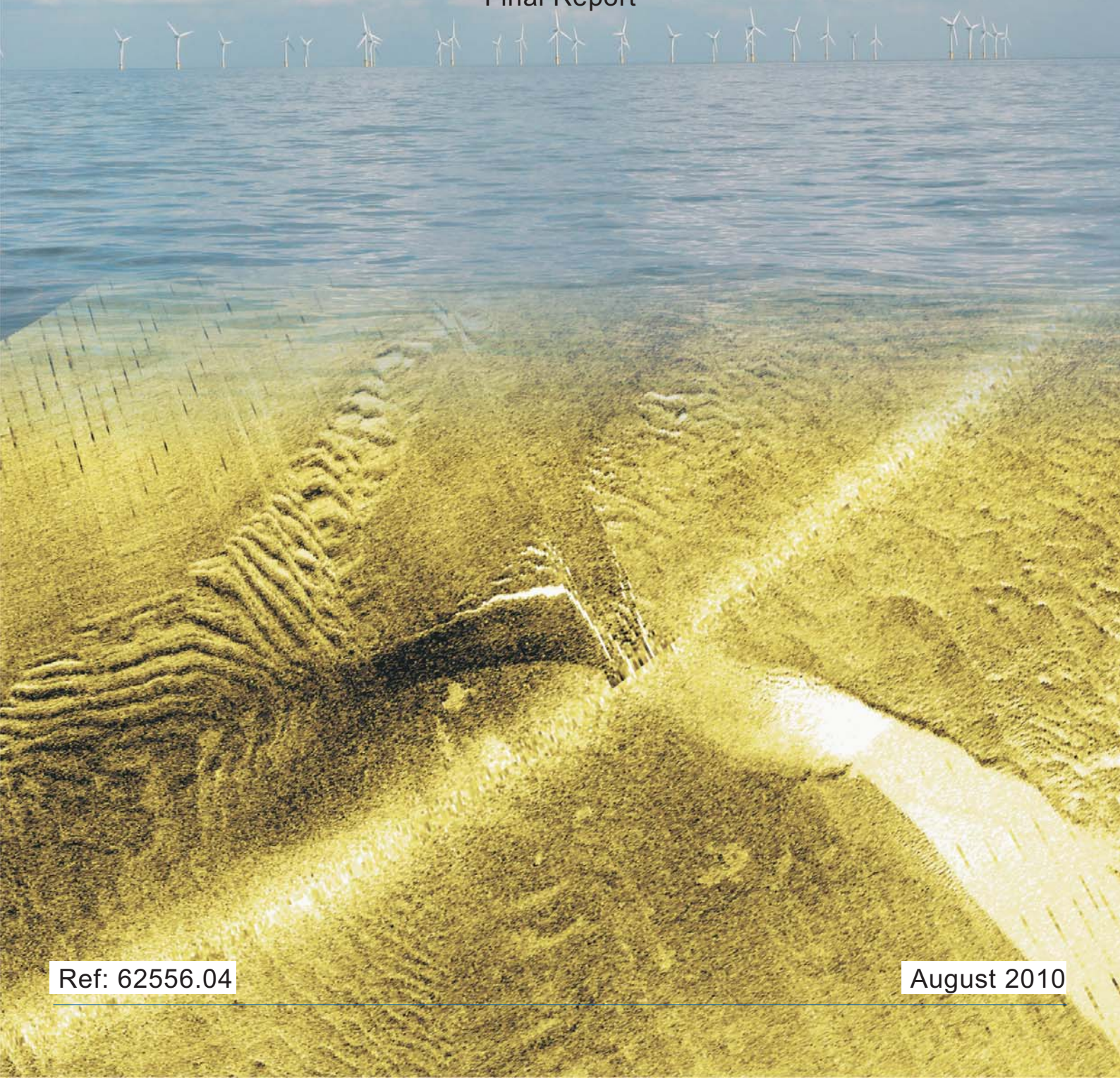




Race Bank and Docking Shoal
Offshore Wind Farms
Additional Areas in The Wash

Assessment of Marine Geophysical Data
and Archaeological Impact Assessment

Final Report



**RACE BANK AND DOCKING SHOAL OFFSHORE WIND FARMS
ADDITIONAL AREAS IN THE WASH**

**ASSESSMENT OF MARINE GEOPHYSICAL DATA
AND
ARCHAEOLOGICAL IMPACT ASSESSMENT**

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RACE BANK AND DOCKING SHOAL OFFSHORE WIND FARMS ADDITIONAL AREAS IN THE WASH

ASSESSMENT OF MARINE GEOPHYSICAL DATA AND ARCHAEOLOGICAL IMPACT ASSESSMENT

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RACE BANK AND DOCKING SHOAL OFFSHORE WIND FARMS ADDITIONAL AREAS IN THE WASH

ASSESSMENT OF MARINE GEOPHYSICAL DATA AND ARCHAEOLOGICAL IMPACT ASSESSMENT

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Summary

Wessex Archaeology was commissioned by AMEC Power and Process Europe, on behalf of Centrica Renewable Energy Limited to undertake an archaeological interpretation of marine geophysical data for the three proposed additional areas of Race Bank and Docking Shoal Offshore Wind Farms, associated with the export cable routes. This report comprises the interpretation of multibeam bathymetry, magnetometer and sidescan sonar data and an archaeological impact assessment covering the additional areas, and is in addition to and informed by the archaeological and impact assessments of the wind farms and cable routes conducted previously.

The results identified a total of 13 sites in **Area 1**, of which one is a probable wreck site of unknown identity which has no corresponding record of loss and two are UKHO wreck losses, for which there is no marine geophysical evidence of their presence or extent. A total of 25 recorded sites were identified in **Area 2** and none represented distinct wrecks or probable wreck material. A total of 80 sites were identified in **Area 3**, of which six represent distinct wreck sites or distinct pieces of probable wreck material.

A large amount of fishing debris and other material of likely modern origin was observed in **Areas 2 and 3**, making the archaeological interpretation of objects of definite anthropogenic origin very difficult. This resulted in the identification of 109 anomalies which are interpreted as not modern but, whose origins remain uncertain. On the basis of the Rochdale Envelope all anomalies are considered to be of archaeological interest. Further evidence via investigation, in areas where impact is proposed, following detailed scheme plans would allow for a more detail interpretation of these sites.

The assessment also identified a possible palaeo-channel within **Area 3**. Buried palaeo-channels are frequently of archaeological interest with respect to the potential survival of prehistoric deposits. Such deposits may yield archaeological material and provide valuable palaeo-environmental data for the reconstruction of past landscapes associated with early human presence.

In order to facilitate the design stages of the development, 50m temporary buffers have been placed around the extent of each known or probable wreck site (**WA7038-WA7043**). As the assessment of marine geophysical data did not establish the presence and extent of UKHO wreck loss records **WA7100** and **WA7001**, a 100m temporary buffer has been placed on the wreck's previously recorded centre point.

In view of further evidence, no temporary buffers have been proposed for the 109 anomalies of uncertain origin. Until further evidence allows for a more detailed interpretation, these anomalies remain of archaeological interest. These anomalies can be addressed on a case by case basis in revisions to the Written Scheme of Investigation once a detailed development scheme has been agreed. These anomalies should be avoided where practical, however any anomalies which lie in the vicinity of the planned route will need to be investigated further during the design / construction phase. It is expected that these investigations, if required, will be undertaken as part of the pre-lay grapnel run.

RACE BANK AND DOCKING SHOAL OFFSHORE WIND FARMS ADDITIONAL AREAS IN THE WASH

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Datasets were provided for the 2006 and 2007 assessments by the National Monuments Record, the UK Hydrographic Office and Norfolk Historic Environment Record. Wessex Archaeology is grateful to the staff of all these organisations for their co-operation.

Cristina Serra processed and interpreted the marine geophysical data and carried out the assessment with quality control provided by Paul Baggaley. The impact assessment was carried out by Victoria Cooper. Kitty Brandon prepared the illustrations. The project was managed for Wessex Archaeology by Caroline Budd and quality assurance was carried out by Euan McNeill.

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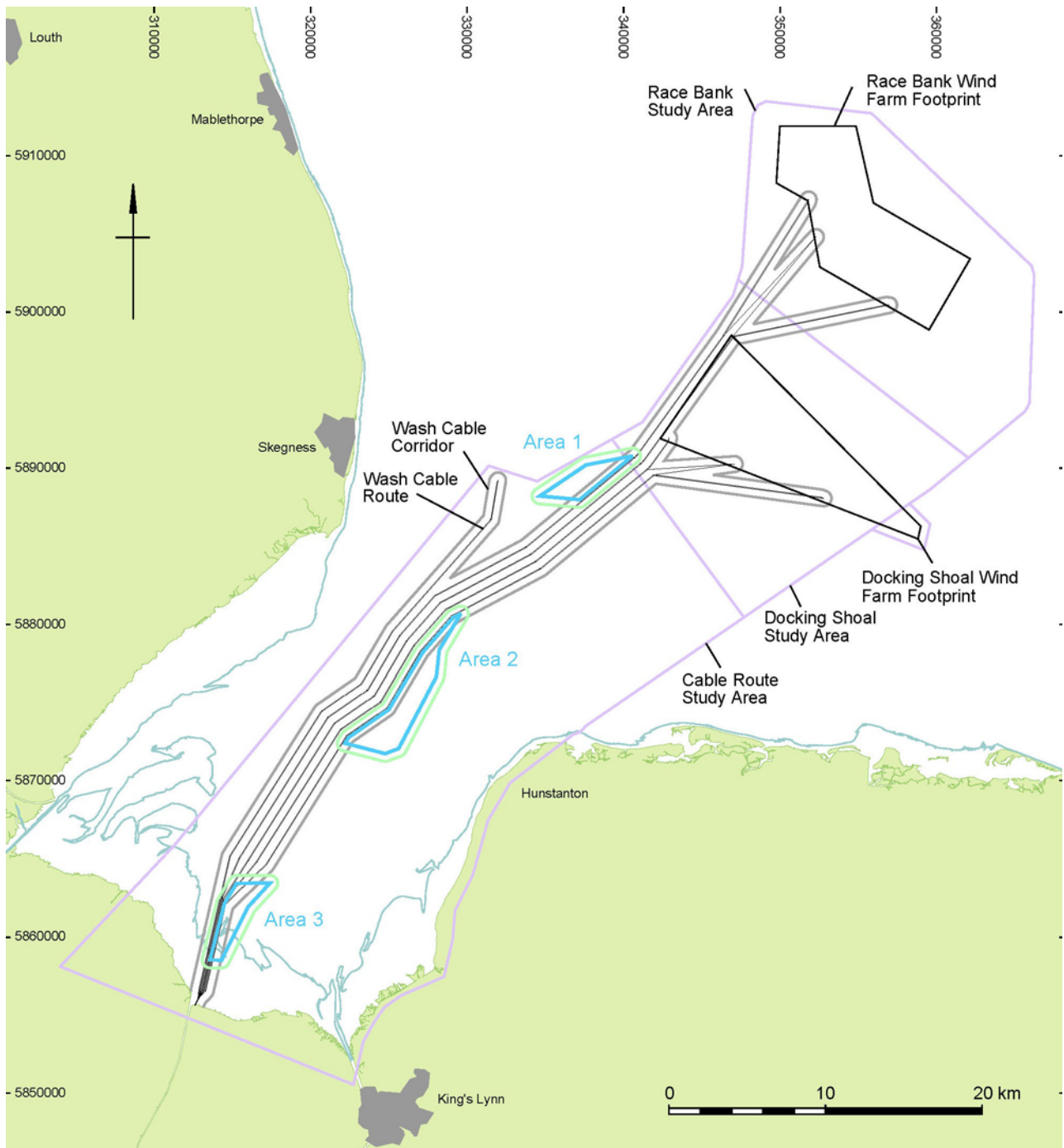
1 INTRODUCTION

1.1 Project Background

- 1.1.1 Wessex Archaeology (WA) was commissioned by AMEC Power and Process Europe, on behalf of Centrica Renewable Energy Limited to prepare an archaeological assessment of additional marine geophysical data, acquired by Emu Ltd, covering three additional areas situated along the Wash cable corridor, and an impact assessment based on these findings. This is in addition to and informed by the previous work conducted in relation to the wind farms and their cable routes.
- 1.1.2 The Wash cable corridor leads to Docking Shoal and Race Bank offshore wind farms situated approximately 14km and 27km respectively off the north Norfolk coast (**Figure 1**). WA has previously undertaken archaeological assessments for proposed wind farms off the coast of Norfolk and Lincolnshire and their associated cable routes situated in The Wash (WA 2002a-b, a-c, 2007a-b, 2008a). These assessments highlighted known and potential archaeological sites within large study areas (**Figure 1**) encompassing the three Wash cable corridor additional areas.
- 1.1.3 This report has been produced to combine reports 62556.01, an archaeological assessment of marine geophysical data acquired by Emu Ltd. for the Wash cable route additional areas, and addendum 62556.02 comprising an impact assessment covering the additional areas.

1.2 Study Areas

- 1.2.1 The three additional areas of proposed development, **Areas 1, 2 and 3**, are attached to the proposed Wash cable route at approximately 40km, 20km and 3km respectively from shore. **Area 1** consist of an area of seafloor of 6 km², **Area 2** of 15.2 km² and **Area 3** of 6.7 km² (below and **Figure 1**)



1.2.2 The footprint for each of the three Study Areas is defined by the following coordinates:

Table 1: Area 1 Coordinates in WGS84 datum, UTM31N

| Area 1 | Area 6 km ² |
|--------|------------------------|
| Node A | 340577E, 5890786N |
| Node B | 337194E, 5887985N |
| Node C | 334652E, 5888220N |
| Node D | 337603E, 5890207N |

Table 2: Area 2 Coordinates in WGS84 datum, UTM31N

| Area2 | Area 15.2 km ² | | |
|--------|---------------------------|--------|-------------------|
| Node A | 325623E, 5872049N | Node F | 327154E, 5878194N |
| Node B | 324763E, 5871724N | Node G | 329121E, 5880453N |
| Node C | 322202E, 5872392N | Node H | 329587E, 5880674N |
| Node D | 322435E, 5872765N | Node I | 328225E, 5878383N |
| Node E | 325014E, 5874565N | Node J | 328034E, 5876632N |

Table 3: Area 3 Coordinates in WGS84 datum, UTM31N

| Area 3 | Area 6.7 km ² | |
|--------|--------------------------|--|
| Node A | 315990E, 5861897N | |
| Node B | 314308E, 5858507N | |
| Node C | 313568E, 5858514N | |
| Node D | 314492E, 5862128N | |
| Node F | 315263E, 5863417N | |
| Node G | 317398E, 5863429N | |

- 1.2.3 A buffer of 500m has been placed around each of the three Study Areas in order to address sites situated on the edge of the proposed areas of development and those anomalies identified in the complete marine geophysical datasets, whose extents may encroach into the area defined by the development (**Figures 1, 3, 5, 7**).

1.3 Aims and Objectives

- 1.3.1 This assessment details the known archaeological resource situated within the three Study Areas as identified during previous assessments and during the assessment of marine geophysical data acquired for this project.
- 1.3.2 It was outside the scope of this report to produce new searches updating the known maritime records or to propose measures of mitigation.

2 DATUMS

2.1 Vertical Datum

- 2.1.1 The vertical datum was Chart Datum at Skegness, 3.5m below Ordnance Datum Newlyn.

2.2 Horizontal Datum

- 2.2.1 The data was acquired by Emu Ltd in WGS84 datum and UTM31N projection with a Hemisphere Crescent DGPS system providing an accuracy of 2-3m. During the **Area 1** and **Area 2** surveys the sidescan sonar fish was accurately positioned using an Ultra Short Baseline (USBL) system providing 1m accuracy. Due to the shallow water depths of **Area 3**, the USBL was not used but the cable-out layback was applied to the data during acquisition. This provided less than 10m accuracy. The magnetometer cable-out layback was applied to the digital data during acquisition for all three areas.
- 2.2.2 The assessment of marine geophysical data has been undertaken in WGS84 UTM31N and the results have been presented in **Appendix I** accordingly.

