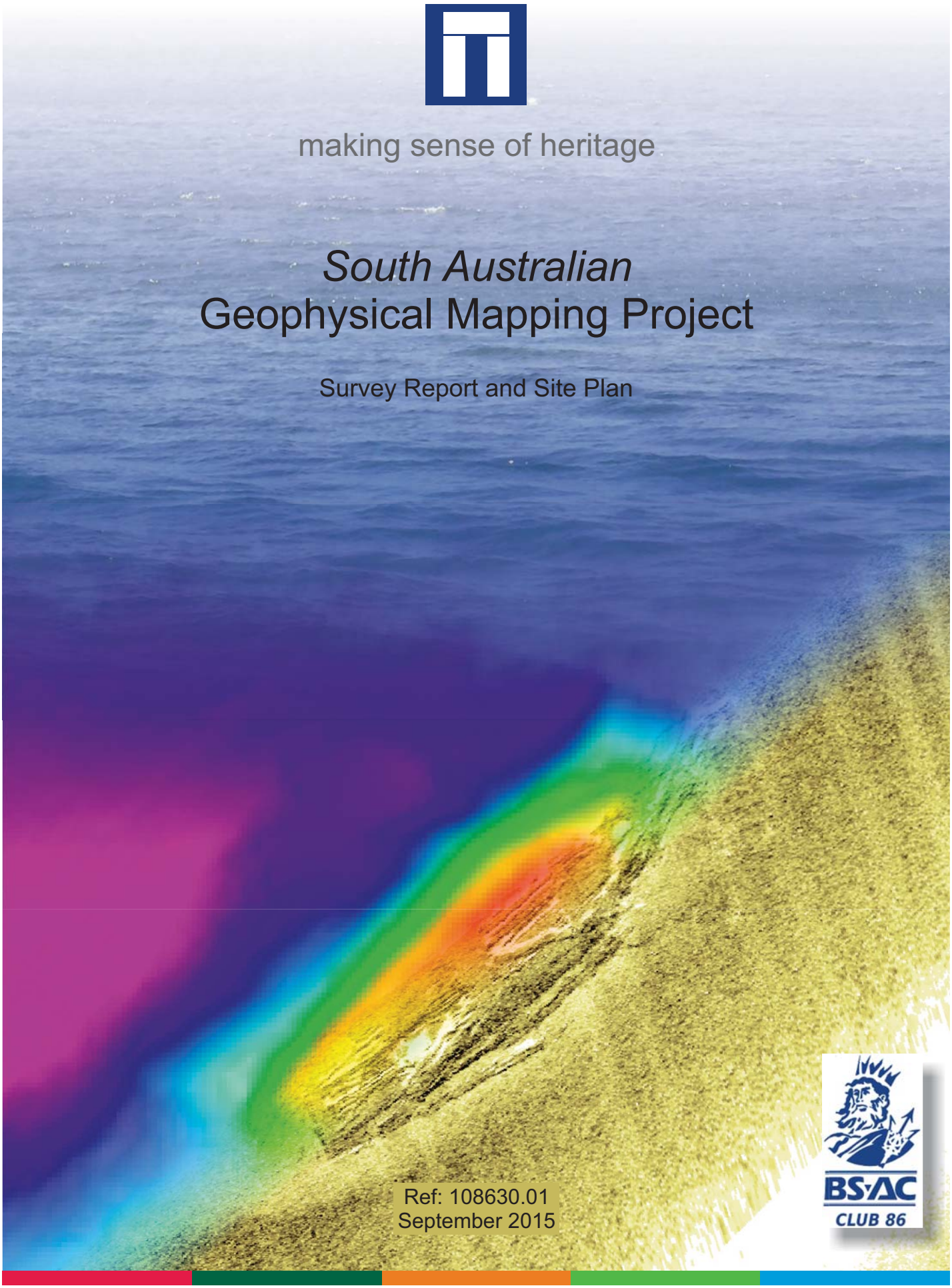
making sense of heritage

South Australian Geophysical Mapping Project

Survey Report and Site Plan



Ref: 108630.01
September 2015

BSAC CLUB 86

geoservices

South Australian Geophysical Mapping Project

Survey Report and Site Plan

Prepared for:
Ilfracombe and North Devon Sub-Aqua Club
Ropery Road
Ilfracombe
Devon
EX34 9EF

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

www.wessexarch.co.uk

September 2015

Report Ref. 108630.01

Quality Assurance

Project Code	108630	**Accession Code**		**Client Ref.**	
Planning Application Ref.		**Ordnance Survey (OS) national grid reference (NGR)**			

Version	Status*	Prepared by	Checked and Approved By	Approver's Signature	Date
V01	E	*S. Arnott*	*P. Baggaley*		23/09/2015
File:	108630_SouthAustralian_report_shla_20150911.docx				
V02	F	*S.Arnott*	*L.Tizzard*		28/09/2015
File:	108630_SouthAustralian_report_shla_20150925.docx				
File:					
File:					
File:					

* I = Internal Draft; E = External Draft; F = Final

DISCLAIMER

South Australian Geophysical Mapping Project

Survey Report and Site Plan

Contents

Figures

Plates

South Australian Geophysical Mapping Project

Survey Report and Site Plan

Summary

Wessex Archaeology conducted a geophysical survey of the wreck of the vessel *South Australian* in July 2015. The survey was undertaken on behalf of the Ilfracombe and North Devon Sub-Aqua Club with the main objective of producing a site plan to inform further diving investigations at the site.

The *South Australian*, built in 1868, was a clipper ship that traded between the UK and Australia and was heavily involved in the emigrant trade. In February 1889 she set sail from Cardiff, laden with rails and fish plates for railway customers, but foundered in severe weather in the Bristol Channel. The wreck was discovered by members of the Ilfracombe and North Devon Sub-Aqua Club in the late 1980s and positively identified as the *South Australian* in 2005.

The wreck lies approximately three miles northeast of the island of Lundy in the Bristol Channel. A sidescan sonar survey was conducted over the site on 23rd July 2015. The data were processed and interpreted along with multibeam bathymetry data obtained from the United Kingdom Hydrographic Office. Further interpretation of features was provided by the divers familiar with the wreck site. Georeferenced images of the geophysical datasets and the positions of the interpreted features were used to produce the site plan.

The interpreted features consist of the rail stack, adjacent scour, debris field and 13 individual items of debris within the debris field. The identities of the majority of the features are not known to the divers and will provide targets for further diving investigations.

South Australian Geophysical Mapping Project

Survey Report and Site Plan

Acknowledgements

The geophysical survey was conducted by Dr Stephanie Arnott and Laura Andrews of Wessex Archaeology aboard the dive vessel *Neptune* of the Ilfracombe and North Devon Sub-Aqua Club (ILFSAC). The vessel was skippered by Shaun Galliver and assistance was provided by Keith Denby, Piers Biddle and Richard Howell, all of ILFSAC. Martin Davis, ILFSAC's Diving Officer, provided enthusiastic support throughout the project.

The geophysical data were processed and interpreted by Laura Andrews. The report was principally written by Dr Stephanie Arnott of Wessex Archaeology. Keith Denby of ILFSAC wrote the Historical Background and Diving and Identifying the Wreck sections. Identification of known, dived features in the sidescan sonar data was provided by Keith Denby, along with photographs of the *City of Adelaide* and frame grabs from dive videos of the *South Australian*. Illustrations were created by Kitty Foster and quality control provided by Dr Paul Baggaley, both of Wessex Archaeology. The project was managed for Wessex Archaeology by Stephanie Arnott.

Dr Alan Platt's assistance with initial research and identification suggestions for the wreck is gratefully acknowledged.

This work was funded by a grant from the Honor Frost Foundation Small Research Grants in Maritime Archaeology and Maritime Cultural Heritage awarded by the British Academy through the BA/Leverhulme Small Research Grants scheme in the SRG 2014-15 Round.

This report is dedicated by ILFSAC to the memory of Phil Durbin.

South Australian Geophysical Mapping Project

Survey Report and Site Plan

1 INTRODUCTION

1.1 Background

1.1.1 Built in Sunderland in 1868 the *South Australian* was the sister-ship of the *City of Adelaide*, one of only two clipper ships that survive today, the other being the *Cutty Sark*. For most of her working life the *South Australian* traded between the UK and Australia carrying cargo and passengers and was heavily involved in the emigrant trade. In February 1889 she set sail from Cardiff, laden with rails and fish plates for railway customers, but foundered in severe weather in the Bristol Channel.

1.1.2 In the late 1980s, members of the Ilfracombe and North Devon Sub-Aqua Club (ILFSAC) discovered a mound of rails within the remains of a wooden shipwreck (**Plates 1** to **4**) whilst investigating a fishing snag and, after many years of diving and comparison of hull fragments with the structure of the *City of Adelaide*, ILFSAC positively identified the wreck as the *South Australian* in 2005. However, working time on the site is limited by depth and strong tidal currents, the visibility is often very poor and ILFSAC has been unable to develop a clear picture of the layout of the site. Funding was provided by the Honor Frost Foundation to acquire high resolution geophysical data over the wreck in order to provide a site map that will guide ILFSAC's future work at the site.

1.1.3 The geophysical survey was undertaken by Wessex Archaeology (WA) in July 2015. The wreck of the *South Australian* lies approximately three miles northeast of the island of Lundy in the Bristol Channel (**Figure 1**). The wreck lies in approximately 45m of water on the southeast side of Stanley Bank. The wreck forms part of the rich maritime heritage of the waters off the island and is well known to local divers. The rarity and importance of clipper wrecks means that this wreck is potentially of international significance, particularly with regard to its status as the sister-ship of the historic vessel *City of Adelaide*, recently transported from Scotland to Port Adelaide in Australia for conservation and public display.

