Wessex Archaeology

Diamond, Cardigan Bay

Designated Site Assessment:

Full Report

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ARCHAEOLOGICAL SERVICES IN RELATION TO THE PROTECTION OF WRECKS ACT (1973)

DIAMOND, SARN BADRIG, CARDIGAN BAY

DESIGNATED SITE ASSESSMENT: FULL REPORT

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DESIGNATED SITE ASSESSMENT: FULL REPORT

Summary

Wessex Archaeology was commissioned by CADW to undertake a designated site assessment of the *Diamond*: a designated wreck site located on the underwater reef of Sarn Badrig (St Patrick's Causeway), Cardigan Bay, Wales. The work was undertaken as part of the Contract for Archaeological Services in Relation to the Protection of Wrecks Act (1973).

The brief required Wessex Archaeology to undertake a baseline survey of the site, and to assist the licensee to recover timber and sheathing samples.

Diving operations were conducted between 1st and 11th June 2004. Approximately 90% of a baseline survey to Recording Level 3a was completed during the time allotted. This involved the survey of a total of 94 archaeological features. All surveyed features have been given geo-referenced positions, photographed and recorded using hand measurements and/or text descriptions. In addition, timber and sheathing samples were recovered by excavation and the type of hull construction was identified.

The site represents the remains of a 19th Century wooden framed merchant vessel with iron hull reinforcements and what are probably iron water tanks. The vessel was approximately 44 metres long, which suggests a ship of about 500-800 tons. It is clear from this survey that the vessel is not 'composite' in the normally accepted meaning of the term, rather it is a wooden vessel with some iron re-enforcing.

The probable recovery of a cuprous bolt with a Muntz Metal stamp, and the probability that the vessel was at least partially sheathed in Muntz Metal, indicates that the vessel was probably lost no earlier than 1832. Whilst identification of the wreck as the *Diamond* is still possible, it appears to be an increasingly untenable theory.

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Acknowledgements

This investigation was commissioned by English Heritage on behalf of CADW as part of the Contract for Archaeological Services in Relation to the Protection of Wrecks Act (1973). The assistance provided by Sian Rees of CADW is gratefully acknowledged.

Wessex Archaeology would also like to thank the following people:

- Ian Cundy, the current Licensee, for information concerning site conditions and suitable harbours, together with full access to his own research (including a number of sources listed in the bibliography) and active co-operation during fieldwork.
- Mr Tony Iles, who originally discovered the site, for a copy of his site sketch plan and information concerning artefacts recovered from the site prior to designation.
- Mr Mike Bowyer, the former Nominated Archaeologist, for information concerning diving conditions and suitable harbours.
- Hafan Pwllheli, for logistical support.
- Mr C Holyhead, for diving operations support and information.
- Mr Peter Holt, of Sonardyne, for assistance with the diver tracking system.

The fieldwork was carried out by Graham Scott, Simon Adey-Davies, Jenny Black, Jens Auer and Frank Mallon. Graham Scott supervised the fieldwork, Graham Scott and Simon Adey-Davies supervised the diving and Jenny Black operated the diver tracking system. The report was compiled by Graham Scott and edited by Steve Webster. Kitty Brandon prepared the illustrations, and the project was managed for Wessex Archaeology by Steve Webster.

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- Digital use of Chart No. 1971

A copy of the report will be sent to UKHO.

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DESIGNATED SITE ASSESSMENT: FULL REPORT

1. INTRODUCTION

1.1.1. This document constitutes a Designated Site Assessment: Full Report for a programme of archaeological work undertaken as part of the Contract for Archaeological Services in Relation to the Protection of Wrecks Act (1973). The document has been prepared by Wessex Archaeology (WA) for CADW. It constitutes an assessment of the *Diamond*: a designated wreck site located on the underwater reef of Sarn Badrig (St Patrick's Causeway), Cardigan Bay, Wales (**Figure 1**).

1.1.2. The work was conducted in accordance with a verbal brief provided by CADW. Diving operations took place between the 1st and 11th June 2004. All diving took place from the diving support vessel *Xplorer*.

1.1.3. A glossary of terms used in this report is included in **Appendix I**.

2. OBJECTIVES

2.1.1. The overall objective for site operations as defined by CADW was for recording to Level 3, and to support the work of the current licensee, Mr Ian Cundy. This level is defined in the following table:

Level	Type	Objective	Sub-level	Character	Scope
3	In situ	A record that enables an archaeologist who has not seen the site to comprehend its components, layout and sequences.	**3a**	Diagnostic	A detailed record of selected elements of the site.
			3b	Unexcavated	A detailed record of all elements of the site visible without excavation.
			3c	Excavated	A detailed record of all elements of the site exposed by open excavation of part or whole of the site.

2.1.2. This was further defined after consultation with Mr Cundy, specifying the following tasks:

- preparation of a geo-referenced site plan showing the location of the main exposed vessel features;
- photographic and measured survey of all exposed features located;
- searches of the area to the WNW and ESE to determine the length of the site;
- seabed profiles across the long and short axes of the site;
- recovery of three sheathing and five timber samples, if necessary by limited excavation;
- preparation of monitoring photographs.

2.1.3. Following initial general visual inspection of the site, it became apparent that suitable timber samples could not be recovered without excavation and that excavation would probably enable information concerning the structure of the vessel to be recovered. This was therefore added as a secondary objective.

3. EXISTING SITE DATA

3.1.1. The position of the centre of the designated site as given in the SI is as follows:

Lat.	**52º 46.531' N**
Long.	**04º 11.025' E**
WGS 84	

3.1.2. The statutory instrument number for the site is 2002 No. (W.), and from the centre point (given above) the designated area consists of a circle with a radius of 200 meters. The current Licensee is Mr Ian Cundy (henceforth described as the Licensee) of the Malvern Archaeological Diving Unit, a team of avocational sports divers who undertake archaeological work on shipwrecks. There is currently no Nominated Archaeologist because it is understood that CADW regard the Licensee as having sufficient experience and knowledge to operate without such assistance.

3.1.3. Documentation available prior to the assessment was as follows:

- UKHO data for the site;
- A copy of the Licensee's site archive, together with his advice concerning diving conditions and suitable harbours. The Licensee's archive contained a detailed sketch plan of the site prepared by Mr Tony Iles;
- Advice from Mr Mike Bowyer concerning diving conditions and suitable harbours. Mr Bowyer, who was nominated archaeologist for the Licensee in 2003-4, stated that he was undertaking research into the site, particularly in the USA. WA did not have the opportunity to examines this research data and has no information about prospective plans for their publication.

3.1.4. The following documentation was received after the completion of fieldwork:

- The Licensee's 2004 Annual Report;
- photographs of the Muntz metal stamped bolt that has been recovered from the site;
- wood sampling report;
- sheathing sampling results;
- a copy of the ADU archive.

3.1.5. Prior to the commencement of the WA survey, data from the site was limited, with the result that a number of mistakes in the interpretation of the vessel appear to have been enshrined in the site literature. These include:

- The form of the hull construction of the wrecked vessel. Persistent claims had been made concerning the presence of iron frames and the vessel had therefore interpreted as composite by the ADU;
- Identification of the vessel as the *Diamond*. The vessel had initially been identified as being probably the *Diamond*. Subsequently this had been challenged.

4. METHODOLOGY

4.1.1. The site was assessed as follows: A geo-referenced site plan was produced by tracked diver survey using a Sonardyne Prospector LBL acoustic positioning system. Positions of archaeological features were obtained by holding or floating the transponder beacon immediately above each feature. The distribution of ballast was plotted by tracking the diver around any recognisable ballast spreads.

4.1.2. Searches were undertaken in order to define the western and eastern boundaries of the site using a semi-circular technique recorded by tracked diver survey.

4.1.3. All archaeological features located were positioned, tagged, photographed and described. Due to limited bottom time only selected features were measured using hand tapes.

4.1.4. A total of three sheathing samples were taken from exposed sheathing using hand tools. Sample size was the smallest practicable. After being photographed these samples were then given to the licensee who arranged chemical composition analysis at the School of Earth, Ocean and Planetary Sciences at Cardiff University.

4.1.5. Insufficient timber was exposed for sampling, therefore it was necessary for two one metre square sampling trenches to be excavated. Excavation and back-filling of the trenches was achieved by hand fanning.

4.1.6. Small finds were recorded and then reburied in the trenches. Both trenches were fully recorded at both pre-disturbance and maximum-excavation stages using still photography, 1:10 scale plans, section drawings and text descriptions. Trench locations were selected to maximise the variety of timber samples available for selection and to obtain maximum information concerning the structure of the hull. However, trench size and depth were kept to the minimum necessary for sampling. The identification of sample sites and the sampling itself was undertaken by Mr Nigel Nayling of Lampeter University opperating as part of the WA dive team.

4.1.7. Four profiles were recorded across and along the site. Depth measurements were recorded at metre intervals along a tape positioned by tracked diver survey, and a video mosaic of each profile tape was prepared.

4.1.8. No specific monitoring photographs were taken, as the general photographic record of the archaeological features was considered sufficient for this purpose. Suitable monitoring points have been recommended on the basis of the general site investigation work.

4.1.9. A total of five divers were available, with one diver in the water per dive, in accordance with normal surface supplied diving practice. Diving was rotated between all five divers. The work of the diver was directed from the surface by the diving supervisor, usually with the assistance of an archaeological recorder who was responsible for entering data in DIVA and operating the diver tracking system.

4.1.10. Initially a Prospector array was deployed to enclose the whole site. As a result of unreliable tracking in variable areas of the site, probably caused by line of sight problems, a total of five different arrays were used. Technical difficulties with the system also resulted in the total or partial loss of tracking capability during dives 157-161.

4.1.11. Full digital colour video footage of the diving operations was recorded using a diver hat-mounted Colourwatch 306 single chip digital inspection camera recording onto digital videotape. The image produced by this system was displayed in real time on a surface monitor for the use of the diving supervisor and archaeological recorder.

4.1.12. Archaeological features were measured using hand tapes and photographed using either a Canon G2 digital camera with 0.56 wide-angle adaptor lens and using natural light or strobe flash, or by 'snatching' still images from the Colourwatch system. Photographs were processed using Paintshop Pro 7 software to remove colour casting and improve contrast.

4.1.13. Depth measurements for the profiles were recorded using a hand held depth gauge reading intervals of 0.1m. All depth measurements are not absolute and are not therefore directly comparable, the primary purpose being to record the seabed profile, rather than absolute depth. Video mosaics were prepared and are available for all profiles. Due to their size and relatively low resolution, they are not reproduced in this report.

4.1.14. Data gathered by the diver was recorded in real time using hard wire surface communications and entered into an MS Access database. This database was linked to the diver tracking system, and tracking information acquired by that system was displayed in real time using ArcPad for the use of the diving supervisor and archaeological recorder.

4.1.15. Most features were tagged using circular yellow plastic survey tags incised with the unique feature number made up of WA and then a two-digit number, with **WA01** being the first feature tagged. Features were tagged in the order that they were located (**Appendix III**). The existing numbering system used by the Licensee was not followed because it was not known whether tags were still *in situ*. Tags were secured to the features using heavy-duty cable ties. This method of tagging features was considered to offer the best compromise in terms of speed, survivability and readability, and feedback will be sought from the Licensee following his diving operations in both 2004 and 2005.

4.1.16. Details of the methodologies used during the 2004 PWA survey are detailed in a separate document (WA 2003b). All work was carried out in accordance with the relevant guidance in the Standards and Guidance papers of the Institute of Field Archaeologists.

5. RESULTS

5.1. SITE POSITION

Lat.	**52º 46.534' N**
Long.	**04º 11.021' W**
WGS 84	

5.1.1. The above position is for the centre point of the known site. It represents the mean position of all of the archaeological features recorded by tracked diver survey (with the exception of **WA92** and **WA93**, which lie outside of the site). It has been converted from UTM using Quest Geodetic Calculator Version 2.4.1.

5.1.2. In addition the following position was obtained for the north-eastern corner of **WA46**, an iron box interpreted as a probable water tank. This position was given for the site in the Preliminary Report to CADW (WA 2004).

Lat.	**52º 46.53232' N**
Long.	**04º 11.03010' W**
WGS 84	

5.1.3. Due to the use of more than one Prospector array and the limited number of repeat position fixes that could be taken in the time available, it is not possible to give average positions for the features surveyed or to reliably estimate the accuracy for individual position-fixes. Nevertheless it has proved possible to screen out some as probably unreliable. Furthermore the analysis conducted during the post-excavation does suggest that average accuracy is unlikely to be worse than +/- one metre.

5.2. DIVING CONDITIONS

5.2.1. Fieldwork took place over a period on 11 days at the beginning of June 2004. This coincided with a period of generally settled weather of unusual length (Tony Iles, pers. comm.). As a result only two operational days were lost to adverse weather (winds of Force 5 and above), and a total of 1839 minutes bottom time was achieved. One day was utilised for non-diving operations. Dive details are listed in **Appendix I**.

5.2.2. The sea-state varied from calm to moderate during the period of operations, and the diving operations were not affected by swell. Recorded visibility varied from 2-10 metres, allowing for full and effective use of still and video photography.

5.2.3. Strong tidal currents are experienced at times on Sarn Badrig (**Appendix X**). These run from south to north on flood tides and from north to south on ebb tides. They can reach in excess of one knot, particularly in the area close to the eastern end of the reef, where a narrow passage exists between the reef and the present shoreline. Reliable data concerning the strength of the flow in the vicinity of the site does not appear to exist, but WA followed advice received from Mr Cundy and Mr Bowyer (pers. comm.) and where possible dived in mid-tide. As a result diving operations

were not significantly affected by tidal currents, although divers did experience some difficulty at times.

5.3. GEOLOGY, TOPOGRAPHY AND FLORA

5.3.1. The site is situated on the northern side of the underwater reef of Sarn Badrig (St Patrick's Causeway). It lies close to the top of the reef, and approximately four kilometres west of the present shoreline.

5.3.2. Sarn Badrig is one of three low, smooth topped ridges within Cardigan Bay that project seaward for up to 15 kilometres at the sea bed level. These ridges or reefs are covered by gravel, cobbles and boulders, and are formed of clast-supported, clayey diamictons (Tappin, 1994). Garrard and Dobson (1974) inferred that the ridges were the remnants of late glacial median moraines of piedmont glaciers extending from the valleys in the adjacent Cambrian Mountains. However, this interpretation has been questioned and an alternative explanation is that the ridges are the remnants of late-glacial sandur (Tappin, 1994).

5.3.3. Sarn Badrig itself extends for approximately 15 kilometres south-west of Mochras Point. It forms the boundary between the largely flat-bottomed Tremadoc Bay and Barmouth Bay. Parts of the ridge are dry during Low Water Spring (LWS) tides.

5.3.4. In the area of the wreck the seabed shelves very gently to the north across the site. The depth recorded at the northern end of Profile 2 (**Figure 2**) was 7.9 metres, whereas depth recorded at the southern end was 7.8 metres. There is little variation in depth along the east-west axis of the site.

5.3.5. The seabed consists of poorly sorted coarse sand, with fine-medium gravel, cobbles and some small boulders. Examination of the remains of black bream 'nests' within the area surveyed and the results of excavation, demonstrates that 0.05-0.15 metres below this is there is a poorly sorted layer with a larger component size of coarse gravel and cobbles with darker coarse sand. The thickness of this layer is unknown.

5.3.6. No survey of site flora was undertaken due to time constraints. An irregular cover of low marine flora (seldom exceeding a height of 0.15-0.20 metres) was noted over most hard surfaces, except where disturbed by black bream 'nests'. Some rough cutting of flora was necessary in order to photograph a small number of the archaeological features, but generally the environmental impact of WA operations appeared to be minimal.

5.3.7. Evidence of the remains of black sea-bream 'nests', comprising shallow scoops in the seabed up to 0.20 metres deep and approximately 1.00 metres diameter, were observed on the south and western sides of the site. Although the absence of marine growth suggested that these 'nests' were of recent construction, they did not appear to be active and no schools of juvenile fish were noted. Local advice was obtained, which suggested that the timing of diving operations was unlikely to impact breeding.

5.3.8. Black sea-bream spawn from April through to early July along the reefs of the English Channel, off the Cornish coast, and especially over the shallow reefs of Cardigan Bay in Wales. It is a 'nest' builder and favours sand and gravel patches and

depressions amongst boulders and rocky reefs in shallow water. The male guards the eggs until they hatch. Thereafter the small bream form schools over the nest area for the first few weeks before venturing further (Irving, 1998).

5.4. ARCHAEOLOGICAL FEATURES SURVEY

Distribution

5.4.1. A total of 94 archaeological features were located, tagged and surveyed. A summary description of these is given in **Appendices III** and **IV**. Further descriptions are available in the project database. The distribution of all tagged features is shown in **Figure 2**, together with the position of the ballast mound. **Figure 3** shows a sketch plan of the site prepared by Mr Iles prior to designation.

5.4.2. All of the surveyed features are contained within an area that measures approximately 52 metres east-west and 20 metres north-south (i.e. an area of 1040 square metres). Within that the main area of the site consists of a slightly irregular flattened oval that is very approximately 44 metres long by 10 metres wide (**Figure 2**). The long axis of this oval is orientated approximately east - west. Most of the iron features and cuprous sheathing lie around the edges of this oval. Most of the remaining archaeological features, including the ballast mound and iron boxes lie within the oval. Isolated areas of features were observed outside of this area. A general view of features located on the southern periphery of the site is shown in **Plate 1**.

5.4.3. The oval is interpreted as roughly defining the outline of the hull of a timber sailing vessel. The 'L-shaped' iron features are interpreted as structural iron supports for wooden futtocks, and many appear to be *in situ*. These features define the sort of shape that might be expected if they were from the lower hull of a wooden ship.

5.4.4. No further archaeological features were detected to the west north west and east south east of the oval, despite detailed searches. The archaeological features outside of the oval are probably the remains of ship structure or fittings that have collapsed outwards.

Knee-riders and other Iron Reinforcement Features

5.4.5. A total of 53 L-shaped iron artefacts or possible fragments thereof were observed. Although the pattern is somewhat complicated a pattern of two alignments defining the northern and southern outer edges of the vessels hull can be discerned (**Figure 2**). Many of the features are lying on the seabed unburied and are therefore probably not *in situ*, however their weight is such that most are likely to be close to their original position.

5.4.6. The features appear to be the remains of knee-riders – iron reinforcements attached to the inner face of the frames of a wooden ship. Typically they are 'L-shaped' with a long inwardly curving lower arm and, at one end, a short straight upper arm attached at the top end of the inner face of the long arm and set at approximately 90 degrees to it. Many are fragmentary and are apparently missing the short arm and part of the curved arm.

5.4.7. They have a narrow, square or rectangular cross section, and some have evidence of penetrating cuprous or iron bolts in the long arm or have round holes that are

suggestive of this. **Plate 2** shows two examples of *in situ* features of this type from the northern alignment. Although the short arms are now missing, these *in situ* features demonstrate that they were vertically aligned and that the curved arm is the lower arm and the straight arm is the upper arm. The curve faces south and the straight arm would have pointed across the site towards the southern alignment. It is not known whether these features are made of wrought or cast iron. Selective examples of these features are described in the following paragraphs.

5.4.8. **WA01** is a long iron bar that lies on its side at the western edge of the site (**Figure 2**) and may be buried at one end. Length is obscured by the presence of **WA73** lying across this end, but the visible length is 2.35 metres. The section is rectangular, 0.17 by 0.15 metre, and the bar is fully penetrated by a probable bolt fragment that is 0.55 metres long.

5.4.9. **WA13** (**Plate 3**) is possibly the best-preserved example of this type of feature on the site. It is an 'L-shaped' iron bar with a long curving arm and a short straight arm. It lies on its side on the northern edge of the site (**Figure 2**), and is partially buried. The extremities, the bottom end of the long arm and the inner end of the short arm, are buried but otherwise the feature is suspended mid-water. Approximately 4.8 metres of the long arm is exposed and approximately 0.74 metres of the lower arm is exposed.

5.4.10. The feature is heavily concreted but the section appears to be square, approximately 0.15 by 0.15 metre. Approximately 1.0 metre from the top of the long arm on the outer face is a protruding concreted iron bolt, which is approximately 0.48m metres long and may therefore be fragmentary. This probable bolt penetrates the long arm and protrudes from the inner face by approximately 0.02 metres. It has a diameter of 0.03 metres. A second more fragmentary probable iron bolt penetrates the long arm 0.75 metres from the junction with the short arm. This bolt has a diameter of 0.06 metres but is more heavily concreted.

5.4.11. **WA18** and **WA19** (**Plate 2**) are heavily concreted curved iron bars set vertically in the seabed close to the mid-point of the northern edge of the site (**Figure 2**). They have a rectangular section to **WA13** and have a similar curved profile to the long arm of **WA13**, with the inner curve facing approximately south. The section measurements of **WA18** are 0.16 metres sided and 0.8 metres moulded and for **WA19** they are 0.15 metres sided and 0.10 metres moulded. **WA18** has an exposed length of 2.84 metres, and **WA19** is slightly shorter. They are interpreted as the long arms of 'L-shaped' iron knee-riders. They are unusual in that they appear to be *in situ*, although both lean towards the north (outboard) and both are missing their short arms.

5.4.12. **WA35** (**Plate 4**) is a concreted iron bar with a similar rectangular section to **WA18** and **WA19**. Its length is 2.48 metres, and its section measurements are 0.12 metres sided and 0.08 metres moulded. It is not buried and lies on the seabed close to the eastern extremity of the site. It is penetrated by three probable bolts of uncertain composition. The diver reported that they appeared to be iron but could also be cuprous alloy. **Plate 4** suggests that they may be concreted (and are therefore probably iron). Bolt diameter is 0.03 metres, although one bolt had evidence of a head of 0.06 metres diameter. The feature is interpreted as a fragment of the long arm of an L-shaped knee-rider that is not *in situ*.

