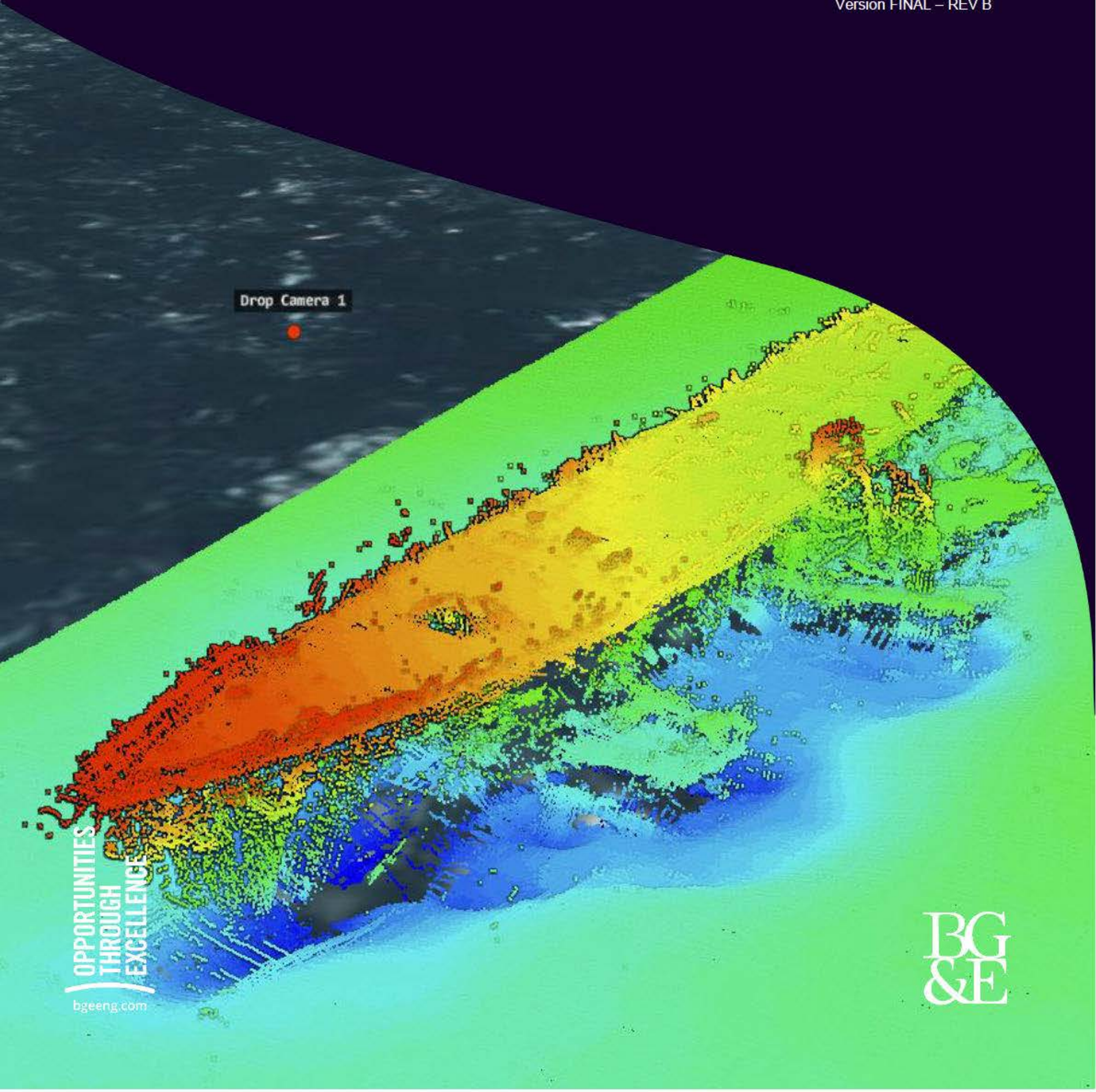
ex-HMAS Adelaide - Structural Condition Report (PROC12925)

Prepared for Department of Planning, Housing, and Infrastructure – Crown Lands

January 2026

Project Number N25028
Version FINAL – REV B



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Document Control				
Revision	Date	Prepared	Reviewed	Approved
A - DRAFT	03/10/2025	[redacted]		
B – FINAL	24/02/2026			

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1. Executive Summary

The Department of Planning, Housing, and Infrastructure – Crown Lands (Crown Lands) engaged BGE Pty Limited to conduct a comprehensive structural condition assessment of the ex-HMAS Adelaide following significant storm-related damage observed in July 2024. The vessel, scuttled in April 2011 to serve as an artificial reef and recreational dive site, is located approximately 1.8 km off Avoca Beach near Terrigal, New South Wales, at water depths of 30 to 32 metres.