2.3 Seabed Geology

- 2.3.1 The geology in **Area 1** comprises Upper Cretaceous Chalk overlain by Bolders Bank Formation deposited in the late Pleistocene (BGS 1991b). The Bolders Bank Formation is a Devensian Till consisting of sandy clay and gravel. According to Emu Ltd technical report, minimal Holocene sediments, predominantly sands and some sandy gravel, cover **Area 1**. Large sandwaves and areas of sand ripples have been digitised and illustrated in **Figure 3**.
- 2.3.2 The geology in **Area 2** comprises Lower Cretaceous bedrock, overlain by Swarte Bank Formation which, on the south-eastern part of the Study Area, is overlain by Bolders Bank Formation (Emu Ltd. 2009 and BGS 1991a and 1991b). A thin veneer of Holocene sand covers most of the Study Area with the exception of the eastern portion where large sandwaves are present. Large sandwaves and areas of sand ripples have been digitised and illustrated in **Figure 5**.
- 2.3.3 The Emu Ltd. (2009) geophysical report identified a number of channels incised into the bedrock. Buried palaeo-channels are frequently of archaeological interest with respect to the potential survival of prehistoric deposits. Such deposits may yield archaeological material and provide valuable palaeo-environmental data for the reconstruction of past landscapes associated with early human presence.
- 2.3.4 The geology in **Area 3** comprises Jurassic bedrock overlain by possible Swarte Bank Formation or Lowestoft Till and covered with Holocene alluvium consisting of marine and estuarine sands, silts, clays and peats (Emu Ltd. 2009). Peat and other organic deposits are of significant archaeological interest as key indicators of the palaeo-environments and former sea level variations which influenced patterns of early human settlement. Emu Ltd. reported several areas of acoustic blanking which may be associated with the decay of organic-rich deposits, although they could also indicate deep gas deposits. A veneer of Holocene sands covers the area in varying thicknesses (Emu Ltd 2009).
- 2.3.5 A buried meandering channel situated on the north-western part of the Study Area was identified during WA assessment of magnetometer data (**Figure 2**). Two additional channels separated by the Whiting Shoal plateau were observed in the bathymetry data. The central and deepest one is the Old Lynn Channel. They are both situated in the north-eastern part of the **Area 3** study area and are orientated north-south. The plateau dries up to 1.52m above CD (Emu Ltd. 2009) and is likely to have the cause of vessel wrecking. Two smaller channels were also observed orientated southwest-northeast to join the Old Lynn Channel (**Figure 2**).
- 2.3.6 The channels observed by Emu Ltd. and WA in the marine geophysical data were compared to information provided by Amec regarding Wisbech Channel variation. This briefing note was based on historic Admiralty Charts and a report from the mid 1970s which considered changes in the Nene outflow and the Great Ouse. The data was compared to the magnetometer assessment revealing correlation between many of identified channels and historic channel movement.
- 2.3.7 However, the meandering palaeo-channel in **Area 2** does not correlate to charted historic channel movements. The sinuous nature of this channel does match the tendencies of other 19th and 20th century channels illustrated in the briefing note but the evidence suggests that this channel either pre dates 1843 or that it was never recorded. Therefore, without further evidence it is not possible to establish the channel origin and date.

- 2.3.8 Three distinct areas of sandy deposits were observed in the bathymetry data. Sandwaves and sand ripples are most common on the western portion of the Study Area where the two western channels lie. A thin strip of sandy ripples is observed along the eastern flank of the Old Lynn Channel. A plateau of sandwaves is observed to the east of the eastern most channel. Sandwaves are generally 0.5-2m and may be big enough to bury archaeological remains. Large sandwaves and areas of sand ripples have been digitised and illustrated in **Figure 7**.
- 2.3.9 The presence of sandwaves in general has implications for the survival and condition of archaeological sites as well as the identification of their presence. The presence of sandwaves indicates that the environment is mobile, with archaeological sites possibly subject to cycles of exposure and burial which will make them vulnerable to deterioration. Additionally, sandwaves may be extensive enough to cover archaeological sites making their detection problematic.

3 METHODOLOGY

3.1 Approach

- 3.1.1 The methodology reflects best practice in carrying out archaeological desk-based assessments, as codified by the Institute for Archaeologists (IfA) Standard and Guidance for Archaeological Desk-based Assessment (IfA 2008), the JNAPC Code of Practice for Seabed Developers (JNAPC 2006) and the COWRIE Guidance Notes (COWRIE 2007, 2008).
- 3.1.2 The approach also reflects the requirements of Environmental Assessment arising from European Council Directive 85/337/EEC as amended by Directive 97/11/EC and Directive 2003/35/EC.
- 3.1.3 All records of known maritime sites, including wrecks and obstructions and casualties, and marine geophysical anomalies identified by WA during previous archaeological assessments and falling within the three Study Areas (**Areas 1-3**), have been used to aid the interpretation of the 2009 marine geophysical data acquired by Emu Ltd. It was outside the scope of this report to produce new desk-based search and update the maritime records falling within the Study Areas.
- 3.1.4 The principal sources consulted by WA in the 2006 and 2007 assessments for Docking Shoal and the Wash cable corridor and relevant to this report are as follows:
- Records of wrecks and obstructions collated by the UK Hydrographic Office (UKHO) and obtained from Metoc plc as Seazone data;
 - Records of known wrecks and documented losses held in the maritime section of the National Monuments Record (NMR);
- 3.1.5 All known sites and marine geophysical anomalies were overlaid and assessed in ArcMap9 Geographical Information System (GIS).

3.2 Marine Geophysical Data Acquisition, Processing and Interpretation

- 3.2.1 WA was commissioned to assess the marine geophysical data acquired for the three additional cable route areas in the Wash. All the anomalies identified were cross-referenced in ArcMap9 GIS to establish an anthropogenic origin and assess their archaeological potential. All maritime records and anomalies associated with

one single object or forming an extended patch of material were grouped into sites and their details listed in a gazetteer in **Appendix I** and illustrated in **Figures 3-8**.

Sidescan Sonar Data

- 3.2.2 Emu Ltd. acquired sidescan sonar data with an Edgetech 4200 dual frequency sidescan sonar. The sidescan sonar data covers all three Study Areas in full with high (400kHz) and low (120kHz) frequencies, at a 100m range and a varying line spacing to suit the water depth. The data were recorded in *jsf* format and instrument layback correction was corrected during acquisition making use of a USBL within **Areas 1** and **2** and by manual logging for **Area 3**. WA did not alter this during the processing and interpretation of the dataset. The *jsf* files were converted to *cod* format by WA.
- 3.2.3 The sidescan sonar data was processed by WA using Coda Geosurvey software. This allowed the data to be replayed with various gain settings in order to optimise the quality of the images. The data were initially scanned to gain an understanding of the geological nature of the area and were then interpreted for any objects of possible anthropogenic origin and the position and dimensions of any such objects recorded.
- 3.2.4 An anomaly is defined as something which differs from the surrounding seabed and which has characteristics which suggest that it is of anthropogenic origin and of archaeological interest, as opposed to modern debris.
- 3.2.5 The form, size and/or extent of an anomaly acts as a guide to its nature. A single small but prominent anomaly may be part of a much more extensive feature that is largely buried. Similarly, a scatter of minor anomalies may define the edges of a buried but intact feature, or it may be all that remains as a result of past impacts from, for example, dredging or fishing. Anomalies that are not upstanding and are highly degraded, particularly those made of wood, can be difficult to identify even with data acquired at high frequency.

Magnetometer Data

- 3.2.6 Emu Ltd. acquired the magnetometer data with a Geometrics G882 caesium magnetometer. The magnetometer towfish cable-out was logged during acquisition. This varied between 50m and 80m. WA did not alter this during the processing and interpretation of the dataset. The data were made available to WA staff in digital format in three separate xyz files.
- 3.2.7 The magnetic data was processed to give an xyz file comprising grid co-ordinates (x,y) and total magnetic field strength (z). Each line of data was then processed to remove the regional magnetic field and also any large diurnal effects, which may have masked small magnetic anomalies of interest to this survey. The data was then gridded to produce a contour map of the survey area and plotted with the magnetic field strength values represented by graded colour bands to show changes in the magnetic field strength.
- 3.2.8 The magnetic anomalies were then assessed and the position and magnitude of all anomalies with a magnetic amplitude of 5nT or more were recorded as anomalies of possible archaeological interest. The magnitude of the anomalies is not proportional to their archaeological potential. The results of the magnetometer data assessment were cross-referenced to the anomalies identified in the sidescan sonar and multibeam bathymetry data in order to discriminate anomalies of modern origin.

Multibeam Bathymetry

- 3.2.9 Emu Ltd. acquired multibeam bathymetry with Reson Seabat 8101 240kHz head and Coda Octopus F180 precision attitude and positioning system. The data was tidally reduced by Emu Ltd. through the collection of Post Processed Kinematic (PPK) GPS data on board the survey vessel. The data were made available to WA staff in digital format in three separate xyz files gridded to 2m cell size.
- 3.2.10 The data was made into a surface by WA staff using IVS Fledermaus software and used to identify the larger, upstanding features observed on the sidescan sonar data as well as mapping the presence of mobile sediments such as sandwaves in which archaeological remains may be buried.

3.3 Impact Assessment

- 3.3.1 The methodology for this assessment takes account of guidelines set out in Historic Environment Guidance for the Offshore Renewable Energy Sector (COWRIE 2007) and Guidance for Assessment of Cumulative Impacts on the Historic Environment from Offshore Renewable Energy (COWRIE 2008).
- 3.3.2 There is a specific requirement to address the historic environment as part of the Environmental Impact Assessment (EIA) process. The requirements of EIA are defined in European Council Directives on Environmental Assessment 85/3378/EEC (amended in 1997 by Directive 97/11/EC).
- 3.3.3 The guiding principles for cultural heritage in EIA are presented in the COWRIE Guidance (2007: 28) and require the EIA to:
- Assess all beneficial and adverse impacts on cultural heritage, including direct, indirect, temporary, permanent and cumulative effects.
 - Evaluate the significance of any impacts on the cultural heritage resource to take account of both the intrinsic value of the resource and how much it will be changed.
 - Use relevant international, national and local legislation and policy to explain the significance, and make explicit the basis for any statements concerning value or importance.
 - Consider a variety of approaches to mitigation, including design modification, appropriate investigation and recording measures.
 - Propose realistically achievable mitigation measures and fully monitor and document any agreed actions, including responsibility for their implementation.
- 3.3.4 With respect to these principles the impact of the development will be discussed with reference to the following:
- Archaeological importance
 - Impact of proposed development
 - Significance of effects
 - Proposed mitigation

3.3.5 This report will also consider the cumulative impact of wind farms and aggregate extraction areas in close proximity to the additional areas in The Wash.

4 TECHNICAL SPECIFICATIONS AND DATA AUDIT

4.1.1 WA was commissioned to audit and interpret the sidescan sonar, magnetometer, and multibeam bathymetry data acquired over the three Study Areas. The data audit concluded that the data was of average quality for archaeological purposes as detailed in **Table 4** below:

Table 4: Data Quality Rating Criteria for Archaeological Purposes

| | |
|----------|---|
| 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. These datasets also provide 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 these datasets, 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. |

4.1.2 The marine geophysical surveys for the Wash Additional Cable Route **Areas 1** and **2** were undertaken by Emu Ltd. on board of the *RV Discovery* between 18th and 23rd May 2009. **Area 3** was surveyed on board of the *Emu Surveyor* between 21st and 30th April 2009.

Bathymetry

4.1.3 The quality of bathymetry data was satisfactory as a datum for the other geophysical datasets but, due to the difficulties of surveying in shallow water, was not of sufficient resolution for the identification of isolated anomalies.

4.1.4 The acquisition of multibeam bathymetry data over **Area 3** was at 25m line spacing. The data quality was assessed as average as some small patches of seafloor had not been ensonified. This may be a result of navigation problems (as reported by Emu Ltd to WA by e-mail) caused by the very shallow water depths in the area.

Sidescan Sonar

4.1.5 The sidescan sonar data was acquired using both low and high frequency at a 100m range. The quality of the sidescan sonar data was average for archaeological purposes (**Table 4**), particularly in respect to the quality of ensonification. The high frequency did not always ensonify the sidescan sonar range in full, thus reducing the effective seafloor coverage. The quality of the data was also, at times, insufficient for a positive distinction between modern and archaeological material. For these two reasons WA reviewed both the low and high frequency datasets.

- 4.1.6 The survey line spacing varied according to the water depths shown on the Admiralty charts. Line spacing in **Area 1** varied between 50m, 75m and 100m, for the three datasets. The majority of sidescan sonar data was acquired at 50m line spacing. This line spacing together with a 100m range resulted in a total seabed overlap of 200%. This level of ensonification enhances the probability for the detection of objects and sites lying on the seafloor, and allows for more accurate positioning of objects identified from more than one survey line.
- 4.1.7 The sidescan sonar line spacing in **Area 2** was 100m. This line spacing together with a 100m range resulted in a total seabed overlap of 100%. This level of ensonification would not maximise the probability of detecting objects and sites lying on the seafloor, and does not allow for accurate positioning of objects identified from more than one survey line.
- 4.1.8 The sidescan sonar data in **Area 3** was acquired at 50m line spacing. This line spacing together with a 100m range resulted in a total seafloor overlap of 200%. This level of ensonification enhances the probability for the detection of objects and sites lying on the seafloor, and allows for more accurate positioning of objects identified from more than one survey line.

Magnetometry

- 4.1.9 Magnetometer line spacing ranged between 70-150m, increasing towards the east to within only three lines in 500m. This line spacing would not allow for the detection of sites of medium/low ferrous content.
- 4.1.10 The magnetometer data quality was considered as average for archaeological purposes with respects to seafloor coverage and data quality (**Table 4**). The magnetometer data were generally good, but some lines were affected by excessive noise. The magnetometer data were acquired at line spacings between 70-100m. Any objects of low ferrous content lying in between survey lines would not have been detected. In addition to this, the northern section of **Area 2**, approximately 1.2Km, was not surveyed with the magnetometer. This was verified by Emu Ltd via e-mail correspondence.
- 4.1.11 The magnetometer data acquired in **Area 3** was considered of good quality for archaeological purposes with regards to seafloor coverage but average overall as some lines were affected by excessive noise. The magnetometer data was acquired at line spacings of between 20-50m. Any objects of low ferrous content lying in between survey lines had a higher probability of detection. This is reflected in the results with the largest number of magnetometer anomalies identified in this area. Lines affected by noise would not have facilitated the detection of objects of low ferrous content.

5 RESULTS

- 5.1.1 The assessment of marine geophysical data was undertaken in conjunction with the records of wreck losses provided by the UKHO and NMR for WA's 2006 Desk-Based Assessment (WA 2006a) and the Admiralty Charts 108 and 1200. The assessment revealed a total of 118 sites and anomalies plus 23 documented losses. A list of sites and geophysical anomalies lying within the three Study Areas are presented in **Appendix II** and illustrated in **Figures 2-8**.
- 5.1.2 The anomalies identified during the 2007 assessment of marine geophysical data for the Wash cable corridor (WA 2007b) and partially covering each of the Study Areas,

were compared during this assessment but have not been listed or illustrated in this report.

5.2 Documented Losses

5.2.1 A total of 23 documented losses were provided by the NMR (**WA2000-WA2022**). These are listed in **Appendix I** and their position illustrated in **Figure 5**. Documented Losses refer to records of vessels lost in an area for which the exact position and physical state of preservation (if any) is unknown. Documented losses are referred to by the NMR as “Named Locations”.

5.2.2 All 23 sites are recorded at the same Named Location which falls within **Area 2**, but since this is only an approximation, and these are often erroneous by miles, the 23 sites may or may not be found within the Study Area. Sites such as these need to be assessed on an individual basis if they are to be subject to impact via the development scheme. It is expected that, in cases where avoidance is not practical, further survey work which could be carried out as part of the design/construction phases (for example via the pre-lay grapnel run) once the final cable route is decided, will provide data that will aid in more definitively determining the archaeological potential of these sites. The results of these investigations will inform any decisions with regards to mitigation, if deemed applicable.

5.3 Results for Study Area 1

Background

5.3.1 The assessment of the multibeam bathymetry data within **Area 1** indicated a water depth between 4.2m and 30.3m below Chart Datum (CD). In conjunction with the sidescan sonar the data also revealed a series of sandwaves (2-8m high) that may affect the identification of archaeological material. These were observed orientated northwest-southeast and covering the central portion of the Study Area but most prominently occurring in the southwest corner as illustrated in **Figure 3**. The second area of large sandwaves is observed on the north-eastern corner, just outside the footprint of the proposed area of development.

5.3.2 No features of archaeological interest were noticeable on the multibeam bathymetry or identified in the magnetometer data. A total of 13 sites and anomalies were identified within **Area 1 (WA7000-WA7012)**, three of which are known and probable wreck sites and ten are anomalies and group of anomalies anthropogenic origin and possible archaeological interest. All but **WA7000** lie inside the direct footprint of **Area 1**. These are listed in **Appendix II** and illustrated in **Figures 3 and 4**.

Table 5: Summary of Sites in Area 1

| Area 1 | Known Sites | Bright reflectors | Dark reflectors | Debris | Seafloor Disturbance | Magnetic only |
|-----------|-------------|-------------------|-----------------|--------|----------------------|---------------|
| Total: 13 | 3 | 1 | 4 | 4 | 1 | 0 |

Known and Probable Wreck Sites

5.3.3 A total of three wreck sites were identified within **Area 1** Study Area. These are two UKHO records and a wreck identified in the sidescan sonar data (**Appendix II and Figures 3 and 4**).

