

Norfolk Boreas Offshore Wind Farm

Appendix 17.3

Norfolk Boreas Archaeological Assessment of Geophysical Data - Addendum

Environmental Statement

Volume 3

Applicant: Norfolk Boreas Limited
Document Reference: 6.3.17.3
RHDHV Reference: PB5640-006-0173
Pursuant to APFP Regulation: 5(2)(a)

Date: June 2019
Revision: Version 1
Author: Wessex Archaeology

Photo: Ormonde Offshore Wind Farm



Norfolk Boreas Offshore Wind Farm

Archaeological Assessment of Geophysical Data – Addendum

Ref: 117123.01
February 2019



© Wessex Archaeology Ltd 2019, all rights reserved.

Portway House
Old Sarum Park
Salisbury
Wiltshire
SP4 6EB

www.wessexarch.co.uk

Wessex Archaeology Ltd is a Registered Charity no. 287786 (England & Wales) and SC042630 (Scotland)

Disclaimer

The material contained in this report was designed as an integral part of a report to an individual client and was prepared solely for the benefit of that client. The material contained in this report does not necessarily stand on its own and is not intended to nor should it be relied upon by any third party. To the fullest extent permitted by law Wessex Archaeology will not be liable by reason of breach of contract negligence or otherwise for any loss or damage (whether direct indirect or consequential) occasioned to any person acting or omitting to act or refraining from acting in reliance upon the material contained in this report arising from or connected with any error or omission in the material contained in the report. Loss or damage as referred to above shall be deemed to include, but is not limited to, any loss of profits or anticipated profits damage to reputation or goodwill loss of business or anticipated business damages costs expenses incurred or payable to any third party (in all cases whether direct indirect or consequential) or any other direct indirect or consequential loss or damage.

Report Information

Document title Norfolk Boreas Offshore Wind Farm
Document subtitle Archaeological assessment of geophysical data- Addendum
Document reference 117123.01



Client name Royal Haskoning DHV
Address 74/2 Commercial Quay, Commercial Street
Leith
Edinburgh
EH6 6PP

On behalf of Vattenfall
Address 1st Floor
One Tudor Street
EC4 Y0AH
London

Site location Southern North Sea
County Offshore Norfolk, UK

WA project codes 74540, 74542, 74545, 74547, 112380, 114841, 114842, 117120
Project management by David Howell
Document compiled by Megan Metcalfe
Contributions from Laura Andrews, Abby Mynett, Alex Jacob, David Howell
Graphics by Kitty Foster

Quality Assurance

Version & issue date	Status	Author	Approved by
V1 05/02/2019	External draft	MM	 DSH
V2 06/02/2019	External Draft	MM	 DSH

DATA LICENCES

This product has been derived in part from material obtained from the UK Hydrographic Office with the permission of the UK Hydrographic Office and Her Majesty's Stationery Office.

© Crown Copyright, 2019. Wessex Archaeology ref. HA294/007/316-01.

The following notice applies:

NOT TO BE USED FOR NAVIGATION

WARNING: The UK Hydrographic Office has not verified the information within this product and does not accept liability for the accuracy of reproduction or any modifications made thereafter.

Contains Ordnance Survey data © Crown copyright and database rights 2019



Contents

Summary	ii
Acknowledgements.....	iii
1 INTRODUCTION	1
1.1 Project background.....	1
1.2 Aims and objectives.....	2
1.3 Co-ordinate system.....	2
2 METHODOLOGY	3
2.1 Data sources	3
2.2 Geophysical data – technical specifications.....	3
2.3 Geophysical data – processing.....	4
2.5 Geophysical data – anomaly grouping and discrimination.....	5
3 PALAEOGEOGRAPHIC ASSESSMENT	6
3.1 Geological baseline	6
4 SEABED FEATURES ASSESSMENT	8
4.1 Introduction.....	8
4.2 Seabed features assessment results	9
5 CONCLUSIONS AND RECOMMENDATIONS.....	10
6 REFERENCES	11
APPENDICES	12
Appendix 1 Seabed features of archaeological potential.....	12

List of Tables

Table 1	Summary of past reports overlapping with the Additional Area
Table 2	Summary of survey equipment
Table 3	Criteria for assigning data quality rating
Table 4	Criteria discriminating relevance of identified features to proposed scheme
Table 5	Shallow stratigraphy of the study area
Table 6	Anomalies of archaeological potential within the study area
Table 7	Types of anomaly identified

List of Figures

Figure 1	Location of Norfolk Boreas Offshore Wind Farm Additional Area
Figure 2	Seabed Features of Archaeological Potential



Summary

Wessex Archaeology was commissioned by Royal HaskoningDHV, on behalf of Vattenfall, to produce an addendum report consisting of review of the existing geophysical anomalies of archaeological potential within the Additional Area of the Norfolk Boreas offshore wind farm, as identified during the 2012 Zonal assessment of the whole East Anglia Round 3 Zone (Wessex Archaeology 2012), the 2014 East Anglia FOUR Preliminary Environmental Information Report (Wessex Archaeology 2014) and the 2017 Norfolk Boreas Offshore Wind Farm Archaeological assessment of geophysical data (Wessex Archaeology 2017, of which this current report is an addendum).

