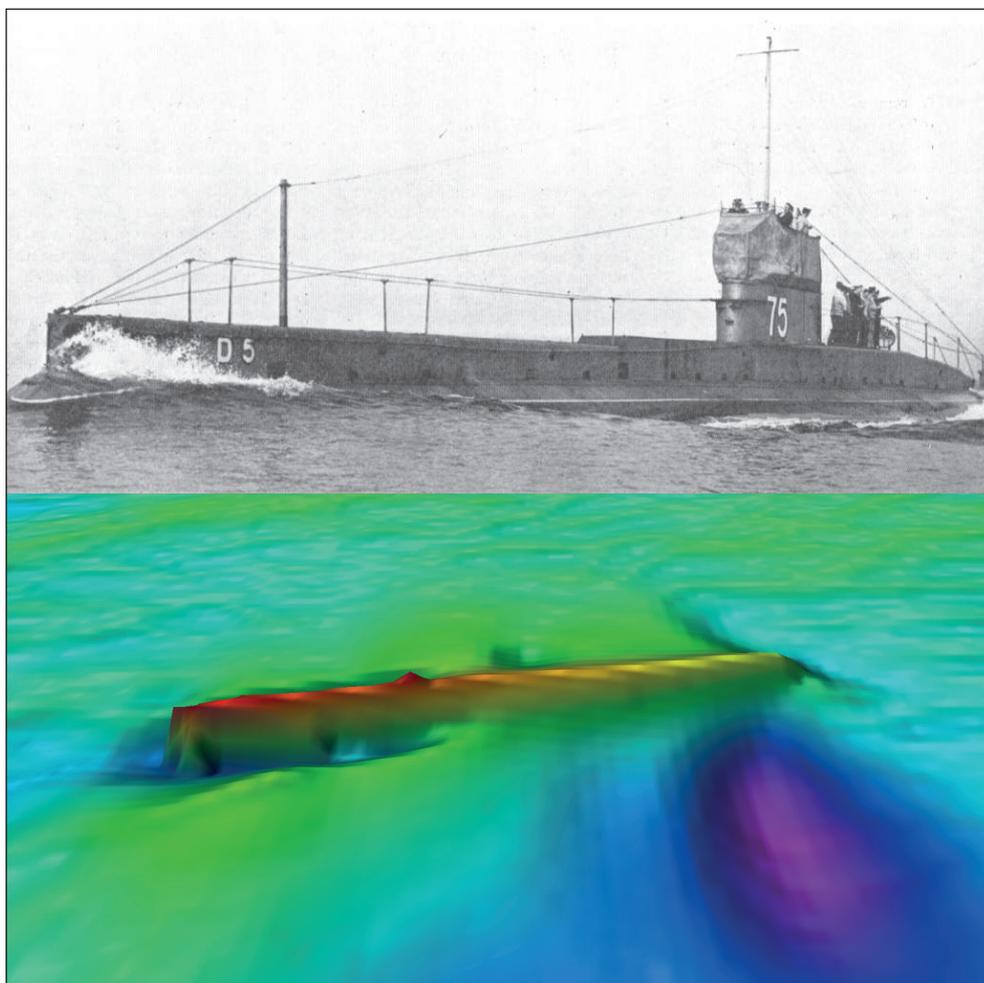




making sense of heritage

HMS D5 Off Lowestoft, Suffolk

Archaeological Services in Relation to Marine Protection
Undesignated Site Assessment



Ref: 108280.19
January 2016



Archaeological Services in Relation to Marine Protection

HMS D5 Off Lowestoft, Suffolk

Undesignated Site Assessment

Prepared for:
Historic England

Prepared by:
Wessex Archaeology
Portway House
Old Sarum Park
Salisbury
WILTSHIRE
SP4 6EB

www.wessexarch.co.uk

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Undesignated Site Assessment

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HMS D5 off Lowestoft

Undesignated Site Assessment

Summary

Wessex Archaeology was commissioned by Historic England to undertake an Undesignated Site Assessment of the wreck site of HMS D5, lost off Lowestoft on 3rd November 1914. The work was undertaken as part of the Archaeological Services in Relation to Marine Protection (diving) contract.

The assessment of the site was undertaken as part of a two stage investigation. Stage one consisted of a geophysical survey over the location of the wreck site of HMS D5 and stage two consisted of a diver survey of the site.

The geophysical survey aimed to confirm the presence of the wreck of a submarine at this location and inform the diving investigation. The diving investigation aimed to confirm the identification of the wreck as HMS D5 and resulted in a video and photographic survey of the wreck site.

The site has been assessed against the criteria required for designation under the Protection of Wrecks Act 1973 and it is Wessex Archaeology opinion that it meets the criteria for designation. Although the preservation condition are not outstanding, HMS D5 is one of the three British submarines lost during the First World War and is considered significant by virtue of its age and connection with the Yarmouth Raid and “Captain William McBride”, a pseudonym of Lt Cdr Godfrey Herbert.

Risk is assessed as low. The wreck presents few fittings or features that could attract potential unauthorised salvage and no evidence of other impacts such as trawling were found. However natural decay is expected and as the stern of the wreck appears to be buried this evaluation should be re-assessed in the event that further areas of the submarine become exposed. At present, no urgent threats have been identified.

No management actions are recommended although it is advised that local divers are encouraged to set an informal monitoring of the site’s condition.



HMS D5 off Lowestoft

Undesignated Site Assessment

Acknowledgements

This investigation was commissioned by Historic England, and the assistance provided by Alison James, Mark Dunkley and Serena Cant is gratefully acknowledged. Mark Beattie-Edwards of the Nautical Archaeology Society kindly provided the position for the wreck and his intervention is greatly appreciated.

Wessex Archaeology would like to thank Mark Beattie-Edwards of the Nautical Archaeology Society, David Ronnan and Sylvia Pryer of Dive125, and George Malcolmson, archive officer at the Royal Navy Submarine Museum in Gosport.

The assessment was carried out by a Wessex Archaeology team comprising the following:

- *Toby Gane, project management, QA and report editor;*
- *Paolo Croce, project officer, archaeological diver and report compiler;*
- *Peta Knott, archaeologist;*
- *Graham Scott, diving supervisor;*
- *Debbie Shefi, stand-by diver;*
- *Karen Nicholls, illustrations; and*
- *Jane Edwards, administrative support.*

The diving support vessel *Sea Stoat* was skippered by Ben Stebbing and crewed by Mike Osborne to whom we express our gratitude.



HMS D5 off Lowestoft

Undesignated Site Assessment

1 INTRODUCTION

1.1 Assessment Background

- 1.1.1 Wessex Archaeology was commissioned by Historic England to undertake an Undesignated Site Assessment of the wreck of submarine HMS D5 (NRHE no. 880008/1490366). The work was undertaken as part of the Archaeological Services in Relation to Marine Protection (Diving Contract) 2015-2017.
- 1.1.2 The location of the site was first reported by Mark Beattie-Edwards of the Nautical Archaeology Society (NAS), based on previous discussions with David Ronnan of Dive125. Photographs taken by Sylvia Pryer suggested that the remains were very likely to be those of HMS D5.
- 1.1.3 The UKHO entry for D5 (wreck ID 10449, NRHE ID 1490366) is for a position c. 7.8 nautical miles from the site, whereas the site position as confirmed by this assessment is associated with a UKHO record for a different vessel: the SS *Perth* (wreck ID 11050). As it was clear that an exposed wreck of a submarine, potentially HMS D5, had been found at the new location it was considered pertinent to survey this position to confirm the identification. Consequently, the recorded UKHO position for D5 (wreck ID 10449), reported to be incorrect, was not surveyed.
- 1.1.4 HMS D5 was a British D-Class Overseas Submarine and is recorded as being lost off Lowestoft on 3rd November 1914 after hitting a mine whilst chasing German ships of I and II *Aufklärung Gruppe* in response to the Raid on Yarmouth.
- 1.1.5 The dive assessment was conducted in accordance with a written brief and agreed scope of work (Historic England 2015). This document is the Undesignated Site Assessment.

2 ASSESSMENT AIMS AND OBJECTIVES

- 2.1.1 The overall aim of the project was an undesignated site assessment, which was separated into the following primary and secondary objectives in the Brief (Historic England 2015):

2.2 Primary Objectives

- **Stage 1**
 - *Undertake a data audit comprising documentary research on the site as appropriate to inform designation assessment;*
 - *Contact the Receiver of Wreck and Historic England to gain a list of droits relating to the sites;*



- *Establish links with local divers, dive groups and skippers to enable future site management options;*
- *Undertake geophysical survey (side scan and magnetometer only) to assess the presence/absence of heritage assets, and to establish extent, stability and character;*
- **Stage 2**
 - *Undertake a diver survey of the exposed remains. Confirm position, extent, stability and character (plotted by tracked diver survey) of the sites;*
 - *Locate and accurately position (plotted by tracked diver survey and probing where appropriate) any additional visual archaeological material; and*
 - *Produce a structure record of field observations (including the collection of appropriate bed level pH values and the collection of footage suitable for broadcast); including a photographic record of the site and a basic site plan. Key artefacts are to be subject to detailed examination and recording (position by diver survey, taped measurements, photographs and video and written database entries).*

2.2.1 The recording level set in the Brief was Level 3a, whereby a diagnostic record is generated comprising 'a detailed record of selected elements of the site'.

2.2.2 The following products were specified in the Brief; this document is P2.

- *P1 – Archaeological Report (suitable for public release);*
- *P2 – Undesignated Site Assessment (confidential);*
- *P3 – Project archive/s compiled in accordance with current accepted standards; and*
- *P4 – Finds should also be logged appropriately with the Receiver of Wreck.*

3 METHODOLOGY

3.1.1 All fieldwork procedures and standards complied with the relevant guidance by the Chartered Institute for Archaeologists (CIfA) as listed on their website (CIfA website, accessed June 2015).

3.2 Data Audit

3.2.1 A limited audit of existing primary and secondary sources relevant to the site location has been undertaken, however this does not amount to a full desk-based assessment.

3.2.2 The following sources have been consulted to inform this assessment:

- *National Record of the Historic Environment (NRHE) data for monument no. 880008 and 1490366 obtained directly from Historic England via Serena Cant;*
- *UKHO data for HMS D5 (wreck ID 10449) and the SS Perth (wreck ID 11050) obtained from the UKHO database;*
- *Documents regarding the D5 loss stored at the National Archives in Kew (ADM1/8401/405, ADM1/8404/481);*
- *Historical photographs of D-class submarines contained in a range of published sources, especially from the work of Tall and Kemp (Tall 1996) and those from the Simonds & Co. collection of the Imperial War Museums (Q 22046, Q 22046A);*

- *Geophysical data: the sidescan sonar and magnetometer data were acquired by Wessex Archaeology on 5th July 2015, whereas the multibeam bathymetry data were acquired in 2014 through the UKHO Civil Hydrography Programme (CHP);*
- *Correspondence with Dave Ronnan and photographs of the wreck taken by Sylvia Pryer;*
- *Technical plans of D-class submarines published in MoD publication BR3043 of 1979 advised by George Malcolmson of the Royal Navy Submarine Museum;*
- *The description of the Raid on Yarmouth and the plot of the navigation course of the I and II Aufklärung Gruppe (AG) during the bombardment of Yarmouth on the 3rd November taken from the recent publication by Staff (2014);*
- *Ron Young (2003) provides a vivid account of the accident reporting the memoirs of Cdr Turner DSO in HMS D3 that witnessed the events; and*
- *Appendix B of Naval Staff Monograph Vol XII – home waters part III - contains the telegrams and signals connected with the Raid on Yarmouth of 3rd November 1914 and the Royal Navy official narration of the episode.*

3.2.3 The following repositories were identified as potential sources for further future research:

- *The National Maritime Museum Greenwich stores a series of boxes of folded ships plans and photographs pertaining to the D-class submarines (ADBB0728, ADBB0729, ADRB0342, ADBB0734, ADBB0735, ADMB0063, VIZB0141, FORB0010, ALB1327, ADBB0736);*
- *The Imperial War Museum’s Burton-Bass (MR) collection, a series of black and white prints of British submarines types featuring D-class submarines (Catalogue number 2005-02-31); and*
- *An authorised biography of the controversial figure Godfrey Herbert of the Royal Navy, Lt Cdr and survivor of the sinking of D5, was written by K. Chatterton and published in 1936.*

3.2.4 Information taken from data audit sources has been used in the site identification discussion **Section 5** and the non-statutory criteria assessment **Section 7.2**.