1.1.4 This project will significantly support future work at the site providing opportunities for ILFSAC divers to gain NAS qualifications and to encourage new members to join. The results will also support ILFSAC's aims to inform local people about the maritime heritage of the Bristol Channel and to provide information for visitors to Lundy about the wreck of the *South Australian*.

1.2 Aims and Objectives

1.2.1 The overall aim of the project was to acquire high resolution geophysical data over the wreck site to provide accurate, georeferenced imagery from which a site plan can be produced. This will significantly improve the current understanding of the wreck which has

previously been limited by working conditions at the site that limit diver surveys to keyhole inspections of small areas of the wreck.

1.2.2 The objectives of the research are:

- *O1: To collate existing geophysical and diver survey data to provide baseline data;*
- *O2: To acquire targeted, high resolution sidescan sonar and magnetometer geophysical data;*
- *O3: To integrate baseline data with acquired data to produce a site plan;*
- *O4: To make recommendations that will guide ongoing voluntary work at the site.*

1.2.3 Fulfilment of these objectives is described below.

Objective O1

1.2.4 Existing multibeam bathymetry data acquired under the Civil Hydrography Programme were obtained from the United Kingdom Hydrographic Office (UKHO) through the Infrastructure for Spatial Information in Europe (INSPIRE) initiative.

1.2.5 These data were processed by WA to provide a georeferenced image of the wreck site that was used to plan the survey. The data were also interpreted to provide information on the appearance of features in the data that may be part of the wreck site.

Objective O2

1.2.6 The geophysical survey was first attempted in June 2015. Owing to technical issues the survey had to be postponed until July 2015 and it was only possible to acquire sidescan sonar data.

1.2.7 The survey was undertaken by WA aboard ILFSAC's club vessel, *Neptune*. Four members of ILFSAC participated in the survey and gained hands-on experience of the application of geophysical techniques to the study of marine archaeology.

Objective O3

1.2.8 The sidescan sonar data acquired on the survey were processed and interpreted by WA. The results were compared to those from the multibeam bathymetry data and a site plan of the features produced with interpretation of known features provided by ILFSAC.

Objective O4

1.2.9 Recommendations are made based on the results to help ILFSAC determine their future research priorities and inform the planning of future dives.

1.3 Research Outputs

1.3.1 The outputs from this work comprise a digital site plan and project archive comprising GIS data and this report, which includes recommendations to inform future ILFSAC surveys. The integration of new and existing geophysical data will also provide information to inform any future monitoring statements for the wreck through assessing its current condition. The project archive is disseminated to key stakeholders including Historic England, the UKHO, the Lundy Warden and the Landmark Trust, which manages Lundy Island. Public access has been enabled through upload to OASIS (Online AccesS to the Index of archaeological investigationS).

2 HISTORICAL BACKGROUND

2.1.1 The clipper *South Australian* met her fate on 14th February 1889 near Lundy in the Bristol Channel. She had been built by William Pile of Sunderland in 1868 and was of 'composite' construction, with an iron frame and wooden hull planking, of 1040 tons and 201 feet (61.3m) long. Composite ships were built mainly in the 1860s and 1870s and only about 500 were laid down. The most famous surviving composite built clipper is the *Cutty Sark* (Platt, pers. comm.).

2.1.2 The *South Australian* traded on the England - Australia run from the time of her launching until 1887 carrying cargo and passengers, many of whom were emigrants. In 1887 she was sold to William Woodside of Belfast and operated principally as a cargo vessel, making voyages to India and New Brunswick under the command of Captain James Arthurs (Platt, pers. comm.).

2.1.3 On Tuesday 12th February 1889, the *South Australian* sailed from Cardiff in fine weather bound for Rosario, on the River Parana in Argentina, loaded with railway lines and fish plates (metal plates for joining the ends of two rails together). The cargo consisted of 5380 steel rails, weighing approximately 1330 tons and 1067 bundles of fish plates, weighing approximately 75 tons. Approximately 900 tons of rails and fish plates were stowed in the lower hold with the remaining cargo stowed in the overlying between decks (Board of Trade 1889).

2.1.4 As the *South Australian* tried to clear the Bristol Channel she ran into a west-southwest gale with high seas and shortly after 11pm on the 13th she sustained damage forward. Conditions did not improve and at 1am on the 14th Captain Arthurs decided to run before the wind to Penarth Roads. The pumps were tried and the vessel found not to be making any water. However a rumbling noise was heard below and the second mate and a seaman were sent to investigate. In the between deck they found that the cargo at the aft end was secure but, sparks were to be seen about the main hatch and there were noises which they thought were the rails striking against each other. The captain then ordered the seaman and the carpenter to go into the between deck forward. There they found the cargo moving in a body as the ship rolled. Some stanchions had broken and the wooden shores that held the rails against the deck above had fallen. The carpenter clambered over the cargo as far as the main hatch, where the cargo was all adrift and, he said, flying about. He could hear water rushing, and though he could not see it, thought that the cargo port on the starboard side had been knocked out. The second mate then looked into the fore hold, where in the light of a candle he thought he could see 7 to 8 feet of water (Board of Trade 1889; Platt, pers. comm.).

2.1.5 The second mate then went on deck, where he told the crew to cut away the boats as the ship was sinking. He reported to the captain on the poop, who brought the ship to the wind on the starboard tack so as to bring the loading-port above water. Looking over the side he and the mate saw that the loading-port was indeed pushed out by six inches. The captain tried to place a bed blanket over the gap but failed. He then gave orders for the port lifeboat to be launched but the crew were already doing this. They then got into it, called to the master to jump or he would be left behind, and he leapt for his life. Whilst fending off all the oars but one were broken, as the ship was plunging and rolling heavily in a cross sea. When the painter was cut, the boat drifted astern where two men were seen on the poop. The boat was close to the vessel and William Heddles, who had been at the wheel, jumped and was picked up, but James Timbrell the Jamaican cook, would not even though he was told to use one of the lifebuoys. He was heard shouting as the

boat slipped further behind the ship. After a while all that could be seen of the *South Australian* were her top-gallant and royal yards silhouetted against the sky and she was undoubtedly sinking (Board of Trade 1889; Platt, pers. comm.).

2.1.6 The survivors in the lifeboat managed to rig a quilt on a broken oar as a sail and ran before the wind until about noon when they were rescued near the Helwick Lightship by the schooner *Spray*. They were transferred to the steam trawler *Flying Scotchman* and landed at Swansea (Board of Trade 1889).

3 DIVING AND IDENTIFYING THE WRECK

3.1.1 In the late 1980s members of Ilfracombe & North Devon Sub-Aqua Club (ILFSAC), alerted by a local fisherman, discovered a pile of railway lines (**Plates 1** and **2**) and some remains of a wooden vessel (**Plates 3** and **4**) in 45m of water on the edge of the Stanley Banks, approximately 3 miles northeast of Lundy (**Figure 1**). The wreck site was dived for some years without any research being undertaken to identify its origins.

3.1.2 In January 1999 ILFSAC was contacted by Alan Platt, of Saline, Dunfermline, a retired power station engineer with a passion for, and an extensive knowledge of, composite sailing ships after becoming aware that ILFSAC were diving a pile of railway lines. He sent an account of the loss of the *South Australian* together with many details of her construction and information on the history of her sister ship the *City of Adelaide.*

3.1.3 The hull of the 791 ton composite clipper ship *City of Adelaide*, built in 1864 also by William Pile, has survived because she was used for a variety of purposes once her seagoing life was over in 1893. She was used as a floating isolation hospital at Southampton, then, as HMS *Carrick* at Greenock, as a Royal Naval Volunteer Reserve (RNVR drill ship (**Figure 2**) and during WW II for training gunners. Finally she became the RNVR (Scotland) Club in Glasgow. She sank there in 1989, then again in 1991 after being moved to Prince's Dock, Govan. A year later she was raised and taken to Irvine near Glasgow where she remained until 2014. The hull was transferred in February 2014 to Adelaide in Australia (**Plate 5**) as the centrepiece of a new maritime museum (Platt, pers. comm).

3.1.4 ILFSAC and Alan Platt started work to prove the identity of the railway line wreck on the Stanley Banks. At first it seemed unlikely that the wreck was the *South Australian* because none of the vital artefacts could be found and the search for the *South Australian* was widened to much of the sea area around Lundy, but with no result. In 2003 ILFSAC divers started to use Trimix (helium, oxygen, nitrogen) breathing mixtures in twin cylinders plus additional oxygen rich decompression and this reduced nitrogen narcosis and gave much longer endurance at 45m. Using this more advanced diving method evidence of iron frames was found at the base of the rail stack. A piece of hull section with signs of frames attached was found at one side of the rail stack by ILFSAC diver Phil Durbin in 2004. Alan Platt suggested that proof positive would be to find the 'yellow metal' (a brass alloy) bolts that were used to attach the hull planking to the frames of a composite ship. A visit to the *City of Adelaide* in Irvine in 2005 provided photographs (**Plates 6** to **8**) of the key frame structures and measurement of the spacing of the bolts holding her planking to her frames was made.

3.1.5 In the summer of 2005, Keith Denby, an ILFSAC diver, in the company of Dan Stevenson, an underwater video cameraman from the Clifton British Sub-Aqua Club, found and filmed

the bolts **(Plate 9**) and other significant structures on the wreck and the proof positive was obtained that the Stanley Banks railway line wreck was indeed the *South Australian*.

3.1.6 With the task of positive identification of the *South Australian* achieved in 2005, ILFSAC have continued to explore the wreck site and diving technology has moved on even further with the use of closed circuit rebreathers using trimix diluent which give very long duration at depth without narcosis. This has allowed much greater exploration of the area of seabed surrounding the wreck and a number of things have been found. These include sections of the hull and frames, two anchors, a possible windlass and a large separated section of the wreck. An intact moulded wineglass was found on this separated section (**Plate 10**).

