



Docking Shoal Offshore Wind Farm  
and Wash Cable Route Corridor

Geophysical Data Audit and Review

**Draft**

**DOCKING SHOAL OFFSHORE WIND FARM AND WASH CABLE ROUTE  
CORRIDOR**

**GEOPHYSICAL DATA AUDIT AND REVIEW**

DRAFT

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# **DOCKING SHOAL OFFSHORE WIND FARM AND WASH CABLE ROUTE CORRIDOR**

## **GEOPHYSICAL DATA AUDIT AND REVIEW**

**Ref: 62550.04**

### **SUMMARY**

Wessex Archaeology was commissioned by AMEC Wind Energy and Renewable Energy Systems Limited, on behalf of Centrica Renewable Energy Limited to undertake an audit and review of the geophysical data collected from the Docking Shoal and Race Bank Offshore Wind Farm and the associated cable route corridor in the Wash. The geophysical data consists of multibeam bathymetry, sidescan sonar, magnetic and single beam shallow seismic data for each area. Following on from this review, selected data will be subjected to archaeological analysis.

This report describes the methodologies used to review each data type and the results of the audit of data from the Docking Shoal Offshore Wind Farm and the Wash Cable Route Corridor. A separate report will be compiled for the data from the Race Bank Wind Farm.

Although there was some variability in quality all datasets received were of adequate quality for full archaeological processing and interpretation.

It is recommended that all sidescan sonar, multibeam bathymetry and magnetic data collected in the Docking Shoal Wind Farm area and a 500m buffer zone around the area are subjected to full geophysical analysis. For the seismic data it is recommended that only every fifth line (20%) needs to be processed.

For the Wash Cable Route Corridor it is recommended that data within the area occupied by the cables and a 500m buffer zone on either side of the corridor are subjected to geophysical analysis. It is recommended that all the sonar, multibeam bathymetry and magnetic data and 20% of the seismic data within this area should be processed.

# **DOCKING SHOAL OFFSHORE WIND FARM AND WASH CABLE ROUTE CORRIDOR**

## **GEOPHYSICAL DATA AUDIT AND REVIEW**

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### **ACKNOWLEDGEMENTS**

This report was commissioned by AMEC Wind Energy and Renewable Energy Systems Limited on behalf of Centrica Renewable Energy Limited. Wessex Archaeology is grateful to Dr Genevra Harker and Julie Drew of AMEC Wind Energy for their co-operation throughout this project.

Datasets were provided by Emu Ltd. and Osiris Projects. Wessex Archaeology would like to thank the staff of both these organisations for their help and co-operation.

Dr Stephanie Arnott carried out the data audit. The data was reviewed by Stephanie Arnott and Cristina Serra, and Stephanie Arnott compiled this report. Illustrations are by Kitty Brandon. The project was managed for Wessex Archaeology by John Gribble.

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# DOCKING SHOAL OFFSHORE WIND FARM AND WASH CABLE ROUTE CORRIDOR

## GEOPHYSICAL DATA AUDIT AND REVIEW

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# **DOCKING SHOAL OFFSHORE WIND FARM AND WASH CABLE ROUTE CORRIDOR**

## **GEOPHYSICAL DATA AUDIT AND REVIEW**

**Ref: 62550.04**

### **1. INTRODUCTION**

#### **1.1. BACKGROUND**

- 1.1.1. Geophysical surveys of the Docking Shoal Offshore Wind Farm (OWF) area and the Wash Cable Route Corridor were undertaken by Emu Ltd. and Osiris Projects during the period from November 2005 to June 2006. The work was conducted as part of the proposed development of the Docking Shoal and Race Bank OWFs by AMEC.
- 1.1.2. The northern section of Docking Shoal was surveyed by Emu while Osiris surveyed the larger southern section plus two additional areas (**Figure 1**). Most of the Wash was surveyed by Emu with additional areas surveyed by Osiris, particularly where the cable route adjoins the Docking Shoal OWF area (**Figure 2**).
- 1.1.3. Sidescan sonar, multibeam bathymetry, shallow seismic and magnetic datasets were collected from both Docking Shoal and the Wash. This report describes the audit of all four types of dataset from each area which were checked for completeness and reviewed in terms of quality by Wessex Archaeology (WA). Some initial processing was carried out to ensure that data formats were compatible with WA software.
- 1.1.4. During the data quality review the datasets were not interpreted for any objects of possible anthropogenic origin and did not undergo analysis with reference to other datasets, including the UKHO reported losses and obstructions.