3.3 Geophysical Survey

3.3.1 The geophysical data were acquired by Wessex Archaeology on-board the MV *Site Seeker* on the 5th July 2015. The survey involved acquisition of sidescan sonar and marine magnetometer data.

3.3.2 A study area was based on a 200 x 200m box within the geophysical survey area centred on the given location and orientated north-south. Main survey lines were orientated north-south into the tide and cross lines orientated east-west across the tide due to the strong tidal currents present within the Cross Sands area.

3.3.3 Multibeam bathymetry data were acquired in 2014 through the UKHO CHP, recorded in WGS84 and provided digitally in gridded 1m CUBE data in .ascii format. The files were then converted to WGS UTM 31N during processing.

Technical Specifications

3.3.4 The sidescan sonar data were acquired using a Klein 3900 system. The system was operated at 445 kHz with a range of 40m per channel. An initial line spacing of 30m was used, with additional lines run if necessary to provide full data coverage. Towfish



positioning information was provided by manual layback during processing. Data was recorded digitally using SonarPro software as .xtf files.

- 3.3.5 The marine magnetometer data were acquired using a Geometrics G-882 Caesium Vapour magnetometer operating at a frequency of 10Hz, towed directly behind the sidescan sonar fish on a 12.8m cable. The data was digitally logged in Hypack navigation software, later converted to .txt files for processing and interpretation.
- 3.3.6 Positioning for the survey was provided by a Hemisphere R110 DGPS receiver system, with the navigation data recorded using HyPack navigation software. All positions for the survey were recorded and expressed as WGS84 UTM31N.

Data Quality

- 3.3.7 The geophysical data used for this report were assessed for quality and their suitability for archaeological purposes, and rated using the following criteria:

Table 1: Criteria for assigning data quality rating

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

- 3.3.8 The sidescan data have been rated as 'Average' using the above criteria. Some snatching due to tidal currents and weather are visible within the data, but does not affect the data detrimentally to a large degree. The positioning accuracy of the sonar towfish was relatively poor due to a combination of strong tidal currents experienced during the survey and the length of towed cable used (itself a function of water depth and current strength). Positioning errors were rectified during data processing.
- 3.3.9 Due to system problems only partial coverage of the site was achieved with the magnetometer. The data that were usable were of 'Average' quality using the above criteria with some spiking and background noise, but did not detrimentally affect the data. The same positioning uncertainties affecting the sidescan sonar also applied to the marine magnetometer. These were also rectified during processing.
- 3.3.10 The multibeam bathymetry data have been rated as 'Good' using the above criteria. The dataset is clean with no snatching or positioning errors visible. This data is suitable for the interpretation of small features and looking at specific sites in greater detail.

Data Processing

- 3.3.11 The sidescan sonar data were processed by Wessex Archaeology using Coda GeoSurvey software. This allowed the data to be replayed with various gain settings in order to optimise the quality of the images. The data were interpreted for any objects of possible anthropogenic origin. This involves creating a database of anomalies within Coda by tagging individual features of possible archaeological potential, recording their positions and dimensions, and acquiring an image of each anomaly for future reference.
- 3.3.12 A mosaic of the sidescan sonar data is produced during this process to assess the quality of the sonar towfish positioning. The survey lines are smoothed, and the navigation corrected by applying individual fixed laybacks and vessel offsets as recorded during the survey. This allows the position of anomalies to be checked between different survey lines and for the layback values to be further refined if necessary.
- 3.3.13 The form, size, and/or extent of an anomaly is a guide to its potential to be an anthropogenic feature, and therefore of its potential archaeological interest. A single, small, but prominent anomaly may be part of a much more extensive feature that is largely buried. Similarly, a scatter of minor anomalies may define the edges of a buried but intact feature, or it may be all that remains of a feature as a result of past impacts from, for example, dredging or fishing.
- 3.3.14 The magnetometer data were processed using Geometrics MagPick software in order to identify any discrete magnetic contacts which could represent buried metallic debris or structures. The software enables both the visualisation of individual lines of data and gridding of data to produce a magnetic anomaly map.
- 3.3.15 The data were loaded into MagPick and laybacks and vessel offset values added as with the sidescan sonar data. The data were then smoothed, a trend fitted to the results, and then the trend values subtracted from the smoothed values. This was carried out in an attempt to remove natural variations in the data (such as diurnal variation in magnetic field strength and changes in geology). The processed data were then gridded to produce a map of magnetic anomalies, and individual anomalies tagged and images taken in a similar process to that undertaken for the sidescan sonar data.
- 3.3.16 The form and size of a magnetic anomaly is a guide to its potential to be an anthropogenic feature. Generally single magnetic amplitudes of over 5nT identified along a short distance are interpreted to be of anthropogenic origin.
- 3.3.17 The 2014 CHP multibeam bathymetry data were fully analysed to identify any unusual structures of the vessel or other anthropogenic debris. The data were gridded to a cell size of 0.5m and fully analysed using IVS Fledermaus software, which enables 3-D visualisation of the acquired data and geo-picking of seabed anomalies.

Anomaly Grouping and Discrimination

- 3.3.18 The previous section describes the initial interpretation of all available geophysical data sets. This inevitably leads to the possibility of any one object being the cause of numerous anomalies in different data sets and apparently overstating the number of archaeological features around the wreck sites.
- 3.3.19 To address this fact, the anomalies were grouped together, allowing one ID number to be assigned to a single object for which there may be, for example, a magnetic response and multiple side scan sonar anomalies.



- 3.3.20 Once all the geophysical anomalies have been grouped, a discrimination flag is added to the record in order to discriminate against those which are not thought to be of an archaeological concern. These flags are ascribed as follows:

Table 2: Criteria for discriminating archaeological importance of features

Non-Archaeological	U1	Not of anthropogenic origin
	U2	Known non-archaeological feature
	U3	Non-archaeological hazard
Archaeological	A1	Anthropogenic origin of archaeological interest
	A2	Uncertain origin of possible archaeological interest
	A3	Historic record of possible archaeological interest with no corresponding geophysical anomaly

- 3.3.21 All the anomalies that have been identified from the survey area are presented in **Appendix 3** and illustrated on **Figure 3**, and are discussed in this report.
- 3.3.22 The grouping and discrimination of information at this stage is based on all available information and is not definitive. It allows for all features of potential archaeological interest to be highlighted, while retaining all the information produced during the course of the geophysical interpretation for further evaluation should more information become available.

3.4 Diving Survey

- 3.4.1 Diving operations were carried out from Dive Support Vessel *Sea Stoa*, an 18 metre long MCA Category 2 coded work boat anchoring with a three point mooring system.
- 3.4.2 All Wessex Archaeology operations complied with the Diving at Work Regulations 1997 and the associated Scientific and Archaeological Diving Projects Approved Code of Practice (ACOP) and guidance (HSE website, accessed June 2015). Diving operations were conducted during daylight hours only on a single shift system with a four person team.
- 3.4.3 Information on tides and currents were sourced by local divers. The diving operations had to be stopped on 9th September and resumed at a later stage on the 22nd September due to poor weather conditions. Unfortunately the diving had to be re-interrupted on the 23rd September, again due to an unexpected turn of the weather.
- 3.4.4 The main aim of the survey was to confirm the identity of the wreck and produce an assessment of its condition. The survey methods employed on-site comprised general and close visual inspection with integrated on-site recording, acoustic tracking and video survey. The video system consisted of a helmet mounted single chip Colourwatch Digital Inspection Camera recording onto MiniDV tape and coupled with a GoPro Hero and still photography. Light levels were limited and therefore a helmet mounted light and a hand-held light was carried.
- 3.4.5 Due to the limited bottom time the survey targeted particular features that were considered diagnostic and significant for identification during the planning process. Therefore, plans and photographs relating to the submarine had been obtained prior the



operation. Due to adverse weather conditions only two dives were undertaken resulting in the top of the submarine being examined, but no mud line search was carried out around the wreck.

- 3.4.6 All data acquired during diving operations, other than images, were recorded in DIVA, a real time Microsoft Access database linked to the tracking system via ArcView 9.3 GIS software. Observations were logged with positional information attached, allowing accurately positioned archaeological features to be displayed in a GIS workspace. Positional information was layered onto a georeferenced geophysical survey image of the site enabling the diving supervisor to provide navigational information to the diver.
- 3.4.7 On the second tranche of the diving operation it was agreed with Historic England not to deploy the tracking system. This decision was taken because the submarine pressure hull was observed as fairly intact during the first dive and considered easy to navigate without tracking. An accurate position of the bow of submarine had been already acquired from the previous dive.
- 3.4.8 Post-survey all observations were compared with a copy of the original manufacturer's drawings and historical photographs for identification of the significant features and evaluation of the condition and processes affecting the wreck.

4 RESULTS

4.1 Summary of Progress against Objectives

- 4.1.1 **Table 3** shows the progress that has been made against the fieldwork objectives presented in **Section 2**.

Table 3: Summary table

Objective	Progress
Stage 1	
Undertake a data audit comprising documentary research on the site as appropriate, to inform designation assessment. Contact Serena Cant to ensure all information is gained from the NRHE.	Achieved. Serena Cant was contacted at the beginning of the planning process. Several primary and secondary sources have been consulted or located.
Contact the Receiver of Wreck and Historic England to gain a list of droits relating to the site.	Achieved. Historic England have no droit records in the area (Pers. Comm. H. Meara 02/11/2015). The Receiver of Wreck was contacted at the beginning of the planning process; no reply has been received.
Establish links with local divers, dive groups and skippers to enable future site management options.	Achieved. David Ronnan of Dive125 has been contacted and plans to dive the site again in 2017. He expressed interest in being contacted by Historic England in the future with regard to the wreck. Mark Beattie-Edwards of NAS expressed his interest in being involved in future fieldwork and assessment of the site.
Undertake geophysical survey (side scan & magnetometer only) to assess the presence/absence of heritage assets, and to establish extent, stability and character.	Achieved. The geophysical survey consisting of side scan sonar and magnetometer was carried on 5 th July 2015. In addition multi beam bathymetry data was also acquired from the UKHO.



Objective	Progress
Stage 2	
Undertake a diver survey of the remains. Confirm position, extent, stability and character (plotted by diver survey) of the site	Partly Achieved. The submarine was located, positioned and a visual inspection was carried out at the deck level and on the bow of the submarine confirming the identity of the sub. The extent of the submarine was ascertained and the stern appeared to be buried at the time of the survey. Unfortunately no mud line inspection was carried out due to insufficient bottom time.
Locate and accurately position (plotted by diver survey and probing as appropriate) any additional archaeological material	Not Achieved. The survey focussed on the main section as no additional material or related debris from the wreckage is visible in the geophysical data.
Produce a structured record of field observation including the collection of appropriate bed level pH values and the collection of footage suitable for broadcast; including a photographic record of the site and a basic site plan.	Partly Achieved using the DIVA recording system and still and video photography. A pH sample was collected but unfortunately it was lost during the dive due to the strong current. Collection of footage suitable for broadcast was made impossible by the lack of visibility and presence of particulate in the water column. A basic site plan showing the main features identified was produced.

4.1.2 Peter Wiggins, grandson of Frederick Elkin Bradley who died on-board of D5, was contacted on the week of Remembrance Day. He expressed his gratitude in obtaining information of the submarine D5 and he expressed his interest in obtaining a copy of the report (Pers. Comm. Peter Wiggins 09/09/2015).

4.2 Site Position

4.2.1 The submarine wreck is located c. 10 nautical miles off Lowestoft at an approximate depth of 23m in a generally flat sandy area characterised by several small sand ripples and generally orientated in an east-west direction (**Figure 1**).

4.2.2 The submarine is upright and stands 2.5m proud of the general seabed level. It is orientated approximately east-west with the bow to the east.

Table 4: Site co-ordinates

WGS84 Long/Lat (DDM)		WGS84 UTM 31N	
Longitude	E 02 1.606	Easting	434093
Latitude	N 52 36.322	Northing	5828816

4.2.3 The site presents a large scour that undercut the wreck at the eastern end. At the other end the submarine is covered by a sand wave to the point that the sides of the hull are not exposed and only the upper part of the pressure hull plating protrudes from the sand. Therefore the stern is not visible and it is unclear to what extent it is covered by sand or, in the light of the fact that the stern is the area that was reported as being damaged by a mine, missing.