- 5.3.4 According to the wreck data obtained in 2006, there are two UKHO recorded wreck losses (**WA7000-1**) for which no geophysical anomalies have been identified in the datasets. **WA7000** is a live record of a wreck believed to be a steamboat of approximately 100 years old and **WA7001** is a wreck of unknown origin and identity, located in an area of mobile seabed.
- 5.3.5 The third wreck site (**WA7002**) was initially identified in the sidescan sonar data. Details of this wreck are listed in **Appendix II** and illustrated in **Figures 3** and **4**. **WA7002** was interpreted as a likely wreck orientated southwest-northeast that appears partially exposed and measures 31m x 7.2m x 0.3m. The exposed section is characterised by two parallel edges, presumably the sides of the hull and angular internal detail. Two discrete parallel linear bright reflectors, continue south-westerly suggesting the wreck extends south-westerly under the sand. The site was only distinctively identified in the sidescan sonar data, whilst the multibeam bathymetry revealed a discrete wreck shape feature resting at the base of a large sandwave. The magnetometer survey lines at this point are 300m apart. With the closest survey line at 100m, the magnetometer may have been too far away to identify the anomaly. **WA7002** was identified in an area where numerous anomalies were identified during the 2007 assessment of the Wash cable corridor marine geophysical data (WA 2007b). Since the site lies approximately 420m northeast of UKHO record **WA7001**, these two sites may be associated or could represent two separate wreck sites.
- 5.3.6 **WA7001** and **WA7002** are situated in an area of mobile sediments and large sandwaves, and they are thus likely over time to become buried and re-exposed.

Anomalies of Archaeological Interest

- 5.3.7 A total of ten anomalies or groups of anomalies were identified as objects of anthropogenic origin and archaeological interest (**WA7003-WA7012**). These include one bright reflector (**WA7003**), four dark reflectors (**WA7004-7**), four pieces of debris (**WA7008-11**) and one seafloor disturbance (**WA7012**) as summarised above in **Table 5**.
- 5.3.8 **WA7003** is a patch of bright reflectors situated by a large sandwave on the south-eastern edge of the Study Area. The largest of which measure 15.5m x 6.7m and 8.4m x 5.2m. One other bright reflector (**WA6345**) of uncertain origin was identified 25m north of **WA7003** during the 2007 assessment of marine geophysical data. **WA6345** measured 5.7m x 2.4m (**Figure 3**).
- 5.3.9 **WA7004-7** and **WA7012** are four dark reflectors and a seafloor disturbance (**Figure 3**) identified in an area where other anomalies were reported in the 2007 assessment of marine geophysical data for the Wash cable corridor (WA 2007b). There is no correlation between the individual anomalies from the two assessments other than that they all fall in the same south-eastern part of the Study Area.
- 5.3.10 **WA7008-11** are isolated pieces of debris of unknown origin (**Figure 3**). They have been identified as man-made objects of possible archaeological interest. **WA7010** was identified as a group of three objects, two of which were distinct pieces of elongated debris measuring 7.2m x 2.7m and 8.5m x 2.8m and lying approximately 6m apart. The third object lies 30m to the north and measures 6.1m x 1.2m.

5.4 Results for Study Area 2

Background

- 5.4.1 The assessment of the multibeam bathymetry data within **Area 2** indicated a water depth between 12.2m and 47.7m below Chart Datum (CD). The greatest depth corresponds to a deep channel, Well Deep, located towards the north-western corner of the Study Area. The bathymetry and sidescan sonar data also revealed a series of sandwaves (1.3-6m) orientated approximately southeast-northwest and restricted to a northeast-southwest strip on the eastern edge of the Study Area. Their size diminishes to sand ripples towards the south-eastern corner of the Study Area as illustrated in **Figure 5**.
- 5.4.2 No features of archaeological interest were identified in the multibeam bathymetry data in isolation; however, the sidescan sonar data revealed numerous sections of fishing gear and associated debris, most notably on the eastern side of the Study Area. The process of discrimination between modern and archaeological anomalies was particular difficult in this area due to the spread and quantity of modern material. Every effort was made to exclude all material believed to be modern debris. The sites and anomalies listed in **Appendix II** are believed to be possible or probable remains of archaeological interest.
- 5.4.3 A total of 25 anomalies and groups of anomalies were identified within **Area 2 (WA7013-WA7037)**. They were all identified as objects of likely anthropogenic origin and archaeological interest. All but two (**WA7014** and **WA7017**) lie inside **Area 2's** direct footprint. These are listed in **Appendix II** and illustrated in **Figures 5** and **6**.

Table 6: Summary of Sites in Area 2

| Area 2 | Known Sites | Dark reflectors | Debris | Mound | Seafloor Disturbance | Magnetic only |
|-----------|-------------|-----------------|--------|-------|----------------------|---------------|
| Total: 25 | 0 | 11 | 5 | 1 | 3 | 5 |

- 5.4.4 The UKHO and NMR searches undertaken in 2006 by WA resulted in a total of 23 Documented Losses. Although the approximate position given by the NMR falls within **Area 2**, as illustrated in **Figure 5**, their location cannot be confirmed. Any of these may or may not be within each of the Study Areas. The 23 records include eight WWII aircraft, which would be automatically protected under the Protection of Military Remains Act (1986); two 18th century vessels and 13 early 19th century vessels as detailed in **Appendix I**.

Known and Probable Wreck Sites

- 5.4.5 No wreck sites or objects of distinctively archaeological origin were identified within **Area 2**.

Anomalies of Archaeological Interest

- 5.4.6 A total of 25 anomalies or groups of anomalies were identified as objects of likely anthropogenic origin and archaeological interest (**WA7013-WA7037**). These include 20 anomalies identified in the sidescan sonar data alone and five magnetometer anomalies for which there is no visual evidence on the sidescan or multibeam bathymetry datasets. The sidescan sonar anomalies consists of 11 dark reflectors, five pieces of debris, one mound and three seafloor disturbances as summarised in **Table 6** above. These are listed in **Appendix II** and illustrated on **Figures 5** and **6**.

- 5.4.7 All but six sidescan sonar anomalies (**WA7014**, **WA7016-7**, **WA7019**, **WA7027** and **WA7037**) are situated along the area of sandwaves dominating the eastern part of the Study Area. This is also an area characterised by a large amount of fishing gear and other modern debris. The loss of fishing gear on the seafloor is indicative of the presence of seafloor obstructions, some of which potentially could be archaeological remains. These anomalies may also represent modern debris of no archaeological interest. The origin of these anomalies cannot be clarified until further evidence is available.
- 5.4.8 There are three sites amongst the 25 which may be more significant due to their size and distinct detail. These are **WA7016**, **WA7026** and **WA7029**. These are detailed in Appendix II and illustrated on **Figures 5** and **6**.
- 5.4.9 **WA7016 (Figure 5)** is a distinct patch of material identified in a flat featureless seafloor. The patch is formed by three distinct dark reflectors, probably forming part of the same structure. All together they measure 24.6m x 7m.
- 5.4.10 **WA7026** is a patch of debris situated amongst sandwaves and is associated with a distinct linear feature interpreted as a cable/rope associated with fishing gear. **WA7026** measures 77m x 16.4m x 0.3m and its origin cannot be established with the available data. The cable/rope appears to go through the site, suggesting **WA7026** was already on the seafloor and the cable/rope snagged on it. However, it is also possible that **WA7026** is part of the fishing gear or other modern debris. **WA7026** is illustrated on **Figures 5** and **6**
- 5.4.11 **WA7029** is an oval shaped mound resembling that of a partially buried shipwreck. Given that it is surrounded by material of modern origin it may represent a partially buried portion of cable or fishing gear. The site is situated amongst sandwaves and appears to be producing some scouring. **WA7029** measures 21.3m x 5.5m x 0.3m (**Figure 5**).
- 5.4.12 A total of five anomalies were identified in the magnetometer data alone (**WA7033-WA7037**). These were identified in a dense area of linear debris associated with fishing gear. They are likely to represent modern debris but without conclusive sidescan sonar evidence, it remains possible that these anomalies may represent material of archaeological interest. These anomalies have been illustrated on **Figure 5**.

5.5 Results for Study Area 3

Background

- 5.5.1 The assessment of the multibeam bathymetry data within **Area 3** indicated a water depth between 3.5m and 16m below Chart Datum (CD). It revealed the old Lynn channels orientated north-south, along with a second set of channels, probably a current or historic channel of the Nene, trending northeast – southwest. Some isolated patches of sandwaves on the eastern and western edges of the study area, and most predominant areas of sand ripples on the western side of the study area, were also identified (**Figure 7**).
- 5.5.2 Additionally, a series of small, sinuous, buried palaeochannels were identified on the magnetometer data in the northwest of the study area (**Figure 7**). Both of these sets of channels are of potential archaeological interest: The historic channels for artefactual information (e.g. small buried wrecks in partially silted up sections of channel), and the buried palaeochannels for both artefactual and palaeoenvironmental information.

- 5.5.3 The process of discrimination between modern and archaeological was also difficult in this area. Every effort has been made to exclude all material believed to be modern debris. The sites and anomalies listed in **Appendix II** are believed to be possible or probable remains of archaeological interest.
- 5.5.4 No features of archaeological interest were identifiable on the multibeam bathymetry alone but the assessment of all datasets identified a total of 80 sites and isolated anomalies within **Area 3 (WA7038-WA7117)**. There are six known or probable wreck sites (**WA7038-WA7043**) and 74 anomalies or groups of anomalies of anthropogenic origin and archaeological interest (**WA7044-WA7117**). All but five anomalies (**WA7059, WA7074, WA7083, WA7115, and WA7116**) lie inside **Area 3's** direct footprint. These are listed in **Appendix II** and illustrated in **Figures 7**.

Table 7: Summary of Sites in Area 3

| Area 3 | Known Sites | Dark reflectors | Debris | Seafloor Disturbance | Magnetic only |
|-----------|-------------|-----------------|--------|----------------------|---------------|
| Total: 80 | 6 | 15 | 6 | 6 | 47 |

- 5.5.5 The **Area 3** sidescan sonar data revealed numerous sections of fishing gear and associated debris which, to a lesser extent than **Area 2**, obstructed the process of discrimination between modern and archaeological anomalies. The loss of fishing gear on the seafloor is indicative of the presence of seafloor obstructions, some of which potentially could be archaeological remains. Every effort was made to exclude all material believed to be modern debris.

Known and Probable Wreck Sites

- 5.5.6 A total of six sites were identified within **Area 3**. All but one, **WA7039**, are known or probable wreck sites (**WA7038-WA7043**). These are detailed in **Appendix II** and illustrated in **Figures 7** and **8**.
- 5.5.7 **WA7039 (Figure 8)** is a known patch of debris measuring 92m x 80m x 0.7m which has a magnetic amplitude of 23nT. The find correlates with an UKHO record of dumped stones, the largest of which measures 5.5m x 1.6m x 0.4m. This feature is likely to be a ballast mound.
- 5.5.8 **WA7038 (Figure 8)** is a wreck orientated east-west with a large patch of associated debris on its southern side. The site is recorded by the UKHO as a wreck of unknown identity. The wreck measures 21m x 7m x 1.5m and has a magnetic value of 19.36nT. The debris field extends for 24m to the south.
- 5.5.9 **WA7040** was identified as a group of angular structures that appear detached or partially buried. There are two main fragments, the largest measuring 5m x 4m with a distinct magnetometer anomaly situated approximately 100m southeast. The site extends east-west for at least 24.7m x 15.8m into an area of small sand ripples.
- 5.5.10 **WA7041** lies approximately 200m east of **WA7038** and has been identified as a series of parallel and angular dark reflectors orientated east-west suggesting the remains of a wreck measuring 11.3m x 3.7m. The site was identified in the magnetometer data and has a magnetic amplitude of 57nT.

- 5.5.11 **WA7042** is a probable wreck site with pieces of debris in close proximity (30m and 80m to the south) and magnetometer anomalies within 140m to the north. The site measures 37.4m x 8m and has a magnetic value of 11.24nT. The site is situated on the western plateau in a similar orientation to the surrounding sandwaves, whose heights range between 0.1-0.3m.
- 5.5.12 **WA7043** is an oval shaped dark reflector orientated east-west and measuring 10.4m x 6.3m. Situated in an area of featureless seafloor the site is likely to represent the remains of a wreck. Despite the narrow line spacing, the magnetometer did not reveal any anomaly for this site. Three isolated magnetometer anomalies lie within 135 m radius of the wreck site.

Anomalies of Archaeological Interest

- 5.5.13 A total of 74 anomalies and groups of anomalies were identified as objects of likely anthropogenic origin and archaeological interest situated within **Area 3** Study Area (**WA7044-WA7117**). All but five anomalies (**WA7059**, **WA7074**, **WA7083** and **WA7115-6**) lie inside **Area 3**'s direct footprint. There are a total of 15 dark reflectors, five pieces or patches of debris, six areas of seafloor disturbance and 47 magnetometer anomalies as summarised above in **Table 7**, detailed in **Appendix II** and illustrated in **Figure 7**.
- 5.5.14 There are a total of 15 dark reflectors, three of which are most notable for their size or character. These are anomalies **WA7044**, **WA7045** and **WA7046**. **WA7044** and **WA7045** are likely to be associated with each other and form part of a possible wreck site. The area around these anomalies is characterised by surfacing linear outcrops. **WA7044** and **WA7045** may represent a possible wreck or a geological formation. The **WA7044** site measures 21m x 4m consisting of three objects arranged in a line approximately 10m apart and orientated east-west. Individual measurements for the objects are 4m x 3.4m; 4.9m x 4.2m and 7.7m x 3.9m. **WA7045** is the fourth anomaly associated with **WA7044**. It has been identified approximately 55m to the south and measures 7.8m x 3.6m.
- 5.5.15 **WA7046 (Figure 8)** is a distinct dark reflector resembling a patch of material and a possible wreck site situated in a featureless seafloor. **WA7046** measures 29.4m x 8.7m and has been identified 128m north of **WA7064**.
- 5.5.16 **WA7047** and **WA7048** are two dark reflectors likely to be pieces of debris associated with site **WA7039**, the UKHO site of dumped stones, due to their close proximity (60m). Both anomalies were detected in the magnetometer survey with respective magnetic amplitudes of 17.48nT and 22.8nT.
- 5.5.17 A total of five pieces of debris (**WA7058-WA7063**) were identified as distinct angular objects but only **WA7060** has got an associated magnetometer anomaly (measuring 7.2nT).
- 5.5.18 An additional patch of material consisting of several scatters of debris and bright reflectors (**WA7064**) were identified approximately 300m north-west of **WA7065-WA7069**. **WA7064** measures 70.6m x 29.2m x 0.2m, it is orientated north-south and has an associated magnetometer anomaly of 29.8nT. The largest component object measures 24m x 8m. **WA7059** is the southern most site in **Area 3** and lies just outside the area's footprint. It has been identified as an angular object of likely archaeological interest measuring 10m x 4m.

- 5.5.19 A total of six areas of seafloor disturbance were identified within **Area 3**. These are **WA7065-WA7070**, four of which have an associated magnetometer anomaly. These are **WA7065-WA7067** and **WA7069**.
- 5.5.20 **WA7065-WA7068** are four mounds of material with distinct magnetometer anomalies. **WA7065** measures 16m x 11m and has a magnetometer anomaly of 11nT. **WA7066** measures 8m x 7m and has a magnetometer anomaly of 22.66nT. **WA7067** measures 6.4m x 5.1 and has a magnetic anomaly of 51nT. **WA7068** is the smallest measuring 6.6m x 3.4m.
- 5.5.21 **WA7069** is a seafloor disturbance consisting of a central mound and four surrounding ones. It measures 22m x 13.3m and has an associated magnetometer anomaly of 154nT. The mounds of material are similar to those discussed above (**WA7065-WA7068**) and are situated on a featureless seafloor on the eastern edge of **Area 3**. Two additional magnetometer anomalies believed to be associated with **WA7069** are situated 30m to the east and have a magnetic amplitude of 6nT (**WA7074**) and 153nT (**WA7116**).
- 5.5.22 The magnetometer identified a total of 47 anomalies representing ferrous objects for which no evidence has been identified in the sidescan or multibeam bathymetry datasets. These are **WA7071-WA7117** and their magnetometer amplitude range from 5-1365nT. **WA7117** was identified as a distinct dipole of 1365nT magnetic amplitude. This is likely to be associated with a modern piece of debris, possibly a buoy, but no evidence of such has been identified on the other datasets or on the admiralty charts. This anomaly was also identified during the 2007 assessment of marine geophysical data undertaken by WA (2007b).