The assessment confirmed that the aluminium superstructure separated from the steel hull during the storm event, collapsing and depositing large sections, including the bridge and O2 deck, onto the seabed. This separation has significantly increased diver safety risks due to jagged, unstable aluminium panels, exposure of new penetration points with entrapment hazards, and compromised structural stability.

Marine surveying using multibeam and side scan sonar technologies, combined with targeted dives limited to 30 metres for diver safety, mapped the wreck and debris field, identified hazards, and evaluated structural integrity. Key findings include an intact main hull with minimal damage, presence of loose and sharp debris on the deck presenting entrapment and injury risks and observed mobility of detached superstructure debris indicating instability of the detached components.

A detailed metocean assessment characterised wave and current conditions impacting the wreck, revealing significant near-bed currents and seabed scour of up to 2 metres, which may influence hull stability and debris movement over time. Hydrodynamic loads were estimated for design considerations, highlighting the need for factors of safety and consideration of flow acceleration effects.

The condition of the steel hull suggests ongoing corrosion risks, exacerbated by loss of the aluminium superstructure as a sacrificial anode. Recommendations include:

- Continuous monitoring of scour and hull movement. However, continuous monitoring may not be required if the risk to diver safety is too high and if the site is closed.
- Removal of loose debris to mitigate diver risks, if maintained as a dive site, and to mitigate the risk of debris mobilisation towards the shore.
- Controlled collapse or demolition of the detached superstructure to reduce hazards.

2. Introduction

2.1 Project Background

Crown Lands engaged BG&E Pty Limited to undertake a structural condition assessment of the ex-HMAS Adelaide following storm-related damage observed in July 2024 and ongoing significant storm events in January, April and May 2025. This project was initiated in response to concerns regarding the safety, stability, and long-term durability of the vessel, which has served as an artificial reef and recreational dive site since its scuttling in April 2011.

The ex-HMAS Adelaide is located approximately 1.8 km off Avoca Beach, near Terrigal on the Central Coast of New South Wales, in water depths of around 30 to 32 metres. The vessel comprises a steel hull and an aluminium superstructure, with the latter having undergone significant deterioration since submersion. Following the July 2024 storm event, the aluminium superstructure separated from the hull, with large sections, including the bridge and O2 deck, depositing onto the seabed. These changes significantly increased diver safety risks due to jagged and unstable aluminium panels, entrapment hazards, and compromised structural stability.

A structural condition report prepared by BG&E in November 2024 highlighted additional hazards, including risks associated with the mast, mooring systems, and the potential mobilisation of debris during storms and strong currents. The findings reinforced the need for a detailed investigation to reassess the stability of the wreck, the integrity of the remaining hull and mast, and the risks posed to divers and the surrounding environment.

The current scope of works therefore seeks to undertake a comprehensive program of investigations and reporting. This includes a general site and structural assessment, stability and integrity analysis, diver safety considerations, and environmental risk evaluation. The outcomes of this work will enable DPHI to make informed decisions on future management measures, balancing diver safety, environmental protection, and the ongoing value of the ex-HMAS Adelaide as a recreational and ecological asset.

2.2 Site History

Please refer to the 2024 report titled “ex-HMAS Adelaide - Structural Condition Report, Nov 2024” for a thorough background on the vessel and timeline of deterioration.

2.3 Provided Information

The following information has been provided by the client to BG&E to assist with this assessment.

- Attachment 1 – Sea Dumping Permit
- Attachment 2 – LTMMP
- Attachment 3 – September 2024 Post Storm Report
- Attachment 4 – Structural Condition Report
- Attachment 5 – Risk Management Guide
- Attachment 6 – Access Points Diagram
- Attachment 7 – Register of Barred-off Items

3. Methodology

The following activities were completed.

