Mainstream Renewable Power

Appendix 19.1: Maritime Archaeology and Cultural Heritage Technical Report

Date: July 2011

EMU Ref: 11/J/1/26/1667/1098

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Neart na Gaoithe Offshore Wind Farm Development: Archaeology Technical Report

Document Release and Authorisation Record			
Job No:	J/1/26/1667	**Version: 2**	
Report No:	11/J/1/26/1667/1098		
Report Type:	Archaeology Technical Report	**Status: Draft**	
Date:	July 2011		
Client Name:	Mainstream Renewable Power		
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Executive Summary

EMU Limited and Headland Archaeology were commissioned by Mainstream Renewable Power to carry out an archaeological technical report in relation to the proposed Neart na Gaoithe Offshore Wind Farm. This report is produced as a technical document to support the Environmental Statement, required under the existing legislative framework.

This technical report assesses the archaeological potential of a study area in three broad themes comprising prehistoric archaeology, maritime and aviation archaeology.

The assessment identified eight charted wrecks within the proposed wind farm site, of which two relate to World War I submarine wrecks protected under the terms of the *Protection of Military Remains Act* 1986. A further 11 charted sites were identified within the confines of the study area. In addition, the assessment highlighted numerous reported losses in the vicinity of the proposed wind farm site. Given the historic context of the Firth of Forth there is thus the potential for unknown and uncharted wrecks and aircraft from various periods to be present within the wind farm site and the cable route corridor.

The archaeological review of geophysical data collected across the study area identified a number of anomalies of possible archaeological interest. Eight of these have been assigned a high archaeological potential rating and represent large iron or steel shipwrecks, and some related debris, and include the two protected K-class submarines, *K4* and *K17*, discussed earlier. The geophysical review also assigned a medium archaeological rating to a further nine anomalies, which may represent uncharted wrecks, including aircraft, but which require further investigation to clarify their nature and more accurately establish their archaeological potential.

The geoarchaeological assessment and assessment of geotechnical data were carried out to establish the palaeoenvironmental and archaeological potential within the study area; in particular the presence of peats or sediments with high organic content. The assessment of the geotechnical data established that the sediments evident in three of the geotechnical datasets are generally of low palaeoenvironmental potential. The report indicates that there is low potential for prehistoric archaeological remains and palaeoenvironmental evidence, although secondary context archaeological material may be encountered within more recent Holocene seabed and surficial sediments.

The assessment identified 28 scheduled monuments, 32 Category A-listed buildings, 761 Category B- and C(S)-listed buildings, six conservation areas and one inventory designed landscape within 25 km of the proposed wind farm. Between 25 and 35 km of the proposed wind farm the number of designated cultural heritage assets is substantially greater as Angus, East Lothian and the Scottish Borders as well as the greater part of Fife fall within this distance. There are nine properties in care, 179 scheduled monuments, 104 Category A-listed buildings, 2252 Category B- and C(S)-listed buildings, 26 conservation areas, 17 inventory registered historic gardens and designed landscapes and one inventory battlefield.

Abbreviations

AD	Anno Domini
BGS	British Geological Survey
BP	Before Present
CD	Chart Datum
COWRIE	Collaborative Offshore Wind Research into the Environment
CPT	Piezocone penetration test
EIA	Environmental Impact Assessment
GIS	Geographical Information System
GPS	Global Positioning System
Historic MPA	Historic Marine Protected Area
IfA	Institute for Archaeologists
JNAPC	Joint Nautical Archaeology Policy Committee
NMRS	National Monument Records of Scotland
OD	Ordnance Datum
OWF	Offshore Wind Farm
PAN	Planning Advice Note
RCAHMS	Royal Commission on the Ancient and Historical Monuments of Scotland
RP	Recorded Positions
SeaZone	SeaZone Solutions Ltd
SPP	Scottish Planning Policy
UKHO	United Kingdom Hydrographic Office

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1. Introduction

EMU Limited (EMU Ltd), in collaboration with Headland Archaeology, was commissioned by Mainstream Renewable Power to produce an archaeological technical report in support of the application for the Neart na Gaoithe Offshore Wind Farm development. This report is a technical document to support the Environmental Statement, required under the existing legislative framework.

The proposed development will cover an area of 105 km² and will contain between 64 and 125 turbines with a target generating capacity of up to 450 MW. Inter-array cables will link each turbine to a sub-station located within the proposed wind farm from where an export cable will convey the electricity generated to the shore at a landing point at Thorntonloch, close to Torness Nuclear Power Station.

This report considers the known archaeology and the potential for unknown archaeology in the area covered by the wind farm development and the cable route, its importance and any likely impacts related to the construction, operation and decommissioning of the wind farm.

The three main areas of archaeological enquiry addressed in this report are:

- Prehistoric archaeology;
- Maritime archaeology; and
- Aviation archaeology.

1.1 Site Boundary and Study Area

The proposed wind farm development is approximately 15.5 km east of Fife Ness in Scottish territorial waters. For the purposes of this report a 1 km buffer was added around the proposed site boundary. This was partly to accommodate any possible future changes to the footprint of the wind farm, but was primarily done to identify and include in the archaeological report sites of archaeological importance near the wind farm boundary and to provide a wider context for the archaeological technical report.

A cable route will connect the proposed wind farm to the Scottish mainland. The proposed cable route is approximately 32 km long and runs south from the wind farm to the area of Torness Point, approximately 8 km south east of Dunbar. Two shore connection options have been considered – one at Skateraw (west) and the other at Thorntonloch (east). While both have been considered in this report, the preferred option is the landfall at Thortonloch.

As was the case with the wind farm area, the cable route and landfall point were analysed with a 1 km buffer, similar to the main development.

The study area for this archaeological technical report therefore comprises the buffered wind farm area and cable route with its landfall location (assessed to the high water mark) as shown in**Error! Reference source not found.**. The co-ordinates of both the wind farm site and the study area are shown in Appendix 1.

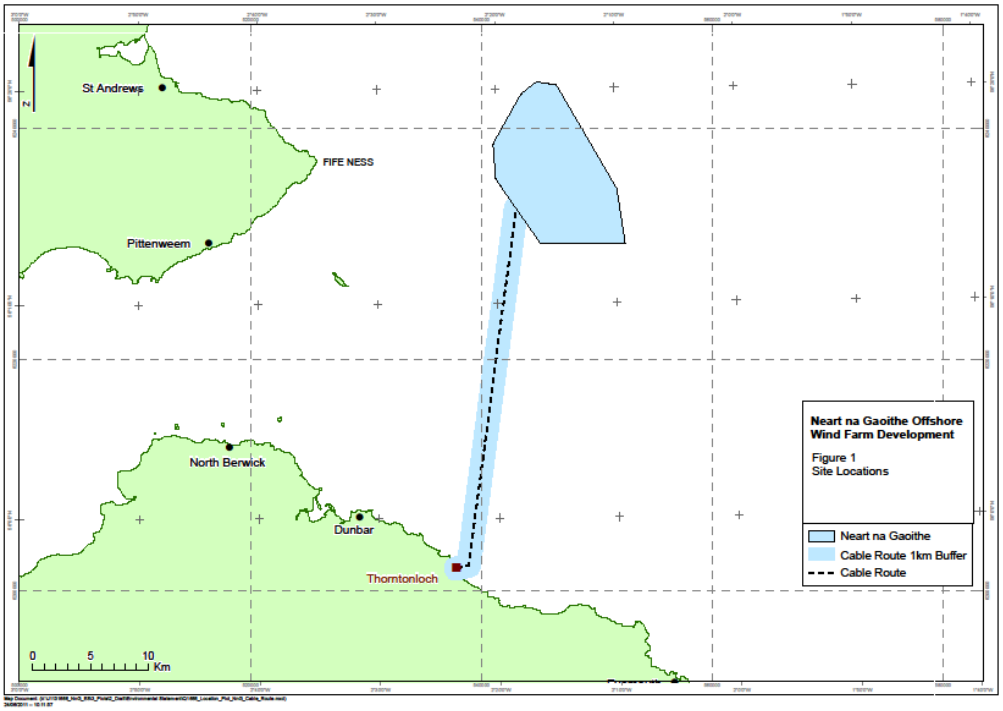

Figure 1 Location of the Development Area and Cable Route

1.2 Supporting Work

This archaeological technical report is based on the results of an archaeological baseline review commissioned by EMU Ltd for Mainstream Renewable Power from Headland Archaeology (UK) Ltd.

Data collected by EMU Limited for Neart na Gaoithe Offshore Wind Limited in 2009 during a geophysical survey of the development site and cable route were also reviewed as part of the archaeological technical report. These data comprised swath bathymetry, sidescan sonar, sub-bottom profiler, acoustic ground discrimination and magnetometer data (EMU Ltd, 2010). These data were used to ground-truth the archaeological baseline, and to identify previously unrecorded sites and materials of possible archaeological interest within the survey area.

Headland Archaeology (UK) Ltd. also undertook an archaeological review of geotechnical data, which comprised a desk-based review of piezocone penetration, or CPT test results, and borehole and vibrocore logs provided by Gardline Geosciences Ltd (Gardline, 2010), and the archaeological recording of a limited number of core samples.

1.3 Datums

Throughout this technical report the Universal Transverse Mercator (UTM) Zone 30 co-ordinate system, based on the WGS84 spheroid, was used for mapping data. This co-ordinate system was used to integrate the geophysical data, the data delivered by SeaZone Solutions Ltd and other data sources into the archaeological technical report.

The vertical reference was Chart Datum at Leith (2.9 m below Ordnance Datum Newlyn).

2. Aims and Objectives

The aim of this work has been to produce an archaeological baseline against which an assessment of the potential impacts of the development of the Neart na Gaoithe Offshore Wind Farm on the archaeological record of the area can be assessed.

In order to do this, the objectives of this study were to:

- Identify the known prehistoric archaeology within the study area and summarise the potential for further prehistoric archaeology in the area to be affected by the development;
- Identify known maritime and aviation archaeological sites and, based on the maritime history of the Firth of Forth, assess the potential for the existence of unknown sites and materials in the study area;
- Review available geophysical data for anomalies of archaeological interest, characterise these anomalies and integrate the results with those of the desk-based work described above; and
- Review available geotechnical data for sediments of archaeological and palaeoenvironmental interest and integrate the results with those of the desk-based work described above.

3. Legislation and Guidance

This section outlines legislation and guidance applicable to offshore archaeological remains in Scotland. It is not an exhaustive list but serves to indicate how archaeological remains should be approached by developers, within Scottish territorial waters.

3.1 Legislation

3.1.1 *Marine Scotland Act 2010*

This Act establishes a comprehensive marine planning system within the Scottish marine area (the area of sea within the seaward limits of the territorial sea of the United Kingdom adjacent to Scotland, i.e., to 12 NM) which integrates marine planning, licensing, fisheries management and conservation – both natural and historic environment. The Act sets economic, social and marine ecosystem objectives and provides a framework for decision making. The key areas covered by the Act include marine planning, marine licensing, marine conservation and enforcement.

The marine conservation elements of the Act provide improved historic conservation in the marine environment with new powers to protect marine historic assets of national importance in the Scottish territorial sea as Historic Marine Protected Areas (MPAs).

Historic Scotland are currently consulting (October 2011) on guidelines with regard to 1) the selection and designation and 2) the management of Historic MPAs.

3.1.2 *Merchant Shipping Act 1995* (MSA)

All wreck recovered from UK territorial waters and any wreck which is landed in the UK from outside UK territorial waters must, in terms of Section 236 of the *Merchant Shipping Act,* be declared to the Receiver of Wreck, who acts on behalf of the Maritime and Coastguard Agency in administering this section of the Act. The Act defines 'wreck' as anything which is found in or on the sea or washed ashore from tidal water.

All items which are raised from the seabed, regardless of age or importance, must be reported to the Receiver who will act to settle questions of ownership and salvage. Finders who report their finds to the Receiver have salvage rights.

3.1.3 *Protection of Military Remains Act 1986* (PMRA)

In terms of this Act, which is administered by the Ministry of Defence, it is an offence to interfere with the wreckage of any crashed, sunken or stranded military aircraft or designated vessel without a licence. This is irrespective of whether there was loss of life associated with the wreck, or whether the loss occurred during peacetime or wartime.

All crashed military aircraft receive automatic protection, but vessels must be individually designated. There are two levels of protection offered by this Act: designation as a *Protected Place* or as a *Controlled Site*.

Protected Places include the remains of any aircraft which crashed while in military service or any vessel designated (by name, not location) which sank or stranded in military service after 4 August 1914. Although crashed military aircraft receive automatic status as a *Protected Place*,

vessels need to be specifically designated by name. The location of the vessel does not need to be known for it to be designated as a *Protected Place*.

Diving is not prohibited on an aircraft or vessel designated as a *Protected Place*. However, it is an offence to conduct unlicensed diving or salvage operations to tamper with, damage, remove or unearth any remains or enter any hatch or other opening. Essentially, diving is permitted on a 'look but don't touch' basis only.

Controlled Sites are specifically designated areas which encompass the remains of a military aircraft or a vessel sunk or stranded in military service within the last two hundred years. Within the controlled site it is an offence to tamper with, damage, move or unearth any remains, enter any hatch or opening or conduct diving, salvage or excavation operations for the purposes of investigating or recording the remains, unless authorised by licence. This effectively prohibits diving operations on these sites without a specific licence.

There are currently two sites designated as *Protected Places* under the *Protection of Military Remains Act* 1986 in the study area. These are the K-class submarines, *K4* and *K17,* which sank in 1918 during the so called Battle of May Island (see Section 8 below).

Any military aircraft remains in the study area would, however, be subject to automatic protection under the Act.

3.1.4 *Ancient Monuments and Archaeological Areas Act 1979* (AMAA)

This Act is primarily terrestrial in its scope and application but has, in recent years, been used to provide some level of protection for underwater sites. Through the Act, buildings, structures or works, caves or excavations, vehicles, vessels, aircraft or other movable structures of national importance may be scheduled as 'monuments'.

Public access to scheduled monuments is not restricted, but it is an offence to demolish, destroy, alter or repair a monument without *scheduled monument consent*. The Act is administered in Scotland by Historic Scotland, on behalf of the Secretary of State for Culture, Media and Sport.

There are currently no scheduled ancient monuments in the study area.

3.2 Guidance Documents

3.2.1 *Scottish Planning Policy* (2010)

Scottish Planning Policy is a statement of the Scottish Government's policy on nationally important land use and planning matters and supersedes and consolidates National Planning Policy Guidelines, including *Planning Advice Note 42: Archaeology and Planning* and *SPP 23 – Planning and the Historic Environment*. The 2010 SPP encompasses a broad range of planning matters including coastal planning and renewable energy. In regard to archaeology it specifically states that,

> *Archaeological sites and monuments are an important, finite and non-renewable resource and should be protected and preserved in situ wherever feasible. The presence and potential presence of archaeological assets should be considered by planning authorities when allocating sites in the development plan and when making*

decisions on planning applications. Where preservation in situ is not possible planning authorities should, through the use of conditions or a legal agreement, ensure that developers undertake appropriate excavation, recording, analysis, publication and archiving before and/or during development. If archaeological discoveries are made during any development, a professional archaeologist should be given access to inspect and record them.

3.2.2 *Conserving the Underwater Heritage. Historic Scotland Operational Policy Papers* (Historic Scotland, 1999)

Historic Scotland is responsible for archaeological and built heritage matters with a remit which includes the seabed to the limit of territorial waters (12 NM). *Conserving the Underwater Heritage* sets out Historic Scotland's key policies and objectives in regard to the protection of underwater heritage and its long term future. The document is aimed at those in the planning and development industry who may already be aware of the standards expected for terrestrial archaeology.

3.2.3 *Listed Buildings and Conservation Areas* (Scotland) Act 1997

Listed Buildings are defined as buildings of special architectural or historic interest in the Planning (Listed Buildings and Conservation Areas) (Scotland) Act 1997 (as amended). The Act states that "*the planning authority, in determining any application for planning permission for development that affects a listed building or its setting, is required to have special regard to the desirability of preserving the building, or its setting, or any features of special architectural or historic interest which it possesses*." (Section 59(1)).

3.2.4 *Planning Advice Note* 2/2011

PAN 2/2011 provides advice regarding archaeology and the planning process. It highlights that archaeology is a finite resource that is important because of its potential to aid our understanding of the past and its contribution to the quality of everyday life. It provides information on the types of information that may be required in order to support a planning application. The document indicates that preservation *in situ* is the preferred option, but that the desirability of this must be weighed against all other material considerations in determining the planning application; where preservation *in situ* is not possible preservation by record should be secured through a planning condition.

3.2.5 *COWRIE Guidance* (2007, 2008 and 2010)

COWRIE (Collaborative Offshore Wind Research into the Environment) has produced the following guidance documents for the UK offshore renewable energy sector with specific reference to the historic environment:

- *Historic Environment Guidance for the Offshore Renewable Energy Sector* (COWRIE, 2007) which promotes an understanding of the conservation issues arising from the impacts of offshore renewable energy projects on the historic environment, and in this way develop capacity amongst developers, consultants and contractors;
- *Guidance for Assessment of Cumulative Impacts on the Historic Environment from Offshore Renewable* (COWRIE, 2008) which provides guidance on the assessment of

cumulative impacts on the historic environment engendered by offshore renewable energy projects; and

- *Offshore Geotechnical Investigations and Historic Environment Analysis: Guidance for the Renewable Energy Sector* (COWRIE, 2010) which provides practical guidance to developers and best practice options in relation to the integration of archaeological assessment into offshore renewable energy project-led geotechnical investigations.

3.2.6 *Protocol for Archaeological Discoveries. Offshore Renewable Projects* (The Crown Estate and Wessex Archaeology, 2011)

Based on a model developed and used by the marine aggregates industry in England since 2005, this *Protocol* sets in place a mechanism for reporting archaeological material found during offshore renewable energy development in the UK. Protocols for archaeological discoveries are recommended as a system for monitoring archaeological finds or those unexpected or incidental finds relating to the historic environment. The relevant regulator and archaeological curator for notifications of archaeological finds in Scottish waters is Historic Scotland.