6 IMPACT ASSESSMENT

6.1 Archaeological Importance

- 6.1.1 The archaeological importance of the sites within the three additional survey areas has been assessed in line with current best practice as advised by *Marine Class Descriptions and Principles of Selection in Aggregate Areas* (WA 2008b).
- 6.1.2 There are no wrecks or sites within the three Study Areas that are subject to statutory protection. Records from the National Monuments Record (NMR) include eight WWII aircraft which would be automatically protected under the Protection of Military Remains Act (1986). However, these records refer to reports of losses located at an arbitrary point on the seabed within **Area 2** for which no actual remains have yet been discovered (**Figure 5**). It is possible that remains of these aircraft may be discovered during the installation and/or decommissioning of the cable route and the associated wind farms. All such remains would be of importance to their country of origin.
- 6.1.3 Likewise, 15 wrecks are recorded by the NMR as having been lost in the area and recorded at the same arbitrary location within **Area 2** (**Figure 5**). Two of these reported losses date to the 18th century and thirteen to the early 19th century. While these records relate to as yet undiscovered remains it is possible that installation and/or decommissioning of the cable route, and the associated wind farms, may reveal remains which may be of national or possibly international importance.

- 6.1.4 The archaeological assessment of marine geophysical data from the Wash cable corridor additional areas identified 118 sites and anomalies of anthropogenic origin and consequently of potential archaeological interest (**Figures 3, 5 and 7**). However, 109 of these had geophysical signatures that were not clear enough to discern whether they represent anthropogenic material of modern origin or material of greater archaeological importance. In particular, a large amount of fishing debris and other material of likely modern origin was observed in **Areas 2 and 3** rendering the interpretation of anomalies problematic. The archaeological importance of these sites cannot currently be discerned.
- 6.1.5 The assessment of the additional areas has established the presence of nine known or probable wrecks, three in **Area 1** and six in **Area 3**. Three of these are reported by the UKHO as unknown wrecks and one as a 'foul'. This 'foul' has been interpreted as a ballast mound which may indicate the location of a wreck. The level of information provided by these records is insufficient to assess their importance.
- 6.1.6 The remaining probable wrecks have been observed in the marine geophysical data. Without further information regarding, for example, the identity, age or condition of these wrecks it is not possible to assess their importance.
- 6.1.7 The assessment also indicated a number of incised channels and potential organic rich deposits, both of which are of archaeological interest. Many of the channels appear to correlate to historic channel movements although a potential palaeo-channel in **Area 3** may be of prehistoric origin.
- 6.1.8 All deposits associated with palaeo-channels and the possible peat deposits in **Area 3** have the potential to yield archaeological material and palaeo-environmental data facilitating the reconstruction of past landscapes associated with early human activity. As such, any palaeo-environmental or artefactual material revealed during the installation and/or decommissioning of the cable route, and associated wind farms, may be significant.
- 6.1.9 The archaeological assessment of the additional areas has revealed potential aircraft, wrecks and prehistoric deposits of possible archaeological potential.
- 6.1.10 The importance of archaeological sites or material is commonly assessed with regard to a number of factors including:
- age: period of time in which a monument, site or artefact was in use;
 - function: contemporary use and meaning of a site or monument for the society that created it;
 - type: technological properties of a monument and their regional and chronological variations;
 - rarity: scarcity of surviving examples;
 - survival and/or condition: extent of preservation;
 - fragility and/or vulnerability: potential threats to continued preservation;
 - group value: location in relation to other sites or monuments;
 - documentation: previous investigation of the site or similar sites;
 - associations: contemporary associations with historical people or events.
 - scientific potential: potential of site or monument to contribute to scientific enquiry;
 - outreach potential: potential of a monument as a visual, educational and recreational resource.

- 6.1.11 These factors help to characterise a site or feature, to assess how representative it is in comparison to other, similar sites, and to assess its potential to contribute to knowledge, understanding and public outreach. In most cases, statutory protection is only provided to a site or feature judged to be an above average example in regard to these factors.
- 6.1.12 The current level of information available for the known sites identified within the archaeological assessment of the Wash cable route additional areas is insufficient to assess their importance with regard to the above factors. Until such time as further information becomes available these known sites, including buffer, should be avoided for the purposes of cable routing.
- 6.1.13 Acquisition of further information will only become necessary if direct impacts to known sites cannot be avoided and further exploratory archaeological work will then be required. Any sites impacted during the installation and/or decommissioning of the cable route will need to be assessed for importance on a site by site basis, this work could be carried out as part of the initial design/construction phase of the works during the pre-lay grapnel run / ROV surveys. Following these investigations exclusion zones would be proposed where relevant and mitigation, if required (in areas where the cable could not be re-routed), would be agreed and outlined via the updated WSI.

6.2 Impact of Proposed Development

Development Overview

- 6.2.1 The following information is taken from the 2006 AMEC report Race Bank - Rochdale Envelope.
- 6.2.2 Up to four 132 kV submarine cables will be required in order to export electricity from the wind turbines to the on shore substation. Cables will be typically laid in pairs with approximately 50 m separation distance between each pair of cables. The cable corridor will be 2.5 km wide from the offshore substation towards the intertidal zone. It will then narrow to approximately 500 m to cross the intertidal zone converging in an approximate 50 m corridor width at the beginning of the salt marsh.
- 6.2.3 The submarine cables will be buried in order to provide protection to the cable. Three techniques currently exist for subsea cable laying: ploughing, jetting and rock cutting.
- 6.2.4 Ploughing tools employ a plough blade, known as a 'share' that cuts a narrow trench into the seabed and holds it open long enough to depress the cable to the bottom of the trench. Ploughing is considered trenchless since the seabed closes behind the share. Ploughing tools are traditionally towed by a suitable vessel or winched by a barge.
- 6.2.5 Jetting tools excavate the seabed by pumping seawater onto the seabed causing it to fluidise and disperse. Jetting tools can be towed or self propelled.
- 6.2.6 Due to ground condition variation and the shallow depths in which the cable installation vessel must operate, a plough or a jet assisted plough is thought to be the most appropriate tool for carrying out burial operations in the site conditions associated with The Wash.
- 6.2.7 Two main methods exist for the laying and burial process:

- Simultaneous lay and burial: as the cable is reeled out from the spool it is buried immediately by a burial tool usually towed or winched by a laying vessel/barge or by its own method of propulsion.
- Post lay burial: The cable is laid first on the sea bed and is then buried at a later time by a suitable burial tool.

6.2.8 The exact burial method employed will depend on the geophysical properties along the route, the submarine cable burial depth required and the machine type employed.

6.2.9 Further protection may be necessary for the cable in areas where the cable is exposed or is deemed to be at risk of exposure. Protection may be afforded by means of rock dumping, the laying of concrete mats or the use of synthetic fronds.

6.2.10 Prior to any submarine cable burial operation a Route Clearance (RC) operation and a Pre-Lay Grapple Run (PLGR) operation must be undertaken. The RC operation consists of detecting and removing obstructions that may lie on the proposed route of the new cable installation. The PLGR operation consists of towing a snagging device behind a suitable vessel in order to clear the path of debris that may compromise burial operations.

Identification of Effects

6.2.11 When identifying effects the Rochdale Envelope worst case scenario approach has been applied.

Installation Effects

6.2.12 The installation effects can be summarised as follows:

- Direct Impacts:
 - Potential damage to prehistoric land surfaces from ploughing and jetting;
 - Potential damage and destruction of shipwrecks and aircraft from ploughing and jetting;
 - Potential damage to shipwrecks, aircraft and prehistoric land surfaces from vessel anchors during installation.

Operational Effects

6.2.13 The operational effects can be summarised as follows:

- Direct Impacts:
 - Potential damage to shipwrecks, aircraft and prehistoric land surfaces from vessel anchors during maintenance;
- Indirect Impacts:
 - Potential damage to shipwrecks, aircraft and prehistoric land surfaces due to increased erosion resulting from changes in scour and sedimentation as a consequence of the development.
 - Potential protection of shipwrecks, aircraft and prehistoric land surfaces due to increased sediment cover resulting from increased sedimentation as a consequence of the development.

Decommissioning Effects

6.2.14 The decommissioning effects can be summarised as follows:

- Direct Impacts:

- Potential damage to shipwrecks, aircraft and prehistoric land surfaces from vessel anchors during decommissioning.

6.3 Significance of Effects

- 6.3.1 When identifying effects the Rochdale Envelope worst case scenario approach has been applied.
- 6.3.2 Although the current geophysical dataset has been archaeologically assessed, and sites of potential archaeological interest identified, it has not been possible to definitively determine the precise nature of all of the highlighted geophysical anomalies. Consequently, it is difficult to fully assess the significance of any effects on the sites during the installation, operation or decommissioning of the cable route and associated wind farms at this time. It is expected that further, more detailed survey work will take place once details of the development scheme are more precisely known.
- 6.3.3 However, all direct impacts to archaeological sites will permanently alter or damage archaeological deposits and material and/or disturb or destroy relationships between deposits and material and their wider surroundings. Therefore, all direct impacts will have a significant adverse effect.
- 6.3.4 If direct impacts to known sites cannot be avoided it will be necessary to assess the significance of the effect on each site individually so that appropriate mitigation can be established.
- 6.3.5 Likewise, while it is possible to suggest the importance of potential sites that may be revealed during the course of the development it will only be possible to fully assess the significance of the effects on a site by site basis if and when they are impacted.
- 6.3.6 There is also potential for indirect impacts. Changes in scour and sedimentation associated with the installation and/or decommissioning of the cable route, and associated wind farms, may expose wrecks, aircraft and prehistoric land surfaces to erosion. Changes may also have a positive effect on sites if increased sedimentation leads to the burial of an archaeological site providing increased protection to a wreck, aircraft or prehistoric landscape.
- 6.3.7 Increased erosion will be permanent and negative and, as such, will have a significant adverse effect. However, the effects on known sites of indirect impacts from, for example, scour and changes to sedimentation patterns are difficult to quantify. Localised, scheme specific studies have, for the most part, indicated little change in sedimentation from wind farm construction.

- 6.3.8 The project Environmental Statement indicates that, based on the present understanding of sediment transport at Race Bank Offshore Wind Farm, cable scour may occur in areas of bedform movement if the buried inter-array cables become exposed (Centrica 2009). It is not anticipated that the export cables would become exposed through scour action alone and countermeasures will be employed to mitigate against any scour.
- 6.3.9 The impact resulting from multiple schemes remains relatively under-researched but it is probable that any changes in scour would be limited in the area of the cable route following installation.

6.4 Proposed Mitigation

- 6.4.1 One of the key principles shared by the historic environment and other environmental concerns is the precautionary principle, the primary aim of which is the prevention of damage to the environment by proactively putting in place protective measures, rather than having to attempt to repair damage (which may be irreversible) after it has occurred (COWRIE 2007: 6).
- 6.4.2 A Written Scheme of Investigation (WSI) has been produced by WA on behalf of Centrica Renewable Energy Limited setting out the design and implementation of mitigation for the Race Bank Offshore Wind Farm. This outlines the agreed measures to be taken to protect known and potential archaeology during the course of the development. An annex to this report will be produced, covering the Wash cable route additional areas, once the final development scheme is established.
- 6.4.3 With regard to archaeological sites, this annex will consider that preservation *in situ* is the preferred means of mitigation. This has primarily been achieved with the implementation of exclusion zones around all discrete sites or more extensive area identified within an EIA. Exclusion zones preclude development related activities within their extents and have been widely applied in offshore contexts to sites and anomalies with known or potential archaeological significance.
- 6.4.4 However, as the marine historic environment of the UK is still largely unknown and poorly documented it is often not possible to fully assess the extent or importance of an archaeological site (see section 6.1). The mitigation methodology presented here, therefore, proposes a two tier strategy with the implementation of temporary buffers as well as exclusion zones.
- 6.4.5 The primary distinction between a temporary buffer and an exclusion zone relates to the current level of information available for a site or area. Where records are sufficient to assess the extent and importance of a known site or area then an exclusion zone to preclude development related activity may be implemented. However, where sites, areas or anomalies have been identified for which there are insufficient records to warrant the implementation of exclusion zone then a temporary buffer should be established.
- 6.4.6 Any site, area or anomaly assigned a temporary buffer will require further investigation before the impact of the proposed development can be assessed and further mitigation measures proposed. Further mitigation may include the implementation of an exclusion zone or measures to reduce, remedy or offset disturbance.

- 6.4.7 It is possible that previously unknown archaeological sites or material may only be encountered during the course of the installation and/or decommissioning of a scheme. Hence, measures should be taken to reduce the impact of development in this instance. Such measures, outlined in the current WSI (WA 2010a, 2010b) may include an archaeological watching brief and/or the establishment of a formal protocol to ensure that any finds are promptly reported, archaeological advice is obtained, and any recovered material is stabilised, recorded and conserved (COWRIE 2007: 44).
- 6.4.8 Where preservation *in situ* through the implementation of exclusion zones is not practicable, disturbance of archaeological sites or material should be offset by appropriate and satisfactory measures, also known as preservation by record. In these circumstances, the effects of the development can be remedied by carrying out excavation and recording prior to the impact occurring (COWRIE 2007: 44). The impact of the development may also be remedied by restabilising sites that have been destabilised, but not destroyed, or by offsetting damage to a site by detailed analysis and safeguarding of otherwise comparable sites elsewhere.
- 6.4.9 The annex to the Race Bank Offshore Wind Farm WSI will consider the above recommendations and will take account of the objectives of a WSI as laid out in the COWRIE Guidance (WA 2007: 43):
- Set out the respective responsibilities of the developer, main contractors, and archaeological contractors/consultants, to include contact details and formal lines of communication between the parties and with archaeological curators;
 - Ensure that any further geophysical and geotechnical investigations associated with the project are subject to archaeological input, review, recording and sampling;
 - Provide for archaeological involvement in any diver and/or ROV obstruction surveys conducted for the scheme;
 - Establish the exact position and extent of archaeological exclusion zones, and methodologies for their monitoring, modification and/or removal;
 - Propose measures for mitigating effects upon any archaeological material encountered during the operation and decommissioning of the scheme;
 - Establish the reporting, publication, conservation and archiving requirements for the archaeological works undertaken in the course of the scheme.
- 6.4.10 The proposed mitigation with regard to the categories of site identified by the archaeological assessment of the additional areas is outlined below.

Known and Probable Ship Wrecks

- 6.4.11 The current level of information suggests that temporary buffers of 50m placed around the extents of each site are recommended for seven of the wrecks (**WA70002, WA7038-WA7043**). As the position and extent of wrecks **WA7000** and **WA7001** could not be verified during the assessment of marine geophysical data, temporary buffers of 100 m around the reported position are recommended.
- 6.4.12 No development related activities should be carried out within the temporary buffers until measures to reduce, remedy or offset disturbance have been established or until further information allows the buffer to be removed or an exclusion zone to be implemented.

Anomalies of Archaeological Interest

- 6.4.13 A total of 109 anomalies within the three Study Areas were identified as of potential anthropogenic origin and archaeological interest although the geophysical signatures could not identify what they represent. Hence, these anomalies require further archaeological investigation to ascertain their origin
- 6.4.14 In order to facilitate the design of the development scheme, no temporary buffer zones are currently proposed for these anomalies. Where practical these anomalies should be avoided. However, in areas where these anomalies are densely concentrated and avoidance is not possible a route should be proposed and the sites subject to impact should be assessed on a case by case basis during the initial design construction phase. This will result in either excluding those anomalies of archaeological significance or disregarding those comprising modern debris. These proposed exclusion zones and required mitigation will be outlined in the annex to the existing WSI once the development scheme has been established and further information on the anomalies has been obtained via routine construction surveys (Pre-lay Grapnel Run).

Palaeo-channels and Prehistoric Land Surfaces

- 6.4.15 Provision should be made, where practicable, for the complete recovery of cores containing pre-inundation prehistoric material and/or organic deposits, and for the analysis of a suitable number of core samples. WA employ a five stage geotechnical assessment process which would be applicable to any planned geotechnical works within the study areas. Provision for such works should be included in the annex to the WSI.

Potential Wrecks or Aircraft

- 6.4.16 The archaeological assessment identified 23 wrecks or aircraft reported lost at an arbitrary point in **Area 2**. It is possible that remains of these craft may be discovered during the course of the installation and/or decommissioning of the cable route and associated wind farms.
- 6.4.17 Due to the presence of large sandwaves, and the lack of clarity of many of the anomalies identified in the geophysical datasets, not all sites may have been detected and wrecks and aircraft may exist undetected within the Study Areas. The mobility of this seabed environment suggests that archaeological sites may be subject to cycles of exposure and re-burial. Therefore, if any further sidescan sonar or magnetometer survey is to take place, with suitable line spacing, then the data should be subject to archaeological assessment.
- 6.4.18 In addition, measures to deal with such discoveries should be set out in the annex to the WSI including provision for excavation, recording, recovery of artefacts, structures or samples, and the subsequent analysis, reporting, archiving and publication (COWRIE 2007: 6).