A total of five anomalies of archaeological potential have been identified within the Additional Area, all of which have been assigned the discrimination A2 (uncertain origin of possible archaeological interest). None of these features have been assigned an Archaeological Exclusion Zone at this time; however, an avoidance strategy is recommended. Further work may be necessary to ascertain the precise nature and archaeological potential of individual features should avoidance prove unfeasible during future works.

It is recommended that if any objects of possible archaeological interest are recovered during any groundwork operations, that they should be reported using the established Offshore Renewables Protocol for Archaeological Discoveries. This will establish whether the recovered objects are of archaeological interest and recommend appropriate mitigation measures.



Acknowledgements

This assessment of geophysical data was commissioned by Royal HaskoningDHV, on behalf of Vattenfall, and the assistance of David Tarrant and Victoria Cooper of Royal HaskoningDHV is acknowledged in this respect.

The geophysical data used for this assessment were originally acquired by Gardline Geosurvey Limited in 2010, EMU Limited in 2012, and Fugro Survey B.V in 2017.



Norfolk Boreas Offshore Wind Farm

Archaeological assessment of geophysical data- Addendum

1 INTRODUCTION

1.1 Project background

- 1.1.1 Wessex Archaeology was commissioned by Royal HaskoningDHV, on behalf of Vattenfall, to produce an addendum report consisting of review of the existing geophysical anomalies of archaeological potential identified within the Additional Area of the Norfolk Boreas offshore wind farm.
- 1.1.2 The proposed Norfolk Boreas site forms part of the former East Anglia Round 3 Zone, and is located approximately 72 km from the coast of Norfolk, within the southern North Sea. The Norfolk Boreas site is approximately 725 km² in size, with the Additional Area being a rectangular area, measuring approximately 7 km², located at the southern edge of the proposed Boreas offshore wind farm (Figure 1).
- 1.1.3 Wessex Archaeology has previously undertaken a number of archaeological, geophysical and geoarchaeological assessments from within the East Anglia Round 3 Zone and in the vicinity of the proposed Norfolk Boreas site:
- Zonal assessment of the whole East Anglia Round 3 Zone (Wessex Archaeology 2012);
 - Assessment of geophysical data from proposed Meteorological Mast (Met Mast) locations, including one currently installed within the proposed Norfolk Boreas site (Wessex Archaeology 2013a);
 - Assessment of geophysical data from the proposed East Anglia FOUR wind farm, located to the south of the Norfolk Boreas site (Wessex Archaeology 2014);
 - Assessment of geophysical data from the proposed Norfolk Vanguard sites (NV East and NV West), located to the west and south of the Norfolk Boreas site, and the associated Norfolk Vanguard OCC (which is planned to be shared with Norfolk Boreas) (Wessex Archaeology 2017);
 - Geoarchaeological assessment of geotechnical logs and samples acquired from both the proposed Norfolk Vanguard and Norfolk Boreas sites (Wessex Archaeology 2017b; 2018b; 2018c).
- 1.1.4 An assessment of the geophysical data within the proposed Boreas Site has been previously undertaken and reported on separately (Wessex Archaeology 2018). This report acts as an addendum to the Norfolk Boreas report issued in 2018.
- 1.1.5 The study area for this addendum report is defined as the extents of the Additional Area (Figure 1), as provided by the client on the 23 January 2019. Any geophysical anomalies identified outside of the defined study area are considered beyond the scope of this report and are not included in the results or gazetteer of anomalies.



1.1.6 This report consists of a compilation of geophysical anomalies identified during previous phases of assessment. This includes the 2012 Zonal assessment of the whole East Anglia Round 3 Zone (Wessex Archaeology 2012), as originally identified using geophysical survey data acquired by Gardline Geosurvey Limited (Gardline); the 2014 East Anglia FOUR assessment, using data acquired by EMU Limited (EMU); and the current Boreas assessment, using data acquired by Fugro Survey B. V. (Fugro). These are summarised in the table below:

Table 1 Summary of past reports overlapping with the Additional Area

Document	Date	Reference	Wessex Archaeology report ref.
Archaeology and ZEA Assessment Chapter, in East Anglia Offshore Wind: Zonal Environmental Appraisal	2012	Wessex Archaeology 2012	74540
Chapter 17: Offshore Archaeology and Cultural Heritage, East Anglia FOUR, Preliminary Environmental Information Volume 1 Revision A	2014	Wessex Archaeology 2014	74546
Norfolk Vanguard Offshore Wind Farm; Marine Archaeological Technical Report	2017	Wessex Archaeology 2017	112380
Norfolk Boreas Offshore Wind Farm; Archaeological assessment of geophysical data	2018	Current phase of assessment	117120

1.2 Aims and objectives

1.2.1 The aim of this assessment is to identify any anomalies of archaeological potential identified during previous phases of assessment located within the Additional Area. This is to be achieved through the following objectives:

- confirm the presence of known or previously located marine sites of archaeological potential and to comment on their apparent character;
- identify, locate and characterise hitherto unrecorded marine sites of archaeological potential;
- compare the results of the geophysical assessment with the results of previous assessments in the area, and with known records (e.g. from the United Kingdom Hydrographic Office (UKHO)), and;
- provide recommendations for archaeological mitigation.

1.3 Co-ordinate system

1.3.1 The survey data used for the 2012 and 2014 assessments were acquired in WGS84 UTM31N. The 2017 Fugro data was acquired using ETRS89 UTM Zone 31N projected coordinates. The difference between the two systems is minimal (less than 1 m) and, as such, the results are presented here using their original acquisition coordinate systems.