#### **1.2. AIMS AND OBJECTIVES**

- 1.2.1. The aim of the data audit and review was to ensure that Wessex Archaeology had received all geophysical data collected from the Docking Shoal OWF area and the Wash Cable Route Corridor and that it was of sufficient quality for future analysis and archaeological assessment.
- 1.2.2. The objectives of this audit and review were to:
  - confirm that all relevant data had been received by WA so a quantitative assessment of the amount of each data type could be made to inform the selection of lines for subsequent analysis;
  - incorporate trackplots into the project GIS to enable this selection of lines;
  - incorporate all data into WA software systems and ensure that all data received was in a suitable format to allow the data to be processed by WA;
  - review test lines of sidescan and seismic data in terms of their quality;

- carry out initial processing of the magnetic data to ensure that data quality was satisfactory;
- convert the multibeam bathymetry data into a surface to allow assessment of its quality.

## 2. METHODOLOGY

### 2.1. DATA AUDIT

2.1.1. In addition to the datasets received from Emu and Osiris, WA requested all survey logs from the geophysical contractors together with trackplots of the lines surveyed. Cross-checking the data files received with the logs and trackplots ensured that WA was able to keep track of all data received, identify missing data and request it from the survey companies, and finally confirm that all relevant data had been received and was available for analysis and archaeological assessment.

2.1.2. A breakdown of the datasets received in terms of size, line kilometres covered and the quality of the data is presented in **Appendix 1**. The data were graded as good, average or variable using the following criteria:

Good	Data which is clear and unaffected by weather conditions or sea state. The dataset is suitable for the interpretation of standing and partially buried metal wrecks and their character and associated debris field. This data also provides the highest chance of identifying wooden wrecks and debris.
Average	Data which is affected by weather conditions and sea state to a slight or moderate degree. The dataset is suitable for the identification and partial interpretation of standing and partially buried metal wrecks, and the larger elements of their debris fields. Wooden wrecks may be visible in this data, but their identification as such is likely to be difficult.
Variable	This category contains datasets with the quality of individual lines ranging from good or average to below average. The dataset is suitable for the identification of standing and some partially buried metal wrecks. Detailed interpretation of the wrecks and debris field is likely to be problematic. Wooden wrecks are unlikely to be identified.

**Table 1: Criteria for data quality rating in assessing suitability for assessing archaeological potential.**

### 2.2. MAGNETIC DATA

2.2.1. The magnetic dataset received by WA was imported into Geometrics MagPick software. Initial processing to remove the regional field was carried out so that the quality of the data could be assessed. The navigation was checked by producing a grid view of the profiles. The dataset was gridded and an interpolated contour map was produced to show changes in the magnetic field strength over the survey area. This will form the basis of future processing and interpretation, and is an important check on data compatibility.

### 2.3. SIDESCAN SONAR DATA

2.3.1. The quality review of sidescan sonar data was undertaken using Coda Geosurvey software. This allows the data to be replayed with various gain settings in order to optimise the quality of the images. The review consisted of looking at approximately 10% of the lines of data from each area. These were evenly selected throughout the

dataset. A mosaic of these lines was also created in order to assess the quality of the navigation information in the files.

## **2.4. SEISMIC DATA**

- 2.4.1. This dataset was reviewed using the same software as the sidescan sonar data and a similar procedure. In addition to adjusting the gain settings the dataset was also filtered to maximise the quality of the images and clarity of reflectors. Instead of mosaicing the lines to check the quality of navigation as was done with the sidescan data a trackplot was created from the navigation information in the files.

## **2.5. MULTIBEAM BATHYMETRY DATA**

- 2.5.1. The multibeam data files were processed using the Interactive Visualization Systems Fledermaus software suite so that the data could be visualised as a surface. The text files received were gridded, shaded with a suitable colour map and displayed as three-dimensional surfaces. The dataset was examined for gaps and dissimilarities in depths of adjacent lines.