6.5 Cumulative Impact Assessment

- 6.5.1 Cumulative impacts are those that result from incremental changes to the historic environment caused by multiple impacts within a development project and/or in combination with past, present and future developments (COWRIE, 2008). Cumulative impacts include recurrent physical or direct impacts diminishing the historic environment due to the development of a number of offshore installations over time and over a wide area. Cumulative impacts also include changes to the perception of the historic environment due to impact on the setting of historic monuments from offshore developments.

6.5.2 The sites considered for this cumulative impact assessment are as follows:

- Lynn Offshore Wind Farm;
- Inner Dowsing Offshore Wind Farm;
- Lincs Offshore Wind Farm;
- Docking Shoal Offshore Wind Farm;
- Race Bank Offshore Wind Farm;
- Sheringham Shoal Offshore Wind Farm;
- The Wash Cable Route Corridor;
- Additional Areas in The Wash;
- Area 481 Aggregate Extraction Area.

6.5.3 All of the above developments have been subject to archaeological assessments that have identified all known wrecks, and assessed geophysical data as part of an attempt to identify unknown losses. These reports have also assessed the potential for the presence of submerged prehistoric archaeology.

6.5.4 Mitigation against damage to known sites, and geophysical anomalies that may represent currently unknown shipwrecks, aircraft or other features of anthropogenic origin, will comprise the implementation of temporary buffers or exclusion zones. By avoiding archaeological sites the cumulative direct impact on known sites from turbine, installation, cable laying, anchoring and dredging, resulting from the above schemes, will be negligible.

6.5.5 Present understanding indicates only minimal and localised changes in scour and sedimentation resulting from wind farm construction. However, such changes may still serve to both cover up, and therefore protect, or uncover and destabilise sites. This can be addressed by the generally adopted principle that further geophysical studies, undertaken during the working life of the projects, will be archaeologically assessed. Thus any currently known or unknown sites exposed by scour or changes to sedimentation could be identified and the general archaeological principals of evaluation can be applied to identify the importance and significance of the effects and remedial mitigation can be applied.

6.5.6 Turbine installation, and possibly cable laying, may pose a threat to as yet unconfirmed prehistoric archaeology although the anchoring of vessels are unlikely to penetrate the seabed to a depth sufficient to cause concern. However, the percentage of the seabed that is subject to permanent negative direct impacts from the foundations of wind farms is relatively small. Therefore, the cumulative impact of the construction of offshore wind farms upon any submerged prehistoric deposits is likely to be small. However, the large number of foundation structures planned indicates that there is still some potential for impact. The procedures for dealing with such discoveries are laid out in individual WSI for each development with the aim of minimising any potential damage.

6.5.7 Changes to the perception of the historic environment, due to the impact on the setting of historic monuments from offshore developments, are likely to be negligible. Several offshore wind farms have been constructed or are being planned in this industrialised region. The Wash cable route additional areas will have no impact on the setting as all installations are sub surface.

- 6.5.8 A positive cumulative effect of studies relating to developments is the accumulation of archaeologically interpreted geophysical and geotechnical data regarding submerged and sub-bottom, prehistoric land surfaces and palaeo-environmental evidence. This developing resource is indicating the broad spread of palaeo-landscape and palaeo-environmental data off the east coast. It is anticipated that any evidence derived from the Wash cable route additional areas assessment will add to this body of data

6.6 Summary

- 6.6.1 The following table (over) summarise the impact assessment outlined above:

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- Wessex Archaeology, 2010b, Race Bank Offshore Wind Farm Archaeological Monitoring and Mitigation Written Scheme of Investigation, unpublished report ref.: 62555.04

APPENDIX I: GAZETTEER OF DOCUMENTED LOSSES

| WA ID | Classification | Easting | Northing | Description | External Reference |
|-------|-----------------------|---------|----------|---|--------------------|
| 2000 | Documented Wreck loss | 323075 | 5872784 | Name: Heinkel HE 1115B S4+DH; German Heinkel He 111 bomber which was shot down in the Wash. It was part of the coastal flying corps; Date lost: 1939 | 1399693 |
| 2001 | Documented Wreck loss | 323075 | 5872784 | Name: Heinkel HE1115B S4+GH; German Heinkel He 111 bomber which was shot down in the Wash; Date lost: 1939 | 1399688 |
| 2002 | Documented Wreck loss | 323075 | 5872784 | Name: Hurricane MK I V7376; British fighter; Date lost: 1940 | 1357686 |
| 2003 | Documented Wreck loss | 323075 | 5872784 | Name: Stirling MK III EH960; British heavy bomber; Date lost: 1944 | 1356979 |
| 2004 | Documented Wreck loss | 323075 | 5872784 | Name: Lancaster MK III ED826; British heavy bomber; Date lost: 1944 | 1356978 |
| 2005 | Documented Wreck loss | 323075 | 5872784 | Name: Armstrong WHITWORTH WHITLEY MK V T4201; British heavy bomber. Date lost: 1940 | 1352258 |
| 2006 | Documented Wreck loss | 323075 | 5872784 | Name: Agenoria; English craft; Date lost: 1823 | 1351099 |
| 2007 | Documented Wreck loss | 323075 | 5872784 | Name: Hms Ocean Gift II; British fishing vessel; Date lost: 1917 | 1349396 |
| 2008 | Documented Wreck loss | 323075 | 5872784 | Name: Hester; English craft; Date lost: 1820 | 1346835 |
| 2009 | Documented Wreck loss | 323075 | 5872784 | Name: Alliance; English craft; Date lost: 1820 | 1346834 |
| 2010 | Documented Wreck loss | 323075 | 5872784 | Sloop of unknown identity; Date lost: 1820 | 1346833 |
| 2011 | Documented Wreck loss | 323075 | 5872784 | Name: Samuel; British craft which foundered in the Wash en route from Blyth to Herne Bay; a wooden sailing vessel; Date lost: 1786 | 1328352 |
| 2012 | Documented Wreck loss | 323075 | 5872784 | Name: Wellington MK IC P9276; British bomber; Date lost: 1940 | 1322653 |
| 2013 | Documented Wreck loss | 323075 | 5872784 | Name: Mosquito MK II DZ305; British fighter, Date lost: 1943 | 1318466 |
| 2014 | Documented Wreck loss | 323075 | 5872784 | Name: Neutral; British cargo vessel which foundered off King's Lynn while en route from London to Wisbech. Laden with nuts and oranges, a wooden sailing; Date lost: 1826 | 1315839 |
| 2015 | Documented Wreck loss | 323075 | 5872784 | Name: Henrietta; English sloop; Date lost: 1881 | 1302414 |
| 2016 | Documented Wreck loss | 323075 | 5872784 | Name: John; British craft which foundered off King's Lynn during a gale, while en route from Blyth to Dover; a wooden sailing vessel; Date lost: 1833 | 1238107 |
| 2017 | Documented Wreck loss | 323075 | 5872784 | Name: Eight Friends; English craft which foundered off Kings Lynn, possibly after departing from Brancaster; a wooden sailing vessel; Date lost: 1773 | 1217120 |
| 2018 | Documented Wreck loss | 323075 | 5872784 | Name: Providence; English craft; Date lost: 1822 | 930136 |
| 2019 | Documented Wreck loss | 323075 | 5872784 | Name: Greyhound; British smack; Date lost: 1887 | 928649 |

| WA ID | Classification | Easting | Northing | Description | External Reference |
|-------|-----------------------|---------|----------|---|---------------------------|
| 2020 | Documented Wreck loss | 323075 | 5872784 | English lugger of unknown identity; Date lost: 1911 | 927563 |
| 2021 | Documented Wreck loss | 323075 | 5872784 | Name: Lizzie; English smack; Date lost: 1909 | 927534 |
| 2022 | Documented Wreck loss | 323075 | 5872784 | Craft of unknown identity that foundered between the Outer Knock Buoy and the Long Sand; a wooden sailing vessel; Date lost: 1833 | 1316103, 1316121, 1316122 |

- 1.- The WA coordinates are in **WGS84 UTM31N**
- 2.- Positions have been provided by the NMR
- 3.- The above gazetteer is illustrated in **Figure 5**

APPENDIX II: GAZETTEER OF KNOWN SITES AND MARINE GEOPHYSICAL ANOMALIES**Area 1**

| WA ID | Classification | Easting | Northing | Length (m) | Width (m) | Height (m) | Total Magnetic Amplitude (nT) | Description | External Reference |
|-------|------------------|---------|----------|------------|-----------|------------|-------------------------------|---|-----------------------|
| 7000 | Wreck | 334284 | 5888485 | | | | | Live UKHO record of a wreck believed to be a steamboat, approximately 100years old | UKHO8600 NMR913198 |
| 7001 | Wreck | 337048 | 5888235 | | | | | Live UKHO record of a wreck of unknown origin or identity | UKHO 8599 |
| 7002 | Wreck | 337369 | 5888502 | 30.9 | 7.2 | 0.3 | | Possible wreck site. Structure found in an area where other objects have been identified in previous assessments (2007) | |
| 7003 | Bright reflector | 336856 | 5888039 | 76 | 70 | 0 | | Patch of bright reflectors situated by a large sandwave. The largest ones measure 15.5m x 6.7m and 8.4m x 5.2m. One other bright reflector (WA6345) of uncertain origin was identified 25m N of this site boundary during the 2007 assessment of marine geophysical data. WA6345 measured 5.7m x 2.4m | |
| 7004 | Dark reflector | 337452 | 5888251 | 3 | 2.3 | 0.5 | | Object found in an area where other objects have been identified in previous assessments (2007) | |
| 7005 | Dark reflector | 336413 | 5888575 | 4.1 | 0.9 | 0.2 | | Object found approximately 60m north of WA7012 | |
| 7006 | Dark reflector | 336380 | 5888523 | 4.5 | 1.3 | 0.3 | | Object found approximately 60m south of WA7005 | |
| 7007 | Dark reflector | 337817 | 5888589 | 10 | 5.8 | 0 | | Possible piece of debris. Object found in an area where other objects have been identified in previous assessments (2007) | |
| 7008 | Debris | 336705 | 5889326 | 7 | 4.3 | 1.3 | | Angular object in isolation | |
| 7009 | Debris | 340426 | 5890663 | 7.9 | 0.4 | 0.1 | | Thin and curved edge possible linear feature or partially buried object | |

| WA ID | Classification | Easting | Northing | Length (m) | Width (m) | Height (m) | Total Magnetic Amplitude (nT) | Description | External Reference |
|-------|----------------------|---------|----------|------------|-----------|------------|-------------------------------|---|--------------------|
| 7010 | Debris | 334820 | 5888232 | 8.5 | 2.8 | 0 | | Two pieces of elongated debris measuring 7.2m x 2.7m and 8.5m x 2.8m lie approximately 6m apart. A third anomaly lies 30 north of these two objects. The third one measures 61m x 1.2 | |
| 7011 | Debris | 336354 | 5888857 | 9.7 | 4.2 | 0.8 | | Isolated object of unknown origin | |
| 7012 | Seafloor disturbance | 337187 | 5887983 | 16.1 | 8.7 | 0 | | Object found in an area where other objects have been identified in previous assessments (2007) | |

Area 2

| WA ID | Classification | Easting | Northing | Length (m) | Width (m) | Height (m) | Total Magnetic Amplitude (nT) | Description | External Reference |
|-------|----------------|---------|----------|------------|-----------|------------|-------------------------------|--|--------------------|
| 7013 | Dark reflector | 325374 | 5872036 | 4.6 | 4.6 | 0 | | possible debris | |
| 7014 | Dark reflector | 325003 | 5874565 | 8.2 | 2 | 0 | | Unknown origin | |
| 7015 | Dark reflector | 325401 | 5872091 | 15.1 | 9.1 | 0 | | Possible debris | |
| 7016 | Dark reflector | 326621 | 5876920 | 24.6 | 6.9 | 0 | | Patch of material, possible wreck site | |
| 7017 | Dark reflector | 323843 | 5874015 | 5.3 | 2.3 | 0 | | Fairly rounded object, possibly debris | |
| 7018 | Dark reflector | 325089 | 5873097 | 5.2 | 3 | 0.8 | | Distinct object of unknown origin | |
| 7019 | Dark reflector | 325821 | 5875548 | 30.4 | 10.9 | 0 | | Possible patch of material | |
| 7020 | Dark reflector | 325891 | 5872757 | 2.1 | 11.5 | 0 | | Distinct site situated perpendicular to sandwaves | |
| 7021 | Dark reflector | 327731 | 5876042 | 20.8 | 2.4 | 0 | | Elongated dark reflector possibly a piece of linear debris | |
| 7022 | Dark reflector | 326547 | 5874997 | 10.2 | 4.1 | 0.5 | | Possible piece of debris, likely to be part of fishing gear but cannot be confirmed. | |
| 7023 | Dark reflector | 326276 | 5874742 | 7.9 | 3.9 | 0 | | Unknown origin, fairly rounded but likely to be associated with fishing gear. | |
| 7024 | Debris | 327884 | 5876756 | 12.3 | 3.1 | 0 | | Object of unknown origin next to seafloor disturbance | |

| WA ID | Classification | Easting | Northing | Length (m) | Width (m) | Height (m) | Total Magnetic Amplitude (nT) | Description | External Reference |
|-------|----------------------|---------|----------|------------|-----------|------------|-------------------------------|--|--------------------|
| 7025 | Debris | 327588 | 5876343 | 2.1 | 1.7 | 0.2 | | Angular piece of debris | |
| 7026 | Debris | 326560 | 5874286 | 77 | 16.4 | 0.3 | | Likely modern debris associated with linear feature but could also be a linear feature caught on archaeological remains. | |
| 7027 | Debris | 326390 | 5876512 | 31.5 | 4.1 | 0.8 | | Distinct object, possibly a section of fishing gear | |
| 7028 | Debris | 327571 | 5876077 | 8.1 | 6.1 | 0.3 | | Patch of material associated with linear feature (cable) | |
| 7029 | Mound | 326512 | 5874020 | 21.3 | 5.5 | 0.3 | | Shipwreck shaped mound of unknown origin | |
| 7030 | Seafloor disturbance | 326785 | 5874304 | 10.1 | 20.8 | 0.2 | | Patch of material and seafloor disturbance possibly associated with a wreck site. | |
| 7031 | Seafloor disturbance | 327872 | 5876678 | 33.3 | 47.2 | 1 | | Area of seafloor disturbance and pieces of debris of unknown origin largest measuring 10m x 6m x 0.5m. Possibly associated with fishing gear, but cannot be confirmed. | |
| 7032 | Seafloor disturbance | 326785 | 5874702 | 7.7 | 19 | 0 | | Patch associated with nearby linear feature/cable | |
| 7033 | Magnetic | 325811 | 5873846 | | | | 11.66 | in an area of linear debris | |
| 7034 | Magnetic | 325251 | 5872490 | | | | 6.67 | in an area of linear debris, likely to be modern but cannot be verified on the sidescan sonar data | |
| 7035 | Magnetic | 325496 | 5873167 | | | | 6.46 | Isolated magnetometer anomaly | |
| 7036 | Magnetic | 325375 | 5873238 | | | | 5.94 | Isolated magnetometer anomaly | |
| 7037 | Magnetic | 323002 | 5872248 | | | | 4.85 | Isolated magnetometer anomaly | |

Area 3

| WA ID | Classification | Easting | Northing | Length (m) | Width (m) | Height (m) | Total Magnetic Amplitude (nT) | Description | External Reference |
|-------|----------------|---------|----------|------------|-----------|------------|-------------------------------|--|------------------------|
| 7038 | Wreck | 314630 | 5859633 | 20.9 | 6.9 | 1.5 | 19.36 | Wreck orientated east-west with a large patch of associated debris on its southern side. Site recorded by the UKHO as a wreck of unknown identity | UKHO10128 NMR913175 |
| 7039 | Debris | 315210 | 5861513 | 91.8 | 79.9 | 0.7 | 23 | Distinct patch of debris of unknown origin. Correlates with UKHO record of dumped stones - foul- Two distinct magnetometer anomalies over this site. Linear feature caught on an object. Not included in the gazetteer. One of the largest objects measures 5.5m x 1.6m x 0.4m | UKHO10132 |
| 7040 | Wreck | 314790 | 5861216 | 4.9 | 3.9 | 0 | | Angular feature, likely to be a wreck section. Distinct magnetometer anomaly approximately 100m southeast | |
| 7041 | Wreck | 314845 | 5859600 | 11.3 | 3.7 | 0 | 57 | Series of parallel dark reflectors resemble a wreck site with associated magnetometer anomaly. | |
| 7042 | Wreck | 314386 | 5861057 | 37.4 | 7.8 | 0 | 11.24 | Likely wreck site with associated magnetometer anomaly. Note that other pieces of debris lie in close proximity (30 and 80metres south). An additional magnetometer anomaly lies over 100metres northeast | |
| 7043 | Wreck | 314764 | 5860188 | 10.4 | 6.3 | 0 | | Oval shaped dark reflector likely to be a wreck. | |
| 7044 | Dark reflector | 316693 | 5863310 | 21 | 4 | 0 | | Three objects in a line orientated east-west and at approximately 10m apart. Forth one approximately 55m south. Possible wreck site. Individual measurements, 4m x 3.4m ; 4.9m x 4.2m and 7.7m x 3.9m | |
| 7045 | Dark reflector | 316673 | 5863260 | 7.8 | 3.6 | 0 | | One of four, possible wreck debris. | |

