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Wessex Archaeology



Race Bank Offshore Wind Farm

Geophysical Data Audit and Review

Ref: 62550.07

May 2007

**RACE BANK OFFSHORE WIND FARM
GEOPHYSICAL DATA AUDIT AND REVIEW**

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On behalf of:

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For:

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Report ref. 62550.07

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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 Farms 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 Race Bank Offshore Wind Farm. An earlier report (WA2006) describes the data from the Docking Shoal Offshore Wind Farm and the Wash Cable Route Corridor.

Although there was considerable variability in quality, most datasets received for the Race Bank Offshore Wind Farm 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 Race Bank 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. If the site plan is still undecided then it is recommended to analyse all data collected.

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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, reviewed the data and compiled this report. Quality assurance was provided by Dr Paul Baggaley. Illustrations are by Kitty Brandon. The project was managed for Wessex Archaeology by John Gribble.

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RACE BANK OFFSHORE WIND FARM
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1. INTRODUCTION

1.1. BACKGROUND

- 1.1.1. Geophysical surveys of the Race Bank Offshore Wind Farm (OWF) area were undertaken by Emu Ltd and Osiris Projects during the period from January 2006 to September 2006. The work was conducted as part of the proposed development of the Docking Shoal and Race Bank OWFs by Centrica.
- 1.1.2. Race Bank was divided into several zones but they were not surveyed individually (**Figure 1**). The largest zone, Zone 1, was split between Emu and Osiris with Emu surveying the larger southern section. Zone 4 was also surveyed by Emu. Osiris surveyed Zone B, the northernmost section. Zone A on the eastern side of Race Bank was dropped from the survey after only a few lines had been surveyed owing to a change in scheme details. WA does not have a final scheme footprint as this is yet to be determined by Centrica.
- 1.1.3. Sidescan sonar, multibeam bathymetry, shallow seismic and magnetic datasets were collected. This report describes the audit of all four types of dataset 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 Race Bank OWF 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, poor 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.
Poor	Data which is affected by weather conditions and sea state to a severe degree or is severely affected by noise. This category also contains datasets where the seabed coverage is below 100%. The dataset may be suitable for the identification of standing and some partially buried metal wrecks, if they are in areas covered by the data. Detailed interpretation of the wrecks and debris field is likely to be problematic. Wooden wrecks are unlikely to be identified.
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 datasets received by WA were 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. Each 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 5% of the data from each area. The lines 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, again with approximately 5% of the data being reviewed. 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 reviewed 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. RESULTS

3.1. SURVEY AREAS

- 3.1.1. The largest zone, Zone 1, was split between Emu and Osiris with Osiris surveying the smaller northern section, Zone 1 North (**Figure 1**). This area contains 37 lines with a spacing of 125m and oriented northwest-southeast. Zone 1 South, surveyed by Emu, contains 58 lines with the same orientation and spacing. Nine cross-lines oriented approximately southwest-northeast were surveyed across the whole survey area by Emu. A 2km line spacing was used. Osiris surveyed 266 line km in Zone 1 and Emu covered 655 line km.
- 3.1.2. Osiris surveyed a second area, Zone B, to the north of Zone 1. This polygon contains 25 lines oriented east-west and with a spacing of 175m. Two cross-lines are spaced 3km apart and run north-south. This area contains 103 line km.
- 3.1.3. Zone 4 was surveyed by Emu. The main section of the area contains 23 lines oriented northwest-southeast and with a spacing of 175m. Six cross-lines spaced 2km apart are oriented approximately southwest-northeast. A total of 276 line km was surveyed in this area.
- 3.1.4. The eastern extent of Zone 4 was the last area to be surveyed and was named ‘virgin lines’ by Emu. This consists of 16 lines in a triangular section at the southeast of the site, 26 short lines along the eastern edge of Zone 1 and 15 lines in a polygon adjacent to Zone 1 to the northeast. All lines are oriented northwest-southeast and

have a line spacing of 175m. The nine cross-lines are oriented southwest-northeast and spaced 2km apart. This area contains 144 line km.

