greatest potential for indirect impacts to occur)
Historic Seascape Character – OPERATION			
Physical presence of wind farm and infrastructure	Maximum number of installed components		Maximum change to historic seascape character
Direct Impacts – DECOMMISSIONING			
Removal of Wind Farm Infrastructure	Complete removal of foundations and cables and dredging for scour protection		Maximum potential disturbance of seabed (greatest potential for new direct impacts to occur)
Vessel anchors/jack-ups	Total decommissioning vessels round trips to port per project (6MW WTGs): 5,150 Jack-up footprint: • Individual leg footprint of 260m² • 6 x legs per jack-up • 26.4m leg penetration • 6 jacking operations per wind turbine • Project total impacted area during decommissioning period of 1,008,000m²	Total decommissioning vessels round trips to port per project (6MW WTGs): 5,150 Jack-up footprint: • Individual leg footprint of 260m² • 6 x legs per jack-up • 26.4m leg penetration • 6 jacking operations per wind turbine • Project total impacted area during decommissioning period of 2,016,000m²	Maximum potential disturbance of seabed at the greatest number of locations (greatest potential for direct impacts to occur)
Indirect Impacts - DECOMMISSIONING (Appendix 9A)			
Changes to Marine Physical Processes	Similar to construction		
Historic Seascape Character – DECOMMISSIONING			

Parameter	Worst case (per project)	Worst case (Teesside A & B)	Rationale
Removal of Wind Farm Infrastructure	Complete removal of wind farm and infrastructure		Maximum change to historic seascape character

6. Assessment of Impacts – During Construction

6.1. Introduction

6.1.1. The construction scenarios on which this assessment has been based are presented in Section 5. The worst case scenarios and potential impacts during construction are identified in **Table 5.1**.

6.1.2. This assessment considers all aspects of the construction of Dogger Bank Teesside A and Dogger Bank Teesside B with the potential to result in damage to or destruction of archaeological receptors or their physical setting.

6.1.3. During construction, effects may arise from any activity which disturbs the seabed, which makes contact with the seabed or, with regard to archaeological receptors with height (i.e. shipwrecks), which occurs in the water column. Direct effects may also occur from activities at the landfall which disturb intertidal deposits.

6.1.4. Indirect effects may occur if construction activities alter the physical processes acting within the study areas to an extent sufficient to affect archaeological receptors.

6.1.5. A change to the historic seascape character will result from the presence of construction activities associated with the installation of the wind farm and the associated infrastructure.

6.2. Landfall

Indirect effects

6.2.1. Sediment transport across the intertidal zone has the potential to be affected by the installation and operation of temporary cofferdams, which would protect excavated trenches within which the export cables will be placed (**Appendix 9A Marine Physical Processes Assessment of Effects Technical Report**). However, actual longshore sediment transport is low in this area and, while the ‘downdrift’ coastline may be affected by construction works, the magnitude of change is likely to be low and temporary. Thus, the presence of the cofferdams will not have an effect on natural coastal erosion rates given the short-term nature of the construction programme.

6.2.2. Trenching, stock-piling and backfilling of the open trenches for placement and burial of the cables connecting the landfall to the offshore export cable has the potential to temporarily increase suspended sediment concentrations in the nearshore zone (**Appendix 9A**). However, due to the low volumes of sediment displacement, the short time durations, and as the volumes of mobilised sediment will be widely and rapidly dispersed, the effects are predicted to be low.

6.2.3. Thus the probability of indirect impacts occurring is expected to be <1% (exceptionally unlikely) and significant impacts from the effects of changes to physical processes are not expected to occur (**Appendix 9A**).

Direct effects

6.2.4. Activities at the landfall that may directly affect archaeological receptors during construction comprise the cable installation, using horizontal directional drilling and the installation of the joint transition bay and cofferdams. All direct impacts to archaeological receptors are permanent. Once archaeological deposits and material, and the relationships between deposits and material and their wider surroundings, have been damaged or disturbed it is not possible to reinstate or reverse those changes. As such, direct impacts to the fabric or setting will represent a total loss of a receptor, or part of it, and the character, composition or attributes of the receptor will be fundamentally changed or lost from the site altogether.

6.2.5. Therefore, the magnitude of effect of direct impacts to archaeological receptors will be high.

6.2.6. In accordance with the significance matrix (**Table 3.4**), unmitigated direct impacts upon archaeological receptors at the landfall, assessed to be of medium value, will be of moderate significance.

6.2.7. Intertidal data recorded by the NRHE and HAP are summary in form and lacking specific detail and during the site visit no remains were observed at the mapped locations. The assessment is of medium uncertainty.

6.2.8. As there are no extant remains between Mean High and Mean Low Water complete avoidance of the mapped locations, recording the former locations of destroyed features or findspots only, would not be considered appropriate.

6.2.9. The assessment of the identified potential for as yet undiscovered archaeological remains within the intertidal areas is of high uncertainty. Interactions cannot be mapped, they are poorly understood and lacking in quantitative data. It is often the case, however, that a full understanding of this potential will only be reached once potential sites have been discovered and impacts have already occurred.

6.2.10. Wherever development or related activities cut through deposits, impacts to in situ or derived material within them are possible. If present within the footprint, the probability of an effect-receptor interaction occurring will be >99% (virtually certain). Where such impacts occur, and can be identified as having occurred, additional mitigation measures will be required to address significant effects. It is not, however, possible to identify beyond doubt the presence or absence of archaeological material within the footprint.

6.2.11. The primary means for addressing the potential for as yet undiscovered sites to be present within the intertidal area will be an archaeological watching brief during construction. Measures to deal with unexpected discoveries in the intertidal zone, which may only be encountered during the course of the projects, are set out in the project WSI (78041.0).

6.2.12. As discussed in Section 2. Wessex Archaeology and The Crown Estate (Wessex Archaeology 2010a) have produced a document outlining model clauses for Written Schemes of Investigation (WSIs), drawing upon a corpus of practical experience in developing and agreeing methodological clauses for marine development.

6.2.13. The application of the recommended mitigation to deal with unexpected discoveries will result in a **negligible** residual impact.

6.3. Dogger Bank Teesside A & B Export Cable Corridor

Indirect effects

6.3.1. Trenching of the export cable may indirectly affect archaeological receptors if suspended sediment resettles to provide additional protection to exposed archaeological receptors.

6.3.2. Over a 30-day simulation for Dogger Bank Teesside A & B (**Appendix 9A**) modelling predicts that the maximum deposition of suspended sediment generated during construction is less than 5mm along the Dogger Bank Teesside A & B Export Cable Corridor. Predicted deposition reduces to 0.5mm up to approximately 35km north of the export cable route within the Dogger Bank Zone and 25km north of the Dogger Bank Teesside A & B Export Cable Corridor outside the zone. Predicted average deposition of 1-5mm occurs in small patches along the cable corridor decreasing to less than 0.5mm along the remainder of the cable corridor and is effectively zero in places.

6.3.3. The increased sediment thickness is also temporary. Modelling at a point mid-way along the Dogger Bank Teesside A & B Export Cable Corridor shows that predicted deposition never exceeds 1.3mm and the longest continuous period when it exceeds 1mm is 2 hours (**Appendix 9A**). At the end of the 30-day simulation, the predicted thickness of sediment resting on the seabed is less than 0.1mm.

6.3.4. Deposition at this limited scale is not expected to impact archaeological receptors.

6.3.5. Thus the probability of indirect impacts occurring is expected to be <1% (exceptionally unlikely) and significant impacts from the effects of changes to physical processes are not expected to occur.

Direct effects

6.3.6. Activities in the cable corridor that may directly affect archaeological receptors comprise the installation of the export cables, and any pre-lay seabed preparation, and the anchoring of vessels deployed during construction. Vessels may also anchor or deploy jack up feet within the TWA.

6.3.7. All direct impacts that results in damage to, or disturbance of, archaeological receptors will be permanent. Therefore, the magnitude of effect of direct impacts to archaeological receptors will be high.

6.3.8. In accordance with the significance matrix (**Table 3.4**), therefore, unmitigated direct impacts upon archaeological receptors of high archaeological value within the Dogger Bank Teesside A & B Export Cable Corridor MSA will be of major significance while effects upon receptors of medium archaeological value will be of moderate significance. Both are significant in EIA terms.

6.3.9. As indicated above, data concerning the nature of archaeological receptors is often limited and there is uncertainty in the data used in examining interactions between receptors and aspects of the development.

6.3.10. Maritime receptors classified as A3s that are recorded by the UKHO and NRHE are mapped and documentary evidence is available. However, as they have not been seen in the geophysical data and assessed by Wessex Archaeology, the current status is unclear. The assessment is of medium uncertainty.

6.3.11. Maritime receptors classified as A1s, that have been seen in the geophysical data and assessed by Wessex Archaeology, are well understood in terms of spatial and structural characteristics even if the exact nature of the archaeological interest is currently unclear. The assessment is of low uncertainty.

6.3.12. Receptors classified as A2s, anomalies of anthropogenic origin and possible archaeological interest, are spatially well documented although the nature of the anomalies is poorly understood. The assessment is of medium uncertainty.

6.3.13. All additional records of receptors located beyond the geophysical survey area are assessed on limited, pre-existing data only. The assessment is, therefore, of high uncertainty.

6.3.14. However, as stated above, it is not the intention of Forewind to allow significant effects to occur. The Overarching National Policy Statement for Energy (EN-1) (Department for Energy and Climate Change 2011a, p. 92) states that there should be a presumption in favour of conservation and recognises that, once lost, heritage assets cannot be replaced. The National Policy Statement for Renewable Energy Infrastructure (EN-3) (Department of Energy and Climate Change 2011b, p. 49-50) recommends that the most effective form of protection can be achieved through the implementation of exclusion zones around such heritage assets which preclude development activities within their boundaries.

6.3.15. The Crown Estate document Model Clauses for Archaeological Written Schemes of Investigation (Wessex Archaeology 2010a) states that Archaeological Exclusion Zones (AEZs) agreed between the developer and archaeological curator (e.g. English Heritage) will be the principal means to preserve in situ any features or deposits of known or possible archaeological interest. All development or related activities associated with the construction, operation and decommissioning of the Dogger Bank Teesside A & B Wind Farms will be prohibited within the boundaries of AEZs. This includes the use of jack-ups and anchors during all phases of the wind farm's lifespan (construction, operation and decommissioning).

6.3.16. AEZs of 100m around the extents of all A1 receptors, and around the point locations of A3 receptors and additional records of medium and high archaeological value (excluding Fishermen's Fasteners), are recommended as part of the proposed mitigation strategy (**Figures 6.1**, **6.2** and **Figure 6.3a-Figure 6.3i**). AEZs necessarily incorporate a cautionary buffer to ensure that all associated material is captured within the boundary.

6.3.17. For A1 receptors, where the full extents of sites are known, AEZs will comprise an irregular buffer of 100m around the full extent of each site as seen in the geophysical data.

6.3.18. For A3 receptors and additional records, where the extent of sites are unknown, AEZs will comprise a 100m buffer around the given point location.

6.3.19. The uncertainty surrounding the records of Fisherman's Fasteners outside the geophysical survey area suggests that further investigation may be required before the presence or absence of remains at the locations can be confirmed. The positions of these records should be avoided until such data becomes available and AEZs can be established if required. The same approach is recommended for three unidentified seabed obstructions recorded by the UKHO (WA2016, WA2020, and WA2018).

6.3.20. A2 receptors, where geophysical anomalies have been identified as being of potential archaeological interest, will be avoided throughout the design layout. As the origin of these anomalies is uncertain, 100m AEZs are not recommended.

6.3.21. In accordance with the significance matrix (**Table 3.4**), unmitigated direct impacts upon archaeological receptors of low archaeological value within the Dogger Bank Teesside A & B Export Cable Corridor MSA will be minor, which is not significant in EIA terms. The avoidance of these locations using AEZs and micrositing will not be required as the assessment has demonstrated that the absence of archaeological material is considered likely and the potential for the presence of buried material at these locations is considered low. If buried remains are discovered during the course of the development direct impacts will be addressed through the applications of a reporting protocol as discussed below.

6.3.22. It should be noted, however, that while there are no archaeological requirements for AEZs around modern wrecks (WA70616, WA70617, and WA2022), consideration should be given to the continued avoidance of these wrecks during the construction, operation and decommissioning of Dogger Bank Teesside A & B.

6.3.23. The implementation of AEZs and the avoidance of A2s through micrositing, will reduce the probability of interactions between developmental effects and known receptors to <1% probability (exceptionally unlikely).

6.3.24. The Model Clauses document states that AEZs may be altered (enlarged, reduced, moved or removed) as a result of further data assessment or archaeological field evaluation of data covering those areas that are subject to AEZs (Wessex Archaeology 2010a, p. 15). Once agreed the alteration of AEZs can only be undertaken with the agreement of the archaeological curators.

6.3.25. Where known archaeological anomalies are avoided during construction there will be **no residual impact**. Details of the proposed AEZs and requirements for micrositing are summarised in **Table 12.1** and detailed in the project WSI.

6.3.26. If preservation in situ is not possible, direct impacts to known receptors will need to be offset by appropriate satisfactory measures to be agreed with the archaeological curator. Such measures may include:

- Excavation and recording (if possible);
- Palaeoenvironmental assessment;
- Targeted high-resolution geophysical survey;
- Targeted geoarchaeological investigations; and
- Diver and/or ROV investigation.

6.3.27. The provision for archaeological works and the details for each AEZ are set out in the project WSI. All archaeological works will be agreed in advance with the archaeological curator.

6.3.28. It is not possible to quantify the probability that interactions will occur between developmental effects and potential archaeological receptors. If present within the footprint, the probability of an effect-receptor interaction occurring will be >99% (virtually certain) wherever activities cut through them. It is not, however, possible to identify beyond doubt the presence or absence of archaeological material within the footprint.

6.3.29. With regard to submerged prehistory, although palaeogeographic assessment allows for the identification and mapping of features and deposits with archaeological potential, these are not known archaeological sites. The actual presence of in situ or derived prehistoric material cannot be confirmed and these may or may not be present at any point within them. Their inherent archaeological value (medium) is associated with their scientific potential and in situ preservation will not be commensurate to their sensitivity. Rather, a full assessment of the sedimentary sequence within the footprint of the proposed development once the design has been finalised would be appropriate.

6.3.30. The assessment of the identified potential for archaeological remains associated with mapped prehistoric features and deposits is of medium uncertainty. Predictions can be made of the likelihood of archaeological remains to be associated with such features but these cannot be validated with the current levels of data.

6.3.31. The assessment of all other potential archaeological receptors within the Dogger Bank Teesside A & B Export Cable Corridor MSA is of high uncertainty. Interactions cannot be mapped, they are poorly understood and lacking in quantitative data. It is often the case, however, that a full understanding of this potential will only be reached once potential sites have been discovered and impacts have already occurred.

6.3.32. Wherever development or related activities cut through these features or deposits, impacts to in situ or derived material within them are possible and, as stated above, if present within the footprint, the probability of an effect-receptor interaction occurring will be >99% (virtually certain). Where such impacts occur, and can be identified as having occurred, additional mitigation measures will be required to address significant effects.

6.3.33. The Overarching NPS for Energy (EN-1) (Department of Energy and Climate Change 2001a, p. 94) states that where there is considered to be a high probability for as yet undiscovered heritage assets with archaeological interest, the Planning Inspectorate should consider requirements to ensure that appropriate procedures are in place for the identification and treatment of such assets if discovered.

6.3.34. The primary means for dealing with unexpected discoveries, which may only be encountered during the course of the Dogger Bank Teesside A & B, will be through the adoption, implementation and enforcement of the Offshore Renewables Protocol for Archaeological Discoveries (ORPAD). ORPAD, a system for reporting and investigating unexpected archaeological discoveries during construction and installation work, was developed for The Crown Estate by Wessex Archaeology and came into effect in December 2010 (Wessex Archaeology 2010b). The ORPAD system, and its application to Dogger Bank Teesside A and B, is set out in the project WSI.