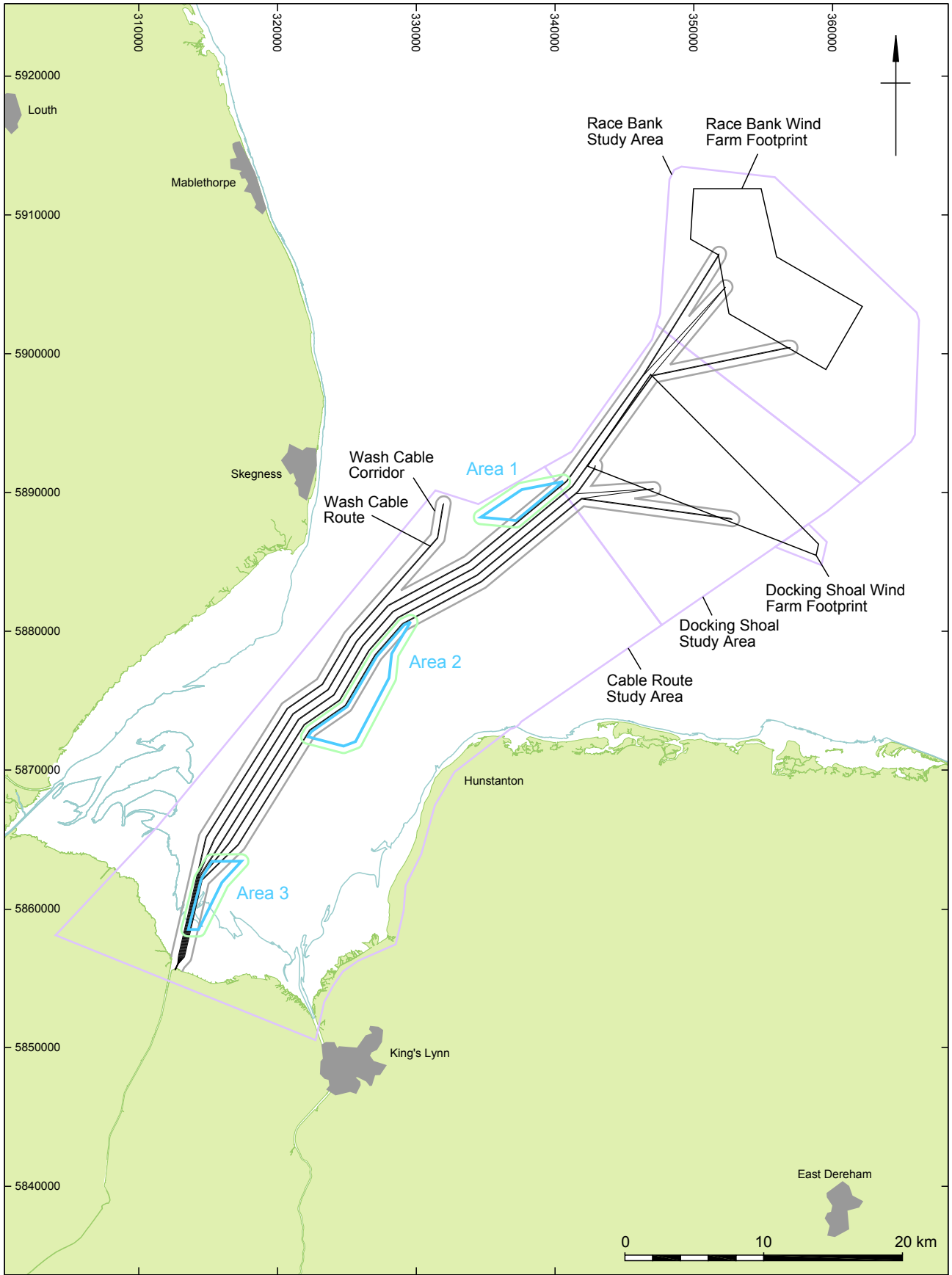
| WA ID | Classification | Easting | Northing | Length (m) | Width (m) | Height (m) | Total Magnetic Amplitude (nT) | Description | External Reference |
|-------|----------------|---------|----------|------------|-----------|------------|-------------------------------|--|--------------------|
| 7046 | Dark reflector | 316163 | 5862397 | 29.4 | 8.7 | 0 | | Patch of material, possible wreck site | |
| 7047 | Dark reflector | 315127 | 5861370 | 7.6 | 7.2 | 0 | 17.48 | Either a curved linear feature or the edge of a structure. It may be associated with the patch of stones approximately 60m northeast. Magnetometer anomaly associated with this feature. Two other pieces of debris approximately 20m east. These measure 2.4m x 1.m and 3.2m x 3.4m | |
| 7048 | Dark reflector | 315123 | 5861579 | 2.3 | 2.2 | 0 | 22.8 | Possible piece of debris near debris field with associated magnetometer anomaly | |
| 7049 | Dark reflector | 314099 | 5858546 | 4.8 | 3.4 | 0 | | | |
| 7050 | Dark reflector | 314639 | 5859582 | 1.1 | 1.2 | 0 | | Likely piece of debris. Possibly associated with nearby wreck | |
| 7051 | Dark reflector | 316094 | 5862633 | 8.8 | 9.1 | 0 | | Oval shaped feature, seafloor disturbance | |
| 7052 | Dark reflector | 315481 | 5861632 | 3 | 2 | 0.3 | | Object of unknown origin with long scour | |
| 7053 | Dark reflector | 315238 | 5860651 | 6.1 | 2.8 | 0 | | Angular object | |
| 7054 | Dark reflector | 315284 | 5860626 | 1.6 | 1.4 | 0 | | Elongated object of unknown origin | |
| 7055 | Dark reflector | 315497 | 5863148 | 2.3 | 2 | 0 | | possible causing seafloor disturbance | |
| 7056 | Dark reflector | 314838 | 5860129 | 16.9 | 1 | 0 | | Elongated feature or linear of unknown origin. Could be the edge of a structure or wreck. In an area of multiple magnetometer anomalies | |
| 7057 | Dark reflector | 315019 | 5860333 | 89.4 | 6.4 | 0 | | Mound of unknown origin situated in an area of multiple magnetometer anomalies. | |
| 7058 | Dark reflector | 314240 | 5860423 | 4.8 | 0.7 | 0 | | Elongated object amongst sandwaves. Fairly linear. Possibly fishing gear or cable | |
| 7059 | Debris | 314160 | 5858452 | 10.1 | 4.1 | 0 | | Angular feature of likely archaeological interest | |

| WA ID | Classification | Easting | Northing | Length (m) | Width (m) | Height (m) | Total Magnetic Amplitude (nT) | Description | External Reference |
|-------|----------------------|---------|------------|------------|-----------|------------|-------------------------------|---|--------------------|
| 7060 | Debris | 315202 | 5861084 | 5.7 | 3.2 | 0 | 7.21 | Angular dark reflector. One or two objects. Unknown origin but with possible associated magnetometer anomaly approximately 35m west | |
| 7061 | Debris | 315274 | 5860647 | 2.1 | 1.3 | 0.1 | | Angular object with scour | |
| 7062 | Debris | 315460 | 5861784 | 2.4 | 2.2 | 0.2 | | Angular object with scour | |
| 7063 | Debris | 315204 | 5861134 | 4.6 | 3.4 | 0.3 | | Piece of debris with scour all around and linear feature (scour or object?). One of two objects of unknown origin | |
| 7064 | Debris field | 316162 | 5862269 | 70.6 | 29.2 | 0.2 | 29.78 | Several scatters of debris and bright reflectors, largest one measuring 24m x 8m given by position. Magnetometer anomaly associated with this site | |
| 7065 | Seafloor Disturbance | 315855 | 5862190 | 16.1 | 11.3 | 0 | 9.55 | Distinct seafloor disturbance, one of three. With distinct magnetometer anomaly. An additional object (1.8m x 0.2m x 0.4m) may be associated. It is situated 25m se | |
| 7066 | Seafloor Disturbance | 315863 | 5862229 | 8.1 | 7 | 0 | 10.01 | Distinct seafloor disturbance, one of three. Adjacent object measures 4m x 0.5m. With associated magnetometer anomaly | |
| 7067 | Seafloor Disturbance | 315900 | 5862207 | 6.4 | 5.1 | 0 | 42.22 | Seafloor disturbance; Smallest of three patches of material with associated magnetometer anomaly. Small object (0.8m x 0.5m x 0.1m) situated 10m SW of main mound | |
| 7068 | Seafloor Disturbance | 315887 | 5862208 | 6.6 | 3.4 | 0 | | Seafloor disturbance | |
| 7069 | Seafloor disturbance | 315773 | 5861523.79 | 22 | 13.3 | | 154.06 | Central mound and four surrounding ones with an associated magnetometer anomaly. Feature of unknown origin. Possibly modern | |
| 7070 | Seafloor disturbance | 314464 | 5861288 | 7.2 | 12.6 | 0 | | Feature of unknown origin found in isolation | |

| WA ID | Classification | Easting | Northing | Length (m) | Width (m) | Height (m) | Total Magnetic Amplitude (nT) | Description | External Reference |
|-------|----------------|---------|----------|------------|-----------|------------|-------------------------------|-------------------------------|--------------------|
| 7071 | Magnetic | 314464 | 5861288 | | | | 4.73 | Isolated magnetometer anomaly | |
| 7072 | Magnetic | 315568 | 5863035 | | | | 4.91 | Isolated magnetometer anomaly | |
| 7073 | Magnetic | 316479 | 5863328 | | | | 5.14 | Isolated magnetometer anomaly | |
| 7074 | Magnetic | 314938 | 5860091 | | | | 6.28 | Isolated magnetometer anomaly | |
| 7075 | Magnetic | 315791 | 5861492 | | | | 6.47 | Isolated magnetometer anomaly | |
| 7076 | Magnetic | 315410 | 5863381 | | | | 6.6 | Isolated magnetometer anomaly | |
| 7077 | Magnetic | 314693 | 5860281 | | | | 6.69 | Isolated magnetometer anomaly | |
| 7078 | Magnetic | 315593 | 5861586 | | | | 6.74 | Isolated magnetometer anomaly | |
| 7079 | Magnetic | 314648 | 5862085 | | | | 7.16 | Isolated magnetometer anomaly | |
| 7080 | Magnetic | 315332 | 5861008 | | | | 7.27 | Isolated magnetometer anomaly | |
| 7081 | Magnetic | 314723 | 5859418 | | | | 7.28 | Isolated magnetometer anomaly | |
| 7082 | Magnetic | 314736 | 5861020 | | | | 7.5 | Isolated magnetometer anomaly | |
| 7083 | Magnetic | 315159 | 5860388 | | | | 8.35 | Isolated magnetometer anomaly | |
| 7084 | Magnetic | 314462 | 5858809 | | | | 8.82 | Isolated magnetometer anomaly | |
| 7085 | Magnetic | 313821 | 5859497 | | | | 9.03 | Isolated magnetometer anomaly | |
| 7086 | Magnetic | 314292 | 5859796 | | | | 9.21 | Isolated magnetometer anomaly | |
| 7087 | Magnetic | 314728 | 5860317 | | | | 9.63 | Isolated magnetometer anomaly | |
| 7088 | Magnetic | 314371 | 5861495 | | | | 10.77 | Isolated magnetometer anomaly | |
| 7089 | Magnetic | 315463 | 5862778 | | | | 11.18 | Isolated magnetometer anomaly | |
| 7090 | Magnetic | 314149 | 5860088 | | | | 11.47 | Isolated magnetometer anomaly | |
| 7091 | Magnetic | 314733 | 5859778 | | | | 13.66 | Anomaly near patch of debris | |
| 7092 | Magnetic | 315102 | 5861614 | | | | 14.13 | Isolated magnetometer anomaly | |
| 7093 | Magnetic | 314382 | 5859393 | | | | 15.06 | Isolated magnetometer anomaly | |
| 7094 | Magnetic | 315243 | 5862833 | | | | 22.06 | Isolated magnetometer anomaly | |
| 7095 | Magnetic | 314693 | 5862263 | | | | 24.38 | Isolated magnetometer anomaly | |
| 7096 | Magnetic | 314487 | 5861154 | | | | 25.33 | Isolated magnetometer anomaly | |
| 7097 | Magnetic | 314306 | 5859956 | | | | 26.53 | Isolated magnetometer anomaly | |
| 7098 | Magnetic | 315178 | 5862377 | | | | 27.05 | Isolated magnetometer anomaly | |
| 7099 | Magnetic | 314107 | 5859956 | | | | 29.8 | Isolated magnetometer anomaly | |

| WA ID | Classification | Easting | Northing | Length (m) | Width (m) | Height (m) | Total Magnetic Amplitude (nT) | Description | External Reference |
|-------|----------------|---------|----------|------------|-----------|------------|-------------------------------|--|--------------------|
| 7100 | Magnetic | 316368 | 5863380 | | | | 30.68 | Isolated magnetometer anomaly | |
| 7101 | Magnetic | 315873 | 5862256 | | | | 32.64 | Isolated magnetometer anomaly | |
| 7102 | Magnetic | 314653 | 5860103 | | | | 35.5 | Isolated magnetometer anomaly | |
| 7103 | Magnetic | 314538 | 5862183 | | | | 38 | Two magnetometer dipoles lying next to each other (14m apart). Smallest measures 16nT | |
| 7104 | Magnetic | 314543 | 5861397 | | | | 42.7 | Isolated magnetometer anomaly | |
| 7105 | Magnetic | 314127 | 5860015 | | | | 44.63 | Isolated magnetometer anomaly | |
| 7106 | Magnetic | 314338 | 5860763 | | | | 45.88 | Isolated magnetometer anomaly | |
| 7107 | Magnetic | 314829 | 5860443 | | | | 48.66 | Isolated magnetometer anomaly | |
| 7108 | Magnetic | 314472 | 5861768 | | | | 50.51 | Anomaly re-identified. The 2007 assessment identified it as an object with a total magnetic amplitude of 5nT | |
| 7109 | Magnetic | 313997 | 5859545 | | | | 64.05 | Isolated magnetometer anomaly | |
| 7110 | Magnetic | 314541 | 5861487 | | | | 69.97 | Isolated magnetometer anomaly | |
| 7111 | Magnetic | 314538 | 5859633 | | | | 77.63 | Isolated magnetometer anomaly | |
| 7112 | Magnetic | 314703 | 5860878 | | | | 87.27 | Two magnetic dipoles lying next to each other. Smallest measures 14nT | |
| 7113 | Magnetic | 314291 | 5861182 | | | | 91.33 | Isolated magnetometer anomaly | |
| 7114 | Magnetic | 314843 | 5861111 | | | | 101.79 | Isolated magnetometer anomaly | |
| 7115 | Magnetic | 314032 | 5858671 | | | | 122.97 | Isolated magnetometer anomaly | |
| 7116 | Magnetic | 315720 | 5861190 | | | | 153.1 | Isolated magnetometer anomaly | |
| 7117 | Magnetic | 315801 | 5861514 | | | | 1364.62 | Anomaly re-identified. The 2007 assessment identified it as an object with a total magnetic amplitude of 7nT | |