2 METHODOLOGY

2.1 Data sources

2.1.1 A number of data sources were consulted during this assessment, including:

- Geophysical survey datasets acquired by Gardline in 2010, EMU in 2012 and Fugro in 2017;
- Client supplied survey reports (Gardline 2011, EMU 2013 and Fugro 2017);
- known wreck and obstruction locations and information for the study area provided by the UKHO, and;
- past reports and assessments undertaken by Wessex archaeology from the East Anglia Round 3 Zone (Section 1.1).

2.2 Geophysical data – technical specifications

2.2.1 The geophysical data assessed as part of the 2012 Zonal assessment (Wessex Archaeology 2012) were acquired by Gardline between 29 June to 27 September 2010 onboard MV *Tridens1* and comprised sub-bottom profiler (SBP), sidescan sonar (SSS), magnetometer and multibeam echosounder (MBES) datasets. The data were acquired in corridors spaced 1 km apart. Each corridor consisted of three lines of data with 50 m line spacing (Gardline 2011).

2.2.2 For the purpose of the ZEA assessment only a limited percentage coverage of the data were reviewed for archaeological purposes. For the seabed features assessment (sidescan sonar and multibeam echosounder data), corridors spaced 6 km apart were selected with two of the three lines reviewed in each of these corridors.

2.2.3 The geophysical datasets assessed as part of the East Anglia FOUR report were acquired by EMU between 19 June and 4 September 2012 onboard the survey vessel MV *Aurelia*. The datasets consisted of SSS, magnetometer, MBES and SBP. The main lines were spaced at 100 m and cross lines spaced at 2 km (EMU 2013).

2.2.4 The geophysical data assessed as part of the current Boreas assessment were acquired by Fugro between 21 May and 30 August 2017, and comprised SBP, SSS, magnetometer and MBES datasets. Main survey lines were acquired at a spacing of 100 m along an approximately NNW-SSE orientation, and cross lines at a spacing of 1 km along an approximately ENE-WSW orientation.

2.2.5 Further details on the equipment used is in Table 2.

Table 2 Summary of survey equipment

Survey Company	Survey Vessel	Data Type	Equipment	Data Format
Gardline (2010)	MV <i>Tridens1</i>	SBP	EG&G Boomer	.sgy
		MBES	Kongsberg Simrad EM710	.xyz
		SSS	Edgetech 4200FS (240 kHz/410 kHz, 100 m range)	.xtf
		Magnetometer	Geometrics G882	.csv
		Positioning	Trimble BD950 DGPS	N/A
		SBP	SES digital Sub-bottom Profiler	.sgy



Survey Company	Survey Vessel	Data Type	Equipment	Data Format
EMU (2012)	MV <i>Aurelia</i>	MBES	Geometrics G882	.xyz
		SSS	Edgetech 4200FS (300 kHz/4600 kHz)	.xtf
		Magnetometer	Geometrics G882/ Marine Magnetics SeaSPY	.csv
		Positioning	Fugro StarPack GNSS	N/A
Fugro	<i>Fugro Pioneer</i>	SBP	16 element Massa TR-1075 hull-mounted pinger	.sgy
		MBES	Kongsberg EM 2040 (400 kHz)	.xyz
		SSS	Edgetech 4200-FS (100 kHz/600 kHz, 125 m range)	.xtf
		Magnetometer	Geometrics G-882	.csv
		Positioning	Fugro StarFix DGNSS	N/A

2.3 Geophysical data – processing

2.3.1 No new geophysical data were processed and interpreted as part of this assessment. Instead, gazetteers produced during the initial phases of interpretation of previous projects were used to identify whether any anomalies of archaeological potential are situated within the study area. These are anomalies that would have been located outside of the scope of work of previous assessments, and so have not been reported before.

2.3.2 The previous gazetteers were loaded into a GIS to identify any situated within the study area. Any such anomalies were then assessed using the relevant project archive, and discriminated as per Section 2.5.

2.3.3 As the results used for this assessment were produced using data originally processed as part of earlier reports, there may be some, small differences in the software used and way in which the data were processed. For more information on the processing methods and the software previously used to interpret each dataset, please refer to the original reports.

2.4 Geophysical data – data quality

2.4.1 During the original processing, the geophysical data sets were individually assessed for quality and their suitability for archaeological purposes, and rated using the following criteria (Table 3).

Table 3 Criteria for assigning data quality rating

Data quality	Description
Good	Data which are clear and unaffected or only slightly affected by weather conditions, sea state, background noise or data artefacts. Seabed datasets are suitable for the interpretation of upstanding and partially buried wrecks, debris fields, and small individual anomalies. The structure of wrecks is clear, allowing assessments on wreck condition to be made. Subtle reflectors are clear within SBP data. These data provide the highest probability that anomalies of archaeological potential will be identified.
Average	Data which are moderately affected by weather conditions, sea state and noise. Seabed datasets are suitable for the identification of upstanding and partially buried wrecks, the larger elements of debris fields and dispersed sites, and larger individual anomalies. Dispersed and/or partially buried wrecks may be difficult to identify. Interpretation of continuous reflectors in SBP data is problematic. These data are not considered to be detrimentally affected to a significant degree.