4.3 Operational Summary

- 4.3.1 Fieldwork was planned from the 6th to the 10th September 2015. Unfortunately due to adverse weather conditions the operation was suspended and on only one day, 7th of September, was it possible to dive. A second operation was then planned from the 22nd to the 24th September. However, the initially fair weather conditions worsened so that only on 22nd September was it possible to carry out a dive safely.
- 4.3.2 Visibility underwater was limited (less than 0.5m) and the presence particulate suspended in the water column meant that the quality of the video and photos captured is also low. Nonetheless most of the features are generally recognisable and the overall arrangement of the wreck discernible.
- 4.3.3 The survey was carried out as follows:
- On the first dive the objective was to confirm the wreck's identity and this was achieved by systematic recording of diagnostic features. Priority was given to locating the bow of the submarine and successfully recording the torpedo tubes sizes and arrangement.
 - Once accomplished, the second dive was spent undertaking a general survey of the deck level aimed to establish the extent of the site and the absence/presence of particular features such as fittings and plating.
- 4.3.4 The inspection of the interior of the wreck from the open hatches revealed that it is almost completely silted up and entering the wreck is not possible.
- 4.3.5 A pH sample was taken at the fore end of the wreck but the sample bottle was lost during the dive so no pH sample were obtained.

4.4 Site Description

Seabed and Ecology

- 4.4.1 The seabed is characterised by fine sand with no inclusions. Large edible crabs (*cancer pragurus*) were observed on part of the wreck and the wreck showed almost no marine growth apart from some dead man's fingers (*Alcyonium digitatum*) growing on the upstanding features located amidships (**Plate 1**).

Seabed Features Assessment

- 4.4.2 A total of 32 sidescan sonar, two multibeam bathymetry and seven magnetic anomalies were identified within the geophysical data. Following the grouping and discrimination procedure outlined above, these were grouped to produce a list of nine sites of potential archaeological interest within the Study Area (**Figure 1**), which were characterised as follows:

Table 5: Sites of potential archaeological interest within the survey area

Archaeological Discrimination	Number of Anomalies	Interpretation
A1	1	Anthropogenic origin of archaeological interest
A2	8	Uncertain origin of possible archaeological interest
A3	0	Historic record of possible archaeological interest with no corresponding geophysical anomaly
Total	9	

- 4.4.3 A wreck of a possible submarine (**WA7000**) has been interpreted in the geophysical data in approximately 23m depth of water, measuring 46.5 x 7.8 x 2.7m and located approximately 5m south of the given position (assuming the central bathymetry position as the centre of the interpreted vessel). The wreck is measured at 38m x 6m x 3m in the bathymetry dataset indicating that the wreck has been exposed since the bathymetry data were acquired in 2014. The wreck is orientated east north-east – west south-west and lying in a small amount of scour around the mid-section, approximately 0.2m in depth and on the same alignment. A magnetic anomaly has been associated with the wreck with a value of 70nT. It should be noted that the magnetometer data did not pass directly over the wreck position and as such this value is an underestimate. A large flare of scour measuring 34 x 20m with a maximum depth of 1.2m has been identified to the north-west of the wreck.
- 4.4.4 A UKHO record (wreck no. 11050) for the vessel SS *Perth* (possibly) is associated with this location. However, it has been independently dived and identified as a submarine. No other wreck sites have been identified within the vicinity using regional multibeam bathymetry.
- 4.4.5 Since the wreck structure appears generally intact, relatively little debris has been recorded within the vicinity. This could be due to the nature of the sandy seabed, which could bury smaller objects. A small debris field (**WA7003**) measuring 10m x 6.5m and containing several small rounded dark reflectors has been identified slightly to the north of the mid-section. This area is covered by the magnetic radius of the wreck and therefore no independent magnetic value is attainable here.
- 4.4.6 A small mound (**WA7008**) has been identified the bathymetry data, 64m north north-east of the position of the wreck, measuring 3 x 2.5 x 0.2m. It was not identified in the sidescan sonar data and this area was not covered by adequate magnetometer data and as such its ferrous nature cannot be assessed.
- 4.4.7 Two further pieces of possible debris (**WA7001** and **WA7002**) have been identified within the survey area. Neither of these anomalies was covered by adequate magnetometer data and as such their ferrous nature cannot be assessed. Anomaly **WA7002** lies closest to the wreck at approximately 100m south-west of the central position. The feature is observed as a diamond shaped object, possibly hollow, with a second dark reflector next to it. The anomaly measures 3.7m x 2.9m and a height of 0.5m is recorded. Anomaly **WA7001** is interpreted as and 'L' shaped debris field of small dark reflectors with some scour but no obvious height measuring 13.2 x 1.6m, approximately 140m directly south of the wreck.



4.4.8 The four remaining anomalies (**WA7004**, **WA7005**, **WA7006** and **WA7007**) are all interpreted as individual features classified as dark reflectors, without associated magnetic anomalies, that are considered uncertain in nature. The anomalies vary in size, the largest measuring 4.7 x 2.9 x 0.5m. These could either be small pieces of debris but could also be natural in origin.

4.5 Vessel Structure

4.5.1 The wreck appears to be in fairly good condition with the pressure hull mostly intact, and little marine growth and no evident signs of corrosion. The main body of the wreck is exposed showing a continuous structure for c. 36m but almost all the features located on the deck and on the top of the pressure hull, including the conning tower and the deck casing, are missing. The reason why the large majority of the superstructure and fittings are not present is not clear and could be natural decay, wire sweeping, salvage activities or a combination of post-depositional factors.

4.5.2 The boat lies upright on an even keel in an east - west alignment with the bow to the east. At the bow the submarine is well exposed with the upper side of the pressure hull standing c. 2.5 m from the seabed. Westward in the direction of the stern the pressure hull becomes buried by a sand wave starting approximately in the area where you would expect the conning tower (**Plate 1**).

4.5.3 A potential area of damage was located on a partially exposed part of the structure towards the stern, although, as at this point the submarine is buried, the extent and character of this damage is not clear. According to the available sources the HMS D5 was hit by a mine at the stern whilst travelling on the surface, so damage consistent with a large explosion is to be expected.

4.5.4 At the very east of the structure is the bow of the submarine which, at the time of the survey, was completely clear of sand and undercut by scouring revealing the whole height of the bow section. This was recorded by the diver to be well over 2m. Two torpedo tubes in a vertical arrangement were observed and both noted as empty. The torpedo tube hatch is open and although partially damaged it is still attached with its pivot to the body of wreck. The torpedo tubes internal diameters were measured as 0.46m (18 inches). The vertical arrangement and the dimension of the diameter of the torpedo tubes correspond to those used on the D-Class and support the confirmation of this submarine as one of D-class type (BR3043, 1979, **Plates 1-2**). By peering into the openings the torpedo tubes were observed to be filled with fine sand.

4.5.5 On the port side of the bow, the hydroplane and hydroplane guard are corroded but still present and recognisable (**Plate 1**).

4.5.6 The upper casing of the pressure hull is missing and only the hinges/railing that once attached it to the pressure hull suggests its former presence. No fittings were found at the very end of the submarine other than a large bollard and a hexagonal nut, which possibly offered anchorage to the derrick that is visible in the blueprint.

4.5.7 Preceding aft, a rectangular opening with curved short sides opens onto the deck. This is identified by location, shape and approximate dimensions as the torpedo loading hatch. The two perpendicular frames visible in the plans are also still in place. The hatch is filled with sediment up to 0.5m from the top confirming that the interior fore section of the submarine is silted up.



- 4.5.8 Proceeding west, the diver encountered a capstan and behind this was a capstan engine that would have been operated with the capstan. A small cleat once covered beneath the deck plating is visible on the starboard side.
- 4.5.9 Continuing along the top of the submarine westwards, a small chassis covered by white anemones protrudes c. 0.7m from the pressure hull. This feature consists of a horizontal rounded frame supported by four vertical frames attached to the pressure hull. This framework is immediately followed by a small c. 0.5m rectangular hole with rounded corners. It is hard to identify this feature although it has been suggested that it could be the front part of the frame for the forward plating of the conning tower. However the substantial remains of the conning tower that are expected aft of it were not visible. Another possible identification is that this feature is framework for the gun lifting mechanism.
- 4.5.10 Approximately 3m from this feature the site starts becoming buried by the sand wave and the structure less discernible. The parts that are exposed are damaged and partially buried making the features in this area difficult to identify. The area of damage starts c. 5m from the chassis described above and seem to break through the pressure hull. A bent pole on top of what seems to be a curvilinear platform might suggest the location of the aft section of the conning tower. This iron pole could be an iron railing or the rod for the steering mechanism in the conning tower. At the very west there is a circular feature that could be a hatchway with a damaged hatch although this identification is provisional as this feature was barely exposed. The presence of intrusive material in this area was observed: a piece of square fabric of c. 0.5m per side was wrapped over a rectangular piece of the wreck that is probably incidental.
- 4.5.11 As the stern is not exposed it is unclear whether the aft part of the submarine is truncated or buried and what the extent of the damage is. Nonetheless the presence of wreckage for at least 3m further west to the last visible feature is ascertained as the diver could "feel" a hard surface underneath a cover of c. 10-30mm of sand. Further on the structure became hard to follow under the sand.

5 DISCUSSION

5.1 Site Identification

- 5.1.1 The survey confirmed the identification of the wreck site as D5. The general dimensions and the features of the wreck correspond with the information available for the D-Class. Although the conning tower and the stern were not inspected at the time of the survey the vertical arrangement and dimensions of the torpedoes tubes and configuration of hatches and few fittings remaining on the fore part of the submarine are consistent with the technical plans of the D-class.
- 5.1.2 The location of the area of potential damage visible towards the stern of the vessel also matches with the description by Cdr Turner in his memoirs. Turner witnessed the sinking of D5 as at the time of the explosion he was commanding D3, one of submarines that were sent to intercept the German flotilla. He stated: *'On leaving the harbour, E18 steered a northerly course, while D3 and D5 proceeded eastwards. On clearing the shoals, I was leading D5 half a mile astern of me. We met the returning fishing fleet. They were waving and sounding their horns and calling out 'Mines, mines everywhere'. I altered the course to northward and I watched D5 put her helm over to follow suit. As she did so, a mine exploded aft. There was a cloud of black smoke and the boat had simply disappeared* (Young 2003).

- 5.1.3 Although the official sources stated that D5 sunk because of the explosion of a German mine, after the war the location of the accident was reported as being 2 miles south of South Cross Sand Buoy. This led some authors (Young 2003; Evans 1986) to claim that the loss was the result of D5 hitting a loose British mine instead of a German one as the position where D5 had been reported to have struck a mine was far from the track of the enemy ships. However the identification of the (United Kingdom Hydrographic Office) UKHO wreck no. 11050 of as the remains of the submarine confirms that D5 hit a German mine laid by the cruiser SMS (*Seiner Majestät Schiff/His Majesty's Ship*) *Stralsund* as the location of the site is in close proximity to the I and II *Aufklärung Gruppe's* navigation course (**Figure 1**). On the 3rd November 1914 before and during the bombardment of Great Yarmouth, the small cruiser *Stralsund* laid several minefields for a total of around 120 mines c. 10 miles of the English Coast (Staff 2014).
- 5.1.4 D5 was travelling at speed on the surface trying to intercept the much faster homebound German cruisers. The submarine had received orders to intercept the enemy near Terschelling and the wreck seems to be along that route.

5.2 Site Characterisation

- 5.2.1 The overall characterisation of the exposed material on the seabed can be summarised as follows, using the Build/Use/Loss/Survival/Investigation (BULSI) method for 'shipwreck biography' as presented within the Aggregate Levy Sustainability Scheme (ALSF) project *On the Importance of Shipwrecks* (Wessex Archaeology 2006).