# **3. DOCKING SHOAL RESULTS**

## **3.1. SURVEY AREAS**

- 3.1.1. The main area of the Docking Shoal OWF, named Z2, measures approximately 17km by 8.5km and consists of 114 lines, running approximately east-west with a spacing of 125m. The northern 50 lines were surveyed by Emu and the remainder by Osiris (**Figure 1**). Five cross-lines oriented approximately north-south were run by Osiris across the whole of the area, 3500m apart. Emu ran two cross-lines across their survey lines, 225m apart. The lines surveyed by Emu total 315 line km and those surveyed by Osiris covered 845 line km.
- 3.1.2. On the northeastern side of the main area there is a second area surveyed by Osiris, called ZC\_Z5 (**Figure 1**). It measures approximately 16.5km by 2km. This area contains 22 lines running northwest-southeast, with a spacing of 175m. There are four cross-lines with an average spacing of 3125m. A total of 234 line km were surveyed in this area.
- 3.1.3. A third area, ADDZ2 adjoins the southeastern side of the main area (**Figure 1**). This small area, measuring approximately 2250m by 1150m was also surveyed by Osiris. 27 survey lines run northwest-southeast with a spacing of 60m. Two cross-lines are separated by 1000m. The distance surveyed in this area is 47 line km.
- 3.1.4. The total length of all lines surveyed in the Docking Shoal OWF area is 1441 line km. All values given for line kilometres are estimates calculated from trackplots and line plans supplied by Emu and Osiris.



## **3.2. MAGNETIC DATA**

### **Emu**

- 3.2.1. The data received by WA from Emu consists of 56 comma-separated variable (.csv) files totalling 35.6 MB.
- 3.2.2. The dataset was received having been de-spiked but without the layback applied. Layback was applied by WA staff using information drawn from Emu's survey logs. The magnetic field values were given in microtesla rather than the standard units of nanotesla. In order to grid the Emu and Osiris magnetic data together in one contour map, the magnetic field strengths in all the files from Emu had to be multiplied by 1000 by WA staff to convert them to nanotesla. The datasets are of average quality and are adequate for further processing and interpretation.

### **Osiris**

- 3.2.3. The data received from Osiris consists of 90 text files containing 142MB for the Z2 area, 29 text files totalling 7.78MB for the ADDZ2 area and 38 text files containing 38.8MB for the ZC\_Z5 area.
- 3.2.4. The dataset was received with the layback already applied. The dataset from the ADDZ2 area was of good quality, containing no spikes. The dataset from the ZC\_Z5 area was also generally of good quality but some lines are noisy. Most of the lines from the Z2 area are of good quality but some are only of average quality. All lines are adequate for further processing and interpretation.

## **3.3. SIDESCAN SONAR DATA**

### **Emu**

- 3.3.1. The sidescan sonar and seismic datasets were received together as 9.56GB of Coda files. Each file contained the sidescan sonar and seismic data for the same line.
- 3.3.2. The sidescan sonar datasets were collected using a frequency of 500kHz and with a range of 75m. This range results in a seabed coverage of 120% as the line spacing was 125m. The datasets were not always received from the full extent of the range, with limited penetration occurring beyond approximately 40m. Layback had not been applied but this can be done during analysis using information given in Emu's survey logs. The datasets were variable in quality with some lines adversely affected by sea state, but are adequate for further processing and interpretation.

### **Osiris**

- 3.3.3. As with the Emu data, the Coda files received from Osiris contained both the sidescan sonar and seismic data within each file. The files from the main Z2 area total 43.8GB with 11.4GB from the ZC\_Z5 area and a further 1.83GB from the ADDZ2 area.
- 3.3.4. The datasets were acquired at 500kHz. Layback had already been applied and included in the files. A range of 75m was used in the Z2 and ADDZ2 areas while the ZC\_Z5 area was surveyed using a range of 125m. The line spacing was 125m in the

Z2 area, 60m in the ADDZ2 area and 175m in the ZC\_Z5 area. These parameters result in seabed coverage of 120% for the Z2 area, 250% for the ADDZ2 area and 140% for the ZC\_Z5 area. The dataset from the Z2 area was variable in quality with striping in some lines caused by movement of the towfish owing to adverse weather conditions. The datasets are adequate for further processing and interpretation.