4 EXISTING DATA

4.1.1 The record for the wreck held by the UKHO was obtained for background information. The wreck identification number is 12251. The wreck is categorised as a non-dangerous wreck as it is not considered a hazard to shipping. The wreck is reported to lie in 39m of water and with a minimum depth of 35m. Depths are referenced to Lowest Astronomical Tide (LAT). The dimensions of the vessel are given as 61.3m length, 11m beam and 6.1m draught. According to the UKHO record the wreck was last surveyed in 2008. The wreck was described as intact and with dimensions of 50.6m x 36.0m x 4.6m as measured in sidescan sonar data.

4.1.2 The record for the wreck held by the National Record of the Historic Environment (NRHE) was also obtained. The wreck has a monument number of 1033938. The position given in this record lies approximately 500m to the northwest of the wreck position as observed by the divers and recorded by the UKHO. The wreck is described as lying on a shifting sand bank, which has covered the wreck in the past. The dimensions of the site are given here as 35m x 18m. These dimensions are reportedly from 2011. As such it would appear that the site has possibly become significantly smaller in the three years from 2008.

4.1.3 It was not possible to obtain plans of the *South Australian* but some plans of the *City of Adelaide* were available from the National Maritime Museum (2015) and a scan of these was obtained (**Figure 2**). These plans show the planned conversion of the vessel in approximately 1923 when she became the RNVR drill ship *Carrick*. The ship underwent a conversion process to be suitable for training purposes and the plans are therefore not of the ship as she was originally built. The plans therefore can only really be used to show the shape of the hull and possibly the number of decks. Even the masts appear to have been reduced from three to two and it is likely that the original bulkheads would have been considerably rearranged in forming the new layout.

4.1.4 Existing multibeam bathymetry data acquired under the Civil Hydrography Programme were obtained from the UKHO through the Infrastructure for Spatial Information in Europe (INSPIRE) initiative. These data were acquired in 2007 to 2008 for the Maritime and Coastguard Agency.

4.1.5 Multibeam, or swathe, bathymetry data is similar to data acquired using a normal boat echosounder as it is a measurement of water depth. An echosounder uses a single beam of acoustic energy that is sent down as a pulse from the transducer, is reflected from the seafloor and received back. The time taken, along with the sound velocity in seawater, is used by the equipment software to calculate the depth below the transducer. Multibeam bathymetry data are acquired by transducers using a fan-shaped array of hundreds of

beams. These cover a strip, or swath, of seabed (**Figure 3**). The water depth to the seabed for each beam is calculated. Data processing is used to reference these depths to a datum, typically chart datum or LAT for the UK.

4.1.6 The multibeam bathymetry data were processed and a georeferenced image of this dataset was used to plan the sidescan sonar survey. The data were also interpreted and features of interest observed within this dataset were noted and compared to those observed in the sidescan sonar data (see **Section 6**).

5 GEOPHYSICAL SURVEY

5.1.1 The geophysical survey was undertaken in July 2015. The ILFSAC dive boat, *Neptune*, was used as the survey vessel (**Plate 11**). The vessel was mobilised on the 22nd of July and the survey was undertaken on the 23rd of July. The vessel was demobilised on the same day, after the survey. Sidescan sonar data were acquired over a survey area of 200m x 200m centred on the wreck position as taken from the multibeam bathymetry data (**Figure 4**).

5.1.2 Acquisition of sidescan sonar data is a standard methodology used for marine archaeology to detect items on the seabed. The data are acquired using a towfish which is towed behind a survey vessel (**Figure 3**). Elongated transducers, one on either side of the towfish, emit a high frequency pulse of acoustic energy. This pulse is emitted in a wide beam and reaches the seabed in a strip from near the towfish to a distance that is termed the range, i.e. furthest extent of the data to each side of the towfish. The range is specified by the user in the acquisition software. A shorter range (e.g. 40m) enables higher resolution data to be acquired but a longer range (e.g. 100m) enables a larger survey area to be covered more quickly as fewer lines of data are required. The seabed in a strip below the towfish is not covered by the data as the acoustic pulse does not reach here since the beam is angled outward.

5.1.3 The pulse is reflected back from the seabed within the range. The strength of the reflection depends on the qualities of the material it is returned from. Harder materials (e.g. rock, gravel or metal) return a stronger signal than softer or finer materials (e.g. waterlogged wood, silt). Objects angled toward the towfish will also give a stronger return than those facing away (**Figure 3**). A strong return is visible in the data as a dark reflector. Weaker returns are lighter. Upstanding objects create an acoustic shadow behind, where the acoustic energy is blocked from reaching the seabed. These shadows appear as very bright areas and are the absence of data (for examples see **Figures 4A** and **6**).

5.1.4 Sidescan sonar data are particularly suitable for the study of marine archaeology as they are of higher horizontal resolution than multibeam bathymetry data. They do not however produce a three dimensional model of the seabed or a wreck but are more akin to an aerial photograph in nature.

5.1.5 The survey was undertaken using a Klein 3900 sidescan sonar towfish (**Figure 3A**) towed behind the vessel on a 200m cable (**Plate 12**). The long length of the cable was required, owing to the depth of water in which the wreck lies, to get the towfish deep enough. After each survey line was completed a long run in of approximately 200m was used to ensure the vessel started the next line with the cable in a straight line behind it. The additional data thus acquired outside the survey area are clearly visible in **Figure 1**.

5.1.6 Sidescan sonar data were recorded digitally (**Plate 13**) using SonarPro software as *.xtf* files. The towfish was operated at a frequency of 445kHz and with the range set to 60m.

Data were thus acquired out to 60m on either side of the towfish but with a gap below the instrument. Data were acquired along survey lines spaced at 40m intervals to ensure that full coverage of the survey area was achieved. Data from overlapping lines filled in the gaps below the towfish left by others. The main lines were run parallel to the wreck in a southwest/northeast direction. Cross lines were run perpendicular to these in a southeast/northwest direction. Running lines in different directions over the wreck site ensonifies it from different directions and hence enables more features to be seen. It also helps with positioning the data more accurately during processing.

5.1.7 Positioning was provided by a Hemisphere R110 GPS receiver system with the antenna attached to the top of the vessel. HYPACK navigation software was used to direct the survey and record the navigation data (**Plate 13**). All positions for the survey were recorded and expressed as WGS84 UTM30N. The offsets from the GPS antenna to the towfish towpoint were measured as was the length of the cable from the towpoint. These offsets were applied during data processing rather than during data acquisition.

6 GEOPHYSICAL DATA PROCESSING

6.1.1 The sidescan sonar data were processed by WA using Coda Geosurvey software. This allows the data to be replayed, in a 'waterfall' scrolling display (as it appears during acquisition, **Plate 13**, and for examples see **Figure 5**), with various gain settings in order to optimise the quality of the images.

6.1.2 Features thought to be related to the wreck site are tagged within the software by adding a tag i.e. marker. The dimensions of the feature are measured and images of the feature are made. When measuring features in sidescan sonar data the maximum length, width and height of each anomaly are measured.

6.1.3 A mosaic of the sidescan sonar data is produced during the data processing (**Figure 4**). The individual lines of data are run into the mosaicking part of the software, where they are plotted as if on a chart. The offsets of the towfish are entered manually. The data are shown at their geographical positions and the mosaic is used to assess the quality of the sonar towfish positioning. This allows the position of anomalies to be checked between different survey lines and for the offset values to be further refined if necessary. As the position of the wreck was known already from the multibeam bathymetry data the offset values were adjusted until the wreck in the sidescan sonar data lined up with the wreck as seen in the other dataset. The details of each tagged anomaly were exported from the software as a text file once the positioning of the data was satisfactory.

6.1.4 The multibeam bathymetry data were gridded with a cell size of 0.5m and made into a digital terrain map, essentially a three dimensional model, using IVS Fledermaus software. This was done prior to the sidescan sonar survey to enable a georeferenced image to be produced and used for survey planning. These data were then examined for evidence of the anomalies seen in the sidescan sonar data as well as additional features thought likely to be related to the wreck. Positions and dimensions of features of interest were entered manually into a spreadsheet.

6.1.5 As the sidescan sonar data from adjacent lines overlap, many features are seen in two or more lines of data. Where this occurs the anomalies for this object are grouped together. The average position of the anomalies is given for the feature. The maximum of each of the three measurement values are given, irrespective of which anomaly the measurement was made on. Bathymetry anomalies are also grouped with those from the sidescan sonar

data. This allows one ID number to be assigned to a single object for which there can be, for example, one bathymetric anomaly and several sidescan sonar anomalies.

6.1.6 Georeferenced images of the wreck site in both datasets were exported (**Figure 4**) and are extremely useful for spatial interpretation and will form the basis of the site plan.

7 INTERPRETATION AND PRODUCTION OF SITE PLAN

7.1 Features Observed in Geophysical Data

7.1.1 A total of 16 features were interpreted in the geophysical data. All 16 features are listed in a gazetteer in **Appendix I**. Full details, including positions and dimensions, of all features are included.

7.1.2 The most obvious feature of the wreck, in both the geophysical datasets and when diving the site is the large stack of rails (**Feature 1, Figure 5**). To the west of the wreck lies a large scour (**Feature 2**), caused by the currents moving past the remains of the wreck. Surrounding the rail stack, particularly on the northwest side are many items of debris lying in a debris field (**Feature 3**). Within the debris field individual items of debris have been interpreted where possible (**Features 4** to **16**).

7.1.3 The positions of all features are shown on the site plan in **Figure 6** along with photographic images of some of the features where available. These images are frame grabs from video taken by ILFSAC divers.

7.1.4 The rail stack, **Feature 1**, is clearly seen in both geophysical datasets. In the multibeam bathymetry data it appears as a roughly rectangular mound oriented southwest to northeast. The highest point of 3.8m above the seafloor is toward the northwest and it slopes down to a height of approximately 1m at the southwest end. There is a rectangular depression of approximately 3.5m x 3m x -0.5m towards the southeast of this feature.