Build

- 5.2.2 HMS D5 was built by Vickers at Barrow yard no. 405, laid down on 23 February 1910, launched on 28 August 1910 and commissioned on 19 February 1911. The D-class was a new submarine design, developed and built in secrecy, was intended to provide the Royal Navy with overseas submarines with proper patrol capability. The design approved by the Admiralty board in 1906 presented several improvements and innovations which marked a step forward in the development of the modern submarine in the Royal Navy and laid the foundation of the subsequent classes of submarine (Akermann 1989).
- 5.2.3 Although the prototype of the D-class - D1 - was launched in 1908, issues with the surface propulsion meant that the construction of remaining D-class submarines was delayed until 1910 (Akermann 1989). From 1907 to the end of 1911 eight of the class were built, six at Vickers in Barrow and two at HM Dockyard in Chatham. As in 1911 an improved design, the E-type, became available the construction of D9 and D10 was halted and the D9 and D10 were built as E1 and E2.
- 5.2.4 Intended for overseas operations the D-class had far better endurance than the much smaller previous boats. It was equipped a pair of six-cylinder Vickers diesel engines of a total of 1200 BHP and this made D-class the first class of diesel-drive submarines signing the end of petrol engines in submarines of the British Navy (and the risks connected with the petrol fumes). Even though the introduction of diesel engines in submarines of the Royal Navy was experimented on in A13, this is the first time they were introduced in series in the planning process of a British submarine class. Another new adoption in the propulsion system was the use of two three-bladed 5ft 3in screws which meant improved manoeuvrability and safety as there was a backup in case one of the two propellers had problems. The D-Class was capable of a surface speed of approximately 14.5 knots.
- 5.2.5 The introduction of external tanks to hold the main ballast water meant the abandonment of the Holland type single-hull approach and the introduction of the new philosophy of double hull submarines. The additional inboard space resulted in the introduction of a

stern torpedo tube (a first for Royal Navy submarines) and allowed for the increased engine size. Moreover it certainly helped reducing the workload of the long missions overseas by allowing for an increased complement of 25 submariners although it is unclear whether the comfort of the boat was improved. The new hull design also meant that more batteries of improved capacity could be stowed qualifying the D-class as the first British submarine to have the capacity to remain submerged throughout the hours of daylight. In addition to the stern torpedo tube, the D-class submarines were fitted with two bow torpedo tubes of 18in each arranged in a characteristic vertical fashion that resulted in finer lines at the bow. The new design resulted in a hull 50.2m long, 6.24m wide and with a draught of 3.35m, a surface displacement of 495 tons and submerged displacement of 620 tons.

- 5.2.6 On top of the pressure hull a much larger conning tower gave a more modern profile. On deck an important innovation was the presence of a wireless system that could receive and send messages up to 30 miles; previous submarines were equipped with receiving equipment only. Only usable on the surface, the aerial of the wireless system had to be rigged to the submarine's mast and had to be stowed away along the side of the vessel before diving.
- 5.2.7 Another innovation, adopted with much controversy by the Admiralty because of the exposure to sea water, was to fit for the first time a submarine with a deck gun mounting. In 1909 a retractable mounting for a 12pdr 8cwt was housed in the superstructure of D4. By 1912 it was decided that all submarines for overseas patrols would be equipped with guns but as the lifting mechanism proved to be quite impractical, fixed mountings were usually preferred (Friedman 2011).

Use

- 5.2.8 With a range of c. 2,500 nautical miles at 10 knots and 24-day endurance the D-class was designed to be employed on offensive patrol on the enemy's coasts.
- 5.2.9 HMS D5 was assigned to the 8th Submarine Flotilla from its mobilisation in July 1914. The patrol submarines of the 8th Flotilla were stationed in Harwich under the command of Commodore Roger Keyes for offensive actions either in the Heligoland Bight or the Kattegat (the sea area between Denmark and Sweden) and mainly consisted of D and E class submarines. Due to the increasing number of ships moored at Harwich some of the units, including D5, were also berthed at Gorleston-on-Sea, Norfolk.
- 5.2.10 At the outbreak of the war, on 10 August 1914, the 8th Submarine Flotilla was ordered to hold the line between the North Goodwin Lightship, Sandettié and Ruytingen Lightships (Admiralty 1921a). A week or so later, on the 19th August 1914, D5 left Harwich at 04:00 with E4 and E9 for a patrol in the Heligoland Bight. On 21 August at 16:00, D5 was on the surface about 75 miles west of Heligoland when it spotted the smoke of the German ships that were proceeding in its direction. At 16:45 D5 attacked a four-funnelled cruiser, SMS *Rostock*. Contrary to orders the D5 fired with both bow tubes simultaneously and both torpedoes missed passing underneath the keel of the German cruiser (Young 2003, Admiralty 1921b). D5 was the attacked but managed to dive and escape. The submarine commanded by Herbert was the first British submarine to fire a torpedo in anger. Apparently Herbert received a reprimand by Keyes and the mascot of D5, a teddy bear, was torn to pieces by the superstitious crew (Young 2003). The German cruisers and the ship of the 6th Flotilla supported by submarines carried out the raid off the Dogger Bank as far as the Outer Well Bank on 22 August 1914 resulting in the sinking of several trawlers.

Loss

- 5.2.11 On 2 November 1914 the I and II *Aufklärung Gruppe* commanded by Admiral Franz von Hipper were heading towards the Smith's Knoll Buoy to carry out War Task no. 19, the bombardment of Great Yarmouth (Staff 2014). As they proceeded towards the coast at 07:15 on 3rd November they spotted, and then opened fire on a British torpedo-gunboat, *Halcyon*. Because five ships, *Seydlitz*, *Straßburg*, *Moltke*, *Blücher* and *Graudenz* misunderstood the signal and fired simultaneously from different directions, the target was not hit. *Von der Tann* then commenced bombarding some reported coastal batteries at the shore but the long range, 10 miles, and the mist resulted in an ineffective attack. At 07:31 *Von der Tann* fired the last shot against *Halcyon* and at 07:35 the German ships were ordered to cease the attack and turn eastward. In the meanwhile the *Stralsund* was laying several mine fields leaving a total of around 120 mines in the area.
- 5.2.12 On the 3rd November D5 was at Gorleston with E10 and D3 ready to start a patrol in the West-Ems (the sea area in the western part of the Netherlands North Sea), as soon as the weather improved. When it was realised that the German ships were attacking Yarmouth, Captain Waistell at Harwich instructed them to proceed in intercepting the enemy near Terschelling (Naval Staff 1925). After leaving harbour, D5 was travelling on the surface with D3 when it was hit aft by a mine and sank within a minute. The position of the accident reported by Herbert was two miles south of the South Cross Sand Buoy 1 (although apparently the telegrams of the other ships read Lightship) (Naval Staff 1925). Herbert and four other members of the crew were saved by the steam drifter *Faithful* but the rest disappeared with the submarine. The skipper of the *Faithful*, James Collin, and his crew were awarded £97 for the rescue.
- 5.2.13 Those lost on-board were Lt Donald Francis O'Callaghan Brodie, Petty Officer Frederick Drury Blunsdon (O/N 203087), Leading Seaman Wright Boardman (O/N 239913), Leading Seaman George W Crimp (O/N 217450), Leading Seaman Albert Norris (O/N 187835), Able Seaman Joseph Dunn (O/N J14000), Able Seaman Ernest Wilcox (O/N 222115), Signalman William Rider Cass Dowsett (O/N J8219), Telegraphist George Clarence King (O/N J5894) CERA Arthur Cecil Smith DSM (O/N 270627), ERA William John Copeland (O/N 271454), ERA Edward Houlcroft (O/N M2924), ERA John Thomas Percival Tilley (O/N 272256), Stoker Petty Officer Timothy Smith (O/N 344519), Leading Stoker Frederick Bradley (O/N 302220), Acting Leading Stoker John Robert Leake (O/N 304084), Stoker 1st Class Thomas Ingham (O/N K7494), Stoker 1st Class Richard Penhaligon (O/N 223326), Stoker 1st Class Sidney Simmons (O/N K1975), Stoker 1st Class Henry (Harry) Whiting (O/N K7502), Stoker 1st Class Ernest Worth (O/N K2292).
- 5.2.14 The survivors were Lt Cdr Godfrey Herbert, Sub Lt Ian Agnew Patterson MacIntyre, Chief Petty Officer Robert Spiers (O/N 154380), Leading Seaman Alfred Dearlove Suttill (O/N J7463) and Able Seaman Charles Henry Sexton (O/N J23950).
- 5.2.15 After the war the possibility that D5 sank because of a British mine that had dragged or broken adrift was suggested, as it was believed that the position in which D5 sank was far from the track of the German ships (Naval Staff 1925). However, the contemporary accounts of the presence of minefields and the proximity of the wreck to the navigation course of I and II *Aufklärung Gruppe* strongly suggest that D5 was actually sunk by a German mine, most likely laid by the cruiser SMS *Stralsund* (**Figure 1**, Staff 2014).

Survival

- 5.2.16 Only the fore section of the wreck is exposed and the condition of the stern section is unknown because it is buried. Although the pressure hull is intact and with little marine growth, no other significant features are preserved apart from a very limited number

fixtures and fittings. The characteristic vertical twin torpedoes and the pivoting hatch is visible and in good condition, although partly damaged. No conning tower was found and it is unclear whether it is buried, salvaged or destroyed during the explosion. From the torpedo tubes and the loading hatch it appears that the interior of the submarine is filled with sand. At the western end of the wreck there is an area of damage, probably caused by the explosion of the mine that sunk the submarine. Unfortunately this area is barely exposed and its limits currently too uncertain to define the extent of the damage and that of the submarine underneath the sand.

- 5.2.17 There is no conspicuous anomaly in proximity to the wreck that suggests a possible location for the stern section or the conning tower. No significant debris trail is evident in the geophysical data although it is likely that the sand has buried any smaller items. Therefore it is reasonable to assume that part of the missing remains might be buried at the western end but it cannot be excluded that are further away in an area not covered by the geophysical survey or destroyed by the explosion. Lastly, even though there is no direct evidence to support this claim, there is the possibility that the wreck was subjected to salvage after the war.

Investigation

- 5.2.18 The UKHO charted the position of the wreck as SS *Perth* (wreck no. 11050) and situated c. 8 nautical miles to the south-west is the recorded UKHO position of D5. The position of the SS *Perth* has been independently dived by David Ronnan and Sylvia Pryer and was provisionally identified as D5. The location of the site was then reported to Wessex Archaeology by Mark Beattie-Edwards of the Nautical Archaeology Society.
- 5.2.19 This survey is the first archaeological assessment of the condition of the wreck and consisted of a visual inspection of the top of the pressure hull and the bow area. The survey confirmed the identity of the submarine, recorded the main features in the area, investigated and located the potential presence of a section of the pressure hull buried at the western end.
- 5.2.20 Geophysical data gathered by the UKHO and Wessex Archaeology were made available and assessed in 2015.

6 RISK ASSESSMENT

- 6.1.1 Using available information, the site has been risk assessed for the purposes of site management using Historic England's *Protected Wreck Sites at Risk: A Risk Management Handbook* (2008). The results are set out in **Appendix 2**.
- 6.1.2 Risk is assessed as **low risk**. The principal vulnerability is the natural erosion and corrosion of the wreck. However this natural decay is unlikely to be prevented and was noted as relatively minor at the time of the survey.

7 ASSESSMENT AGAINST NON-STATUTORY CRITERIA FOR DESIGNATION

7.1 Assessment Scale

- 7.1.1 For each criterion, one of the following grades has been selected. This has been done in order to help assess the relative importance of the criteria as they apply to the site. The 'scoring' system is as follows:

- *Uncertain – insufficient evidence to comment;*

- *Variable – the importance of the wreck may change, subject to the context in which it is viewed;*
- *Not Valuable – this category does not give the site any special importance;*
- *Moderately Valuable – this category makes the site more important than the average wreck site;*
- *Highly Valuable – this category gives the site a high degree of importance. A site that is designated is likely to have at least two criteria graded as highly valuable;*
- *Extremely Valuable – this category makes the site exceptionally important. The site could be designated on the grounds of this category alone.*

7.2 Non-Statutory Criteria Assessment

7.2.1 The HMS D5 site has been assessed against the Protection of Wrecks Act 1973 using the assessment scale outlined above. Should further evidence be found relating to the site, this assessment should be updated appropriately.

Period

7.2.2 HMS D5 was built in 1910 and sunk at the beginning of the war in 1914. It is one of the three British submarines (C29, E6) that were lost in English waters during the First World War (Cotswold Archaeology 2014).

7.2.3 The D-Class, approved by the Admiralty Board in 1906, was an innovative pre-war design that shows the new approach to the philosophy of submarine construction by the Royal Navy (Akermann 1989). The submarines were designed to overcome the limitations of the earlier submarine classes and were much larger than the C class and most importantly embodied innovative features that became adopted in the subsequent submarine types of the Royal Navy. The main changes in the design were the introduction of the saddle tank-type of construction and the abandonment of petrol engines in favour of diesel propulsion and twin propellers. Other firsts for British submarines were the installation of wireless system aerial able to both transmit and receive, the incorporation of the 18in torpedo tube at the stern and the fitting of a 12pdr 8cwt deck gun (initially on D4).