5.4.13. **WA54** (**Plate 5**) is a concreted iron bar that lies on the southern edge of the site close to Trench 1 (**Figure 2**). It is partly buried and almost vertical (with a slight lean to the south), that is perpendicular to the long axis of the site. The exposed length is 0.76 metres, with a rectangular section of 0.17 metres moulded by 0.11 metres sided. A length of cuprous sheathing orientated along the long axis of the site is exposed less than 1.0 metre to the south of this feature. This is interpreted as the partial remains of a knee-rider

5.4.14. **WA55** (**Plate 6**) is situated on the edge of Trench 1, and is very similar to **WA54** (see above). It is a upright, concreted iron bar that is located on the southern periphery of the site (**Figure 2**). An approximately 1.0 metre length of the object is exposed. It has a subtle curve, with the inner curve facing approximately north. Just above the seabed it is penetrated by a cuprous bolt. The excavation of Trench 1 revealed that it is resting on the inner, sided face of a vertical timber that is interpreted as being a futtock (frame). The futtock does not survive above the level of the seabed but it appears likely that it originally continued upwards and that the cuprous bolt secured the iron bar to the timber. The iron bar appears to have similar dimensions to **WA13** and is therefore interpreted as a fragment of an *in situ* knee-rider, with the upper section of the long arm and the short arm missing.

5.4.15. **WA64** (**Plate 7**) is a long curved iron bar that lies on its side and is not buried. It is situated towards to south-western edge of the site (**Figure 2**). It is approximately 3.05 metres long and has a similar profile to **WA13**. It is penetrated by two probable cuprous bolts. It is interpreted as a fragment of the long arm of an knee-rider that is not *in situ*. The short arm appears to be missing.

5.4.16. **WA40** (**Plate 8**) is a sharply curved, concreted iron bar. It is lying on its side and is not buried. It is 1.85 metres long with a moulded dimension of 0.15 metres and sided of 0.09 metres (including concretion). No penetrating bolts were observed. This may be a fragment of the long arm of a knee-rider that is not *in situ*, although the curve is more pronounced than usual.

5.4.17. **WA33** (**Plate 11**) is a 'Z-shaped iron bar'. It lies on its side, on an area of ballast close to the eastern end of the site (**Figure 2**), and is not buried. It has a long straight arm approximately 2.50 metres long (long face) and two short straight arms, approximately 0.40 and 0.25 metres long. The feature is concreted but has a rectangular section measuring 0.15 by 0.11 metres. The angle of both bends is approximately 45º. The interpretation of this feature is uncertain but it may be an unusual knee-rider or breasthook reinforcement, or fragment thereof (it appeared to be broken at the short arm end). It is not apparently *in situ*.

5.4.18. **WA88** (**Plate 15**) is a 'W-shaped' iron bar. It lies unburied on the seabed to the west of **WA33** (**Figure 2**). It has two straight long arms, measuring approximately 1.21 metres and 1.86 metres long (measured on the outer face). The angle between the arms is approximately 135º and the distance between the tips of the arms is approximately 2.90 metres. The feature is concreted but appears to be rectangular in section, with measurements of 0.09 metres wide by 0.13 metres deep. It is interpreted as a the iron reinforcement for a wooden breasthook, which is not *in situ*. Similar shaped features were noted *in situ* on the wreck of the *Jhelum* (Stammers and Keaton, 1992; 63 and 118)

5.4.19. The 'L-shaped' features and fragments thereof are interpreted as knee-riders on the basis that:

- **WA55**, interpreted as part of a long lower arm, is attached to the inner, sided face of a futtock;
- **WA13** has the full characteristics of a knee rider;
- the alignment of the features defines the north and south edges of the site, along what would have been the long axis of the vessel, and therefore the features are correctly positioned for knee riders.

5.4.20. An alternative explanation for those iron bars without short arms or not obviously set vertically *in situ*, particularly for those with a more obviously rectangular profile is that they could be part of a diagonal or other strapping system for the lower hull. However, this is considered to be less likely than the knee rider explanation.

Other Iron Features

5.4.21. **WA10** (**Plate 9**) is a metal cylinder, described by the diver as being concreted iron. It stands vertically, is part buried and appears to be *in situ*. Approximately 0.55-0.65 metres of the object is exposed above the seabed. The feature is hollow and the opening on the top surface has a diameter of 0.07m and has an internal lip. Circumference at the base is 0.80m and diameter at the top is 0.22m.

5.4.22. The object is associated with two smaller diameter cylinders (approximately 0.07m) that are offset at 90% to it on opposite sides of the vertical cylinder. The feature lies very close to **WA46** (**Figure 2**). Interpretation is uncertain, but it may be part of the pump equipment carried by the vessel, particularly as the feature is situated approximately midway along the long axis of the site. This is roughly where the pumps might be expected if the visible extent of the site represents the original length of the vessel.

5.4.23. **WA27** is a large iron box on the northern edge of the site (**Figure 2**). It is partly buried, but is exposed to a height of approximately 1.04 metres. It is rectangular in form, with flat iron plate sides and upper surface, except for the south west facing side, which is open. The plates are generally fragmentary with significant holes in places caused by the decay of the metal (**Plate 10**). The box is internally braced by iron bars (**Plate 10**). Measurements of the sides produced a slightly irregular result but this is likely to have been affected by concretion and marine growth and the box is at least 1.90-1.98 by 2.95-3.00 metres in size (measurements to the top edges of the side plates).

5.4.24. **WA46** (also recorded as **WA09**) is another large iron box, close to the southern edge of the site (**Figure 2**). This is also partly buried, and is exposed to a maximum height of approximately 1.06 metres. It is also rectangular, with flat iron plate sides and upper surface, in this case the east-facing side is open (**Plate 12**). The plates are similarly generally fragmentary with significant holes, and the box is also internally braced by iron bars (**Plate 12**). Measurements of the sides also produced a slightly irregular result but this is again likely to have been affected by concretion and marine growth. The box is approximately 1.90-2.00 by 2.75-2.87 metres in size and therefore roughly similar to **WA27** in size.

5.4.25. **WA46** does however have two features not seen on **WA27**: a fragmentary plate projects 0.88 metres from the south east corner as a continuation of the south west side of the box (**Plate 13**). There is also a cut out or rebate in the upper surface and north west side (**Plate 14**). The upper surface is rebated approximately 0.20 metres deep for 0.60 metres width. It is not known whether the feature or **WA27** are cast or wrought iron, although the latter seems highly probable.

5.4.26. The purpose of these iron boxes is uncertain. It has been suggested by previous investigators of this site that the boxes are tanks and that the most probable explanation is that they are the remains of water tanks. MacGregor (1984(b); 147) cites the naval architect J.Bennett, commenting on progress in the use of iron in ship design in the 1820s, as saying that wooden casks (of water) were being replaced by iron tanks. By the mid-19th Century it was not uncommon to see water tanks being shown in the plans of naval architects.

5.4.27. Although the physical evidence for pre-20th Century iron water tanks carried aboard wooden sailing vessels is very limited, there is an interesting parallel in the *Jhelum*, the mid-19th Century merchant sailing vessel surveyed as a hulk in the Falklands in the 1980s. When recorded this vessel had two large wrought iron tanks immediately abaft of the main mast, one on the port and the other on the starboard sides. The evidence suggests that they were fitted to the ship prior to her use as a hulk and they are interpreted as water tanks (Stammers *and* Keaton, 1992; 105).

5.4.28. The starboard tank of the *Jhelum* was rebated along its forward edge to enable it to fit under a hold beam. This rebate is very similar to that noted on **WA46**. Like **WA46** it was internally braced and had lead piping (as observed on the *Diamond* site by Mr Iles). A characteristic of water tanks of this period was a thin internal coating of cement to stop contamination with rust (Stammers and Keaton, 1992) but no detailed examination of the interior of the *Diamond's* tanks was carried out due to time constraints.

5.4.29. Water casks were notorious for leaking and the carriage of goods vulnerable to water damage such as cotton, nitrates and guano may have created a financial incentive for the fitting of iron water tanks. Therefore, the observation of a cotton-like substance on the *Diamond* site by Mr Iles may therefore be of significance in this context. Comparison of the planned dimensions of the *Jhelum* water tanks does however demonstrate that they are significantly smaller than either **WA27** or **WA46**. Nevertheless there are sufficient similarities to cautiously interpret **WA27** and **WA46** as being wrought iron water tanks.

5.4.30. **WA 93** (**Plate 16**) is a fragment of iron plate measuring 0.7 by 0.5 metres and 0.02-0.03 metres thick. It is possibly a corner fragment from a larger plate. It was located approximately 23 metres north east of the eastern end of the long axis of the site (**Figure 2**). Association with the site is therefore probable but not certain.

Timber Features

5.4.31. No unburied timber features were seen, except for a small fragment that was visible in Trench 2 prior to excavation. However, timber features were observed following excavation in Trenches 1 and 2. These features are described and interpreted in section 5.6.

Cuprous Fasteners

5.4.32. A large number of thin cuprous metal bars, up to 0.46 metres long with round sections, were observed during the survey. In addition to being attached to and therefore associated with iron features such as **WA35** and **WA55**, a number of these features were observed to be loose or free standing, although the latter may have been attached to buried features. All of these features are likely to be copper bolts (possibly of various types) used to fasten the wooden and iron components of the wreck together.

5.4.33. The distribution of these features is shown in **Figure 2** Some of these features are distributed outside of what is interpreted as being the line of the vessel hull, suggesting that fragments of vessel structure may lie outside of the oval.

5.4.34. **WA 56-63** (**Plate 17**) are a group of cuprous bolts that appear to lie outside of the hull of the vessel as defined by the alignment of knee-riders and sheathing (**Figure 2**). All are upright and partly buried, although the length exposed varies significantly and is therefore unlikely to be a reliable guide to former seabed levels. All of the bars appear to be either deeply buried or, more likely, attached to other buried features. All show evidence of erosion and subtle 'waisting'. **WA58-61** (**Plate 17**) form an approximately straight line suggesting that they may be attached to the same buried feature.

5.4.35. The bolt attached to iron knee-rider **WA55** appears to have been used to secure the iron reinforcement to a futtock. The form of the copper fastening attached to other probable knee-riders suggests that they are also 'through bolts'. The exact form of bolt is unknown (there is no universally agreed terminology in any event), but a 'clinch bolt' is considered more likely than a 'drift bolt' as no obvious tapering was observed and the bolt penetrating **WA55** would also have penetrated the futtock to its full thickness. Fastening **WA61** has a distinct 'lip' at the exposed end, which suggests that it may be a 'drift bolt'.

5.4.36. **WA92** was a loose bolt situated beside knee-rider **WA91**. It was 0.24 metres long, with a pronounced round section 'head' of 0.02 metres diameter and a shaft diameter of 0.015 metres.

5.4.37. Most of the bolts are interpreted as clinch or drift bolts. Some are associated with the knee-riders, although most of the iron reinforcements appear to be attached with iron bolts. It is possible that iron and cuprous bolts were used for different parts of the vessel, with the copper fastenings being used (more often than not) to fasten the wooden elements of the vessel.

Cuprous Sheathing

5.4.38. Exposed cuprous sheathing was observed at several points around the southern periphery of the site and in Trench 2. The alignment of these features closely corresponded with the 'vessel like' shape of the site as described above (**Figure 2**).

5.4.39. Sheathing was noted in Trench 1, and is described in section 5.6. A probable joint was observed and the overlap was noted to be to the east (**Plate 18**). The overlap would normally be at the aft end of an individual sheet, which suggests that, unless the overlap is an unusual patch or modification, the bow of the vessel lies the western end of the site. However, excavation of the area around the sheathing for sampling

could not be justified, and therefore it cannot be stated with absolute confidence that it was a joint or an overlap that was as described.

5.4.40. **WA52** is a 7.4 metre long section of exposed sheathing, incorporating the sheathing observed in Trench 1. The sheathing was aligned roughly east - west, with Trench 1 at its western end. The maximum height of exposed sheathing at western and eastern ends was 0.05 and 0.07 metres respectively. At the eastern end of the sheathing small cuprous nails penetrated the upper edge of the sheet at approximately 0.08 metre intervals. These are almost certainly sheathing nails. Joints were not observed other than in Trench 1, possibly due to heavy marine growth, which obscured much of the feature.

5.4.41. Three sheathing samples were taken from three different locations. These are described in section 5.8.

Ballast

5.4.42. Three discrete areas of ballast were observed. Due to time constraints only one area, on the western edge of the site (**Figure 2**), was surveyed, in any detail. The diver was tracked around the ballast but it was not otherwise examined. The edge of the ballast was not clear in places and could only be tracked approximately. It can be seen in Profiles 2 and 3 (**Figure 4**). The height difference between the top of ballast and the surrounding seabed was observed to be variable, the profiles recorded a maximum difference of 0.5 metres.

5.4.43. Ballast was observed to be running along the northern periphery of the wreck. The ballast and a slight scour immediately to the north and is visible in Profiles 1 and 2 (**Figure 4**). Depth variation is again variable but a maximum of 0.9 metres was observed in Profile 1. This area of ballast appears to be similar to that described above, comprising moderately or well-sorted cobbles and small boulders.

5.4.44. A discrete area of ballast was also seen to the east of **WA 27** and **WA46** at the eastern end of the site (**Figure 2**). Mr Iles' sketch plan (**Figure 3**) records the eastern area of ballast to be over two-foot high, and composed of "large irregular stones". This ballast can be seen in Profile 4 (**Figure 4**). A number of features are lying on top of this ballast, including two iron reinforcements **WA33** (**Plate 11**) and **WA88** (**Plate 15**). Depth variation between the ballast and the surrounding seabed does not appear to exceed 0.7 metres.

Site Features Not Observed by WA

5.4.45. A number of features recorded by Mr Iles, and shown in his sketch plan of the site (**Figure 3**), were not relocated by WA.

5.4.46. Mr Iles records 'hull timber (ribs/ceiling/strakes)' along the northern edge of the site. A number of iron reinforcements were recorded in this area, but it appears that the timber was covered up at the time of the WA survey.

5.4.47. A lead pipe is recorded inside the southernmost of the two iron tanks (**WA46**). WA did not inspect the inside of the tank, thus the presence of this feature cannot be confirmed. Also iron plates were shown lying next to the tank. These were also not seen, though it is possible that they were buried at the time of the WA survey.

5.4.48. A ‘bronze bracket’ is recorded to the north east of the main wreck area. WA did not undertake systematic searches around the wreck, therefore the location of this feature was probably not inspected.

5.4.49. A capstan is recorded towards the southern end of the site. It is understood that this feature was salvaged prior to designation, and therefore it has not been viewed. To the north of the capstan ‘ship structure/pins’ are recorded. This alignment of pins was not observed, for reasons that are unclear.

5.4.50. Mr Iles observed ‘iron bars’ within the eastern ballast mound. Due to time constraints WA did not undertake a detailed inspection of the ballast, therefore this cannot be confirmed. Also WA understands that a material resembling raw cotton has been observed when ballast stones have been moved (Ian Cundy, pers. comm.).

5.5. SITE PROFILES

5.5.1. A total of four profiles were recorded at various points across the site (**Figures 2** and **4**). Profiles 1, 2 and 4 were taken across the long axis of the site, and Profile 3 was a partial longitudinal profile (running in from the western end of the wreck). Video mosaics have been produced for each profile. The profile measurements are presented in **Appendix VI**.

5.5.2. Profile 1 crosses the approximate centre of the long axis of the site (**Figure 2**). It has a maximum depth variation of 0.5 metres over its 25-metre length, and is generally level (**Figure 4**). Ballast is visible along the northern edge of the site. There appears to be a slight dip in the seabed, probably a scour pit, immediately to the north of the ballast.

5.5.3. Profile 2 crosses the long axis close to the western end of the site (**Figure 2**). The maximum depth variation over its 20-metre length is 0.6 metres and the profile is generally level. Ballast is again visible in both the profile (**Figure 4**) and video mosaic, and this corresponds approximately with the area of ballast tracked during Dive 162. Again a slight scour pit appears to be visible in the profile immediately to the north of the ballast and changes in depth due to the presence of black bream nests were recorded.

5.5.4. Profile 3 is along the long axis, from beyond the western edge of the site to approximately the mid-way point (**Figure 2**). Maximum depth variation over the 30-metre length is 0.5 metres, and the profile is generally level. Although ballast is visible in the video mosaic, it is not visible in the profile (**Figure 4**). Changes in depth due to the presence of black bream nests were also recorded in this profile.

5.5.5. Profile 4 runs across the long axis of the site to the east of **WA27** and **WA46**, and close to the eastern edge of the site (**Figure 2**). Although the northern end of the profile was not correctly positioned by the diver tracking system, it has been plotted using **WA33**, which is visible in the video mosaic. Ballast is visible in both **Figure 4** and the video mosaic and corresponds with the area of ballast shown in the sketch plan prepared by Mr Iles (**Figure 3**). The difference in depth between the ballast and the surrounding seabed recorded in the profile appears to approximately match that recorded by Mr Iles. No obvious scour is visible.

5.6. EXCAVATION

5.6.1. Two trenches, each measuring one by one metre, were excavated in order to obtain wood samples. A catalogue of trench descriptions, giving context descriptions, dimensions and finds information can be found in **Appendix V**.

Trench 1 - Position

5.6.2. Trench 1 (**WA05**) was located on the southern edge of the wreck. It was sited immediately north of the exposed sheathing from which Sheathing Sample 3 (**WA04**) was taken, and partially incorporated the iron reinforcement **WA55** (**Figure 2**). The location was chosen because it appeared that intact *in situ* remains of the lower hull of the vessel were buried between **WA04** and **WA55**. This maximised the potential for recovering timber samples, and simultaneously recovering information about the structure of the vessel.

5.6.3. **Figure 5** is a plan and section of Trench 1, as excavated, and **Plates 6** and **19** are oblique and plan view photographs of the trench. The trench was excavated to a maximum depth of 0.35 metres between the outer hull planking and sheathing and the ceiling planking.

Trench 1 – Description

5.6.4. Prior to excavation the seabed was observed to consist of poorly sorted coarse sand and gravel with some very small cobbles (**WA100**). Prior to the excavation cuprous sheathing (**WA108**) and **WA55** (re-numbered **WA110** within the trench) were the only artefacts exposed. The former was exposed to a height of approximately 0.06 metres. The thickness of this upper layer was approximately 0.05 metres. Below this a darker layer of poorly sorted coarse sand and gravel with a greater component of cobbles of all sizes (**WA101**) was observed. This lay directly on top of the timber structures below (**WA102**). Small fragments of possible ship fastenings (**WA06**) were observed within **WA101**, they were not recovered and were reburied in the trench.

5.6.5. The archaeological features within Trench 1 consisted of a run of four closely spaced, substantial, rectangular wooden frames, set at a near vertical angle and aligned approximately east - west. These were heavily eroded by both fauna and mechanical action, therefore the moulded and sided dimensions could not be established with certainty. However, the maximum moulded and sided dimensions recorded (**WA104**) are 0.40 metres and 0.28 metres respectively. Three of these timbers (**WA103, WA104** and **WA106**) were identified as oak. The fourth (**WA105**) could not be identified on site. It was therefore sampled, and subsequently confirmed to be larch.

5.6.6. A 01. Metre wide plank was attached to the northern face of the frames. The wood was identified as elm, but insufficient space within the trench meant the length and width of the timber could not be determined. On the southern edge of the trench a plank (**WA107**) was observed, approximately 0.15 metres from the nearest frame. The plank followed the same alignment as the frames and was set vertically on its side. No joints were observed and therefore the length of the plank could not be established. The width of the plank could not be established because the lower edge was not visible in the trench, although it was at least 0.27 metres wide. It was

measured to be 0.12 metres thick on the top edge. The wood was sampled and has been identified as elm (Nayling 2005).

5.6.7. Two sheets of cuprous sheathing were nailed to the southern face of plank **WA107**. The length and width of the sheets could not be established, but an overlapping joint was observed. The overlap was to the east (**Figure 5** and **Plate 18**). Immediately to the north of the posts, and abutting them was another plank set near vertically on its side. For similar reasons the length and width of the plank could not be established, although its width was recorded in the section as being 0.12 metres. The plank was sampled and subsequently identified as elm (Nayling, 2005). The distance between the southern face of **WA105** and the northern face of **WA107** in the section is 0.87 metres.

5.6.8. To the north of plank **WA109** the seabed was not excavated, because it was not necessary to do so for the purposes of sampling. However, knee-rider **WA55** almost abuts the plank and sits adjacent to one of the oak frames. It is curved and overhangs the planking and posts. It is pierced by a cuprous bolt, which fixes the knee-rider (**WA110**) to frame (**WA104**).

Trench 1 – Interpretation

5.6.9. **WA100** and **WA101** are interpreted as being natural mobile seabed sediment, although it is conceivable that they could contain some ballast material. They post-date the wrecking event, but similar layers are likely to have been present on the site prior to the deposition of the wreck.

5.6.10. The archaeological features observed in Trench 1 can be reliably interpreted as part of the amidships hull of a timber framed and planked vessel whose structure has been reinforced using iron. **WA103-106** are very probably futtocks or other framing timbers. **WA107** and **WA109** are probably outer hull and inner (ceiling) planking respectively. **WA110/WA55** can be interpreted as an iron reinforcement for the hull, probably a knee, knee-rider or iron strap. Taking into account other evidence concerning the identification of similar features on the site, it is probably a knee-rider. This therefore suggests that the features observed in the trench are from the lower hull of the vessel.

5.6.11. Although the scantlings of the timbers in Trench 1 were not established with complete reliability, they do appear to be consistent with a vessel of the size suggested by the length of the exposed wreckage on the site as a whole.

Trench 2 – Position

5.6.12. Trench 2 (**WA08**) was positioned on the northern periphery of the site, close to its western extremity and **WA11**. It lies just outside of the vessel outline described above, and in the slight scour noted to the north of the site. This location was chosen because it was on the opposite side of the site from Trench 1 and also contained the only timber on the site that was exposed before excavation, thus maximising the potential for recovering timber samples. It was also thought possible that further information about the structure of the vessel might be obtained.