Data quality	Description
Below Average	Data which are affected by weather conditions, sea state and noise to a significant degree. Seabed datasets are suitable for the identification of relatively intact, upstanding wrecks and large individual anomalies. Dispersed and/or partially buried wrecks, or small isolated anomalies may not be clearly resolved. Small palaeogeographic features, or internal structure may not be resolved in SBP data.
Variable	This category contains datasets where the individual lines range in quality. Confidence of interpretation is subsequently likely to vary within the study area.

2.4.2 For information on the data quality for the each of the different datasets used for this assessment, please refer to the original reports (Wessex Archaeology 2012, 2014 and 2018).

2.4.3 It should be noted that there is an area along the central section of the Additional Area which was not covered by data acquired for the 2014 East Anglia FOUR, or the 2018 Norfolk Boreas data assessments. As such, there is no geophysical data in this area. These areas have been mapped and can be seen in Figure 1. It cannot be guaranteed that there are no anomalies of archaeological potential within these areas with no data coverage, although a pipeline runs through this area and so it is possible that any archaeology will already have been disturbed.

2.5 Geophysical data – anomaly grouping and discrimination

2.5.1 During the original data processing and interpretation, all data types were interpreted independently of each other (Wessex Archaeology 2012, 2014 and 2018). This process inevitably leads to the possibility of any one object being the cause of numerous anomalies in different datasets, and apparently overstating the number of archaeological features in the Additional Area.

2.5.2 To address this fact the anomalies were grouped together; allowing one ID number to be assigned to a single object for which there may be, for example, a UKHO record and multiple SSS anomalies.

2.5.3 Once all the geophysical anomalies and desk-based information have been grouped, a discrimination flag is added to the record in order to discriminate against those which are not thought to be of an archaeological concern. For anomalies located on the seabed, these flags are ascribed as follows (Table 4).

Table 4 Criteria discriminating relevance of identified features to proposed scheme

Overview classification	Discrimination	Criteria	Data type
Archaeological	A1	Anthropogenic origin of archaeological interest	MBES, SSS, Mag.
Archaeological	A2	Uncertain origin of possible archaeological interest	MBES, SSS, Mag.
Archaeological	A3	Historic record of possible archaeological interest with no corresponding geophysical anomaly	MBES, SSS, Mag.

2.5.4 The grouping and discrimination of information at this stage is based on all available information and is not definitive. It allows for all features of potential archaeological interest to be highlighted, while retaining all the information produced during the course of the geophysical interpretation and desk-based assessment for further evaluation should more information become available.



3 PALAEOGEOGRAPHIC ASSESSMENT

3.1 Geological baseline

- 3.1.1 The Norfolk Boreas offshore project area is situated within the southern North Sea Basin. The environment within the study area is currently fully marine, and a shallow marine basin has existed in the approximate location of the North Sea since the Early Tertiary (although the exact location and extent has altered over time), which is reflected in the geology of the region (Cameron *et al.* 1992).
- 3.1.2 The background geology of the study area is dominated by a series of Pleistocene deposits, ranging in age from the Lower to Middle Pleistocene (Yarmouth Roads Formation) to the Upper Devensian (Twente Formation). These were deposited in a range of environments, from terrestrial to marine, and it is the terrestrial sediments, deposited during periods of low relative sea level, that are of the highest archaeological potential. For further information on the geological background of the area, as well as the archaeological potential of the different geological units expected to be present, please refer to the previous reports produced as part of the East Anglia and Norfolk developments (Wessex Archaeology 2012, 2014, 2017 and 2018).

3.2 Palaeogeographic assessment results

- 3.2.1 The palaeogeographic features investigated for this assessment were all originally identified during the initial phases of interpretation for previous assessments (Wessex Archaeology 2012, 2014 and 2018).
- 3.2.2 The shallow geology expected in the area is based on the Norfolk Boreas data assessment (Wessex Archaeology 2018). The expected geology within the wider Norfolk Boreas Offshore Wind Farm area has been divided into 5 major units, plus additional subunits, as described below (Table 5):

Table 5 Shallow stratigraphy of the study area

Litho-stratigraphic Unit	Geological Unit	Geophysical Characteristics ⁽¹⁾	Sediment Type ⁽²⁾	Archaeological Potential
Unit 5	Holocene seabed sediments (post-transgression, MIS 1)	Generally observed as a veneer or thickening into large sand wave and bank features up to 20 m thick. Boundary between surficial sediments and underlying units not always discernible.	Medium to coarse sand with frequent shell fragments – marine	Considered of low potential in itself, but possibly contains re-worked artefacts and can cover wreck sites and other cultural heritage
Unit 4c	Holocene (pre-transgression, MIS 2-1)	Not identified within the geophysical data	Coarsening upwards sequence of structureless clay overlain by laminated silt with evidence of crossbedding and organic laminations – transgression/intertidal	Potential to contain <i>in situ</i> and derived archaeological material, and palaeoenvironmental material