3.2.7 *Code of Practice for Seabed Development* produced by The Joint Nautical Archaeology Policy Committee (Joint Nautical Archaeology Policy Committee, 2008)

Produced by The Joint Nautical Archaeology Policy Committee this document sets out a best practice model for seabed development in the UK, both within and beyond the remit of the formal Environmental Impact Assessment process.

4. Methodology

The methodology used in this technical report reflects best practice set out in:

- *The Code of Practice for Seabed Development* (JNAPC, 2008);
- *The Standard and Guidance for Archaeological Desk-based Assessment* published by the Institute for Archaeologists (IfA, 2008); and
- *The Historic Environment Guidance for the Offshore Renewable Energy Sector* (COWRIE, 2007).

4.1 Data Sources

The principal sources consulted in this technical report are:

- The United Kingdom Hydrographic Office Wreck Index, provided by SeaZone Solutions Ltd for records of charted wrecks and seabed obstructions, which as defined by the UKHO is debris thought to stand more than two metres proud of the seabed;
- Databases of designated cultural heritage assets maintained by Historic Scotland including designated wrecks;
- The National Monument Records of Scotland held by the Royal Commission on the Ancient and Historical Monuments of Scotland for records of historical shipping casualties and losses; and onshore and island sites in relation to the impacts on 'setting'
- Historic Environment Record of East Lothian Council;
- The Ministry of Defence for information related to military remains;
- The National Library of Scotland and National Archives of Scotland for maps, charts and plans;
- Admiralty charts, including Fife Ness to Saint Abb's Head and Montrose to Fife Ness;
- Relevant Strategic Environmental Assessment report; and
- Other readily available published sources and grey literature (written material not generally available through conventional channels such as publishers, which includes technical reports from government agencies or scientific research groups, working papers from research groups or committees, white papers or preprints) related to the submerged prehistory and maritime archaeology of the Firth of Forth.

The sources outlined above were consulted for information related to known and potential archaeological sites within the study area.

4.2 Site Visit

A site visit was undertaken at both landfall options at Skateraw and Thortonloch on the12th November 2010 to verify the findings of the desk-based element of the study, gather information regarding current land use and identify any factors that might affect the archaeological potential of the proposed export cable landfall sites. No previously unrecorded sites were identified.

An further onshore site visit was completed on the 2nd November 2011 in connection with the 'setting' impacts on onshore cultural heritage assets. During consultation, eleven sites had been

identified by Historic Scotland, all of which were visited during the course of the site visit. The baseline condition of each monument was noted, as were key views from each location.

4.3 Baseline Review

The potential for prehistoric sites in the study area was assessed through a review of secondary sources, including books, journals and previous archaeological investigations in the wider area. Sub-bottom profiler data from 2009 were also assessed and interpreted to identify prehistoric features of interest (see Section 5), and the results integrated with the desk-based data.

The maritime and aviation archaeological record for the study area was assessed using a range of secondary sources, records of charted wreck sites and seabed obstructions provided by SeaZone and shipping losses recorded in the NMRS. These datasets were superimposed on a base map of the study area in a Geographical Information System workspace to plot the distribution of known and recorded losses in the area. Information related to the maritime history of the Firth of Forth was drawn from secondary sources and used qualitatively, particularly to develop an understanding of the likelihood of unknown and unrecorded maritime archaeological sites and remains in the study area.

Records of aircraft casualties in the SeaZone and NMRS data were supplemented by the record of World War II Air/Sea Rescue Operations. Together with a review of historic aviation patterns, these records were used to understand the density and general distribution of aircraft activity in the vicinity of the study area, and thus highlight the potential for the discovery of aircraft crash sites.

Records of shipping and aviation losses were compared with the results of the review of the geophysical data to ground-truth the records and identify anomalies which represent unknown or uncharted wrecks, aircraft crash sites or other humanly derived debris of archaeological interest on the seabed. The review of the potential for unknown and uncharted maritime and aviation archaeological sites was also supplemented by an assessment of both the nature of the archaeological material itself and the nature of the seabed environments which can be expected to affect archaeological site survival and visibility within the study area.

4.4 Geophysical Data Processing and Archaeological Review

Geophysical data were acquired over the survey area between 3 - 6 June 2009, utilising fully motion-aided Reson Seabat 7125 and 8101 multibeam echosounders, an Edgetech 4200 dual frequency sidescan sonar, an Applied Acoustics boomer catamaran with 200 J boomer plate and a Sonar Equipment Services Digital Transmitter (pinger).

Swath bathymetry and sidescan sonar data were collected with line spacing optimised to ensure 100% seabed coverage. Sidescan sonar data provided full coverage across the site boundary and the 1 km buffer. Along the buffered cable route and shore connection options, sidescan sonar data only covered a strip approximately 450 m wide. As a result, some maritime features within the route and the shore connection option study area, and recorded in the SeaZone and NMRS datasets, were not covered by the sidescan sonar data.

Seismic data were collected with survey lines spaced at 100 m and cross lines at 1000 m. Seismic data were analysed with reference to published geology maps from the British Geological Survey (1987 (Tay Forth Quaternary sheet)). The review highlighted the existence of a number of in-filled valleys incised into the bedrock within the study area (see Section 5).

EMU Ltd processed the sidescan sonar data using SonarWiz processing software. The data were mosaiced using optimum gain settings and each survey line was then interpreted to identify features and anomalies that may be anthropogenic in origin, such as shipwrecks, aircraft wrecks and debris of archaeological interest.

Sidescan sonar produces an acoustic image of the seabed, the interpretation of which is by nature subjective, but through experience objects such as shipwrecks and aircraft remains can be identified. In the case of isolated objects, which do not have specific characteristics, it is more difficult to identify them and to discern whether they are anthropogenic in nature. It must be noted that to ascertain their archaeological character and interest based solely on the geophysical data without further documentary information or physical ground-truthing, can be problematic.

Each anomaly was measured, described, assigned a unique identifier, and an image produced from the sidescan data. A full report of interpreted anomalies was exported from SonarWiz and archaeologically reviewed to produce an archaeological gazetteer (Appendix 2), in which anomalies were assigned a rating of archaeological potential, based on the following criteria:

- The shape, size and character of the sidescan sonar signature;
- The degree of difference between the sidescan sonar signature and the signature of the surrounding geology;
- The association of the anomaly with other anomalies in the vicinity; and
- The coincidence of the location of an anomaly with a known anthropogenic/archaeological site.

The archaeological potential is described in **Table 1** below:

Archaeological Potential Rating	Description
High	An anomaly representing an object or site of anthropogenic origin and of archaeological interest.
Medium	An anomaly representing an object or site of likely anthropogenic origin that requires further investigation in order to clarify its nature and establish its archaeological potential.
Low	An anomaly representing an object or site of possible anthropogenic origin and unknown archaeological interest that does not require further investigation.

Table 1: Archaeological potential rating definitions

4.5 Geotechnical Data Review

The geotechnical review was carried out by Headland Archaeology and comprised the review of core logs and the visual assessment of one sample recovered during the geotechnical survey by Gardline. The specific objectives of which were to:

- Review available data in respect of seabed and sub-seabed deposits likely to be of palaeoenvironmental and archaeological interest;
- Identify any deposits of palaeoenvironmental potential, particularly within the Wee Bankie and Forth Formations and their interface; and
- Suggest mitigation measures, where appropriate to the findings of the review.

5. Baseline Results

5.1 Submerged Prehistoric Archaeology

The proposed development is located in the outer Firth of Forth, on the eastern coast of Scotland. For substantial periods since the earliest recorded human occupation of Britain approximately 950,000 years ago, much of the Forth was covered by successive ice sheets up to 2 km thick as the result of major glacial episodes. By locking sea water up in these ice sheets glacial periods caused the lowering of the sea level by as much as 120 m below its present level.

During the more temperate interglacial periods and after the end of the last ice age c.13,500 years ago, the ice sheets retreated, resulting in areas formerly covered by ice becoming dry and exposed, prior to being inundated by the sea. Areas of the Forth which are now marine were thus terrestrial at times in the past and form part of a submerged landscape of potential prehistoric archaeological interest.

5.1.1 *Sea Level and Glaciation*

The potential for prehistoric archaeological sites and materials within the study area is closely linked with past changes in climate and relative sea level.

During glacial episodes, of which Scotland has experienced at least six over the last 500,000 years, much of the Scottish continental shelf was covered by successive ice sheets (Ballantyne and Dawson, 2003). During the last, Devensian (*c*.110,000-13,500 Before Present (BP)), ice age Scotland and the Western Isles were again covered by thick ice sheets until rapid de-glaciation and the melting of this ice occurred between 22,000 and 13,500 BP. By *c*. 14,000 BP the ice sheet had retreated to more or less the line of the modern coastline of Scotland, leaving large areas of what is now the North Sea exposed as a terrestrial landscape (Flemming, 2004). Sea level started rising from its glacial low stand as a result of the climatic warming, gradually inundating those areas of the current seabed which had been exposed as a terrestrial landscape as the ice retreated. At the same time the removal of the weight of the ice sheet resulted in isostatic rebound of the earth's crust, creating a complex interplay of factors which determined the extent of this now submerged, formerly terrestrial landscape (Ballantyne and Dawson, 2003; Smith *et al*., 1999).

Although Scotland experienced a brief return to glacial conditions during the Younger Dryas (11,000 – 10,000 BP), for a period of approximately 3,500 years after the end of the Devensian, extended areas of the Scottish continental shelf, including the Firth of Forth, would have been exposed and potentially habitable by modern humans, prior to the Holocene marine transgression.

Current evidence, which is presented in Section 5.4 below, confirms that modern humans had occupied northern Scotland and the outer islands by 9,000 BP, which suggests that they may have been present in the area for some substantial time prior to that (Flemming, 2004).

5.1.2 *Geo-Chronology of the Study Area*

The prehistoric archaeological potential of the east coast of Scotland is relatively unexplored and there is a paucity of palaeoenvironmental and archaeological information for all periods prior to

the Mesolithic (i.e. before *c*.9,000 BP). Many of the former land surfaces and sediments described above and associated with prehistoric archaeological deposits now lie beneath the seabed. The following section outlines the overall geomorphology and sedimentology of the study area with the emphasis on the potential for archaeological deposits that may be impacted by wind farm development.

The Quaternary geology and palaeolandscape evolution of the Firth of Forth is complex, comprising a sequence of marine, lacustrine, fluviatile and glacial sedimentation and erosion (BGS, 1987).

The illustrative cross-section of the sedimentary sequence shown below has been drawn from seismic data from an area with known infilled valleys in the study area.

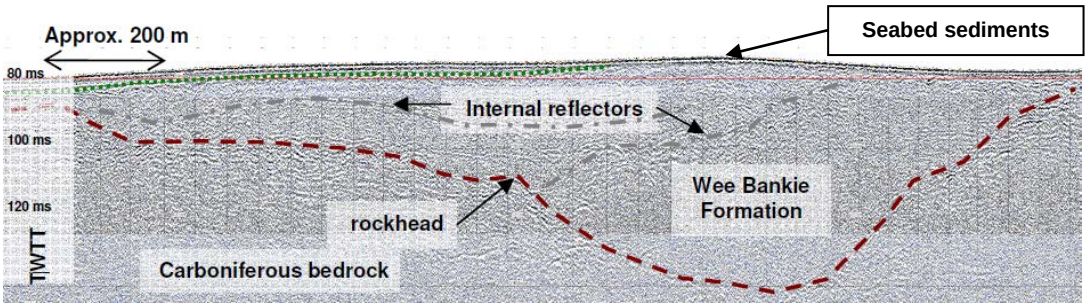

Figure 2 Seismic profile across the site (line MRP131) showing an infilled valley incised into the bedrock

The deepest sediment unit observed in the seismic data is Carboniferous bedrock. This bedrock, which is exposed at the seabed at the southern end of the cable route, is overlain in places by Permian sediments between 299 - 251 million years old which have no archaeological potential and are not considered further in this report.

The earliest Quaternary unit of possible archaeological interest relates to the Wee Bankie Formation, a basal or morainal till deposited at the margins of the ice sheet in the latter part of the Devensian glaciation, which overlies bedrock in part of the study area (**Figure 2**).

Two in-filled valleys running across the study area were identified in the geophysical data (EMU Ltd, 2010). These valleys were originally incised into the underlying bedrock by glacial processes and were subsequently in-filled with up to 40 m of Wee Bankie Formation till, a series of sands, gravels and silty clays; abraded, transported and re-deposited by the glacial ice.

With climate amelioration at the end of the Devensian, these valleys are likely to have become meandering river systems, with sediment accumulation initially comprised of glacial outwash deposits such as coarse gravels, followed by the deposition of glaciolacustrine and glaciomarine parallel-bedded laminated clays and sands indicative of rising sea level and the marine inundation of the area.

The occurrence of archaeological material within the Wee Bankie Formation is unlikely given the circumstances of its formation and deposition. Archaeological material may, however, survive in a variety of contexts, as post-glacial moraines or palaeosols (former soils preserved by burial underneath later sediments), at the interface between the Wee Bankie Formation and later Holocene sediments. Recent discoveries like the collection of handaxes recovered from a licenced dredging area off the coast of Norfolk support this, suggesting that material of

archaeological interest is capable of surviving glacial processes and marine inundation (Wessex Archaeology, 2004).

In the study area the Wee Bank Formation is overlain by post-glacial Holocene sediments including the St. Abbs Formation, the Largo Bay Member and the St. Andrews Bay Member. Within the Firth of Forth these formations are indicative of glaciomarine and estuarine environments. In particular, the St. Andrews Bay Member represents 'the build up of accretionary banks in muddy tidal channels' (BGS, 1987) and is comprised of interbedded sand and clays in the west and pebbly muds and shelly sands in the east of the study area (EMU Ltd, 2010).

Glaciomarine, fluviomarine and estuarine sediments themselves are unlikely to contain primary context archaeological deposits (i.e., material that survives in the position in which it was originally deposited). Instead, secondary context archaeological finds, which have been moved from their original point of deposition usually by natural agents like ice or water, can be expected in the study area. Even if material is no longer *in situ*, such finds are important in that they provide archaeologists with evidence of a past human presence in the area (see Hosfield and Chambers, 2003).

Holocene seabed sediments were deposited during the final marine transgression when rising sea level flooded the region, causing the deposition of silts and sands across the Firth of Forth. Generally less than 0.5 m thick, but with occasional patches of muddy sediments a few metres deep, seismic profiles show these seabed sediments overlying Quaternary sediments, which suggests the reworking or scouring out of underlying sedimentary formations to create the modern seabed sediments. Primary context archaeological deposits are unlikely to be found in transgressive marine sediments, but Flemming (2004) points to the high lithic gravel content of seabed sediments in the Firth of Forth and suggests that this is a possible environment in which secondary context lithic artefacts are likely.

Intertidal areas associated with the cable route shore connection options generally consist of shallow silts 1-2 m thick, and areas of exposed bedrock (Robinson, 1982; Barras and Paul, 2000).

Archaeological work carried out in advance of the construction of the Torness Nuclear Power Station found evidence of raised beach deposits along the shoreline that had been continuously re-sorted through wave action (Mercer, 1975). This suggests that the intertidal deposits are unlikely to preserve primary context archaeological material.

5.2 Geotechnical Review

5.2.1 *CPT core logs*

Thirty-six Core Penetration Tests (CPT), 33 vibrocore logs and 2 borehole logs, together with photographs, where available, from the proposed area of wind farm construction, were reviewed to establish whether the deposits contained any sediments of palaeoenvironmental potential; in particular peats or sediments with high organic contents such as organic silts. A laboratory visit was also undertaken to visually inspect and record the sediments from one borehole (BH_GT024/A/B/C/D).

5.2.2 *Vibrocore Results*

Forty-two vibrocores were collected from 33 locations across the study area. The maximum vibrocore penetration was 3.56 m (LES_GT019) and the minimum, 0.91 m (LES_GCT010A).

The sediments recorded in the vibrocore logs are likely to represent deposits of Holocene age and consist mainly of sands, silty sands, clays and gravels, with shell fragments observed in rare to frequent quantities within sands in all but four of the vibrocore logs (LES_GT008, LES_GT010/010A, LES_GT032/032A and LES_GT033). The sequence of deposits in vibrocores across the area is quite variable, although sand and silty sand deposits are generally the uppermost deposit in the sequences. These sand units are generally underlain by clay layers, which in turn are underlain by further sand units. No organic sediments such as peats or organic silts were recorded in any of the vibrocore logs.

5.2.3 *Piezocone Penetration Test Results*

Forty-eight CPTs were taken at 36 locations across the study area. CPTs reached a minimum depth of 0.18 m at CPT_GT028A and a maximum depth of 27.52 m at CPT_GT035.

The stratigraphic sequences recorded in the upper 2-3 m of sediment were generally similar to the vibrocore results, consisting of silty sand with occasional gravel inclusions and clay layers. Up to six distinct lithological units were identified in the CPT sequences within the palaeo-valley which runs northeast to southwest across the study area, whilst only four units tend to occur across the remainder of the wind farm area. The sequences themselves consist of alternating units of sands and clays, with gravelly clays found to make up the basal unit in all sequences. As with the vibrocore results no organic sediments were recorded in any of the penetration test logs.

5.2.4 *Borehole Results*

Two boreholes (BH_GT024A/B/C/D and BH_GT021A/B) were taken: one within the NE-SW palaeo-valley and the other within the wind farm development area. The boreholes reached maximum depths of 19.99 m (BH_GT021A/B) in the palaeo-valley and 37.58 m (BH_GT024A/B/C/D) in the wind farm area, suggesting that deposits become shallower to the north; a trend also seen to some extent in the vibrocore and CPT records.

The sedimentological record for the shallower borehole, BH_GT021A/B, consists mainly of sands, with minor units of sandy silts and sandy gravelly clay also encountered. Solid geology of sandstone with intercalated bands of mudstone was reached at a depth of 9.25 m. No organic materials were found to be present within the sequence.