5.6.13. **Figure 6** is a plan and section of Trench 1as excavated, **Plate 20** is a photograph of the trench. The trench was excavated to a maximum depth of 0.11metres, although this was variable. Due to the loose nature of the seabed and the slight dip noted in the

topography in the area of the trench, a regular shape could not be maintained and it therefore constituted a slightly irregular 'scoop' of approximately one by one metre. As a result depths could only be very approximately recorded, although it was possible to draw two sections.

Trench 2 – Description

5.6.14. Prior to excavation the seabed was observed to consist of poorly sorted coarse sand and gravel with some very small cobbles (**WA200**). Cuprous sheathing (**WA210**) and timber (**WA205**) were the only archaeological features exposed prior to excavation. The depth of **WA200** was recorded as being variable but up to 0.05 metres. Below this a darker layer of poorly sorted coarse sand and gravel with a greater component of cobbles (**WA201**) was observed. This lay above **WA202**, a similar layer with larger cobbles, which lay directly on top of and between the timbers.

5.6.15. Below **WA202** there was a spread of wooden and other archaeological features. Features observed included a scarfed timber with possible nail holes (**WA204**), a thin bent cuprous bar with a circular section (**WA208**), the distorted edge of a cuprous sheet (**WA210**) and a heavily concreted iron bolt (**WA213**), possibly attached to a large shaped timber (**WA205**) (all **Plate 20**).

Trench 2 – Interpretation

5.6.16. **WA200-202** are interpreted as being natural mobile seabed sediments, although it is conceivable that they could contain some ballast material. They are likely to post-date the wrecking event but similar layers are likely to have been present on the site prior to the deposition of the wreck.

5.6.17. **WA204** is interpreted as being a possible outer hull plank because of the presence of small nail holes that may have resulted from the attachment of sheathing. It is unlikely to be *in situ*. **WA208** is interpreted as a detached cuprous fastening. **WA210** is almost certainly a sheet of cuprous sheathing from the outer hull of the vessel. Other wooden features are interpreted generally as ships structure that is not *in situ*.

5.6.18. The remains as a whole appear to lie just to the north of the probable line of the hull. The presence of sheathing and the probable sheathing nail holes suggests that it may be hull structure that has collapsed outwards. The distorted edge of the sheathing (**WA210**) may have been caused by the hull collapsing upon it, which suggests that the features observed in the trench may have originated from hull structure that would have been just above the current level of the seabed at the time of collapse.

5.7. SEARCHES

5.7.1. Tracked diver visual searches were undertaken to the west and east of the core of the site. No archaeological features were observed in the areas searched, although an old survey datum (**WA72**) was noted. Visibility was such that it is highly unlikely that exposed archaeological features were present in these areas at the time of the search. It is possibly that features associated with the vessel exist buried within this area, although the visual character of mobile sediments covering these areas did not appear to differ from those observed within the area of the seabed where archaeological features were located.

5.8. SAMPLING - SHEATHING

5.8.1. Samples were taken from exposed sheathing. No stamp or other marking was observed on the sheathing inspected for this purpose. A total of three samples were taken (**WA02-04**) (**Plate 21**). Samples were cut using hand shears and then labelled and bagged. Sample size was the smallest practicable. The sample locations were recorded by tracked diver survey.

5.8.2. The samples were handed over to the licensee after being photographed but not otherwise recorded. The licensee contracted the School of Earth, Ocean and Planetary Sciences of the University of Cardiff to undertake chemical composition analysis of the samples, which were sectioned, polished and then examined under an electron microscope for this purpose (Cundy 2004).

5.8.3. The results of this analysis are given in **Appendix VII**. It should be noted that reference to port and starboard (Cundy 2004: Table A) refers to the notional orientation given to the vessel at the time of sampling, rather than the true orientation, which remains uncertain.

5.8.4. Two sheathing samples were sectioned once. Examination of the cut section revealed the samples to be composed mostly of a darker structure (Position 1) but with smaller 'streaks' of lighter coloured structure (Position 2) (Ian Cundy pers. comm.). Chemical composition analysis of Position 1 subsequently showed the majority structure to be 61.44 - 62.83 % copper and 36.96 - 37.17% zinc.

5.8.5. Analysis of Position 1 does not provide a close match with the composition of muntz metal, a form of brass widely used for sheathing and fasteners after 1832, that is usually quoted by sources (60% copper, 40% zinc). However, in his patent for sheathing plates (1832 GB6325), Muntz states: "in any proportions between fifty per cent. of copper to fifty per cent. of zinc, and sixty-three per cent of copper to thirty per cent of zinc….I prefer the alloy to consist of about sixty per cent of copper to forty per cent of zinc."

5.8.6. The chemical composition of Position 1 does therefore correspond approximately with the chemical composition given in the Muntz patent. However it also corresponds with the 30-38% zinc composition of alpha brass (Goodwin 1987: 62) and could be Forbes' 'mixed (mixt) metal' which comprised an alloy of copper 100 parts and 1-60 parts zinc (up to 37.5%) (McCarthy, 1996, 202). Therefore although the analysis of the sampled sheathing demonstrates that it could be Muntz metal, in the absence of a patent stamp it does not prove that it is. Analysis of Position 2 revealed a high but variable percentage of lead, suggesting that the lighter areas of structure are impurities.

5.8.7. In addition a nail, interpreted as a sheathing nail, was sampled. Analysis revealed a composition of 85% copper, with a small proportion of zinc and tin, and is therefore identifiable as a non-specific copper alloy.

5.9. SAMPLING - WOOD

5.9.1. Two test trenches were excavated to the minimum depth necessary to expose sufficient wood for sampling. Thereafter the trenches were inspected and five wood

samples (**WA75-79**) were taken. Sample sizes were the smallest practical. A visual inspection, for the purpose of preliminary identification of wood types, was then undertaken immediately prior to sampling. The sample locations were recorded by tracked diver survey.

5.9.2. Selection and recovery of the samples was undertaken by Nigel Nayling as part of the WA diving operation. Analysis was subsequently undertaken by Mr Nayling at the Dendrochronology Laboratory of the Department of Archaeology and Anthropology at the University of Wales Lampeter (Nayling, 2005).

5.9.3. The results of the analysis are given in **Appendix VIII**. The outer hull and ceiling planking exposed by excavation in Trench 1 and a displaced timber sampled in Trench 2 are elm (**Plate 20** and **Figure 6**). A timber in Trench 2, interpreted as possible outer hull planking, is pine, and a framing timber sampled in Trench 1 is larch (**Plate 19** and **Figure 5**). In addition during the visual inspection the majority of framing timbers identified in Trench 1 were quartered oak (Nayling, 2004). The type of oak is unknown.

5.10. MONITORING PHOTOGRAPHS

5.10.1. A total of five photographs have been selected for the purposes of future monitoring of erosion, deposition, damage and deterioration. The location of the photographer and direction of view are shown in **Figure 2**. It is recommended that monitoring photographs MP1 and MP2 should be repeated at no greater than annual or biannual intervals. Photographs monitoring changes in seabed level should be repeated as often as practicable, as it is possible that annual or biannual repeats may not be sufficient to identify short term cycles of erosion and deposition.

5.10.2. The photographs are listed as follows:

- **MP1** – (**Plate 10**) is a view of **WA27** taken from the north. This feature has been interpreted as a possible iron water tank and may therefore be an early and important survival of this type of ship fitting. It is corroding and is currently unprotected, and is likely to be subject to further corrosion and eventual collapse. It is also vulnerable to any fishing or anchoring operations that take place on the site. Repeats of this photograph at intervals will allow gross damage to or gross changes in the condition of the structure of this feature, together with changes in seabed level relative to the feature to be monitored.
- **MP2** – (**Plate 17** is a view of **WA58-61**, taken from the east. These features are interpreted as cuprous bolts that lie immediately outside of the southern edge of the vessel hull. Repeats of this photograph at intervals will allow gross changes in the level of the seabed along the southern edge of the site to be monitored.
- **MP3** – (**Plate 1**) is a view of the exposed run of sheathing (**WA52**) and knee-riders **WA54** and **WA55** on the southern edge of the site, taken from the east. Repeats of this photograph at yearly intervals will allow gross changes in the level of the seabed around the south side of the surviving hull to be monitored.
- **MP4** – (**Plate 2**) is a view of **WA18** and **WA19** from the west. These, part-buried features that are interpreted as knee riders that have become detached from the futtocks that they were attached to. Although they are solid to touch

their angle suggests that they may be unstable and gradually collapsing to the north. Repeats of this photograph at yearly intervals will allow any gradual or sudden collapse to be monitored.

- **MP5** – (**Plate 20**) is a view of Trench 2 as excavated. Subsequently the trench was reinstated and all features buried prior to excavation were reburied. Trench 2 appears to be in a slight scour immediately to the north of the northern edge of the site, repeats of this photograph at yearly or more frequent intervals will allow any long term erosion in this scour or any instability caused by the excavation to be monitored.

6. DISCUSSION

6.1. VESSEL IDENTIFICATION

6.1.1. Position-fixes have been obtained for all of the archaeological features that were seen, and most have been recorded. Bad weather for two days at the end of site operations prevented WA from completing the recording process and it is suspected that there may be a limited number of exposed but low profile archaeological features that were not located due in the time available and localised weed cover. Furthermore some of the features recorded by WA require further survey; nevertheless it is estimated that at least 90% of a baseline survey to Level 3a has been completed.

6.1.2. The archaeological evidence can be summarised as follows: The archaeological features observed by WA all lie within the designated area. The features lie within a flattened oval that is approximately 44 metres long by 10 metres wide, and is orientated approximately east - west. No evidence was found for archaeological features outside of this area to the west or to the east.

6.1.3. Apart from a slight scour along the northern side of the site here is very little variation in relief across the wreck. There is a very low mound of apparent ballast stones possibly extending the full length of the site along the north side and across the east-south-east end.

6.1.4. There is conclusive archaeological evidence that the site represents the remains of a wooden sailing vessel.

6.1.5. The width of the site suggests a vessel with a beam of not less than nine metres (29.5 feet), but possibly larger. The evidence is not conclusive as to the actual breadth of the vessel as the precise lines of the hull and the extent of burial cannot be determined at the present time. The absence of visible features to the west or east suggests that the vessel is unlikely to greatly exceed the 44-metre (144 feet) length of the site. The vessel could be smaller but it is noted that the distribution of exposed features does appear to resemble the complete outline of a vessel hull. A typical merchant vessel of the mid-19th Century of 144 feet in length would have had a tonnage of between 500 and 800 tons, depending upon its beam and draught.

6.1.6. No features definitely diagnostic of the bow or stern areas of the vessel have been observed, although a possible iron breast hook (not yet confirmed) has been observed towards the eastern end of the site. This is contradicted by the fact that in Trench 1

an overlap of sheathing suggests that the bow may lie to the west. However, only a single joint was exposed and the area exposed was too small to be conclusive.

6.1.7. Evidence from Trench 1 indicates that the vessel was timber framed and planked, with iron reinforcements. The frames observed were mainly oak, although larch has also been used. The planking is a mixture of elm and pine. It appears likely that a substantial part of the lower hull survives buried, although the vessel is unlikely to survive above the level hold.

6.1.8. The scattered iron features previously reported as iron frames (ADU, 2001) appear to be iron knee-riders in varying states of completeness or other iron reinforcements. There are a large number of these around the edge of the site. The majority are collapsed and are lying flush with the seabed. However, a number of them appear to be *in situ*. These include a run of three, on the southern edge of the site, which have an approximately even spacing. No iron frames were observed by WA. There are other types of iron reinforcement present, including knees and 'W' and 'W' shaped iron knees. The 'W' feature is probably a breasthook. Numerous fastenings were observed and these are generally cuprous or iron bolts associated with the iron reinforcements.

6.1.9. Runs of exposed cuprous sheathing have been observed along the edges of the site, particularly along the southern side. This is likely to represent the line of the hull where exposed. However, collapsed parts of the vessel are probably buried outside of the run of sheathing, as evidenced by cuprous bolts apparently firmly fixed in the seabed a short distance to the south and by timbers apparently collapsed over the sheathing in Trench 2 on the north side of the site.

6.1.10. Sampling of the sheathing indicates that it is composed of a cuprous alloy. The test results are inconclusive as to whether it is Muntz metal. However, these results, when combined with the reported recovery from the site of a cuprous bolt stamped with a Muntz metal patent (**Plate 22**), suggest that the vessel very probably has sheathing and cuprous fastenings that were manufactured in 1832 or later. Nevertheless a note of caution must be sounded as the recovery of the bolt was not sufficiently recorded for its providence to be accepted as being entirely reliable.

6.1.11. Two large iron boxes were observed within the wreck. Their purpose is uncertain but they are probably the remains of water tanks. No anchors were seen, which may suggest that the vessel lost her main anchors during the wrecking incident, and certainly appears to indicate that the hold containing her spare anchors remains buried.

6.1.12. The archaeological and archival evidence available to WA suggests, on a balance of probability basis, that the wreck on this site is likely to be that of a mid-19th Century or later merchant ship of European origin.

6.1.13. The overall character of the exposed material on the seabed can be summarised as follows (after Watson *and* Gale 1990):

Area and distribution of surviving ship structure:	A flattened oval approximately 44m by 10m. Most archaeological features are distributed around the periphery of this oval.
Character of ship structure:	Wooden framed vessel with iron reinforcements, cuprous sheathing and iron and cuprous fastenings.

Depth and character of stratigraphy:	Shallow layers of mobile sediment over ship structure observed within excavation trenches. Deeper deposits are probable in the centre of the site.
Volume and quality of artefactual evidence:	Only isolated small finds associated with ship structure were located during WA fieldwork. None were recovered. A cuprous bolt with muntz metal patent stamp was probably recovered from the site prior to designation.
Apparent date of ship's construction and/or loss:	Unknown. Construction probably post-1832.
Apparent function:	Merchant sailing vessel, cargo unknown (although cotton has been suggested by the Licensee).
Apparent origin:	Unknown, probably of European construction.

6.1.14. The data gathered by WA indicates that this vessel is not a 'composite vessel' in the usually accepted sense, i.e. it is not a vessel combining metal frames with timber planking. Suggestions made previously that the wreck may be 'composite' appear to be based upon a misidentification of the knee-riders as iron frames, a misunderstanding as to the definition of the term or a rather looser use of it than is generally accepted.

6.2. RECOMMENDATIONS

6.2.1. In the short term, the question of whether this site is, or is not, the wreck of the *Diamond* is likely to be best addressed by dendrochronological dating. Nigel Nayling has confirmed that suitable samples are likely to be obtained from frame timbers inspected in Trench 1 (Nayling, 2005). This trench should therefore be re-excavated and samples obtained. The Licensee could carry out this task with limited support as Trench 1 can be easily relocated. The cost of dating using this method is likely to be prohibitive for a private individual such as Mr Cundy and therefore assistance in this respect is likely be required.

6.2.2. In the short term both Mr Cundy and Mr Bowyer should be encouraged to publish the results of their respective documentary researches at the earliest possible opportunity. Mr Cundy has been examining records of losses in the vicinity and has identified a number of vessels that could have been wrecked at this site (Ian Cundy pers. comm.). It is therefore vital that this research should be published in an appropriate journal (such as IJNA or Maritime Wales) and deposited for public access at RCHMW. Mr Bowyer has told WA that he is conducting documentary research in North America (Michael Bowyer pers. comm.) but no further details are known.

6.2.3. In the short to medium term, further analysis and survey work is required in order to add more detail to selected areas of the WA 2004 survey, and to integrate the WA survey data with the results of the ongoing documentary research. It is suggested that detailed examination and measurement of some of the archaeological features surveyed by WA may provide diagnostic evidence that could lead to a better understanding of the design and date of the wrecked vessel. This is particularly true of the knee-riders and the possible water tanks (the latter should include a more detailed internal inspection). WA understands that Ian Cundy intends to pursue such a strategy, initially by further analysis of existing WA data as part of his desk-based research.

6.2.4. A sample of the cuprous bolts located during the 2004 survey should be examined for muntz patent marks. Although due regard is given to the bolt recovered by Mr Iles, the location of a such a mark *in situ* within the site would prove conclusively that this vessel was not the *Diamond* (which sank before the development and use of Muntz metal). It is also suggested that a test pit should be inserted to examine the outer face of the *in situ* sheathing to determine whether any patent or other markings are visible.

6.2.5. It is also suggested that a probe survey to determine the west and east limits of the known site should be carried out. If necessary, further test pits should then be excavated to confirm the results of this survey. All intrusive work should be subject to a project design which makes adequate provision for reinstatement, and for either the reburial or curation and storage of finds.

7. ASSESSMENT ARCHIVE

7.1.1. The project archive consisting of a hard copy file and computer records, together with miscellaneous hardcopy photographs and plans are currently stored at WA under project code 53111.

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APPENDIX I: GLOSSARY

Bolt – the names and definitions of ship fasteners have changed considerably over time and there is no universal agreement on precise definitions. However a bolt is usually defined as a cylindrical or square pin of iron or copper/copper alloy, usually driven into an augered hole. Through-bolts pass completely through the wooden pieces they join. A clinch bolt is a through bolt with a head on one end that is clinched on the other. A drift bolt is clinched or headed at one end, with a pronounced taper to the other. It does not necessarily pass completely through the pieces that it joins and is likely to be driven at least part way.

Bottom time – time between diver leaving surface and beginning ascent.

Coarse Component Size Ranges – Fine Sand (0.06-0.2mm); Medium Sand (0.2-0.6mm); Coarse Sand (0.6-2.0mm); Fine Gravel (2.0-6.0mm); Medium Gravel (6.0-20.0mm); Coarse Gravel (20.0-60.0mm); Cobbles (60.0-200.0mm); Boulders (200.0mm+).

Composite construction - a hull combining metal and wood, usually in the form of an iron frame with wood planking. Wooden vessels with iron reinforcements such as knees are normally categorised as being of wooden construction, rather than composite. The *Excelsior* of 1850 is generally regarded as the first composite vessel, although several similar style vessels had been built in the previous two decades (MacGregor 1993: 61)

Cuprous – copper or copper alloy (including brass and bronze), term used when the presence of copper is probable but the chemical composition is otherwise unknown.

Futtock – section of a wooden frame.

Knee rider – an iron hanging-knee with a long curved vertical arm/leg that typically runs from the keelson up the inner surface of the hull, and a short horizontal arm that is fixed to the under side of a deck beam.

Moulded – the edge dimension of a framing timber (i.e. the thickness of the frame from the outer hull planking to the ceiling planking).

Muntz metal – a form of brass with a high proportion of zinc, designed to be hard at low temperatures and malleable at high temperatures. It is also known as ‘yellow metal’ or 60/40 brass. It was patented for sheathing and fasteners in 1832 (1832 GB6325/6347 respectively) by the English businessman George Muntz, whose company had obtained a dominant position in the market by the time that the patent ran out in 1846. Whereas pure copper sheathing was expensive and had a fairly short life span, Muntz’s alloy was flexible enough to adapt itself to a wooden hull and corroded at a much slower rate than copper. As a result of the use of a high percentage of inexpensive zinc it also cost substantially less than pure copper. It is usually quoted by sources as comprising an alloy of 60% copper and 40% zinc, but the patent indicates that this was the preferred approximate composition and that the proportion of zinc could vary from 37-50%.

Outwash plain – a broad, gently sloping sheet of outwash deposited by meltwater streams flowing in front of or beyond a glacier, and formed by coalescing outwash fans.

Reef – a ridge of rock or coarse material, the top of which lies close to the surface of the sea, and may be exposed at low water.

Sarn (plural 'sarnau') – a Welsh word for 'causeway', used in west Wales for a roughly linear boulder or cobble reef derived from glacial moraine, lying at shallow depth (maximum depth about 10 metres below chart datum), and completely covered at low tide (May and Hansom 2003). Welsh word meaning 'causeway' (Tappin et al. 1994).

Sandur - a synonym for outwash plain, an Icelandic loanword meaning the broad plain formed by the deposition of glacially derived sediments in front of the margin of a glacier.

Sided – the thickness of a framing timber (i.e. the measurement taken fore to aft across the timber).

Waisting – uneven erosion (usually at or just above seabed level) of a part-buried iron or cuprous fastener, and resulting in a pronounced narrowing of the section in one part of the profile.

APPENDIX II: DIVE DETAILS

Dive	Date	Diver	Start time	Max. / Min. Depth (m)*	Bottom Time (min.)	Estimated Visibility (m)	Current and Sea State
155	02/06/04	Scott	13:04	5.5 / -	93	c. 2 (?)	- / slight swell
156	02/06/04	Mallon	15:31	6.0 / 4.75	70	3-4	Slack / slight swell
157	03/06/04	Adey-Davies	11:33	6.25 / 4.75	117	3-4	- / 3-4
158	03/06/04	Auer	14:28	5.5 / 4.3	115	4	Slight / 2-3
159	04/06/04	Auer	11:21	8.25 / 5.5	115	4	Slight / 2-3
160	04/06/04	Mallon	13:49	6.75 / 5.0	117	4	Moderate-slight / 2-3
161	04/06/04	Adey-Davies	16:18	5.0 / -	63	5	Slack/ 2-3
162	05/06/04	Scott	12:26	7.75 / -	111	-	- / slight
163	05/06/04	Mallon	15:05	5.75 / 5.0	72	7	Moderate from N / slight
164	05/06/04	Auer	17:16	5.0 / 4.75	53	-	- / slight
165	06/06/04	Adey-Davies	11:13	9.0 / 8.25	115	10	Moderate, reducing / slight
166	06/06/04	Mallon	13:29	7.5 / 6.5	32	8	Slack / slight
167	07/06/04	Mallon	11:04	9.0 / 8.5	36	8	Moderate, reducing / slight
168	07/06/04	Nayling	12:11	9.0 / 8.5	57	-	Slight / slight
169	07/06/04	Black	13:52	8.0 / -	54	5	Slack / slight
170	07/06/04	Auer	15:27	6.5 / -	75	4-5	Slight, increasing / slight
171	08/06/04	Adey-Davies	10:44	8.25 / 6.25	98	-	- / calm
172	08/06/04	Mallon	12:50	8.25 / 8.0	121	8	Slack / calm
173	08/06/04	Adey-Davies	15:24	7.25 / 6.5	132	3-4	Slack/ calm
174	09/06/04	Auer	12:36	8.0 / 7.75	100	4	Strong, reducing / 3
175	09/06/04	Mallon	14:42	7.5 / 7.25	93	8	Moderate, reducing / 2-3

* Minimum recorded rather than minimum absolute.