### **3.4. SEISMIC DATA**

#### **Emu**

- 3.4.1. This dataset was included in the 9.56GB of Coda files that contained the sidescan sonar data.
- 3.4.2. The dataset was of variable quality and noisy in places owing to adverse weather conditions. Penetration of the seabed was achieved to approximately 10m to 15m. The layback was not included in the files but can be applied during analysis using information available in Emu's survey logs. The dataset is of adequate quality for further processing and interpretation.

#### **Osiris**

- 3.4.3. This dataset was included within the Coda files that contained the sidescan sonar data, with 43.8GB from the Z2 area, 11.4GB from the ZC\_Z5 area and 1.83GB from the ADDZ2 area.
- 3.4.4. The dataset was typically of average quality with penetration generally achieved to a depth of 15m to 20m. Data below this are obscured by the seabed multiple. Some lines were adversely affected by the weather but the dataset is adequate for further processing and interpretation.
- 3.4.5. The sidescan layback is included in the files but as this was different to that of the boomer it will need to be altered during analysis using the details given in the survey logs.

### **3.5. MULTIBEAM BATHYMETRY DATA**

#### **Emu**

- 3.5.1. The multibeam dataset was received from Emu as three large text files with a total size of 209 MB
- 3.5.2. Examination of the text files showed that the data had been gridded at 2m intervals. Once the dataset had been imported into Fledermaus it was seen to be of good quality with only a few small gaps, generally less than 50m across. There are only a few spikes in the data and these can be edited out if required. The dataset is more than adequate for further processing and interpretation.

#### **Osiris**

- 3.5.3. The multibeam dataset from Osiris was received as nine text files totalling 368MB. These dataset only cover the main Z2 area, although according to the survey logs multibeam datasets were also collected in the ADDZ2 and ZC\_Z5 areas.

- 3.5.4. The text files appear to have been gridded at 2m intervals. There are gaps in between each line of data of approximately 75m, while each swath has a width of approximately 50m. WA has therefore yet to receive approximately 60% of the data for the Z2 area, and all of the Osiris data for the ADDZ2 and ZC\_Z5 areas.

## **4. WASH CABLE ROUTE CORRIDOR RESULTS**

### **4.1. SURVEY AREAS**

- 4.1.1. Osiris collected data in three areas within the cable route corridor, Wash cable A, Wash cable B and Wash cable C (**Figure 2**), with a line spacing of 125m and cross-lines separated by 1250m. A total of 494km of lines were surveyed in these three areas. In addition, coarsely spaced cross-lines were collected across the cable route and beyond to a distance of approximately 4km to the east. This amounts to 274 line km with a line spacing of 1km.
- 4.1.2. Emu acquired data within the cable route corridor in three main areas, the Upper, Middle and Lower Wash (**Figure 2**), with additional lines run along the eastern edge of the Middle Wash survey area and the western edge of the Osiris' Wash cable A survey area. The Upper Wash, Middle Wash and Lower Wash areas all contain lines with a spacing of 125m and cross-lines with a separation of 1250m. 242 line km were surveyed in the Upper Wash area, 397 line km in the Middle Wash area and a further 45 line km in the cross-lines. The Lower Wash area contained 102 line km of survey lines but the cable route was altered after data was collected in this area. The additional cable route lines were therefore surveyed to cover the route alteration. They have the same spacing as the other lines and cross-lines and amount to 234 line km. Approximately 30 line km from the northwestern corner of the Lower Wash area were included in the new cable route corridor. This gives 948 line km for the new cable route corridor out of a total of 1020 line km surveyed by Emu.
- 4.1.3. A total of 1761 line km were surveyed along the Wash Cable Route Corridor. All values given for line kilometres are estimates calculated from trackplots and line plans supplied by Emu and Osiris.

### **4.2. MAGNETIC DATA**

#### **Emu**

- 4.2.1. The magnetic dataset from EMU was provided to Wessex Archaeology in the form of three comma-separated variable files (.csv), totalling 11.1MB for the Upper and Middle Wash areas and the Wash cross-lines. A further 130 small text files totalling 5.59MB contain data collected in the additional cable route areas and the north-western corner of the Lower Wash area.
- 4.2.2. Four of the files from the additional cable route areas could not be imported into MagPick. This is probably a result of bad navigation points and it may be possible to rectify this to enable these lines to be included in the next stage of data processing. The dataset was also provided in units of microtesla rather than the standard unit of nanotesla. This can easily be altered by WA staff to enable the Emu and Osiris data to be merged. The .csv files contained data that had been laid back, while the text files contained data that had not been laid back. Layback was applied to these files

prior to gridding in MagPick. Additionally, the text files contained coordinates in latitude and longitude and these had to be converted into projected coordinates (eastings and northings) before they could be imported into MagPick.