The upper part of the sedimentological sequence for BH_GT024A/B/C/D is similar to that of BH_GT021A/B consisting predominantly of sands, together with bands of sandy, gravelly clay and is again in keeping with both the vibrocore and CPT records. Down the sequence BH_GT024A/B/C/D becomes clay rich, with sandy clays and sandy gravelly clays dominating the borehole below approximately 20 m. Possible organic material was noted in the borehole log for BH_GT024A/B/C/D; the only instance in which organics are noted across all the geotechnical data. This material is recorded in the logs as organic clay lenses, 1-2 cm thick, within a gravelly sandy clay layer within the top 1 m of the sequence. Further possible organics are also noted in

clay laminations within principally sand deposits between one and 17 m, including a 4 cm band between 10.08 and 10.12 m.

These organic layers and laminations have the potential to contain palaeoenvironmental information. Unfortunately, due to the fact that the samples available for archaeological inspection at the Gardline Geosciences laboratory were disturbed bulk samples rather than intact core samples, none of these organic bands was noted in any of the samples.

5.2.5 *Palaeoenvironmental Potential*

The available geotechnical data provide a record of sub-surface sediments in the study area to a maximum depth of approximately 38 m. These sediments consist principally of sands, which dominate the sequence, with intermittent layers of clay. At two locations (CPT_GT003 and BH_GT021A/B) solid geology was reached in the form of limestone and mudstone respectively. The CPT and borehole sequences contain both Quaternary and Holocene sediments.

The sedimentary sequences in the geotechnical data appear to confirm that the development site lies shoreward of the Wee Bankie Formation beds, with no intercalated sand and gravel sequences evident that could be linked to these formations. This suggests that the area of the proposed wind farm development lies within the limit of the Devensian ice sheet.

The sedimentary sequences evident in the three geotechincal datasets are generally of low palaeoenvironmental potential. The dominance of sands means that potential for the preservation of microfossils such as pollen and plant macrofossils is limited. There is some potential for the presence of microfauna such as ostracods within the sands and clays, while shell fragments were also noted in the majority of vibrocore logs. Such fossil marine fauna can provide palaeoclimate data (e.g. temperature), which can in turn be used to give an approximate date for these deposits.

Organic material was observed in only one geotechnical sample - borehole BH_GT024A/B/C/D. The borehole log notes organic matter in a number of thin laminations of clay within the predominant sand units within the top 17 m of the sequence. A small band of organic matter was also recorded at around 10 m. Unfortunately, due to the nature of the samples (disturbed bulk samples rather than intact core samples) inspected in the laboratory, none of these thin bands was observable. The presence of organic material is potentially of palaeoenvironmental significance, and given the depth of these occurences (between 1 m and 17 m) could provide information of pre-Devensian date.

5.2.6 *Prehistoric Archaeological Potential*

From the previous section it is clear that the glacial and sea level history of Scotland is complex and that much of the area has been covered by glacial ice for extended periods since the first early human occupation of the UK.

Although human populations are known to have been active in proximity to the margins of glacial ice fronts (see Woodcock, 2000) they are unlikely to have spent extensive periods of time in this sort of environment. Prehistoric archaeological remains are thus predominantly found beyond the extents of the succession of ice sheets (Flemming, 2004).

There is a paucity of Palaeolithic sites in Scotland, which is attributed to the effects of repeated glacial ice incursions in the last 500,000 years during which archaeological deposits are likely to have been either destroyed or substantially reworked by subsequent glaciations (Flemming, 2004). Little hard evidence therefore exists for a human presence in Scotland prior to the end of the Devensian. This lack of evidence should not be taken, however, to mean that humans did not occupy Scotland prior to this, or that Palaeolithic sites will not be found in the future. Sites have survived elsewhere in the UK despite being over-run by ice – at High Lodge in Norfolk, for example.

It is thus only during the period since the last glacial maximum that there is likely to be a substantial, *in situ* prehistoric archaeological record for Scotland and its continental shelf. Although there are currently very few prehistoric archaeological finds from an offshore context in Scotland a worked Upper Palaeolithic flint found in 1981 within a borehole core indicates some potential of a past human presence in an area that is now submerged. The Viking Bank flint was covered by 28 cm of recent silty sand, in a water depth of 143 m, and based on its context is likely to have been deposited when this area of the seabed was last dry, between 10,000-18,000 years ago (Long *et al.*, 1986).

Faunal remains recovered in large quantities by fishermen in the North Sea for many years confirm the presence of reindeer, bison, woolly mammoth, red deer and woolly rhino on expansive late and post-Devensian landscapes which are now submerged. From the faunal evidence the environments represented by these landscapes would have been attractive to humans and will have been colonised and utilised by human groups. The retreat of the Devensian ice sheet and the amelioration of climatic conditions in Scotland would have seen the development of terrestrial palaeo-landscapes off the east coast of Scotland, including the study area, very similar to those that existed further south.

There is ongoing debate about the extent and nature of early Holocene human culture in northwest Europe, with some suggesting the 'Doggerland' region of the southern North Sea, to the southeast of the Forth, as the heartland of an Early Mesolithic culture (Gaffney *et. al*., 2009).

Seismic records for the Neart na Gaoithe study area show evidence of palaeo-landscape features similar to those south of the Dogger Bank studied by Gaffney *et al*, whose reconstructions of North Sea palaeo-landscapes highlighted environments such as river valleys and marshland. These environments would have been favoured by humans during the Mesolithic, and possibly earlier, and are thus areas of archaeological potential (Gaffney *et al*., 2007; Gaffney *et al*., 2009). Consequently, the palaeo-valleys in the seismic records for the Neart na Gaoithe study area may have presented an attractive and productive environment for Late Palaeolithic and Mesolithic human populations and evidence of their activity has some potential to be preserved within the sedimentary sequence.

Within seabed sediments, organic deposits such as peat can provide palaeoenvironmental information about the processes of environmental and geomorphological change. Limited palaeoenvironmental information is available from the British Geological Survey (http://shop.bgs.ac.uk/GeoRecords/) for the Firth of Forth, but previous studies of intertidal areas in the vicinity of the study area have noted an absence of peat at these locations, and diatom

analysis (Robinson, 1982, 1993) and geochemistry (Barras and Paul, 2000) have indicated a low potential in regard to palaeoenvironmental deposits. The geotechnical data from the study area assessed for this report and described above tend to support this conclusion.

Organic deposits such as submarine peat have been identified in submerged contexts elsewhere in Scottish waters (Shetland and Orkney) and at numerous offshore locations within the North Sea, to the south of the study area (Flemming, 2004). Some potential may thus exist for organic deposits to be recovered at offshore locations within the Firth of Forth.

In summary, Late Palaeolithic and Mesolithic artefacts may be present in the study area and would be valuable in providing evidence for early human activity in Scotland. However, whilst archaeological artefacts can survive ice sheet impact and sea level change, particularly in unconsolidated deposits, caves, lagoons or in gullies between ridges of rock (Flemming, 2004), the potential for discovering prehistoric archaeological material in the study area is regarded as low.

Any archaeological material, including palaeoenvironmental deposits, discovered within the study area in the course of the development of the wind farm, would be of archaeological interest.

5.3 Maritime Archaeology

Maritime archaeological sites and materials are the physical remains of boats and ships that have been wrecked, sunk or have foundered, and also include artefacts which came to be in or on the seabed as the result of being jettisoned or lost overboard (e.g. anchors, cannon and fishing gear).

This report has identified a long term and sustained growth in commercial and military activity off the east coast of Scotland, and notes a large number of maritime losses in the study area from the modern period, particularly World Wars I and II.

Given the historic volume of maritime traffic and the confined approaches and potential hazards of parts of the Firth of Forth, it is unsurprising that there is a numerous and diverse range of vessels resting on the seabed within this region (see **Figure 3**).

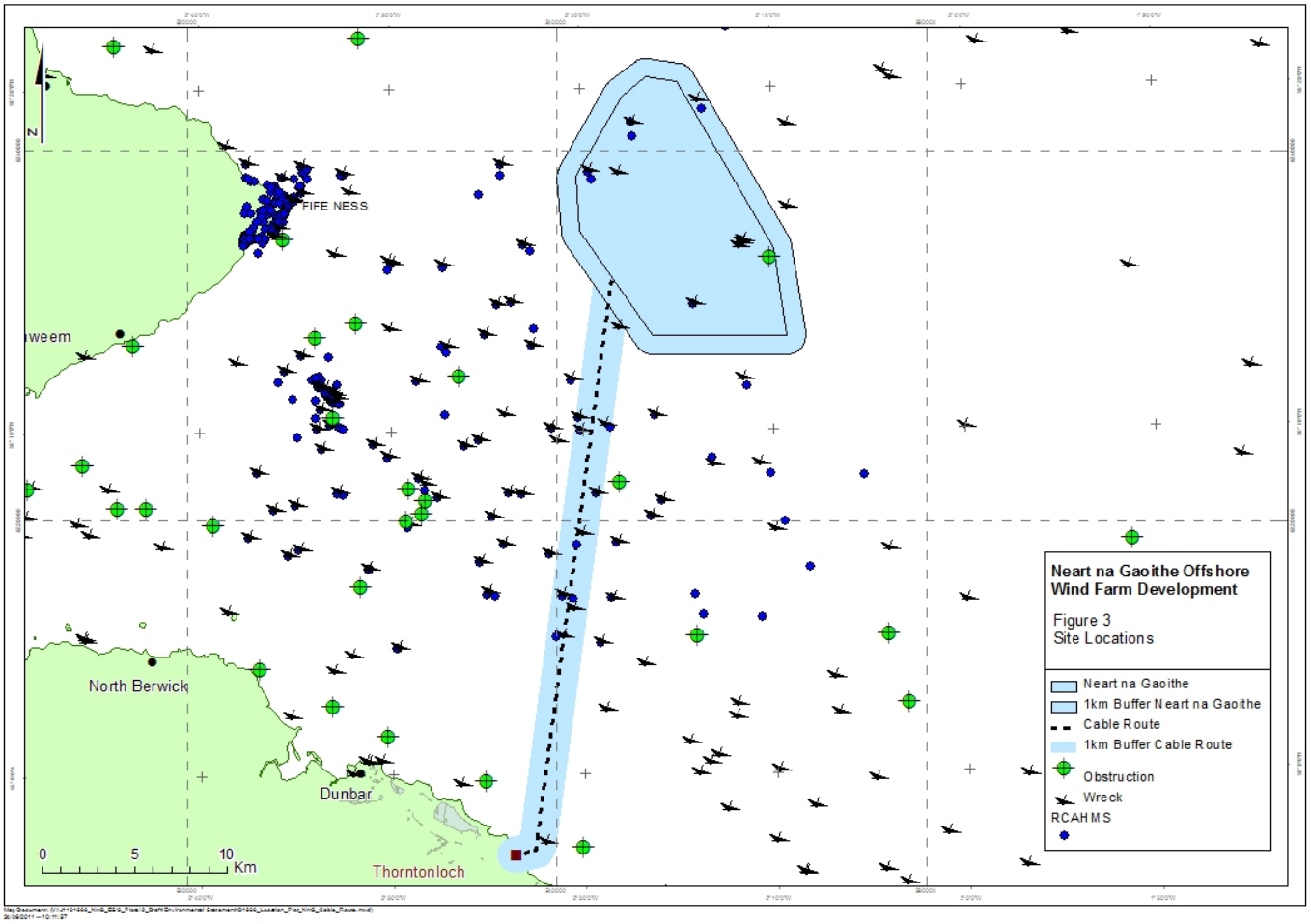

Figure 3 Location of SeaZone Wrecks and Obstructions and Maritime records in the NMRS within the outer Firth of Forth

5.3.1 *Maritime Potential*

There is the potential for maritime archaeological material in the study area dating from much of the known period of human occupation of Scotland. The Firth of Forth forms one of the few approaches to the east of Scotland from England and the entrance to the Forth is likely to have been an important transport corridor and trade route since sea-going vessels first traversed the area after the marine transgression around 9,300 BP.

The earliest evidence for maritime activity in the region is a logboat discovered in the Tay Estuary in 2001. Named the 'Carpow' logboat, this Bronze Age boat has been dated to approximately 3,000 BP and is one of the oldest boats to be discovered in Scotland. Boats dated to the Bronze Age have also been recovered elsewhere in the UK, including Catherine Field in Dumfriesshire and North Ferriby on the Humber (Cunliffe, 2001). Although only some of these vessels are likely to have been capable of sea voyages, they bolster the evidence for early seaborne transport around the North Sea and the east coast of Scotland.

Direct evidence for maritime activity in the study area during the period prior to the end of the first millennium AD is limited, and maritime remains earlier than the medieval period are so rare that any examples of craft from this period are of particular archaeological interest.

There is substantial documentary evidence for trade across the North Sea dating back to the Roman period, which has been confirmed by a number of archaeological finds, including Roman pottery (mortaria) recently recovered off the coast of Lincolnshire and a Spanish 'Dressel 20' amphora, dated to the 1st – 2nd centuries AD, dredged up by a fisherman on the Dogger Bank (BMAPA and Wessex Archaeology, 2009; Wessex Archaeology, 2004). the largest seaports during the Roman period within the Firth of Forth were Musselburgh and Cramond. They served as supply depots for the Roman forts built at both places (Larn and Larn, 1998). Roman era wrecks are possible in the vicinity of both ports, and also elsewhere in the wider Firth of Forth, including the study area.

During the 5th and 6th centuries AD the Lothians were invaded and settled by Angles from the Jutland Peninsula. Between 739 and 1066 AD maritime activity across the North Sea intensified as a result of Viking raiding, colonisation and trade; and areas of Scotland were occupied by the Vikings around 800 AD. The study area is likely to have experienced significant maritime traffic during the Angle and Viking periods as the large sea-worthy clinker-built Scandinavian boats allowed significant cross-sea movement and resulted in the opening of new trade routes across much of northern Europe (Greenhill, 1976). The Viking presence and influence on the eastern seaboard of Scotland would have controlled the rivers and estuaries, such as the Firth of Forth, which secured access to trade routes across the North Sea.

In Scotland, as in other parts of the UK, the difficulty of inland communication encouraged travel and transport of goods by sea, and the development of numerous small ports and harbours. Shipping activity in the Forth, and the development of its ports and harbours, therefore expanded during the medieval and post-medieval periods, as maritime traffic in the Forth increased.

Within the study area Skateraw Harbour is an example of the type of small harbour which is likely to have been used as a convenient landing point by mariners of all periods. Within Skateraw bay a small inlet runs through the littoral rocks to a small sandy beach, forming a natural approach for small boats. The harbour is mentioned as a possible landing point for 'disaffected persons' in the Register of the Privy Council in 1565 (Graham, 1971: 273), whilst Adair's map of 1682 shows an anchorage here with a depth of three fathoms, as well as buildings to the south and east of the harbour and the chapel at Chapel Point. Around 1700 Skateraw was listed as a `creek' for use by barks in summer time (Graham, 1971: 273). The construction of harbour works appears to have been carried out between 1799 and 1825, before the harbour structure was destroyed, possibly during a storm in the 19th century (Triscott, 1996: 192).

Industry has also been an important feature of East Lothian with lime-working carried out as early as 1680 and coal-mining and salt-panning carried out during the mid-17th century. These and other products are likely to have been imported and exported by vessels utilising the Firth of Forth.

Rapid industrialisation in the 18th and 19th centuries revolutionised shipbuilding, with the adoption of iron and steel in ship construction and the development of steam propulsion to replace sail. This encouraged the construction of larger vessels, which were self-propelled and thus not constrained, like sailing vessels, by the limitations imposed by the wind. Vessel movements

between the UK and Europe, across the North Sea, increased considerably (Young, 2003) and thus the potential for shipping losses in the Firth of Forth also increased during this period.

The modern period is characterised by the large-scale industrial use of the sea with heightened levels of commercial activity. The North Sea was a focus for military activity during the two World Wars with Scapa Flow, in the far north of Scotland, a naval base for the British fleet in both wars.

The Firth of Forth itself witnessed extensive activity during World Wars I and II. A new naval dockyard was developed at Rosyth from 1909 as part of the programme to strengthen the Royal Navy's presence on the eastern seaboard of the UK in the arms race that led up to World War I. In January 1918 a convoy of naval ships and submarines *en route* from Rosyth to naval exercises in the North Sea was involved in a series of accidents that resulted in the sinking of two K-class submarines, both of which are located within the Neart na Gaoithe study area. The so-called Battle of May Island is described in more detail later in this report.

The coasts of Fife and East Lothian contain a large number of sites related to 20th century warfare (Moore and Wilson, 2006). There were a number of large defences built within the Firth of Forth and extensive minefields were laid, both within the Forth itself and in the sea to the east. During World War II German bombers targeted Edinburgh and the surrounding suburbs, and attacked Rosyth Naval Dockyard. In addition, bombers are reported to have attacked ships in the Forth, particularly if they had surplus ordnance after a bombing run.

British mines and German bombs are occasionally recovered around the Forth (1986, 2006, 2007 and 2008) mainly by trawlers and two historical munitions dumps are recorded by the Ministry of Defence around the Isle of May and centred on 56° 10' 45"N 02° 30' 15" W and 56° 11' 24" N 02° 29' 00" W. These are dumps of standard rather than chemical munitions and their heritage value is normally considered to be negated by the extreme hazard they pose.

5.4 Aviation Archaeology

Thousands of military and civilian aircraft casualties have been recorded in UK waters since the advent of powered flight in the early 20th century. The bulk of these losses occurred off the south and southeast coasts of England, mainly during World War II. However, a number of World War II British Air/Sea Rescue operations are recorded in and around the Firth of Forth, which implies an equal number of aircraft wrecks on the seabed in the area.

Due to the strategic importance of the Firth of Forth, the area witnessed both Allied and Axis aviation activity during World War II, including the first air attack of the war in October 1939. German aircraft targeted the Royal Naval base at Rosyth on this occasion, and two German Heinkels were shot down in the Firth of Forth and a bomber off the Isle of May. These are said to be the first enemy aircraft shot down over the UK during World War II (www.itscotland.org.uk/scotlandhistory).