7.1.5 More detail is visible in the sidescan sonar data where it can be seen that **Feature 1** is made up of long linear features, mostly lying parallel to the length of the mound but with some at angles across it. **Feature 1** (illustrated in **Figure 5A**) has maximum dimensions of 42m x 15m x 5.0m. The northeast end of this feature appears more broken up and lower lying and it may be that it consists of debris, possibly fish plates, adjacent to the end of the rail stack. It is not possible to tell from the geophysics data where the rail stack ends and other debris begins.

7.1.6 Full details of how the rails and fish plates were stowed within the vessel are given in the Board of Trade wreck report (1889). The majority of the cargo was stowed in the lower hold with the remaining items stowed in the overlying between decks. The rails were not all stowed lying parallel to each other along the length of the ship. Some layers were arranged in diamond and chequered fashion within the lower hold. In the between decks the rails do all appear to have been aligned fore and aft. The fish plates were fitted in around the stacked rails. The appearance of the rails in the sidescan sonar data matches the description of how they were stowed, with the majority of the rails appearing parallel to each other as they were arranged in the upper hold.

7.1.7 The rail stack has been dived many times by ILFSAC. The divers have measured the length of the stack to be 89 feet 5 inches, approximately 27.5m. This is quite a bit less than the length of the feature as measured in the geophysics data, again suggesting that the northeastern end may consist of other debris adjacent to the end of the rail stack. The

individual rails were measured to be 42 feet 3 inches in length, approximately 13m. The cross-section of the rails was measured to be 14cm high, 12 cm wide at the bottom and 8 cm wide at the bullnose (**Figure 6**).

7.1.8 The scour (**Feature 2**) lies to the west of the rail stack and has approximate dimensions of 125m x 65m. It has a maximum depth, near the rail stack, of 1.2m below the adjacent seabed. Some items of debris are observed in the scour close to the rail stack. This is discussed below.

7.1.9 The debris field (**Feature 3**) surrounding the rail stack contains many items of debris, the majority of which are visible on the northwest side of the rail stack. Where possible, individual items of debris have been interpreted separately, as described below. The debris field covers an area of approximately 58m x 45m.

7.1.10 **Feature 4** is a small rounded object of debris measuring 2.0m x 1.1m x 0.3m (**Figure 5**). It is surrounded by a slight scour and lies approximately 10m west of the northwest end of **Feature 1**.

7.1.11 **Feature 5** is an elongated, irregularly shaped item of debris lying adjacent to the northwest side of **Feature 1**, near the northeast end (**Figure 5**). It consists of a linear dark reflector aligned approximately east to west with two shorter dark reflectors protruding to the south. The overall dimensions are 7.3m x 2.4m x 0.6m but the linear section of the feature has a width of only 0.4m.

7.1.12 **Feature 6** is a curvilinear feature adjacent to the western end of **Feature 5**, which may cross it. It is a U-shaped object with a total length of 8.2m and a width of 0.4m. The area covered by this feature is 3.5m x 2.4m x 0.3m. It is possible that this feature is a cable or similar object. The small dark reflectors in the southern part of **Feature 5** may be continuations of **Feature 6**.

7.1.13 **Feature 7** consists of two adjacent items of debris. They are linear in shape with shadows indicating the height varies along their lengths (**Figure 5**). They lie parallel to each other to the west of **Feature 6**. The larger object has dimensions of 6.3m x 0.3m x 0.3m. The second, smaller object, measures 2.4m x 0.5m x 0.2m.

7.1.14 **Feature 8** consists of two bright reflectors adjacent to each other (**Figure 5**), covering a total area of 14.1m x 2.5m x 0m. Individually they measure 8.3m and 7.6m in length. They lie within an area identified by the divers as a section of hull material. Bright reflectors can indicate wood but it is also possible that these features are depressions. They do not match the scouring in this area shown in the bathymetry data but that dataset was acquired seven to eight years earlier than the sidescan sonar data and the sediment may have moved during the intervening period. The features do appear somewhat angular though and it seems less likely that they are depressions and more likely that they are manmade in origin.

7.1.15 **Feature 9** is a very distinct linear object with a small amount of height (**Figure 5**). It has dimensions of 3.3m x 0.2m x 0.1m and lies within the area the divers have identified as a section of collapsed hull.

7.1.16 **Feature 10** is an irregularly shaped object with height that has dimensions of 2.8m x 0.9m x 0.6m. It lies approximately 10m to the northwest of the southwest end of the rail stack (**Feature 1**) within the area the divers have interpreted as an area of hull that has fallen away from the rail stack.

7.1.17 **Feature 11** is a linear item of debris that may be a section of cable or similar. It has a northwest to southeast orientation and lies approximately 3m west of **Features 12** and **13**. It may possibly be connected to one or both of these features. It also lies partially within the area the divers have identified as a section of collapsed hull.

7.1.18 **Feature 12** is an irregularly shaped object with height near the edge of the large scour, **Feature 2**. It is the object furthest to the northwest of the rail stack, **Feature 1**. This object has dimensions of 5.7m x 1.6m x 0.6m. It has been interpreted by the divers as possibly being the windlass of the vessel, which is known to lie in this area of the wreck site. This feature lies within a wider area identified by the divers as containing remains of a section of the vessel's hull. The windlass is believed to be an Emerson and Walker Patent Windlass (Denby, pers. comm.).

7.1.19 **Feature 13** is a small, distinct object with height lying approximately 3m south of **Feature 12**. It may also be related to the windlass. It has dimensions of 0.9m x 0.2m x 0.1m and is situated near the edge of the large scour, **Feature 2**. It also lies within the area the divers have interpreted as containing remains of the hull.

7.1.20 **Feature 14** is a large linear item of debris lying at an angle close to the rail stack on the southern side. It has dimensions of 11.5m x 1.2m x 0.3m. This feature has been interpreted by divers from ILFSAC as likely to be rails fallen from the main stack. The dimensions of the feature support this interpretation.

7.1.21 **Feature 15** consists of a pair of small dark reflectors close together. They may be parts of a single object measuring 1.5m x 1.5m x 0.5m. They are situated on the southeast side of the wreck, near the northeast end. This feature has a small scour around it.

7.1.22 **Feature 16** is a small object with dimensions of 1.8m x 0.6m x 0.2m. It is surrounded by a scour and lies approximately 15m east of the northeast end of the rail stack, **Feature 1**.

7.2 Known Objects Not Visible in the Geophysical Data

7.2.1 ILFSAC report that there is a further area of wreckage 50m to 100m southwest of the rail stack - that is where Martin Davis found the wineglass (**Plate 10**). However, there is no evidence of any additional debris to the southwest of the rail stack in either the sidescan sonar data or the multibeam bathymetry data. It is possible that debris here has become buried by the seabed sediments and therefore was not able to be detected by the geophysical equipment at the time of the surveys. As the position of this additional area of wreckage is not known it has not been possible to add it to the site plan at this time.

7.2.2 The bolts found by Keith Denby and Dan Stevenson, which proved the identity of the wreck, are too small to be detected by the geophysical data. The approximate position of the bolts is however noted on the site plan (**Figure 6**). Similarly, the anchor chain observed by the divers has not been interpreted from the geophysical data but the approximate position is given on the site plan.

7.2.3 Two anchors have been observed by the divers to the southwest of the southwest end of the rail stack. These were not interpreted within the geophysical data. They appear to be covered in marine life and some sediment (**Plates 14** to **16**) which would make them less likely to be detected.

8 ENVIRONMENTAL AND DATA LIMITATIONS

8.1.1 The wreck of the *South Australian* lies approximately 400m southeast of the Stanley Bank. This sand bank is known to move and the NRHE record states that this sand bank has covered the wreck in the past. The multibeam bathymetry data were acquired from 2007 to 2008. It is likely that the sediment in the area around the wreck has moved between then and July 2015, when the sidescan sonar data were acquired. It should therefore be appreciated that the seabed morphology may be considerably different now, particularly following the storms of the winter of 2013 to 2014. The scour does appear to be rather more extensive in the multibeam bathymetry data compared to its appearance in the sidescan sonar data. However, it is not easy to determine the full extent of scours in sidescan sonar data.

8.1.2 Debris buried below the surface of the seabed will not be visible in the geophysical data. Small objects, less than approximately 1m across, will also not be observed. Objects hidden in acoustic shadows of objects closer to the towfish will not be visible in the data. The third of these limitations has been minimised as far as possible by acquiring lines of data ensonifying the wreck site from several directions.

8.1.3 The positions given for each of the interpreted features are estimated to be accurate to within approximately ±5m.

9 DISCUSSION AND FUTURE WORK

9.1.1 The key to a better understanding of the site is the site plan that can be used to relate the artefacts/hull sections together and form a coherent understanding of the layout. The site plan and georeferenced sidescan sonar images can now be used as the basis for this recording and ILFSAC plan to investigate, photograph and measure the various findings and relate them back to the site plan. This is a project that will take a number of years because the site is very challenging and can only be accessed in very good surface conditions – which can be hard to find in the Bristol Channel. Only one dive on the site has been possible in 2015.

9.1.2 A total of 16 features were identified in the geophysical data and are shown on the site plan (**Figure 6**). In addition, the positions of the brass bolts, anchor chain and area of hull structure as identified by the divers have been included.

9.1.3 The wreck is broken up with very little remaining of significant height other than the cargo of rails. The hull has split open and collapsed and what remains is likely to be at least partially buried. The vessel had dimensions of 61.3m x 11m and as the interpreted debris field measures 58m x 45m the debris does appear to be widely scattered. Further debris may be present beyond the extents of this debris field, particularly buried debris not detected by the geophysical data.