- 3.1.5. The total length of all lines surveyed in the Race Bank OWF area is 1444 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 2 comma-separated variable (.csv) files, totalling 34 MB.
- 3.2.2. The dataset was received with the layback applied. The magnetic field values of the majority of data (the 31MB file) 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 of the affected data from Emu had to be multiplied by 1000 by WA staff to convert them to nanotesla.
- 3.2.3. For Zone 1 South and the main area of Zone 4 the dataset is very variable. Many lines are poor quality, most of these containing electrical noise, but some are of average quality. A lot of processing will be needed to remove spikes and extract the data that are of reasonable quality. A large part of this dataset is inadequate for interpretation.
- 3.2.4. The data collected in the 'virgin lines' area of Zone 4 contains lots of electrical noise and is not possible to process. It is of poor quality and inadequate for archaeological interpretation.

Osiris

- 3.2.5. The data received from Osiris consists of 49 text files containing 54.4MB for the Zone 1 North area and 28 text files totalling 17.4MB for the Zone B area.
- 3.2.6. The dataset was received with the layback already applied. The quality of the data is average, with some lines being noisy. 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 33GB of mainly Coda files with a few in .xtf format. Some files contained the sidescan sonar and seismic data for the same line, some contained just sidescan and some were just seismic.
- 3.3.2. The sidescan sonar datasets were collected using a frequency of 500kHz. Layback had mostly been applied but this had been done incorrectly. This can be corrected during analysis using information supplied by Emu.

- 3.3.3. In Zone 1 South, a mix of 75m and 100m ranges was used, with no specific pattern. As this area has a line spacing of 125m this gives a seabed coverage of 120%, 140% or 160%. The data contain a lot of noise from the survey vessel in the water column and data was only received out to approximately two thirds of the range, resulting in effective seabed coverage of 80%, 95% or 110%. Some lines are noisy and contain dark diagonal stripes. The quality of data in this area is variable, with many lines below average quality. It is just adequate for full processing and interpretation although full seabed coverage has not been achieved.
- 3.3.4. In the main section of Zone 4, the range used was again a mix of 75m and 100m although data was only received out to approximately 45m. The line spacing used was 175m, resulting in an effective seabed coverage of 50% rather than 85%, 100% or 115% which should have been achieved. The data quality in this area is variable with many lines below average quality. These data are adequate for full processing and interpretation but it should be noted that the coverage is far less than satisfactory.
- 3.3.5. In the 'virgin lines' section of Zone 4, 100m range was used but data was only received from out to approximately 20m. This gives a seabed coverage of approximately 20% as the line spacing here was 175m. The quality of this data is poor and is inadequate for further processing and interpretation
- 3.3.6. Additional lines of data were reviewed to ensure that the general data quality was assessed fairly and that the worst lines had not been picked inadvertently.

Osiris

- 3.3.7. The Coda files received from Osiris contained both the sidescan sonar and seismic data within each file. 50 files totalling 14.2GB cover the Zone 1 North area and 5.19GB in 28 files cover Zone B.
- 3.3.8. The datasets were acquired at 410kHz. Layback had already been applied and included in the files. A range of 75m was used in the Zone 1 North area and a range of 125m in the Zone B area. The line spacing was 125m in Zone 1 North and 175m in Zone B. These parameters result in seabed coverage of 120% in Race Bank and 140% in Zone B. The data from Zone 1 North were average in quality with striping in some lines caused by movement of the towfish owing to adverse weather conditions. Data was only received to approximately 100m of the 125m range in Zone B, resulting in an effective seabed coverage of 115% rather than the expected 140%. The data quality in Zone B was variable with some lines below average quality. The datasets are adequate for further processing and interpretation.