Recorded aircraft losses in the vicinity of the study area consist of five modern aircraft, the earliest of which both date to 1970 (a Lightning and a Cessna 320) and the most recent relating to the loss in 2005 of a Panavia Tornado (UKHO 66913), approximately 20 km northwest of the study area. The NMRS also records the remains of a World War II Bristol Beaufighter, near the

the Skateraw cable route. Although the positions of these recorded losses are not accurate, there is nonetheless some potential for their remains to be discovered within the study area.

Crashed aircraft are notoriously difficult to identify in seabed surveys. The aviation archaeology of the study area is thus largely unknown and unrecorded. However, the identification of aircraft wrecks has become increasingly common in recent years, with a number of aircraft wrecks identified and located in the course of surveys in support of seabed development in UK waters (Wessex Archaeology, 1997, 2003, 2006 and 2008b), and there is the potential for such sites to be located in the course of seabed development during construction.

As stated in Section 3.1.3, the wrecks of all military aircraft are automatically protected under the terms of the *Protection of Military Remains Act* 1986.

5.5 Known and Recorded Maritime and Aviation Archaeology

Data for known and recorded shipping and aircraft losses in the study area were obtained from SeaZone and the NMRS. SeaZone data comprise the UKHO Wreck Index, which is the record of charted wrecks, and seabed obstructions whose positions are known and whose existence has generally been confirmed through survey. SeaZone data contain co-ordinates for each wreck or obstruction, a description of the site and the survey history of each site.

The marine component of the NMRS originally comprised just the UKHO Wreck Index, but has since been enhanced by the addition of substantial numbers of historic records of shipping casualties drawn from documentary and archival sources. The records which originated with the UKHO are associated with charted positions, but those drawn from archival sources are usually based on descriptions in the documentary record. Their positions therefore reflect the general loss locations of ships or the indicated position of seabed finds and are not (except by chance) the actual or real position of the physical remains of the sites on the seabed which they list.

In light of the outline of maritime history of the Firth of Forth given above it is important to remember that these datasets provide a general idea of known and recorded maritime casualties in the study area, largely within the last 250-300 years. They should thus not be taken to represent the totality of maritime archaeological remains in the study area.

5.5.1 *SeaZone Wrecks and Obstructions*

Wrecks and obstructions listed by SeaZone are generally charted, although a small number lack accurate positional information. It is also worth noting that although most of these wrecks and obstructions have at one time or another been located on the seabed, many were first identified before the advent of modern surveying techniques and may have been located using a positional system such as DECCA, which is considerably less accurate than modern satellite navigation systems, such as the United States' Global Positioning System (GPS).

Previously charted wrecks or obstructions not located during subsequent surveys may have had their status amended by the UKHO to 'dead'. This may be the result of mistaken identification, inaccurate co-ordinates, the degradation/destruction of the wreck, or its burial by sediment. This means that the wreckage has not been detected in repeated surveys, but it cannot be taken to

imply that the wreckage is no longer on the seabed. All SeaZone records for the study area are thus discussed below, regardless of their current status.

In reviewing SeaZone records for this report each was given a unique EMU Archaeology number with the suffix 'EA', for ease of reference. The unique UKHO identifier supplied by SeaZone is listed alongside the EA numbers in **Table 2**, which shows the 19 recorded or charted wrecks and obstructions located within the study area. Eight of these lie within the wind farm footprint (**EA62-EA68** and **EA70**), one within the 1 km site buffer zone (**EA69**) and the remaining 10 within the buffered cable route corridor (**EA52-EA61**).The positions of the SeaZone records are shown in **Figures 4** and **5**.

EMU ID (EA)	SeaZone ID/ UKHO ID	Name/Type	Position WGS 84 UTM 30	UKHO Status	Description
52	4226	Wreck of *Livlig*	539438 6202545	Dead	Norwegian schooner sunk in 1917
53	2900	Wreck *(Bellax)*	540349 6213674	Live	Notable debris which may be the wreck of the *Bellax.* Could be geological outcropping
54	3099	Wreck	540912 6215172	Dead	Unnamed dead wreck
55	3097	Fisherman's Fastener	540335 6215939	Dead	Dead wreck
56	2916	Submarine wreck (*U12)*	541357 6219256	Dead	German submarine now dead, as site confirmed elsewhere
57	3081	Unknown	542129 6221490	Dead	Unknown obstruction, now dead
58	2943	Wreck of *Asta*	541303 6224820	Dead	Swedish steamship which sank in 1927
59	65441	Unknown	542594 6225142	Dead	Dead wreck
60	2947	Wreck of *Thrive*	541193 6225530	Dead	British steam trawler which sank in 1946
61	2962	Wreck of *Ballochbuie* (former)	543316 6230405	Dead	British steam ship *Ballochbuie*. Now located at EA62

62	2964	Wreck of *Ballochbuie*	547378 6231700	Live	British steamship sunk in 1917
63	2969	Obstruction	551539 6234207	Live	Unknown seabed obstruction
64	2975	Submarine wreck – *K4* or *K17*	549981 6235037	Live	British submarine sunk in accident in 1918. Protected Place
65	2973	Submarine wreck – *K4* or *K17*	550042 6235149	Live	British submarine sunk in accident in 1918. Protected Place
66	2982	Wreck of *Einar Jarl* (former)	543231 6238752	Dead	Norwegian steamship sunk in 1941. Now located at EA68
67	2984	Unknown	541692 6238908	Live	Unknown, possibly a wreck
68	2989	Wreck of *Einar Jarl*	544025 6241465	Live	Norwegian steamship sunk in 1941
69	2990	Wreck	547520 6242692	Dead	Dead wreck
70	7116	Wreck	549807 6234816	Live	Probable bow section of *K4* or *K17*. Protected Place

Table 2: Records within the SeaZone data

'Live' Wrecks

There are eight 'live' sites in the study area.

K4 (**EA64**, UKHO 2975) and ***K17*** (**EA65**, UKHO 2973)

Two wrecks are designated as *Protected Places* under the *Protection of Military Remains Act* 1986, and may not be disturbed except under licence from the MOD. They are K-class steam powered submarines – *K4* and *K17* – which sank in 1918 during the so called Battle of May Island. This incident was not a battle but a series of collisions which took place within a convoy of British battleships and submarines *en route* from Rosyth to Scapa Flow on the evening of 31 January 1918. A series of mistakes and navigational errors over a period of several hours led to the sinking of the two submarines by British vessels in the same convoy, serious damage to several other vessels and the loss of over 100 lives. The full details of the 'battle' have been described by Everitt (1999) and Nash (2009).

The wrecks were originally located in 1962 during a survey by HMS *Scott* but their identification has led to some confusion, principally with regard to which wreck was which.

K4 was built between 1915 and 1917 at the Fairfield yard on the Clyde. During the 'Battle of May Island' it was hit by two other K-class submarines in succession. One of these, *K6*, hit *K4* side on and is said to have nearly cut the latter in half, causing it to sink rapidly. Despite this, the wreck of *K4* is described by several divers in the NMRS entry as being largely intact. *K4* lies in approximately 46 m of water and stands around 7 m proud of the seabed (Baird, 2009: 180-187).

K17, built by Vickers at Barrow-in-Furness, sank after being rammed by the battleship HMS *Fearless*. The wreck has broken into several pieces. Divers describe the main body of the submarine as standing upright on the seabed to a height of approximately 6 m, with the conning tower or deck-house lying to the starboard of the wreck. The wreck lies in 46 m of water.

The presence of human remains on a wreck has a significant bearing on its perceived cultural heritage value. In the cases of *K4* and *K17*, the RCAHMS record concludes that 'the survival of a substantial quantity of human remains is considered likely within *K4*, but improbable in *K17*'. According to the accounts of their sinking none of the 55 crew of *K4* escaped from the submarine before it sank. In the case of *K17*, although most of the crew managed to leave the vessel after it was rammed 47 died in the water.

Andrew Jackson, a diver from the Scarborough Sub-Aqua club, recorded the discovery of possible human remains at *K4* in June 2007 (RCAHMS entry) which lay 'in the severed end of the wreck'. A licence is required from the Home Office to exhume human remains and it is important that anyone encountering buried remains should leave them in place and contact the Home Office immediately (COWRIE and Wessex Archaeology, 2007).

Unknown (**EA70**, UKHO 7116)

This structure is thought to relate to the bow section of either the *K4* or the *K17* and has been recorded approximately 280 m southwest of **EA64** and approximately 400 m southwest of **EA65**.

EA64, **EA65** and **EA70** are all discussed further in the geophysical review in Section 6.

The remaining 'live' wrecks are:

Einar Jarl (**EA68**, UKHO 2989)

This record relates to the wreck of the *Einar Jarl*, a Norwegian steamship built in 1921 which struck a mine and sank in 1941. Prior to a diver survey this large and collapsed single propeller steamship wreck (approximately 89 m long and 21 m wide) was thought to be HMS R*ockingham*, which was significantly different in design. A previous location recorded for the *Einar Jarl* (**EA66** UKHO 2982) is now thought to be erroneous and has been amended to 'dead'.

Ballochbuie (**EA62**, UKHO 2964)

This charted wreck lies in the south of the wind farm area and is thought to be the *Ballochbuie*, a Scottish cargo steamer built in 1905 and sunk by a German U-boat in 1917. The location, recorded with GPS and accurate to approximately 15 m, has been dived and confirmed as a wreck 55 m in length and 8 m wide, with a height above the seabed of approximately 7 m. A previous location recorded for the *Ballochbuie* (**EA61** UKHO 2962) has now been amended to 'dead' and is not considered to be of archaeological interest.

Unknown (**EA67**, UKHO 2984)

Located in the northwest of the site, this unnamed wreck was first recorded in 1967 and was surveyed again in 2008 when its location was recorded with Differential GPS to an accuracy of 3 m. It is 45 m in length and approximately 10 m breadth.

Unknown (EA63, UKHO 2969)

EA63 is an obstruction recorded in 1939 and is considered to be a possible wreck. The location of this obstruction has not been recently recorded or investigated and given the potential for poor positional accuracy (between 100 and 1000 m), this obstruction may have been confused with the wrecks of K4 and K17, which lie approximately 1.7 km northwest of the recorded obstruction.

Unknown (**EA53**, UKHO 2900)

'Notable debris' was recorded at this location by sidescan sonar in 1945. The site was not found during a survey in 1977, but was noted again in 2003 when debris was found covering an area of approximately 31 m by 9.8 m, with a height of 1.5 m. Although the UKHO does not identify this debris, an entry on www.wrecksite.eu (last accessed 10 November 2010) states that this may be the wreck of the *Bellax*, a Norwegian steamer built in 1914 and sunk by a German submarine in 1917. An alternative explanation as a result of geophysical analysis is given in Section 9.

'Dead' Wrecks

There are eleven 'dead' wrecks or obstructions locations in the study area (see **Table 2** and **Figure 4** and **5**).

Thrive (**EA60,** UKHO 2947)

EA60 (UKHO 2947) was charted as a possible wreck in 1949 and 1972 near the northern end of the cable route. The anomaly was identified as the wreck of *Thrive*, a steam trawler which sank after picking up a mine in its nets in 1946, the site was not located during a subsequent survey in 1977 and has been marked as 'dead' by the UKHO.

Asta (**EA58,** UKHO 2943)

A wreck charted to the south of **EA60**, **EA58** (UKHO 2943) may represent the wreck of the Swedish cargo steamer *Asta*, built in 1883 and sunk after a collision in 1927. The accuracy of this charted position is considered to be in the range of a kilometre, and surveys in 1977 and 2001 have failed to find any trace of the wreck. Although the wreck survives in some form on the seabed it is now listed as 'dead'.

Unknown (**EA59,** UKHO 65441)

EA59 (UKHO 65441) lies more than a kilometre northwest of **EA58**. The site was first recorded in 1919 and although the charted location is included in the UKHO database, it is based on a reported loss and not a surveyed anomaly. The site could not be located during a survey in 1977 and is considered to be 'dead'.

Unknown (**EA57**, UKHO 3081)

EA57 (UKHO 3081) is a possible wreck reported in 1979 and positioned using a DECCA system. A recent survey in 2004 found no trace of a vessel in the vicinity of the recorded position and it has been listed as 'dead'.

U-12 (**EA56,** UKHO 2916)

EA56 is a German submarine, *U-12,* recorded in 1915 as sunk, at a position within the cable route corridor. A subsequent survey in 1977 could not locate **EA56** and the *U-12* has recently been located by diver survey at a position approximately 32 km beyond the study area. The original position is now listed as 'dead'.

Obstruction (**EA55,** UKHO 3097)

EA55 (UKHO 3097) is the site of a physical snag reported by a fishing vessel in 1979. A survey of the area in 2004 failed to locate any wreck or obstruction at this location.

Unknown (**EA54**, UKHO 3099)

EA54 (UKHO 3099) comprises debris reported in 1979 and thought to be a possible wreck. Subsequent surveys have failed to find any evidence of a wreck and as the debris was originally positioned by DECCA there is the possibility of it being confused with the nearby entry at **EA53** approximately 1.6 km to the south.

Livlig (**EA52,** UKHO 4226)

The Norwegian schooner *Livlig* foundered in a gale in March 1917, approximately 1.5 km north of the shore at Torness. The ship was 277 tons, with a cargo of pit props. The wreck of the *Livlig* was recorded at this location in 1919, but has not been located during recent seabed surveys and is listed as 'dead'.

Unknown (**EA69**, UKHO 2990)

EA69 is an unknown wreck located during a survey by HMS *Malcolm* in 1975. This wreck is now listed as 'dead'.

5.5.2 *NMRS Recorded Positions*

As stated above, the marine component of the NMRS includes records from the UKHO Wreck Index enhanced by historical records of shipping casualties drawn from documentary and archival sources.

The NMRS lists 28 historical shipping casualties in the study area, represented by 22 Recorded Positions, of which two (RP10 and RP11) comprise a total of eight vessels (see **Table 3** and **Figure 4** and **5**). Recorded Positions such as RP10 and RP11 are aggregations at a single position, often at the southwestern corner of a 1 km grid square, of more than one historical maritime record for which no other grid reference or accurate position is available. A number of the NMRS Recorded Positions correspond to known and charted wrecks. Others relate to reported losses and do not reflect actual loss positions.

There are no records within the NMRS list for the study area of losses that predate the 19th century, except for HMS *Nymphe*, which was built in the late 18th century but sank in 1810. Military losses recorded by the NMRS include the *K4* and *K17* discussed already, a number of British registered ships and a World War II Bristol Beaufighter aircraft.

Recorded Position ID	NMR ID	Name/Type	Position UTM 30 WGS 84	Description
RP1	96715	Wreck of *Ballochbuie*	547362 6231685	British steamship sunk in 1917
RP2	101617	Wreck of HMS/M *H11*	549982 6235163	Submarine wreck of *H-11*
RP3	102066	Wreck of *Thrive*	541181 6225525	Modern trawler lost 7 miles ESE of Isle of May
RP4	102076	Wreck of u-boat *U-12*	541090 6218663	U-boat lost off Eyemouth. Now located elsewhere
RP5	102077	Obstruction	540330 6215932	Obstruction in Outer Forth Estuary
RP6	102113	Wreck of *Scotia*	539992 6213677	Wreck of 19th century dredger reported off Dunbar
RP7	102133	Unknown wreck / obstruction	542129 6221488	Unknown obstruction, located in Outer Forth Estuary
RP8	102143	Unknown wreck / obstruction	540902 6215800	Unknown obstruction, located in Outer Forth Estuary
RP9	115514	Wreck of *Denwick Head*	536211 6203391	20th century steamship reported off Barnsness Lighthouse
RP10	119967 119972 119975 119984	Wrecks of: *Andromeda;*, *King Ja Ja; Agnes;* and *Prosum*	537619 6202811	19th and 20th century wrecks reported off Londcraig Rocks, Thorntonloch

RP11	119986 260658 273767 274081	Wrecks of: *Ribnitz; Saxon; Antelope*; and *Orient*	536014 6203188	19th century wrecks reported in Outer Forth Estuary
RP12	120576	Wreck of HMS/M *K17*	549962 6235143	British submarine which sank during a training exercise in 1918
RP13	120577	Wreck of HMS/M *K4*	549964 6235033	British submarine which sank during a training exercise in 1918
RP14	120972	Unknown wreck	541658 6238833	Unknown wreck. Off Bodo, Outer Forth Estuary
RP15	120976	Wreck of HMS *Rockingham*	544019 6241538	Wreck of HMS *Rockingham*. Now thought to be wreck of *Einar Jarl*
RP16	195136	Wreck of *Livlig*	539424 6202537	Wreck lost off The Reef, Torness Point
RP17	195139	Possible wreck of HMS *Nymphe*	536112 6203290	Fifth rate warship which sank in 1810. Lost off Chapel Point
RP18	199996	Unknown wreck	540857 6212659	Unknown wreck. Off Dunbar, Outer Forth Estuary
RP19	200041	Unknown wreck	541903 6238477	Unknown wreck. Off Fife Ness, Outer Forth Estuary
RP20	200044	Unknown wreck	547849 6242243	Unknown wreck. Off Fife Ness, Outer Forth Estuary
RP21	200124	Unknown wreck	544110 6240759	Unknown wreck. Off Fife Ness, Outer Forth Estuary
RP22	273467	Bristol Beaufighter aircraft	537293 6204607	Aircraft JL427 crashed 1.5 miles from Barness lighthouse

Table 3: Maritime records in the NMRS

There are no obstructions or navigational hazards in the vicinity of the wind farm site. The Isle of May, which may be considered a natural hazard to shipping, is more than 12.5 km to the west of

the site. The shallow waters associated with the landfall end of the cable route options represent a hazard to shipping, largely as a result of the outcropping bedrock and shallow water depth.

The potential for currently unknown and unrecorded wrecks in the study area that are reflected in neither the SeaZone nor the NMRS data is variable. Those portions of the study area close to the shore and its shallow bedrock outcrops are a greater shipping hazard than the deeper portions of the study area and thus have a higher potential for containing such sites. There is the possibility that previously unknown wrecks may exist elsewhere in the study area, but the potential is assessed to be relatively low, based on the seabed morphology and nature of the surface sediments across the study area.