6.3.35. The protocol provides for the introduction of temporary AEZs around areas of possible archaeological interest, for prompt archaeological advice and, if necessary, for archaeological inspection of important features prior to further construction in the area. Industry staff are offered guidance and advice on how to protect heritage assets and all finds of archaeological interest are reported through a PAD Implementation Service. It complies with the Merchant Shipping Act 1995, including notification of the Receiver of Wreck, and accords with the Code of Practice for Sea bed Developers (Joint Nautical Archaeology Policy Committee 2006)

6.3.36. The institution of measures, including ORPAD, to deal with unexpected discoveries offshore will result in a **negligible** residual impact.

6.4. Dogger Bank Teesside project development areas

Indirect effects

6.4.1. The installation of foundations for wind turbines and associated infrastructure may indirectly affect archaeological receptors if suspended sediment resettles to provide additional protection to exposed archaeological receptors.

6.4.2. Over a 30-day simulation for Dogger Bank Teesside A & B (**Appendix 9A**), modelling predicts that the largest predicted change associated with the deposition of suspended sediment generated during construction is 5-50mm. Average deposition of 1-5mm occurs within and 10km to the north of the foundations. Deposition is predicted to occur over a larger area for 12m monopoles than for conical gravity base foundations although the areas are broadly similar.

6.4.3. The increased sediment thickness is also temporary. For conical gravity bases, modelling within the foundation layout shows that sediment thicknesses predicted to be greater than 3mm persist continually for a maximum of 102 hours within the simulation period before dropping to below 3mm at all other times (**Appendix 9A**). Thicknesses greater than 7mm and 10mm occur continuously for a maximum of 36 hours and 18 hours, respectively. The longest continuous period where predicted thicknesses are greater than 1mm is 176 hours.

6.4.4. Approximately 20km west-southwest of the foundation layout predicted sediment thicknesses do not exceed 3.2mm at any time over the simulation period and the longest period where they continuously exceed 1mm is 22 hours (**Appendix 9A**). Approximately 55km to the west of the foundation layout the deposition at any one time rarely exceeds 1mm. At the end of the simulation, the predicted thickness of sediment resting on the seabed is less than 0.1mm.

6.4.5. For 12m monopile foundations, the longest continuous time periods that sediment remains at predicted thicknesses greater than 10mm and 7mm are longer than those for the conical gravity base foundations (**Appendix 9A**). Within the foundation layout sediment thicknesses greater than 10mm and 7mm persist for maximum continuous periods of 32 hours and 38 hours, respectively. Thicknesses greater than 3mm and 1mm occur continuously for a maximum of 80 hours and 174 hours, respectively; shorter than the conical gravity base foundations.

6.4.6. Approximately 20km west-southwest of the foundation layout sediment thicknesses greater than 3mm only persist for a maximum continuous period of 10 hours whereas 1mm thick sediment persists for a maximum continuous period of 22 hours (**Appendix 9A**). At the end of the simulation the predicted thickness of sediment resting on the seabed is slightly thicker than for the conical gravity base foundations, but still less than 0.1mm.

6.4.7. With regard to suspended sediment, therefore, deposition at this limited scale is not expected to impact archaeological receptors.

6.4.8. Sediment particles larger than 0.18mm, however, are not expected to enter the water column in suspension (**Appendix 9A**). These particles are assumed to deposit at the source position and, if undisturbed, this would form a 9m high cone with a circular seabed footprint of approximately 31m diameter. Due to reworking of this sediment cone by waves and tidal currents, however, the sediment pile will subsequently be reduced in height and distributed over a wider area of seabed. As the predominant tidal current directions are north and south, and the predominant wave direction is from the north, the sediment pile will be redistributed mainly in those directions to form a 31m wide sand wave, of 100m wavelength and height of c.1.5m.

6.4.9. Due to the implementation of AEZs around known archaeological receptors, no foundations will be installed within 100m of A1 or A3 receptors and there will be no impact from non-suspended sediment.

6.4.10. The deposition of non-suspended sediment may increase sediment cover at the locations of receptors of possible archaeological interest (A2 anomalies and additional records) and as yet undiscovered archaeological material that may be present on or within the seabed. However, the resulting sand waves are similar to those observed to occur naturally with an average wavelength of 100m (range 50-150m) and average crest height of 0.5m (maximum 2m) (**Appendix 9A**). The magnitude of effect is, therefore, considered to be negligible.

6.4.11. Thus the probability of indirect impacts occurring is expected to be <33% (unlikely) and significant impacts from the effects of changes to physical processes are not expected to occur.

Direct effects

6.4.12. Activities in the development areas that may directly affect archaeological receptors comprise seabed preparation, the installation of foundations for wind turbines and associated infrastructure, the installation of cables and the deployment of vessel anchors and jack-ups.

6.4.13. As discussed in Section 4, all archaeological receptors within the development areas are considered to be of medium or high value and the magnitude of effect of direct impacts to archaeological receptors will be high. In accordance with the significance matrix (**Table 3.4**), therefore, unmitigated direct impacts upon archaeological receptors within the development areas will be of either moderate or major significance.

6.4.14. As discussed above for the Dogger Bank Teesside A & B Export Cable Corridor MSA, data concerning the nature of archaeological receptors is often limited and there is uncertainty in the data used in examining interactions between receptors and aspects of the development.

6.4.15. However, as it is not the intention of Forewind to allow significant effects to occur, the avoidance of known archaeological receptors through AEZs and micrositing will reduce the probability of interactions between developmental effects and known receptors to <1% probability (exceptionally unlikely). Details of the proposed AEZs and requirements for micrositing are summarised in **Table 12.1** and detailed in the project WSI.

6.4.16. If preservation in situ is not possible, direct impacts to known receptors will need to be offset by appropriate satisfactory measures to be agreed with the archaeological curator as set out in the project WSI. The application of mitigation will result in a **negligible** residual impact.

6.4.17. In theory, archaeological material (in situ and derived) may be present within, or absent from, all deposits dating from the Palaeolithic onwards. As discussed above (Section 4.3), a selection strategy for the assessment of geophysical data was agreed with English Heritage, due to the large size of tranches A and B, and is expected to be addressed post-consent by the assessment of pre-construction geophysical data within the development footprint once the design has been finalised. Nonetheless, even if full geophysical data coverage is achieved within areas subject to impact, there will still be potential for further unidentified material to be present. As it is not possible to quantify or avoid impacts to these potential receptors, additional mitigation is required.

6.4.18. This mitigation may include further geoarchaeological assessment of the borehole samples comprising full analysis of the pollen, plants and foraminifera from the samples investigated to date. It is also recommended that these analyses are supported by further 14C dating and also Amino Acid Racemisation, and possibly Optically Stimulated Luminescence to resolve some of the dating problems identified within boreholes BH1279 and BH1257.

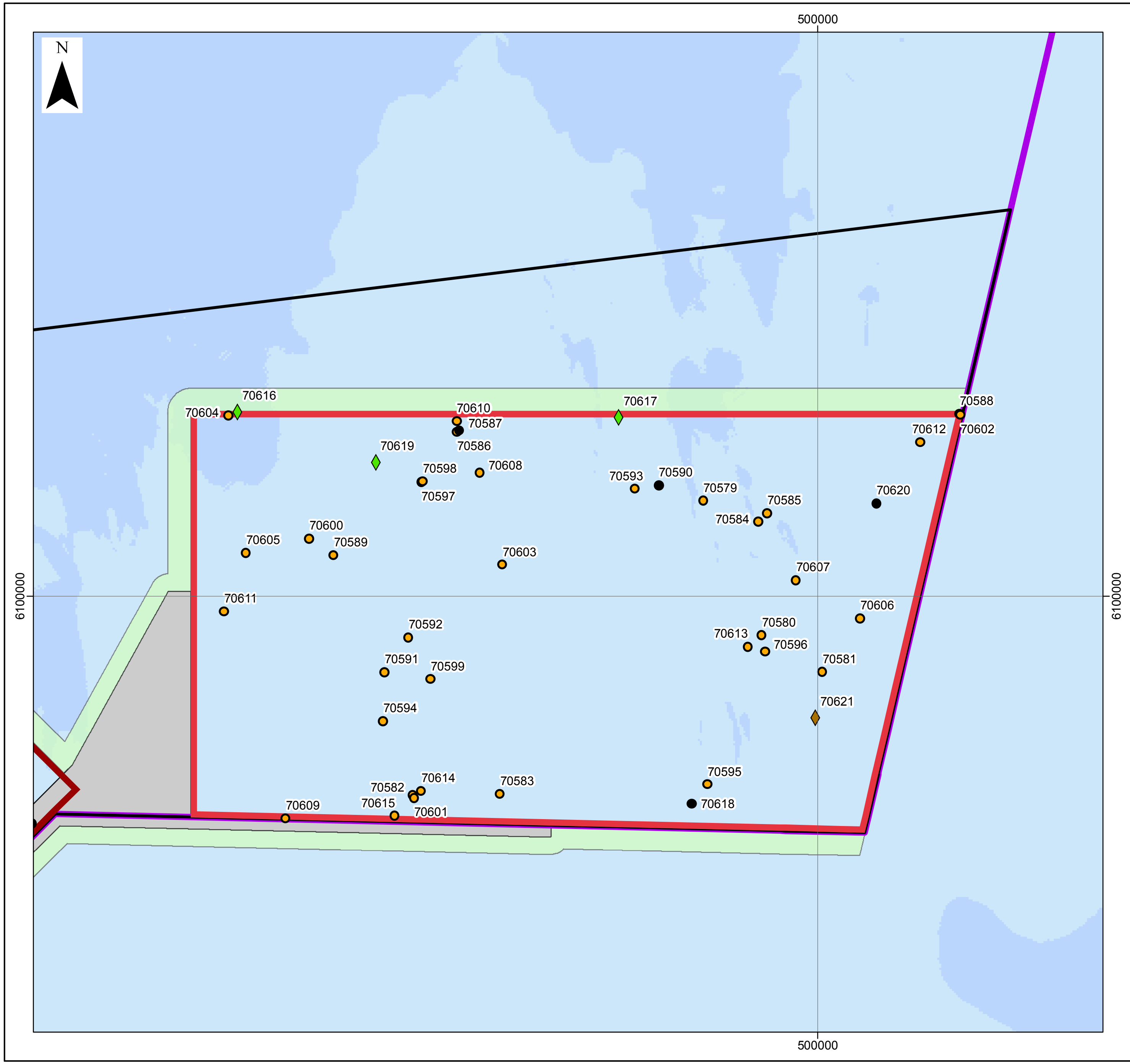
6.4.19. In particular the late Glacial, Windermere Interstadial sequence within borehole BH1282 is of particular interest for further analysis as no sequences of this date are previously recorded on the Dogger Bank and only rare occurrences of sediments of this date are known in the British Isles, the best known being the type site in Cumbria and Holywell Combe in Kent (Preece and Bridgland 1999). Specific recommendations are given in the geoarchaeological assessment report (Appendix 2 to **Appendix 18A**) and if agreed will be set out in the project WSI.

6.4.20. The geoarchaeological assessment to date has revealed interesting results and it is likely that further data and sequences are extant across the Study Area, including the Dogger Bank Teesside A & B Export Cable Corridor. With such large datasets, this work is likely to be achievable post consent with a more targeted approach to retrieving samples from features identified within the geophysical data and which are impacted by the proposed development. Further geotechnical campaigns in the area should be supported with archaeological research in mind. In this way it is hoped that samples can be obtained in conjunction with the ongoing geotechnical work.

6.4.21. The uncertainty and probability of interactions with potential archaeological receptors, however, is the same as that discussed for the Dogger Bank Teesside A & B Export Cable Corridor MSA above. The inclusion of measures, including ORPAD, to deal with unexpected discoveries offshore will also result in a **negligible** residual impact.

6.5. Historic seascape character

6.5.1. A change will occur during construction from activities associated with the installation of the wind farm and infrastructure. This change, however, will be temporary and transitory and the activities will cease once the construction phase is complete.



LEGEND

- Dogger Bank Zone
- Tranche boundary
- Dogger Bank Teesside A
- Dogger Bank Teesside B
- Dogger Bank Teesside A & B Export Cable Corridor
- Temporary works area
- Proposed Archaeological Exclusion Zones
- A2 Anomalies to be avoided in desing layout (not to scale)
- Wrecks and obstructions (non-archaeological)
- Membland record of loss

0 3 6
Kilometres

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

PROJECT TITLE

DOGGER BANK TEESSIDE A & B

DRAWING TITLE

Figure 6.1 Dogger Bank Teesside A - exclusion zones

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

DRAWING NUMBER:

F-OFL-MA-623

SCALE	1:250,000	PLOT SIZE	A4	DATUM	WGS84	PROJECTION	UTM31N

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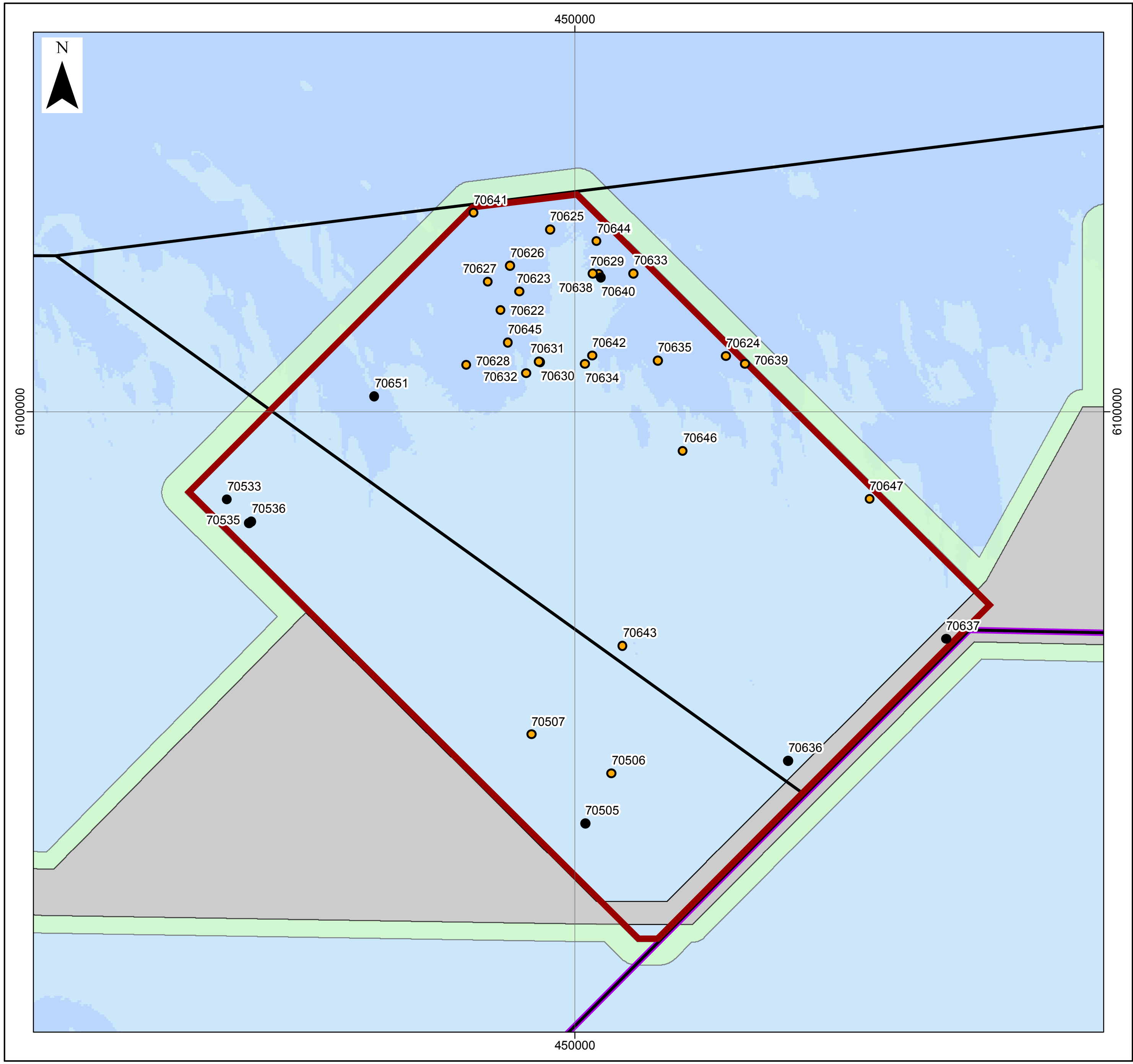