9.1.4 The main part of the wreck site, consisting of the rail stack and possibly adjacent debris, measures 42m x 15m x 5.0m. The UKHO record includes dimensions of 50.6m x 36.0m x 4.6m from sidescan sonar data acquired in 2008. The wreck is also stated in the record to be intact. The sidescan sonar data acquired during the 2015 survey and the observations of the divers all clearly indicate that the wreck is not intact. The dimensions in the UKHO record are broadly similar to those of the debris field, which contains the rail stack. The height of 4.6m is very similar to that of 5.0m from the 2015 data. As the 2015 data indicates a larger debris field it is possible that this may result from the dataset being of higher resolution or that more surrounding debris is currently visible than was the case in

2008. It may also be a combination of the two. Sidescan sonar technology has developed significantly since 2008 and the 2015 data were obtained with equipment and settings chosen to produce the highest resolution data possible. The wreck site lies in an area of mobile sediment and it is highly likely that areas of debris are repeatedly covered and exposed owing to the movement of sediment in the area.

9.1.5 The dimensions of the site given by the NRHE are 35m x 18m from 2011 data. The type of dataset is not stated. It is likely that these dimensions refer to the main area of wreckage, the rail stack. The width of 18m given here is similar to the width of 15m observed in the 2015 data. The length of 35m is rather less than the 42m observed in the 2015 data. It is possible that more of the lower debris at the northeast end of the rail stack has now become exposed or that debris has fallen off the main structure since 2011 and increased the length of this feature.

9.1.6 The northeast end of the rail stack would require further investigation by divers to determine whether this consists of rails that have fallen from the stack or whether it consists of other debris such as fish plates or part of the hull. It is not possible to tell in the geophysical data.

9.1.7 The anchors that were not visible in the geophysical data and for which positions are not known will be dived and related spatially to surrounding features and then added to the site plan. This is likely to be one of the first tasks undertaken in 2016.

9.1.8 The individually interpreted debris surrounding the wreck would be valuable to dive in order to identify, or in some cases confirm, what they consist of. It is possible, for instance, that **Features 12** and **13** may both be part of the windlass.

9.1.9 When planning future diving surveys it is suggested that divers initially target the larger features as those of around 2m or less will be more difficult to find, given the issues in positioning a diver accurately and the ±5m accuracy in feature positions.

9.1.10 The site plan should be considered a work in progress and will be updated following further dives on the wreck site. Should further multibeam bathymetry data be acquired in the future and become available through the Civil Hydrography Programme these data could be subject to archaeological assessment and also used to update the site plan.

9.1.11 The details of the composite construction of the *City of Adelaide* have been vital in the identification of the *South Australian* - particularly the 'yellow metal' bolts. As investigation of the wreck site of the *South Australian* proceeds, comparison with the *City of Adelaide* will continue to provide valuable information.

9.1.12 It is proposed that ILFSAC contact the Maritime Museum in Adelaide and seek to exchange information that will assist both groups in understanding and preserving the history of these two very special ships.

9.1.13 This project has been a rewarding and effective collaboration between a recreational dive club and a commercial archaeological organisation. The successful geophysical survey has made possible the site plan and will fuel the investigation and research undertaken by ILFSAC well into the future.

10 REFERENCES

Board of Trade, Marine Department, 1889. *(No. 3749.) "South Australian." Report of Court and Annex* (accessed http://www.plimsoll.org/images/15736_tcm4-203187.pdf)

National Maritime Museum, 2015. Plans of the *City of Adelaide*: Proposed conversion into RNVR Training Ship. Profile/decks c.1923. Scale 1:96.

APPENDIX I: GAZETTEER OF FEATURES OF INTEREST

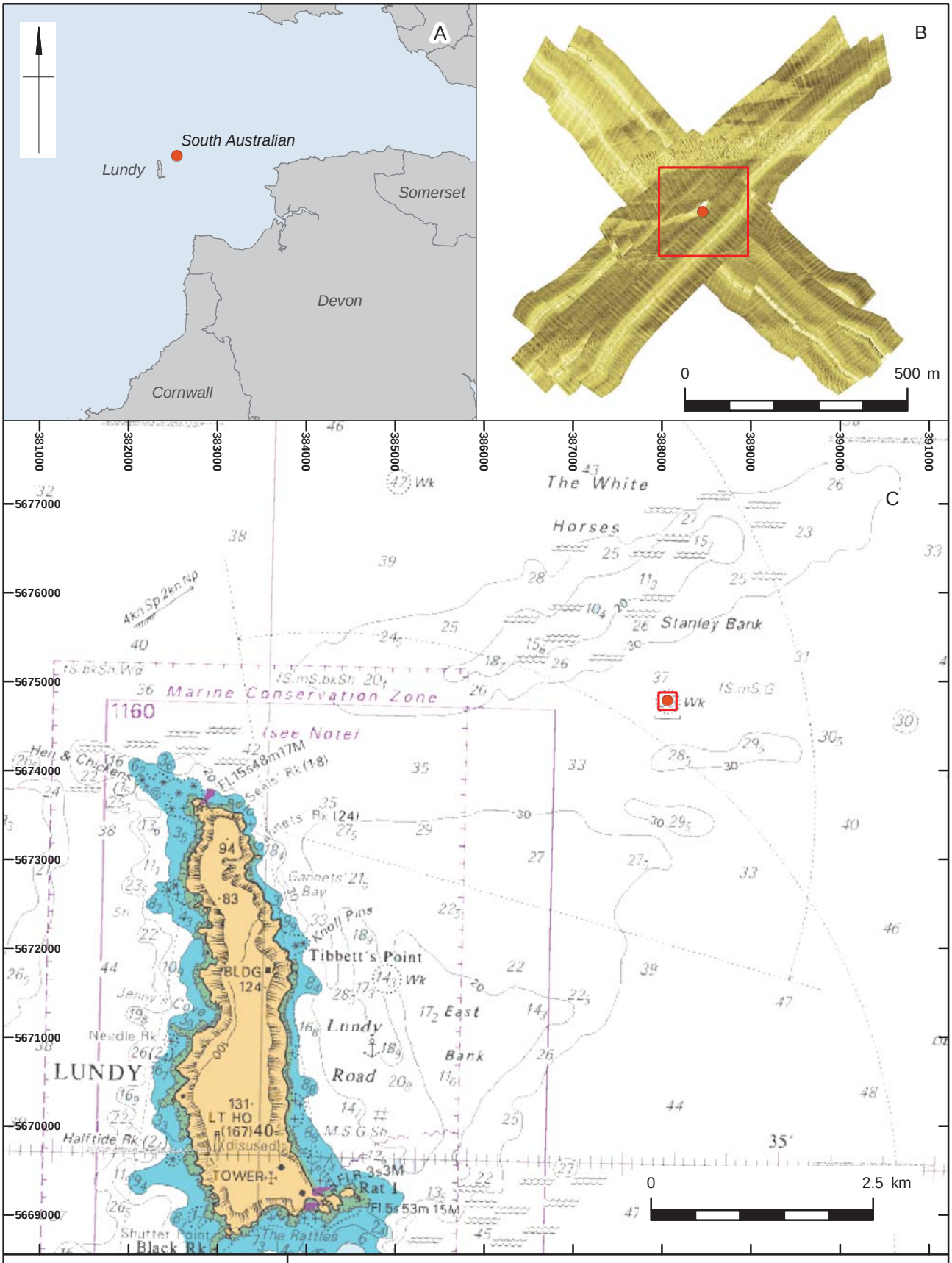
ID	Feature Type	Easting	Northing	Latitude	Longitude	Length (m)	Width (m)	Height (m)	Description
1	Rail Stack	388061	5674780	51° 12.8058' N	4° 36.1603' W	42	15	5	Distinct rectangular outline, broken up at the NE end and surrounded by debris, seen in an otherwise featureless seabed. Contains many linear features with height, most of them lying approximately parallel to the length of the structure. Lying at a NE to SW alignment with a large scour **(2)** to the west. Varying height shadow indicates presence of upright structure. Position taken from central location in bathy data. Seen in the bathy as a rectangular object aligned NE to SW measuring 43m x 14 with slightly tapered ends. Appears tilted towards SE with highest point towards NW at 3.8m and slopes down to 1m in SW. There is a slight rectangular looking depression of approximately 3.5m x3m x 0.5m towards SE of object. Identified as a stack of rail tracks by divers. Divers have identified a section of hull fastened with brass bolts located at the north side of the stack. UKHO record 12251.
2	Scour	388001	5674779	51° 12.8045' N	4° 36.2118' W	125	65	-1.2	Large area of scour to the west of the rail stack **(1)**. General depth of seabed approximately 40m below LAT. The scour doesn't quite meet the edge of the stack so it is possible some surrounding debris maybe buried here and not visible in sidescan sonar data. Dimensions are approximate.
3	Debris Field	388057	5674787	51° 12.8095' N	4° 36.1639' W	58	45	0	Large area of debris surrounding the rail stack **(1)**. Several objects identified to the northwest side with a few also at the southeast side. Individual objects of debris are described separately where possible and have their own ID numbers.

ID	Feature Type	Easting	Northing	Latitude	Longitude	Length (m)	Width (m)	Height (m)	Description
4	Debris	388060	5674797	51° 12.8149' N	4° 36.1615' W	2	1.1	0.3	Rounded object with slight scour and corresponding shadow. Lies approximately 10m west of the NW end of the rail stack.
5	Debris	388059	5674793	51° 12.8128' N	4° 36.1623' W	7.3	2.4	0.6	Irregular shaped debris of straight dark reflector measuring 0.4m in width, aligned E-W, with two shorter perpendicular dark reflectors protruding to the south. Lies adjacent to the NW side of the wreck near the NE end. At the end of the object furthest away from the rail stack is **(6)**.
6	Debris	388054	5674795	51° 12.8138' N	4° 36.1666' W	3.5	2.4	0.3	Curvilinear feature adjacent to end of **(5)**. U-shaped object with a total length of 8.2m and an actual width of 0.4m. Other dimensions are for the area covered by this feature. May be cable or similar.
7	Debris	388053	5674792	51° 12.8122' N	4° 36.1674' W	6.3	1.3	0.3	Two straight linear dark reflectors with varying height shadow. Lying parallel to each other on the NW side of the rail stack near the NE end. The largest object has dimensions of 6.3m x 0.3m x 0.3m. The second measures 2.4m x 0.5m x 0.2m.
8	Debris	388045	5674786	51° 12.8089' N	4° 36.1742' W	14.1	2.5	0	Two irregularly shaped bright reflectors very close together. Individually these measure 8.3m and 7.6m in length. Bright reflectors can indicate wooden material. Although these may possibly be depressions they do appear somewhat angular. Divers interpret as an area of hull here.
9	Debris	388041	5674781	51° 12.8061' N	4° 36.1775' W	3.3	0.2	0.1	Very distinct linear dark reflector with some height. Lies within the area the divers have interpreted as an area of hull.