APPENDIX III: ARCHAEOLOGICAL FEATURES LOG

WA No.	Dive Obs. No.	Dive No.	Description	Licensee Tag	Photographs (Dive/Photo Number -video stills in italics)
01	1511, 1585,1693, 1694, 1814, 1820	155, 165, 169	Iron reinforcement		2921, 2922, 2923, 2924,2925, 2926, 2927, 2928 (all 167)
02	1541	156	Sheathing sample 1		3015, 3016, 3017 (all 156), 0005(surface), 0004 (surface), 3005, 3006, 3007, 3008 (all 171), *WA02_1-2 (163)*
03	1544, 1749	156, 165	Sheathing sample 2		3018, 3019, 3020, 3021, 3022, 3023, 3024 (all 156), 0016 (surface), 0018 (surface)
04	1546, 1667, 1761	156, 163, 165	Sheathing sample 3		3025, 3026, 3027, 3028, 3029, 3030, 3031 (all 156), 0022 (surface)
05	1558, 1760	157, 165	Trench 1		3035, 3036, 3037, 3038, 3039, 3040, 3041 (all 157), 3047, 3048, 3049, 3050, 3051, 3052, 3053, 3054, 3055, 3056, 3057, 3058, 3059, 3060, 3061, 3062, 3063, 3064, 3065, 3066, 3067, 3068, 3069, 3070 (all 158), 2903, 2904, 2905, 2906, 2907, 2908, 2909, 2910, 2911, 2912, 2913, 2914, 2915, 2916, 2917, 2918, 2919, 2920, 2921, 2922, 2923, 2924, 2925, 2926 (all 159), 2998, 2999, 3000, 3001, 3002 (all 171), *WA5backfilled_1 (173)*
06			Small finds, Trench 1		2927, 2928, 2929 (all 159)
07			Not used		
08	1689, 1695	164, 165	Trench 2		2931, 2932, 2933, 2934, 2935, 2936, 2937, 2938, 2939, 2940, 2941, 2942 (all 160), 2921, 2922, 2923, 2924, 2925, 2926 (all 161), 2983, 2984, 2985, 2986, 2987, 2988 (all 171), *WA8backfilled_1-2 (173)*
09	See WA46	See WA46	Large iron box (as WA46)		See WA46
10	1527, 1734, 1897	155, 165, 172	Metal cylinder, vertical		2943, 2944,2945, 2946, 2947, 2948 (all 160), 2907, 2908, 2912, 2913, 2914, 2915, 2916, 2917, 2918, 2919, 2920 (all 161)
11	1821	169			2921, 2922, 2923, 2924, 2925, 2928 (all 167)
11	1583, 1696	162, 165	Iron reinforcement, W end		
11	1584, 1697	162, 165	Iron reinforcement, E end		
12	1588	162	Cuprous sheathing		*WA12_1 (162)*
12	1677	164	Cuprous sheathing		
12	1833	170	Cuprous sheathing		
13	1869	172			2970, 2971, 2972, 2973, 2974, 2975, 2976, 2977, 2978, 2979, 2980, 2981, 2982 (all 171)

WA No.	Dive Obs. No.	Dive No.	Description	Licensee Tag	Photographs (Dive/Photo Number -video stills in italics)
13	1507, 1590, 1700	155, 162, 165	Iron reinforcement, W end	S10	
13	1591, 1699	162, 165	Iron reinforcement, position on WA datum tag	S10	
13	1592, 1701	162, 165	Iron reinforcement, E end	S10	
14	1871	172			*WA14_1-3 (162)*
14	1506, 1593, 1702	155, 162, 165	Iron reinforcement, position on WA datum tag	S09	
14	1594, 1703	162, 165	Iron reinforcement, W end	S09	
14	1595, 1704	162, 165	Iron reinforcement, E end	S09	
15	1596, 1872	162, 172	Iron reinforcement		*WA15_1 (162)*
15	1597, 1705	162	Iron reinforcement, position on WA datum tag, N end		
15	1598, 1706	162, 165	Iron reinforcement, S end		
16	1600, 1707, 1708, 1873	162, 165, 172	Iron reinforcement, upright		3026 (171), *WA16_1 (162)*
17	1601, 1874	162, 172	Iron reinforcement		No image?
17	1709	165	Iron reinforcement, W end		
17	1710	165	Iron reinforcement, E end		
18	1875	172			3028, 3029, 3030, 3031 (all 171)
18	1602	162	Iron reinforcement, position on WA datum tag	S8	
18	1603	162	Iron reinforcement, other end	S8	
19	1503, 1604, 1876	155, 162, 172	Iron reinforcement, upright	S7	3028, 3029, 3030, 3031 (all 171)

WA No.	Dive Obs. No.	Dive No.	Description	Licensee Tag	Photographs (Dive/Photo Number -video stills in italics)
19	1605, 1717	162, 165	Iron reinforcement, position on WA datum tag	S7	
19	1714	165	Iron reinforcement, top		
19	1715	165	Iron reinforcement, top		
19	1716	165	Iron reinforcement, top		
19	1718	165	Iron reinforcement, base		
20	1877	172			3032 (171)
20	1607, 1608, 1719	162, 165	Iron reinforcement, E end		
20	1609, 1720, 1721	162, 165	Iron reinforcement, W end		
21	1610, 1722	162, 165	Iron reinforcement, position on WA datum tag		3030, 3031 (171)
21	1611, 1723	162, 165	Iron reinforcement, N end		
21	1724	165	Iron reinforcement, S end		
22	1612, 1613, 1725	162, 165	Iron reinforcement		*WA22_1-2 (162)*
23	1614	162	Iron reinforcement, E end		*WA23_1 (162)*
23	1615	162	Iron reinforcement, E end		
24	1616, 1729	162	Iron reinforcement, position on WA datum tag, W end		*WA24_1-3 (162)*
24	1728, 1727	165	Iron reinforcement, E end		
25	1617, 1618, 1878	162, 172	Iron reinforcement		*WA25_1-2 (162), WA25pan (162), WA25pan_1-7 (162)*
26	1619, 1881	162, 172	Iron reinforcement		*WA26_1-4 (162), WA26pan (162), WA26pan_1-8 (162), WA26,84and85 (172)*

WA No.	Dive Obs. No.	Dive No.	Description	Licensee Tag	Photographs (Dive/Photo Number -video stills in italics)
27	1514, 1620	155, 162	Large iron box, centre point		2906, 2907, 2908, 2909, 2910, 2911, 2912, 2913, 2914, 2915 (all 165), 2901, 2902, 2903, 2904, 2905, 2906, 2907, 2908, 2909, 2910, 2911, 2912, 2913, 2914, 2915, 2916, 2917, 2918, 2919, 2920, 2921, 2922, 2923, 2924, 2925, 2926, 2927, 2928 (all 171), *Ntank_1 (175), WA27and28_1-2 (162)*
27	1891	172	Large iron box		
27	1787	165	Large iron box, SE corner		
27	1788	165	Large iron box, SW corner		
27			Large iron box, NE corner		
27	1789	165	Large iron box, NW corner		
28	1621	162	Iron reinforcement, position on WA datum tag		*WA28_1-2 (162), WA27and28_1-2 (162)*
28	1884	172			
29	1622, 1623	162	Cuprous fastening		*WA29_1-3 (175), WA29and30_1-4 (162)*
30	1624, 1955	162, 174/5	Iron reinforcement		*WA29and30_1-4 (162)*
31	1520	155	Iron reinforcement	S1	*WA31and32_1-2 (174)*
31	1933	174/5		S1	
32	1517, 1519, 1627, 1628	155, 162	Iron reinforcement	S0	*WA31and32_1-2, WA32_1 (174)*
33	1516, 1932	155, 174/5	Iron reinforcement (Z-shape)		*WA33_1-11 and mosaic (174), WA33and88_1-2 (175)*
33	1629	162	Iron reinforcement (Z-shape), one end		
33	1630	162	Iron reinforcement (Z-shape), other end		
34	1631, 1934	162, 174/5	Misc., iron cylinder/pipe		*WA34_1-2 (174)*
35	1633	162	Iron reinforcement		*WA35_1-3 and pan (174)*
35	1929	174/5			
36	1634, 1930	162, 174/5	Cuprous fastening	Different S2 tag	*WA36_1-2 (174)*
37	1635	162	Iron reinforcement, position on WA datum tag		*WA37_1-6 and pan (174)*
37	1928	174/5			

WA No.	Dive Obs. No.	Dive No.	Description	Licensee Tag	Photographs (Dive/Photo Number -video stills in italics)
38	1521, 1522, 1642, 1935	155, 163, 174/5	Iron reinforcement, upright	P0	*WA33_1-4 (174)*
39	1643	163	Iron reinforcement, one end		*WA39_1-4 (175), WA39and40_1-2 (175), WA39and41_1-2 (175), WA39, 40and41_1-2 (175)*
39	1644	163	Iron reinforcement, other end		
40	1645	163	Iron reinforcement, position on WA datum tag	missing	*WA40and90_1-4 (174), WA89,90and40_1-15(174), WA39and40_1-2 (175), WA39and40_1-2 (175)*
40	1646	163	Iron reinforcement, N end		
40	1647	163	Iron reinforcement, S end		
40	1944	174/5			
41	1648	163	Iron reinforcement, position on WA datum tag		*WA39and41_1-2 (175), WA39and40_1-2 (175)*
41	1649	163	Iron reinforcement, E end		
42	1650, 1735	163, 165	Iron reinforcement, position on WA datum tag, upright		*WA42_1-2 (175), WA42and43_1-2 (175)*
43	1651, 1736	163, 165	Misc., iron cylinder/pipe		*WA43_1-2 (175), WA42and43_1-2 (175)*
44	1525, 1555, 1652, 1737	155, 157, 163, 165	Iron reinforcement, upright	P6	*WA44_1-3 (175)*
45	1653, 1738	163, 165	Iron reinforcement	P7	*WA45_1-2 (175)*
46	1526, 1654, 1730, 1731	155, 163, 165	Large iron box, centre point		3043, 3044, 3045 (all 158), 2929, 2930, 2931, 2932, 2933, 2934, 2935, 2936, 2937, 2938, 2939, 2940, 2941, 2942, 2943, 2944, 2945, 2946, 2947, 2948, 2949, 2950, 2951, 2952, 2953, 2954, 2955, 2956, 2957, 2958, 2959, 2960, 2961, 2962, 2963, 2964, 2965, 2966, 2967, 2968, 2969 (all 171), Panorama 1, *WA46and48_1-2 (163)*
46	1732, 1893	165, 172	Large iron box, SE corner		
46	1733, 1894	165, 172	Large iron box, SW corner		
46			Large iron box, NE corner		
46	1895	172	Large iron box, NW corner		
46	1896	172			

WA No.	Dive Obs. No.	Dive No.	Description	Licensee Tag	Photographs (Dive/Photo Number -video stills in italics)
47	1655, 1739	163, 165	Iron reinforcement, position on WA datum tag		*WA47_1-5 (163)*
48	1656, 1740, 1898	163, 165, 172	Iron reinforcement, position on WA datum tag		*WA48_1 (163), WA46and48_1-2 (163)*
49	1657, 1741	163,165	Iron reinforcement, position on WA datum tag		3013 (all 171), *WA49_1-3 (163), WA49and50_1 (163)*
49	1899	172			
50	1658, 1742, 1900	163, 165, 172	Iron reinforcement		*WA50_1-5 (163), WA49and50_1 (163)*
51	1660, 1743, 1901	163, 165, 172	Iron reinforcement, position on WA datum tag		3005, 3006, 3007, 3008 (all 171)
52	1661	163	Sheathing, WA datum tag position (WA02)		3005, 3006, 3007, 3008 (all 171)
52	1662	163	Sheathing, eastern end		
52	1664, 1747	163, 165	Sheathing, western end		
52	1843	170	Sheathing		
53	1902	172	Iron reinforcement		
53	1663	163	Iron reinforcement, position on WA datum tag, S end		3005, 3006, 3007, 3008 (all 171)
53	1745	165	Iron reinforcement, N end		
54	1531, 1665, 1752, 1842	155, 163, 165, 170	Iron reinforcement	P12	3003, 3004 (all 171)
55	1532, 1543, 1666, 1759	155, 156, 163	Iron reinforcement	P13	WA55_1 (165)
56	1668, 1750, 1840	163, 165, 170	Cuprous fastenings (2)		3015, 3016 (all 171)
57	1669, 1751, 1839	163, 165, 170	Cuprous fastenings (2)		3015, 3016 (all 171)
58	1670, 1754, 1838	163, 165, 170	Cuprous fastening		3017, 3018 (all 171)
59	1671, 1753	163, 165	Cuprous fastening		3017, 3018 (all 171)
60	1672, 1755, 1836	163, 165, 170	Cuprous fastening		3017, 3018 (all 171)

WA No.	Dive Obs. No.	Dive No.	Description	Licensee Tag	Photographs (Dive/Photo Number -video stills in italics)
61	1674, 1756, 1834	164, 165, 170	Cuprous fastening		3017, 3018 (all 171)
62	1675, 1757, 1841	164, 165, 170	Cuprous fastening		3019, 3020 (all 171)
63	1676, 1758, 1835	164, 165, 170	Cuprous fastening		3021, 3022 (all 171)
64	1678, 1832	164, 170	Iron reinforcement		*WA64_1-11, WA64-67Mosaic (all 173)*
64	1764	165	Iron reinforcement, position on WA datum tag, E end		
64	1765	165	Iron reinforcement, position on WA datum tag, W end		
65	1537, 1679, 1766, 1831	155, 164, 165, 170	Iron reinforcement, upright	P14	*WA65_1-3, WA64-67Mosaic (all 173)*
66	1680, 1768, 1829	164, 165, 170	Iron reinforcement, upright		*WA66_1-2, WA64-67Mosaic (all 173)*
67	1681	164	Iron reinforcement		*WA67_1-3, WA64-67Mosaic (all 173)*
67	1830	170	Iron reinforcement		
67	1769	165	Iron reinforcement, position on WA datum tag		
67	1770	165	Iron reinforcement, NW end		
67	1771	165	Iron reinforcement, SE end		
68	1682, 1772	164, 165	Iron reinforcement, position on WA datum tag, W end		*WA68_1-2 (173)*
68	1773, 1828	165, 170	Iron reinforcement		
69	1683, 1827	164, 170	Iron reinforcement		*WA69_1-3 (173)*
70	1684, 1775, 1797,1819	164, 165, 166,169	Cuprous fastening		*WA70_1-2 (165)*
71	1762	165	Sheathing, west end		
71	1763	165	Sheathing, east end		*WA71_1-2 (165)*
72	1776	165	Old survey datum (orange)		*WA72_1-2 (165)*
73	1793, 1926	166, 170	Iron reinforcement		2926 (167), 2989, 2990, 2991 (all 171)
73	1794	166	Iron reinforcement, E end		
73	1795	166	Iron reinforcement, W end		

WA No.	Dive Obs. No.	Dive No.	Description	Licensee Tag	Photographs (Dive/Photo Number -video stills in italics)
74	1808, 1822, 1825	167, 169, 170	Misc., iron artefact		*WA74_1-2 (170)*
75	No Obs.		Wood sample 1		No Image
76	No Obs.		Wood sample 2		No Image
77	No Obs.		Wood sample 3		No Image
78	No Obs.		Wood sample 4		No Image
79	No Obs.		Wood sample 5		No Image
80	1844	170	Cuprous fastening		*WA80_1 (170)*
81	No Obs.		Iron object		No image?
82	1879	172	Iron reinforcement		*WA82_1-5 (172)*
83	1880	172	Iron reinforcement	S5	*WA83_1-2 (172)*
84	1882	172	Iron reinforcement		*WA84_1-3 (172), WA84_1-2 (172), WA26,84and85 (172)*
85	1883	172	Iron plate, under part of WA84		*WA85_1-2 (172), WA84_1-2 (172), WA26,84and85 (172)*
86	1926, 1927	174/5	Iron reinforcement		*WA86_1 (174)*
87	No Obs.		Cuprous fastening		*WA87_1-5 (174)*
88	1939	174/5	Iron reinforcement (W-shaped), SW end	P1	*WA88_1-13 (174), WA33and88_1-2 (175)*
88	1940	174/5	Iron reinforcement (W-shaped), NE end		
89	1931, 1936, 1937, 1938	174/5	Iron reinforcement		*WA89_1-2 (174), WA89,90and40_1-15(174)*
89	No Obs.		Iron reinforcement		
90	1943	174/5	Iron reinforcement		*WA40and90_1-4 (174), WA89,90and40_1-15(174)*
91	1956	174/5	Iron reinforcement		*WA91_1-3*
92	1956	174/5	Cuprous fastening		*WA92_1-2*
93	1923	173	Misc., iron plate fragment		*WA93_1-2 (173)*
94	1924	173	Iron reinforcement		*WA94_1-3 (173)*

N.B. Some features may be listed more than once if Prospector positions were taken on more than one point of the feature. Dive Observations for Dive 174 *and* 175 were not recorded separately, due to operator error.

APPENDIX IV: MEASUREMENTS OF ARCHAEOLOGICAL FEATURES

WA No.	Dive Obs. No.	Dive No.	Description	Measurements and supplementary information (from Dive Obs.)
01	1820	169	Iron reinforcement	Rectangular profile. WA 01 has WA 73 lying across it and is concreted to it. Cannot ascertain true length as end is obscured by WA 73. Length: 2.35m (exposed length) Looks straight. From 0m on the tape to the bolt: 1m The bolt sticks out 0.55m, and is curved/bent Section measurements: Width, Long face: 0.17m. Width, short face: 0.15m.
09			Large iron box (as WA46)	See WA46
10	1897	172	Metal cylinder, vertical	Height upstanding: 55cm Diameter seabed 17cm Diameter top 22cm Circumference. Bottom: 80cm 6.9cm diameter of centre hole Approx. Diameter of pipes: 7cm, distorted to 10cm Length exposed base to base: southernmost pipe 58cm Northernmost pipe 90cm
11	1821	169	Iron reinforcement, W end	Has an obvious curve, and is 4.7m long. Has a similar rectangular section to WA 01. It is 0.16m by 0.16m in profile WA11 is orientated at 150 degrees. WA01 is orientated at 180 degrees.
12	1833	170	Sheathing	Cuprous Length: 0.07m (exposed) West 130 degrees West end upstanding 0.06m and disappears into the seabed at the eastern end.

WA No.	Dive Obs. No.	Dive No.	Description	Measurements and supplementary information (from Dive Obs.)
13	1869	172	Iron reinforcement	Length 4.85m Distance from lower end to bolt 3.8m Length of "l" (buried) 74 cm Length of bolt 48cm Diameter 3cm Protrudes slightly on other side Moulded 15cm Sided 15cm Diameter of 2nd bolt head: 6cm Diameter of 2nd bolt shaft: 6cm (concreted) Bolt close to non "l" end, 12cm long, Orientation of wa 13 (western end of which is buried). Second bolt is 75cm from western end of wa 13
14	1871	172	Iron reinforcement	Western end of WA 14 to first bolt 55cm, second bolt 1.14m Overall length 4m, flush with seabed at the end Sided: 12cm Moulded: 8cm Length of second bolt: 48cm, Diameter 3cm Length of first bolt: 14cm Diameter 3cm
15	1872	172	Iron reinforcement	Overall length 1.78m Sided: 15cm Moulded: 15cm
16	1873	172	Iron reinforcement, upright	Height upstanding: 75cm Moulded 8cm Sided 12cm Rectangular profile Bolt hole visible 40cm from the top
17	1874	172	Iron reinforcement, fragmentary	Overall length: 1.24m From eastern end to bolt 80cm Length of bolt 24cm, Diameter 8cm (?) Section: Sided: 15cm Moulded 8cm

WA No.	Dive Obs. No.	Dive No.	Description	Measurements and supplementary information (from Dive Obs.)
18	1875	172	Iron reinforcement, upright	Length upstanding: 2.84m Upstanding end to seabed: 1.6m (angled) Section: Sided: 16cm Moulded: 8cm
19	1876	172	Iron reinforcement, upright	Top of WA 19 to seabed 2.1m (straight line) Top to start of curve: 1.6m Curve to seabed: Sided: 15cm Moulded: 10cm
20	1877	172	Iron reinforcement	Overall length: 3.2m Sided: 14cm (wide) Moulded: 8cm (depth) No bolts
25	1878	172	Iron reinforcement	Overall length: 2.14m Sided: 10cm Moulded: 10cm Square section Orientation: 70 degrees Feature underneath western end of we25: (wa 81) iron reinforcement, copper bolts Length exposed 20cm, Length (visible) of bolt 45cm, diameter 3cm
26	1881	172	Iron reinforcement	Overall length: 43cm Sided: 10cm Moulded: 10cm Orientation: 100 degrees

WA No.	Dive Obs. No.	Dive No.	Description	Measurements and supplementary information (from Dive Obs.)
27	1891	172	Large iron box	**Base:** Northern face 2.15m Western face 3.25m Southern face 2.08m Eastern face 2.99m **Height of topside corners above seabed:** East 1m South west corner 74cm North west corner 1m Other corner 1.04m **Topsides:** Northern face 1.9m Eastern face 2.95m Western face 3m Southern face 1.98m
28	1884	172	Iron reinforcement, position on WA datum tag	North eastern end 30cm upstanding Overall length: 1.14m Distance exposed end to bolt 60cm Sided: 10cm Moulded: 10cm Diameter of bolt: 3cm Length of bolt 35cm
31	1933	174/175	Iron reinforcement	WA32 *and* WA31. Two bolts sitting in the same iron reinforcement Orientation; 300 degrees WA32 - S0 WA31 - S1 Iron reinforcement they are in is mostly buried. Length exposed is ;0.75m Sided 0.15m Moulded; 0.10m v. Concreted. W. End to 1st bolt; 0.21m W. End toto 2nd ; 0.69m Wa32 is 0.49m upstanding Diameter; 0.32m bolt is cuprous. Wa31 0.53m upstanding Diameter 0.32m