LEGEND

- Dogger Bank Zone
- Tranche boundary
- Dogger Bank Teesside A
- Dogger Bank Teesside B
- Dogger Bank Teesside A & B Export Cable Corridor
- Temporary works area
- Proposed Archaeological Exclusion Zones
- A2 Anomalies to be avoided in desing layout (not to scale)

0 3 6
Kilometres

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Round 3 offshore wind farm boundary © Crown Copyright, 2013
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PROJECT TITLE

DOGGER BANK TEESSIDE A & B

DRAWING TITLE

Figure 6.2 Dogger Bank Teesside B - exclusion zones

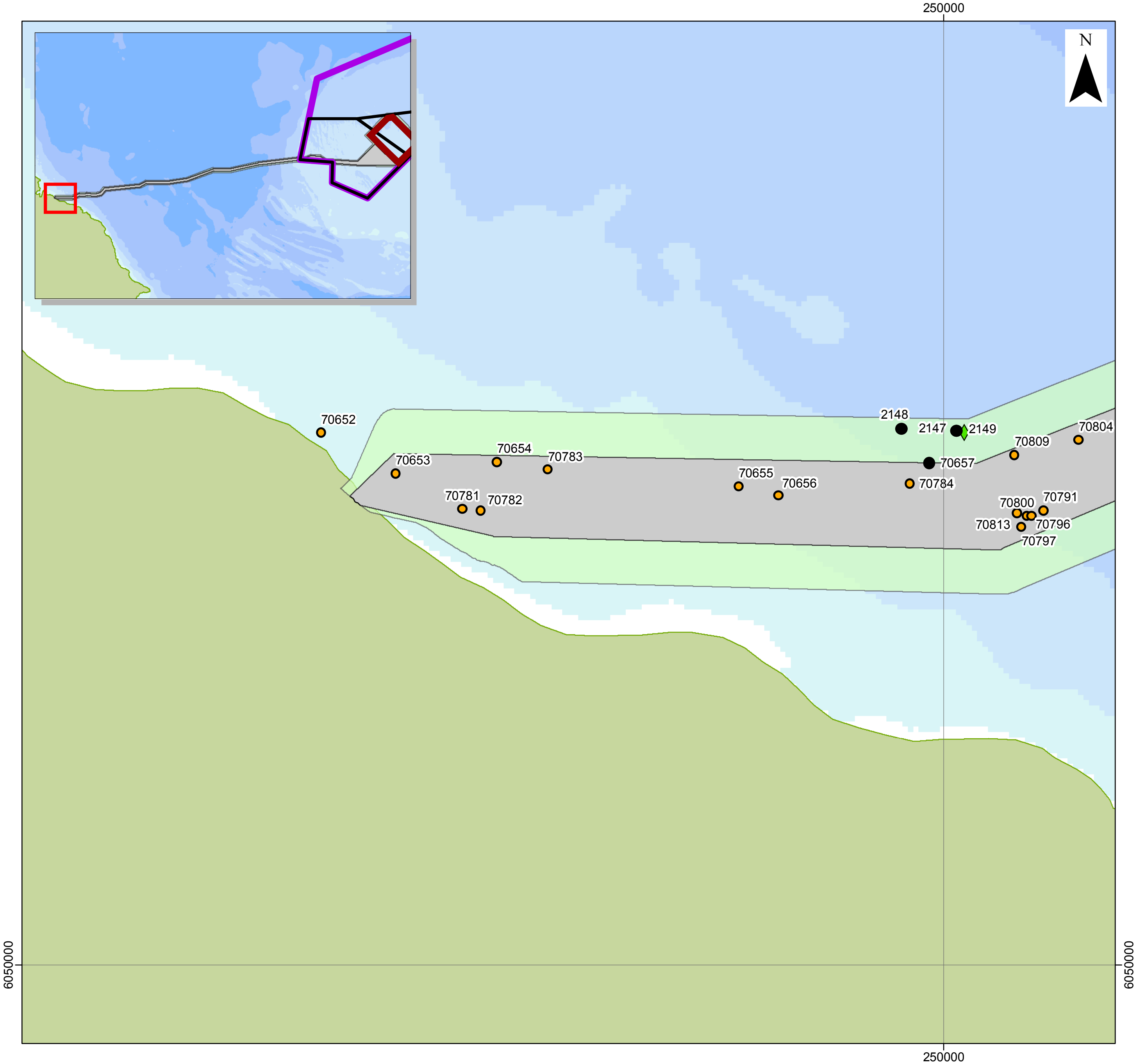
VER	DATE	REMARKS	Drawn	Checked
1	02/10/2013	PEI3	GC	FS
2	07/02/2014	DCO Submission	GC	FS

DRAWING NUMBER:

F-OFL-MA-624

SCALE	1:250,000	PLOT SIZE	A4	DATUM	WGS84	PROJECTION	UTM31N

FOREWIND



LEGEND

- Dogger Bank Zone
- Tranche boundary
- Dogger Bank Teesside A
- Dogger Bank Teesside B
- Dogger Bank Teesside A & B Export Cable Corridor
- Temporary works area
- A2 Anomalies to be avoided in design layout (not to scale)
- Wrecks and obstructions (non-archaeological)
- Fishermen's fasteners (not to scale)
- Proposed Archaeological Exclusion Zones

0 1 2
Kilometres

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

PROJECT TITLE

DOGGER BANK TEESSIDE A & B

DRAWING TITLE

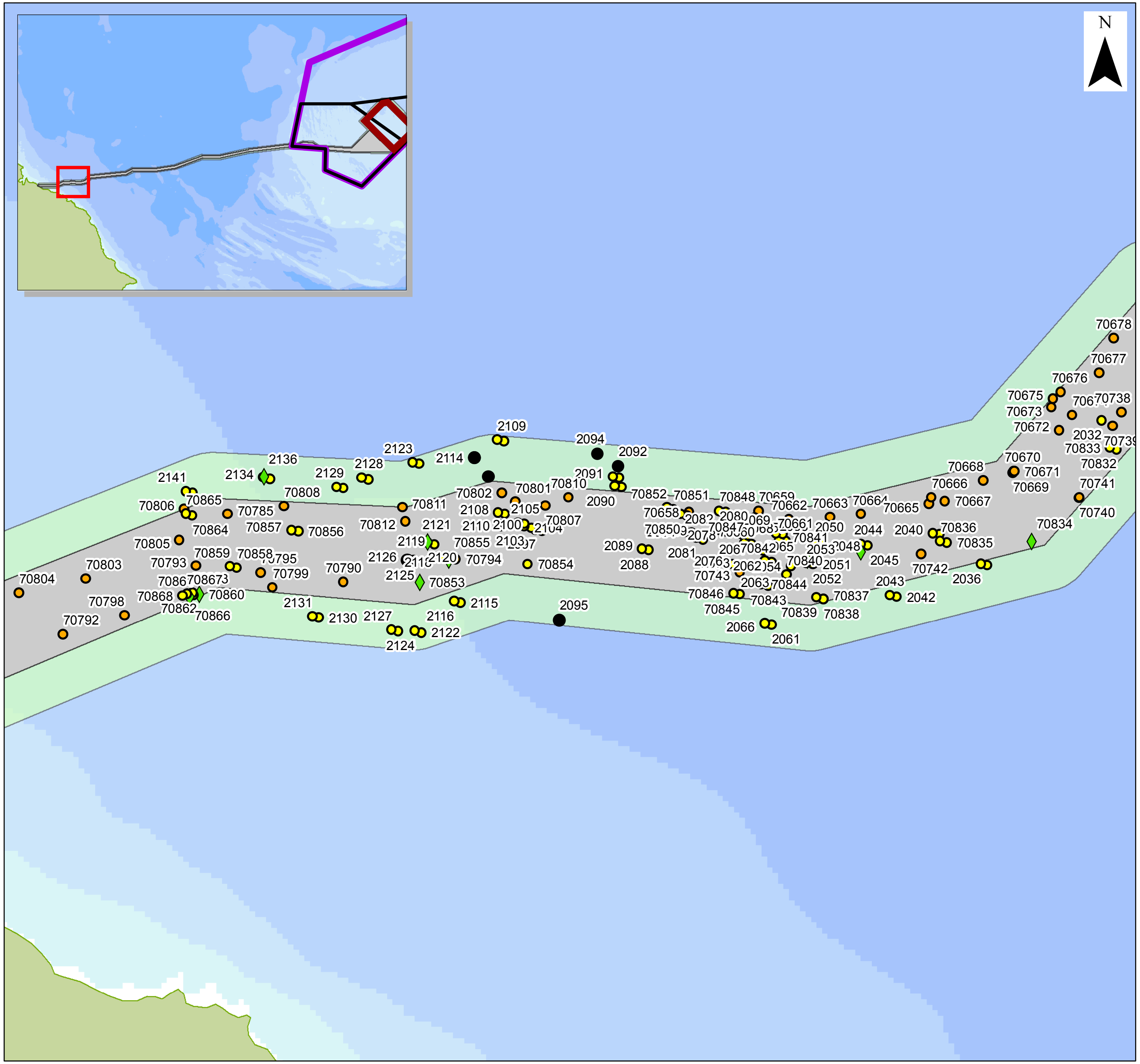
Figure 6.3a Export cable corridor exclusion zones

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

DRAWING NUMBER: F-OFL-MA-625

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

FOREWIND



LEGEND

- Dogger Bank Zone
- Tranche boundary
- Dogger Bank Teesside A
- Dogger Bank Teesside B
- Dogger Bank Teesside A & B Export Cable Corridor
- Temporary works area
- A2 Anomalies to be avoided in design layout (not to scale)
- Wrecks and obstructions (non-archaeological)
- Fishermen's fasteners (not to scale)
- Proposed Archaeological Exclusion Zones

0 1 2
Kilometres

Data Source:
Archaeology data © Wessex Archaeology, 2013
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PROJECT TITLE

DOGGER BANK TEESSIDE A & B

DRAWING TITLE

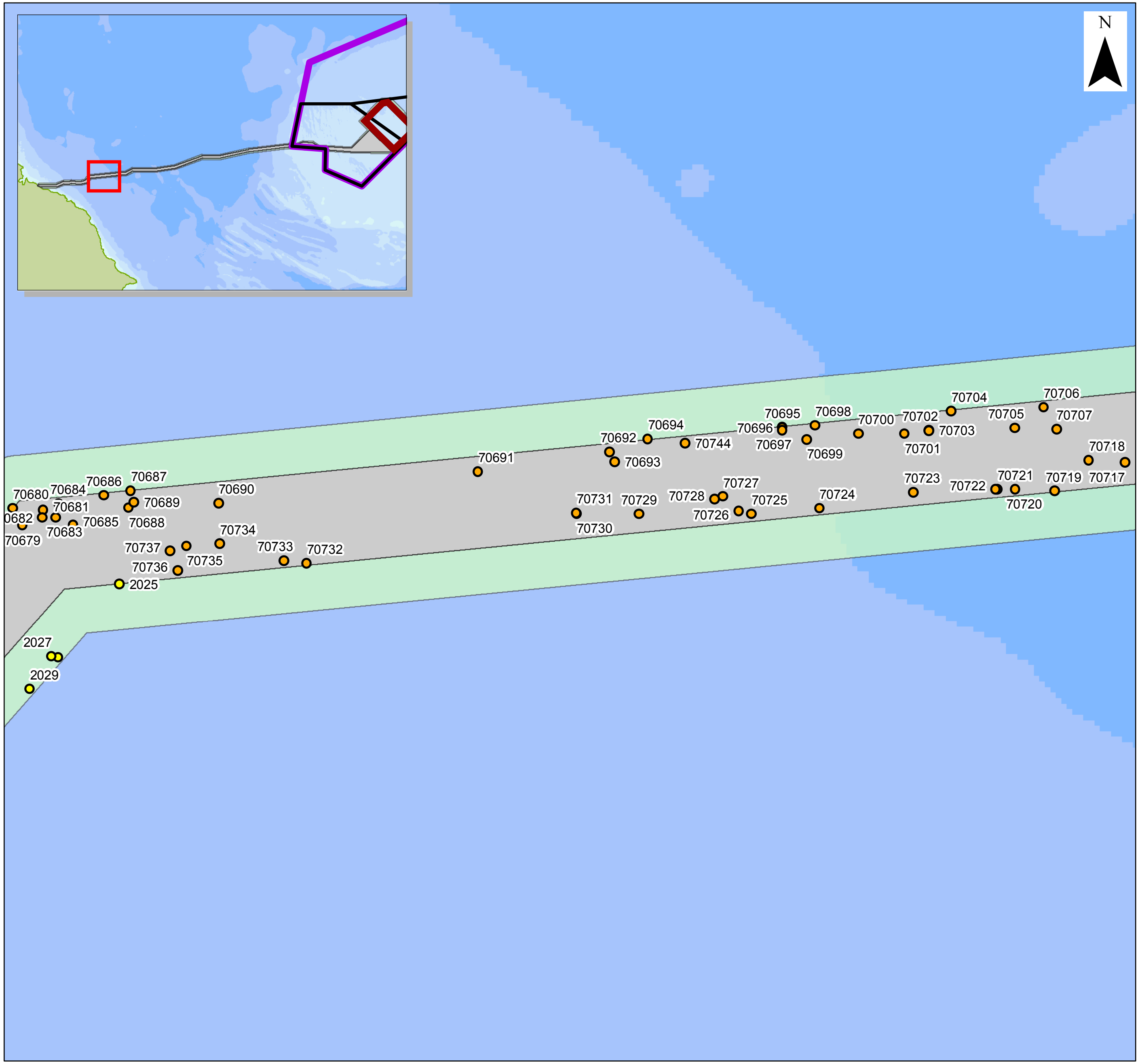
Figure 6.3b Export cable corridor exclusion zones

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

DRAWING NUMBER: **F-OFL-MA-626**

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

FOREWIND



LEGEND

- Dogger Bank Zone
- Tranche boundary
- Dogger Bank Teesside A
- Dogger Bank Teesside B
- Dogger Bank Teesside A & B Export Cable Corridor
- Temporary works area
- A2 Anomalies to be avoided in design layout (not to scale)
- Wrecks and obstructions (non-
- Fishermen's fasteners (not to scale)
- Proposed Archaeological Exclusion

0 1 2
Kilometres

Data Source:
Archaeology data © Wessex Archaeology, 2013
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PROJECT TITLE