ID	Feature Type	Easting	Northing	Latitude	Longitude	Length (m)	Width (m)	Height (m)	Description
10	Debris	388038	5674779	51° 12.805' N	4° 36.1801' W	2.8	0.9	0.6	Distinct irregular object with bright tapering shadow. Lies approximately 10m to the NW of the SW end of the rail stack within the area the divers have interpreted as an area of hull.
11	Debris	388034	5674776	51° 12.8033' N	4° 36.1834' W	8.8	0.2	0	Possible cable or rope oriented NW/SE. Near **(12)** and **(13)**. Possibly connected to one or both. Lies within the area the divers have interpreted as an area of hull.
12	Debris	388039	5674774	51° 12.8023' N	4° 36.1791' W	5.7	1.6	0.6	Indistinct irregularly shaped object with height right on the edge of the scour. Furthest object to the north west of rail stack. Tapered bright shadow. Identified by divers as possibly the windlass and lying within an area of hull that had fallen away from the rail stack.
13	Debris	388040	5674771	51° 12.8007' N	4° 36.1782' W	0.9	0.2	0.1	Small distinct object with height lying near **(12)**. Lies within the area the divers have interpreted as an area of hull.
14	Debris	388064	5674772	51° 12.8015' N	4° 36.1576' W	11.5	1.2	0.3	Long object lying at an angle to the SE side of the rail stack. Some bright shadow indicates height. Position taken from bathy data. According to divers, this is probably rails that have fallen at an angle from the main stack. Dimensions are suitable for this interpretation.
15	Debris	388075	5674780	51° 12.8059' N	4° 36.1483' W	1.5	1.5	0.5	Pair of dark reflectors very close together. May be parts of a single object. Situated adjacent to the wreck towards the NE end on the SE side. Bright shadow and some scour.
16	Debris	388088	5674785	51° 12.8088' N	4° 36.1372' W	1.8	0.6	0.2	Small object with some scour. Approximately 15m east of NE end of rail stack.

Notes

1. Co-ordinates are in WGS84 UTM30N (eastings and northings) and WGS84 DDM (latitude and longitude)
2. Positional accuracy estimated at ±5m



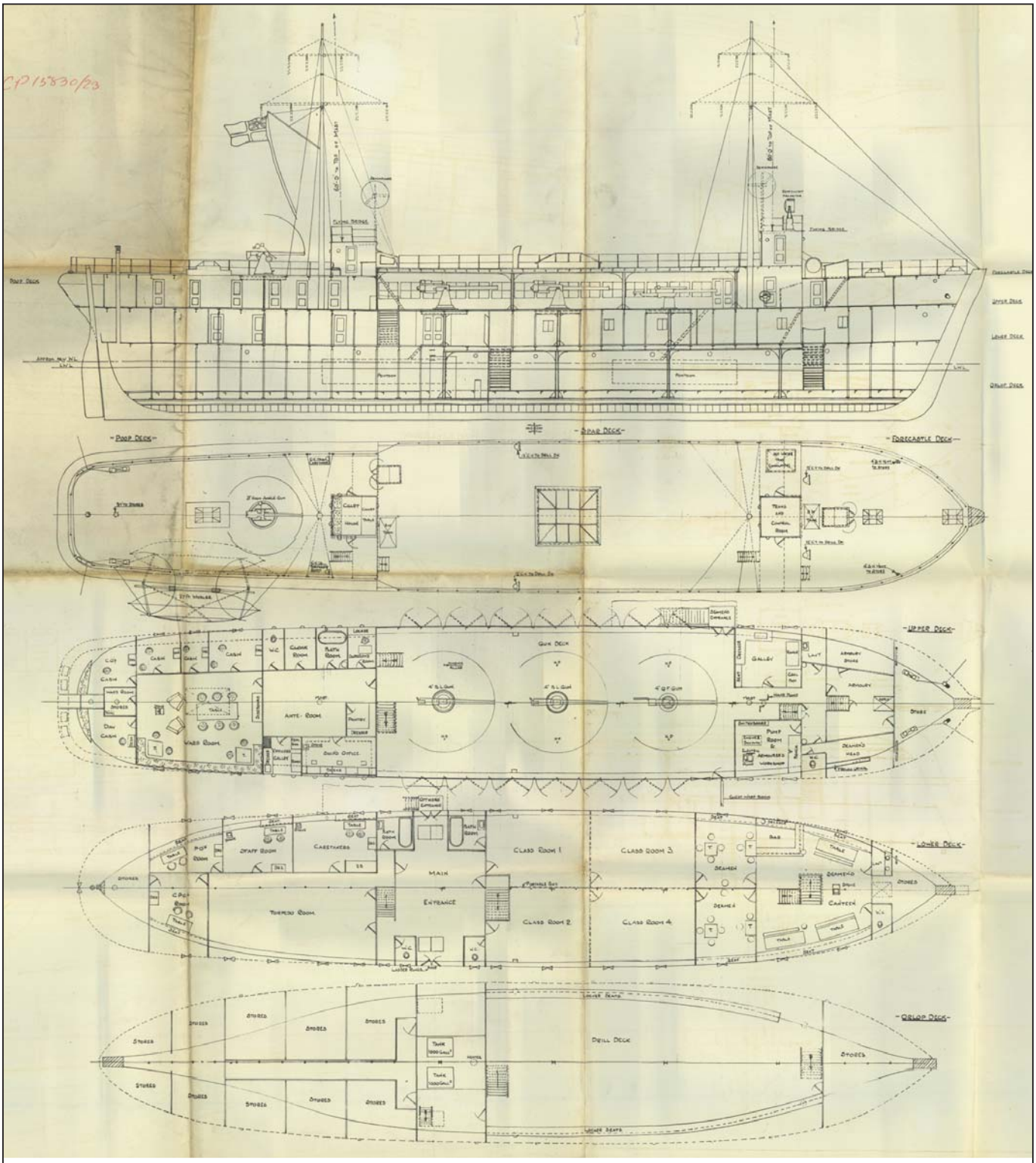
Wreck Location

Survey Area

Date:	18/09/2015	Revision Number:	0
Scale:	B. 1:12,500 C. 1:62,500	Illustrator:	KJF
Path:	W:\Projects\108630\GIS\FigsMXD\Geophys\2015_09_18		

Location of *South Australian* geophysical survey

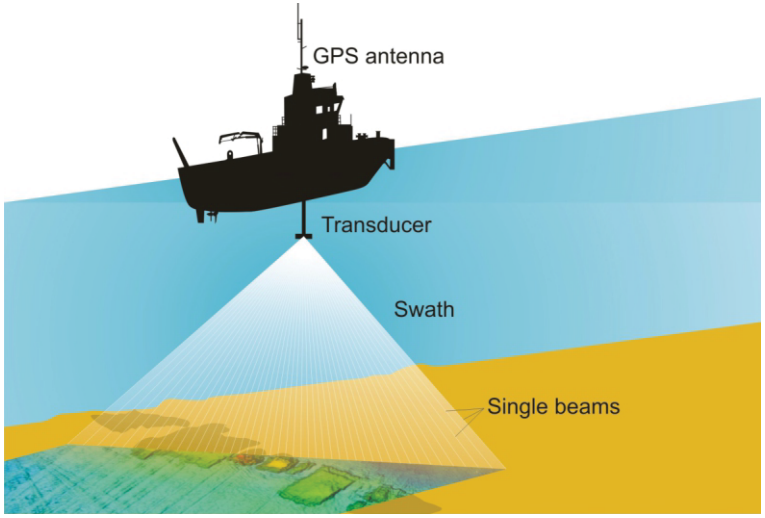
Figure 1



Date:	18/09/2015	Revision Number:	0
Scale:	NTS	Illustrator:	KJF
Path:	W:\Projects\108630\Graphics_Office\Rep figs\Geophys\2015_09_18		

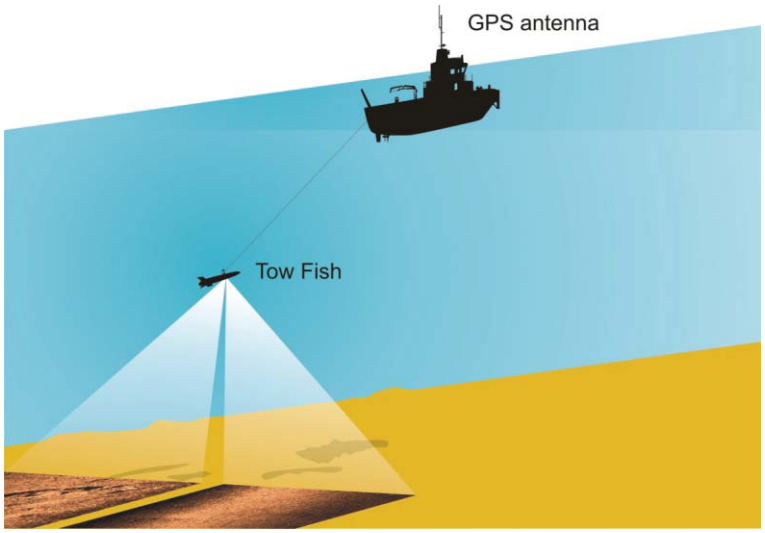
City of Adelaide plans, circa 1923, for conversion to RNVR drill ship *Carrick*. Scale 1:96. (© National Maritime Museum, Greenwich, London)