3.1.1 Phase 1A: Planning and Implementing the Digital Data Capture

To promote efficiency and safety for the dive team, BG&E utilised digital data capture of the scuttled vessel as a preliminary assessment. As recommended in our previous report from 2024 we completed the following:

- Mapped the dive site and seafloor detecting objects that had detached from the main part of the ship and resultantly scattered along the seafloor using multibeam echosounder technology.
- Obtained high-resolution imagery of the vessel and seafloor and detected the wreck and any small objects using side scan sonar technology.
- A 6m survey vessel was launched and equipped with the Norbit i77h multibeam echosounder and Edgetech 4125 side scan sonar.
- The survey area was systematically covered to ensure complete data acquisition.
- Data was processed and analysed to create a 3D point cloud of the site.
- Data collected during the survey was processed using specialised software (Hypack and sonarwiz) to generate bathymetric maps.

3.1.2 Phase 1B: Drawings or Documents from Surveyor to Dive Team for Planning

The dive team met with surveyors and engineers to create a dive plan. They reviewed the survey drawings, models, reports, and attachments provided by DPHI to plan efficient dives. It should be noted that dives deeper than 30m did not proceed as divers deemed it unsafe until debris and detached sections were removed or made safe.

3.1.3 Phase 1C: Execute a Preliminary Dive & Wreck Configuration

For the divers to familiarise themselves with the vessel and condition of the detached superstructure, a preliminary dive was completed. This was conducted to assess the overall position of the scuttled vessel, major hazards, and divers to familiarise themselves with the area.

3.1.4 Phase 1D: Execute Targeted Dives

The following dive schedule was conducted. In all 4 of these dives key risks were highlighted, depth profiles assessed, vessel condition was assessed, and photos and videos were captured.

- Dive 1 – Main Hull External
- Dive 2 – Main Hull Internal Rooms and Passageways, initially planned but was not completed due to debris around access points and diver safety concerns.
- Dive 3 – Mast
- Dive 4 – Other Detached Structures

3.1.5 Phase 1E: Debris Washup Assessment

We conducted bathymetry surveys from the wreck towards the shore at Avoca beach utilising equipment previous discussed in Phase 1A. This highlighted unnatural formations and provided divers with location data to assess if those formations are debris from the scuttled vessel.

3.1.6 Phase 1F: Environmental and Metocean Analysis

BG&E assessed the following to understand what mechanisms might be at play when considering if debris, or further deterioration of the scuttled vessel, could wash to shore:

- Derivation of wave climate.
- Literature evaluation of local currents.

- Calculation of wave-orbitals at depth.
- Estimation of wave-induced loads.
- Derivation of wave-induced near-bed stresses, to estimate debris mobility.
- Consideration of drift patterns and uncertainty associated with debris variability.

3.1.7 Phase 2: Planning and Pricing the Remediation Works

Following our diving investigations and dive reports, BG&E worked with quantity surveyors and our in-house construction engineering team to develop a remediation strategy with associated costings.

3.1.8 Exclusions and Limitations

The following items were excluded from this investigation.

- No samples were retrieved from the scuttled vessel or from the ocean floor.
- No diving was conducted within the main hull as it was deemed unsafe.

4. Results

4.1 Marine Surveying

Astute Surveying Pty Ltd was contracted by BG&E to undertake a hydrographic survey of the HMAS Adelaide, Avoca. The surveys are being used to aid in monitoring of the wrecks condition over time. This section covers the Global Navigation Satellite System (GNSS) control used, vessel, equipment, survey method and checks conducted while undertaking the surveys.

Figure 1 - Survey Area

4.1.1 Setup and Referencing

The project horizontal datum used is the Geocentric Datum of Australia 2020 (GDA2020) with coordinates projected onto the Map Grid of Australia 2020 (MGA2020) Zone 56. Table 2 below lists the key settings for the datum.

Table 1 - Key Datum Settings

PARAMETER	VALUE
Datum	Geocentric Datum of Australia 2020 (GDA2020)
Reference Frame	International Terrestrial Reference Frame 2014 (ITRF2014)
Ellipsoid	GRS80
Semi Major Axis	6,378,137.0 meters
Inverse flattening	298.257222101
Projection	Map Grid of Australia 2020 (MGA2020)
Projection Method	Universal Transverse Mercator (UTM),
Zone	56
Latitude of Origin	0° S
Longitude of Origin	153° E
Scale factor at Origin	0.9996
False Easting	500,000m
False Northing	10,000,000m

Depths were determined relative to the GDA2020 ellipsoid, Australian Height Datum.