- 4.2.3. The datasets were considered to be of average quality. There appeared to be few spikes but some lines were very noisy and it will not be possible to interpret them. In general, the dataset is of adequate quality for further processing and interpretation.

#### **Osiris**

- 4.2.4. The magnetic data from Osiris consisted of 61 text files, totalling 45.0MB for the coarse Wash cross-lines and 83 text files with a collective file size of 80.7MB for the areas Wash cable A, B and C.
- 4.2.5. The dataset was received with layback included and was considered to be of average quality. There were no spikes but some lines were very noisy and it may not be possible to interpret them. The majority of the dataset is adequate for further processing and interpretation.

### **4.3. SIDESCAN SONAR DATA**

#### **Emu**

- 4.3.1. The dataset was provided as Coda files totalling 33.2GB with both the sidescan and seismic data for each line contained within the same file. Data has not yet been received for the Lower Wash area.
- 4.3.2. The dataset was collected at 500 kHz and with a 75m range in the Middle and Upper Wash areas. The same frequency was used for the additional lines but the range was increased to 100m. As the line spacing was 125m this represents 160% coverage of the seafloor in the additional Wash and 120% in the Upper and Middle Wash areas.
- 4.3.3. The dataset was considered to be of average quality. The navigation data for this survey was good and will allow the interpretation and mapping of potential objects of archaeological interest. Occasional drop-outs existed but they were not substantial enough to affect the processing of the data. The dataset is adequate for further processing and interpretation.

#### **Osiris**

- 4.3.4. The dataset was received as Coda files with 23.4GB for the Wash cable A, B and C areas and 14.2GB for the coarse Wash cross-lines. Both the sidescan and seismic dataset for each line was contained in each file.
- 4.3.5. The dataset was collected at 500kHz and with a range of 75m. Together with the line spacing of 125m in the Wash cable areas this gives a 120% coverage of the seabed. There is no overlap between the coarse Wash lines. The dataset was of good quality and is more than adequate for further processing and interpretation.

#### **4.4. SEISMIC DATA**

##### **Emu**

- 4.4.1. The dataset was provided as Coda files totalling 33.2GB with both the sidescan and seismic data for each line contained within the same file. Data has not yet been received for the Lower Wash area.
- 4.4.2. The dataset is generally of good quality with penetration of 10m to 30m achieved until deeper reflectors are obscured by the seabed multiple. Some lines have been adversely affected by weather conditions and are only of average quality. Even for these lines, seabed penetration was still generally achieved for 5m to 10m, which is adequate for archaeological purposes. The dataset is of adequate quality for further processing and interpretation.

##### **Osiris**

- 4.4.3. The dataset was received as Coda files with 23.4GB for the Wash cable areas and 14.2GB for the coarse Wash cross-lines. Both the sidescan and seismic dataset for each line was contained in each file.
- 4.4.4. The dataset is of very variable quality with some lines adversely affected by weather conditions. The data in these lines had much reduced clarity and definition. The remaining lines had good quality data with seabed penetration achieved to approximately 20m, at which depth the seabed multiple obscured any deeper reflectors. The majority of the dataset is of adequate quality for further processing and interpretation.

#### **4.5. MULTIBEAM BATHYMETRY DATA**

##### **Emu**

- 4.5.1. The dataset was provided as three large text files, totalling 533MB. It covers the Upper Wash, Middle Wash and Lower Wash areas with the appropriate Wash cross-lines included in each. At the time of writing data are still being collected in the additional cable route areas.
- 4.5.2. There is a gap in the data from the Upper Wash area, approximately 90m wide and running through the centre of most of the area. There are no obvious spikes but there are some edge effects where adjacent lines overlap. The dataset from the Middle Wash area also displays the gap down the middle, as well as other small gaps throughout the dataset. Edge effects are also present as spikes along the edges of lines. In addition, adjacent lines occasionally differ in depth by up to 1m. The dataset from the Lower Wash area is of below average quality with the lines in the southwest of the area displaying obvious edge effects with ridges approximately 1m high. In general however, the dataset is adequate for further processing and interpretation.