Litho-stratigraphic Unit	Geological Unit	Geophysical Characteristics ⁽¹⁾	Sediment Type ⁽²⁾	Archaeological Potential
Unit 4b	Holocene (pre-transgression, MIS 2-1)	Extensive areas of intermittent, relatively flat, high amplitude reflectors. Often associated with shallow channelling	Peat ranging from strongly to weakly decomposed with plant fragments (reeds) roots and wood preserved – terrestrial land surface	Potential to contain <i>in situ</i> and derived archaeological material, and palaeoenvironmental material
Unit 4a	Holocene (pre-transgression, MIS 2-1)	Small, shallow, infilled channels with either seismically transparent fill, or fill characterised by sub-parallel internal reflectors	Fining upwards sequence of sand with silt laminations and plant/root fragments overlain by laminated to organic silt with roots and plant fragments – fluvial/intertidal	Potential to contain <i>in situ</i> and derived archaeological material, and palaeoenvironmental material
Undifferentiated	Holocene pre-transgression or Upper Brown Bank	Acoustically chaotic unit at the top of Brown Bank Formation, potentially comprising numerous phases of cross cutting channels	Interbedded sand and silty clay with shell fragments and silt laminations (occasionally organic) – unknown, possible fluvial/intertidal	Unknown – potential will depend on precise age and depositional environment of unit
Unit 3	Upper Brown Bank Formation (MIS 5d-3)	Observed as a blanket deposit across much of the area, either acoustically transparent or characterised by sub-horizontal layered reflectors. Contains numerous internal erosion surfaces, occasional fluid escape structures, and areas of acoustic blanking	Silty clay and clayey silt with closely spaced fine laminations. May be sandy in places or comprise sand partings/laminations – lagoon/intertidal	<i>In situ</i> Lower Palaeolithic artefacts may be protected. Middle Palaeolithic <i>in situ</i> and derived artefacts may be associated, particularly with channel edges dependent on the age of the fill. Palaeoenvironmental information. Basal contact may cover old land surfaces
Unit 2	Lower Brown Bank Formation (MIS 5e-5d)	Observed within large topographically controlled depressions. Characterised by low relief basal reflector and either an acoustically transparent or well-layered fill	Silty sand and sandy silt - possible intertidal/shallow marine	<i>In situ</i> Lower Palaeolithic artefacts may be protected. Middle Palaeolithic <i>in situ</i> and derived artefacts may be associated, particularly with channel edges dependent on the age of the fill. Palaeoenvironmental information. Basal contact may cover old land surfaces



Litho-stratigraphic Unit	Geological Unit	Geophysical Characteristics ⁽¹⁾	Sediment Type ⁽²⁾	Archaeological Potential
Unit 1	Yarmouth Roads Formation (>MIS 13)	Thick unit either seismically chaotic or containing numerous areas of well-defined cross cutting channel complexes characterised by layered sub-parallel internal reflectors. Top of unit generally a well-defined regional erosion surface	Silty sand with occasional shell fragments and occasional layers of clay. Generally becoming silty with depth - deltaic	Possibility of <i>in situ</i> finds in later part of formation if not eroded. Contemporaneous with terrestrial Cromer Forest Bed Formation (Pakefield and Happisburgh). Has been found to contain plant debris, wood and peat in some areas of possible palaeoenvironmental importance. Potential greatest where associated with river valleys.
⁽¹⁾ Based on geophysical data				
⁽²⁾ Based on vibrocore data and Cameron <i>et al.</i> (1992)				

- 3.2.3 Within the Additional Area, the shallow geology is expected to comprise a blanket deposit of Upper Brown Bank Formation (Unit 3), however it is possible that there may be some Lower Brown Bank Formation (Unit 2) underlying Unit 2 in the north-western corner of the Additional Area (Wessex Archaeology 2017 and 2018).
- 3.2.4 Unit 2 and Unit 3 together comprise the dominant shallow geological unit within the wider Norfolk Boreas Area. Although both thought to be part of the Brown Bank Formation, they have been divided into two separate units based on acoustic character and previous work undertaken in the wider region (Wessex Archaeology 2017 and 2018).
- 3.2.5 The Brown Bank Formation is generally interpreted as a lagoon deposit (Cameron *et al.* 1992), and vibrocore data have determined the Upper Brown Bank comprises silty clay and clayey silt with sand partings and laminations (VC016, VC047, Wessex Archaeology 2018b). However, the numbers of internal reflectors suggest it may have a much more complex history. As such, the archaeological potential of the unit is variable; where the unit is seen as a blanket deposit, the archaeological potential is considered to be of relatively low potential. As such, the feature has not been given an anomaly ID number. In other areas, where the feature is seen to have internal reflectors which suggests it may have had changes of sediment input and potential periods of drying out/exposure, the surfaces could be of higher archaeological potential as they may represent buried land surfaces.
- 3.2.6 For more information on the geological features identified in the wider area, as well as the archaeological potential of the different units, please refer to the previous reports produced as part of the East Anglia and Norfolk developments (Wessex Archaeology 2012, 2014, 2017 and 2018).

4 SEABED FEATURES ASSESSMENT

4.1 Introduction

- 4.1.1 The geophysical anomalies reported on for this assessment were all originally identified during the initial phases of interpretation for previous assessments (Wessex Archaeology 2012, 2014 and 2018). They have not been reported on previously as they would have

originally been identified outside of their original study areas. However, they are located within the Additional Area which forms the study area for this current phase of assessment. These features have been grouped together and collated in gazetteer format detailed in Appendix 1 and illustrated in Figure 2.

4.2 Seabed features assessment results

4.2.1 Five features have been identified as being of possible archaeological potential within the study area and are discriminated as shown in Table 6.

Table 6 Anomalies of archaeological potential within the study area

Archaeological discrimination	Quantity	Interpretation
A1	0	Anthropogenic origin of archaeological interest
A2	5	Uncertain origin of possible archaeological interest
A3	0	Historic record of possible archaeological interest with no corresponding geophysical anomaly
Total	5	

4.2.2 Furthermore, these anomalies can be classified by probable type, which can further aid in assigning archaeological potential and importance (Table 7).