The following equipment was used to record the multibeam and side scan survey shown in Table 2 below.

Table 2 - Survey Equipment

Equipment	Parametre
Vessel	Type: Aluminium Single hull. Length: 6m Beam: 2.4m Draft: 0.3m Propulsion: 200hp Suzuki outboard
Bathymetry Systems	Type: Norbit i77h Transducer Frequencies: 400 kHz Beams: 1024 Motion Compensation: Oceanmaster Ping Rate: 20Hz+ Installation: Over the Side Limiting Sea Conditions: Primarily aeration of transducers at > 1.5m swell
Position and motion sensor	POSMV Ocean Master The antenna is mounted directly above the transducer with unimpeded access to satellites.
RTK Rover	Emlid Reach RS3
Radio RTK correction data receiver	4G
Sound Velocity Probe	AML Base X SVP – direct Sound Velocity profile measurement

This setup described above greatly improves mapping and 3D imaging of the scuttled ex-HMAS Adelaide by producing high-resolution point clouds from the Norbit i77h multibeam echosounder, capturing 1024 beams per ping across 200% overlapping swaths for dense, accurate seafloor models of the wreck and debris at 30m. Centimeter-level RTK positioning from Emlid Reach RS3 and POSMV motion corrections ensure every data point aligns precisely, enabling creation of TIN models, contours, and 1m grids.

AML SVP corrections fix sound speed variations (e.g., 1517-1521 m/s), preventing depth distortions in 3D renders, while pole mounting reduces flex and aeration for cleaner data near complex wreck structures. Combined with side scan sonar images, it yields detailed 3D visuals of topside damage and shifted debris, supporting repeatable surveys via bar checks and patch tests for monitoring corrosion or shifts. Outputs like XYZ point clouds and KMZ/TIF files allow immersive 3D wreck mapping for dive safety and engineering assessments.

4.1.2 Multibeam and Side Scan Sonar

Multibeam in marine surveying refers to a sonar-based system called a Multibeam Echosounder (MBES) that is used to map the seafloor. Unlike single-beam sonar, which sends out one sound beam, multibeam sonar emits multiple sound beams simultaneously in a fan-shaped pattern beneath the vessel. This allows it to cover a wide swath of the seafloor on both sides of the ship, as shown in Figure 2(a).

Side scan sonar in marine surveying is an active sonar system designed to image large areas of the seafloor by emitting sound waves sideways from a transducer array, often mounted on a towed device called a towfish or directly on a ship's hull, as shown in Figure 2b. Unlike systems that measure depth, side scan sonar creates detailed images of the seafloor surface and objects by recording the intensity of sound waves reflected from the seabed.

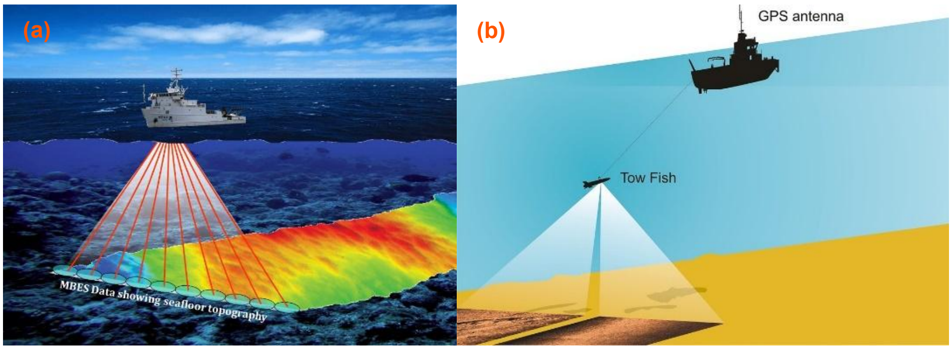

Figure 2 - Example of Multibeam (a) and Side Scan Sonar (b)

4.1.3 Imagery and Mapping Output from Marine Surveying

The following images and maps are provided as a visual representation of the ocean floor, scuttled vessel, surrounding formations, and debris on the sea floor.