3.4. SEISMIC DATA

Emu

- 3.4.1. This dataset was included in the 33GB of Coda and xtf files that contained the sidescan sonar data. Some lines of data are included in the same file as the sidescan sonar data for that line while others are in separate files.
- 3.4.2. The dataset was of variable quality. Some lines were noisy in places owing to adverse weather conditions while others contained significant electrical noise. The

quality of other lines was good with reflectors clearly seen. Penetration of the seabed was achieved to approximately 15m to 20m. The layback was often included in the files but incorrect amounts were sometimes applied. The correct laybacks can be input during analysis using information from Emu. 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 14.2GB in 50 coda files from the Zone 1 North area and 28 coda files totalling 5.19GB from the Zone B area.
- 3.4.4. The dataset was of variable quality with penetration achieved to a maximum depth of 15m to 20m, above the seabed multiple. The top 2 – 5m is obscured by an unusually large seabed pulse, possibly a result of poor tuning, poorly maintained equipment or excessive power being used. Any features within this region would be obscured. The lines were adversely affected by the weather and are noisy 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 information from Osiris.

3.5. MULTIBEAM BATHYMETRY DATA

Emu

- 3.5.1. The multibeam dataset was received from Emu as seven large text files with a total size of 1.30GB.
- 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 variable quality. The data from the Zone 4 ‘virgin lines’ was generally average in quality with some edge effects, including spikes up to approximately 1.5m along the edges of adjacent lines. Vertical offsets between adjacent lines were up to approximately 0.5m. The data in the Zone 1 South and main Zone 4 areas was of noticeably lower, below average, quality. The data in these areas had differences of up to a metre or more between adjacent lines. The edge effects were also greater with spikes of up to 10m. The dataset is adequate for further processing and interpretation.

Osiris

- 3.5.3. The multibeam dataset from Osiris was received as two text files totalling 373MB.
- 3.5.4. The text files have been gridded at 2m intervals. There are three gaps where the Zone B and Zone 1 North areas haven’t quite overlapped. The largest of these measures 90x35m. Individual lines are visible but adjacent lines differ in depth by only a few centimetres. The dataset is of good quality and is more than adequate for archaeological interpretation.