WA No.	Dive Obs. No.	Dive No.	Description	Measurements and supplementary information (from Dive Obs.)
32	1933	174/175	Iron reinforcement	See 31 above
33	1932	174/175	Iron reinforcement (Z-shape)	Z shaped. Orientation; 320 degrees Length of long arm; 2.50m outer face 1st length of z ; 0.40m 2nd length of z; 0.25m end appears broken here. Length 0.44m across z Outer face to end of z 0.44m Moulded? Depth 0.15m Width 0.11m
34	1934	174/175	Misc., iron cylinder/pipe	Cylinder Hole in one end Small concretions attached. Length; 0.63m Diameter; 0.095m
35	1929	174/175	Iron reinforcement	2 bolts. Straight in shape. Cross section rectangular Length; 2.48m Sided; 0.12m Moulded; 0.08m From end to 1st bolt; NE feature buried Orientation; 220 degrees Lose bolt found next to feature; NE end to 1st bolt. 0.45m all bolts 0.03m diameter. 1st bolt 0.11m long. NE end to 2nd bolt; 0.85m 2 nd bolt length; 0.28m. NE to 3rd bolt; 1.45m 3rd bolt 0.48 in length 0.03m in diameter bolt head still there diameter of bolt head is 0.06m. NE to 4th bolt; 1.95m length of bolt 0.21m NE end to 5th bolt; 2.33m Length bolt; 0.26m and its tagged. Bolts appear iron but are possibly copper alloy. Lose bolt copper alloy - wa87 next to wa35 Diameter; 0.22m Length; 0.57m Video shots taken of bolt. Possible p written on the head of the bolt. Nothing visible on the shaft

WA No.	Dive Obs. No.	Dive No.	Description	Measurements and supplementary information (from Dive Obs.)
36	1930	174/175	Cuprous fastening	Upstanding 0.235m datum; Diameter; 0.03m
37	1928	174/175	Iron reinforcement, fragment	Length; 1.35m Sided;0.15m Moulded; 0.10m Orientation; 260 degrees Length from eastern to 1st bolt (tagged bolt; 0.12m Eastern end to 2nd bolt; 0.66m. 1st bolt; height upstanding; 0.145m Diameter 0.03m concreted. 2nd bolt heavily concreted; 0.04m height upstanding.
38	1935	174/175	Iron reinforcement, upright	Slightly tapered at the top not broken, other end buried. Is at a slight angle Length upstanding; 1.19m Distance to seabed from exposed end; 0.55m Orientation 260 degrees Width at top 0.14m Depth at top; 0.06m At base depth; 0.075m Video shot taken looking south
40	1944	174/175	Iron reinforcement, S end	Feature is curved. Bolts protruding both sides. Length between arm tips 1.92m Inner face offset at 1m; 0.55m Tape orientation; 320degrees

WA No.	Dive Obs. No.	Dive No.	Description	Measurements and supplementary information (from Dive Obs.)
46	1893-6	172	Large iron box, centre point	Length of projection from south east corner 88cm Upstanding: 1.06m, south west corner of water tank. Upstanding 65cm, the north west corner of the water tank. **Top sides:** Western face 1.9m Northern face 2.87m Projection: 30cm Eastern face 2m Southern face 2.75m Top, measurements to notch: 60cm on eastern side Same on western side Height of notch 20cm, notch at right angle **Base measurements:** South face 2.09m Western face 3.2m Eastern face 3.3m North face 2.16m
48	1898	172	Iron reinforcement, upright	Overall length/ height upstanding: 28cm Sided: 12cm (wide) Moulded: 10cm (deep)
49	1899	172	Iron reinforcement	Overall length/ height upstanding: 2.7m Length to bolt from western end: 1.6m Length of bolt 28cm Diameter of bolt 3cm Sided: Moulded: 7cm Orientation: 300 degrees
50	1900	172	Iron reinforcement, upright	Length upstanding: 12cm Diameter concreted end 14cm Shaft 4cm Length exposed 47cm
51	1901	172	Iron reinforcement, upright	Overall length/ height upstanding: 1.15m Sided: 14cm Moulded: 10cm

WA No.	Dive Obs. No.	Dive No.	Description	Measurements and supplementary information (from Dive Obs.)
52	1843	170	Sheathing	Length exposed: 6.4m (to trench 1), 7.4m total. Upstanding: 0.07m at eastern end. Distance between nails: 0.08m. A continuation from trench 1. Some copper nails are present, at the eastern end of the sheathing, which measure 0.035. Joints obscured by marine growth.
53	1902	172	Iron reinforcement, L-shape	Length to L on southern arm: 1.2m Length from L to east 75cm Length to bolt 60cm Length of bolt 40cm (exposed) 3cm diameter Moulded: 7cm Sided: 9cm
54	1842	170	Iron reinforcement	Upstanding: 0.76m Width of long face: 0.17m Width of other face: 0.11m Rectangular in section.
56	1840	170	Cuprous fastenings (2)	Length upstanding: 0.05m Diameter of head: eroded Diameter of bolt: 0.03m Bent.
57	1839	170	Cuprous fastenings (2)	Length upstanding: 0.49.3m Diameter of head: eroded Diameter of bolt: 0.03m
58	1838	170	Cuprous fastening	Length upstanding: 0.22m Diameter of head: eroded Diameter of bolt: 0.018m
60	1836	170	Cuprous fastening	Length upstanding: 0.18.5m Diameter of head: eroded Diameter of bolt: 0.03m
61	1834	170	Cuprous fastening	Length upstanding: 0.26m Diameter of head: 0.05m Diameter of bolt 0.02m
62	1841	164, 165	Cuprous fastening	Length upstanding: 0.26m Diameter of head: eroded Diameter of bolt: 0.022m

WA No.	Dive Obs. No.	Dive No.	Description	Measurements and supplementary information (from Dive Obs.)
63	1835	170	Cuprous fastening	Length upstanding: 0.12m Diameter of head: 0.02m, eroded. Diameter of bolt:
64	1832	170	Iron reinforcement	Slightly curved on the moulded face. Bolts are located on the inside of the curve Length; 3.05m Sided; 0.14m Moulded; 0.10m Orientation; 250 degrees tag at sw end Two bolts in feature. Length to first bolt from sw end;1.13m Bolt 0.04m diameter. Length of bolt with on eastern sided 0.33m long were bolt head it then on the other side it protrudes 0.165m Distance between first bolt and second bolt; 0.66m Protrudes both sides.0.35m on the eastern side, 0.16m on the western side. Bolts diameter; 0.04m
65	1831	170	Iron reinforcement, upstanding	Square in section, slightly obscured by concretion. Length upstanding; 1.03m Sided; 0.14m Moulded;0.08m
66	1829	170	Iron reinforcement	Rectangular in section. Length 0.89m Sided; 0.16m Moulded; 0.12m
67	1830	170	Iron reinforcement	0ne iron bolt in the sided face, partially buried - s.e end buried. 320 degrees Length; 1.44m Sided; 0.15m Moulded; 0.10m Se end to bolt centre ;0.54m Length of bolt; 0.47m Diameter of bolt; 0.04m
68	1828	170	Iron reinforcement	Slightly curved broken/ concreted at the north eastern end. Length;1.26m Sided;0.15m Moulded; 0.10m Rectangular section

WA No.	Dive Obs. No.	Dive No.	Description	Measurements and supplementary information (from Dive Obs.)
69	1827	170	Iron reinforcement, upright	Length upstanding; 0.76m Sided; 0.15m Moulded; 0.12m Slightly curved Rectangular section
73	1926	170	Iron reinforcement,	It is more or less straight, and might be concreted to WA11. Length: 2.15m Width across top face: 0.11m Depth: 0.15m The ends don't appear broken Orientated at NE end 240 degrees Profile: possibly square concreted and partially obscured.
74	1808, 1825	170	Misc., iron artefact	Length; 1.20/1.15m Width (from middle);0.08m Depth upstanding 0.085 and it is partly buried The southern end is upstanding 0.11m and is also partly buried
80	1844	170	Cuprous fastening	Loose eroded copper pin lying on seabed. Length: 0.12m Width: 0.015m
82	1879	172	Iron reinforcement	Overall length: 3.34m Sided: 10 cm Moulded: 10cm Orientation: 150 degrees
83	1880	172	Iron reinforcement, upright	Overall length upstanding: 43cm Sided: 15cm Moulded: 10cm (unclear)
84	1882	172	Iron reinforcement	Upstanding at shallow angle, western end disappears into seabed, eastern end 39cm upstanding Overall length: 1.24m Length to bolt 1.14m from exposed end Bolt head 5cm Bolt diameter 3cm Sided: 20cm Moulded: 15cm Orientation: 40 degrees
85	1883	172	Iron plate, under part of WA84	Partly buried by stones, obscured by WA 84, Area of exposure: 20cm by 20cm, 4cm thick

WA No.	Dive Obs. No.	Dive No.	Description	Measurements and supplementary information (from Dive Obs.)
86	1927	174/175	Iron reinforcement , L-shaped	SW end upstanding end of knee length; 2.25m Orientation; 270 degrees Sided; 0.15m Moulded; 0.10m Length of other arm; 1m Has a number of concretion on the sided face (the one measured) possible bolt heads. Distance from end of knee to 1st bolt; 0.06m 3 bolts visible before arm in seabed 1st to 2nd bolt; 0.3m 2nd to 3rd bolt; 0.38m Bolts are heavily concreted.
88	1931	174/175	Iron reinforcement (W-shaped)	Arms of 'w' are straight. Orientation; 250 degrees Length of NE arm; 1.21m outer face. 1st length w 0.23m outer side 2nd length w 0.33m 3rd length of other arm ; 1.86m Width; 0.09m Depth; 0.13m Distance between the two arms; 2.90m Tape laid over the feature for a video mosaic
89	1936	174/175	Iron reinforcement	Orientation; 300 degrees Length; 1.79m Width; 0.11m Depth; 0.155
90	1943	174/175	Iron reinforcement	No bolts Orientation; 320 degrees Length; 1.85m Width; 0.15m Depth; 0.09m

WA No.	Dive Obs. No.	Dive No.	Description	Measurements and supplementary information (from Dive Obs.)
91	1956	174/175	Iron reinforcement	Copper alloy bolt on seabed beside it (WA 92) Bolt 24cm long, 2cm diameter at head, shaft 1.5cm On WA91 fragments of two copper alloy bolt, 10cm upstanding Length 1.65m Width 15cm (possibly moulded) Depth 17cm Lying flush with seabed on side Western end to first bolt 70cm, to broken bolt 1.14m
92	1956	174/175	Cuprous fastening	See 91 above
93	1923	173	Misc., iron plate fragment	Approx. 0.5m by 0.7m, 0.02-3m thick

Notes: Some features may be listed more than once if tracked diver positions were taken on more than one point of the feature.
Observations for Dives 174 and 175 were not recorded separately, due to operator error.

APPENDIX V: TRENCH DESCRIPTIONS

Trench No. 1 (WA05)

WA No.	Type	Description	Depth
100	Layer	Poorly sorted coarse sand and gravel with some very small cobbles. Mobile sediment characteristic of the seabed in and around the site. Deposited post-wrecking event.	0.05m
101	Layer	Poorly sorted coarse sand and gravel with greater component of cobbles of all sizes than 100. Darker colour than 100. Boundary between 100 *and* 101 could not be defined sufficiently to plan in section. Depth of layer variable. Mobile sediment characteristic of the seabed in and around the site, observed below 100 in bream nests. Deposited post-wrecking event.	Variable, 0.03-uncertain, below 100.
102	Feature	Wooden hull structure (incorporates 103-110). Probably incorporates futtocks, outer and inner planking, copper sheathing and iron knee rider or other reinforcement. Deposited during wrecking event.	Unknown, below 100.
103	Feature	Rectangular section wooden post. Probably oak. Probable futtock. Deposited during wrecking event.	Uncertain, below 100.
104	Feature	Rectangular section wooden post. Probably oak. Probable futtock. Deposited during wrecking event. Wood sample 2.	Uncertain, below 100.
105	Feature	Rectangular section wooden post. Larch. Probable futtock. Deposited during wrecking event.	c.0.14m, below 100.
106	Feature	Rectangular section wooden post. Probably oak. Probable futtock. Deposited during wrecking event.	Uncertain, below 100.
107	Feature	Wooden plank. Elm. Probable outer planking. Deposited during wrecking event. Wood sample 1.	Uncertain, below 100.
108	Feature	Cuprous metal sheets attached to southern face of 107. Probable joint between two sheets visible. Probable hull sheathing. Deposited during wrecking event.	Upper edge exposed above seabed, not excavated
109	Feature	Wooden plank. Elm. Probable ceiling (inner) planking. Deposited during wrecking event. Wood sample 3.	Uncertain, below 100.
110	Feature (WA55)	Upright rectangular section iron post, probably fragmentary, with cuprous bolt, probably attached to 109 and 104 by buried cuprous or iron bolts. Iron hull reinforcement, probably a knee rider.	Not excavated

Trench No. 2 (WA08)

WA No.	Type	Description	Depth
200	Layer	Poorly sorted coarse sand and gravel with some very small cobbles. Mobile sediment characteristic of the seabed in and around the site. Deposited post-wrecking event.	Variable not exceeding 0.05m, not recorded
201	Layer	Poorly sorted coarse sand and gravel with greater component of small cobbles than 200. Darker colour than 200. Boundary between 200 *and* 201 could not be defined sufficiently to plan in section. Depth of layer variable. Mobile sediment characteristic of the seabed in and around the site, observed below 200 in bream nests. Deposited post-wrecking event.	Variable, not exceeding 0.10m, not recorded, below 200.
202	Layer	As 201 but slightly greater component of cobbles with wider size range.	Variable, not recorded, below 201
203	Feature	Apparently disarticulated wooden hull structure, incorporating 204-214.	Partially exposed on seabed, not recorded, below 202
204	Feature	Scarfed plank with possible sheathing nail holes. Pine. Probable outer planking. Wood sample 4.	Not recorded, below 202
205	Feature	Shaped timber. Probably oak.	Not recorded, below 202
206	Feature	Heavily eroded shaped timber. Possible plank.	Not recorded, below 202
207	Feature	Shaped timber.	Not recorded, below 202
208	Feature	Cuprous bar. Probable cuprous bolt or other fastening.	Not recorded, below 202
209	Feature	Shaped timber. Not in trench but adjacent and exposed during excavation.	Not recorded, below 202
210	Feature	Cuprous sheet with small cuprous nails penetrating north to south along upper edge. Distorted edge.	Not recorded, below 202
211	Feature	Thin piece of eroded timber.	Not recorded, below 202
212	Feature	Shaped timber with square hole, probably for an iron fastening. Wood sample 5.	Not recorded, below 202
213	Feature	Heavily concreted iron bolt, under and possibly attached to 205.	Not recorded, below 202
214	Feature	Shaped timber, upper surface eroded.	Not recorded, below 202
215	Feature	As 214.	Not recorded, below 202

APPENDIX VI: PROFILE DATA

Profile 1
(Data in Obs. 1911)

25m -7.9m (west)
24.5m - 7.8m
24m - 7.9m
23m - 7.8m
22m - 7.8m
21m - 7.9m
20m - 7.6m
19m - 7.6m
18.7m - 7.4m (top of **WA58**)
18m - 7.6m
17m - 7.6m (possible spoil from excavation)
c.17m - 6.9m (top of **WA55**)
16m - 7.6m
15m - 7.6m
14m - 7.4m
13m - 7.4m
12m - 7.4m
11m - 7.4m
10m - 7.3m
9m - 7.4m
8m - 7.8m
7m - 7.9m
6m - 8.2m
5m - 7.9m
4m - 7.8m
3m - 7.8m
2m - 7.8m
1m - 7.8m
Zero - 7.8m (east)

Notes: Ballast mound between 6.3m and approximately 10m.

Profile 2
(Data in Obs. 1913)

20m - 7.9m (north)
19.5m - 7.8m
19m - 7.8m
18m - 7.9m (in black sea-bream nest)
17m - 7.6m
16m - 7.8m (in black sea-bream nest)
15m - 7.6m
14m - 7.6m
13m - 7.6m

12m - 7.4m
11m - 7.3m
10m - 7.6m
9m - 7.9m
8m- 7.6m
7m - 7.6m
6m - 7.8m
5m - 7.9m
4m - 7.8m
3m - 7.8m
2m - 7.9m (in black sea-bream nest)
1m - 7.8m
Zero - 7.8m (south)

Notes: Trench 1 **WA55** on tag depth 6.6m, on top of reinforcement 6.8m
Ballast mound between 11.5m and approximately 9.5m.

Profile 3
(Data in Obs. 1915)

30m - 7.3m (east)
29m - 7.4m (bream nest)
28m - 7.3m
27m - 7.3m
26m - 7.3m
25m - 7.4m (nest)
24m - 7.3m
23m - 7.4m
22m - 7.4m
21m - 7.6m (nest)
20m - 7.6m
19m - 7.6m
18m - 7.6m
17m - 7.6m
(17.5m on ballast)
16m - 7.4m
15m - 7.3m
14m - 7.6m
13m - 7.6m
12m - 7.6m
11m - 7.6m
10m - 7.6m
9m - 7.6m
8m - 7.8m
(**WA70** at 8.3m approximately 1m from tape)
7m - 7.6m
6m - 7.4m
5m - 7.6m
4m - 7.6m
3m - 7.6m

2m - 7.6m
1m - 7.6m
0m - 7.8m (west)

Profile 4
(Data in Obs. 1960)

0m - 7.7m (north)
1m - 8.0m
2m - 7.9m
3m - 8.1m
4m - 8.0m
(4.5m on ballast)
5m - 8.1m
6m - 7.9m
7m - 7.3m (top of **WA 33**)
8m - 7.4m
9m - 7.6m
10m - 7.6m
11m - 7.8m
12m - 7.9m
13m - 7.7m
14m - 7.9m
15m - 7.7m
16m - 7.9m
17m - 7.7m (south)

APPENDIX VII: SAMPLING ANALYSIS

Sample:- Location:- Description:-	Sample A Location 1 (port - amidships) Sheathing Sample						
Processing option:- All results:-	All elements analysed (Normalised) In weight %						
Spectrum	In stats.	O (oxygen)	Cu (copper)	Zn (zinc)	Pb (lead)	Sn (tin)	Total
Position 1	Yes		62.83	37.17			100
Position 2	Yes		15.28	9.78	74.94		100

Sample:- Location:- Description:-	Sample B Location 1 (port - amidships) Sheathing Fastening						
Processing option:- All results:-	All elements analysed (Normalised) In weight %						
Spectrum	In stats.	O (oxygen)	Cu (copper)	Zn (zinc)	Pb (lead)	Sn (tin)	Total
Position 1	Yes	0.87	85.02	8.96		5.15	100

Sample:- Location:- Description:-	Sample C Location 3 (starboard - bow) Sheathing Sample						
Processing option:- All results:-	All elements analysed (Normalised) In weight %						
Spectrum	In stats.	O (oxygen)	Cu (copper)	Zn (zinc)	Pb (lead)	Sn (tin)	Total
Position 1	Yes		61.44	36.96	1.6		100
Position 2	Yes	0.85	49.15	29.94	20.06		100

Tables courtesy of Ian Cundy

APPENDIX VIII: WOOD IDENTIFICATION ANALYSIS

The following report extract has been reproduced from Nayling (2005) by kind permission of the author.

Introduction

This document is a technical archive report on the recovery and subsequent identification of wood identification samples taken from a wreck provisionally identified as the Diamond, located in Cardigan Bay and designated as an historic wreck under the provisions of the Protection of Wrecks Act 1973. This investigation and analysis were carried out under an excavation licence issued by Cadw: Welsh Historic Monuments, on behalf of the licensee, Ian Cundy of the Malvern Archaeological Diving Unit.

The aims of this study were to recover wood samples for species identification, and to assess the tree-ring dating potential of timbers exposed by excavation carried out by the 'Preservation of Wrecks Act' dive team of Wessex Archaeology.

Methodology

The site was dived on once by the author following limited excavation by Wessex Archaeology. Samples were taken from timbers exposed in two locations designated Trench 1 and Trench 2. Samples were approximately $1cm^3$. Exposed timbers were examined visually to assess their suitability for dendrochronological analysis.

In the laboratory, the cell structure of all samples was examined in three planes under a high power microscope and identified using reference texts (e.g. Schweingruber 1978) and reference slides. Identification has only been taken as far as genus in cases where there is more than one native species and the cell structure of the wood is not sufficiently different to separate them (e.g. *Ulmus* spp.).

Results

A total of five samples were recovered for identification. These are listed in Table 1 giving information on their location and identification.

The identification of the samples indicate the use of pine for at least some of the outer hull planking; the use of elm for ceiling planking and possibly for hull planking; and the use of larch for some of the framing timbers. The majority of the frames examined in Trench 1 were however oak (*Quercus* spp.).

Most of the frames exposed in Trench 1 appear to comprise quartered oak timbers with long tree ring sequences (c.100 rings) making them potentially suitable for dendrochronological dating.

Comment

The wood identifications given here need to be compared with any documentary evidence for wood usage in the construction of the Diamond and any other likely wrecks which might be linked to the remains under investigation. It should be stressed that pine, elm and oak species are native to both Britain and the Americas, and that larch is native to the Americas and has been extensively planted in Britain since the eighteenth century (Brown 1928). Hence the wood identifications made here cannot, on their own, be used to identify the origin of the vessel under investigation.

The dendrochronological potential of the framing timbers exposed in Trench 1 is considered to be good. It is suggested that samples taken from multiple frames offer the potential to provide both dating and provenance for the timber used in the vessel's construction.

Acknowledgements

I am most grateful to Graham Scott and the rest of the Wessex Archaeology dive team who provided access to the site and also to Ian Cundy and members of the Malvern Archaeological Diving Unit for advice and background information.