DOGGER BANK TEESSIDE A & B

DRAWING TITLE

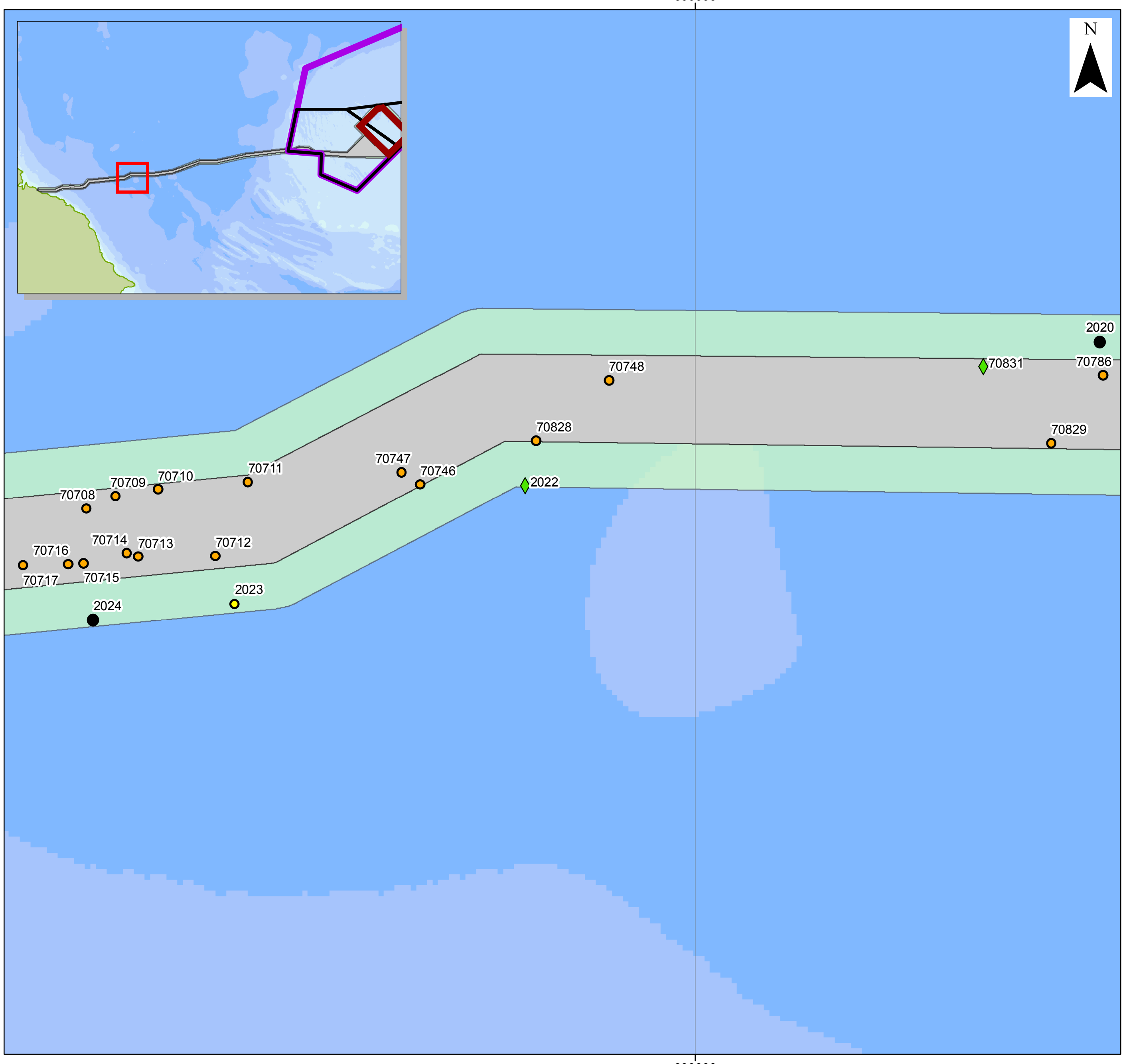
Figure 6.3c Export cable corridor exclusion zones

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

DRAWING NUMBER: **F-OFL-MA-627**

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

FOREWIND



LEGEND

- Dogger Bank Zone
- Tranche boundary
- Dogger Bank Teesside A
- Dogger Bank Teesside B
- Dogger Bank Teesside A & B Export Cable Corridor
- Temporary works area
- A2 Anomalies to be avoided in design layout (not to scale)
- Wrecks and obstructions (non-archaeological)
- Fishermen's fasteners (not to scale)
- Proposed Archaeological Exclusion

0 1 2
Kilometres

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

PROJECT TITLE

DOGGER BANK TEESSIDE A & B

DRAWING TITLE

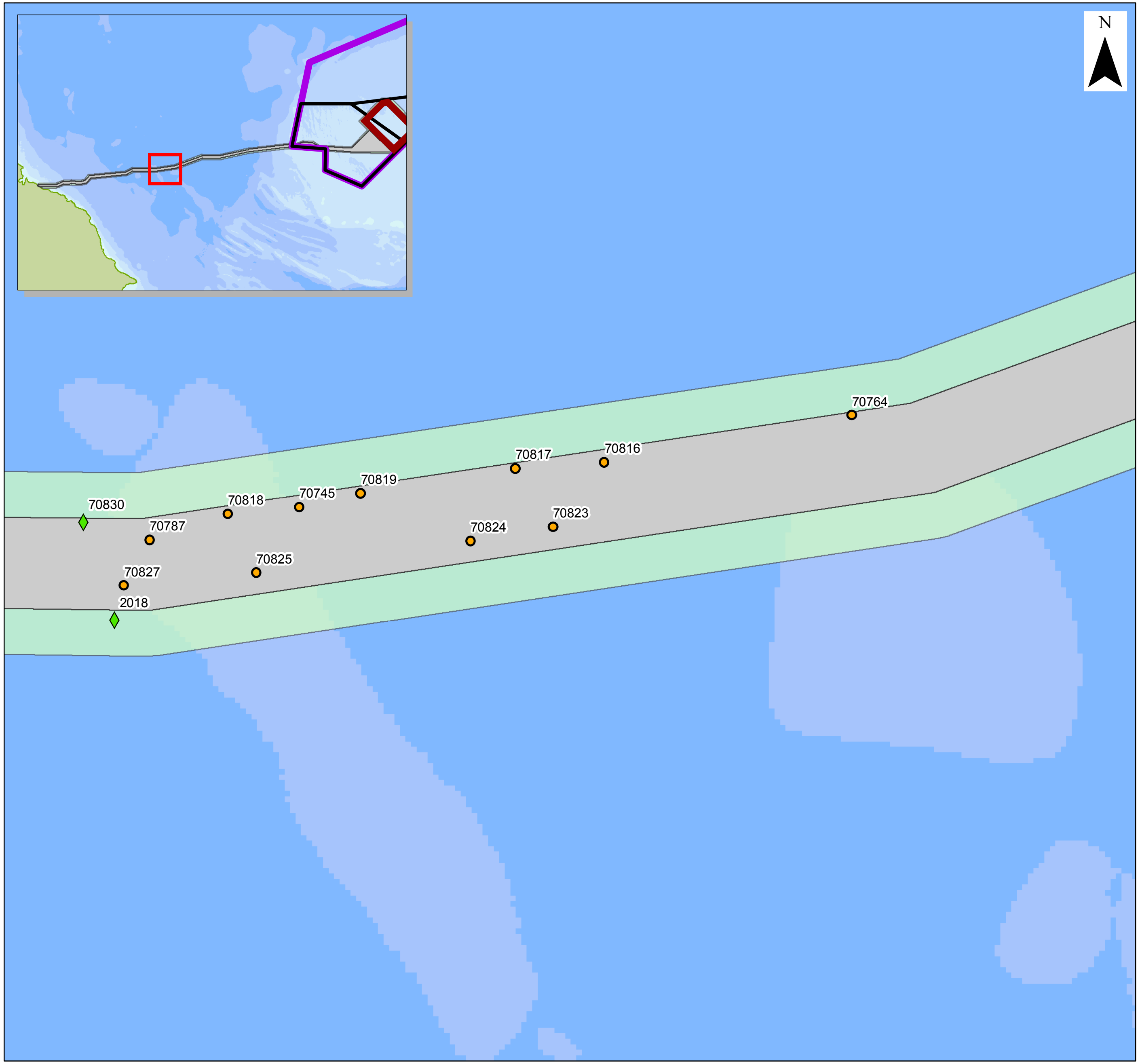
Figure 6.3d Export cable corridor exclusion zones

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

DRAWING NUMBER: **F-OFL-MA-628**

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

FOREWIND



LEGEND

- Dogger Bank Zone
- Tranche boundary
- Dogger Bank Teesside A
- Dogger Bank Teesside B
- Dogger Bank Teesside A & B Export Cable Corridor
- Temporary works area
- A2 Anomalies to be avoided in design layout (not to scale)
- Wrecks and obstructions (non-archaeological)
- Fishermen's fasteners (not to scale)
- Proposed Archaeological Exclusion

0 1 2
Kilometres

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PROJECT TITLE

DOGGER BANK TEESSIDE A & B

DRAWING TITLE

Figure 6.3e Export cable corridor exclusion zones

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

DRAWING NUMBER: **F-OFL-MA-629**

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

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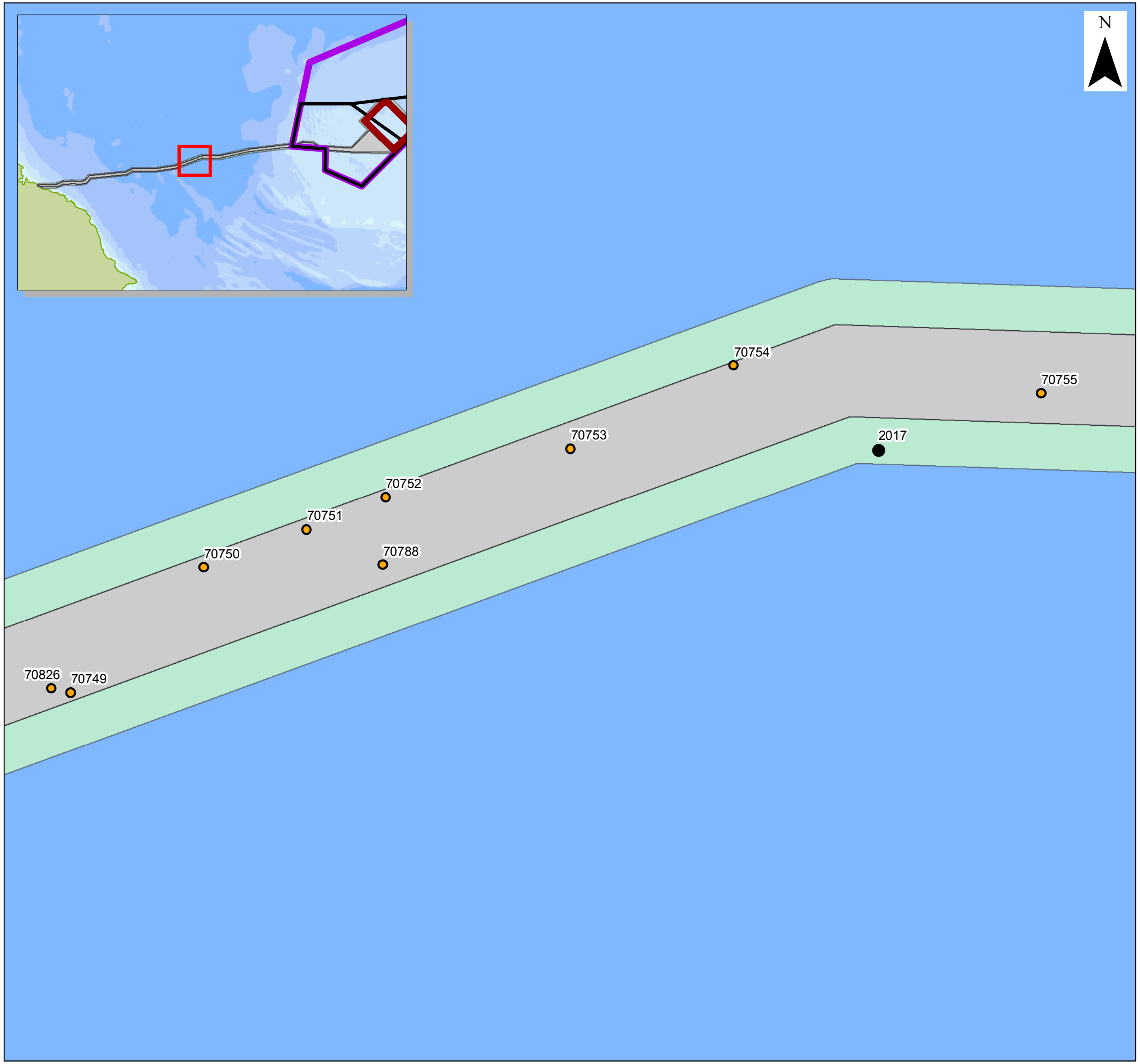

LEGEND

- Dogger Bank Zone
- Tranche boundary
- Dogger Bank Teesside A
- Dogger Bank Teesside B
- Dogger Bank Teesside A & B Export Cable Corridor
- Temporary works area
- A2 Anomalies to be avoided in design layout (not to scale)
- Wrecks and obstructions (non-archaeological)
- Fishermen's fasteners (not to scale)
- Proposed Archaeological Exclusion

0 1 2
Kilometres

Data Source:
Archaeology data © Wessex Archaeology, 2013
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Background bathymetry image derived in part from © TCarta data 2009.

PROJECT TITLE

DOGGER BANK TEESSIDE A & B

DRAWING TITLE

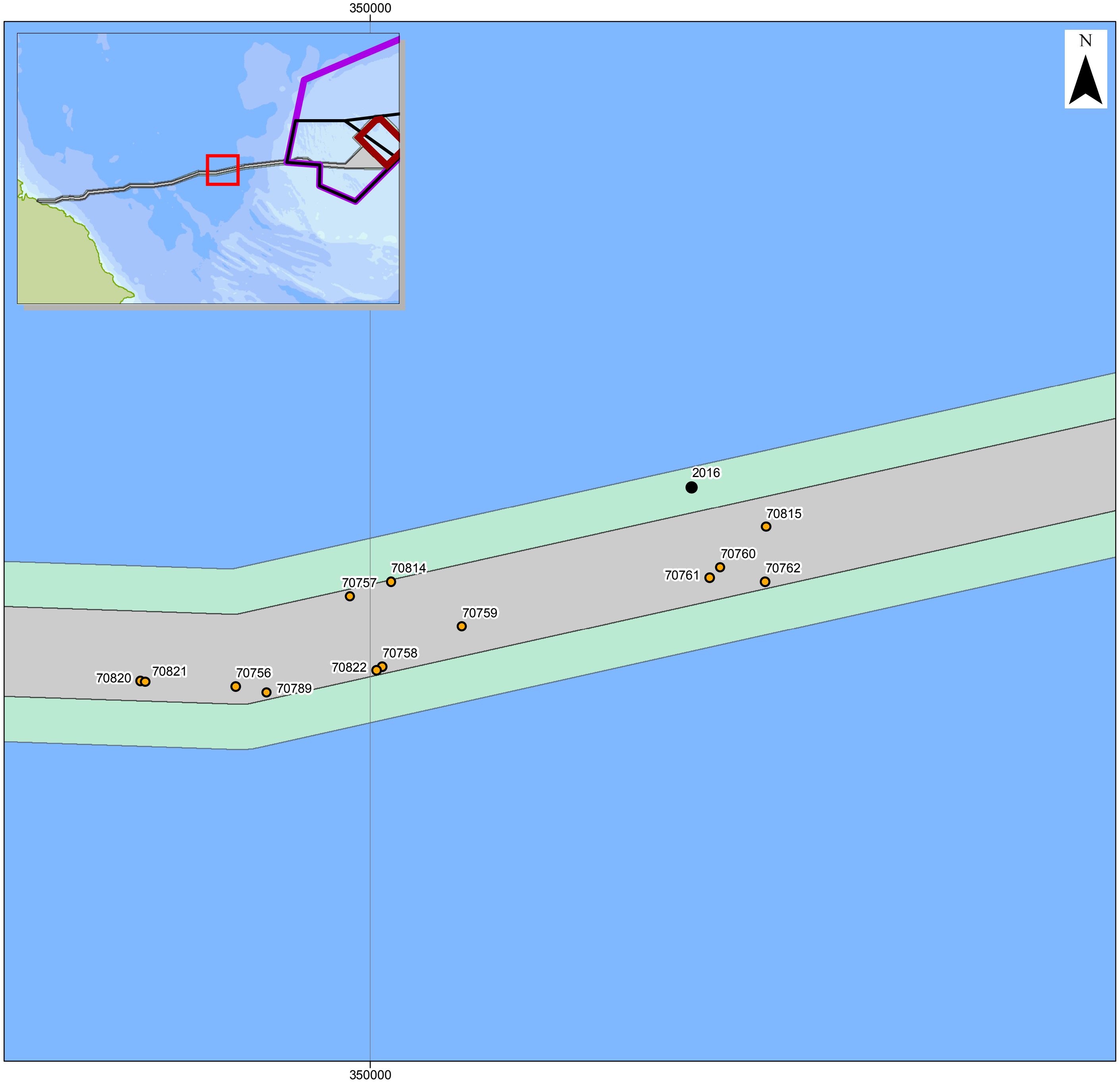
Figure 6.3f Export cable corridor exclusion zones

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

DRAWING NUMBER: **F-OFL-MA-630**

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

FOREWIND



LEGEND

- Dogger Bank Zone
- Tranche boundary
- Dogger Bank Teesside A
- Dogger Bank Teesside B
- Dogger Bank Teesside A & B Export Cable Corridor
- Temporary works area
- A2 Anomalies to be avoided in design layout (not to scale)
- Wrecks and obstructions (non-archaeological)
- Fishermen's fasteners (not to scale)
- Proposed Archaeological Exclusion Zones