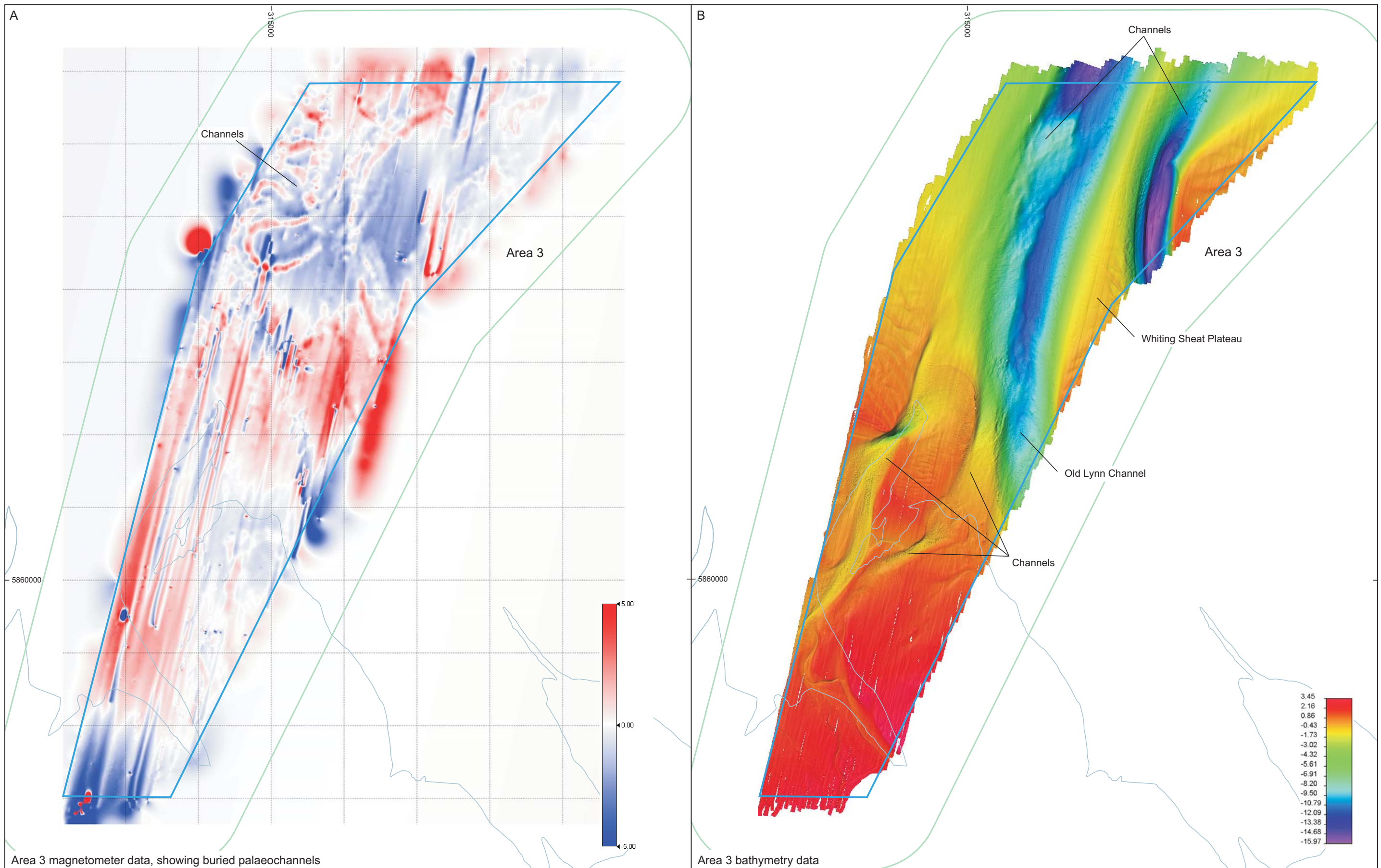
- 1.- The WA coordinates are in **WGS84 UTM31N**
- 2.- Positions and dimensions are given as a guide only
- 3.- All above gazetteers are illustrated in **Figures 2-8**



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Wash Cable Corridor and Additional Areas

Figure 1



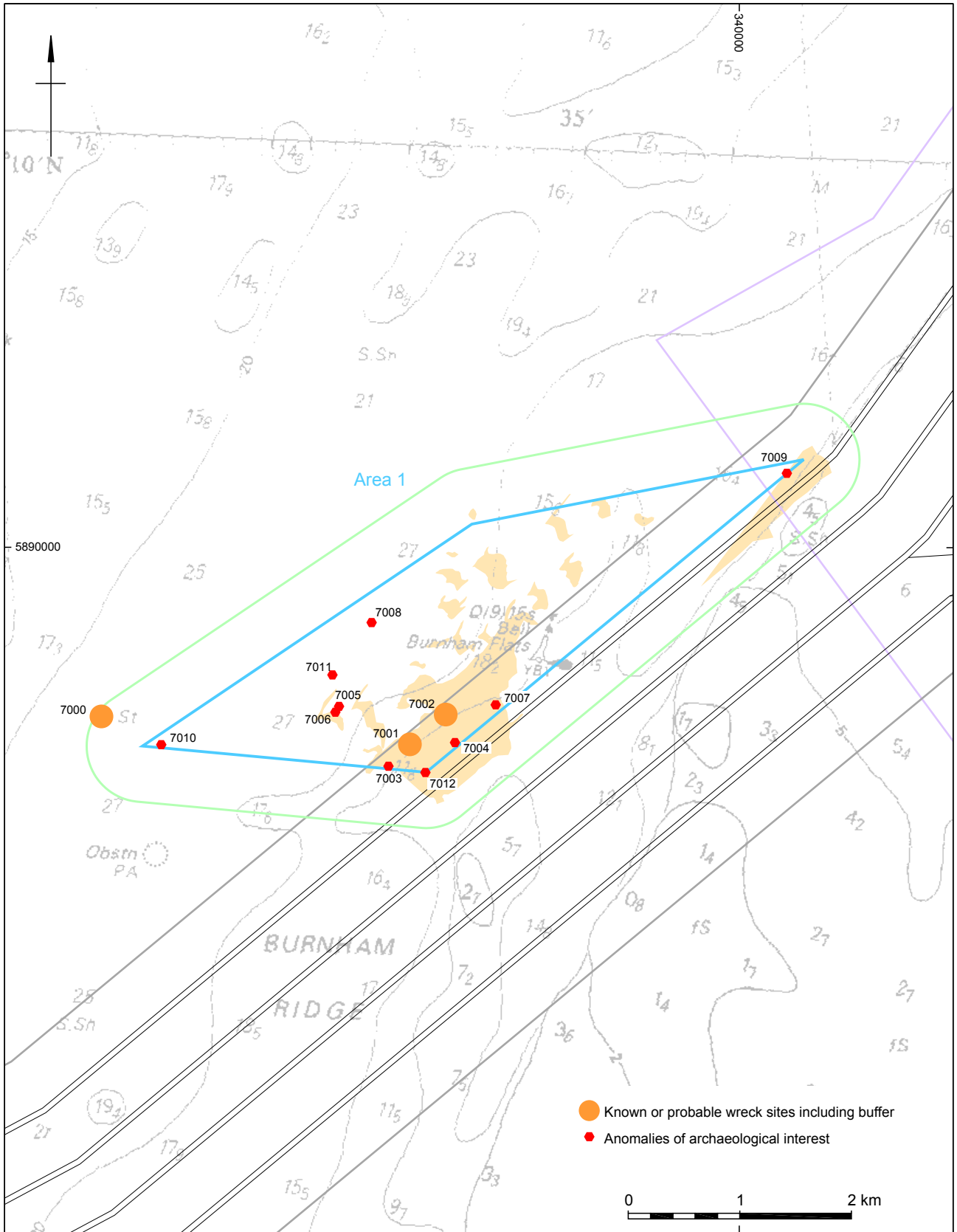
Area 3 magnetometer data, showing buried palaeochannels

Area 3 bathymetry data

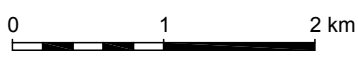


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- Known or probable wreck sites including buffer
- Anomalies of archaeological interest



- Study Areas (with 500m buffer)
- Cable route corridor
- Development areas
- Sand ripples / waves

Drawing Projection: UTM WGS84 z31N.
 Admiralty chart 108 (dated 2000)
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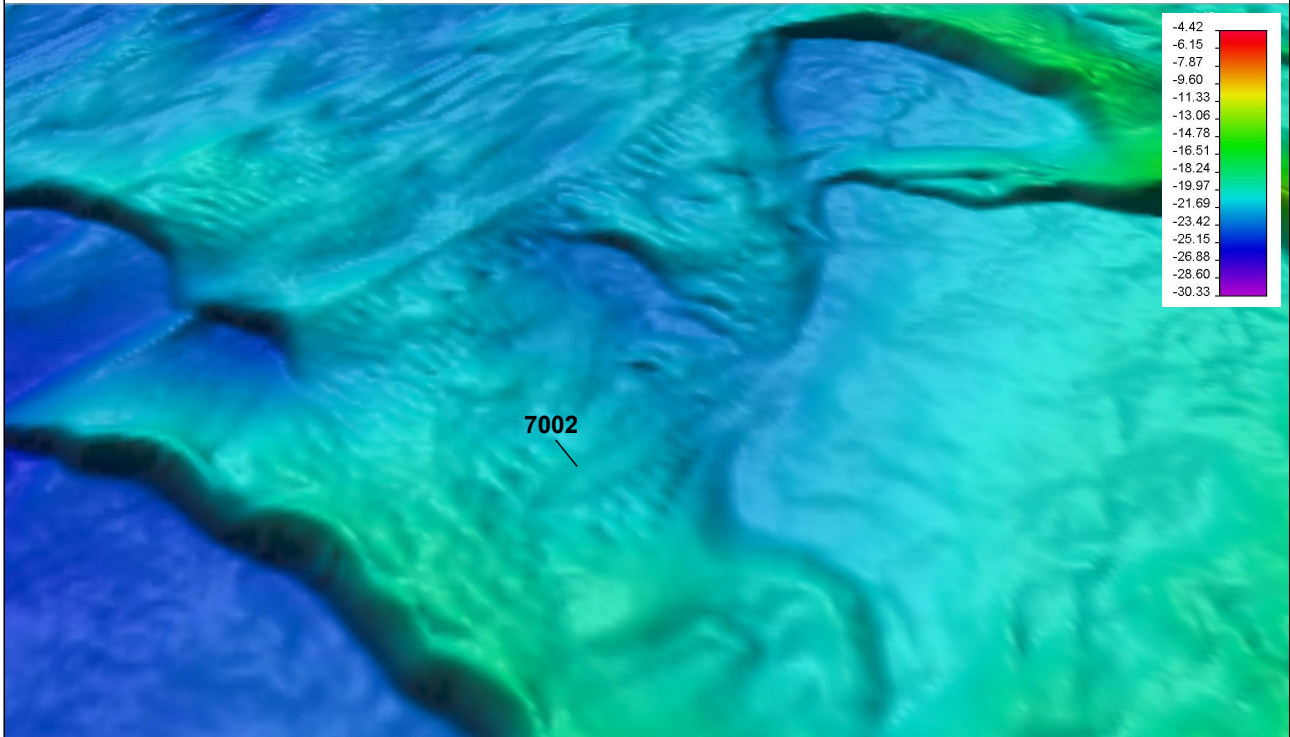


Known Maritime Sites and Marine Geophysical Anomalies in Area 1


Figure 3

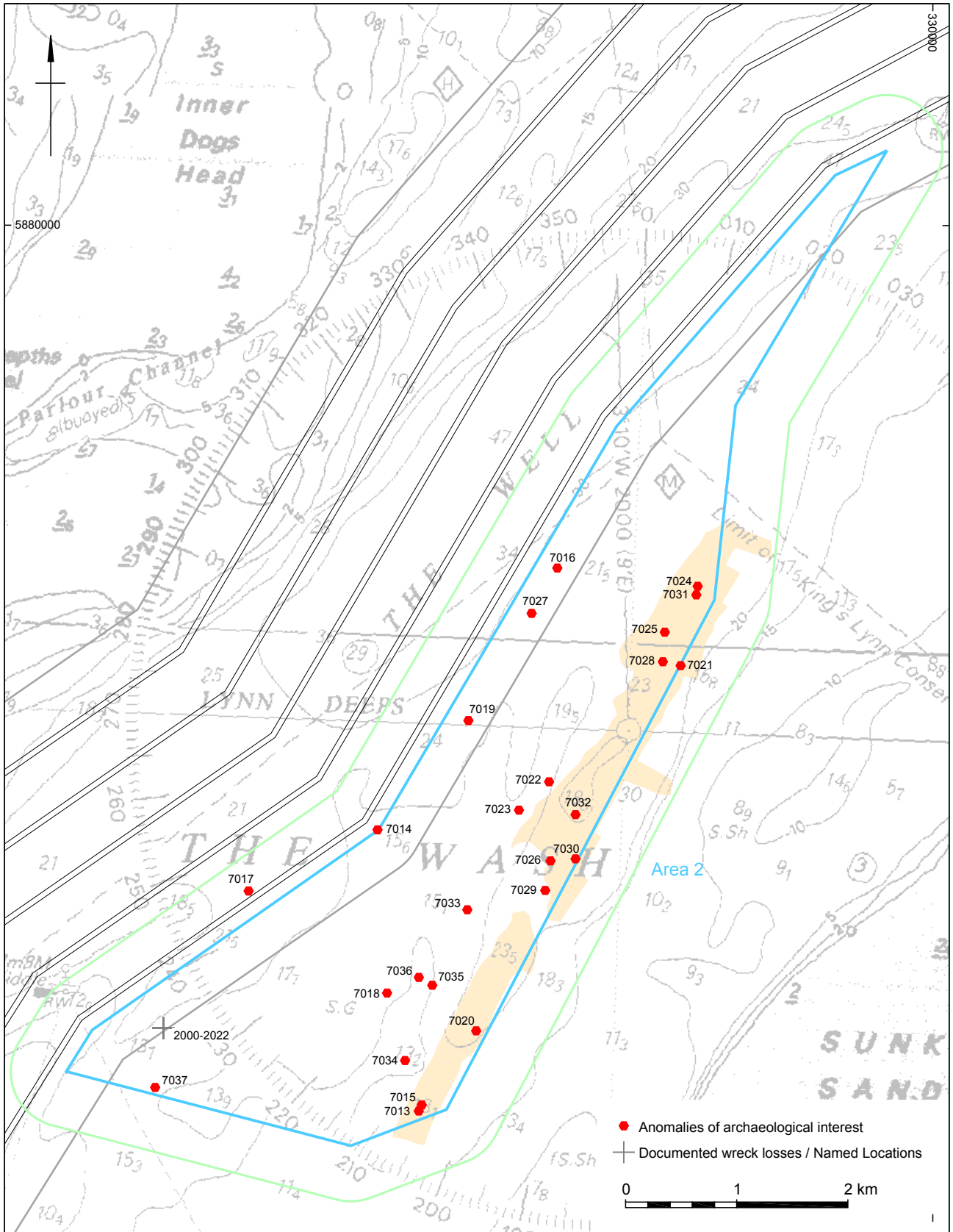


A: **WA7002**: Probable wreck site measuring 31m x 7.2m x 0.3m. Structure found in an area where other objects have been identified in previous assessments (2007).



B: Multibeam bathymetry view of **WA7002**.