References

Brown, H.P., 1928, *Atlas of the Commercial Woods of the United States*, Bulletin of The New York State College of Forestry at Syracuse University (Vol. 1, Number 4)

Schweingruber, F., 1978, *Microscopic Wood Anatomy*.

Table 1

Sample descriptions and microscopic identification

Sample	Description	Species Identification
01	Trench 1, outer hull plank?	Elm, *Ulmus* sp.
02	Trench 1, framing timber	Larch, *Larix* sp.
03	Trench 1, ceiling plank	Elm, *Ulmus* sp.
04	Trench 2, scarfed outer hull plank?	Pine, *Pinus* sp.
05	Trench 2, displaced timber with square hole (former Fe fastening?)	Elm, *Ulmus* sp.

APPENDIX IX: IDENTIFICATION OF THE SITE AS THE *DIAMOND*

The identification of the vessel contained within the site is currently being researched by Mr Cundy. WA understand that Mr Cundy no longer believes that the wreck is likely to be that of the *Diamond*, and is currently seeking to identify alternative suggestions (Ian Cundy pers. comm.). At the time of writing he is believed to be conducting a desk-based assessment of 19th century vessels lost in the area.

The assessment of the vessel identification evidence that has been produced is not part of the brief given to WA by CADW. Nevertheless the following comments can be made, based upon the WA fieldwork data and a limited analysis of the licensee's archive.

The length of the wrecked vessel is not known with certainty but appears be about 44 metres. This is considerably longer than the *Diamond*. Mr Bowyer has suggested that any disparity between the length of the site and the recorded length of the *Diamond* could be due to a collapse of the stern outwards (Michael Bowyer pers. comm.). There appears to be no visible archaeological evidence to support this, but as the site has not been excavated for the purposes of determining this issue and neither the stem or the stern post has been found, his theory cannot be entirely discounted at this stage.

Mr Iles states that the cuprous bolt stamped with a Muntz metal patent mark in his possession was raised from the south western end of the site, but that the precise find spot was not measured, photographed or otherwise recorded. Mr Iles appears from limited contact to be a straightforward and reliable witness but WA has not had the opportunity to examine the bolt (other than by photograph). It is also the case that WA have not conducted a sufficiently extensive search around the site to entirely discount the possibility of this bolt being a later intrusion.

Nevertheless if Mr Iles' account is accepted at face value, the stamp is in fact a Muntz metal patent stamp and the bolt is not a later intrusion, it provides a *terminus post quem* for the wrecking event of 1832, the date that the patent was taken out. This would rule out identification of the wreck as being that of the *Diamond*. This evidence is now corroborated by the sampling results. Whilst inconclusive in themselves, taken together they indicate a strong probability that the wreck was at least partly sheathed and fastened using items manufactured not earlier than 1832.

It should be noted that no firm evidence for the *Diamond* being reinforced with iron appears to have been published. Iron reinforcement is not characteristic of newly built early 19th century North American merchant vessels and the movements of the *Diamond* before its wrecking do not appear to have allowed sufficient time it to have been refitted with them. The presence of iron reinforcements and iron water tanks suggest that a mid-19th century European origin is more likely.

On balance the available evidence suggests that it is highly improbable that the vessel on this site is the *Diamond*. Nevertheless sufficient uncertainty remains concerning the archaeological evidence to prevent the theory that it is the *Diamond* from being entirely discounted at this stage. Mr Bowyer's belief that the probability of it being the *Diamond* is 99% (Michael Bowyer pers. comm.) cannot be supported at the present time.

APPENDIX X: FUTURE OPERATIONS PLANNING

The following advice is based upon experience using SSDE techniques only. It is intended as a general guide only and no liability can be accepted for reliance upon it.

General

The location is exposed and can suffer from significant sea swell. WA lost two days out of a total of eleven to adverse weather in June, and the experience of others suggests that the significant time is likely to be lost to adverse weather conditions at all times of year. Therefore if possible future operations should be scheduled in June, July or August to maximise the likelihood of coinciding with a period of settled weather. The site is potentially hazardous in all sea states other than 1-2.

Insufficient bottom time was achieved to determine the best conditions for good visibility. WA understands that periods of planktonic bloom are experienced, mainly in the spring or early summer. During these periods visibility may be seriously affected. Visibility is also likely to be affected after a prolonged period of rain, because of run-off from the land.

Approach

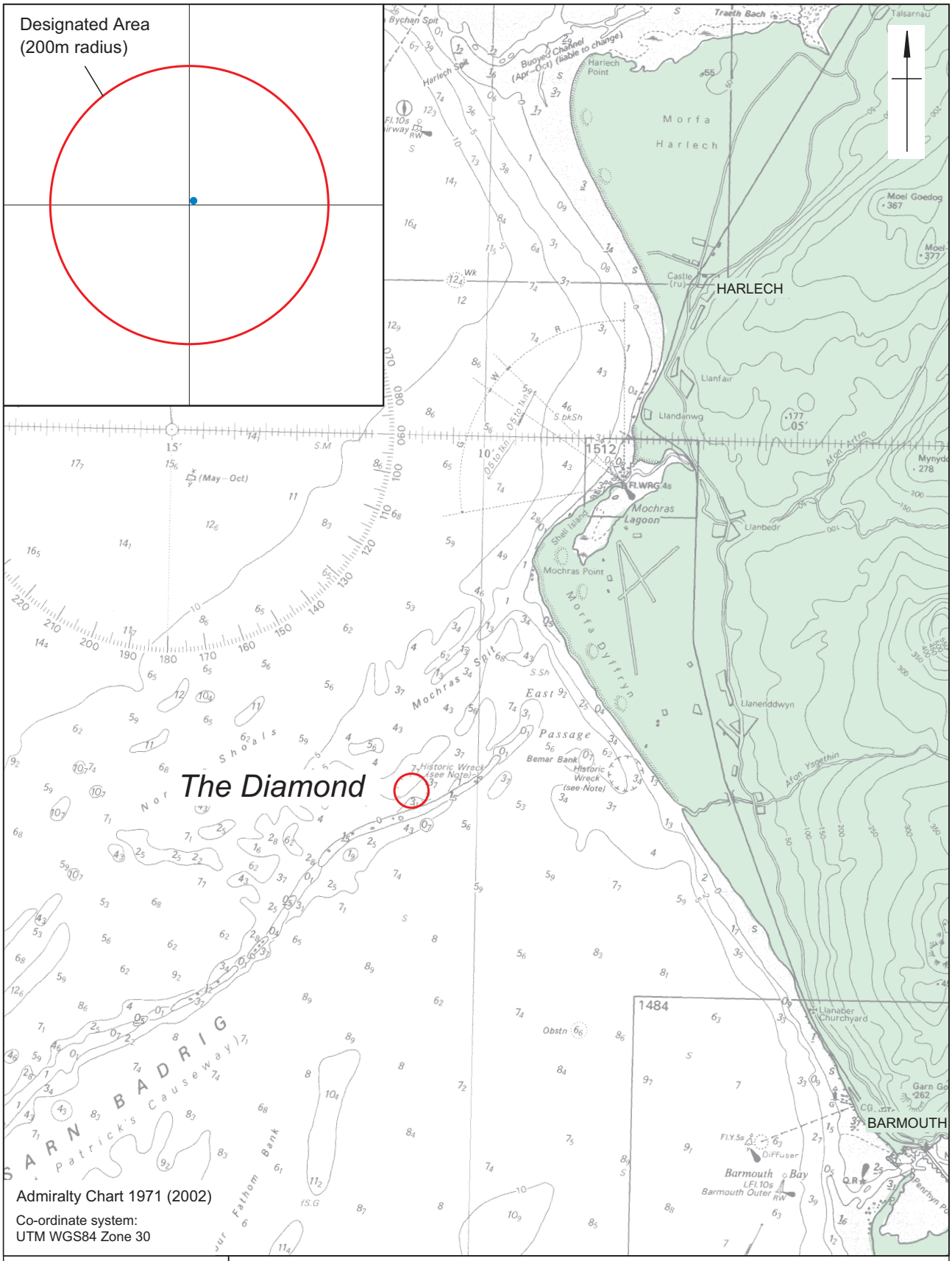
Sarn Badrig remains a significant navigational hazard at low water. Approach from the south should therefore be made with caution.

Anchoring

Anchoring was not found to be especially problematic, although there is a risk of dragging an anchor across the site. The dropping of anchors within 50 metres of the wreck should be avoided by all but the lightest craft. None of the archaeological features are suitable for the attachment of a mooring line, although it may be possible to use the more substantial features for securing a lightweight shot for use by ascending and descending divers. There is little risk of damage from the deployment of a lightweight shot from the surface, provided that an appropriate distance is kept from iron boxes **WA27** and **WA46**, whose iron plates may be or become fragile.

Dive Windows

Strong tidal currents are experienced at times on Sarn Badrig. These run from south to north on flood tides and from north to south on ebb tides. They can reach in excess of one knot, particularly close to the eastern end of the reef, where a narrow passage exists between the reef and the present shoreline. Reliable data concerning the strength of the flow in the vicinity of the site does not appear to exist, but WA followed advice received from Mr Cundy and Mr Bowyer (Ian Cundy and Michael Bowyer pers. comm.), and were possible dived at around the middle of the tide. As a result tidal currents did not significantly affect diving operations, although divers did experience some difficulty at times.



● Tracked diver position for centre point of wreck, N. water tank
52 46.534 N 004 11.021 W
(WGS. 84)

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Diamond site location

Figure 1

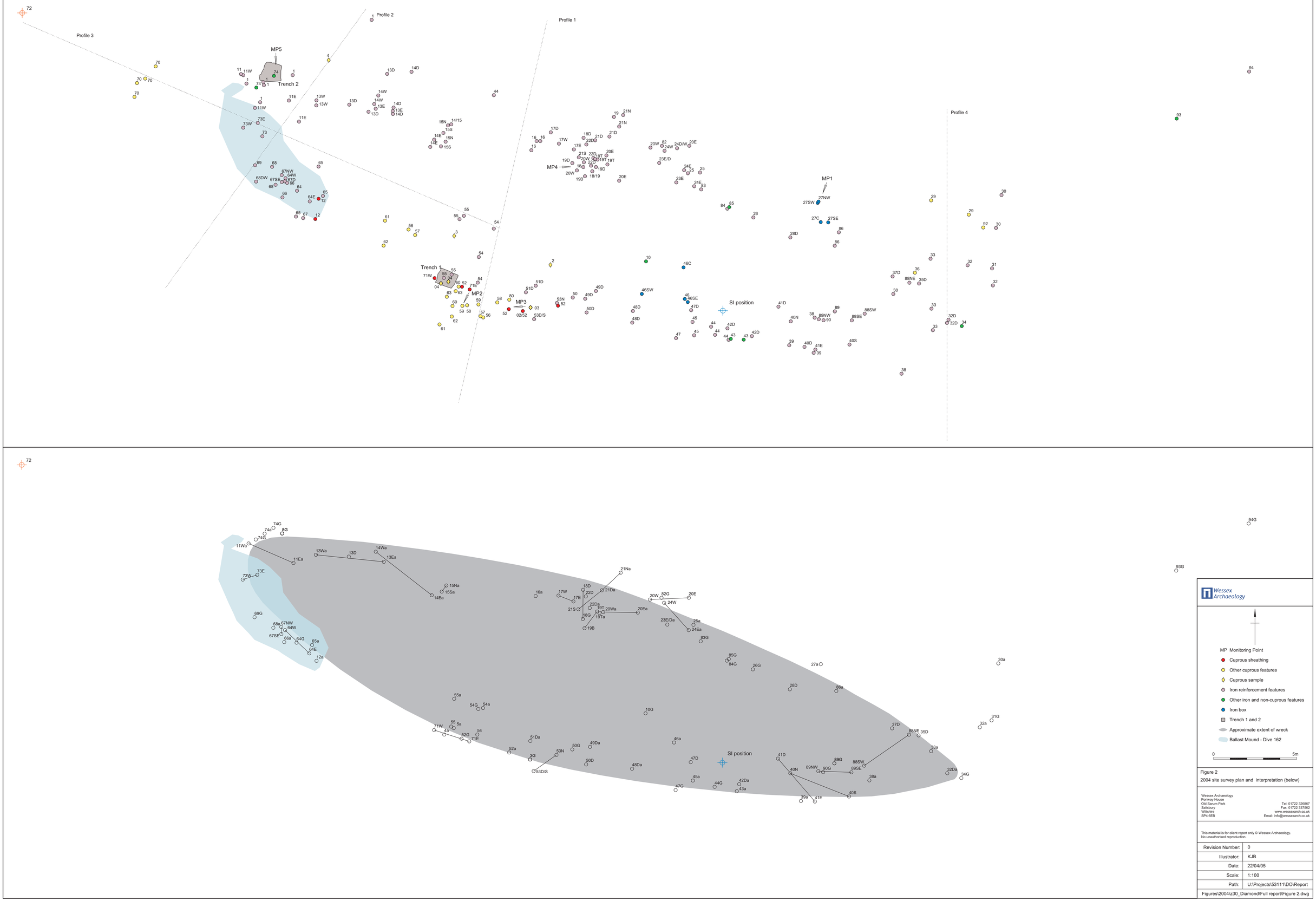

Figure 2
2004 site survey plan and interpretation (below)

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Revision Number:	0
Illustrator:	KJB
Date:	22/04/05
Scale:	1:100
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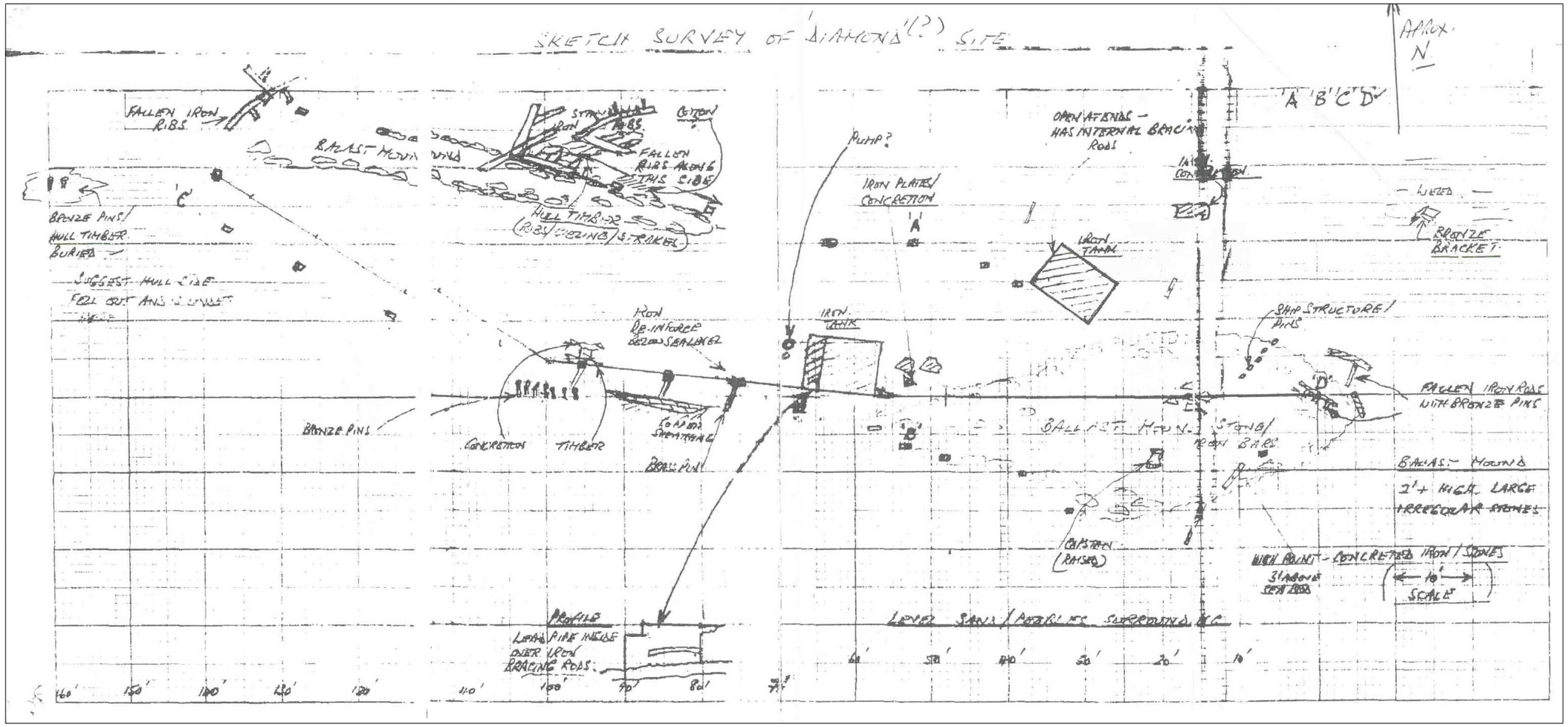
Figures\2004\u30_Diamond\Full report\Figure 2.dwg



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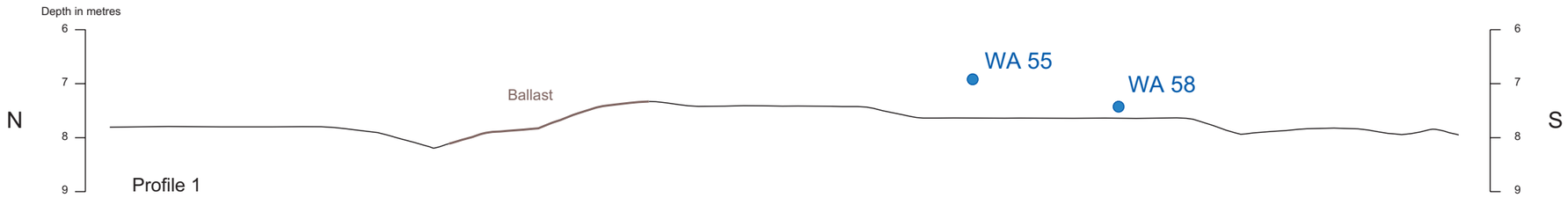
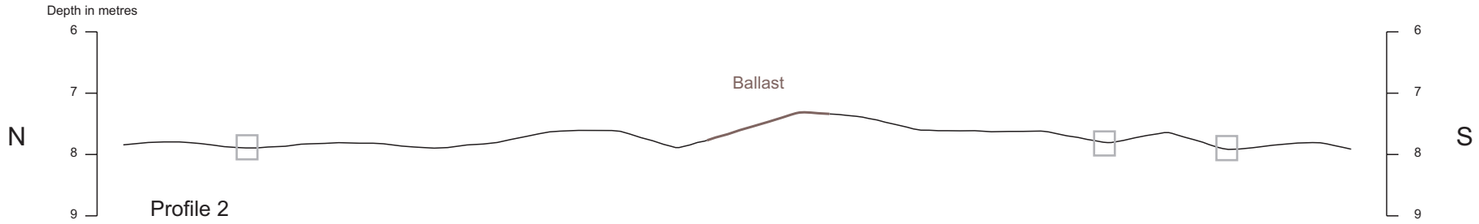
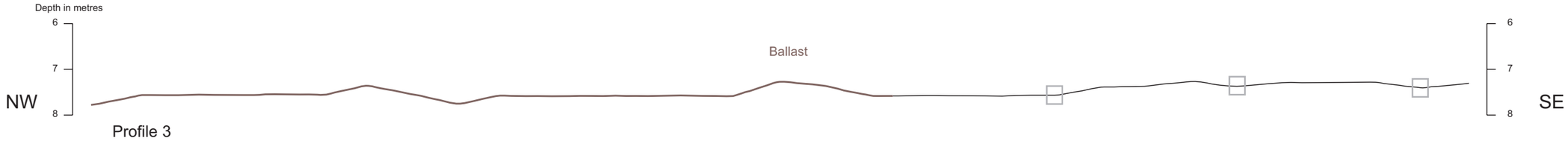
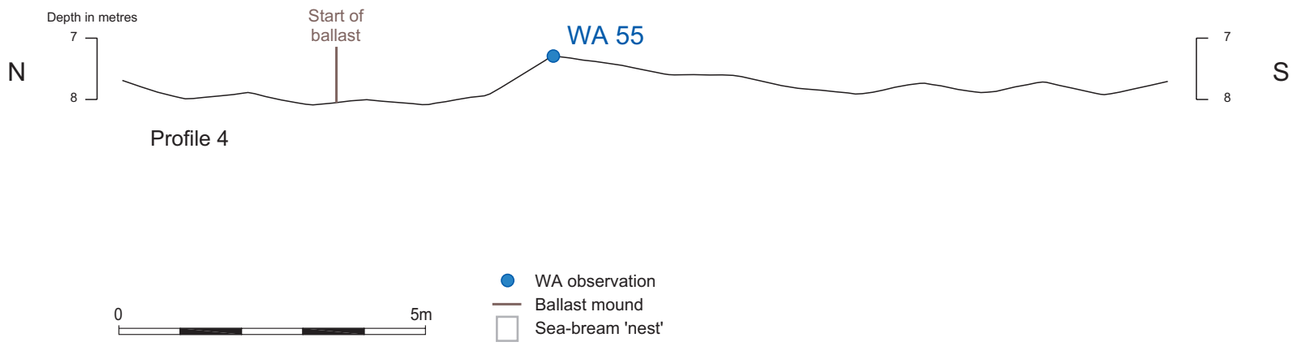
Site sketch plan (Mr A. Iles)