##### **Osiris**

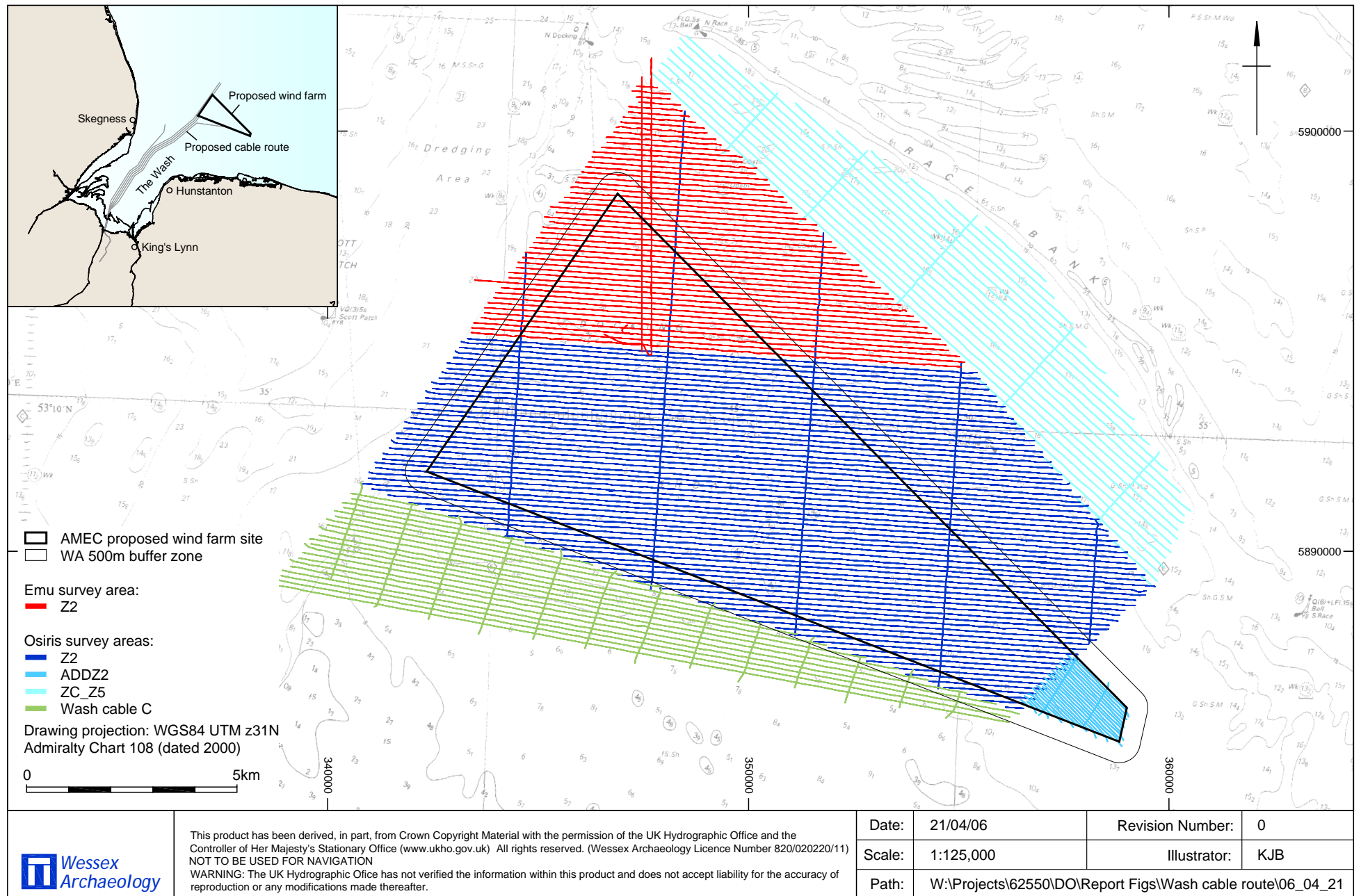
- 4.5.3. Multibeam data from Osiris have not yet been received.