- Figure 3 shows the full survey plan around the scuttled vessel (pictured in the centre).
- Figure 4 shows the point cloud model generated from the multi-beam and side scan surveys. This image shows the scuttled vessel, detached superstructure, and debris on the sea floor.
- Figure 5 shows the bathymetry survey with the scuttled vessel centred. This image is an extraction from the full survey image and shows rock formations and depth profiles to illustrate the conditions around the vessel.
- Figure 6 to 11 show 3D point cloud images of the scuttled vessel from various orientations.

This imagery allowed the planning of safe divers for further investigation and established an accurate, repeatable baseline for further inspections and monitoring should this been required. The images provided us with accurate locations and depths for metocean assessment.

A snapshot of the survey plan is provided below. An expanded survey plan can be found in Appendix A.

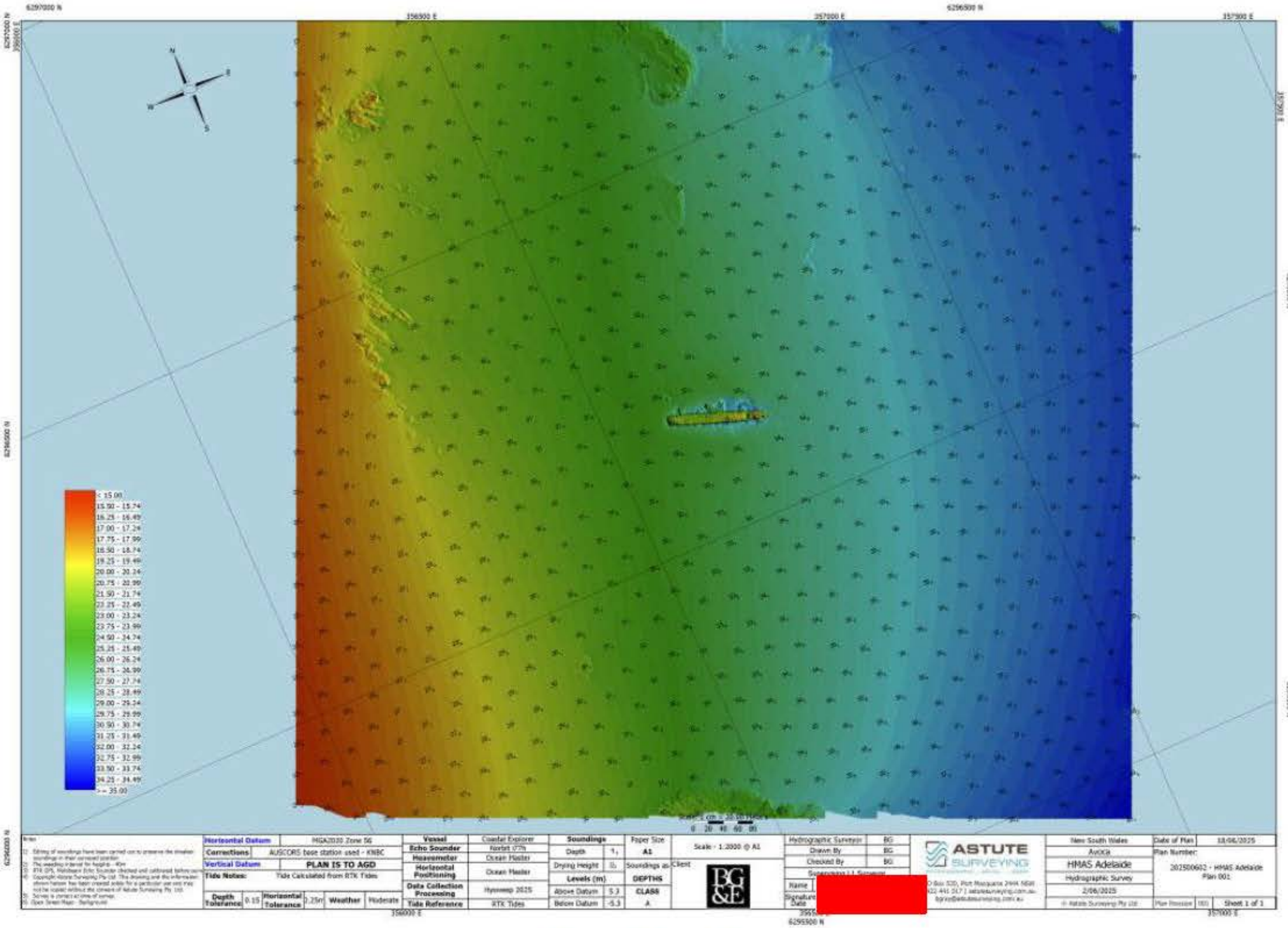

Figure 3 - Survey Plan

The following images were generated from the marine surveying multibeam and side scan sonar and can be viewed in a 3D space here:

https://app.pointerra.io/pointclouds/20250602-hmas-adelaide-ship/?guest_token=co_nzwEPopXfjrpJDCJm5sy8G