It must be noted that unknown wrecks, or recorded losses whose the position is not accurately known, may be discovered as a result of seabed disturbance.

5.5.3 *Wreck Characterisation and Preservation Potential*

Although the Firth of Forth is an area with historically high levels of shipping activity and also vessel loss, the survival of maritime archaeological remains in the study area will depend on a range of factors, including the age and construction material of any wreck.

There is a dearth of charted wrecks pre-dating the late 18th century in the study area. The majority of known shipwrecks in the area are iron and steel vessels dating from the 19th and 20th centuries. This dominance of modern wrecks in the records of known and charted sites is the result, not only of the nature of their construction, but also the method in which wrecks were recorded in the past.

Until the early 20th century, unless a vessel was lost on or close to the shore the precise position of its wreck was often difficult to ascertain. Since the UK Hydrographic Office was given responsibility in 1913 for conducting routine seabed obstruction surveys, large numbers of wrecks have been located and charted offshore. The bulk of these date to within the last 150 years and have been located because of their size and iron or steel construction, which make such wrecks more likely to be identified during remote sensing surveys (Parham, 2007).

Compared to iron and steel wrecks, wooden shipwrecks tend to be older, smaller and to have carried less ferrous material. They also tend to break up more quickly than iron and steel wrecks and are thus more likely to be scattered, dispersed and have a generally lower physical profile on the seabed. Consequently, they are less likely to be located by geophysical survey.

The other factors which govern the site formation processes associated with a shipwreck and the potential for its long-term survival and preservation are environmental, and include water depth, current flow and strength, seabed type, and also sediment depth, transport and deposition. In general, wrecks which remain exposed on the seabed will degrade and break up more quickly than those which become covered by sediment.

Where the seabed is composed of anaerobic soft muds, clays and silts there is an increased potential for the preservation of shipwreck remains, particularly organic material such as wood. At Neart na Gaoithe the modern (Holocene) seabed sediment of the study area is underlain by glacial till, with areas of exposed bedrock particularly along the cable route near the coast. These

sediments are well consolidated and maritime remains will not ‘sink’ into them (Merritt 2008: 60). The modern seabed is also a relatively thin veneer and will thus not constitute an environment beneficial for shipwreck preservation by burial.

Thus, whilst the maritime history of the study area suggests that the potential for pre-modern maritime archaeological sites and remains is greater than is suggested by the known and recorded remains, the likelihood for the preservation of substantial, coherent wooden wrecks is low. If such wrecks do exist in the study area, wreck material will still be present, albeit as low profile, possibly scattered archaeological sites.

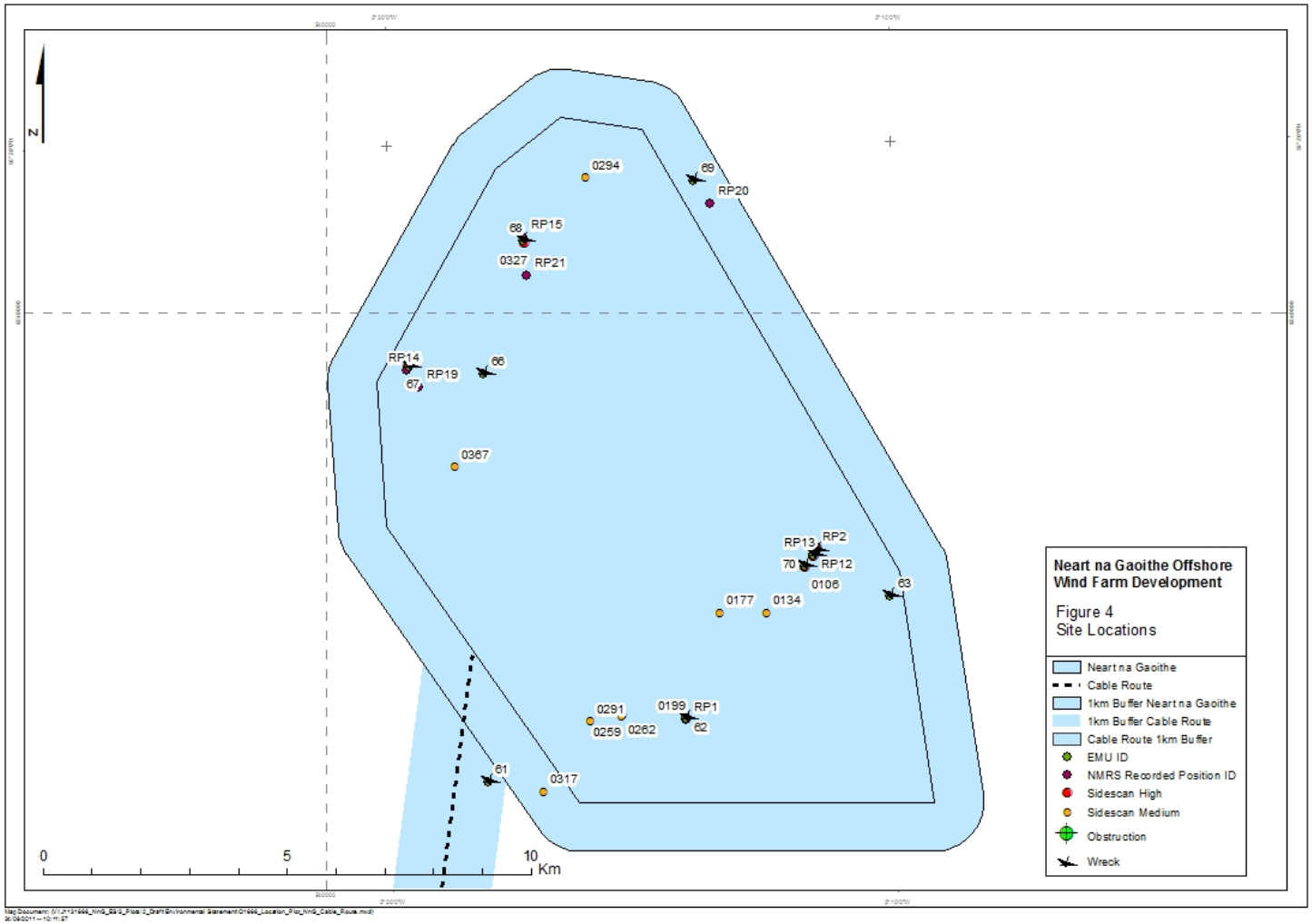

Figure 4 Location of SeaZone Wrecks and Obstructions and Maritime records in the NMRS in the main development area and 1km buffer

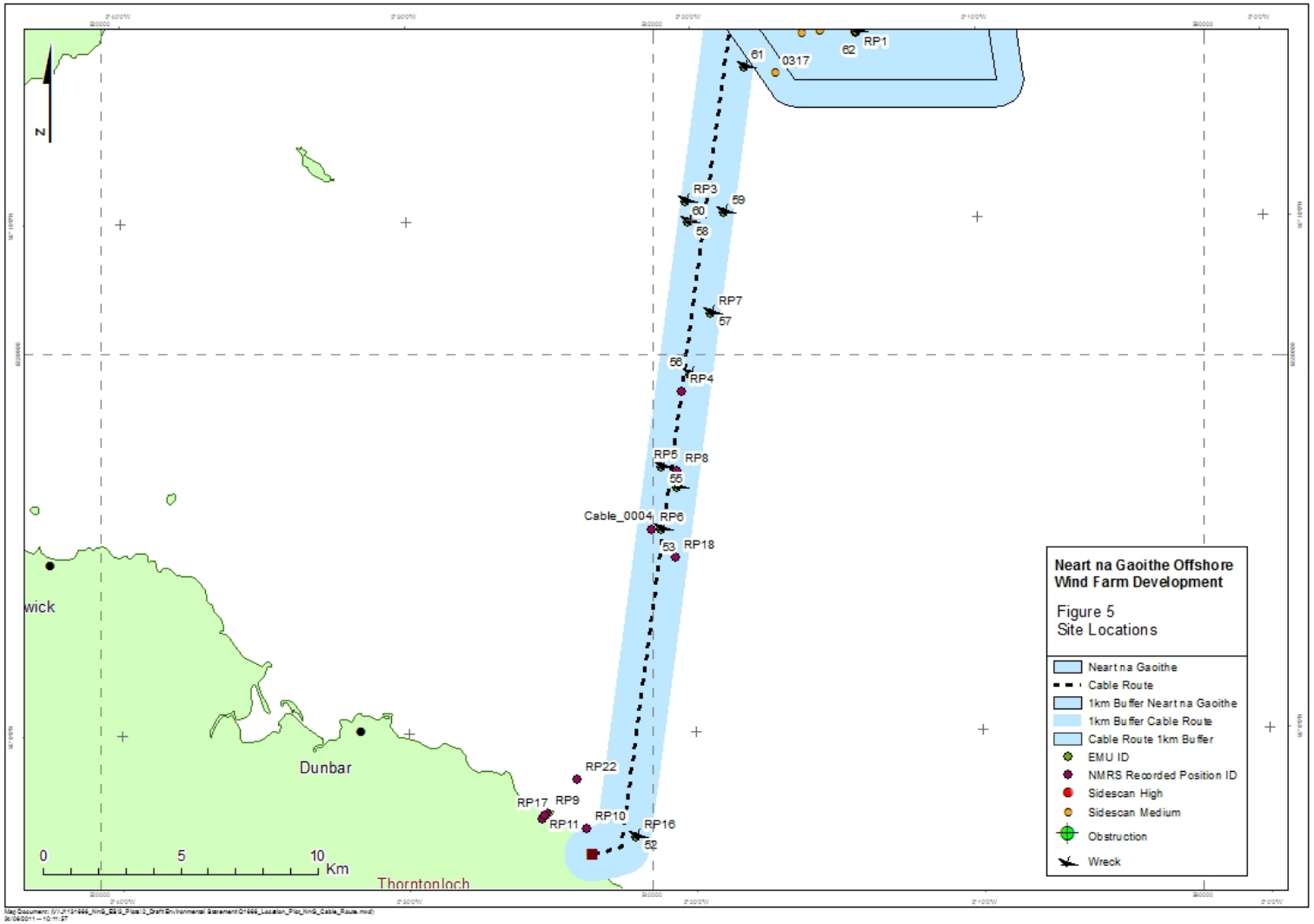

Figure 5 Location of SeaZone Wrecks and Obstructions and Maritime records in the NMRS in the cable route

6. Geophysical Review

6.1 Introduction

Thirty anomalies of potential archaeological interest were identified across the study area by the archaeological review of sidescan sonar data. A number of magnetometer contacts were also noted in the study area, some of which correlate with wrecks or wreck-related debris identified in the sidescan sonar data. The positions of all anomalies are shown in **Figure 6** below with details listed in Appendix 2.

Each sidescan sonar anomaly was given an archaeological potential rating (see **Table 4** below) according to the methodology described in Section 4.3 above. Eight anomalies were rated as being of high potential, nine of medium and 13 of low potential. Anomalies rated as being low potential are not considered to require investigation and are not discussed further in this report.

Figure 6 Sidescan sonar mosaic with geophysical anomalies

Each sidescan sonar anomaly was given an archaeological potential rating (see **Table 4** below) according to the methodology described in Section 4.3 above. Eight anomalies were rated as being of high potential, nine of medium and 13 of low potential. Anomalies rated as being low potential are not considered to require investigation and are not discussed further in this report.

Archaeological Rating	Anomalies
High	8
Medium	9
Low	13
Total	**30**

Table 4: Distribution of anomalies by archaeological rating

The anomalies detected have been reviewed on the basis of their archaeological potential and classification and the results presented below.

6.1.1 *Anomalies of High Archaeological Potential Rating*

Of the eight sidescan sonar anomalies ascribed a high archaeological potential rating, five are shipwrecks, whilst the others appear to be debris or large structural elements derived from wrecks. A full listing of all the anomalies can be found in Appendix 2.

EMU_0095 is the probable wreck of a World War I submarine. Sidescan sonar analysis shows a linear feature with a curved hull form and no noticeable superstructure (**Figure 7**). The wreck is largely intact, with no dislodged sections or extensive debris field. There is little visible sediment accumulation over the wreck, but some scour is apparent at its southern end. The anomaly is 82.7 m long and 6.9 m wide. Its height above the seabed varies along its length, averaging approximately 5 m with a maximum height of approximately 7.8 m in the area which corresponds with the position of the conning tower. This anomaly corresponds with a magnetometer contact

on a line approximately 65 m to the west. Anomaly **EMU_0095** lies just 17 m from the charted position of **EA65** (UKHO 2973) and is likely to be the wreck of HMS *K4*.

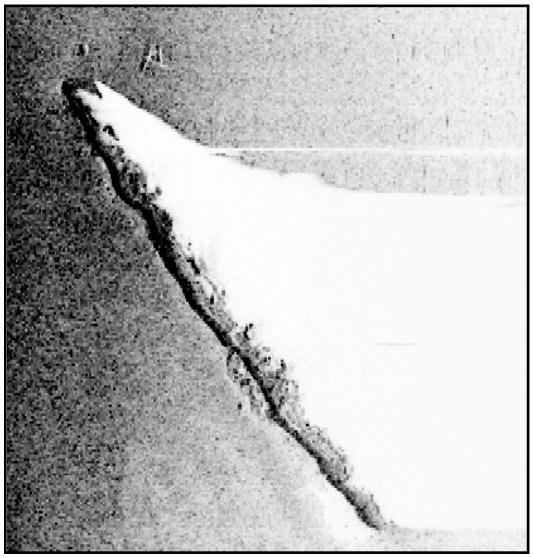

Figure 7 Sidescan sonar image of EMU_0095.

EMU_0098 is also the wreck of a submarine, and is located approximately 150 m south west of EMU_0095. The sidescan sonar image shows a large, linear object with curved sides and significant height above the seabed. The wreck is approximately 103 m long, 12.4 m wide and 4.3 m high and appears largely intact with no dislodged sections (**Error! Reference source not found.8**). Contact **EMU_0100,** roughly 14 m southwest of contact **EMU_0098** may be debris from the wreck. There is no sediment accumulation or significant scour apparent around any part of the wreck. Both of these anomalies correspond with a large magnetometer signature.

The position of contact **EMU_0098** is within eight metres of the given location for **EA64** (UKHO 2975) and the wreck is likely to be that of HMS *K17*.

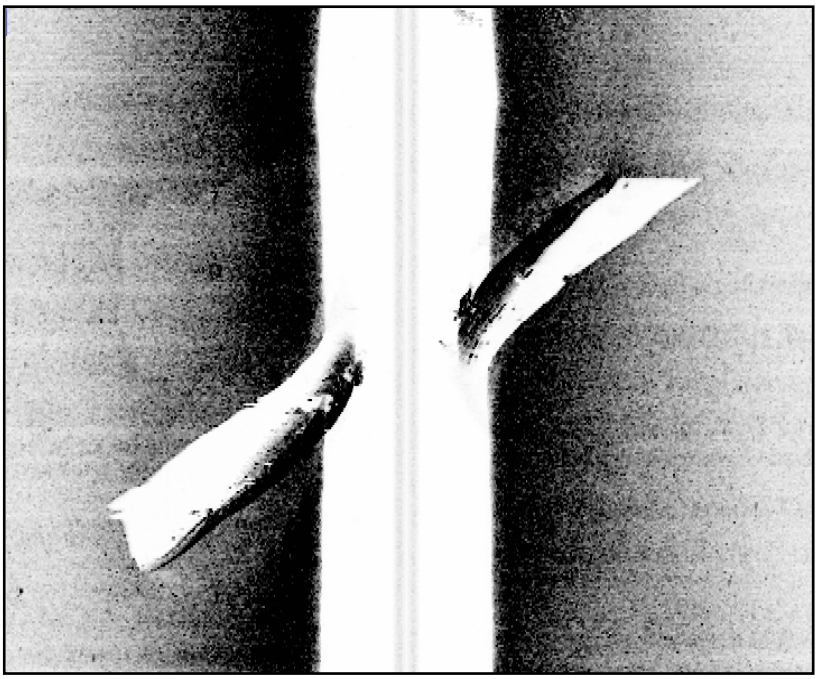

Figure 8 Sidescan sonar image of EMU_0098

EMU_0106: Sidescan sonar analysis suggests that this anomaly is part of a wreck. It is a large angular object, clearly anthropogenic in nature (**Error! Reference source not found.9**). There is no apparent debris field surrounding it and limited burial of the anomaly. It is 20.4 m long, 3.8 m wide and its height above the seabed varies from 2 – 4.7 m. No superstructure is apparent and it is possible that **EMU_0106** is the bow section of the submarine identified as contact **EMU_0095**. The combined length of the two segments is 103.1 m, which is almost exactly the length given of a K-class submarine.

This anomaly may correspond to **EA70** (UKHO 71166) as it has matching measured dimensions and lies within 15 m of the UKHO position. A magnetometer anomaly was recorded roughly 75 m northwest of **EA70**.

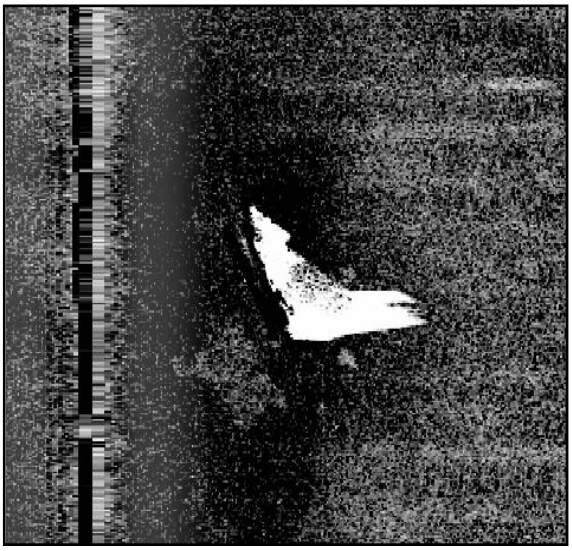

Figure 9 Sidescan sonar image of EMU_0106

The relative positions, sizes and alignments of **EMU_0095**, **EMU_0098** and **EMU_0106** on the seabed are shown in **Error! Reference source not found.and 11** below.