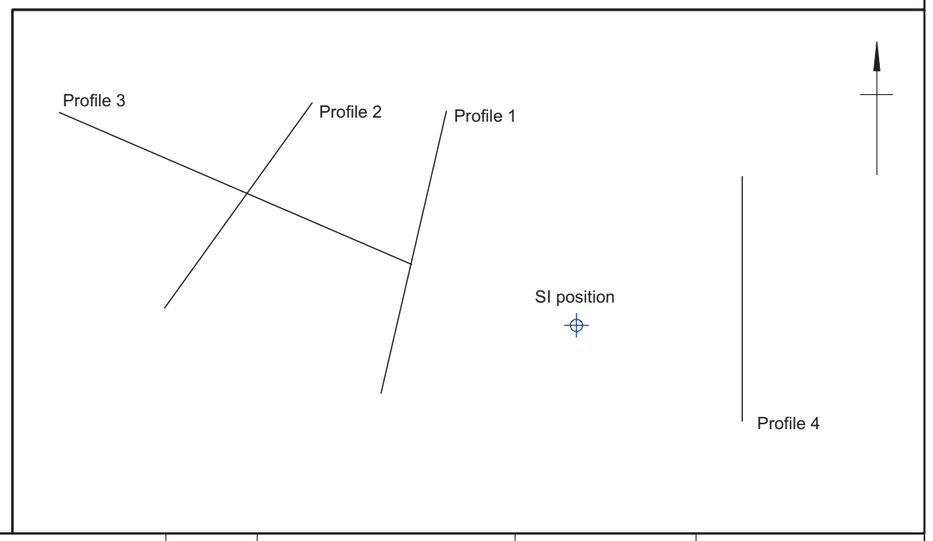
Figure 3











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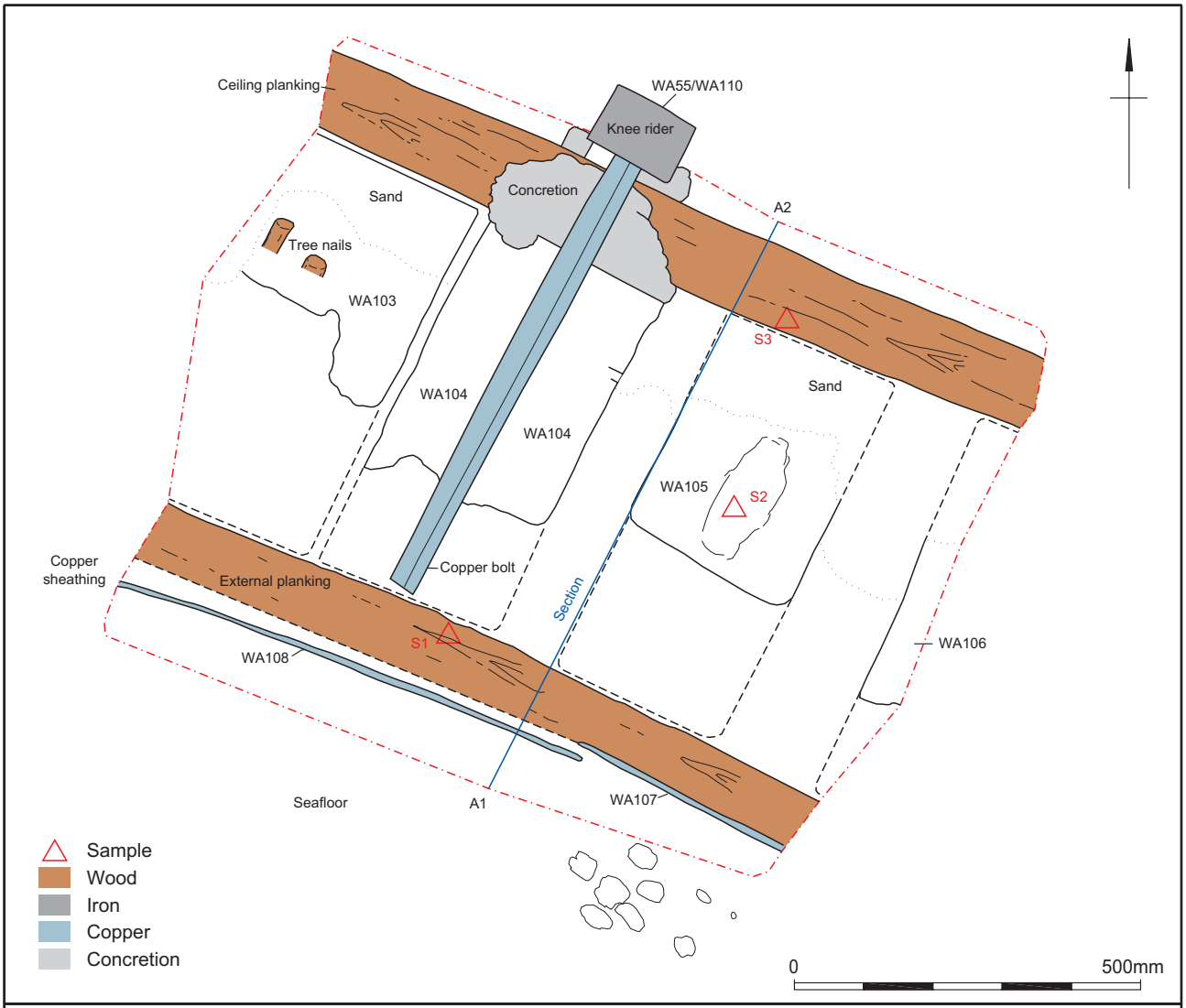
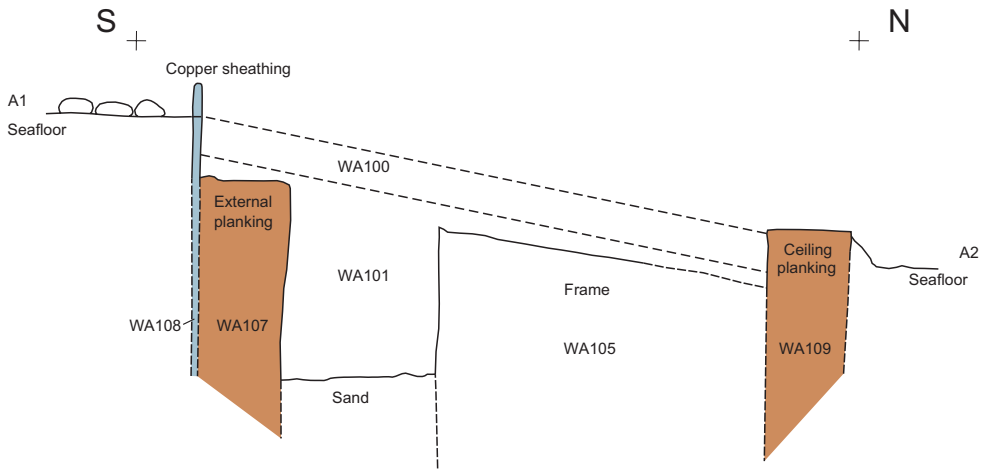
Profiles 1-4

Figure 4





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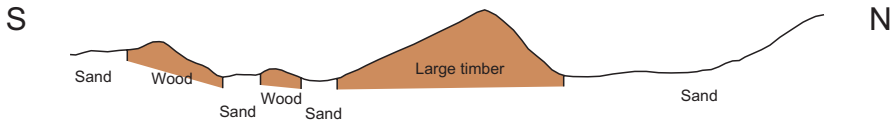
Wessex Archaeology

Trench 1 - plan and section

Figure 5



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Trench 2 - plan and sections

Figure 6

Plate 1: General view of southern edge of site, looking west-north-west

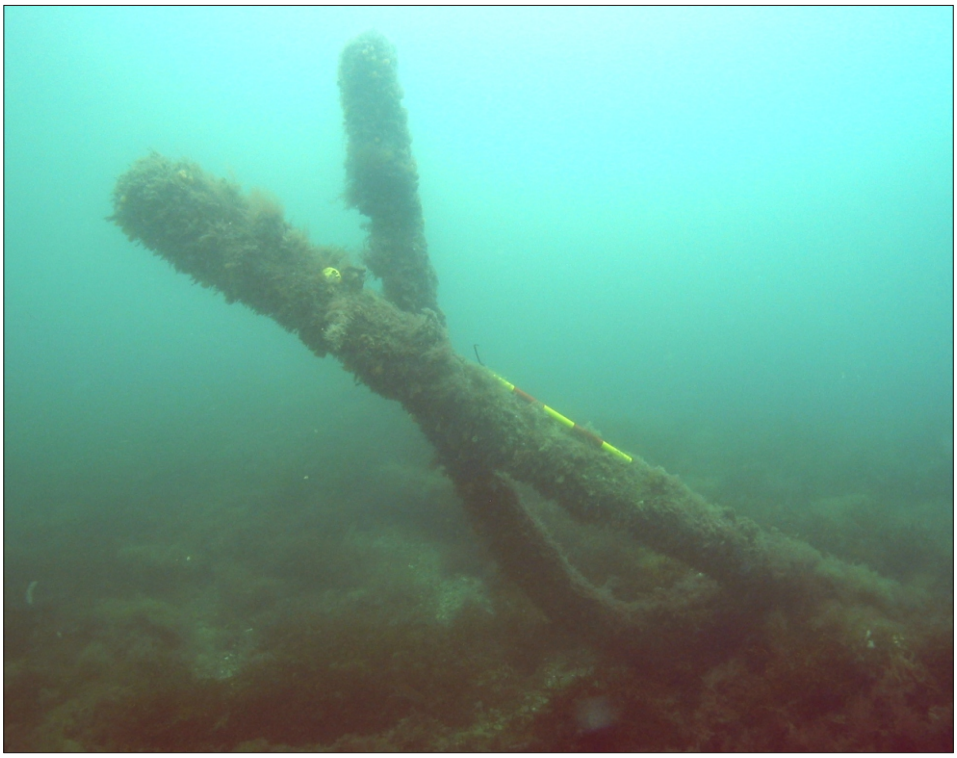

Plate 2: Knee-riders WA18 and WA19

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Plate 3: Knee-rider WA13

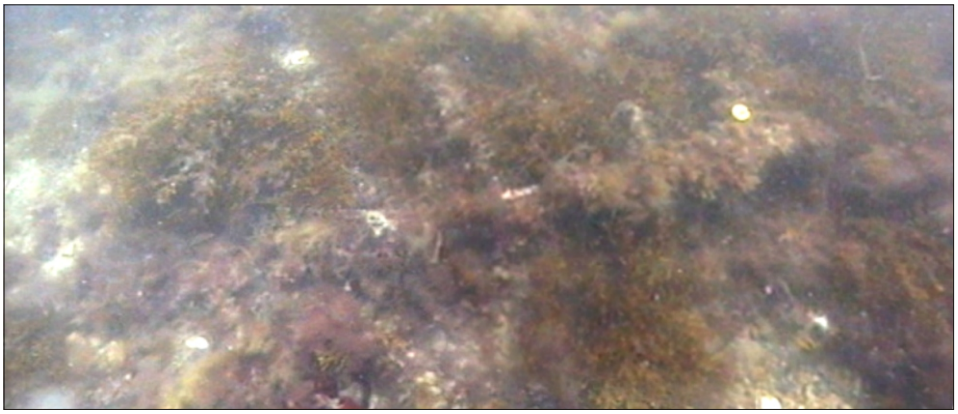


Plate 4: Iron reinforcement WA35

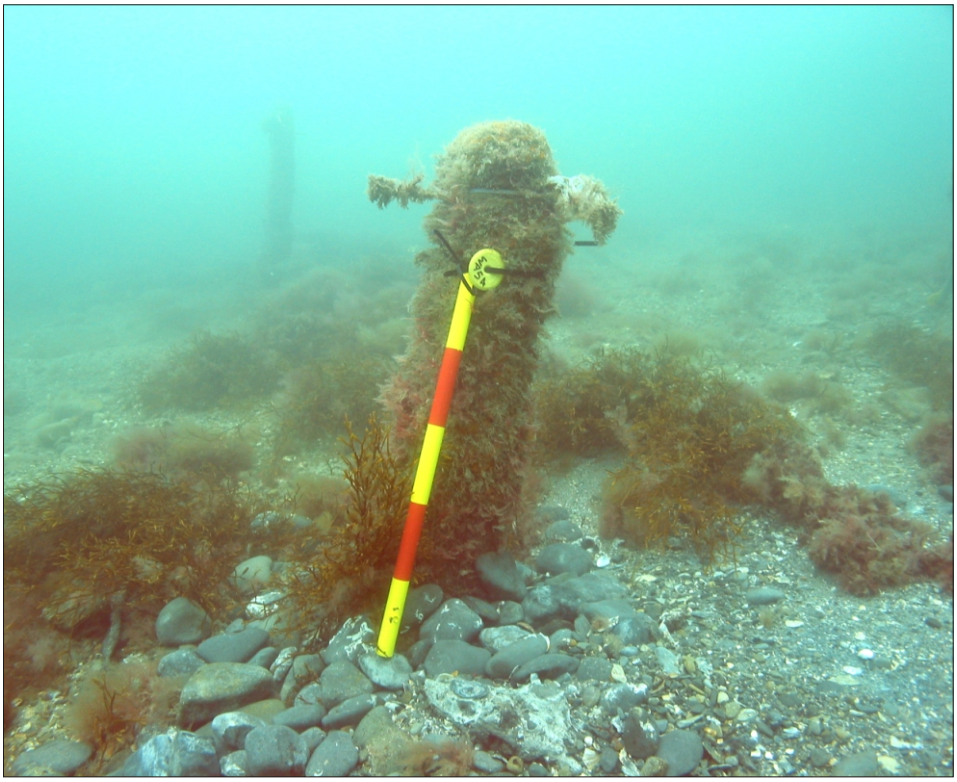


Plate 5: Knee-rider WA54

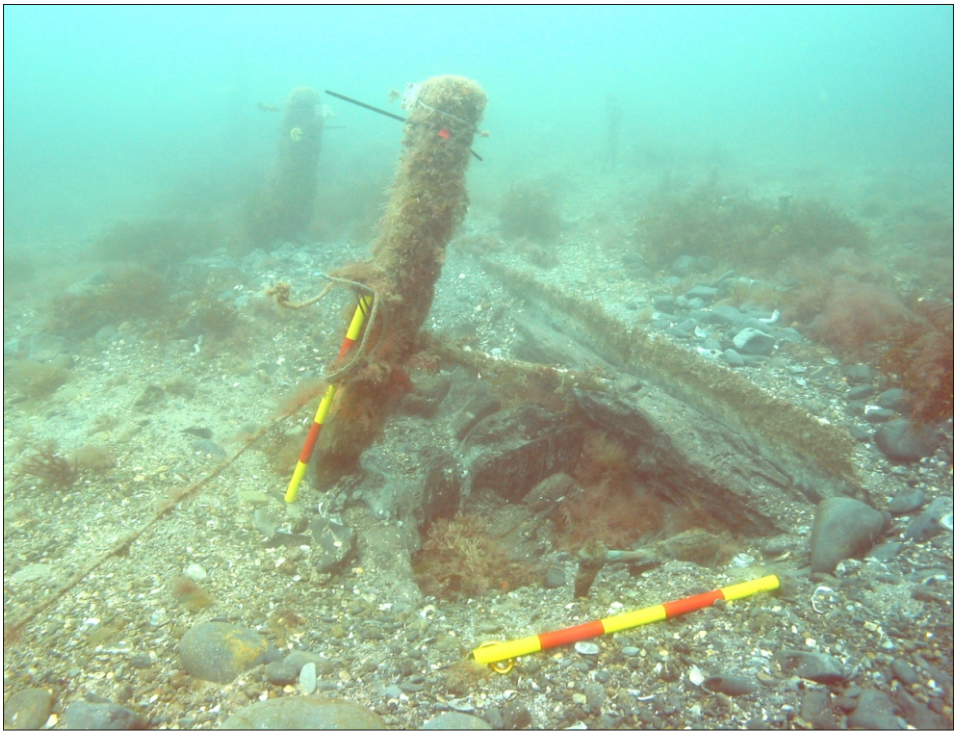
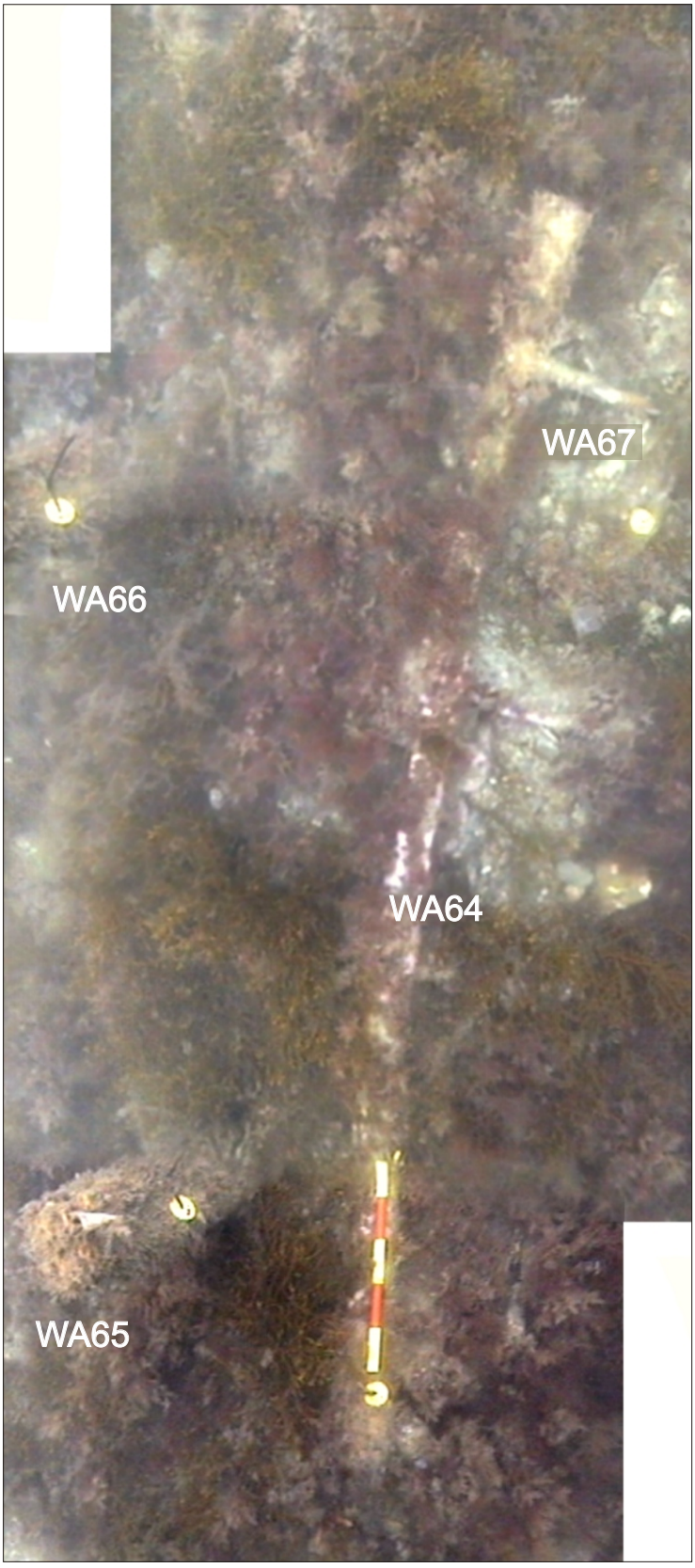


Plate 6: Knee-rider WA55 in Trench 1



Approx

Plate 7: Knee-riders WA64-67

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Plate 8: Iron reinforcement WA40

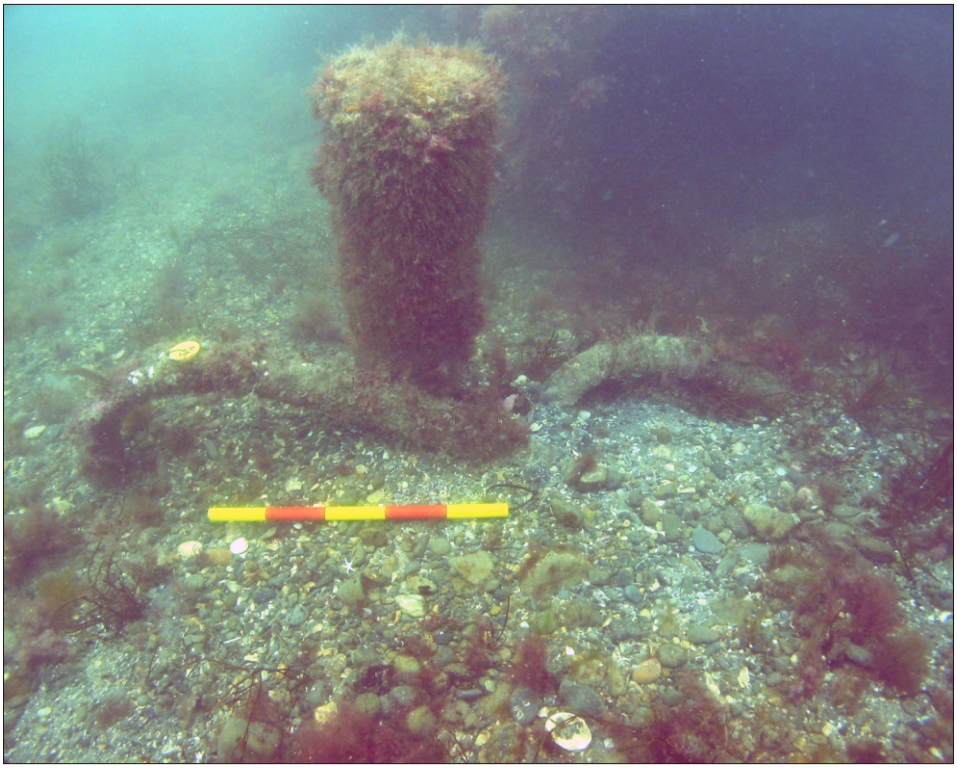

Plate 9: WA10 (possible part of a water pump)