Table 7 Types of anomaly identified

Anomaly classification	Definition	Number of anomalies
Debris	Distinct objects on the seabed, generally exhibiting height or with evidence of structure, that are potentially anthropogenic in origin	1
Dark reflector	Individual objects or areas of high reflectivity, displaying some anthropogenic characteristics. Precise nature is uncertain	3
Magnetic	No associated seabed surface expression, and have the potential to represent possible buried ferrous debris or buried wreck sites	1
Total		5

4.2.3 A total of five geophysical anomalies have been identified within the Additional Area. All of which have been assigned an A2 archaeological discrimination.

4.2.4 One feature (**7551**) has been classified as an item of debris. This was originally identified during early phases of the 2014 the East Anglia FOUR data assessment, and was seen on the SSS data as a large, irregularly shaped dark reflector measuring 13.4 x 8.3 x 0.8 m. The feature is seen to have a bright, angular shadow. On the MBES data, the feature is identified as an irregular mound with some, slight associated scour. The feature is reported as having no obvious structure; however, its size suggests a significant item of debris, although this cannot be confirmed without further investigation. The feature does not appear to have an associated magnetic anomaly, suggesting it comprises non-ferrous material.

4.2.5 The feature is located approximately 1.2 km ENE of the sinking position of a sailing vessel (UKHO 11135), and it is therefore possible that this feature is associated with this UKHO record. However, as this cannot be confirmed without further investigation, the feature have not been definitively grouped with the UKHO record.



- 4.2.6 Three anomalies have been classified as dark reflectors (**7550** and **7553-4**). The largest of these is a slightly irregular dark reflector measuring 8.0 x 8.0 x 0.4 m (**7550**), which was originally identified during the 2017 Boreas data assessment. On the MBES data, this feature is seen as a rounded mound identified on the edge of a sand ripple. Another of the dark reflectors (**7554**), measuring 2.0 x 0.7 x 0.3 m, was identified during the 2017 assessment and the other (**7553**), measuring 3.6 x 1.5 m, during the 2012 data assessment.
- 4.2.7 None of these dark reflectors have associated magnetic anomalies, indicating they comprise non-ferrous material.
- 4.2.8 The remaining anomaly is a small magnetic anomaly measuring 14 nT (**7552**), which was identified during the 2017 data assessment. Nothing was identified on the SSS or MBES data at this position, indicating a ferrous item of debris which is either buried or has no surface expression.
- 4.2.9 As noted in Section 2.4, not all of the Additional Area was covered by geophysical data acquired for the previous assessments (Figure 1). As such, it cannot be guaranteed at all geophysical anomalies within the Additional Area have been identified. However, a pipeline runs through this area, and so it is possible that any archaeology in the vicinity of the pipeline will already have been disturbed by previous pipeline installation work.

5 CONCLUSIONS AND RECOMMENDATIONS

- 5.1.1 The assessment of the geophysical anomalies identified within the Additional Area resulted in a total of five anomalies being classified as seabed features of possible archaeological interest, all of which were assigned an A2 archaeological rating.
- 5.1.2 For features assigned A2 archaeological discrimination rating, no AEZs are recommended at this time. However, avoidance of these features by micro-siting is recommended if they are proposed to be directly impacted by development in the future.
- 5.1.3 It is recommended that if any objects of possible archaeological interest are recovered during any groundwork operations, that they should be reported using the established Protocol for Archaeological Discoveries: Offshore Renewables Projects (The Crown Estate 2014). This will establish whether the recovered objects are of archaeological interest and recommend appropriate mitigation measures.



6 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

EMU Limited 2013 East Anglia THREE Offshore Wind Farm Geophysical Survey Report.
Unpublished Client Report, Ref: 12/J/1/02/2066/1346 FINAL.

Fugro Engineers B.V. 2017 Norfolk Boreas Offshore Wind Farm UK Continental Shelf, North
Sea, Operations and Calibrations Report 1 of 2, Ref: GEO59-R1-1(2)

Gardline Geosurvey Limited 2011 East Anglia Offshore Wind Geophysical Survey, Area A, June
to September 2010, Survey Report, Unpublished Survey Report, Ref: 8402.1

The Crown Estate, 2014. Protocol for Archaeological Discoveries: Offshore Renewables
Projects. Published by Wessex Archaeology, Salisbury, on behalf of The Crown Estate.

Wessex Archaeology 2012 Archaeology and ZEA Assessment Chapter, in East Anglia Offshore
Wind: Zonal Environmental Appraisal. Salisbury, unpubl report in public domain

Wessex Archaeology 2013 East Anglia Offshore Wind, Installation of Meteorological Masts:
Archaeological Baseline. Salisbury, unpubl survey report, ref: 74542.01

Wessex Archaeology 2014 Chapter 17: Archaeology and Cultural Heritage, East Anglia FOUR,
Preliminary Environmental Information Volume 1 Revision a, unpubl report

Wessex Archaeology 2017 Norfolk Vanguard Offshore Wind Farm, Marine Archaeological
Technical Report. Salisbury, unpubl report, ref: 112380.02

Wessex Archaeology 2017b Norfolk Vanguard Offshore Wind Farm, Stage 2 Geoarchaeological
Recording. Salisbury, unpubl. report, ref: 112380.03