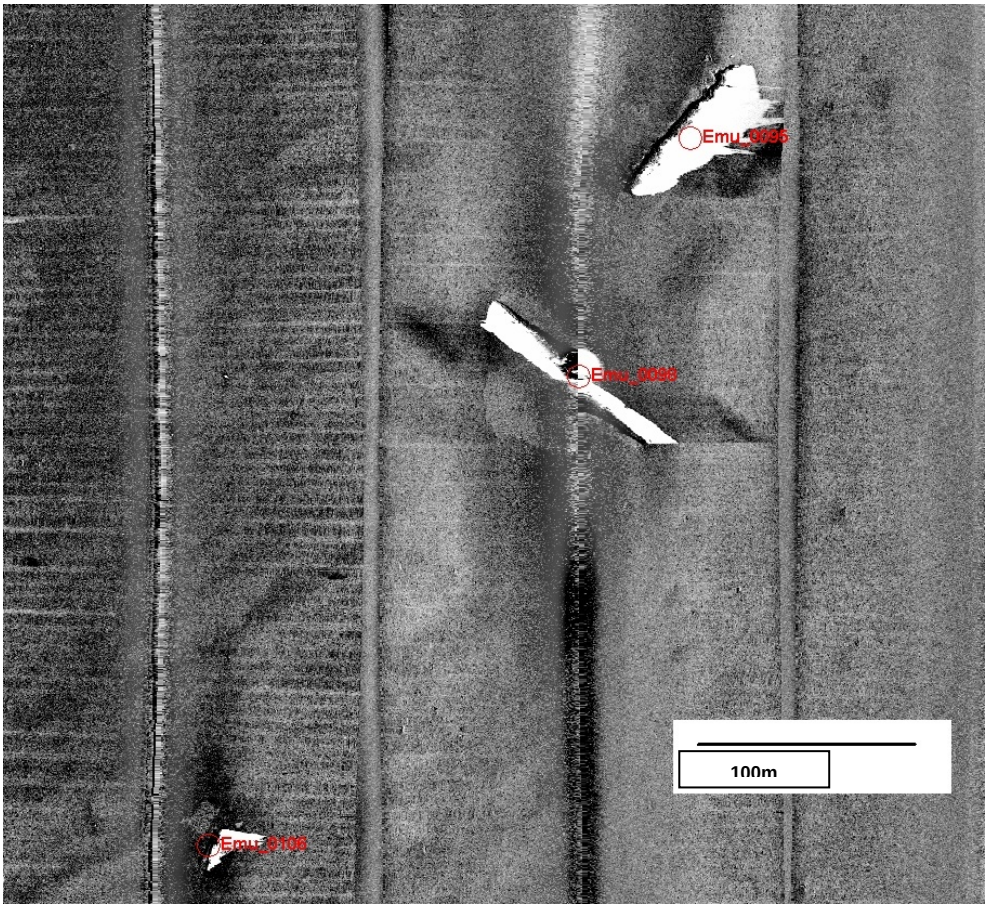

Figure 10 Relative positions of EMU_0095, EMU_0098 and EMU_0106

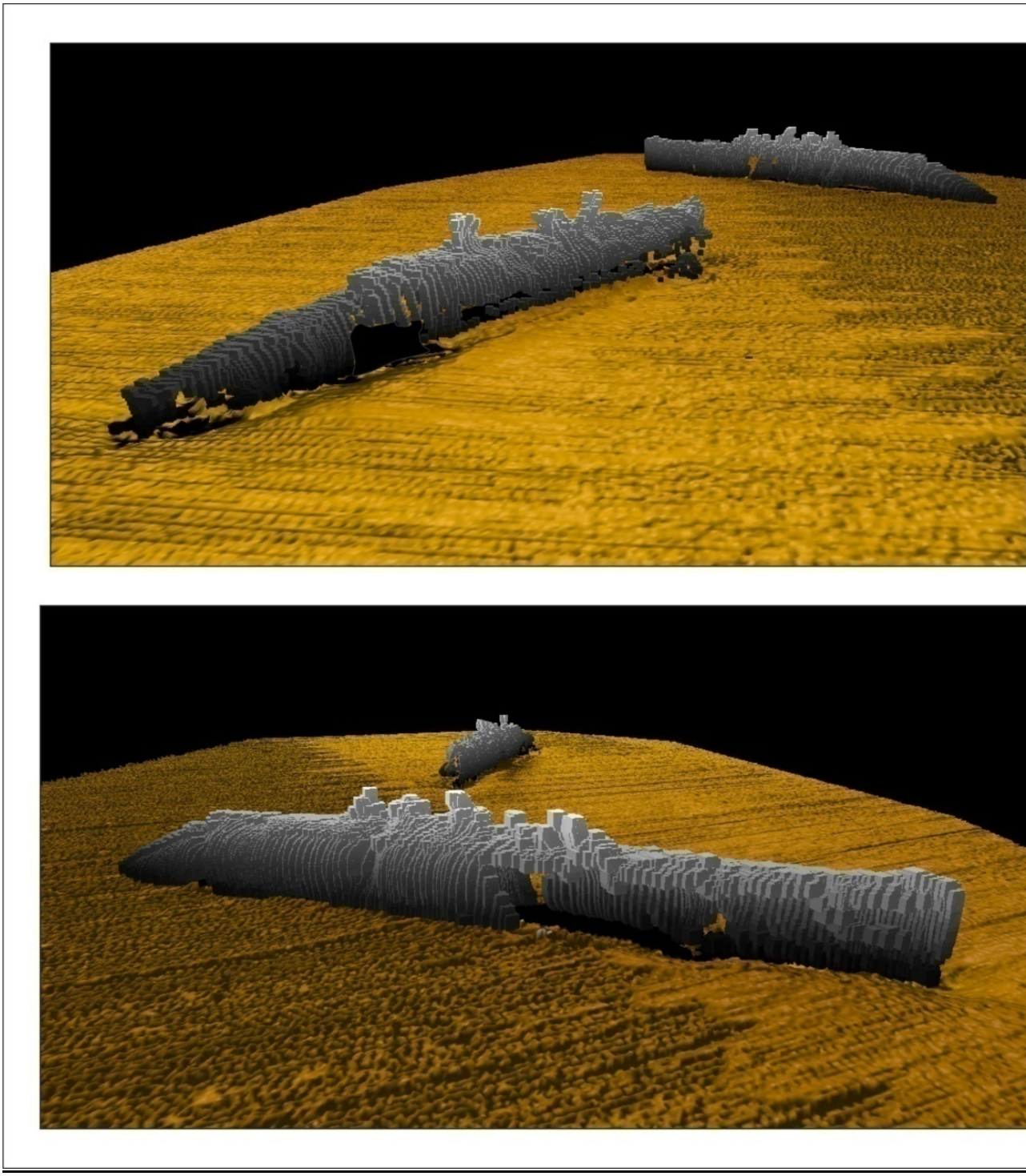

Figure 11 Swath bathymetry showing submarine wrecks HMS K4 and HMS K17

EMU_0199: Sidescan sonar data show anomaly **EMU_0199** to be a wreck, 55.4 m long, 11.2 m wide, and with a maximum height above the seabed of 6.9 m (**Figure 12**). Two distinct rectangular shapes are apparent and have been interpreted as possible hatch/hold openings. Alternatively, depending on the degree of collapse of the wreck, these features may be the boiler/s and engine. The wreck appears to be sitting upright on the seabed and some scour is

visible at both ends of the contact, although no burial is apparent. The wreck appears largely coherent with no visible debris field surrounding it.

This anomaly is approximately 18 m charted position of **EA62** (UKHO 2964) and with a large magnetic anomaly. Its position and dimensions suggest that the anomaly is the wreck of the steamship *Ballochbuie*.

The *Ballochbuie* was a cargo steamer built by Duthie of Aberdeen in 1905 and torpedoed by a German submarine in April 1917 with the loss of three lives (www.wrecksite.eu).

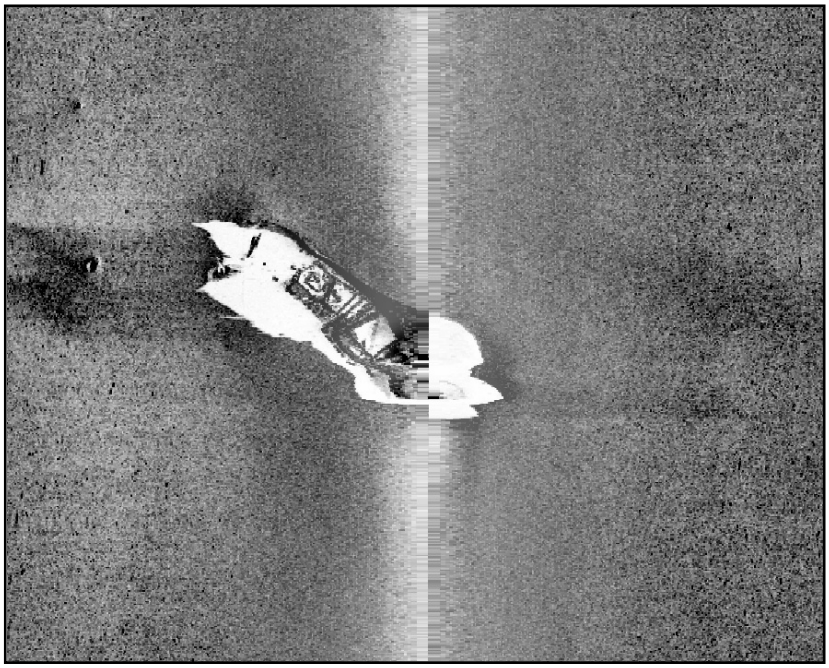

Figure 12 Sidescan sonar image of EMU_0199

EMU_0327 is a wreck with dimensions of 60.7 m by 19.7 m, and a maximum height above the seabed of 6.4 m (**Figure 13**). This wreck sits upright and is partially broken up, with debris collapsing outwards.

The shadow thrown by the amidships section of the wreck suggests an area of superstructure which survives to approximately 3 m above the rest of the wreck. It is likely that this superstructure is in a state of collapse and some of the features shown in **Figure 13** may be the engine and boilers.

This anomaly is approximately 35 m southeast of **EA68** (UKHO 2989), the wreck of the Norwegian steamship *Einar Jarl*. The anomaly also corresponds with a magnetometer contact. The sidescan sonar image corresponds well a small historical photograph of the *Einar Jarl* found at www.wrecksite.eu.

The *Einar Jarl* was mined in March 1941 while outbound for Halifax, with the loss of one life. The condition of one end of the wreck shown in the sidescan sonar image is suggestive of damage that could have been caused by a mine.

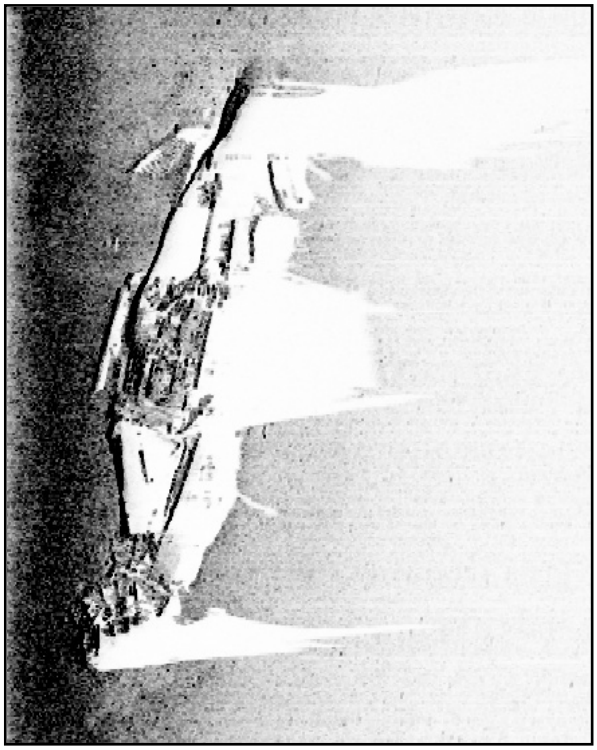

Figure 13 Sidescan sonar image of EMU_0327

EA68 was originally thought to be the wreck of HMS *Rockingham*, a Clemson class destroyer, given to the Royal Navy as part of the Lend-Lease agreement in 1940 (Bactec report 3165TA 2010) and sunk by a mine while under tow in September 1944. Diver surveys since 2008 have, however, confirmed that the wreck is not a destroyer, and have suggested that it is the *Einar Jarl*.

EMU_0384 is a wreck with a strongly linear profile (**Figure 14**). The wreck appears to lie on its starboard side and shows features which have been interpreted as superstructure. Some scour is evident around the wreck, but no burial by sediment is visible and no outlying debris is associated with the site. The wreck is believed to be largely intact and coherent with dimensions of: length 46.6 m, width 9.3 m, height 6.2 m.

This anomaly is approximately 9 m from the charted position of **EA67** (UKHO 2984), an unnamed historical wreck, and is also associated with a magnetic anomaly.

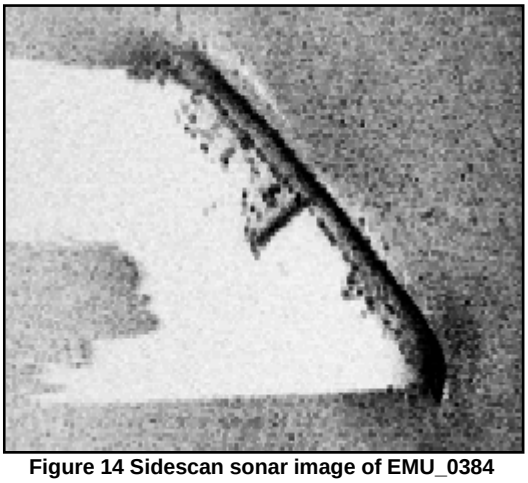

Figure 14 Sidescan sonar image of EMU_0384

EMU_0100 is a small, compact anomaly located approximately 14 m from wreck **EMU_0098**. The anomaly is surrounded by a sub-circular area of lower reflectivity, which is not thought to be shadowing (**Error! Reference source not found.**). The extent of this area of lower reflectivity, its proximity to **EMU_0098** and its association with the same magnetic anomaly as **EMU_0098** suggests an object of probable anthropogenic origin. Its dimensions are: length 2.3 m, width 1.1 m and height 0.1 m.

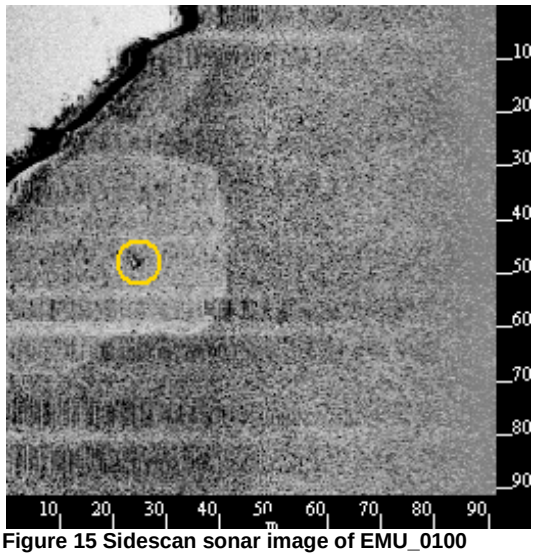

Figure 15 Sidescan sonar image of EMU_0100

EMU_0413 is located within 40 m of **EA65** / **EMU_0095** and the sidescan sonar image shows several angular, linear objects (**Figure 16**). The anomaly is believed to be wreck related and associated with one of the K-class submarines. Its dimensions are: length 4.5 m, width 2.2 m, and height 0.5 m.

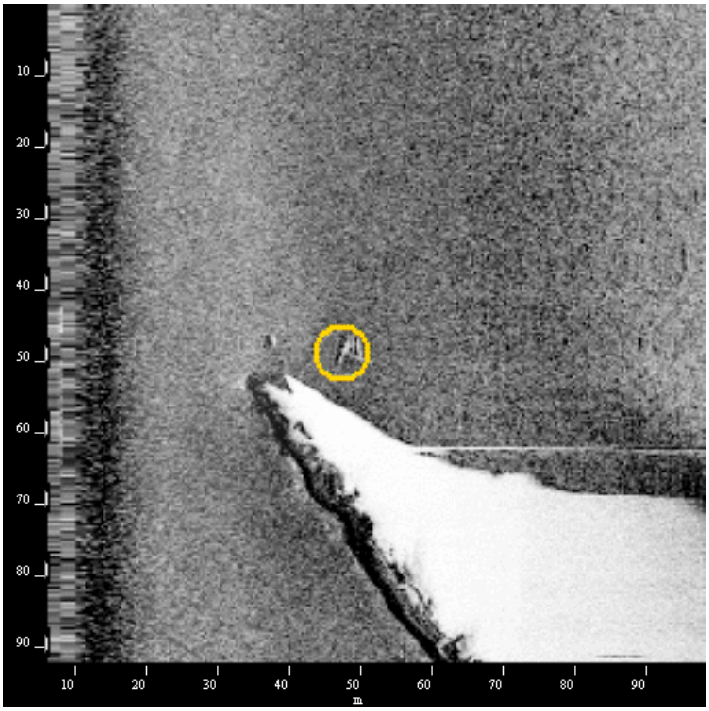

Figure 16 Sidescan sonar image of EMU_0413

6.1.2 *Anomalies of Medium Archaeological Potential Rating*

Nine anomalies were assigned a medium archaeological rating and require further investigation to fully assess their character and archaeological value. These anomalies may represent archaeological remains or modern material of limited archaeological interest. A full listing of all the anomalies can be found in **Appendix 2**.