Figure 2

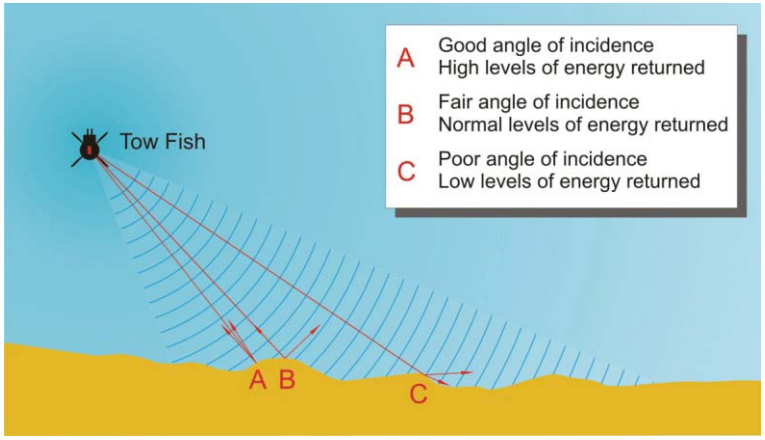


A. Acquisition of multibeam bathymetry data

B. Sidescan sonar towfish



C. Acquisition of sidescan sonar data

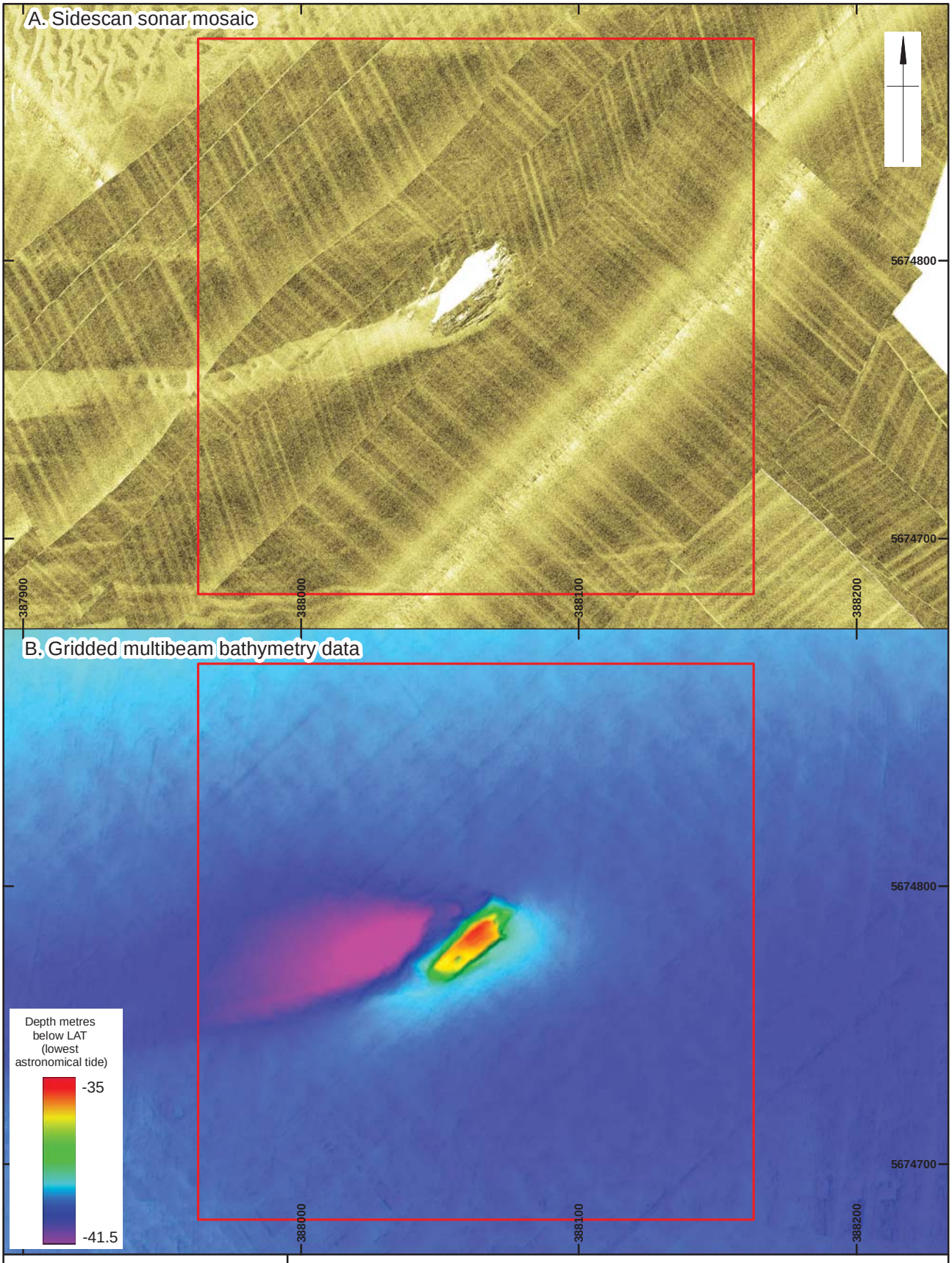


D. Details of sidescan sonar data acquisition

Date:	18/09/2015	Revision Number:	0
Scale:	NTS	Illustrator:	KJF
Path:	W:\Projects\108630\Graphics_Office\Rep figs\Geophys\2015_09_18		

Sidescan sonar and multibeam bathymetry data acquisition

Figure 3



Survey Area

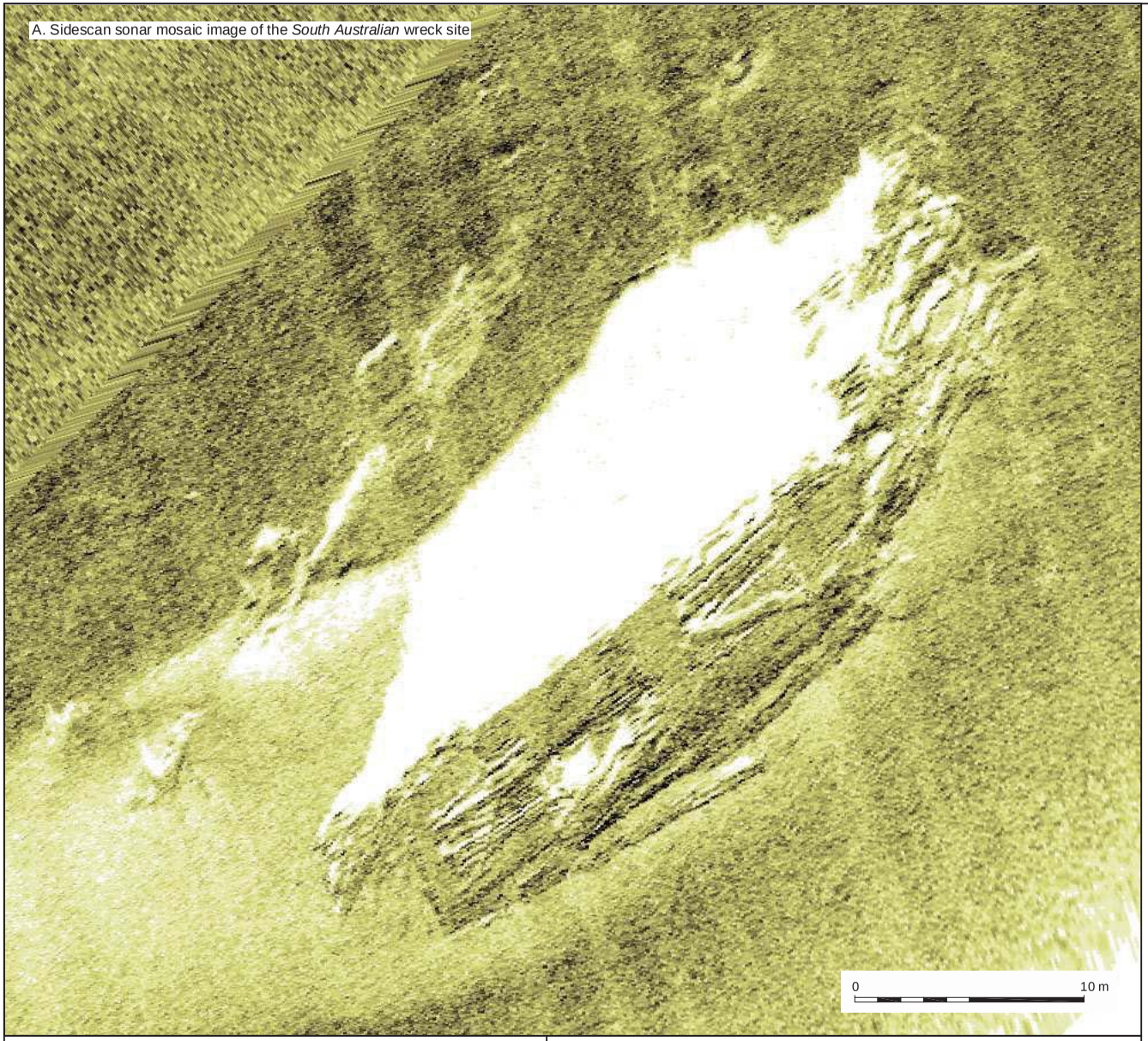
0 50 m

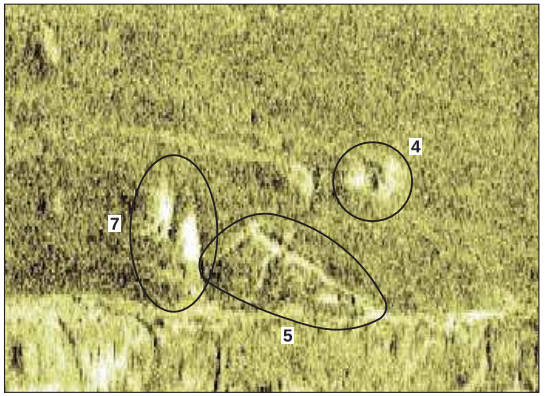
Date:	18/09/2015	Revision Number:	0
Scale:	1:2000 @A4	Illustrator:	KJF
Path:	W:\Projects\108630\GIS\FigsMXD\Geophys\2015_09_25		