4. RECOMMENDATIONS

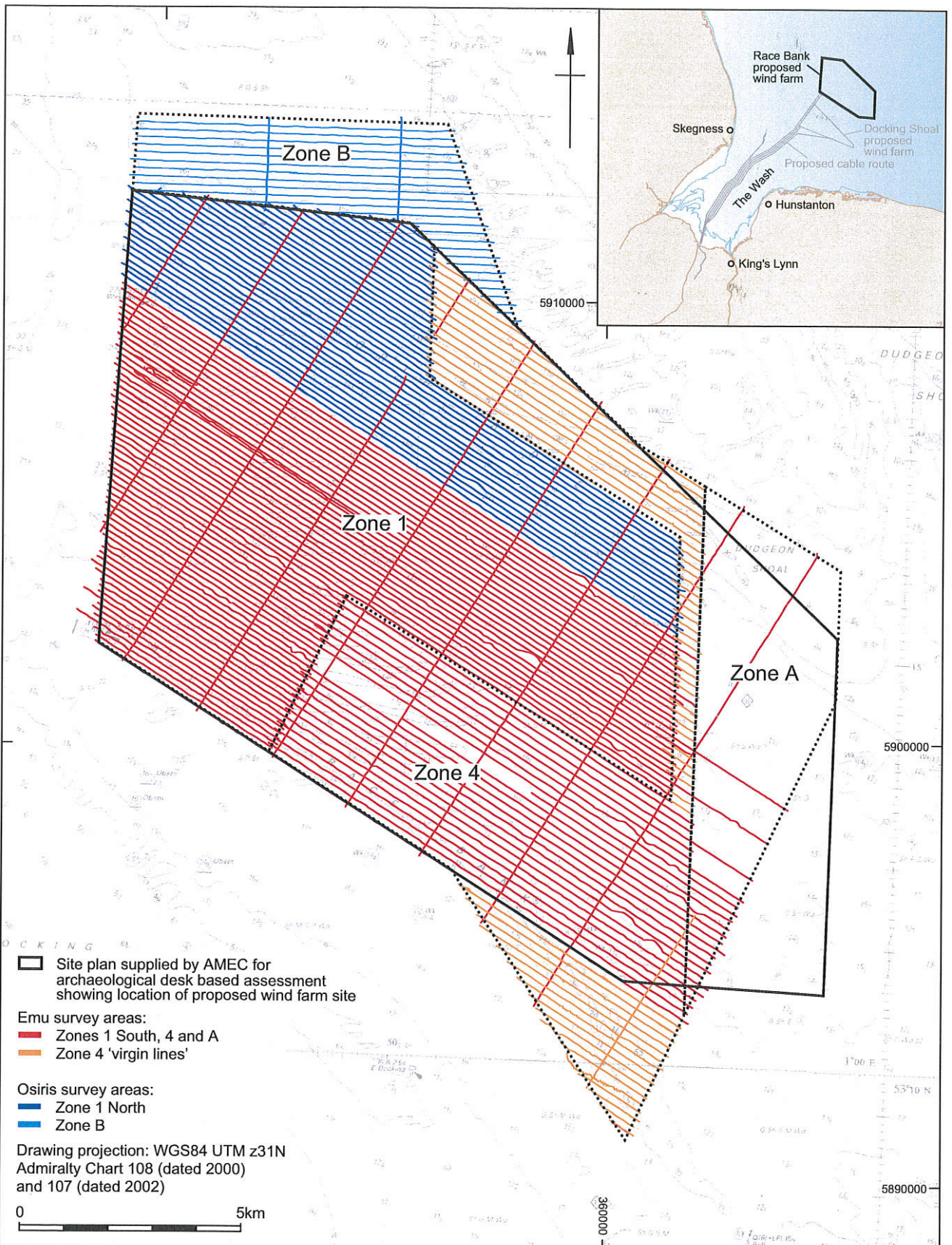
- 4.1. It is proposed that the next stage of data processing and interpretation will be to locate sites of archaeological potential that could be affected by the construction of the Race Bank OWF.
- 4.2. It is recommended that all adequate sidescan sonar, multibeam bathymetry and magnetic datasets are 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.
- 4.3. These recommendations are based on evaluating all geophysical data as there are no final scheme details supplied by Centrica at the time of writing. Should the scheme details be confirmed prior to the archaeological geophysical assessment it would be necessary to re-evaluate the extent of the proposed assessment. It would then be recommended that data in the proposed wind farm area and a surrounding buffer zone of 500m are processed and interpreted. Changes to scheme details after the archaeological assessment has been completed may require additional archaeological geophysical assessment.

5. REFERENCES

Wessex Archaeology, 2006, 'Docking Shoal Offshore Wind Farm and Wash Cable Route Corridor: Geophysical Data Audit and Review', Unpublished report ref: 62550.04.

APPENDIX 1: SUMMARY OF DATA AUDIT AND REVIEW

Data Type	Data Quantity	Quality	Line km Covered
Emu Mag	33.9MB	Poor/variable	Zone 1 South - 655km Zone 4 main - 276km Zone 4 'virgin lines' - 144km Total - 1075km
Emu Sidescan	33.4GB with seismic	Poor/variable	
Emu Seismic	33.4GB with sidescan	Variable	
Emu Multibeam	1.30GB	Variable	
Osiris Mag	Zone 1 North - 54.4MB Zone B - 17.4MB	Average	Zone 1 North - 266km Zone B - 103km Total - 369km
Osiris Sidescan	Zone 1 North - 14.2GB with seismic Zone B - 5.19GB with seismic	Variable/average	
Osiris Seismic	Zone 1 North - 14.2GB with sidescan Zone B - 5.19GB with sidescan	Variable	
Osiris Multibeam	Zone 1 North - 272MB Zone B - 121MB	Good	



Site plan supplied by AMEC for archaeological desk based assessment showing location of proposed wind farm site

Emu survey areas:
 Zones 1 South, 4 and A
 Zone 4 'virgin lines'

Osiris survey areas:
 Zone 1 North
 Zone B

Drawing projection: WGS84 UTM z31N
 Admiralty Chart 108 (dated 2000)
 and 107 (dated 2002)

0 5km

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Race Bank Offshore Wind Farm survey areas and trackplots

Figure 1



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