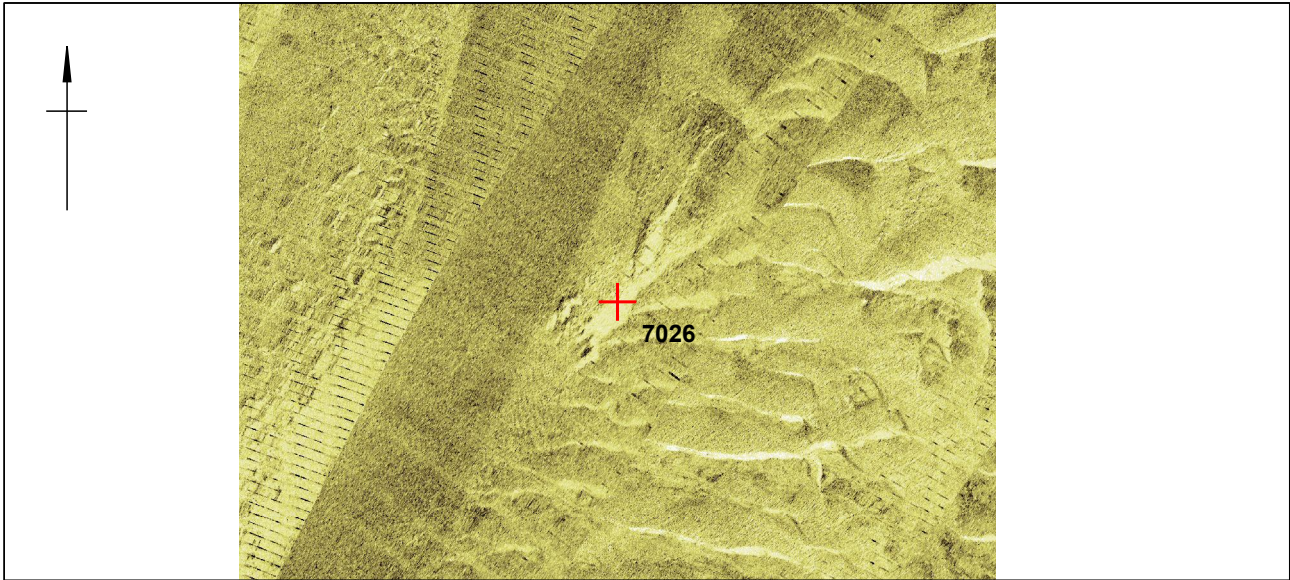
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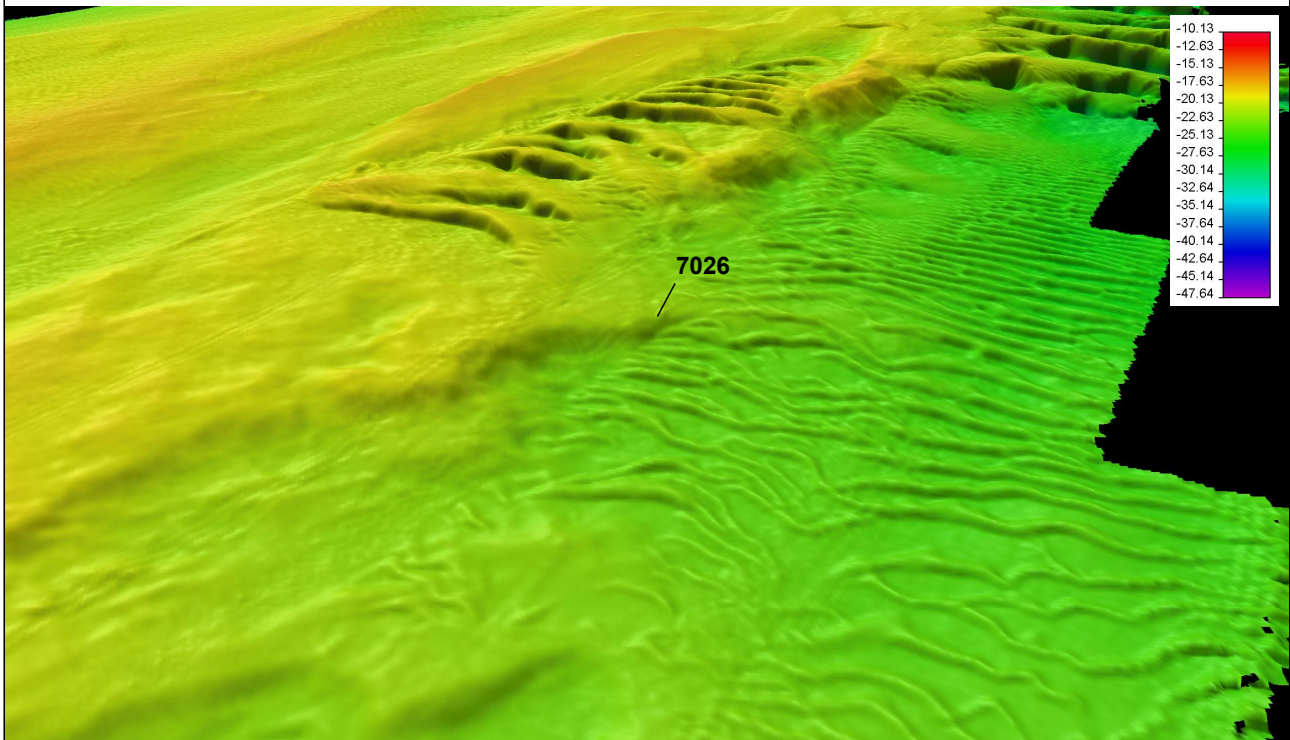
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Known Maritime Sites and Marine Geophysical Anomalies in Area 2


Figure 5

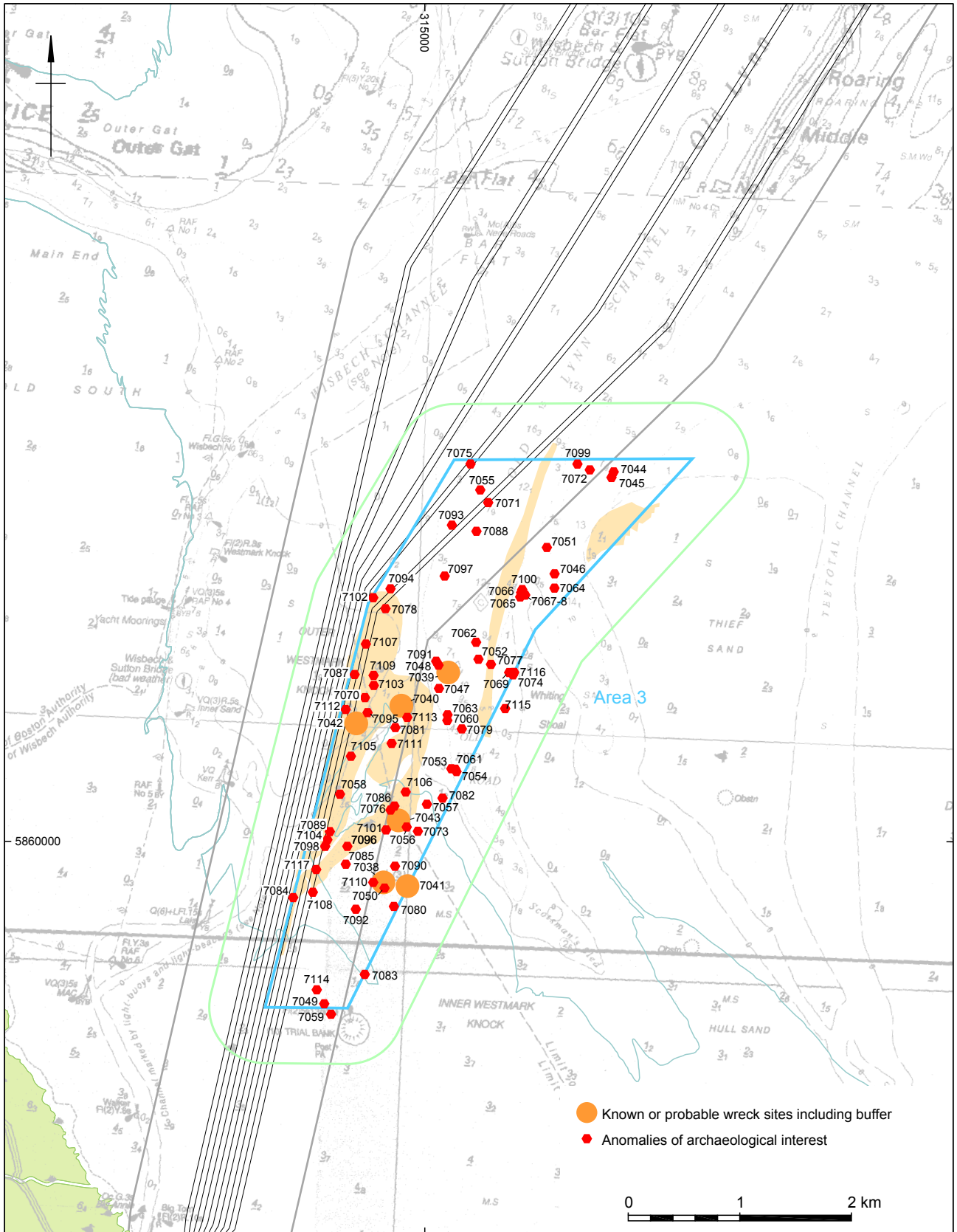


A: **WA7026**: Likely modern debris associated with linear feature or a linear feature caught on archaeological remains (77m x 16.4m x 0.3m)

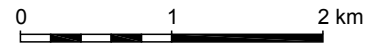


B: Multibeam bathymetry view of **WA7026**.

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● Known or probable wreck sites including buffer
● Anomalies of archaeological interest



- Study Areas (with 500m buffer)
- Cable route corridor
- Development areas
- Sand ripples / waves

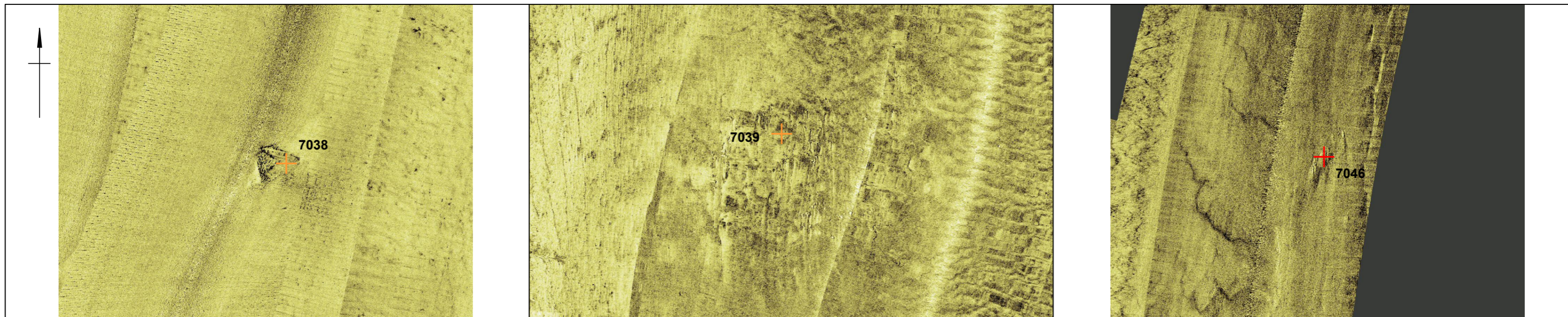
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 Admiralty chart 1200 (dated 2010)
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Known Maritime Sites and Marine Geophysical Anomalies in Area 3

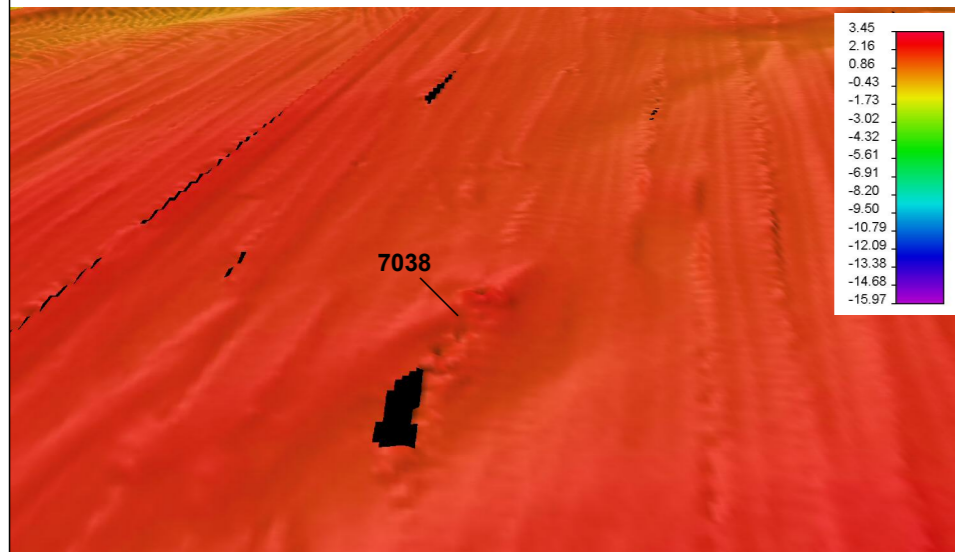
Figure 7



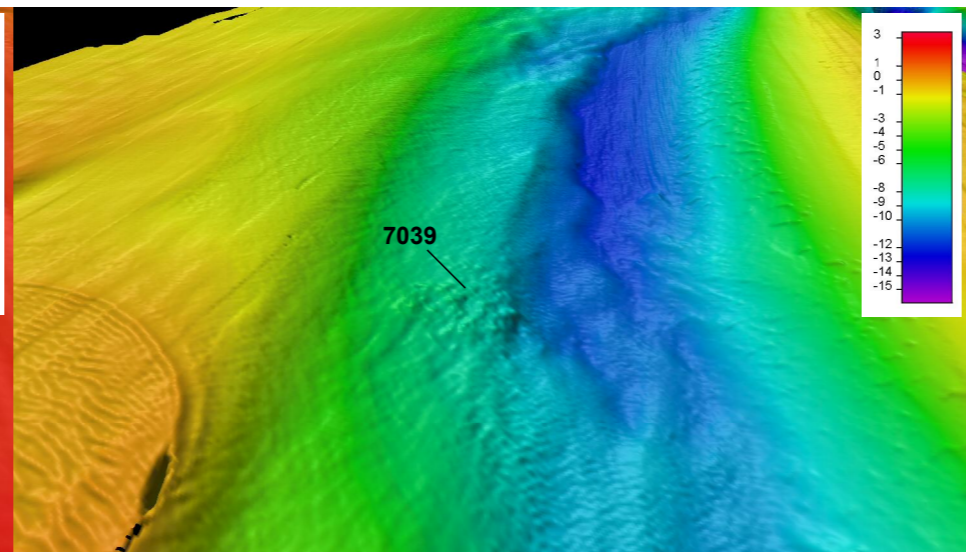
A: **WA7038**: Wreck orientated east-west with a large patch of associated debris on its southern side. Site recorded by the UKHO as a wreck of unknown identity. Site measures 21m x 7m x 1.5m and has a total magnetic amplitude of 9.8nT.

D: **WA7039**: Distinct patch of debris of unknown origin measuring 91m x 80m x 0.7 and has a magnetic amplitude of nearly 23nT. One of the largest objects measures 5.5m x 1.6m x 0.4m. The site correlates with UKHO record of dumped stones.

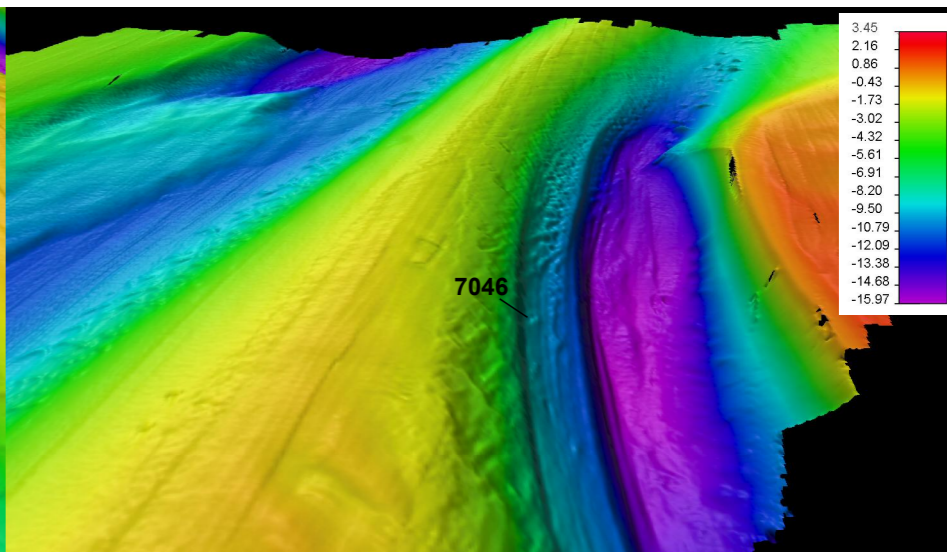
G: **WA7046**: Distinct patch of material of archaeological interest measuring 29.4m x 8.7m. It may represent the remains of a wreck site. WA7046 may be associated with **WA7064**.



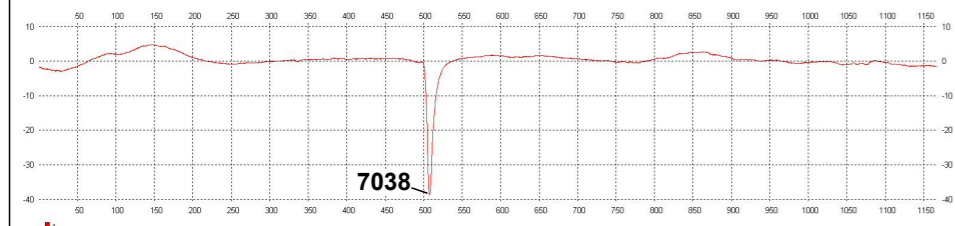
B: Multibeam bathymetry view of **WA7038**.



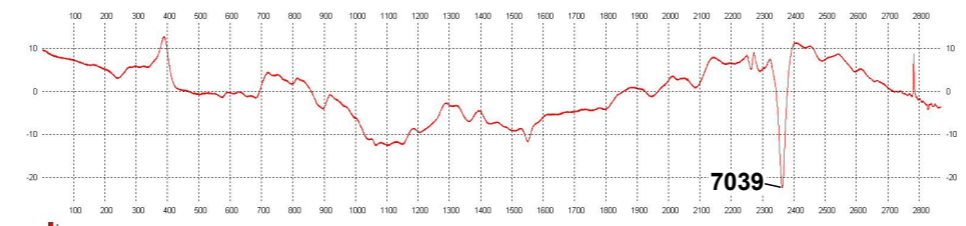
E: Multibeam bathymetry view of **WA7039**



H: Multibeam bathymetry view of **WA7046**.



C: Magnetometer anomaly associated with **WA7038** (total magnetic amplitude is 19nT)



F: Magnetometer anomaly associated with **WA7039** (total magnetic amplitude is 23nT)



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