7.2.4 D5 is significant by virtue of its age and its loss in a well-known historical action during the war.

7.2.5 Historically, D5 not only epitomises the development of submarine warfare, which is one of the unprecedented aspects of the First World War (FWW), but also is a tangible connection with the Yarmouth Raid. Although the raid had no significant material consequences, to the point that Admiral Franz von Hipper always refused to wear the iron cross medal he had received for the operation, it is an event that demonstrated to the Admiralty that the Imperial German Navy could elude the large number of British ships patrolling the North Sea and attack the English coast.

7.2.6 Royal Navy officer Godfrey Herbert is connected with D5 as he was its commanding officer at the time of the sinking. Godfrey Herbert is a remarkable although controversial figure of some historical prominence. During the FWW he not only survived the sinking of three submarines (A4, D5, K14) but his service as the captain of various Q-ships was also a role in which he became renowned. As the commander of HMS *Baralong*, known under the pseudonym of 'Captain William McBride' to keep his identity hidden, he became the centre of an international dispute. He was accused by the German government of War crimes for his involvement in the murder of the members of U27's crew survivors during the first *Baralong* incident. The request for investigation led to an escalation of

accusations between the British and German governments which showed the reluctance of both sides to prosecute their own soldiers and ultimately led to an increase of the level of violence and inhumanity during the war. The *Baralong* incidents were cited as specific cases in international complaints and were viewed by the *Kaiserliche Marine* as war crimes and moral justification to the practice of unrestricted submarine warfare. On the other hand for the Admiralty, Captain Godfrey Herbert was doing his duty and was decorated for his services on-board of Q-ships with the Distinguished Service Order (DSO) and bar (Young 2003; Evans 1986; Grant 1969).

- 7.2.7 The site is assessed as **highly valuable** for the above criteria as HMS D5 not only is important for its age and significance in connection to the development of the submarine as a weapon, but also its loss during a renowned historical event and it was also commanded by a historically significant figure of the FWW.

Rarity

- 7.2.8 Between 1907 and 1912, eight of this class were built; six at Barrow and two at Chatham. Different solutions were adopted as a result of changes in submarine warfare and D1, D2 and D3-8 can be considered as three different types (BR3043, 1979).
- 7.2.9 Of a total of eight D-class submarines, D5 is possibly the only submarine of this class to be in English territorial waters.
- 7.2.10 Of the D-class submarines, D2 was sunk by a German patrol craft off the West-Ems in the Netherlands, D3 was accidentally sunk by a French aircraft approximately 12 nautical miles N of Fécamp (McCartney 2003; <http://www.rnsubs.co.uk/Dits/Articles/D3.php> accessed on 23/11/2015) and D6 is possibly located off Northern Ireland (UKHO wreck no. 3553, Cotswold Archaeology 2014, <http://www.divernet.com/wrecks-general/p301624-deep-in-the-northern-approaches.html> accessed on 13/11/2015) and is reported to have been torpedoed amidships by U73. Of the remaining boats, D1 was sunk deliberately as a target in October 1918 and D4, D7, D8 survived the war and were sold in 1921 and presumably scrapped. The survival and condition of D2, D3 and D6 is currently unknown, although D2 is listed by the UKHO as DEAD. D-6 is listed as LIVE and reported as badly damaged.
- 7.2.11 The site is assessed as **highly valuable** for the above criteria as it is the only known example of D-class submarine in English territorial waters.

Documentation

- 7.2.12 The site has been only recently identified and this is the first archaeological assessment of its condition.
- 7.2.13 A number of primary and secondary sources provide detailed descriptions of the characteristics of the design of the D-class. However, ad-hoc solutions and innovations fitted to each submarine are often not documented in the written sources. Historical photographs and blueprints of the D-class and D5 are available and published in different sources.
- 7.2.14 Primary sources such as the contemporary accounts of the accident by Herbert and Turner are available in the well-researched book *Silent Warriors* by Armstrong and Young (Young 2003).
- 7.2.15 Vol. XII of the *Naval Staff Monographs* published after the war details the history of the naval operations during the first German raid at Yarmouth presenting the official British

version of the attack. The telegrams and signals broadcast in relation to the Yarmouth Raid on the 3rd of November 1914 are also available in appendix B of the monograph (Naval Staff 1925).

- 7.2.16 The description of the actions taken by Admiral Hipper and his I and II *Aufklärung Gruppe* during the bombardment of Yarmouth on the 3rd of November is covered in a publication by Gary Staff (Staff 2014).
- 7.2.17 Documents regarding the loss of D5 at the National Archives in Kew includes the reports of the deaths of the members of the crew of the letters and notes regarding the disposal and storage of the logs of the submarine and a letter from the captain of HMS *Maidstone* reporting the list of the casualties (ADM1/8401/405, ADM1/8404/481).
- 7.2.18 The National Maritime Museum Greenwich stores a series of boxes of folded ships plans and photographs pertaining to the D-class submarines (ADBB0728, ADBB0729, ADRB0342, ADBB0734, ADBB0735, ADMB0063, VIZB0141, FORB0010, ALB1327, and ADBB0736). The Imperial War Museums hold in the Burton-Bass collection; a series of black and white prints of British submarines types featuring D-class submarines (Catalogue number 2005-02-31). Although this documentation has not been accessed there is currently no indication that it will revolutionise our archaeological understanding of this type of vessel or their activities.
- 7.2.19 In addition there is substantial documentation related to the wider historical and maritime landscape context of the East Coast War Channels during the FWW (Fjodr 2014).
- 7.2.20 The site is assessed as **Moderately Valuable** for the above criteria.

Group Value

- 7.2.21 The location of the remains, c. 10 nautical miles from the shore, corresponds with the mine barrier laid by the small German cruiser SMS *Stralsund*. Although no other wrecks are known to be associated with this particular minefield, the importance of minesweeping and the use mines to attack shipping are crucial themes in dealing with FWW heritage.
- 7.2.22 The association of the submarine with the naval actions of the 8th Flotilla and its loss in an attempt to pursue the German warships that attacked Yarmouth is significant and the site is a tangible connection with the wider history and character of the East coast during the FWW when the two navies tried to extract their adversary out their harbours.
- 7.2.23 The site is part of the conflict landscape of the East Coast War Channels and it is connected with the local and regional history of Yarmouth and the East Coast. However, its location 10 miles off shore, appears to be relatively isolated and its value is not particularly strengthened by the presence of other FWW remains close by. Therefore the site assessed as **Moderately Valuable** for the above criteria

Survival/Condition

- 7.2.24 Although the only part of the wreck that is well preserved is the pressure hull and it almost completely lacks fixtures and fittings, the submarine still retains shape and other distinctive features such as the torpedo tubes and torpedo loading hatch, which are visible and identifiable.
- 7.2.25 The survey confirmed the presence of a section buried at the western end but the extension and the character of the material buried has not been ascertained. Historical

accounts of the sinking and other evidence suggest this may be an area of damage incurred during the sinking.

- 7.2.26 No large areas of debris were highlighted by the geophysical survey and this could indicate that the features that have not been found, such as the conning tower, still lie buried within the surrounding sands. Other possibilities are that they were destroyed during the mine's detonation or have been salvaged in the past.
- 7.2.27 It is estimated that more than 40% of the site is preserved and exposed but the general condition is good, although little remains of the fixtures, fittings or external plating of the submarine especially if compared with similar submarine wrecks of the same period.
- 7.2.28 It is also possible that further areas of the wreck might be exposed in the future considering the mobility of the sand waves that are currently covering the western end. The interior of the submarine appears to be silted up and the conditions of preservation are unknown. No evidence that the casualties trapped within the pressure hull were recovered was found, and therefore there is a strong possibility that the wreck may contain human remains.
- 7.2.29 Despite the limited condition that the physical wreck displays, and the absence of key elements such as the conning tower, the wreck may be the best preserved example of a D-class submarine in existence. Further work may yet strengthen or rebut this argument.
- 7.2.30 The site is assessed as **Variable** for the above criteria as the submarine condition is fairly average for a wreck from the FWW. On the other hand it may be the best example in existence and its importance may be heightened following further work.

Potential

- 7.2.31 The survey only covered the upper part of the pressure hull and the study of the site would benefit from a survey at mudline level in order to better understand its condition.
- 7.2.32 Also the wreck is only partially exposed and the section that is buried may become exposed in future as the sand wave shifts. This would provide an opportunity to survey the stern of the submarine and shed light on the parts that are currently unaccounted for and verify the mine damage reported by the historical sources.
- 7.2.33 Further research could improve our understanding of technical details and particular solutions adapted for this specific submarine and there is some potential for study of this submarine as a representative example for the D-class.
- 7.2.34 Although the bow torpedo tubes and the torpedo loading hatch were found silted up it is likely that the mine explosion holed and flooded the pressure hull. Nonetheless, it is sensible to assume that human remains are still contained within the pressure hull and other material of historical significance might be contained as well, and it should go without saying that the submarine is to be treated as War Grave.
- 7.2.35 The site is therefore assessed as **Moderately Valuable** for the above criteria.

7.3 Summary

- 7.3.1 The site is identified as the wreck of HMS D5, a pre-war submarine lost in the outbreak of the First World War. HMS D5 is the only surviving example of a D-class submarine known in English Waters.

- 7.3.2 The D-class is a historically significant design and differed from the previous submarines built for the Royal Navy incorporating several technological innovations that were later repeated in subsequent submarine designs.
- 7.3.3 HMS D5 has a degree of historical significance because it was lost in action during the war and it is associated with the events, personalities and locations of the Yarmouth Raid. Also at the time of the sinking it was commanded by Godfrey Herbert whose actions later in the war had some consequences in the relationship between the German and British governments.
- 7.3.4 The site should be considered of special interest in the light of the anniversary of the FWW as part of the commemoration of British submariners who died trying to defend the British coast.
- 7.3.5 For the above reasons D5 must be considered particularly significant and it is considered to fully meet the criteria for designation.

8 CONCLUSION AND RECOMMENDATIONS

- 8.1.1 The survey led to the confirmation of the identity of the wreck as HMS D5. Its rarity and significance make it a possible candidate for designation.
- 8.1.2 The history of the sinking suggests that the wreck contains the remains of most, if not all of the 21 navy submariners that died, and the site could also be designated as protected place by the MoD under the Protection of Military Remains Act 1986.
- 8.1.3 Although the wreck conditions are not outstanding the pressure hull of D5 shows some significant features of the D-class and demonstrates a high level of robustness being made of steel. The potential for a large section buried at the W end of the submarine is confirmed by the diving survey.
- 8.1.4 The D5 is nationally significant both as rare example of D-class submarine and for the particular historical events that it is associated with, and the historical value of D5 is enhanced when appreciated within the context of the East Coast at War and the narrative of the local history of Great Yarmouth (Fjord 2014).
- 8.1.5 The character of the site is summarised in the following table, which focuses on seven topics for evaluating underwater wreck sites (Watson and Gale 1990, 183).

Table 6: Summary of site character, based on Watson and Gale 1990

Area and distribution of surviving ship structure	Approximately 40 metres long section of a submarine – identified as HMS D5.
Character of the ship structure	Fairly intact pressure hull of submarine – aft section buried or missing and not investigated. The conning tower is missing. No debris visible around the wreck.
Depth and character of stratigraphy	The submarine bow lies in a scour and is completely exposed whilst the area of the stern is completely covered by a sand wave. The interior of the submarine appears to be completely silted.
Volume and quality of artefactual evidence	The deck plating and most of the fixtures expected on deck are missing. There is no evidence of debris around the wreck.

Apparent date of the ship's construction and/or loss	HMS D5 (I.75) was laid at Yard no. 405 on 22 nd February 1910 by It was launched on 28th August 2010 and completed 19 th January 1912.HMS D5 hit a German mine and sunk during the Yarmouth Raid on 3 rd November 1914.
Apparent function	D-class was the first English overseas submarine able to carry out offensive operations in enemy waters.
Apparent origin	Vickers, Barrow for the Royal Navy.