EMU_0291 is a lozenge shaped object 23.5 m long and 5.5 m wide, divided lengthways into areas of higher and lower reflectivity (**Error! Reference source not found.**). It is not associated with any rise in seabed morphology and is located within one of the gravel channels cascading down from a hummock associated with the Wee Bankie Formation. There is a small anomaly in the magnetometer data 75 m to the east of **EMU_0291**. The anomaly may be a buried object.

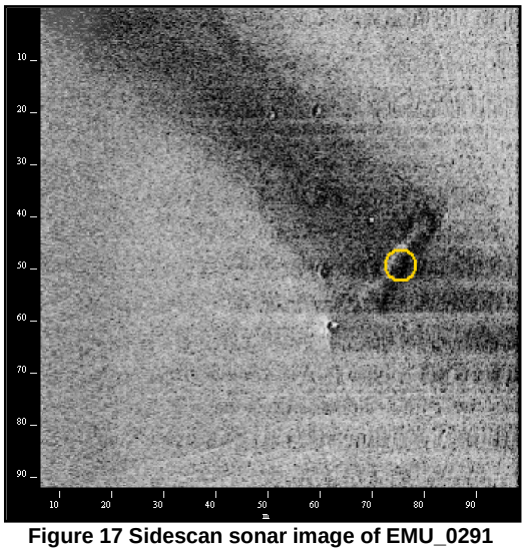

Figure 17 Sidescan sonar image of EMU_0291

EMU_0259 and **EMU_0262** are believed to be related, comprising two medium sized objects approximately 21 m apart on the seabed (**Figure 18**). The two anomalies form segments of a

curve and appear to be connected by a slight rise in the seabed. This may indicate a single, partially buried object, protruding at two points. The dimensions of visible structure are: length 6.2 m, width 1 m, and height above the seabed, 0.5 m.

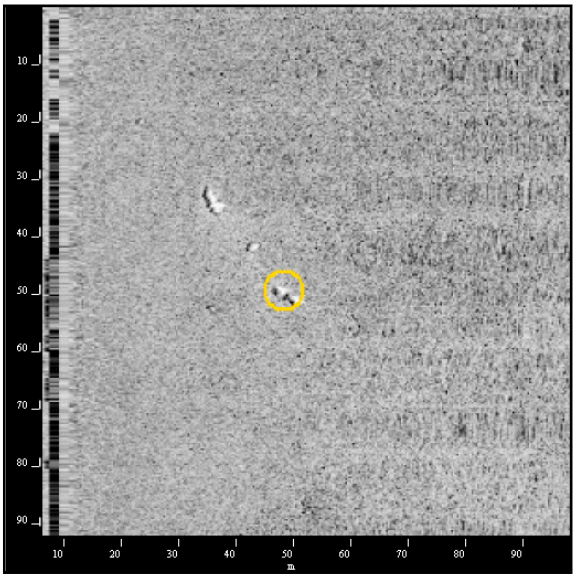

Figure 18 Sidescan sonar image of EMU_0259 and EMU_0262

EMU_0134 is a linear feature with prominent scour (**Error! Reference source not found.)**. From one side of the feature three evenly spaced reflectors appear to protrude from the seabed at approximately 90^{o}. The anomaly has the shape of the head of a trident. The 'forks' of the 'trident' are not wholly distinctive and could be scour or the build up of sediment. Anomaly dimensions are: length 4.1 m, width 1.9 m, and height 0.3 m.

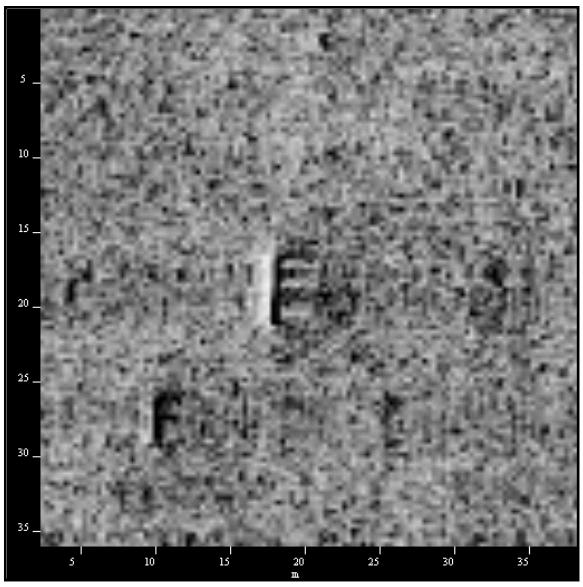

Figure 19 Sidescan sonar image of EMU_0134

EMU_0177 may be an anchor with an attached cable (**Error! Reference source not found.**). A narrow, high reflectivity strip believed to represent a cable attaches to an object with visible dimensions of 2.1 m by 1.3 m and a maximum height of 0.5 m. The anomaly is located on a flat, smooth area of seabed and is associated with a strong magnetic anomaly approximately 150 m to the east. Its origin is uncertain, but it is thought to be anthropogenic.

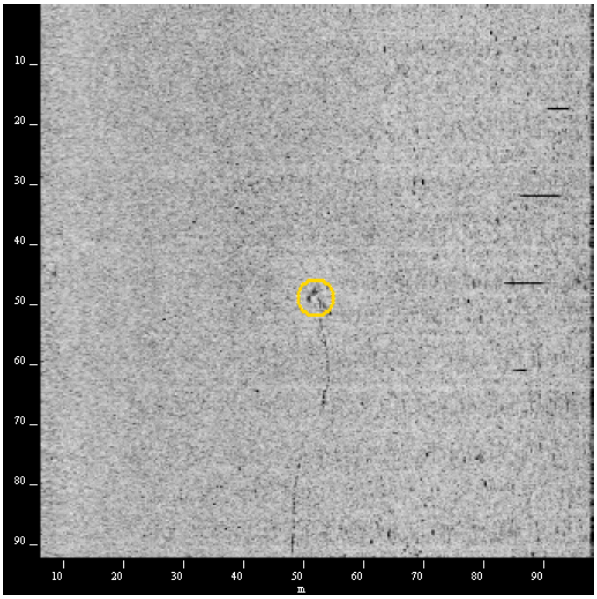

Figure 20 Sidescan sonar image of EMU_0177

EMU_0294 has been interpreted as debris of possible anthropogenic origin. The anomaly is approximately 12.3 m long, singularly narrow and located on flat, smooth seabed (**Error! Reference source not found.21**). There is a magnetometer anomaly approximately 200 m west of **EMU_0294**.

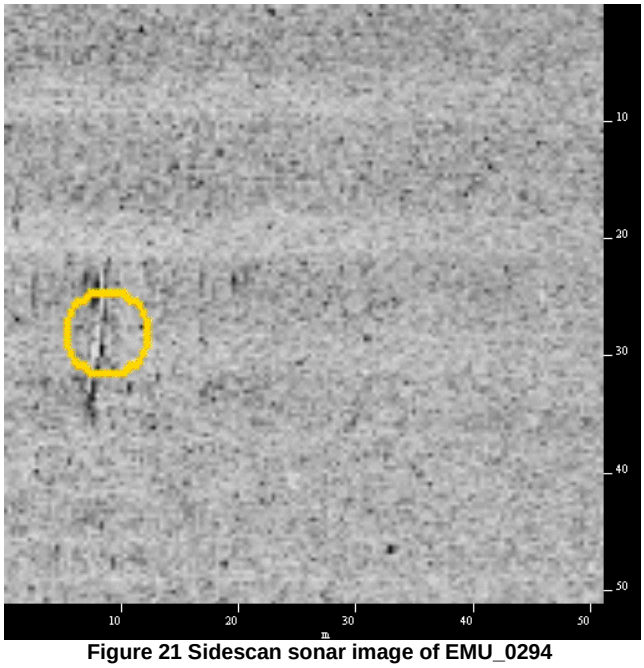

Figure 21 Sidescan sonar image of EMU_0294

EMU_0317 is a high reflectivity, thin linear anomaly believed to be debris of probable anthropogenic origin (**Error! Reference source not found.22**). It is approximately 9 m long, 1.2 m wide and no more than 0.3 m high.

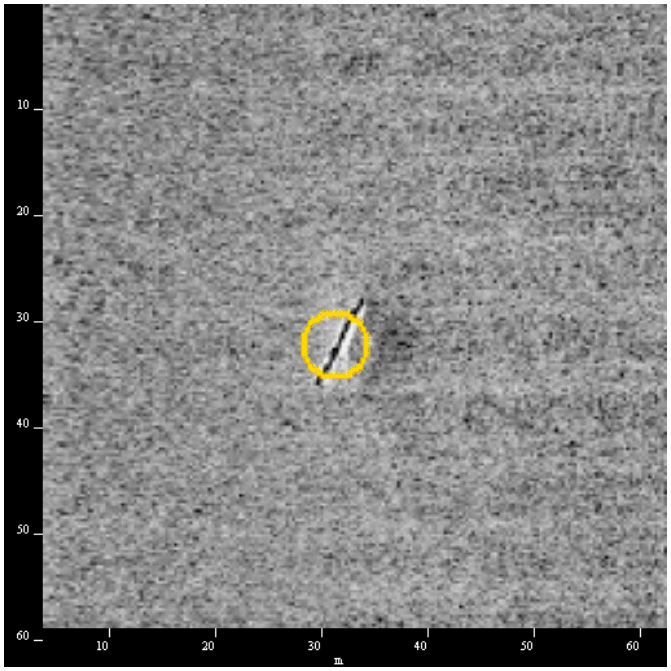

Figure 22 Sidescan sonar image of EMU_0317

EMU_0367 is an unusually shaped anomaly with a shadow-casting and a non shadow-casting reflector. It is believed to be of anthropogenic origin (**Error! Reference source not found.23**). Its dimensions are: length 15 m, width 0.9 m and a maximum height 0.8 m. Some sections of the anomaly display a lower height.

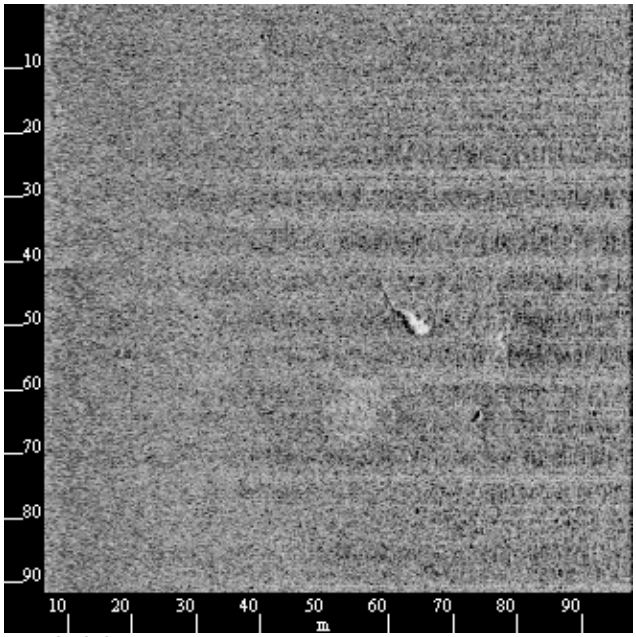

Figure 23 Sidescan sonar image of EMU_0367

6.1.3 *Offshore Cable Route*

Four anomalies were identified in the archaeological review of the available sidescan sonar data in the portion of the study area covered by the cable route (see **Figure 6**). One of these anomalies was rated as being of medium archaeological potential and is described below. The

remainder were given a low archaeological potential rating and are not considered further in the report. A full listing of all the anomalies can be found in **Appendix 2**.

EMU_Cable_0004 is approximately 27 m by 9 m in extent, with a height above the seabed of 1.3 m, thought to be an area of outcropping of the Wee Bankie Formation ( ). The anomaly has a similar signature to other areas classified as outcropping noted during the geophysical survey of the study area which were identified as Wee Bankie Formation, (EMU Ltd, 2010). The sidescan sonar image in **Figure 24** shows the anomaly in relation to these other areas of outcropping.

The reason this anomaly has been given a medium archaeological rating is due to a rough correspondence with the position of **EA53** (UKHO 2900), described as 'notable debris' of similar dimensions, and located approximately 75 m southeast of the anomaly. A magnetic contact was also recorded in the magnetometer data approximately 265 m north of **EMU_Cable_0004** (see), although it is possible that this, and some of the other magnetic targets in the study area, reflect remnant magnetism in the underlying glacial till sediments (EMU Ltd, 2010:15).

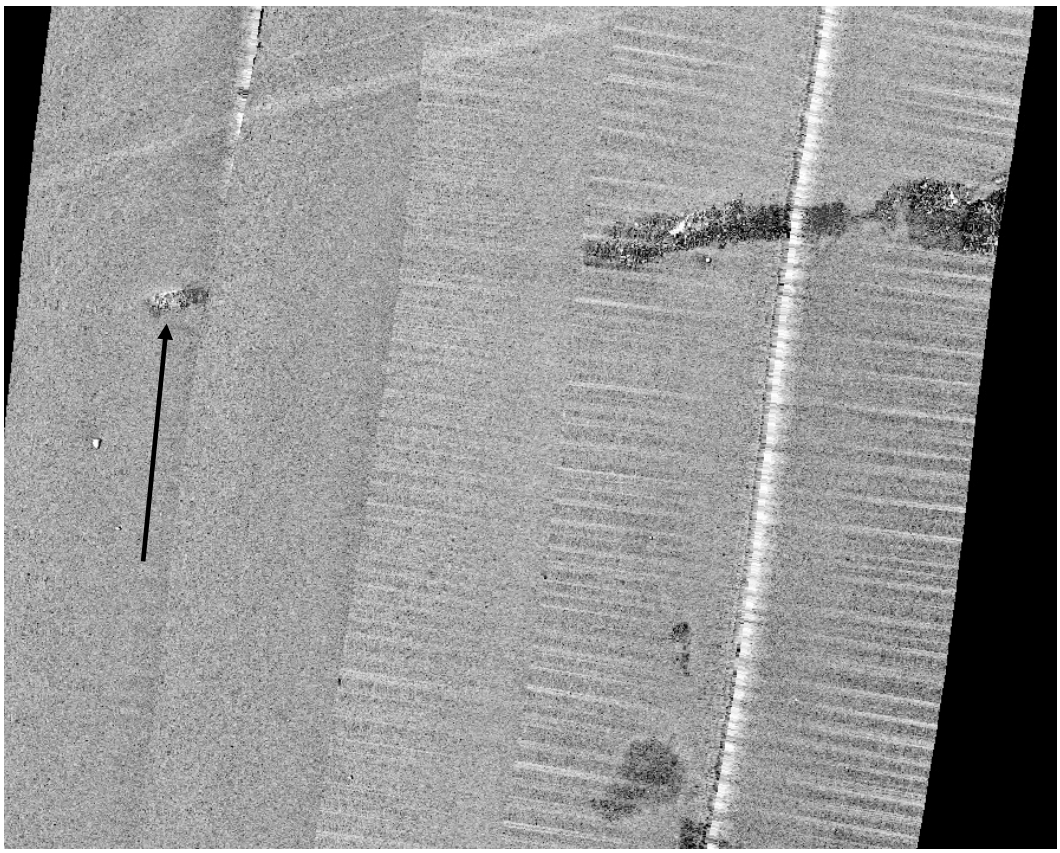

Figure 24 Sidescan sonar mosaic image of EMU_Cable_0004 (arrow) and other rock outcrops

7. Setting: Designated Cultural Heritage Assets

The potential for the proposed development to have operational impacts on the setting of key designated onshore and island based cultural heritage assets has been considered. The proposed wind farm will theoretically be visible from a substantial part of the east coast of Scotland along the Angus, Fife and East Lothian coast, and therefore from a large number of designated cultural heritage assets. However, the distance of the wind farm from the mainland, a minimum of 15.5 km, greatly reduces the likelihood of its having significant impacts upon the setting of cultural heritage assets and restricts this potential to those assets that have very strong visual relationships with the sea and where this is a very important part of their cultural significance. The assessment therefore concentrates on such assets.

The designated assets within the study area can be split into two groups based on their distance from the wind farm: those in east Fife, which are within 25 km of the wind farm, and those in central and west Fife, Angus and East Lothian, which lie between 25 and 35 km.

Within 25 km of the proposed wind farm there are 28 scheduled monuments, 32 Category A-listed buildings, 761 Category B- and C(S)-listed buildings, six conservation areas and one inventory designed landscape.

Between 25 and 35 km of the proposed wind farm the number of designated cultural heritage assets is substantially greater as Angus, East Lothian and the Scottish Borders as well as the greater part of Fife fall within this distance. There are nine properties in care, 179 scheduled monuments, 104 Category A-listed buildings, 2252 Category B- and C(S)-listed buildings, 26 conservation areas, 17 inventory registered historic gardens and designed landscapes and one inventory battlefield.

Although the wind farm will be visible from many of these designated cultural heritage assets, it is clear that in most instances there is no potential for this to have a significant impact upon setting; for there to be such potential the asset's significance would have to relate closely to its visual relationship with the sea. Historic Scotland's scoping response identifies 11 assets that have a 'seascape setting' and 'may be subject to [a setting] impact as a result of the proposed offshore turbines' (see **Figure 25**). Accordingly these assets (listed below) have been considered for assessment:

Scheduled Monuments

- Tentsmuir Coastal defences (Index no. 9712);
- Crail Airfield, airfield 1 km east of Kirklands Farm (Index no. 6642);
- Crail Airfield, pillbox, Foreland Head (Index no. 6461);
- St Andrews Castle (Index no. 90259);
- St Andrews Cathedral and adjacent ecclesiastical remains (Index no. 90260);
- Isle of May, lighthouse (Index no. 887);
- Isle of May Priory (Index no. 883).

Category A Listed Buildings

- St Andrews Harbour (HB no. 40596);
- Bell Rock Lighthouse (HB no. 45197).

Gardens and Designed Landscapes

- St Andrews Links;
- Cambo.

In addition to the above assets, the Category A-listed Arbroath signal tower (HB no. 21230) has been selected because of its historic link to the Bell Rock lighthouse. No cultural heritage assets have been considered in relation to the proposed cable route.