0 1 2
Kilometres

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

PROJECT TITLE

DOGGER BANK TEESSIDE A & B

DRAWING TITLE

Figure 6.3g Export cable corridor exclusion zones

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

DRAWING NUMBER: **F-OFL-MA-631**

SCALE	PLOT SIZE	DATUM	PROJECTION
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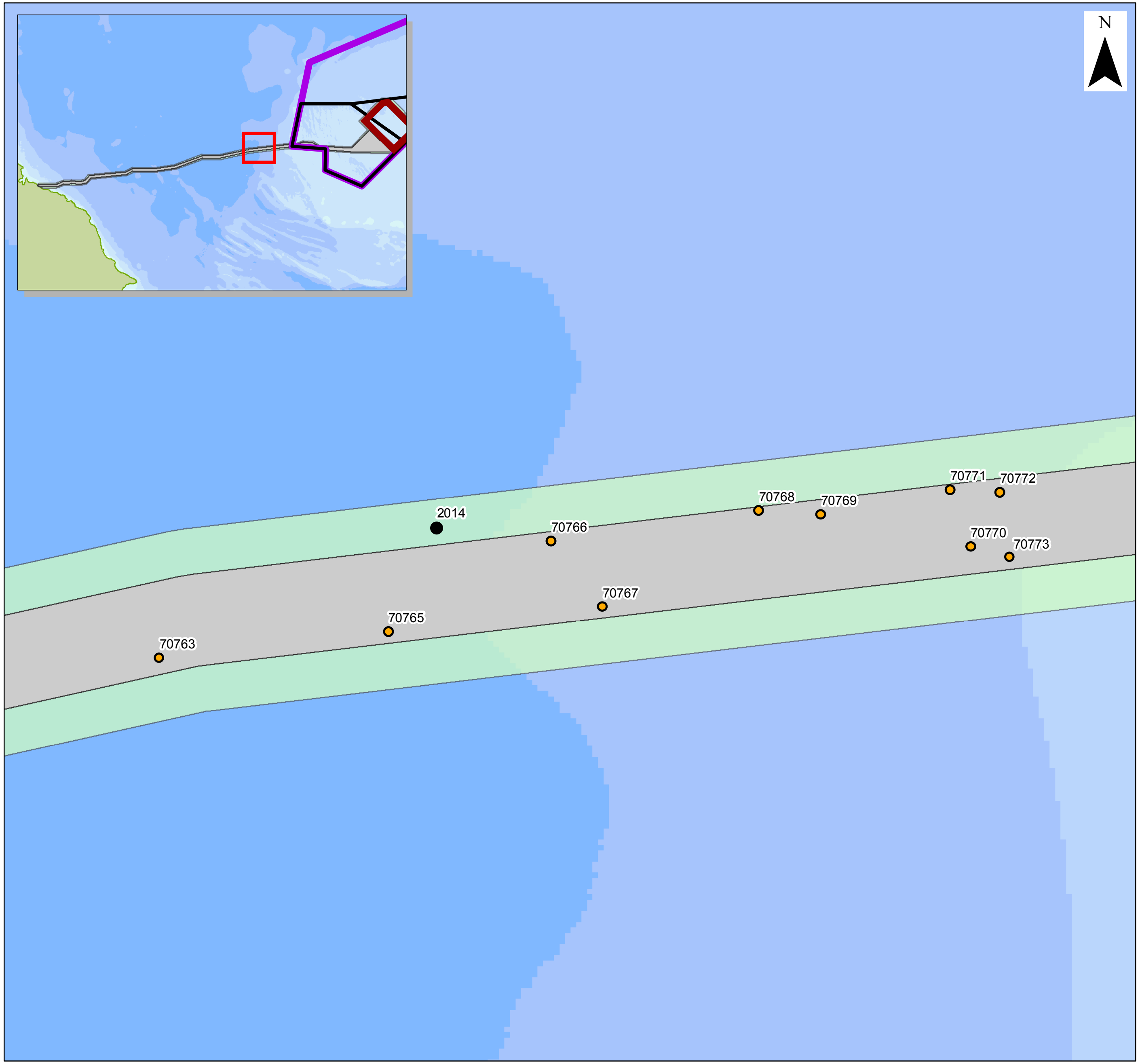
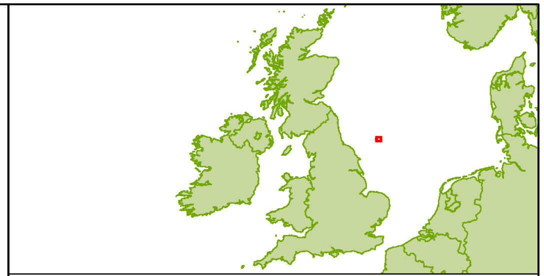
FOREWIND





LEGEND

- Dogger Bank Zone
- Tranche boundary
- Dogger Bank Teesside A
- Dogger Bank Teesside B
- Dogger Bank Teesside A & B Export Cable Corridor
- Temporary works area
- A2 Anomalies to be avoided in design layout (not to scale)
- Wrecks and obstructions (non-archaeological)
- Fishermen's fasteners (not to scale)
- Proposed Archaeological Exclusion

0 1 2
Kilometres

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

PROJECT TITLE

DOGGER BANK TEESSIDE A & B

DRAWING TITLE

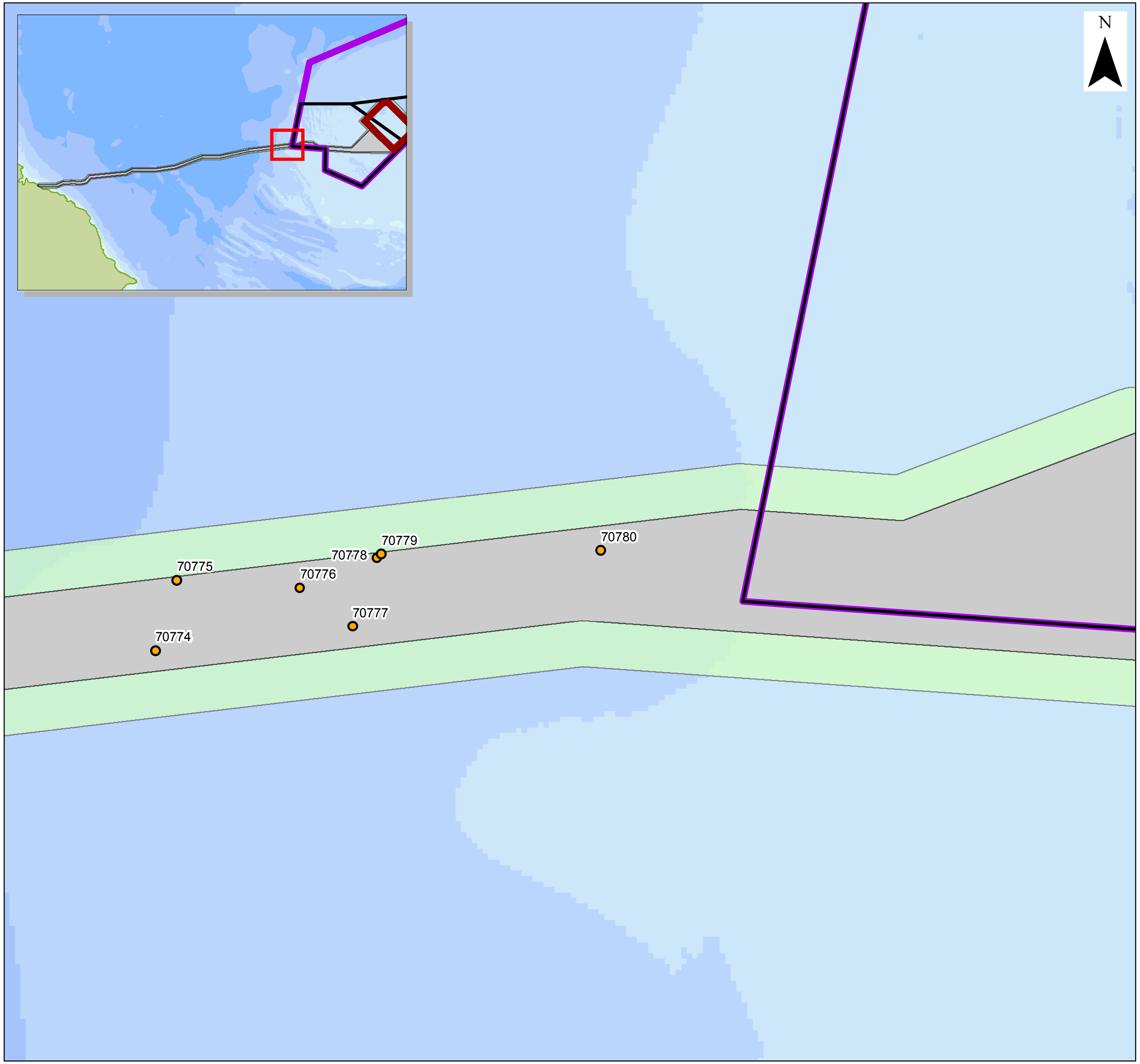
Figure 6.3h Export cable corridor exclusion zones

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

DRAWING NUMBER: **F-OFL-MA-632**

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

FOREWIND



LEGEND

- Dogger Bank Zone
- Tranche boundary
- Dogger Bank Teesside A
- Dogger Bank Teesside B
- Dogger Bank Teesside A & B Export Cable Corridor
- Temporary works area
- A2 Anomalies to be avoided in design layout (not to scale)
- Wrecks and obstructions (non-archaeological)
- Fishermen's fasteners (not to scale)
- Proposed Archaeological Exclusion

0 1 2
Kilometres

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

PROJECT TITLE

DOGGER BANK TEESSIDE A & B

DRAWING TITLE

Figure 6.3i Export cable corridor exclusion zones

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

DRAWING NUMBER: **F-OFL-MA-633**

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

FOREWIND

7. Assessment of Impacts – During Operation

7.1. Introduction

7.1.1. The worst case scenarios and potential impacts during operation are identified in **Table 5.1**.

7.1.2. This assessment considers aspects of the operation and maintenance of Dogger Bank Teesside A & B with the potential to result in damage to or destruction of archaeological receptors or their physical setting.

7.1.3. During the operation phase, effects may arise from any activity which disturbs the seabed, makes contact with the seabed or, with regard to archaeological receptors with height (i.e. shipwrecks), occurs in the water column. Indirect effects may also occur if the presence of the wind turbines and associated infrastructure alter the physical processes acting within the study areas to an extent sufficient to affect archaeological receptors.

7.2. Landfall

Indirect effects

7.2.1. No physical processes effects are anticipated during the operation phase at the landfall as all cables will be buried beneath the shore platform and cliff (**Chapter 9**).

7.2.2. In the immediate subtidal zone (inshore of 2km along the cable route) the worst case for indirect impacts to archaeological receptors has been identified in **Table 5.1** as the use of rock armour to protect cables on the surface. Rock armour protection is expected to be up to 15m wide and 1.3m above the seabed and will provide a physical barrier to water flow and sand transport on, and close to, the seabed (see **Chapter 9**). The interruption to flows due to the presence of rock armour could, potentially, have two effects:

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

7.2.3. With respect to bedload transport of sediment, the rates of longshore sediment transport in the sub-tidal zone are relatively low and it is anticipated that the volumes of sediment trapping on the ‘updrift’ side of any cable protection will be small (**Appendix 9A**).

7.2.4. The extent of predicted scour is difficult to quantify. Whitehouse *et al*. 2000 predict that the extent of downstream bed disturbance induced by a cable is limited to about 10h (where h is the cable diameter). For a 1.5m high cable protection berm, therefore, up to 15m of scour may be expected, horizontally from the berm on the downstream side. Vertical scour, however, is predicted to occur to a depth of less than one metre and is not expected to expose buried features.

7.2.5. Moreover, the flood and ebb currents in the sub-tidal zone are different in magnitude, so that there is a net (residual) current, generally to the southeast (**Appendix 9A**). Any secondary scour hole created in the down-flow direction on one side of the cable protection would be partially infilled by deposition into the scour on the reverse tide.

7.2.6. As such, the potential impact upon archaeological receptors will be **minor adverse** and not significant.

Direct effects

7.2.7. There will be no direct effects at the landfall during the operation phase as there will be no disturbance of intertidal deposits (i.e. **no impact**).

7.3. Dogger Bank Teesside A & B Export Cable Corridor

Indirect effects

7.3.1. No effects relating to marine physical processes are anticipated during the operation phase within the Dogger Bank Teesside A & B Export Cable Corridor assuming all export cables will be buried beneath the seabed (see **Chapter 9**). Consequently, there will be no indirect effect upon archaeological receptors.

7.3.2. If burial to a sufficient depth is not possible on any part of the route then the use of cable protection is envisaged. Typical cable protection measures include rock armour, concrete mattressing, pipe, half-pipe or cable clip. The potential for additional scour at these locations is expected to be small scale and localised. As discussed above (Section 7.2) predicted scour is not expected to exceed depths of 1m to a horizontal distance of up to 15m from the line of protection on the downstream side. As scour to this depth is not expected to expose buried features, the potential impact upon archaeological receptors will be **minor adverse** and not significant in EIA terms.

Direct effects

7.3.3. The deployment of vessels' anchors within the Dogger Bank Teesside A & B Export Cable Corridor MSA in the event of required maintenance to cables may directly affect archaeological receptors on the seabed.

7.3.4. As discussed above, unmitigated direct impacts upon archaeological receptors within the Dogger Bank Teesside A & B Export Cable Corridor MSA will be of either moderate or major significance. However, the retention of AEZs throughout the project lifetime which prohibits all activities within their boundaries, including the anchoring of vessels, will prevent direct impacts to known archaeological receptors from occurring.

7.3.5. Together with the use of ORPAD to deal with unexpected discoveries, this mitigation will result in a **negligible** residual impact.

7.4. Dogger Bank Teesside project development areas

Indirect effects

7.4.1. Marine physical process modelling reported in **Chapter 9** identifies potential effects from Teesside A & B during the operation phase as:

- Effects on tidal currents of the conical gravity base foundations;
  - local changes in the vicinity of each foundation created by interaction with the currents;
  - regional changes, which are the overall changes created by the group of foundations in a particular layout pattern;
- Effect of foundation structures on waves; and
- Increase in scour and suspended sediment concentrations.

7.4.2. With regard to tidal currents, modelling for Teesside A & B (**Chapter 9**) has shown that the predicted change in tidal current velocities are unlikely to affect the form of recent sediments over and above the natural tidal processes. Likewise, percentage changes to wave heights are within the natural variation of wave height across Dogger Bank.

7.4.3. Forewind deployed instruments to collect wave and tidal current data at three locations (the northern limit of the Dogger Bank Zone, inside Tranche A and inside Tranche B) and hydrodynamic and wave models were run to compare the existing environmental conditions with predicted conditions created by the construction, operation and decommissioning of Dogger Bank Teesside A & B.

7.4.4. The worst case for changes to tidal current and wave heights has been identified as 400 6MW conical gravity base foundations across Dogger Bank Teesside A & B (**Appendix 9A**). Modelling showed up to only 2% predicted change in tidal current velocities and a maximum change in significant wave height of c.1%.

7.4.5. The predicted changes are sufficiently small to conclude that indirect impacts to archaeological receptors from these changes in tidal currents and wave heights will not be significant.

7.4.6. Potential protection afforded to exposed archaeological receptors by increased sediment cover is assessed by reference to changes in increased suspended sediment. Maximum and average changes in suspended sediment concentrations from the presence of the foundations was modelled for a 30-day simulation period and the results presented for a run of the model after one year (a one-year storm is applied to half of the foundations) and a run of the model after two years (all the foundations are struck by a 50-year storm).

7.4.7. For the one-year storm, this model showed maximum increase in deposition of predominantly 0.1-0.5mm with isolated patches up to 1mm (**Appendix 9A**) Average deposition is mainly less than 0.1mm with small patches between 0.1mm and 0.5mm. Analysis of the time series of deposition from the plume over the 30-day simulation period demonstrates that the maximum thickness of sediment never exceeds 0.7mm at any of seven selected points.