- 8.1.6 It is recommended that the NRHE records for HMS D5 (monument no. 880008 and 1490366) are updated with the data from this survey that confirms the identity of the submarine. It is also recommended that UKHO record for the wreck of SS *Perth* (wreck no. 11050) is updated with the results from the survey.
- 8.1.7 There is scope for an informal monitoring and reporting routine by avocational divers to be established. An opportunity exists for Historic England to encourage the involvement for further reporting and information gathering by a member of Dive125 as he has declared his intention to continue to explore the wreck in 2017 and has said that he will collaborate with Historic England in this regard. It is suggested that a copy of this report should be sent to Dive125 and Mark Beattie-Edwards of the NAS. This may encourage Dive125 to share information with regard to this and other sites and help support his collaborative intentions.

9 ARCHIVE

- 9.1.1 The project archive consists of a hard copy file and computer records and is currently stored at Wessex Archaeology under project code 108280. The project archive will be transferred to the NRHE.
- 9.1.2 Shapefiles generated for the project comply with Marine Environment Data and Information Network (MEDIN) standards for metadata (Seeley *et al.* 2014).

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11 APPENDICES

11.1 Appendix 1: Dive Log

Dive	Date	Start Time	Duration*	Max. Depth (m)	Divers	Task
1002	08-09-2015	15:35	25	24	Croce	Site inspection
1005	22-09-2015	12:15	28	25	Croce	Investigation of the limits of the site

* Bottom time in minutes (time from diver left surface to diver left bottom; actual working time will be shorter)

11.2 Appendix 2: Site Risk Assessment

Wreck/Site Name	HMS D5		
NRHE / UKHO No.	EH Region	Restricted Area	Principal Land Use
1490366/11050	East of England	N/A	Coastland 1: Marine
Latitude (WGS84)	N 52° 36.322'		
Longitude (WGS84)	E 02° 1.606'		
Class Listing	Period	Status	
Submarine	WWI	D: Non-designed wrecksite	
Licensee	Nominated Archaeologist	Principal Ownership Category	
N/A	N/A	C: MoD	
Seabed Owner	Navigational Administrative Responsibility		
C: Crown	Unknown		
Environmental Designations			
G: None			
Seabed Sediment	Energy		
S: Sand	High		
Survival			
Medium			
Overall Condition	Condition Trend	Principal Vulnerability	
B: Generally Satisfactory	B: Declining	NAT	
Amenity Value: visibility			
A			
Amenity Value: physical accessibility		Amenity Value: intellectual accessibility	
A: Full		C: no interpretation	
Management Action	A: no action required		
Management Prescription	H, I, L		
Notes:			



The remains are identified as the bow section of HMS D5, British submarine of pre-war design lost during the First World War during the Yarmouth Raid on 3 November 1914.

The wreck is in fairly good condition although most of the fittings, external plating and fixtures are missing. However the conning tower is also not present and an area of potential damage was located aft. An assessment of the trajectory of the condition of the wreck is difficult considering that the Wessex Archaeology's survey is the first archaeological survey of the site. However it is possible that further areas of the wreck that are now buried will be exposed in the future as the mobile sand wave shifts.

It is possible that human remains are contained within the pressure hull and that the submarine is a War Grave. Wessex Archaeology is not aware of any management plan for the site and the MoD is to be considered the current owner of D5.

Risk Assessed is LOW.

Risk is assessed as:	Low		
Data Source	CON/OT	Date & Initials	Wessex Archaeology November 2014



11.3 Appendix 3: Anomalies Gazetteer

Notes

Positional accuracy estimated $\pm 5\text{m}$.

WA ID	Classification	Easting (UTM 31 N)	Northing (UTM 31 N)	Latitude (WGS 84 DDM)	Longitude (WGS 84 DDM)	Archaeological Discrimination	Length (m)	Width (m)	Height (m)	Magnetic Amplitude (nT)	Description
7000	Wreck	434093	5828816	N 52 36.322	E 02 1.606	A1	46.5	7.8	3	70	Large distinct outline of a vessel upright on the seabed. There is an area of scour immediately surrounding the vessel measuring approximately 26.5m by 13.5m. Several internal dark and bright reflectors could indicate structure. There is a linear object sticking out of the structure with a length of 8m by 1.8m. Height recorded as 2.7m in sidescan data. Seen as a slightly tilted intact vessel in the bathymetry data, partially embedded in an area of geology, measuring 38m x 6m x 3m. Position taken from the bathymetry data. There is a second flare of scour to the north-west of the vessel measuring 34mx20m. Wreck location not actually covered by mag data so the largest



WA ID	Classification	Easting (UTM 31 N)	Northing (UTM 31 N)	Latitude (WGS 84 DDM)	Longitude (WGS 84 DDM)	Archaeological Discrimination	Length (m)	Width (m)	Height (m)	Magnetic Amplitude (nT)	Description
											magnetic amplitude was taken from nearby data. Associated with UKHO record for SS <i>Perth</i> (possibly). Position has been independently dived and identified as a submarine, thought to be the real D5. The recorded UKHO position of the D5 is some 14km to the South West.
7001	Debris Field	434081	5828681	N 52 36.249	E 02 1.597	A2	13.2	1.6	-	-	Possible L shaped area of three clusters of small irregular dark and bright reflectors. Unclear if largest object is part of a sandwave formation. But the smaller look anomalous to the rest of the seabed. This position was not covered by bathymetry data or magnetometer data.



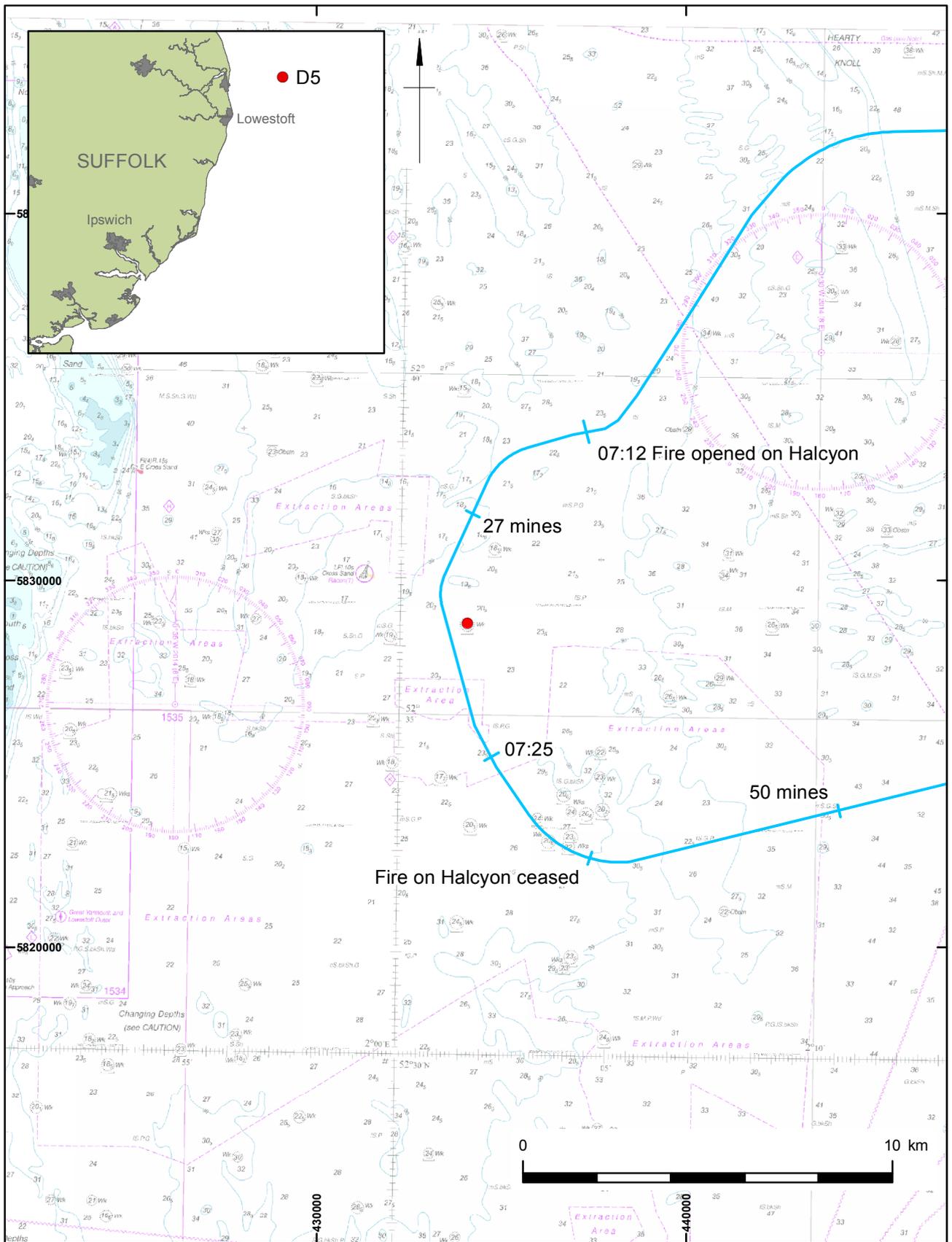
WA ID	Classification	Easting (UTM 31 N)	Northing (UTM 31 N)	Latitude (WGS 84 DDM)	Longitude (WGS 84 DDM)	Archaeological Discrimination	Length (m)	Width (m)	Height (m)	Magnetic Amplitude (nT)	Description
7002	Debris	434032	5828744	N 52 36.282	E 02 1.553	A2	3.7	2.9	0.5	-	Diamond shaped dark reflector, possibly hollow, with another dark reflector to the side. Height value of 0.5m is recorded from one of the lines. Not observed in the bathymetry data. This position wasn't covered by magnetic data.
7003	Debris Field	434094	5828825	N 52 36.326	E 02 1.607	A2	10	6.5	-	-	Irregular patch of round looking objects probably associated with the wreck. Not observed in the bathymetry data. No independent magnetic anomaly visible as obscured by magnetic value of the wreck.
7004	Dark Reflector	434114	5828941	N 52 36.389	E 02 1.623	A2	3	0.5	0.5	-	Rounded object with pointed bright shadow. Not observed in the bathymetry data. Not covered by the magnetometer data.



WA ID	Classification	Easting (UTM 31 N)	Northing (UTM 31 N)	Latitude (WGS 84 DDM)	Longitude (WGS 84 DDM)	Archaeological Discrimination	Length (m)	Width (m)	Height (m)	Magnetic Amplitude (nT)	Description
7005	Dark Reflector	433945	5828928	N 52 36.381	E 02 1.474	A2	4.7	2.9	0.5	-	Rounded object with corresponding shadow. Not covered by the magnetometer or bathymetry data.
7006	Dark Reflector	433957	5828932	N 52 36.383	E 02 1.484	A2	2.8	1.1	-	-	Small T shaped object in regular sandwaves. Not covered by the magnetometer or bathymetry data.
7007	Dark Reflector	434182	5828951	N 52 36.395	E 02 1.683	A2	4	0.8	-	-	Small thin rectangular object crossing sandwaves. Not covered by the magnetometer or bathymetry data.