## **5. RECOMMENDATIONS**

- 5.1. It is proposed that the next stage of data processing and interpretation will be to locate sites of archaeological potential that could be affected by the construction of the Docking Shoal OWF and associated cable route through the Wash.
- 5.2. It is recommended that all sidescan sonar, multibeam bathymetry and magnetic datasets in the proposed wind farm area and a surrounding buffer zone of 500m are processed and interpreted. For the seismic data it is recommended that only 20% is subjected to further processing. This is because seismic data is used to identify palaeogeographic features which change on a larger scale than the smaller archaeological sites that are identified by the other data types.
- 5.3. For the cable route corridor, WA recommends that datasets from the cable route and a buffer zone of 500m around it are processed and interpreted. Again, it is recommended that all sidescan sonar, multibeam bathymetry and magnetic data are fully interpreted but that only 20% of the seismic data is considered.
- 5.4. These recommendations are based on scheme details supplied by AMEC and current at the time of writing. Should the scheme details change prior to the archaeological geophysical assessment it would be necessary to re-evaluate the extent of the proposed assessment. Changes to scheme details after the archaeological assessment has been completed may require additional archaeological geophysical assessment.

**APPENDIX 1: SUMMARY OF DATA AUDIT AND REVIEW**

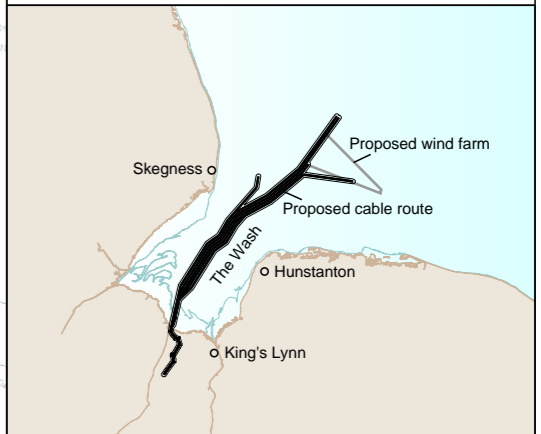
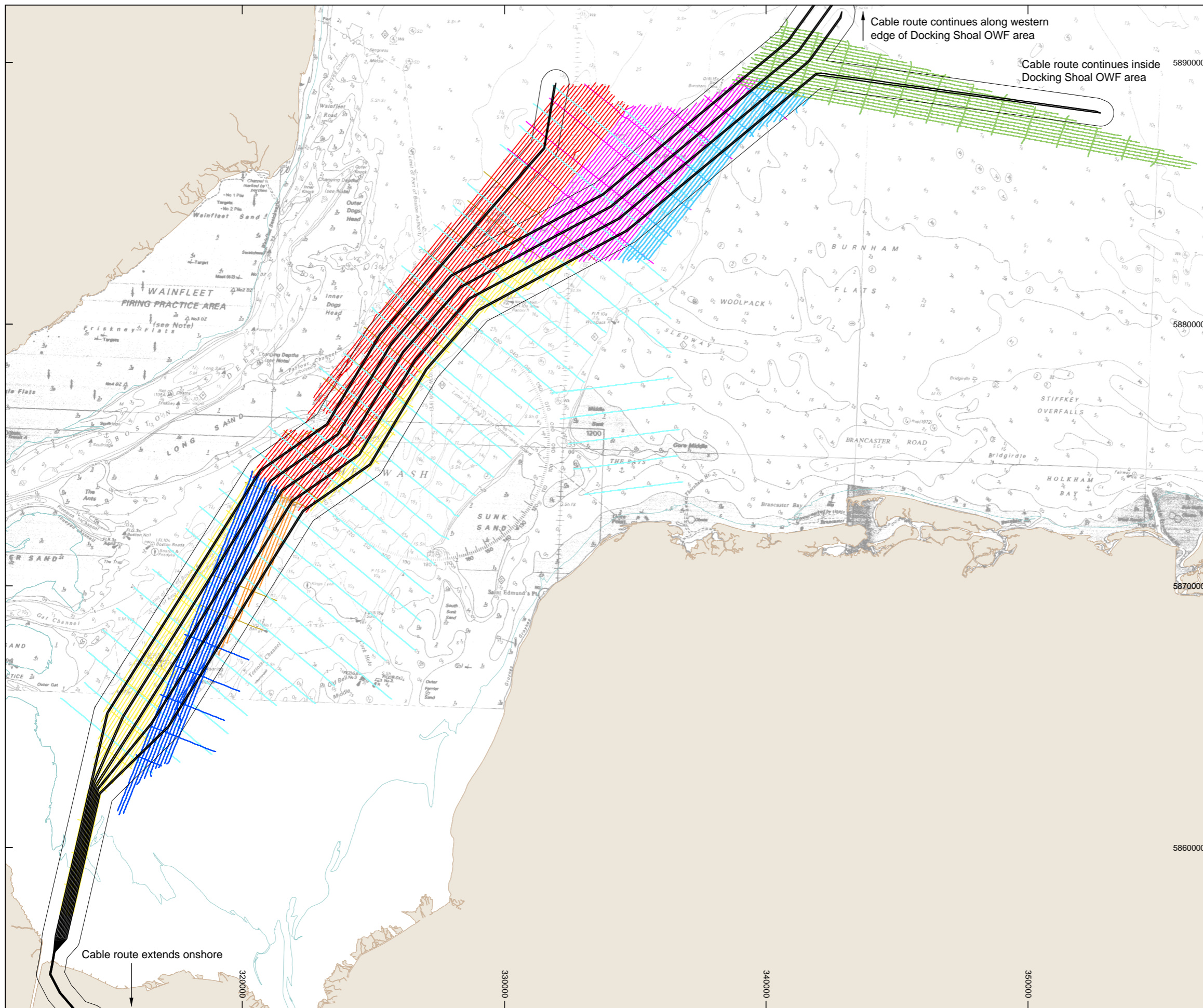
<b>Area</b>	<b>Data Type</b>	<b>Data Quantity</b>	<b>Quality</b>	<b>Line km Covered</b>
<b>Docking Shoal</b>	Emu Mag	35.6MB	Average	315km