7.4.8. For the fifty-year storm, this model showed maximum increase in deposition of 5mm with the majority of the project areas subject to maximum deposition between 0.5mm and 5mm (**Appendix 9A**). Average deposition is predicted to be between 0.5mm and 5mm in a 32km long, 14km wide area located between the two projects and elsewhere the maximum average deposition is less than 0.5mm. The greatest length of time that thicknesses greater than 1mm (but less than 3mm) persist at any of seven selected point is 72 hours.

7.4.9. Deposition at this limited scale is not expected to impact archaeological receptors.

7.4.10. Thus the probability of indirect impacts occurring is expected to be <1% (exceptionally unlikely) and significant impacts from the effects of changes to physical processes are not expected to occur.

7.4.11. Scour assessments for **Chapter 9** have also been carried out to assess the depths and volumes of scour that could be expected to occur around the turbine support structures and around the infrastructure planned for Dogger Bank Teesside A & B. Predicted sediment values were modelled to determine sediment volumes disturbed during a one-year and 50-year storms across Dogger Bank without foundations in place.

7.4.12. The model shows that the expected scour volumes predicted to occur around a 6MW conical gravity base foundation under 50-year storm conditions are at least 6 times lower than naturally occurring volumes of suspended sediment. Under one-year storm conditions the volume is 5 times lower. While this demonstrates that scour lies with the range of natural variation, it is possible that deeper areas of scour around the base will expose previously buried archaeological receptors if no scour protection is used. Monitoring of scour throughout the operation phase will be required to ensure that archaeological receptors are not subject to impact. Provisions for monitoring, to be agreed with the curator, are set out in the project WSI (78041.06).

7.4.13. Residual impacts from changes to waves, tidal currents and suspended sediment are not expected. Assuming scour is monitored throughout the lifetime of the wind farm, the residual impact of indirect effects upon archaeological receptors from localised scour around foundations is expected to be **negligible**.

7.4.14. If monitoring of physical processes demonstrate changes to tidal currents and waves greater than those predicted, and beyond the range of natural variation, the indirect effect upon archaeological receptors will need to be reassessed. Provisions for monitoring, to be agreed with the curator, are set out in the project WSI (78041.06).

Direct effects

7.4.15. The deployment of anchors from planned and unscheduled maintenance vessels and the use of jack-ups in the event of wind turbine replacement may directly impact archaeological receptors on the seabed.

7.4.16. As discussed above, unmitigated direct impacts upon archaeological receptors within the development areas will be of either moderate or major significance.

However, the retention of AEZs throughout the project lifetime which prohibit all activities within their boundaries, including the anchoring of vessels, will prevent direct impacts to known archaeological receptors from occurring.

7.4.17. Together with the use of ORPAD to deal with unexpected discoveries, this mitigation will result in a **negligible** residual impact.

7.5. Historic seascape character

7.5.1. Due to the presence of existing cables within the MSAs the installation of new cables will result in no change to the current historic seascape character. Dogger Bank Teesside A & B, and further offshore wind farms comprising Dogger Bank Creyke Beck and Dogger Bank Teesside C & D, will result in a change to the current historic seascape character to include a character associated with offshore renewables.

8. Assessment of Impacts – During Decommissioning

8.1. Introduction

8.1.1. The worst case scenarios and potential impacts during decommissioning are identified in **Table 5.1**.

8.1.2. This assessment considers aspects of the decommissioning of Teesside A and Teesside B with the potential to result in damage to or destruction of archaeological receptors or their physical setting.

8.1.3. During the decommissioning phase, effects may arise from any activity which disturbs the seabed, makes contact with the seabed or, with regard to archaeological receptors with height (i.e. shipwrecks), occurs in the water column. Direct effects may also occur from activities at the landfall which disturb intertidal deposits. Indirect effects may occur if decommissioning activities alter the physical processes acting within the study areas to an extent sufficient to affect archaeological receptors.

8.2. Landfall

Indirect effect

8.2.1. At the landfall, if components are left in place, there will be no effect upon physical or coastal processes. If components are removed, the effects will be similar to those described during construction (see **Chapter 9**). In both scenarios, indirect impacts to archaeological receptors are not expected to occur (i.e. **no impact**) (see Section 6.2 for construction effects).

Direct effects

8.2.2. At the landfall, if components are left in place, as is currently envisaged under the decommissioning plan outlined in **Chapter 5** of the ES, there will be no direct effect upon archaeological receptors (i.e. **no impact**).

8.3. Dogger Bank Teesside A & B Export Cable Corridor

Indirect effects

8.3.1. Within the Dogger Bank Teesside A & B Export Cable Corridor, if cables are left in place there will be no effect upon physical processes. If cables are removed, the effects will be less than those described during the construction phase (see **Chapter 9**). In both scenarios, indirect impacts to archaeological receptors are not expected to occur (i.e. no impact) (see Section 6.3 for construction effects).

Direct effects

8.3.2. Within the Dogger Bank Teesside A & B Export Cable Corridor, if cables are left in place there will be no direct effect upon archaeological receptors.

8.3.3. If the cables are removed, activities in the Dogger Bank Teesside A & B Export Cable Corridor that may directly affect archaeological receptors comprise the removal of cables and cable protection and the deployment of vessel anchors.

8.3.4. As discussed above, unmitigated direct impacts upon archaeological receptors within the development areas will be of either moderate or major significance. However, the retention of AEZs throughout the project lifetime which prohibit all activities within their boundaries, including the anchoring of vessels, will prevent direct impacts to known archaeological receptors from occurring.

8.3.5. Impacts from cable installation may be expected to have already occurred during the construction phase although there is some potential for the act of removal to impact new areas that were not impacted during installation. However, the inclusion of measures, including ORPAD, to deal with unexpected discoveries offshore will result in a **negligible** residual impact.

8.4. Dogger Bank Teesside project development areas

Indirect effects

8.4.1. Within the development area, if the foundations and cables are left in place, there will be no effect upon physical processes. If components are removed, the effects will be less than those described during the construction phase (see **Chapter 9**). In both scenarios, indirect impacts to archaeological receptors are not expected to occur (i.e. **no impact**) (see Section 6.4 for construction effects).

Direct effects

8.4.2. Activities in the development areas that may directly affect archaeological receptors comprise the removal of foundations, dredging of scour protection and the deployment of vessel anchors and jack-ups.

8.4.3. As discussed above, unmitigated direct impacts upon archaeological receptors within the development areas would be of either moderate or major significance. However, the retention of AEZs throughout the project lifetime which prohibit all activities within their boundaries, including the anchoring of vessels, will prevent direct impacts to known archaeological receptors from occurring (i.e. **no impact**).

8.4.4. Impacts from foundations may be expected to have already occurred during the construction phase although there is some potential for the removal process to impact new areas that were not impacted during installation or through exposure by scour. Dredging to retrieve scour protection may also impact new areas of seabed which lie beneath. However, the inclusion of measures, including ORPAD, to deal with unexpected discoveries offshore will result in a **negligible** residual impact.

8.5. Historic seascape character

8.5.1. A change will occur with the decommissioning of the wind farm with the partial or complete removal of the wind turbines and associated infrastructure resulting in further change to the character, reminiscent of the pre-wind farm character.

9. Inter-relationships

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

9.1.2. **Table 9.1** summarises the inter-relationships that are considered of relevance to marine and coastal archaeology and identifies where they have been considered within the ES.

9.1.3. Inter-relationships between offshore archaeology and Marine Physical Processes (**Chapter 9**) and Seascape Visual Character (**Chapter 20**) have been discussed as part of the impact assessment above. This has demonstrated that no significant residual impacts are expected for any single archaeological receptor as a result of the construction, operation or decommissioning of Teesside A & B. As such, there is no potential for the accumulation of residual impacts on a single archaeological receptor.

9.1.4. There is potential for an inter-related impact between marine physical processes and marine and coastal archaeology due to a change in hydrodynamics. Impacts in relation to marine physical processes have been assessed in this chapter as **negligible**. The assessment has been based on the results of the hydrodynamic modelling as presented in **Chapter 9**.

9.1.5. A further potential inter-relationship may occur with the displacement of fishing activities as a result of Dogger Bank Teesside A & B. **Chapter 15 Commercial Fisheries** details concerns raised during fisheries consultations that any loss or restricted access to fishing grounds due to Dogger Bank Teesside A & B could result in increased competition for grounds outside of the site.

9.1.6. It is possible that this increased competition will result in greater potential for impacts to archaeological receptors within these grounds from fishing gear and anchors.

9.1.7. However, the residual impacts identified in **Chapter 15** for displacement in relation to fishing grounds within Dogger Bank Teesside A & B project and cable corridor was identified as minor. In addition, as existing grounds are already subject to fishing activity it is expected that the locations of obstructions on the seabed will be known and avoided. Although there is potential for further wrecks and aircraft to be present that have not yet been discovered, newly exposed as a result of shifting sands, for example, it may also be expected that fishermen will strive to avoid such sites once discovered to avoid damage to their boats or gear.

9.1.8. The accumulation of residual impacts on a single archaeological receptor as a result of displacement of fishing activities is thus not expected to be significant.

9.1.9. As such, no inter-relationships have been identified where an accumulation of residual impacts on marine and coastal archaeology give rise to a need for additional mitigation.

Table 9.1 Inter-relationships relevant to the assessment of marine archaeology

Inter-relationship	Section where addressed	Linked chapter
Construction and decommissioning		
Changes to marine physical processes (namely hydrodynamics) may affect archaeological receptors, for example by uncovering previously buried archaeological deposits.	Throughout this chapter under 'indirect effects'	**Chapter 9 Marine Physical Processes**

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

10. Cumulative Impacts

10.1. Cumulative impact assessment strategy and screening

10.1.1. Cumulative impact assessment has been carried out in accordance with guidance and methodologies issued by Forewind. This approach takes account of Guidance for Assessment of Cumulative Impacts on the Historic Environment from Offshore Renewable Energy issued by COWRIE (Oxford Archaeology 2008).

10.1.2. Cumulative impacts may occur where archaeological receptors also have the potential to be impacted by other existing, consented and/or proposed developments or activities (see **Chapter 33**). The assessment of cumulative impact considers:

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

10.1.3. The approach taken by Forewind allows for increasing levels of confidence in the cumulative assessment to develop with time as new development plans and proposals come forward and new data becomes available for plans and projects already under consideration.

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

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

10.1.6. This also identifies where cumulative impacts are not anticipated, thereby screening them out from further assessment.

10.1.7. For marine and coastal archaeology, the potential for cumulative impacts is identified in relation to indirect effects from increased suspended sediment concentration and subsequent deposition during construction and operation (within 1km of the Dogger Bank Zone and Dogger Bank Teesside A & B Export

Cable Corridor) and in relation to multiple types of impact on the archaeological resource (both within and outside the Dogger Bank Zone and Dogger Bank Teesside A & B Export Cable Corridor) (**Table 10.1**).

Table 10.1 Potential cumulative impacts (impact screening)

Impact	Dogger Bank Zone and Dogger Bank Teesside A & B Export Cable Corridor (within 1km)		Beyond 1km from the Dogger Bank Zone and Dogger Bank Teesside A & B Export Cable Corridor		Rationale for where no cumulative impact is expected
	Potential for cumulative impact	Data confidence	Potential for cumulative impact	Data confidence	
Direct impact via archaeological receptor damage and/or loss (due to placement of project infrastructure).	No	N/A	No	N/A	Cumulative direct impacts within 1km will be prevented by the application of AEZs to all known archaeological receptors across the Dogger Bank Zone and the avoidance of A2 anomalies through micrositing. Cumulative direct impacts beyond 1km will not occur as there is no geographical overlap.
Indirect impact via increased suspended sediment concentration and sediment deposition (construction phase).	Yes	Medium-High	No	N/A	Beyond 1km no significant cumulative effects to physical processes are expected to occur. Hence, there will be no significant cumulative indirect effects to archaeological receptors.
Indirect impact via increased suspended sediment concentration and sediment deposition (via scour in operation phase).	Yes	Medium-High	No	N/A	Beyond 1km no significant cumulative effects to physical processes are expected to occur. Hence, there will be no significant cumulative indirect effects to archaeological receptors.
Direct impact via vessel activity (jacking-up and anchoring) in operation phase for operation and maintenance activities.	No	N/A	No	N/A	Cumulative direct impacts within 1km will be prevented by the retention of AEZs to all known archaeological receptors across the Dogger Bank Zone and the continued avoidance of A2 anomalies. Cumulative direct impacts beyond 1km will not occur as there is no

Impact	Dogger Bank Zone and Dogger Bank Teesside A & B Export Cable Corridor (within 1km)		Beyond 1km from the Dogger Bank Zone and Dogger Bank Teesside A & B Export Cable Corridor		Rationale for where no cumulative impact is expected
	Potential for cumulative impact	Data confidence	Potential for cumulative impact	Data confidence	
					geographical overlap.
Multiple impacts during construction, operation and decommissioning upon the archaeological resource (including on palaeo-environmental features (i.e. prehistoric landscape elements).	Yes	Medium	Yes	Low	N/A

10.1.8. The other plans, projects and activities that may contribute to cumulative impacts on marine and coastal archaeology are identified in the sections 10.2 to 10.5 below.

10.1.9. It should be noted that:

- Where Forewind is aware that a plan, project or activity could take place in the future, but has no information on how the plan, project or activity will be executed, it is screened out of the assessment; and
- Existing projects, activities and plans are considered to be a part of the established baseline and are therefore not included in the cumulative assessment.

10.2. Plans, projects and activities inside the Dogger Bank Zone and Dogger Bank Teesside A & B Export Cable Corridor

10.2.1. As set out above, cumulative impacts may occur where archaeological receptors identified within Dogger Bank Teesside A & B have the potential to be impacted by the wind farm project(s) subject to the application(s) and other wind farm projects, activities and plans in the Dogger Bank Zone (either consented or forthcoming).

10.2.2. In addition to Dogger Bank Teesside A & B, other projects that have, so far, been defined within the Dogger Bank Zone include Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D.

10.2.3. The sequence of construction of the projects is yet to be determined by Forewind and it is possible that any of the above projects may be built first. Consequently, the Dogger Bank Teesside projects may equally be constructed before the Dogger Bank Creyke Beck developments. Decisions regarding phasing, however, will not include consideration of archaeological receptors in this respect as they are fixed spatially and not subject to effects controlled by temporal factors.

Indirect effects

10.2.4. Forewind has developed a range of potential construction programmes that may apply to Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B, and Dogger Bank Teesside C & D. The minimum and maximum construction periods for each project are three years and six years, respectively. As identified in **Chapter 9** the worst case scenario for physical processes would be for all projects to be constructed at the same time over a three-year period. This would provide the greatest opportunity for interaction of waves, tidal currents and sediment transport during construction and operation of all projects. Wave and tidal currents together have the potential to increase scour and sediment deposition, both these scenarios combining represent the worst case scenario with respect to the marine archaeological environment.

10.2.5. During construction, cumulative effects will be restricted to the potential interaction of sediment plumes from foundation installation and cable laying activities and the subsequent deposition of disturbed sediments on the seabed (**Appendix 9A**). Numerical modelling for Dogger Bank Teesside A & B (Section 12) and for the Dogger Bank Creyke Beck Environmental Statement has shown that the maximum thickness of sediment that would remain deposited on the seabed at the end of the 30-day simulation periods would be less than 0.1mm. Thus it is considered that the potential for thick sequences of sediment persistently accumulating on the seabed due to plume interaction from all six projects is low, even if the construction programmes coincide.

10.2.6. During operation the maximum cumulative effect on tidal current velocities is predicted to be up to approximately 3%, restricted to narrow (up to 2km wide) patches along the western boundaries of Dogger Bank Creyke Beck B and Dogger Bank Teesside D (**Appendix 9A)**. For wave heights, the maximum change in significant wave height is approximately up to 1.5% along the southern and south-western boundaries of Dogger Bank Creyke Beck A and up to 1% along the northern and north-eastern boundaries (**Appendix 9A**). With regard to increased deposition of suspended sediment concentrations, the maximum change in deposition predicted at any time over the 30-day simulation period (for a fifty-year storm event) is 5mm with average deposition predicted to be 0.1-0.5mm in numerous patches across and outside most of the projects (**Appendix 9A**). The greatest length of time that thicknesses of greater than 3mm will be maintained is 244 hours.