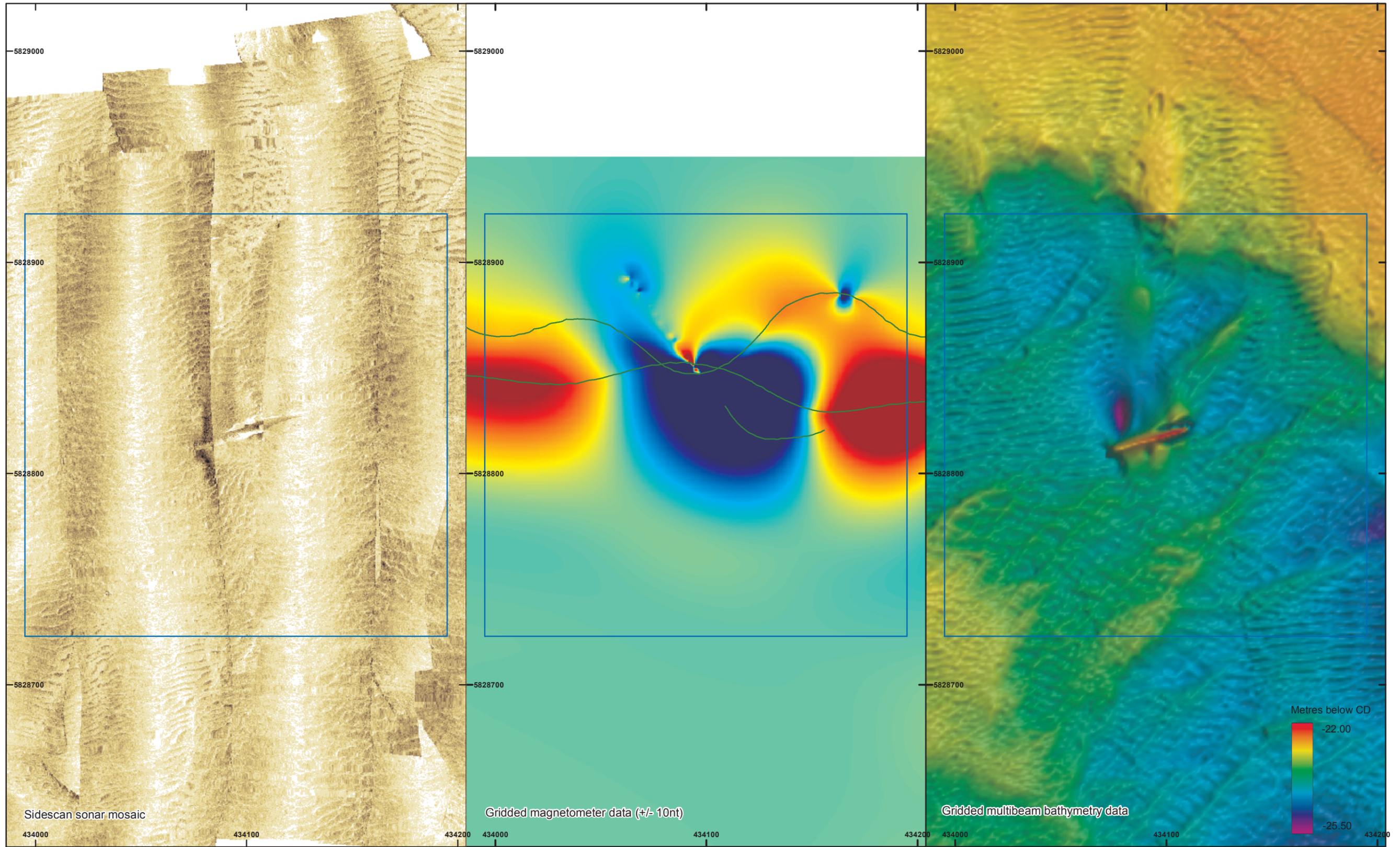
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7008	Mound	434114	5828880	N 52 36.356	E 02 1.624	A2	3	2.5	0.2	-	Identified in the bathymetry data only as a small mound located to the north of the wreck. Not covered by magnetometer data. Not observed in the sidescan sonar data.



Target location Course of German flotilla	Digital data sourced from Staff 2014 and prepared by WA Charts from MarineFIND.co.uk. © Crown Copyright 2016. All rights reserved. Licence No. EK001-0582-MF0050. This material is for client report only © Wessex Archaeology. No authorised reproduction.			
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Site location

Figure 1



Bathymetry data sourced from www.UKHO.gov.uk and contains public sector information, licensed under the Open Government Licence v2.0, from Maritime and Coastguard Agency. Image prepared by Wessex Archaeology. This material is for client report only © Wessex Archaeology. No unauthorised reproduction.

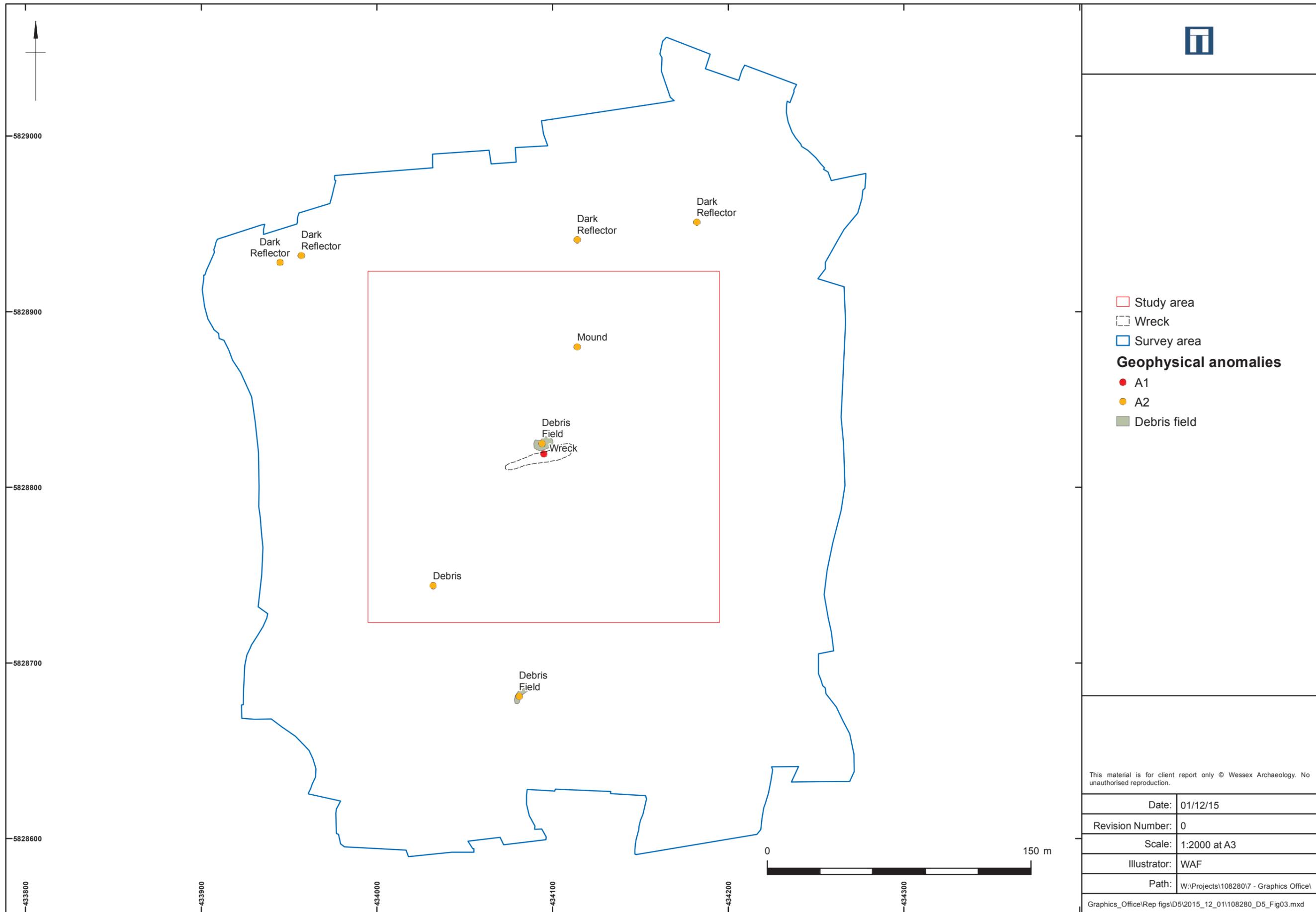
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Study area

Sidescan sonar mosaic, gridded magnetometer data and multibeam bathymetry data

Figure 2



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Anomalies of potential archaeological interest

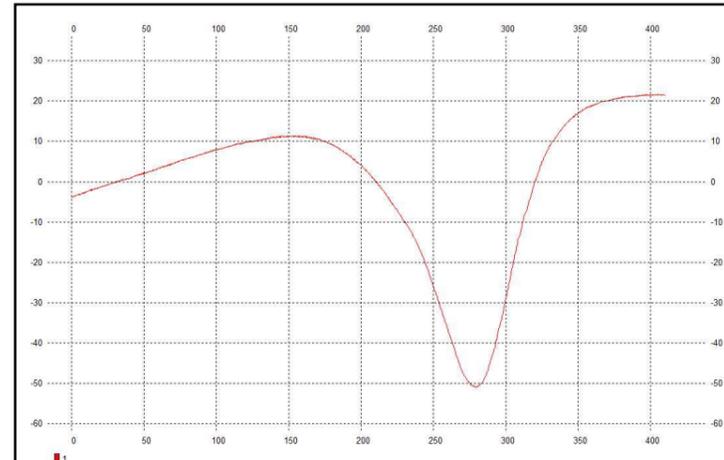
Figure 3

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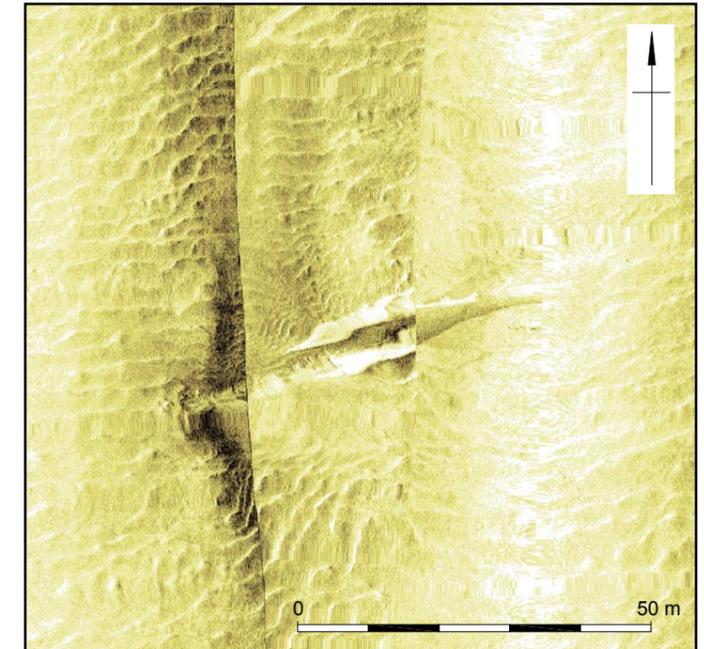
HMS D5