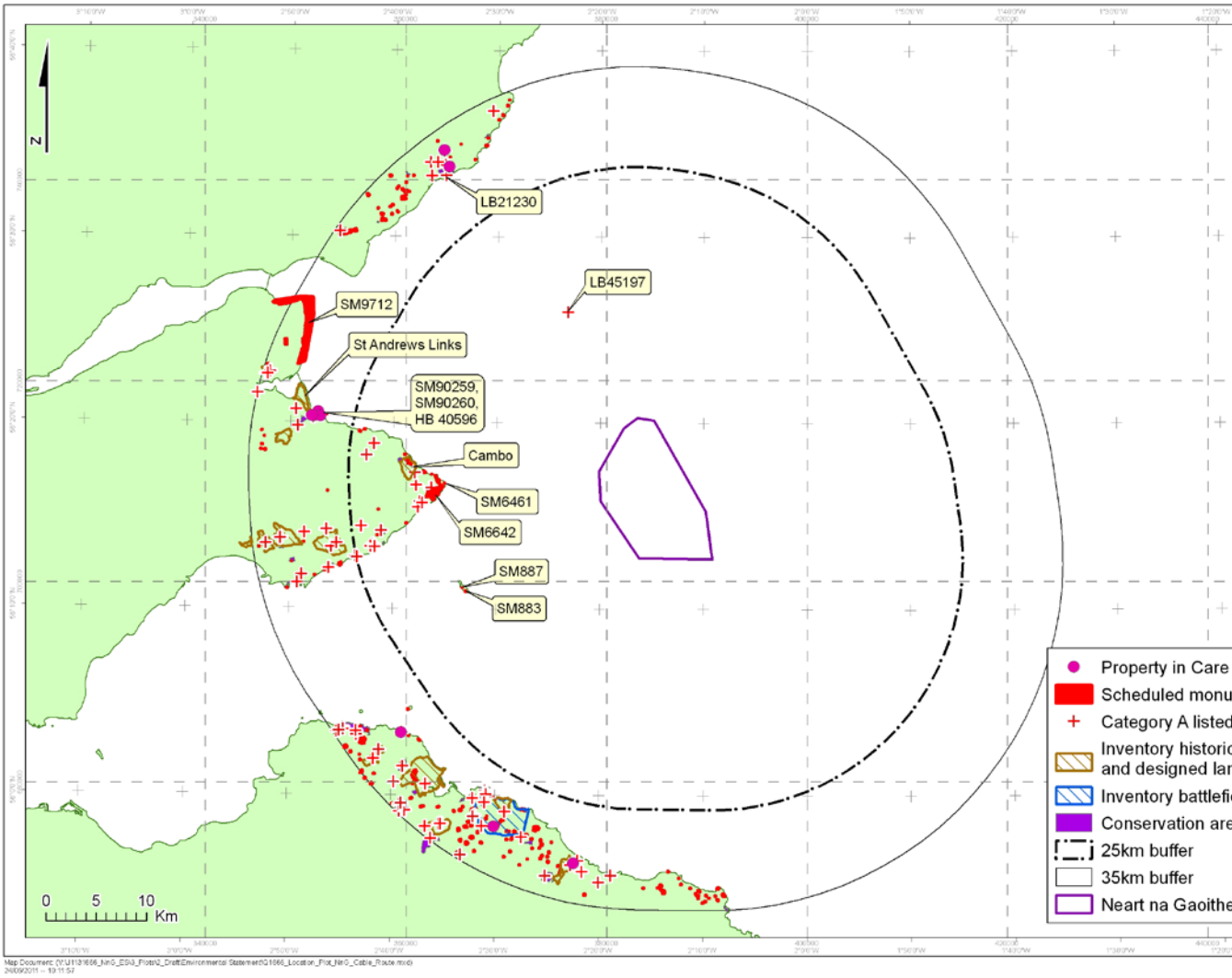

Figure 25 Location of onshore Designated Cultural Heritage Assets

8. Discussion and Summary

8.1 Submerged Prehistoric Archaeology

From available evidence it is likely that the Devensian ice sheet destroyed or substantially reworked most archaeological material deposited prior to the last glacial maximum. This should, however, not be taken to mean that humans did not occupy Scotland prior to this, or that Palaeolithic sites will not be found there in the future.

The retreat of the Devensian ice sheet and the amelioration of climatic conditions in Scotland would have seen the development of terrestrial palaeo-landscapes off the east coast of Scotland, including the study area, very similar to those that existed further south in the North Sea. Current evidence confirms that modern humans had re-occupied northern Scotland and the outer islands by 9,000 BP, which suggests that they may have been present in the study area for some substantial time prior to that.

Seismic records for the study area show evidence of palaeo-landscape features similar to those known from south of the Dogger Bank. These river valleys and marshlands may have presented an attractive and productive environment for Late Palaeolithic and Mesolithic human populations and evidence of their activity has some potential to be preserved within the sedimentary sequence of the study area: particularly in organic deposits such as peat. Because the shallow geology of much of the study area comprises till overlying bedrock there is only limited potential for the preservation of palaeoenvironmental remains, or for the occurrence of *in situ* archaeological sites and material. The geotechnical data from the study area assessed for this report and described above tend to support this conclusion.

In summary, Late Palaeolithic and Mesolithic artefacts may be present in the study area and would be valuable in providing evidence for early human activity in Scotland. However, the potential for discovering such archaeological material in the study area is regarded as low.

Any archaeological material, including palaeoenvironmental deposits, discovered within the study area in the course of the development of the wind farm, would be of archaeological interest.

8.2 Maritime and Aviation Archaeology

The Firth of Forth is a region with historically high levels of shipping activity and associated vessel loss. The physical survival of maritime archaeological remains on the seabed depends on the interplay of a range of factors, including the age and construction material of any wreck, water depth, exposure to the influence of waves and tides and seabed sediments and substrate.

In general, wrecks which remain exposed on the seabed will degrade and break up more quickly than those which become covered by sediment. Wrecks found in shallow waters are more likely to be subject to hydro-dynamic and environmental processes and are thus less likely to break up or decay more quickly, reducing their visibility in the archaeological record. The SeaZone and NMRS data provide a record of known wrecks and recorded maritime losses in the study area, the majority of which are 19th and 20th century losses. The dominance of modern wrecks in the SeaZone records and NMRS database is a factor not only of the method by which shipping

losses were recorded in the past, but also their relatively recent date and the nature of their construction, which increases their visibility on the seabed.

In contrast to iron and steel wrecks, wooden shipwrecks tend to be older, smaller and to break up more quickly. They are thus likely to have a lower physical profile on the seabed, and are less likely to be located by geophysical survey.

This is borne out by the results of the archaeological review of geophysical data collected across the study area which identified a number of anomalies of possible archaeological interest. Eight of these have been assigned a **high** archaeological potential rating and represent large iron or steel shipwrecks, and some related debris, and include the two protected K-class submarines, *K4* and *K17*, discussed earlier (see **Figure 23**).

The geophysical review also assigned a **medium** archaeological rating to a further nine anomalies, which may represent uncharted wrecks, including aircraft, but which require further investigation to clarify their nature and more accurately establish their archaeological potential.

Together, the SeaZone, NMRS and geophysical data provide a picture of the known and potential maritime archaeology of the study area and cable route corridor. It must be stressed, however, that these data probably do not reflect the totality of the maritime archaeology of the area, and based on the maritime history of the Firth of Forth, the potential exists for further, unknown wrecks and sites in the study area.

The seabed of the study area is comprised of sand and gravelly muddy sands with frequent outcrops of the underlying Wee Bankie Formation and occasional boulders. Sediment transport across the study area is considered to be limited, and no features have been identified which indicate significant sediment mobility. This is likely to prevent the rapid burial of wrecks and thus reduce the potential for the structural preservation of particularly older, wooden wrecks. Such sites, if they occur in the study area, will have a low vertical profile and will not be easy to identify in geophysical data.

8.3 Setting: designated cultural heritage assets

The potential for the proposed development to have operational impacts on the setting of key designated onshore and island based cultural heritage assets has been considered. The proposed wind farm will theoretically be visible from parts of the east coast of Scotland around Angus, Fife and East Lothians, and therefore from a large number of designated assets. However, its distance from the mainland, a minimum of 15.5 km, greatly reduces the likelihood of its having significant impacts upon the setting of cultural heritage assets and restricts this potential to those assets that have very strong visual relationships with the sea and where this is a very important part of their cultural significance.

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Appendix 1: Site Boundary and Study Area Co-ordinates

Point	WGS84 UTM 30N **Site Boundary**	
	Easting	Northing
1	541026.81	6238605.43
2	543465.80	6242935.63
3	544802.08	6243988.45
4	546462.31	6243745.50
5	551736.53	6234715.14
6	552458.60	6229993.92
7	545182.36	6229993.92
8	541238.75	6235631.61

Point	WGS84 UTM 30N **Study Area** (generalised)	
	Easting	Northing
1	544552.23	6245152.70
2	547272.24	6244731.72
3	552842.00	6235026.12
4	553688.26	6229771.63
5	552892.69	6228869.55
6	544792.78	6228846.35
7	543770.42	6230096.34
8	539914.36	6201366.49
9	538597.22	6200992.70
10	537675.33	6201968.26
11	541938.74	6232819.85
12	540134.56	6235105.14
13	539894.00	6239014.19
14	542660.41	6243765.19

15	538592.16	6207399.43
16	537983.68	6202776.98
17	537216.08	6202423.61
18	536446.87	6202640.45
19	536104.80	6203659.10
20	536647.89	6204335.59

Appendix 2: Gazetteer of Archaeological Anomalies

EMU ID	Easting WGS84 UTM31N (m)	Northing WGS84 UTM31N (m)	Classification	Dimensions (m)	Description	Archaeological Rating
EMU_0007	553232	6231152	Cable	41.05 x 1.28	Long, curved, ephemeral anomaly. Possible narrow cable or fishing gear. No shadow and no anchor visible	Low
EMU_0051	550939	6233153	Debris	1.5 x 1.18 x 0.5	Anomaly surrounded by halo of lower reflectivity - possible finer sediment or additional debris	Low
EMU_0087	550256	6237795	Debris	5.39 x 1.31 x 0.59	Thin, linear contact with stark shadow	Low
EMU_0092	550094	6232170	Debris	3.54 x 1.48 x 0.29	Raised features within an area of coarser appearing sediment. Possible debris	Low
EMU_0095	**550043**	**6235166**	**Wreck**	**82.67 x 6.91 x 4.82**	**Probable K-Class submarine lost in 1918. Possibly related to anomaly EMU_0106**	**High**
EMU_0098	**549974**	**6235036**	**Wreck**	**103 x12.39 x 4.35**	**Probable K-Class submarine lost in 1918. Intact**	**High**
EMU_0100	**549964**	**6235026**	**Debris**	**2.3 x 1.7 x 0.11**	**Small object proximal to submarine wreck. Surrounded by large (25 m) halo of lower reflectivity. Possible result of scour action proximal to wreck**	**High**
EMU_0104	549831	6239939	Debris	5.16 x 0.8 x 0.25	Very long and thin anomaly	Low
EMU_0106	**549794**	**6234808**	**Wreck (section)**	**20.43 x 3.81 x 4.69**	**Highly variable height (4.5 m-2 m). Possible casing/flared bow section from a submarine wreck. Possible association with anomaly EMU_0095**	**High**
EMU_0134	549018	6233868	Debris	4.09 x 1.85 x 0.28	Distinctive three-pronged trident shaped shadow	Medium

EMU ID	Easting WGS84 UTM31N (m)	Northing WGS84 UTM31N (m)	Classification	Dimensions (m)	Description	Archaeological Rating
EMU_0177	548044	6233870	Anchor/Cable	2.11 x 1.3 x 0.48	No shadow, thin, possible fishing gear/cable. Small object anchors one end (small object: shadow approx 1.5 m, height approx 0.3 m)	Medium
EMU_0181	547891	6232140	Debris	5.45 x 1.36 x 0.34	Linear with blocky appearance. Possibly an isolated boulder. Constant height	Low
EMU_0199	**547362**	**6231707**	**Wreck**	**55.44 x 11.21 x 6.89**	**Wreck, upright and largely intact. Can detail hatch/hold. Some scour visible**	**High**
EMU_0220	546938	6241938	Possible boulder field	12.04 x 11.26	Possible boulder field or debris. Small area of numerous small, shadow casting reflectors	Low
EMU_0227	546832	6243717	Debris	5.59 x 1.03 x 0.59	Unusual shape - right angular kink - possible debris or isolated boulder	Low
EMU_0259	546068	6231770	Possible buried object	6.19 x 0.96 x 0.54	Stark shadow, thin and long. Probable debris, connected by raised area to EMU_0262	Medium
EMU_0262	546053	6231754	Possible buried object	5.36 x 1.37 x 0.26	Possible debris - seems connected to another object by a raised area. Possible buried object protruding at two points	Medium
EMU_0279	545650	6230491	Debris	5 x 1.2 x 0.86	Debris or isolated boulder	Low
EMU_0291	545412	6231657	Possible buried object	23.47 x 5.45	Lozenge shaped disturbance in a 'gravel finger'. Possible buried wreck. No height increase seen in bathymetry bit signature also seen on overlap	Medium
EMU_0294	545313	6242768	Debris	12.35 x 1.04	Long, thin, curved feature with little shadow. Possible debris/ fishing gear	Medium
EMU_0313	544648	6233951	Debris	41.57 x 17.61 x 0.47	A collection of clustered linear features/scours/raised areas	Low

EMU ID	Easting WGS84 UTM31N (m)	Northing WGS84 UTM31N (m)	Classification	Dimensions (m)	Description	Archaeological Rating
EMU_0317	544451	6230222	Debris	9.01 x 1.19 x 0.3	Long, thin, narrow anomaly. Very linear profile and high reflectivity. Probable debris	Medium
EMU_0327	**544044**	**6241436**	**Wreck**	**65.63 x 19.72 x 5.25**	**Wreck, broken up in appearance and collapsing outwards. Covered by sediment at one end. Higher in central section and at the extremes**	**High**
EMU_0367	542643	6236851	Debris	15.03 x 0.91 x 0.78	Long, linear feature, half of which does not cast a shadow	Medium
EMU_0384	**541684**	**6238903**	**Wreck**	**46.58 x 9.26 x 6.24**	**Largely intact wreck. No debris field visible and possibly lying on its side. Shadow variable, some scour**	**High**
EMU_0413	**550053**	**6235203**	**Debris**	**4.47 x 2.15**	**Wreck related angular debris proximal to HMSM *K4*. Angular, high reflectivity anomaly comprising several linear objects**	**High**
EMU_Cable_0001	542341	6229517	Possible debris	2.67 x 1.06 x 0.55	Unusual, blocky anomaly. Isolated on an otherwise unremarkable seabed	Low
EMU_Cable_0002	542961	6232347	Possible debris	5.45 x 2.61 x 1	Very large – debris or boulder	Low
EMU_Cable_0003	539361	6205919	Possible debris	2.82 x 1.27 x 0.66	Possible circular anomaly	Low
EMU_Cable_0004	540296	6213726	Possible debris	27.07 x 8.92 x 1.29	Possible outcropping of Wee Bankie Formation. Proximal to a larger area with a similar sidescan sonar signature	Medium

Appendix 3: Gazetteer of Onshore Designated Cultural Heritage Assets

Name	Designation	Description	Reference No.	NGR
Isle of May Priory	Scheduled Monument	The remains of a Benedictine priory, this priory have largely been excavated although the main upstanding part of the monument stands to two storeys. It is traditionally thought that the priory was built on the site of a community established by St Ethernan or Adrian in the 9th century. The priory was built in the 12th century and was in occupation until the 15th century	SM883	365880, 699000
Isle of May, lighthouse	Scheduled Monument	A lighthouse was built here in 1636, the lower half of this survives although it was replaced in the 19th century. The old lighthouse is considered to be one of the oldest lighthouses in Britain	SM887	365555, 699390
Crail Airfield, airfield 1km E of Kirklands Farm	Scheduled Monument	Built during the First World War and reused in Second World War and the Cold War. Initially a small airfield and hangar it was later increased in size and used for naval training and operations during the Second World Was	SM6642	362750, 708760
Crail Airfield, pillbox, Foreland Head	Scheduled Monument	Second World War Pillbox, well preserved and located at the easternmost tip of the south coast of Crail	SM6461	363820, 709760
St Andrews Castle	Scheduled Monument	Castle first built c1200 as the residence of the Bishops of St Andrews one of the best preserved medieval Episcopal residence in Scotland, it also has the remains of a it also has the best preserved mine and counter mine in Britain	SM90259	351236, 716930
St Andrews Cathedral and adjacent ecclesiastical remains	Scheduled Monument	Cathedral built in the 12th century replacing earlier ecclesiastical buildings. After use by the leading bishops of Scotland for centuries the cathedral was eventually abandoned in 1560 during the Reforamation. The cathedral never returned to full use.	SM90260	351510, 716570
Arbroath signal tower	Category A Listed Building	Built 1813 this signal tower's flagpole rose and fell to alert the workers construction the Lighthouse. It was built as a classical and castellated group of twin lodges and a 4 storey signal tower.	HB21230	364051, 740447
St Andrews Harbour	Category A Listed Building	Largely 18th century harbour although a harbour is thought to have been located on this spot since the 13th century.	HB40596	3151655, 716607
Bell Rock Lighthouse	Category A Listed Building	Lighthouse built between 1806-11 by John Rennie and Robert Stevenson (engineers). It was built in an exceptional position on a rock outcrop which is barely uncovered at low tide in the sea over 10 mile from land between Fife Ness and Angus. This is the oldest surviving rock built lighthouse in Britain.	HB5197	376165, 726808
St Andrews Links	Inventory Historic Garden and Designed Landscape	A series of some of the oldest public link golf courses in the world. Known as the "Home of Golf" there are records of golf being played on the Links since the 15th century		349400, 718400

Cambo	Inventory Historic Garden and Designed Landscape	Victorian era Historic garden and designed landscape including walled garden and model farm		360070, 711450