10.2.7. The modelling presented in **Chapter 9**, therefore, shows that changes to tidal currents, wave heights and sediment depositions will not results in a significant cumulative effect. Consequently, cumulative indirect impacts to archaeological receptors will not be significant.

Direct effects

10.2.8. Cumulative direct impacts to known receptors within the MSAs will not occur due to the avoidance of archaeological receptors using AEZs and micrositing across the Dogger Bank Zone. The adoption of mitigation to prevent significant impacts by Forewind is expected to be applied to all Dogger Bank projects. Hence, significant cumulative impacts to potential receptors will also be prevented by the adoption of appropriate mitigation to deal with unexpected discoveries as set out in the WSI, including ORPAD.

10.2.9. Only one project with the potential to disturb archaeological receptors on or within the seabed lies within the Dogger Bank Zone in addition to the Dogger Bank Creyke Beck, Dogger Bank Teesside A & B and Dogger Bank Teesside C & D, aggregate Area 466/1. As this is outside any of the planned project areas within the zone, there is no potential for cumulative effects to known receptors. With regard to potential archaeological receptors within the zone, cumulative effects upon the seabed from dredging and the extraction of seabed material which might include archaeological material have the potential to be significant. The effect is mitigated, however, by the BMAPA Protocol for Reporting Finds of Archaeological Interest. Thus the cumulative effect is expected to be **minor adverse**.

Historic seascape character

10.2.10. Across the zone cumulative effects to the historic seascape character will occur although effects associated with construction will be temporary and transitory while decommissioning will result in a further change to the character, reminiscent of the pre-wind farm character.

10.3. Plans, projects and activities outside the Dogger Bank Zone and Dogger Bank Teesside A & B Export Cable Corridor

10.3.1. As set out above, cumulative impacts may occur where archaeological receptors identified within Dogger Bank Teesside A & B have the potential to be impacted by other activities, projects and plans outside the Dogger Bank Zone (e.g. other offshore wind farm developments), for which sufficient information regarding location and scale exist.

10.3.2. As for the above impact assessment, cumulative indirect impacts may occur as a result of changes to prevailing physical processes. Cumulative direct impacts may occur as a result of multiple unavoidable impacts to a receptor across the region.

10.3.3. Projects relevant to the assessment of cumulative effects upon archaeology and cultural history have been selected from the full list of projects supplied by Forewind. Screening of the full list was carried out to identify the types of plans, projects and activities that could contribute to cumulative effects upon archaeological receptors and to screen out those which are not expected to contribute. Projects relevant to the assessment of indirect and direct cumulative effects are outlined below.

Indirect effects

10.3.4. Outwith the Dogger Bank Zone, the projects screened in for **Chapter 9** in assessing the cumulative impact assessment for marine physical processes are:

- Offshore wind farms:
  - *Project One and Two of the Hornsea Zone;*
  - *Teesside Offshore Windfarm;*
  - *Blyth Demonstration;*
  - *H2-20;*
  - *Idunn Energipark; and*
  - *Nord-Ost Passat I, II and III.*
- Aggregate license areas (Humber Aggregate Region):
  - *Application Area 466 immediately northwest of Dogger Bank Creyke Beck B; and*
  - *Application Area 485 (1 and 2) approximately 25km to the southwest of Dogger Bank Creyke Beck A and 20km south of the Dogger Bank Teesside A & B Export Cable Corridor.*

10.3.5. As concluded in **Chapter 9** it is considered unlikely that the construction plume of Hornsea (there will be no operation plume because of scour protection) would interact with the cumulative construction plume of Dogger Bank Teesside A & B, Dogger Bank Creyke Beck A & B and Dogger Bank Teesside C & D (foundations and cable laying) (**Appendix 9A**):

- The shortest distance between the Dogger Bank and Hornsea developments is approximately 65km and construction plumes containing suspended sediment concentrations above the background are predicted to occur a maximum of 10km north of Project One; and
- There is a low probability that construction of Dogger Bank Teesside A & B, Dogger Bank Teesside C & D and Dogger Bank Creyke Beck A & B will overlap with construction of Project One of Hornsea.

10.3.6. It is similarly unlikely that the Project One construction plume will interact with the Dogger Bank operation plume because the latter is created by a 50-year storm during which time it is unlikely that any construction at Project One will be possible.

10.3.7. Cumulative effects with the operation of the Teesside Offshore Windfarm will be prevented by the intended application of scour protection around the Teesside Offshore Windfarm turbine foundations (**Appendix 9A**). Cumulative effects with the Blyth Demonstration project are also considered unlikely due to the limited number of turbines planned for these projects, and due to the distance between the schemes, no effects are predicted.

10.3.8. H2-20 and Nord-Ost Passat I, II and III offshore wind farms are in the German sector of the North Sea and Idunn Energipark is in the Norwegian sector of the North Sea. Given the distance of the German and Norwegian wind farms from the Dogger Bank Zone, the likelihood of interaction with the Dogger Bank projects is low (**Appendix 9A**).

10.3.9. With regard to aggregates areas, Application Area 466 is located adjacent to the northern boundary of Dogger Bank Creyke Beck B and the western boundary of Dogger Bank Teesside C and lies within the extent of the footprints of the Dogger Bank cumulative plumes generated from both construction and operation (**Appendix 9A**). The predicted suspended sediment concentrations and deposition for both construction and operation of the Dogger Bank projects, however, shows that deposition out of the Dogger Bank cumulative plumes would have little persistent effect on the characteristics of the seabed sediment in Area 466.

10.3.10. Aggregates Area 485 is located approximately 25km to the southwest of Dogger Bank Creyke Beck A and 20km south of the Dogger Bank Creyke Beck Dogger Bank Teesside A & B Export Cable Corridor. If Area 485 is licensed during the lifetime of Dogger Bank Teesside A & B, Dogger Bank Teesside C & D and Dogger Bank Creyke Beck A & B, the aggregate extraction activities have the potential to release further suspended sediment into the water column and to give rise to cumulative effects (**Appendix 9A**). However, the predicted plume form Area 485 is expected to be short term, localised and small, lying within the natural range of conditions likely to be experienced at the proposed dredging area. Thus, significant cumulative effects are not predicted to occur.

10.3.11. No significant cumulative effects to physical processes are expected to occur. Hence, there will be no significant cumulative indirect effects to archaeological receptors.

Direct effects

10.3.12. Archaeological receptors within the MSAs will not be subject to direct impacts from any projects outwith the Dogger Bank Zone as there is no geographical overlap.

Historic seascape character

10.3.13. The introduction of offshore wind farms alongside other planned installations outwith the Dogger Bank Zone will change the historic seascape character.

10.4. Cumulative effect on the archaeological resource

10.4.1. As identified above, cumulative direct impacts to individual archaeological receptors within Dogger Bank Teesside A & B will not occur due to the use of AEZs and micrositing to avoid archaeological receptors. The effect of unavoidable impacts to potential receptors will be mitigated by agreed measures set out in the project WSI. It is important to note, however, that, although the effects can be mitigated, the impacts have still occurred and permanent damage or destruction will have taken place.

10.4.2. The extents of palaeolandscapes, from various periods, are largely unmapped and may be confined within a 'project area', but may equally extend beyond the bounds of a project. The assessment of sub-bottom profiler data within Dogger Bank Tranche A, for example, has shown how the fluvial systems mapped by the NSPP extend into the study area, linking the Phase I channel features to the submerged landscape of Doggerland in the Southern North Sea.

10.4.3. Likewise, shipwrecks and aircraft within the MSAs form part of a wider body of data relating to maritime and aviation networks which extend beyond the boundary of the Dogger Bank Zone.

10.4.4. It is possible, therefore, for projects beyond the zone to impact the archaeological resource that traverses the project boundaries.

10.4.5. The presence of features and deposits with high potential to contain, or be associated with, potential prehistoric, maritime or aviation receptors, has been discussed within the discussion of the baseline. However, the uncertainly with the data for these potential sites is high and it is not possible to quantify the extent of these impacts. Neither is it possible to screen in or screen out projects from the full list of plans or activities provided by Forewind.

10.4.6. If multiple (unavoidable) impacts occur from the construction, operation or decommissioning of the Dogger Bank Zone wind farms, combined with current and future plans, projects or activities outwith the zone, then cumulative effects may occur. It is possible that unique aspects of former landscapes and seascapes may be lost as a result of projects, plans and activities both within and beyond the zone. In addition, if a site is damaged or destroyed, comparable sites elsewhere may increase in importance as a result of greater rarity and any future direct impacts will be of greater significance. Thus a cumulative impact is expected to occur.

10.4.7. However, together with the accumulation of archaeologically interpreted geophysical and geotechnical data carried out for offshore developments in recent years, the information provided by chance discoveries is contributing significantly to a greater understanding of the offshore archaeological resource. As such, these unavoidable impacts and the data and records produced in mitigating their effects can also be regarded as a significant, positive cumulative effect.

10.4.8. Any positive effect, however, must be demonstrated by the completion of studies to professional archaeological standards, and the results produced must be made publicly available, as set out in the project WSI (78041.06).

10.4.9. National Policy Statement EN-3 (Department of Energy and Climate Change 2011b, p. 49) states that assessment of the historic marine environment should include the identification of any beneficial effects such as the contribution to new knowledge that arises from investigation. The National Planning Policy Framework (Department for Communities and Local Government 2012, p. 32) is clear that the dissemination and publication of results are important and that information about the historic environment gathered as part of the planning process should be made publically accessible. Likewise, the Marine Policy Statement (Department for Environment, Food and Rural Affairs 2011, p. 21) states that 'opportunities should be taken to contribute to our knowledge and understanding of our past by capturing evidence from the historic environment and making this publicly available, particularly if a heritage asset is to be lost'.

10.4.10. It is anticipated that any such information derived from the Dogger Bank development will contribute to this body of data and thus to an understanding of the submerged cultural heritage. Forewind has expressed commitment to supporting a continued programme of assessment and publication, a body of work that will contribute significantly to current understanding of North Sea archaeology.

11. Transboundary Effects

11.1.1. Transboundary effects may occur as the result of:

- Impacts that might occur on the environment within other European Economic Area (EEA) member states (i.e. not within the UK Regional Economic Zone (REZ)); and
- Impacts that might occur on interests of another EEA member state within the UK REZ.

Indirect effects

11.1.2. Modelling of the changes to wave and tidal current regimes across the entire developable area demonstrates that effects do cross over the international boundary into the Dutch and German waters beyond the eastern boundary of the Dogger Bank Zone (see **Chapter 9**). The results showed, however, that predicted changes would be of small magnitude in international waters with limited secondary effects on sediment transport or seabed morphology. Scour is limited to the immediate vicinity of the Dogger Bank Teesside A and Dogger Bank Teesside B foundations and sediment plumes for construction and operation do not disperse into international waters.

11.1.3. Indirect transboundary effects upon archaeological receptors are not, therefore, expected to occur.

Direct effects

11.1.4. Direct effects to archaeology and cultural history within other EEA member states, from development of related activities associated with Dogger Bank Teesside A & B are not expected to occur during the lifetime of the project.

11.1.5. Impacts on interests of another EEA member state within the UK REZ may occur if wrecks of non-British, European nationality are subject to impact from development. Such wrecks may fall within the jurisdiction of another country, and may include, for example, foreign warships lost in UK waters. In theory, there is the possibility of remains of vessels from any maritime nation to be present within the study areas which may be of importance to that country.

11.1.6. There is a wreck of a German submarine within Dogger Bank Teesside B (WA70535) and within the Dogger Bank Teesside A & B Export Cable Corridor MSA there is a Spanish steamship (WA2114).

11.1.7. Further, potential wrecks of varying nationalities are also expected to be present within the study areas, including aircraft of German and US nationality. All military aircraft wrecks are automatically protected under the Protection of Military Remains Act 1986.

11.1.8. As the implementation and enforcement of AEZs will prevent direct impacts to known archaeological receptors, transboundary impacts to known wrecks and aircraft are not expected.

11.1.9. It is possible that potential, as yet undiscovered wrecks and aircraft may be impacted, although the archaeological assessment of pre-construction geophysical and geotechnical survey reduces this likelihood and additional mitigation (ORPAD) will address unexpected discoveries. If wrecks or aircraft from another EEA member state are discovered during the course of the development, further advice should be sought regarding the legal status of the remains in their country of origin.

11.1.10. Impacts to the palaeolandscapes of the North Sea may also be subject to transboundary effects. Member states bordering the North Sea have a shared interest in the palaeoarchaeology of the seabed representing a former landsurface that connected these states at times of reduced sea level.

11.1.11. The developments proposed by Forewind within the Dogger Bank Zone have generated, and will continue to generate, archaeologically interpreted geophysical and geotechnical data leading to an increased understanding of North Sea palaeolandscapes. There is also potential for the accumulation of information provided by chance discoveries encountered during the construction, operation and decommissioning of Dogger Bank wind farms and reported through ORPAD. Provision for the publication and dissemination of this data will be set out in the scheme specific WSIs to ensure that the results of this research are made available to all member states that may be subject to transboundary effects from impacts to palaeolandscapes. Thus, this is considered a significant, positive transboundary effect.

12. Summary

12.1.1. A summary of the project assessment and residual impacts for Dogger Bank Teesside A & B is included in **Table 12.1**.

12.1.2. "Direct" effects are those associated with the damage or destruction of archaeological deposits and material and their physical setting from direct impacts.

12.1.3. "Indirect" effects are those associated with the damage or destruction of archaeological deposits and material and their physical setting from indirect impacts.

12.1.4. Known and potential archaeological receptors within the Study Area have been identified and discussed with regard to archaeology at the landfall, submerged prehistory, maritime and aviation archaeology and historic seascape character.

12.1.5. Impacts to these receptors are assessed with reference to:

- The direct effect of the physical siting of the development;
- Indirect changes to the physical marine environment; and
- The effect of the development upon the setting of archaeological receptors.

12.1.6. Visual impacts to the setting of the above receptors have not been considered as part of the offshore archaeological assessment as none of the receptors are considered to have a 'setting' that directly contributes to their significance as heritage assets.

12.1.7. Significant impacts from the effects of changes to physical processes are not expected to occur. If monitoring during the operation phase indicates greater than expected change reassessment of the indirect effects upon archaeological receptors may need to be reassessed.

12.1.8. As there are no known extant archaeological receptors at the landfall there will be **no impacts**. Unexpected discoveries that may come to light during the installation of landfall components will be reported and addressed through the application of the ORPAD.

12.1.9. Direct impacts to A1 receptors will be avoided through the application of 100m AEZs around the extents of the receptor as seen in the geophysical data.

12.1.10. Direct impacts to A2 receptors will be avoided through micrositing the scheme layout to avoid the recoded positions where possible.

12.1.11. Direct impacts to A3 receptors and additional records of medium and high archaeological value will be avoided through the application of 100m AEZ around the recorded point location.

12.1.12. If preservation in situ is not possible, direct impacts to known receptors will need to be offset by appropriate satisfactory measures to be agreed with the archaeological curator.

12.1.13. For all other A3 receptors and additional records, of low archaeological value, the absence of material remains of archaeological interest is considered likely and the potential for buried remains is considered to be low. Mitigation through avoidance is not considered necessary.

12.1.14. If unexpected remains are discovered during the course of the development direct impacts will be addressed through the application of the ORPAD. In theory, archaeological material (in situ and derived) may be present within, or absent from, all deposits dating from the Palaeolithic onwards.

12.1.15. It is noted that, due to the large size of the Study Area, a selection strategy was adopted with regard to the assessment of geophysical data.

12.1.16. With the application of mitigation, the residual impacts to archaeological receptors will be either **negligible** or will result in **no impact**, both of which are not significant in EIA terms.

12.1.17. With regard to inter-relationships, no significant residual impacts are expected for any single archaeological receptor as a result of the construction, operation or decommissioning of Dogger Bank Teesside A & B. As such, there is no potential for the accumulation of residual impacts on a single archaeological receptor.