UKHO 11050

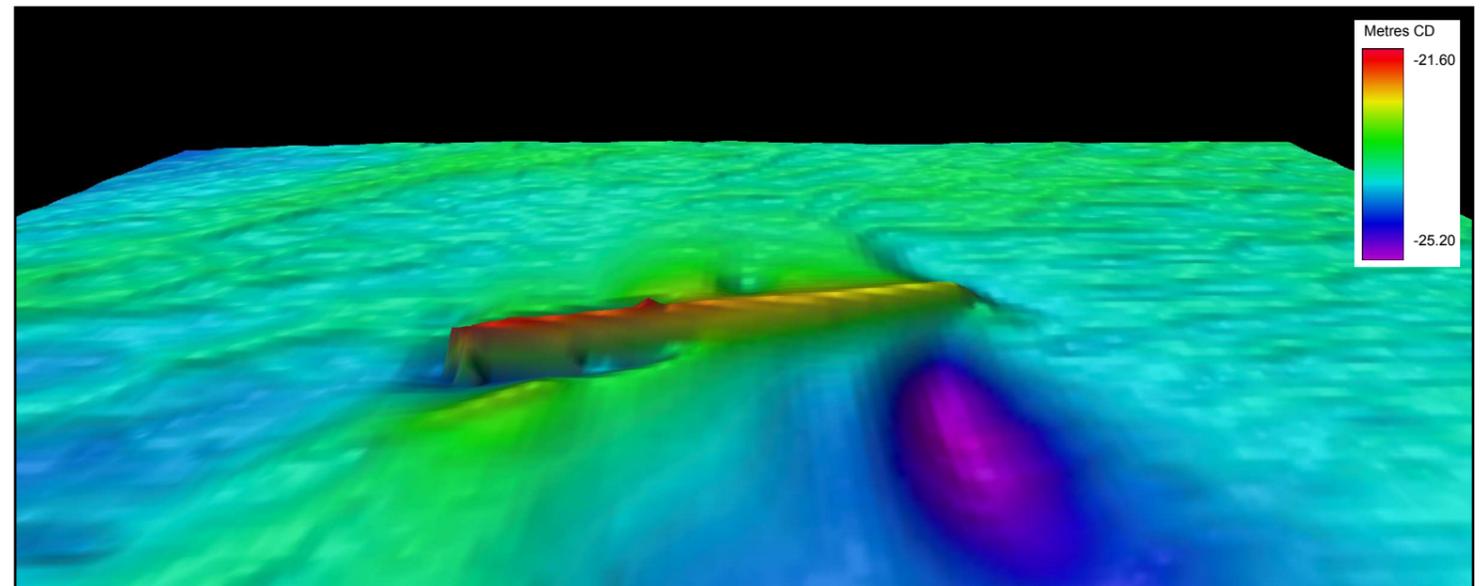
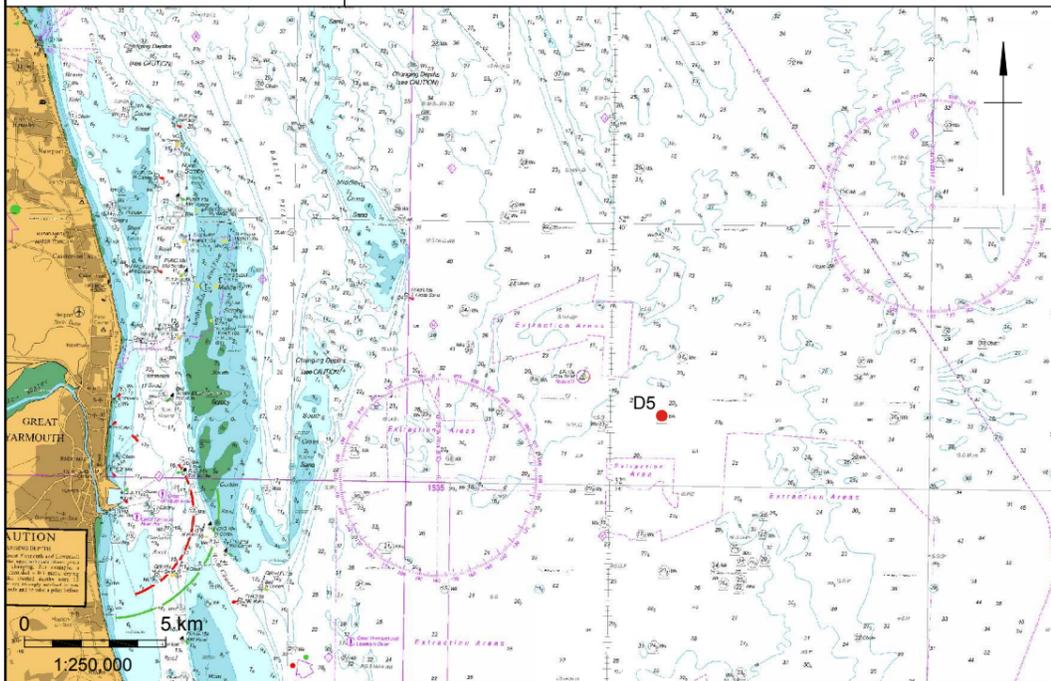
Location		434093 E, 5828816 N (UTM31N)
Archaeological Importance		High
Geophysical survey dimensions and notes		<p>Dimensions: 46.5m x 7.8m x 3.0m.</p> <p>Long, thin outline of a vessel, interpreted as an upright submarine due to presence of conning tower, observed immediately surrounded by scour measuring 26.5m x 13.5m. The vessel was observed with dimensions of 46.5m x 7.8m in sidescan sonar data. The vessel was observed in the multibeam bathymetry data as 38m x 6m. The vessel is orientated NE-SW with some structure visible.</p> <p>A linear object is observed sticking out of the structure with a length of 8m x 1.8m. There is an associated magnetic amplitude of 70nT, not obtained directly over the wreck, and therefore is a minimum value.</p>
Build	Type	British Submarine
	Construction	Steel
	Dimensions	162ft x 21ft x 11ft
	Shipyard	Vickers, Barrow-in-Furness
Loss	Cause	Lost after striking a mine 3rd November 1914
Extent of Survival		<p>Has been independently dived and identified as the D5.</p> <p>Distinct outline of a submarine, observed in the multibeam bathymetry data with the north east end of the vessel embedded in an area of geology. This vessel could have been further exposed before the sidescan sonar data acquisition. The multibeam bathymetry indicates sediment build-up around the vessel, however debris was observed around the vessel in the sidescan sonar data, which further supports this movement of sediment.</p>



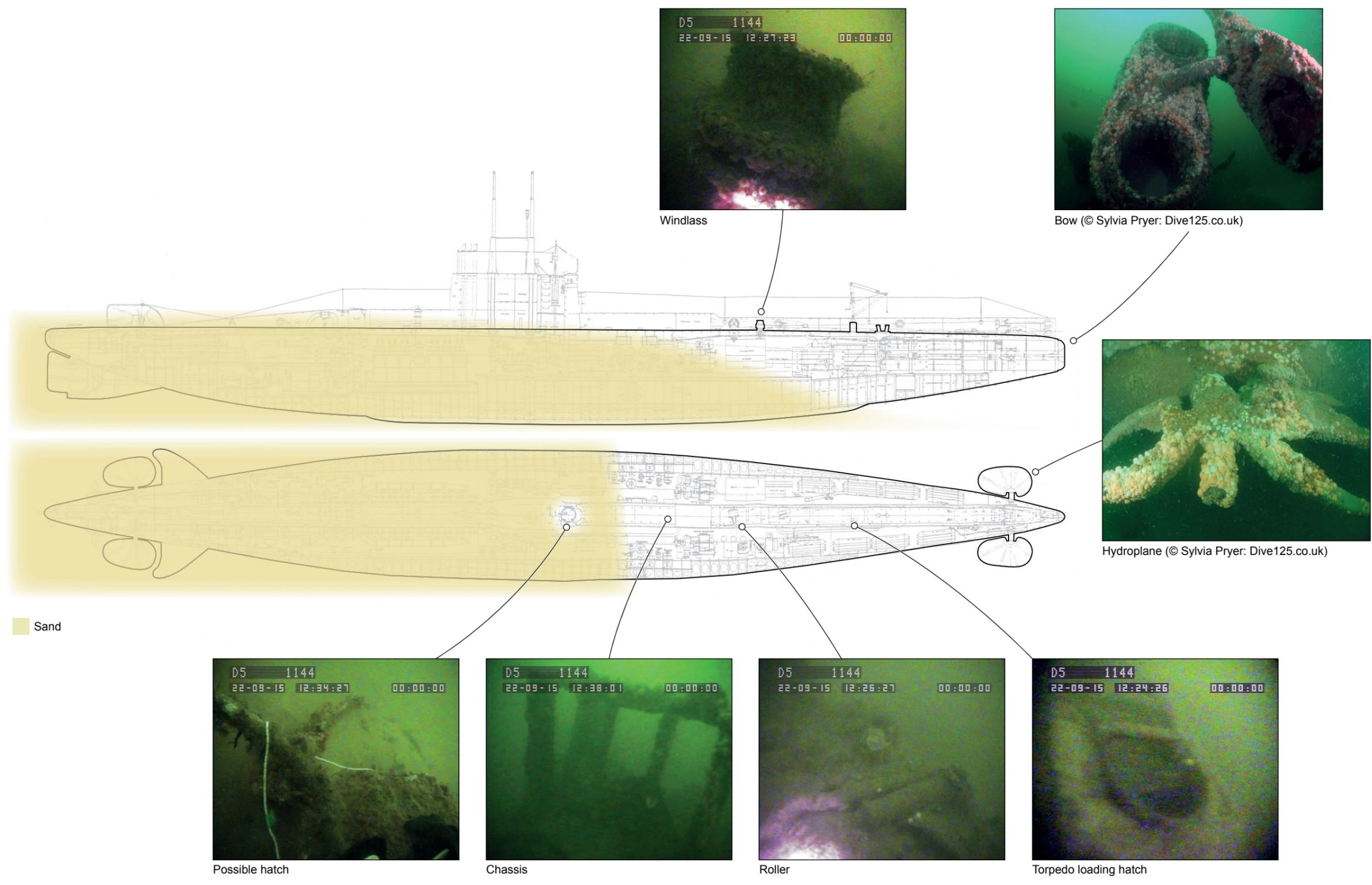
An image of magnetometer profile alongside the D5, 70nT



A sidescan sonar mosaic image of the D5, 46.5m x 7.8m x 3.0m



A multibeam bathymetry image of the D5, facing south, 1x vertical exaggeration



Technical Drawing is taken from BR3043, 1979
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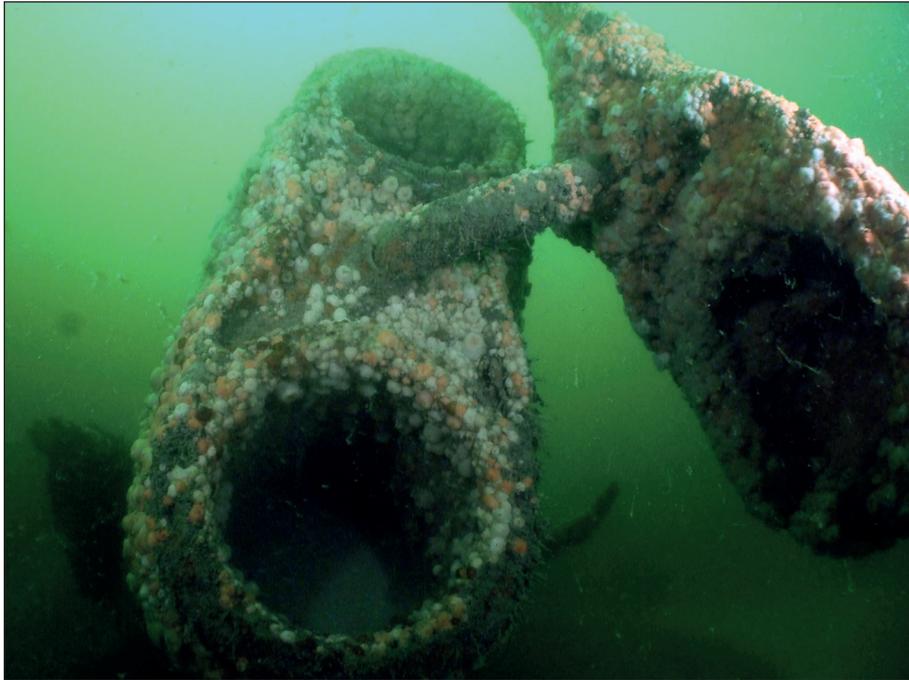


Plate 2a: Bow torpedo tubes arrangement (© Sylvia Pryer: Dive125.co.uk)

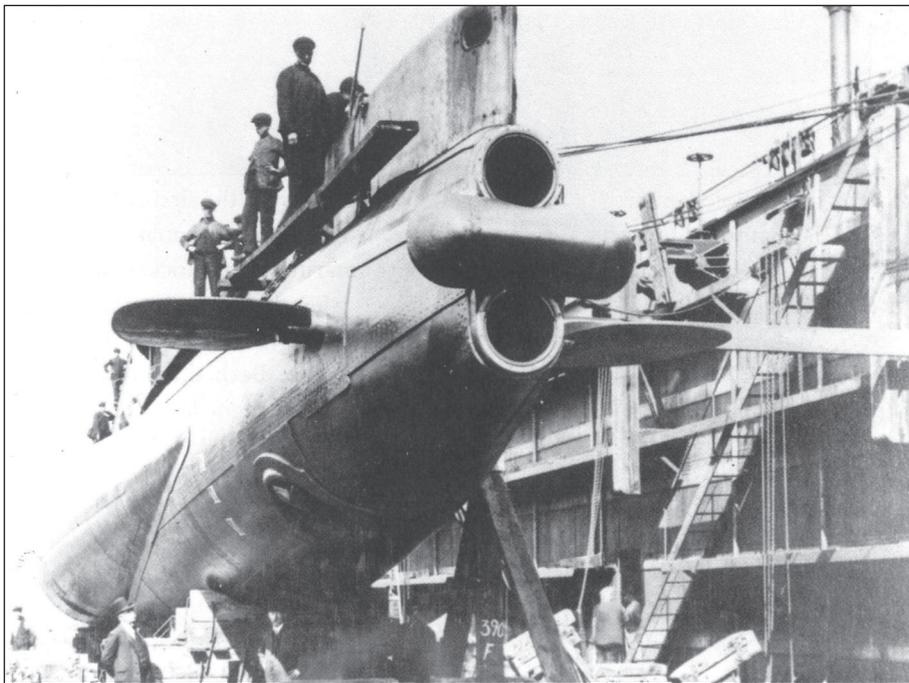


Plate 2b: A view of a D-Class submarine in dry dock. (Tall 1996)

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



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