Wessex Archaeology 2018 Chapter 17: Archaeology and Cultural Heritage, East Anglia FOUR,
Preliminary Environmental Information Volume 1 Revision a, unpubl report

Wessex Archaeology 2018b, Boreas Offshore Wind Farm, Stage 1 Geoarchaeological Review.
Salisbury, unpubl. report, ref: 117120.0

Wessex Archaeology 2018c, Boreas Offshore Wind Farm, Stage 2 Geoarchaeological
Recording and Deposit Modelling. Salisbury, unpubl. report, ref: 117120.1

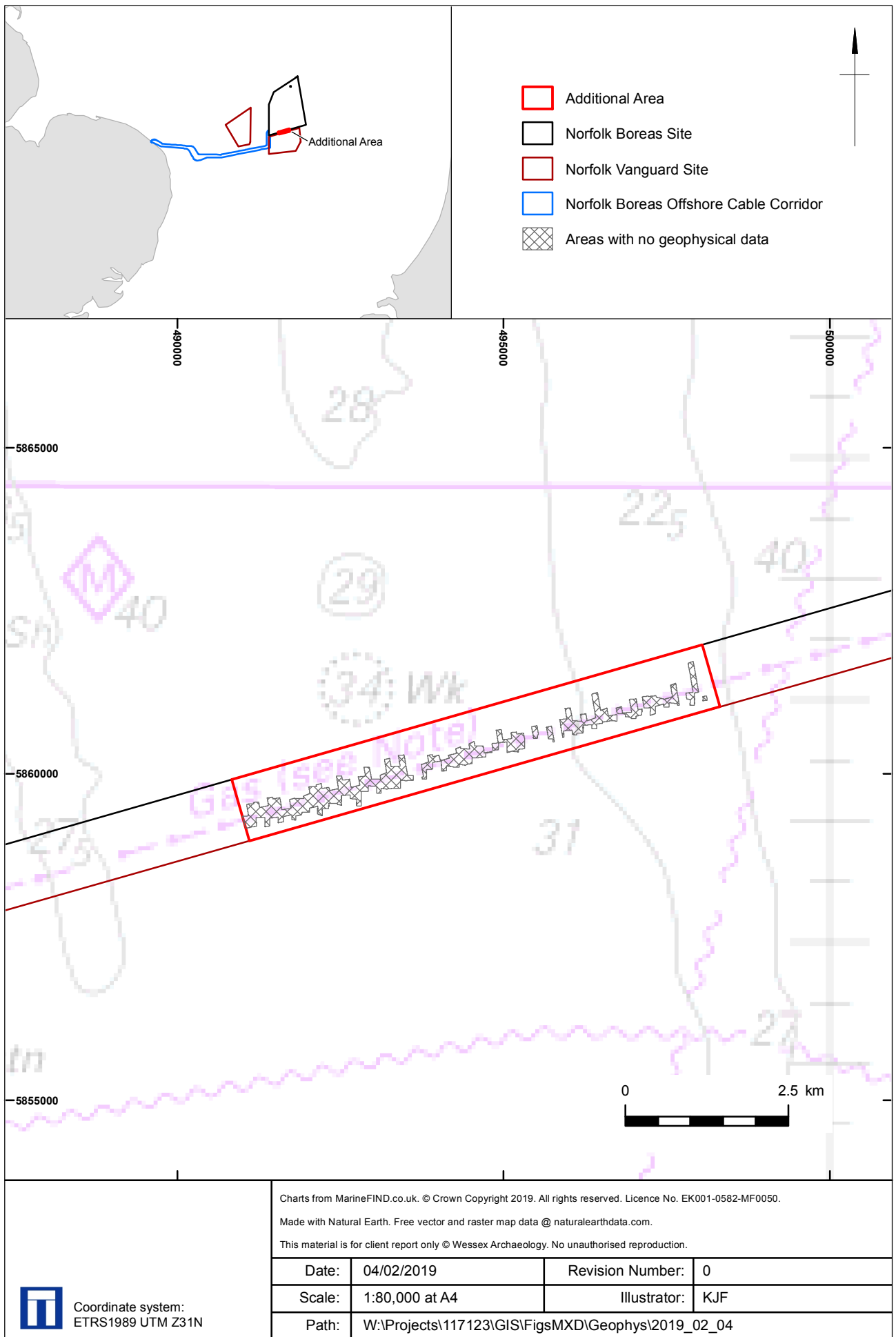


APPENDICES

Appendix 1 Seabed features of archaeological potential

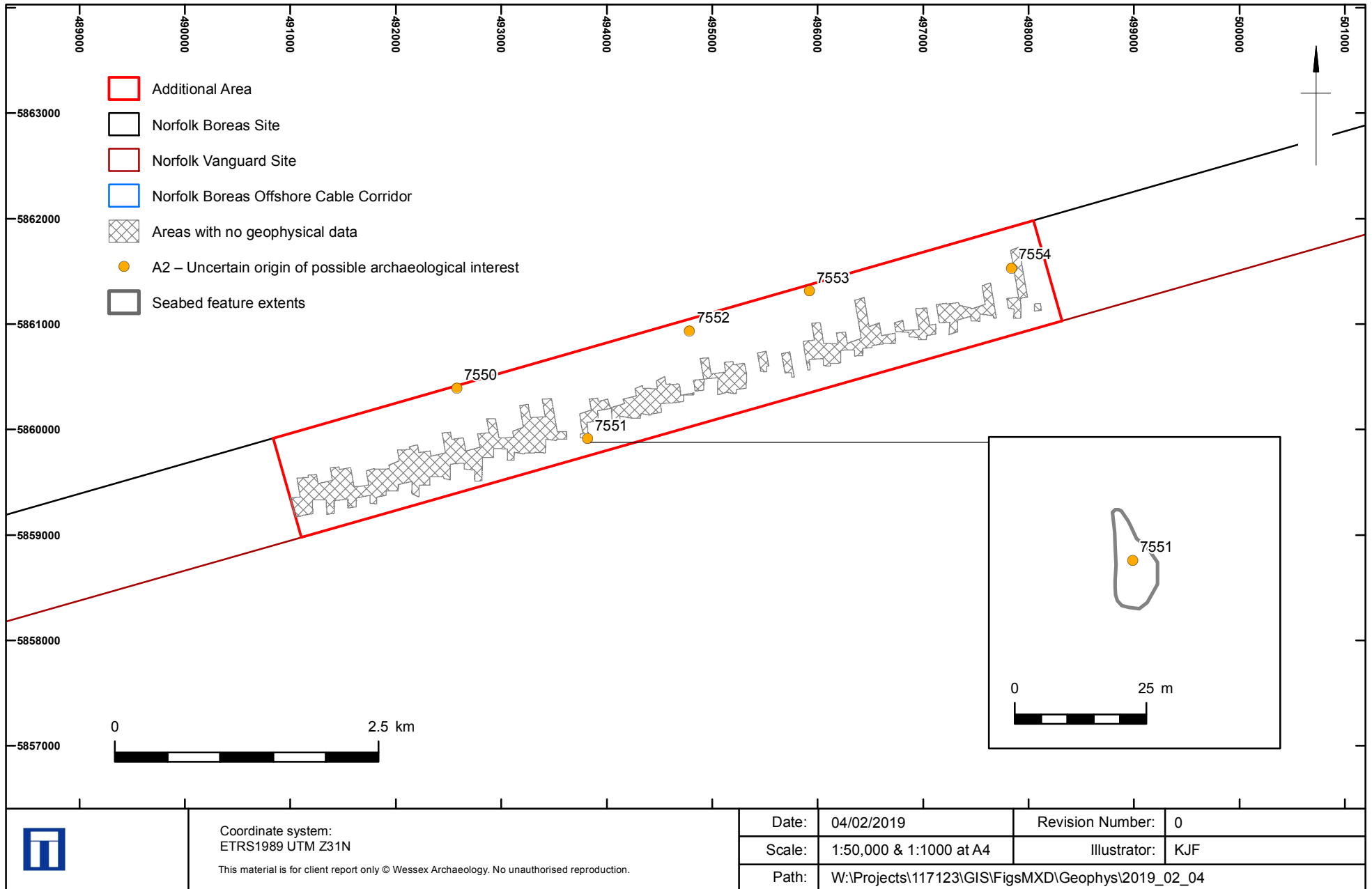
ID Number	Classification	Easting	Northing	Archaeological discrimination	Length (m)	Width (m)	Height (m)	Magnetic Amplitude (nT)	Description	External references	Report ref.
7550	Dark reflector	492579	5860391	A2	8.0	8.0	0.4	-	Relatively large, slightly irregular dark reflector with height identified on the SSS data. The feature corresponds with a rounded mound, identified on the edge of a sand ripple, seen on the MBES data. Possibly natural however has the potential of being a non-ferrous item of debris.	-	117120
7551	Debris	493819	5859912	A2	13.4	8.3	0.8	-	A large, irregularly shaped dark reflector with a bright, angular shadow. Possibly a few items close together, however, as there is no discernible separation between the objects, they have been tagged as one feature. The feature has some associated scour and appears to possibly be partially buried. Feature has no obvious structure however its size suggests debris.	-	74546