12.1.18. As discussed, significant transboundary and cumulative effects are not expected to occur to known archaeological receptors. With regard to potential receptors, however, it is likely that receptors will only be identified once they occur and multiple impacts across the region to archaeological landscapes and seascapes are possible. However, the accumulation of archaeologically interpreted geophysical and geotechnical data carried out for offshore developments in recent years and the information provided by chance discoveries is contributing significantly to a greater understanding of the offshore archaeological resource. As such, these unavoidable impacts and the data and records produced in mitigating their effects are a significant, positive cumulative effect.

Table 12.1 Summary of residual impacts

Receptor Class	Receptor	Effect	Mitigation	Residual Impact
Dogger Bank Teesside A				
Submerged Prehistory	Potential in situ prehistoric sites, isolated artefact discoveries and palaeoenvironmental data	Direct	Measures to deal with unexpected discoveries set out in WSI	**Negligible**
		Indirect	Monitoring of scour and changes to physical processes as set out in WSI	**No discernible impact**
Maritime	2 known (A1) wrecks of high archaeological value (WA70587, WA70590) 2 (A3) records of wrecks high archaeological value (WA70618, WA70620)	Direct	Archaeological Exclusion Zones (A1: 100m around extent of site; A3: 100m around point location)	**No discernible impact**
		Indirect	Monitoring of scour and changes to physical processes as set out in WSI	**No discernible impact**
	Potential *in situ* maritime sites and isolated artefact discoveries	Direct	Measures to deal with unexpected discoveries set out in WSI	**Negligible**
		Indirect	Monitoring of scour and changes to physical processes as set out in WSI	**No discernible impact**
	2 (A3) records of modern wrecks of low archaeological value (WA70616, WA70617)	Direct	None required although avoidance recommended	**No discernible impact**
	1 (A3) recorded loss (WA70621)	Direct	Measures to deal with unexpected discoveries set out in WSI	**Negligible**
Aviation	Potential in situ aviation sites and isolated artefact discoveries	Direct	Measures to deal with unexpected discoveries set out in WSI	**Negligible**
		Indirect	Monitoring of scour and changes to physical processes as set out in WSI	**No discernible impact**
Additional Anomalies	35 known (A2) anomalies of potential archaeological value	Direct	Positions to be avoided in design layout	**No discernible impact**
		Indirect	Monitoring of scour and changes to physical processes as set out in WSI	**No discernible impact**

Receptor Class	Receptor	Effect	Mitigation	Residual Impact
Dogger Bank Teesside B				
Submerged Prehistory	Potential in situ prehistoric sites, isolated artefact discoveries and palaeoenvironmental data	Direct	Measures to deal with unexpected discoveries set out in WSI	**Negligible**
		Indirect	Monitoring of scour and changes to physical processes as set out in WSI	**No discernible impact**
Maritime	4 known (A1) wrecks of high archaeological value (WA70636, WA70637, WA70505 and WA70640)	Direct	Archaeological Exclusion Zones (100m around extent of site)	**No discernible impact**
		Indirect	Monitoring of scour and changes to physical processes as set out in WSI	**No discernible impact**
	Potential in situ maritime sites and isolated artefact discoveries	Direct	Measures to deal with unexpected discoveries set out in WSI	**Negligible**
		Indirect	Monitoring of scour and changes to physical processes as set out in WSI	**No discernible impact**
	3 (A3) recorded losses/dead wreck (WA70533, WA70535, and WA70536)	Direct	Measures to deal with unexpected discoveries set out in WSI	**No discernible impact**
Aviation	1 (A3) record of an aircraft of high archaeological value (WA70651)	Direct	Archaeological Exclusion Zones (100m around point location)	**No discernible impact**
		Indirect	Monitoring of scour and changes to physical processes as set out in WSI	**No discernible impact**
Additional Anomalies	25 known (A2) anomalies of potential archaeological value	Direct	Positions to be avoided in design layout	**None**
		Indirect	Monitoring of scour and changes to physical processes as set out in WSI	**None**
Dogger Bank Teesside A & B				
Submerged Prehistory	Potential in situ prehistoric sites, isolated artefact discoveries and palaeoenvironmental data	Direct	Measures to deal with unexpected discoveries set out in WSI	**Negligible**
		Indirect	Monitoring of scour and changes to physical processes as set out in WSI	**No discernible impact**
Maritime	6 known (A1) wrecks of high archaeological value	Direct	Archaeological Exclusion Zones (A1: 100m around extent of	**No**

Receptor Class	Receptor	Effect	Mitigation	Residual Impact
	(WA70587, WA70590, WA70636, WA70637, WA70505 and WA70640) 2 (A3) records of wrecks high archaeological value (WA70618, WA70620)		site; A3: 100m around point location)	discernible impact
		Indirect	Monitoring of scour and changes to physical processes as set out in WSI	No discernible impact
	Potential in situ maritime sites and isolated artefact discoveries	Direct	Measures to deal with unexpected discoveries set out in WSI	Negligible
		Indirect	Monitoring of scour and changes to physical processes as set out in WSI	No discernible impact
	2 (A3) records of modern wrecks of low archaeological value (WA70616, WA70617)	Direct	None required although avoidance recommended	No discernible impact
	4 (A3) recorded losses/dead wreck (WA70621, WA70533, WA70535, and WA70536)	Direct	Measures to deal with unexpected discoveries set out in WSI	Negligible
Aviation	1 (A3) record of an aircraft (WA70651)	Direct	Archaeological Exclusion Zones (100m around point location)	No discernible impact
		Indirect	Monitoring of scour and changes to physical processes as set out in WSI	No discernible impact
	Potential in situ aviation sits and isolated artefact discoveries	Direct	Measures to deal with unexpected discoveries set out in WSI	Negligible
		Indirect	Monitoring of scour and changes to physical processes as set out in WSI	No discernible impact
Additional Anomalies	60 known (A2) anomalies of potential archaeological value	Direct	Positions to be avoided in design layout	No discernible impact
		Indirect	Monitoring of scour and changes to physical processes as set out in WSI	No discernible impact
Dogger Bank Teesside A & B Export Cable Corridor				
Landfall	Potential for buried features and artefacts	Direct	Measures to deal with unexpected discoveries set out in WSI	Negligible
		Indirect	Monitoring of scour and sediment transport processes as set	No

Receptor Class	Receptor	Effect	Mitigation	Residual Impact
			out in WSI	**discernible impact**
Submerged Prehistory	Potential in situ prehistoric sites, isolated artefact discoveries and palaeoenvironmental data	Direct	Measures to deal with unexpected discoveries set out in WSI	**Negligible**
		Indirect	Monitoring of scour and changes to physical processes as set out in WSI	**No discernible impact**
Maritime	1 known (A1) wrecks of high archaeological value (WA70657)	Direct	Archaeological Exclusion Zones (A1: 100m around extent of site)	**No discernible impact**
		Indirect	Monitoring of scour and changes to physical processes as set out in WSI	**No discernible impact**
	33 (A3) Fishermen's Fasteners and 4 (A3) wrecks of low archaeological value (WA70855, WA70860, WA70866, WA70853)	Direct	Measures to deal with unexpected discoveries set out in WSI	**Negligible**
	Additional records of Fishermen's Fasteners outside geophysical survey areas 3 additional records of seabed obstructions outside geophysical survey areas (WA2016, WA2020, WA2018)	Direct	Positions to be avoided in design layout	**No discernible impact**
	Record of modern wreck of low archaeological value outside geophysical survey areas (WA2022)	Direct	None required although avoidance recommended	**No discernible impact**
	Nine additional records of wrecks of high and medium archaeological value outside geophysical survey areas ((WA2014, WA2017, WA2110, WA2024, WA2092, WA2094, Moorwood WA2095, HMS Ruthin Castle WA2148, Anboto Mendi WA2114, Hartley WA2147, Early Percy WA2126)	Direct	Archaeological Exclusion Zones (100m around point location)	**No discernible impact**
		Indirect	Monitoring of scour and changes to physical processes as set out in WSI	**No discernible impact**
	Two wrecks considered absent or inaccurately recorded (Moorwood WA2095, HMS Ruthin Castle WA2148)	Direct	Measures to deal with unexpected discoveries set out in WSI	**Negligible**
	Potential in situ maritime sites and isolated artefact discoveries	Direct	Measures to deal with unexpected discoveries set out in WSI	**Negligible**
		Indirect	Monitoring of scour and changes to physical processes as set	**No**

Receptor Class	Receptor	Effect	Mitigation	Residual Impact
			out in WSI	**discernible impact**
Aviation	1 (A3) records of modern aircraft of low archaeological value (WA70834)	Direct	None required although avoidance recommended	**No discernible Impact**
	Potential in situ aviation sites and isolated artefact discoveries	Direct	Measures to deal with unexpected discoveries set out in WSI	**Negligible**
		Indirect	Monitoring of scour and changes to physical processes as set out in WSI	**No discernible impact**
Additional Anomalies	177 known (A2) anomalies of potential archaeological value	Direct	Positions to be avoided in design layout	**No discernible impact**
		Indirect	Monitoring of scour and changes to physical processes as set out in WSI	**No discernible impact**

13. References

Cameron, T. D. J., Crosby, A., Balson, P. S., Jeffery, D. H., Lott, G. K., Bulat, J. and Harrison, D. J. 1992. *The Geology of the Southern North Sea*, British Geological Survey United Kingdom Offshore Regional Report, London HMSO.

Coles, B.J. 1998. *Doggerland: a speculative survey*. Proceedings of the Prehistoric Society 64, pp. 45-81.

COWRIE. 2007. *Historic Environment Guidance for the Offshore Renewable Energy Sector*. Produced by Wessex Archaeology for COWRIE.

COWRIE. 2008. *Guidance for Assessment of Cumulative Impacts on the Historic Environment from Offshore Renewable Energy*. Produced by Wessex Archaeology for COWRIE.

COWRIE. 2011. *Offshore Geotechnical Investigations and Historic Environment Analysis: Guidance for the Renewable Energy Sector*. COWRIE Ltd. Emu.

Department of Communities and Local Government. 2010. *PPS 5 Planning and the Historic Environment*. TSO.

Department for Communities and Local Government. 2012. *National Planning Policy Framework*.

Department for Environment, Food and Rural Affairs. 2011. Marine Policy Statement. London: The Stationary Office.

Department of Energy and Climate Change. 2011a. *Overarching National Policy Statement for Energy* (EN-1).

Department for Energy and Climate Change. 2011b. National Policy for Renewable Energy Infrastructure (EN-3). London: The Stationary Office.

English Heritage. 1996. *England's coastal heritage*.

English Heritage. 1998. *Identifying and Protecting Palaeolithic Remains*.

English Heritage. 2002. Military Aircraft Crash Sites. *Archaeological guidance on their significance and future management*. English Heritage

English Heritage. 2010. PPS5 Planning for the Historic Environment: Practice Guide.

English Heritage. 2011. *The Setting of Heritage Assets*. English Heritage.

Fitch, S., Thomson, K. and Gaffney, V. 2005. Late Pleistocene and Holocene Depositional Systems and the Palaeogeography of the Dogger Bank, North Sea, *Quaternary Research*, 64, pp 185-196

Funnell, B. M., 1989. Quaternary, In : Jenkins, D. G. and Murray, J. W. Eds., *Stratigraphical atlas of fossil foraminifera*. London: Ellis Horwood Ltd., 563-569.

Gaffney, V., Thomson, K. & Fitch, S (eds). 2007. *Mapping Doggerland: The Mesolithic Landscapes of the Southern North Sea*. Archaeopress

GEMS Survey Ltd. 2011. *Dogger Bank Tranche A Acoustic And Geophysical Survey*: Volume 4 of 9, Geophysics Results Report, Unpublished Survey Report, Ref: GSL10109-GPH-OF008

Hijma, M.P., Cohen, K.M., Roebroeks, W., Westerhoff, W.E. and Busschers, F.S., 2012. *Pleistocene Rhine-Thames landscapes: geological background for hominin occupation of the southern North Sea region*, Journal of Quaternary Science 27, 17-39.

Hosfield, R. and Chambers, J. 2007. *The Archaeological Potential of Secondary Contexts* University of Southampton

Institute for Archaeologists. 1994 (revised November 2012). Standard and Guidance for Historic Environment Desk-based Assessment.

Jacobi, R.M., and Higham, T.F.G. 2009. *The early Lateglacial re-colonisation of Britain: new radiocarbon evidence from Gough's Cave, southwest England*. Quaternary Science Reviews. p1-19.

Joint Nautical Archaeology Policy Committee. 2006. *Code of Practice for Seabed Development*.

LUC. 2013. *Dogger Bank Teesside A & Teesside B: Seascape and Visual Impact Assessment*. Technical Report.

Long, D., Wickham-Jones, C. and Ruckley, N. 1986. *A flint artefact from the northern North Sea*, pp. 55–62 in Roe, D. A. (ed.), Studies of the Upper Palaeolithic of Britain and North-West Europe (BAR International Series 296). Oxford: British Archaeological Reports.

Lisiecki, L. E. and Raymo M. E. 2005. *A Pliocene- Pleistocene stack of 57 globally distributed benthic d18O records, Paleoceanography*, 20, PA1003, doi:10.1029/2004PA001071.

Peeters *et al.* 2009. *North Sea Prehistory Research and Management Framework*.

Shennan, I., Lambeck, K., Flather, F., Horton, B., McArthur, J., Innes, J., Lloyd, J., Rutherford, M. and Wingfield, R. 2000. *Modelling western North Sea palaeogeographies and tidal changes during the Holocene*, in Shennan, I. and Andrews, J. (eds.) Holocene Land-Ocean Interaction and Environmental Change around the North Sea, Geological Society Special Publications 166, London, Geological Society, pp. 299–319.

Tizzard, L., Baggaley, P. and Firth, A. 2011. *Seabed Prehistory: Investigating Palaeolandsurfaces with Palaeolithic Remains for the Southern North Sea*. In: Benjamin, J. et al. eds. Submerged Prehistory. Oxford: Oxbow.

Turner, C. 2000, *The Eemian interglacial in the North European plain and adjacent areas*. Geologie en Mijnbouw 79 (2/3), 217-231

Val Baker, M., Tapper, B., Johns, C. and Herring, P. 2007. *England's Historic Seascapes: Scarborough to Hartlepool and adjacent marine zones*. Historic Seascape Characterisation. Historic Environment Service, Cornwall County Council ref. 2007R021

Ward, I., Larcombe, P. and Lillie, M. 2006. *The dating of Doggerland - post-glacial geochronology of the southern North Sea*. Environmental Archaeology 11(2), pp. 207-218

Waughman, M., Innes, J., and Tooley, M. 2005. *The changing palaeoenvironment of Hartlepool Bay*. In: Waughman, M., et al. eds. Archaeology and Environment of Submerged Landscapes in Hartlepool Bay, England. Tees Archaeology Monograph Series 2. pp. 121-142

Wessex Archaeology. 2010a. *Model Clauses for Archaeological Written Schemes of Investigation*. Offshore Renewables Projects. The Crown Estate. WA ref: 73340.05.

Wessex Archaeology. 2010b. *Protocol for Archaeological Discoveries: Offshore Renewables Projects*. The Crown Estate. WA ref 73830.04.

Wessex Archaeology. 2011a. Seabed Prehistory: Site evaluation techniques (Area 240) – Synthesis. Wessex Archaeology ref: 70754.04.

Wessex Archaeology. 2011b Licence Area 240 - Archaeological Monitoring of Dredging. Wessex Archaeology ref: 77860.02.

Wessex Archaeology. 2012. Dogger Bank Offshore Wind Project Tranche A Archaeological Stage 3 Sample Assessment. Wessex Archaeology Ref: 78040.04.

Wessex Archaeology. 2013d. Palaeoenvironmental Evidence from Dogger Bank North Sea (Draft). Wessex Archaeology Ref: 89600.

Whitehouse, R. J. S., Damgaard, J.S. and Langhorne, D.N. 2000. *Sandwaves and seabed engineering: Applications to submarine cables*. Proc. Marine Sandwave Dynamics Workshop, Lille.