	Emu Sidescan	9.56GB with seismic	Variable	
	Emu Seismic	9.56GB with sidescan	Variable	
	Emu Multibeam	209MB	Good	
	Osiris Mag	Z2 - 142MB ADDZ2 - 7.78MB ZC_Z5 - 38.8MB	Average/good	Z2 - 845km ADDZ2 - 47km ZC_Z5 - 234km Total - 1126km
	Osiris Sidescan	Z2 - 43.8GB with seismic ADDZ2 - 1.83GB with seismic ZC_Z5 - 11.4 GB with seismic	Variable	
	Osiris Seismic	Z2 - 43.8GB with sidescan ADDZ2 - 1.83GB with sidescan ZC_Z5 - 11.4 GB with sidescan	Average	
	Osiris Multibeam	Z2 - 368MB, incomplete ADDZ2 - none ZC_Z5 - none	Unknown	
<b>Wash</b>	Emu Mag	16.69MB	Average	948km
	Emu Sidescan	33.2GB with seismic, incomplete	Average	
	Emu Seismic	33.2GB with sidescan, incomplete	Average/good	
	Emu Multibeam	533MB, incomplete	Variable	
	Osiris Mag	coarse Wash - 45.0MB Wash cables - 80.7MB	Average	coarse Wash - 274km Wash cables - 494km Total - 768km
	Osiris Sidescan	coarse Wash - 14.8GB, with seismic Wash cables - 23.4GB, with seismic	Good	
	Osiris Seismic	coarse Wash - 14.8GB, with seismic Wash cables - 23.4GB, with seismic	Variable	
	Osiris Multibeam	none	Unknown	



Docking Shoal Offshore Wind Farm survey areas and trackplots

Figure 1





- AMEC proposed cable route
- WA 500m buffer zone
- Emu survey areas:
  - Upper Wash
  - Middle Wash
  - Lower Wash
  - Wash cross-lines
  - Additional Wash
- Osiris survey areas:
  - Wash cable A
  - Wash cable B
  - Wash cable C
  - Coarse Wash cross-lines

Drawing projection: WGS84 UTM z31N  
Admiralty Chart 108 (dated 2000)



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Scale:	1:150,000
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Figs\Wash cable route\06\_04\_21

Wash Cable Route Corridor survey areas and trackplots

Figure 2



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