7552	Magnetic	494787	5860931	A2	-	-	-	14	Small magnetic anomaly identified on the magnetometer data. Nothing visible on the sonar data or bathymetry. Possibly ferrous debris which is either buried or has no surface expression.	-	117120
7553	Dark reflector	495923	5861311	A2	3.6	1.5	0.0	-	Elongated and distinct dark reflector visible in an area of sand waves. Distinct height variations of the seabed are noted in the wider area. Possibly natural however has the potential of being a non-ferrous item of debris.	-	74540
7554	Dark reflector	497838	5861529	A2	2.0	0.7	0.3	-	Small linear dark reflector with height. Feature is identified within a depression, possibly associated scour. Possibly natural however has the potential of being a non-ferrous item of debris.	-	117120

1. Co-ordinates of features with the report reference 117120 are in ETRS89 UTM31N. Those with report reference 74540 and 74546 are in WGS84 UTM31N. The difference between the two systems is <1 m
2. Positional accuracy estimated ± 10 m



Location of Norfolk Boreas Offshore Wind Farm Additional Area

Figure 1



Seabed Features of Archaeological Potential

Figure 2



Wessex Archaeology Ltd registered office Portway House, Old Sarum Park, Salisbury, Wiltshire SP4 6EB
Tel: 01722 326867 Fax: 01722 337562 info@wessexarch.co.uk www.wessexarch.co.uk