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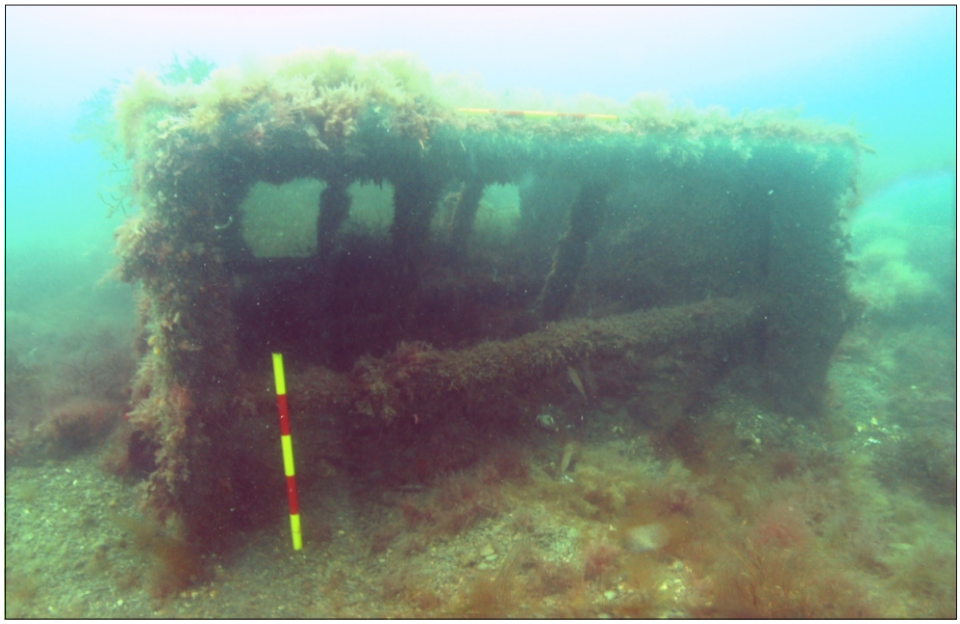

Plate 10: Iron box WA27

Plate 11: Iron reinforcement WA33

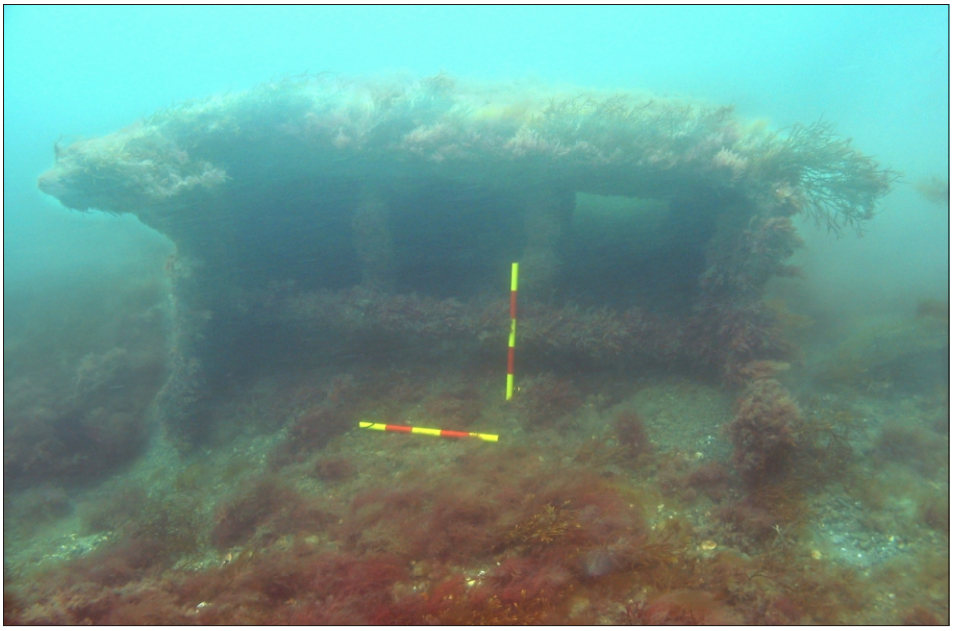

Plate 12: Iron boxWA46/09

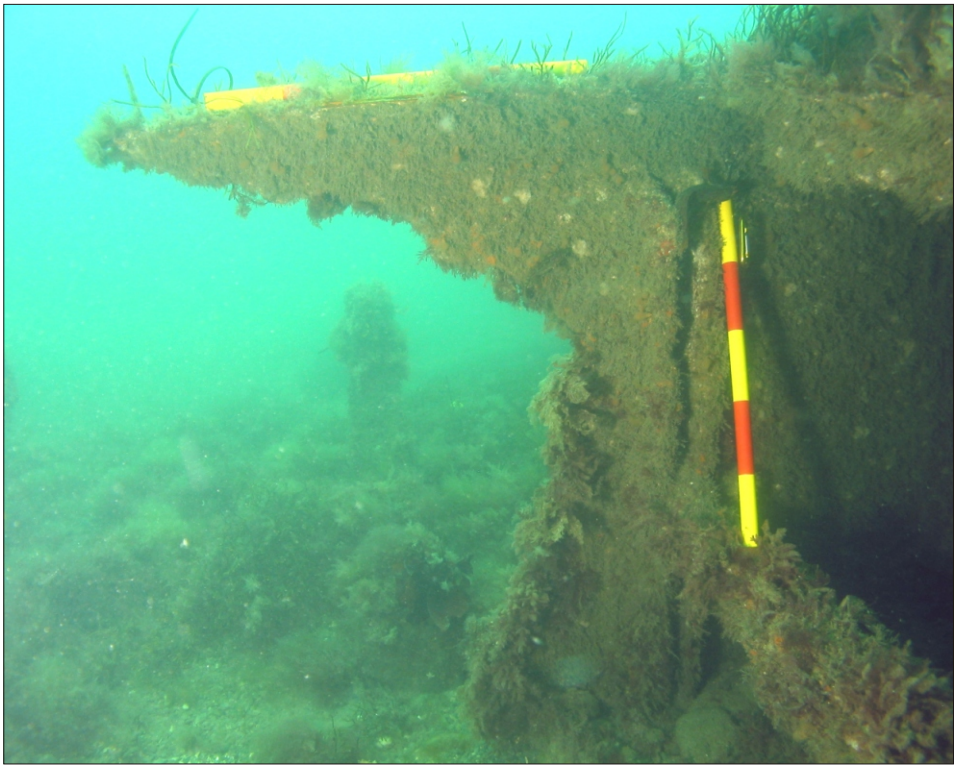

Plate 13: WA46 - detail (iron plate extension to box)

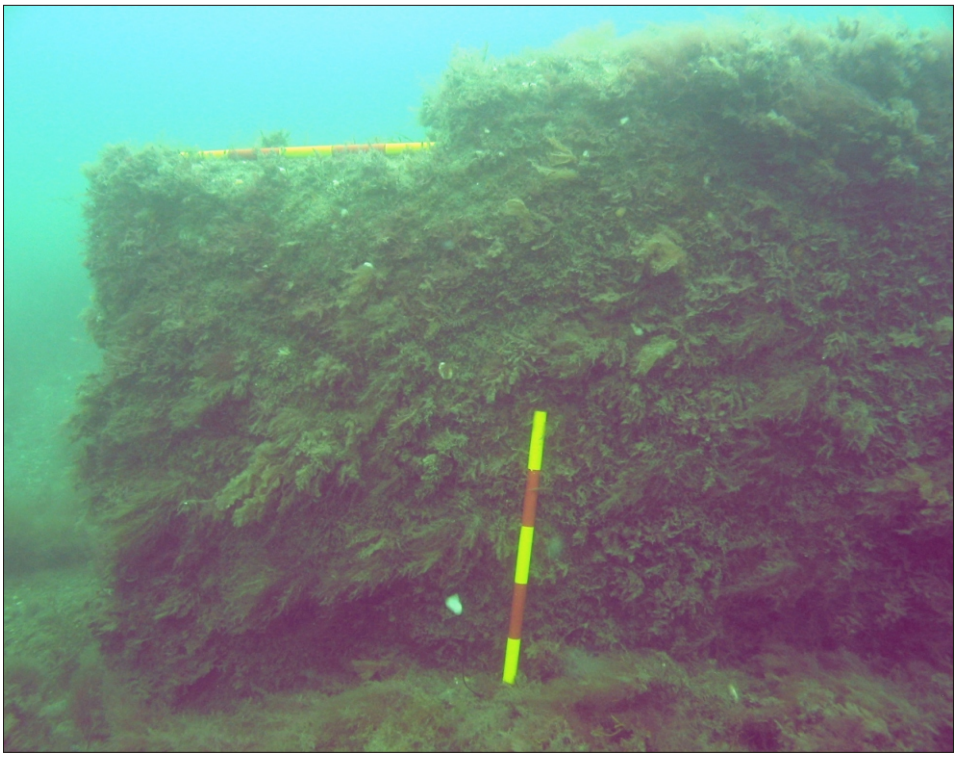

Plate 14: WA46 - detail (constructional feature)

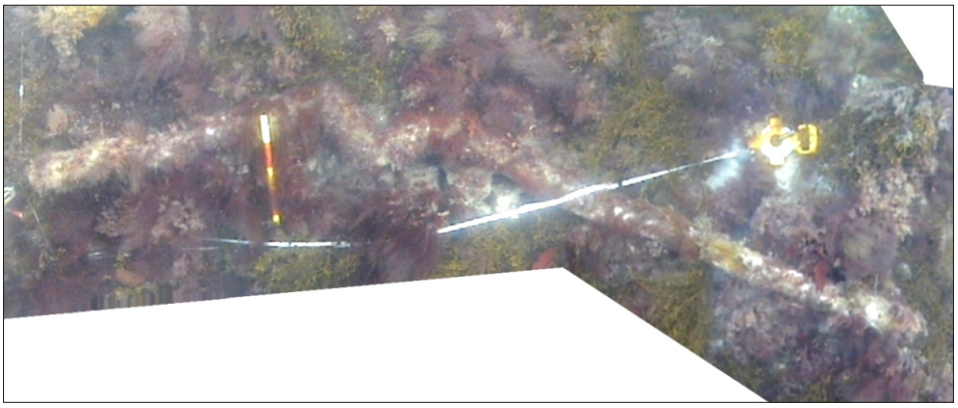

Plate 15: Iron reinforcement WA88

Plate 16: Iron plate fragment WA93

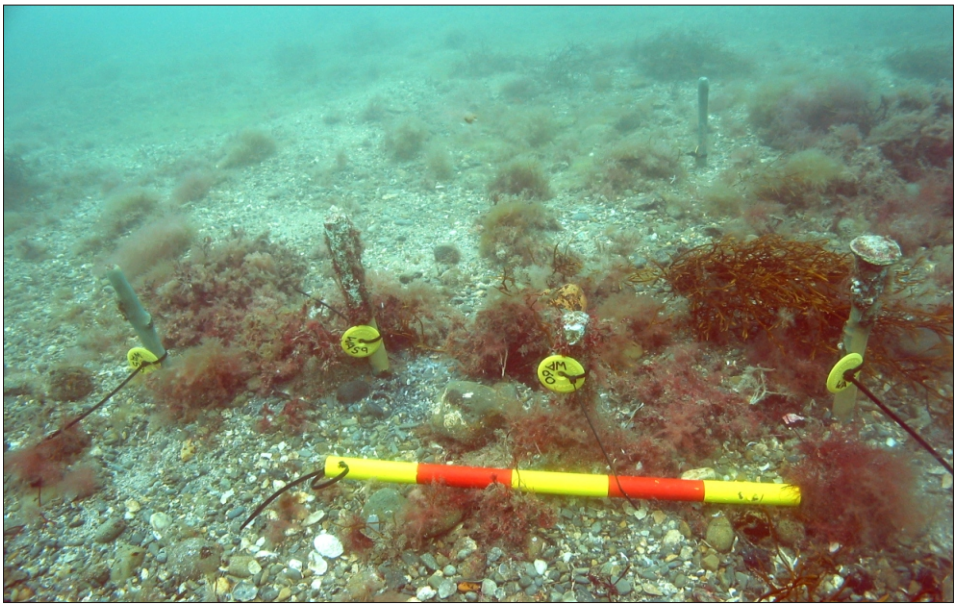

Plate 17: Cuprous bolts WA58-60

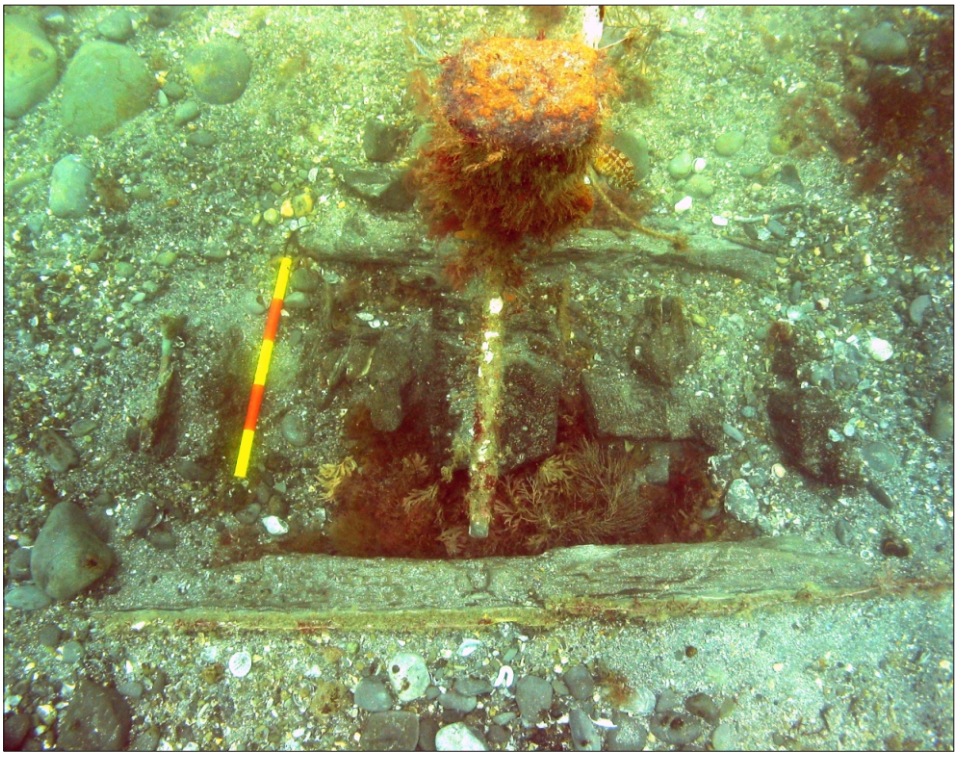

Plate 18: WA05 - sheathing joint

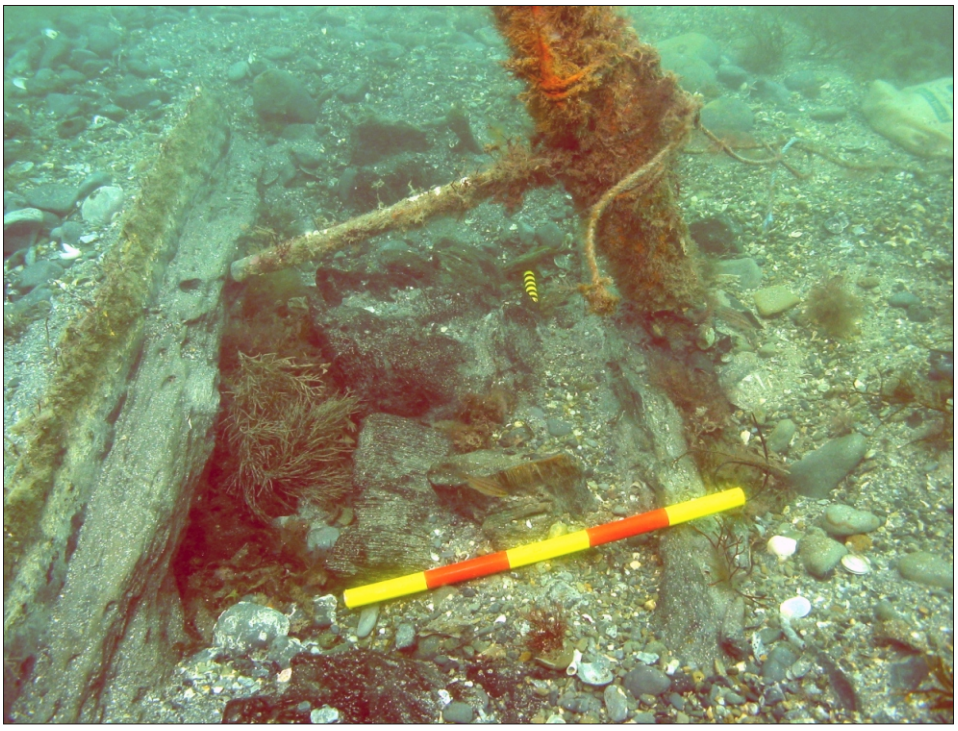

Plate 19: WA05 - Trench 1

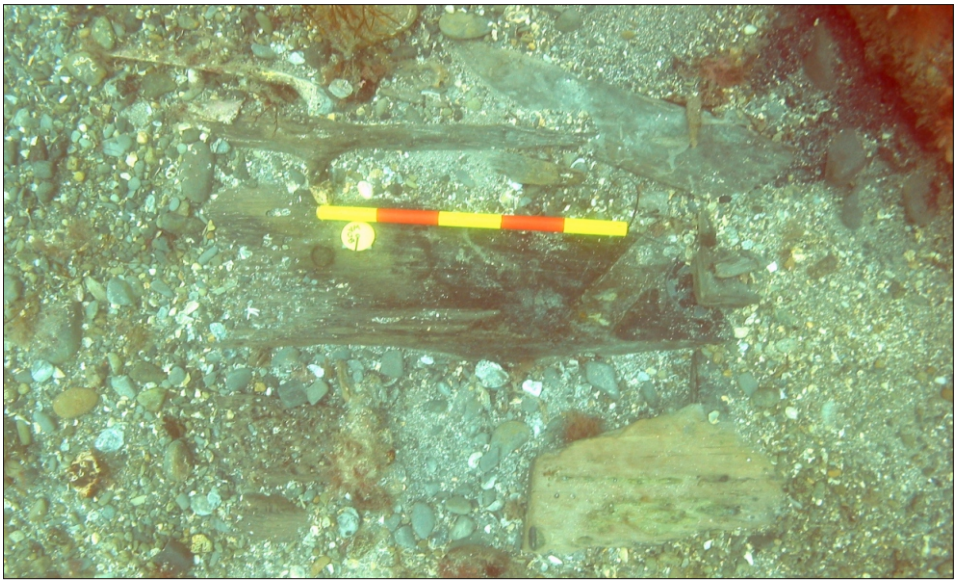

Plate 20: WA08 - Trench 2

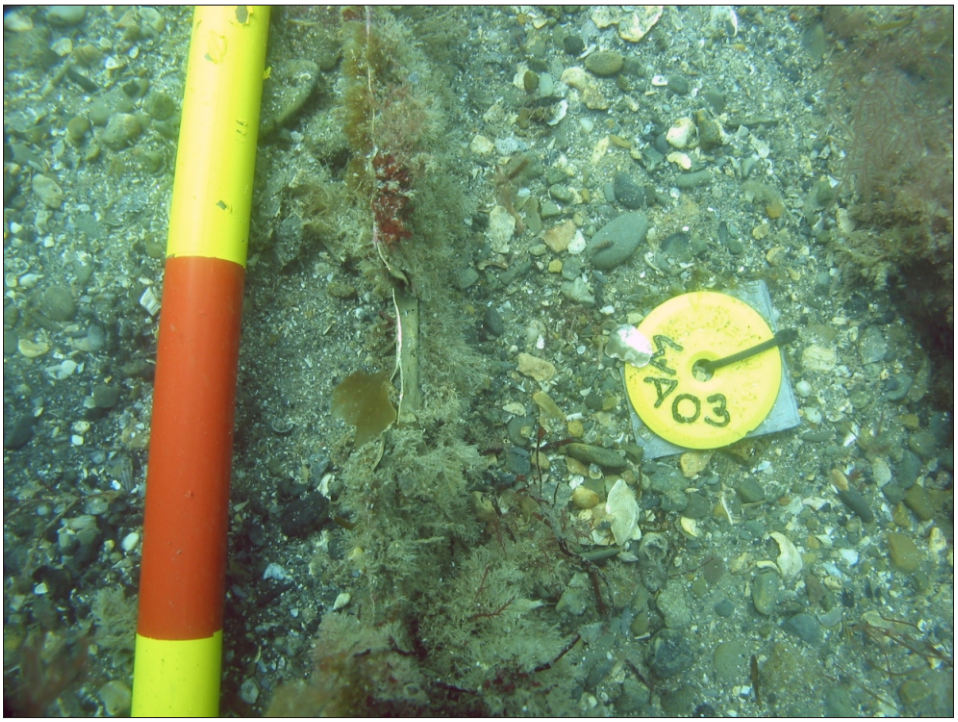

Plate 21: WA04 - Sheathing sample 3 location

Plate 22: Cuprous bolt stamped with Munz Metal patent (copyright Ian Cundy)

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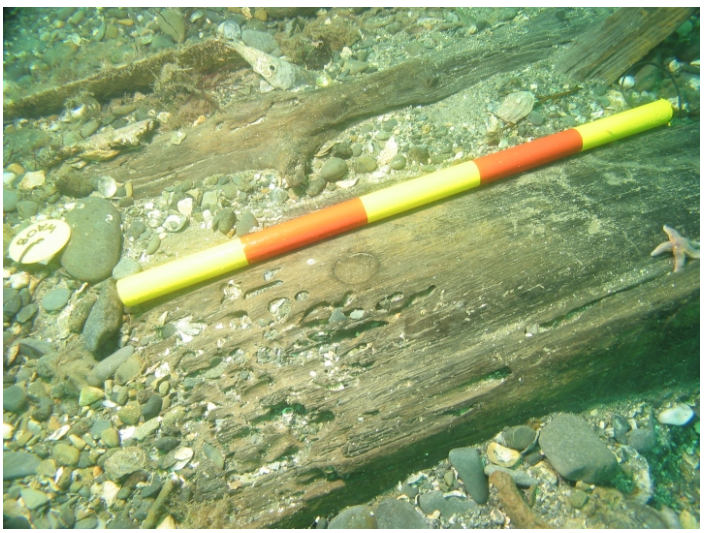

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