Data coverage of survey area

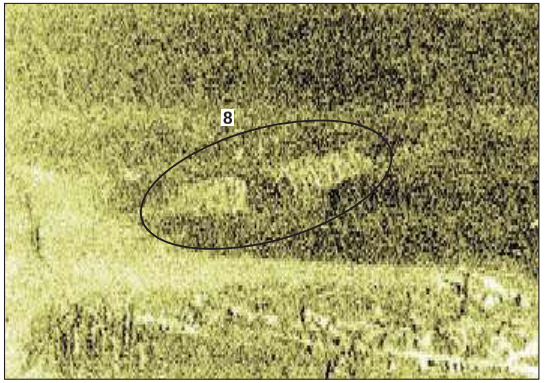
Figure 4

A. Sidescan sonar mosaic image of the *South Australian* wreck site

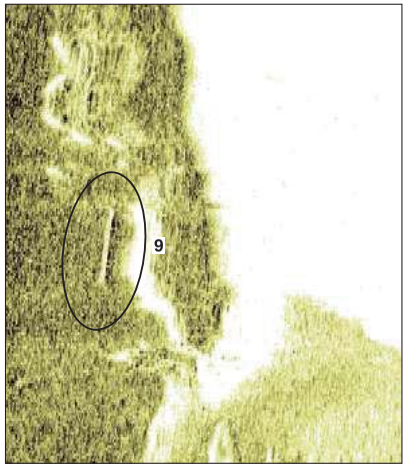




B. Waterfall image of debris next to rail stack, **Features 4**, **5** and **7**



C. Waterfall image of **Feature 8**, pair of bright reflectors covering an area of 14.1m x 2.5m



D. Waterfall image of **Feature 9**, linear debris (3.3m x 0.2m x 0.1m)

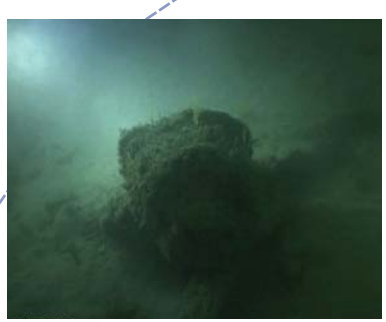
Date:	18/09/2015	Revision Number:	0
Scale:	A 1:200 @A3	Illustrator:	KJF
Path:	W:\Projects\108630\Graphics_Office\Rep figs\Geophys\2015_09_25		

Sidescan sonar images of key features

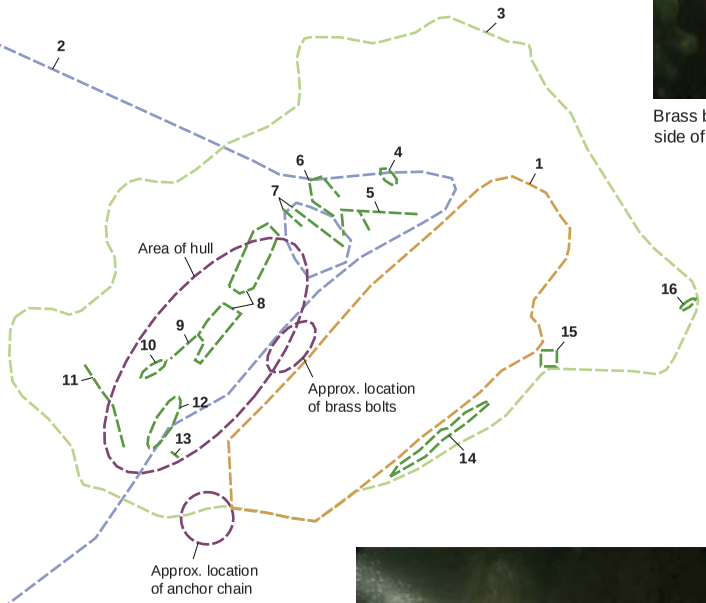
Figure 5

Frame, part of area of hull containing **Features 8** to **13**

Brass bolts on NW side of **Feature 1**



Windlass, possibly **Feature 12** or **Feature 13**

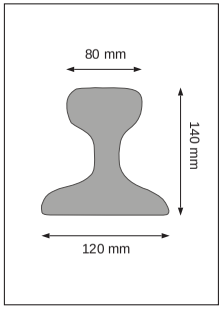


Rail stack, **Feature 1**

Wheel at one side of the windlass

Anchor chain close to SW end of **Feature 1**

Detail of rail



Rail profile

Wreck Location
Survey Area
Rail Stack
Scour
Debris Field
Debris
Diver Interpretation

0 10 20 m

Area shown

Date:	18/09/2015	Revision Number:	0
Scale:	1:500 @A3	Illustrator:	KJF
Path:	W:\Projects\108630\Graphics_Office\Rep figs\Geophys\2015_09_25		

Site plan and photographs of known features

Plate 1: Diver on the rail stack

Plate 2: Rail stack

Plate 3: Remains of the hull

Plate 4: Conger eel by a frame and hull planking

Date:	18/09/2015	Revision Number:	0
Scale:	N/A	Illustrator:	KJF
Path:	W:\Projects\108630\Graphics_Office\Rep figs\Geophys\2015_09_18		

Plate 5: *City of Adelaide* in Adelaide 2015

Plate 6: Iron knee (2005)

Plate 7: Interior of the hull, showing wooden planking and metal frames (2005)

Plate 8: Bolt spacing (2005)

Date:	18/09/2015	Revision Number:	0
Scale:	N/A	Illustrator:	KJF
Path:	W:\Projects\108630\Graphics_Office\Rep figs\Geophys\2015_09_18		

Plate 9: *South Australian* 'yellow metal' brass bolts

Plate 10: Wineglass from *South Australian*

Date:	18/09/2015	Revision Number:	0
Scale:	N/A	Illustrator:	KJF
Path:	W:\Projects\108630\Graphics_Office\Rep figs\Geophys\2015_09_18		

Plate 11: ILFSAC's club boat *Neptune* was used as the survey vessel

Plate 12: Sidescan sonar fish towed behind *Neptune*

Plate 13: Data acquisition – sidescan sonar (left) and navigation (right)

Date:	18/09/2015	Revision Number:	0
Scale:	N/A	Illustrator:	KJF
Path:	W:\Projects\108630\Graphics_Office\Rep figs\Geophys\2015_09_18		

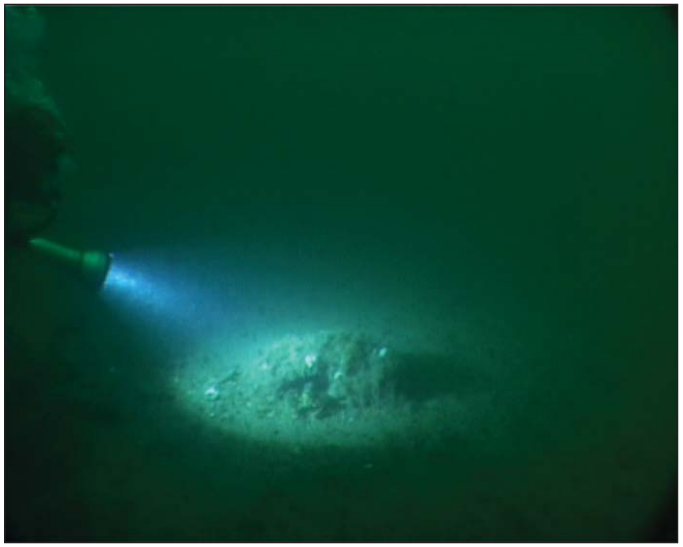


Plate 14: Diver approaching anchor

Plate 15: Anchor

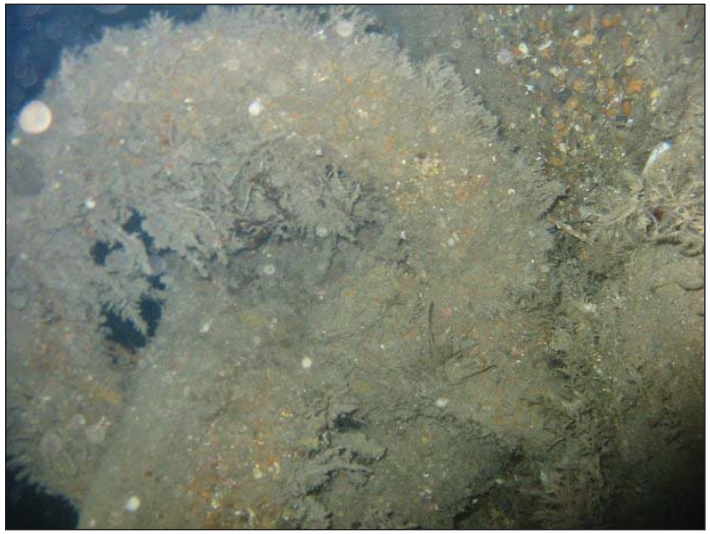


Plate 16: Ring at top of anchor stock

Date:	18/09/2015	Revision Number:	0
Scale:	N/A	Illustrator:	KJF
Path:	W:\Projects\108630\Graphics_Office\Rep figs\Geophys\2015_09_18		

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