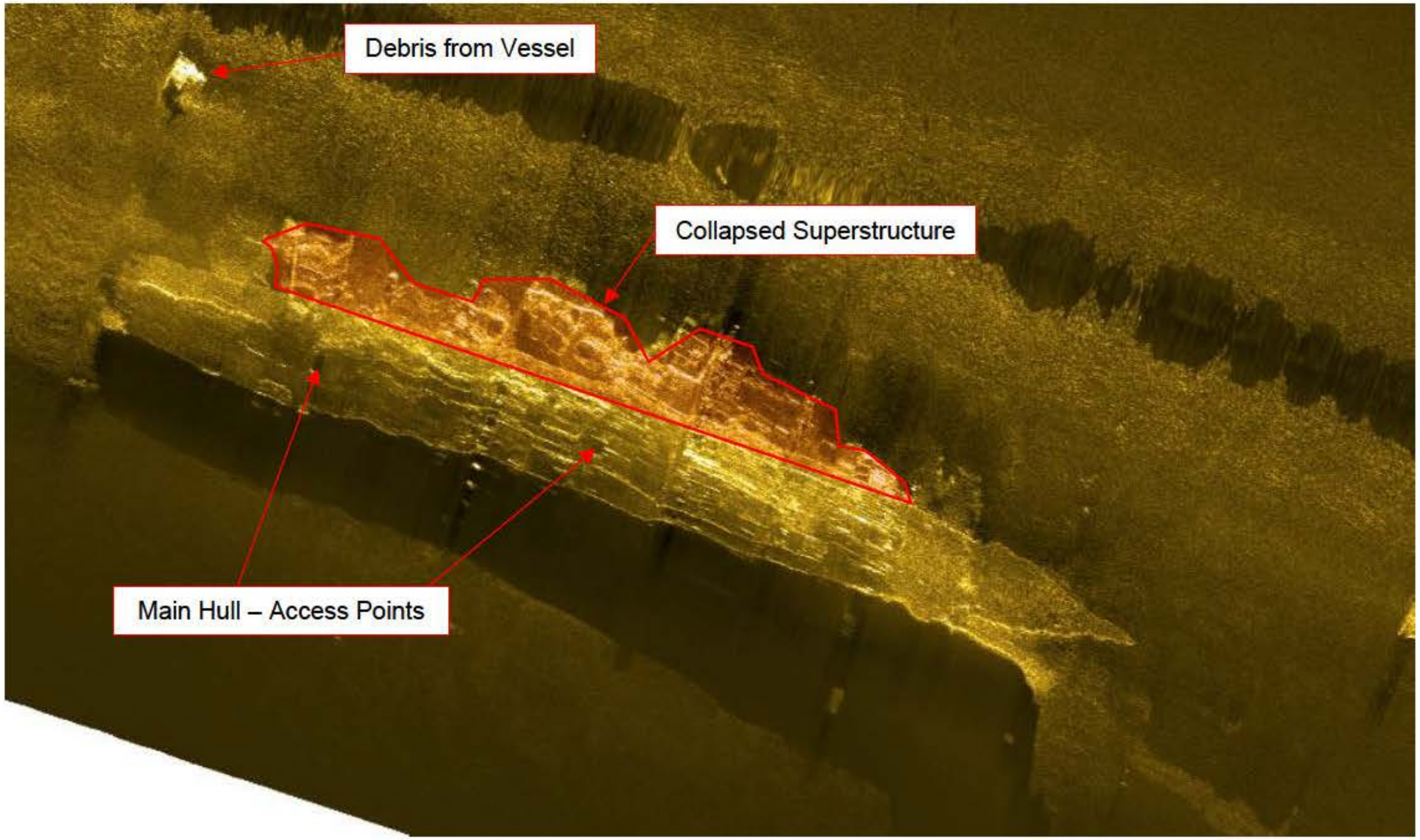

Figure 4 - Side Scan Sonar Image

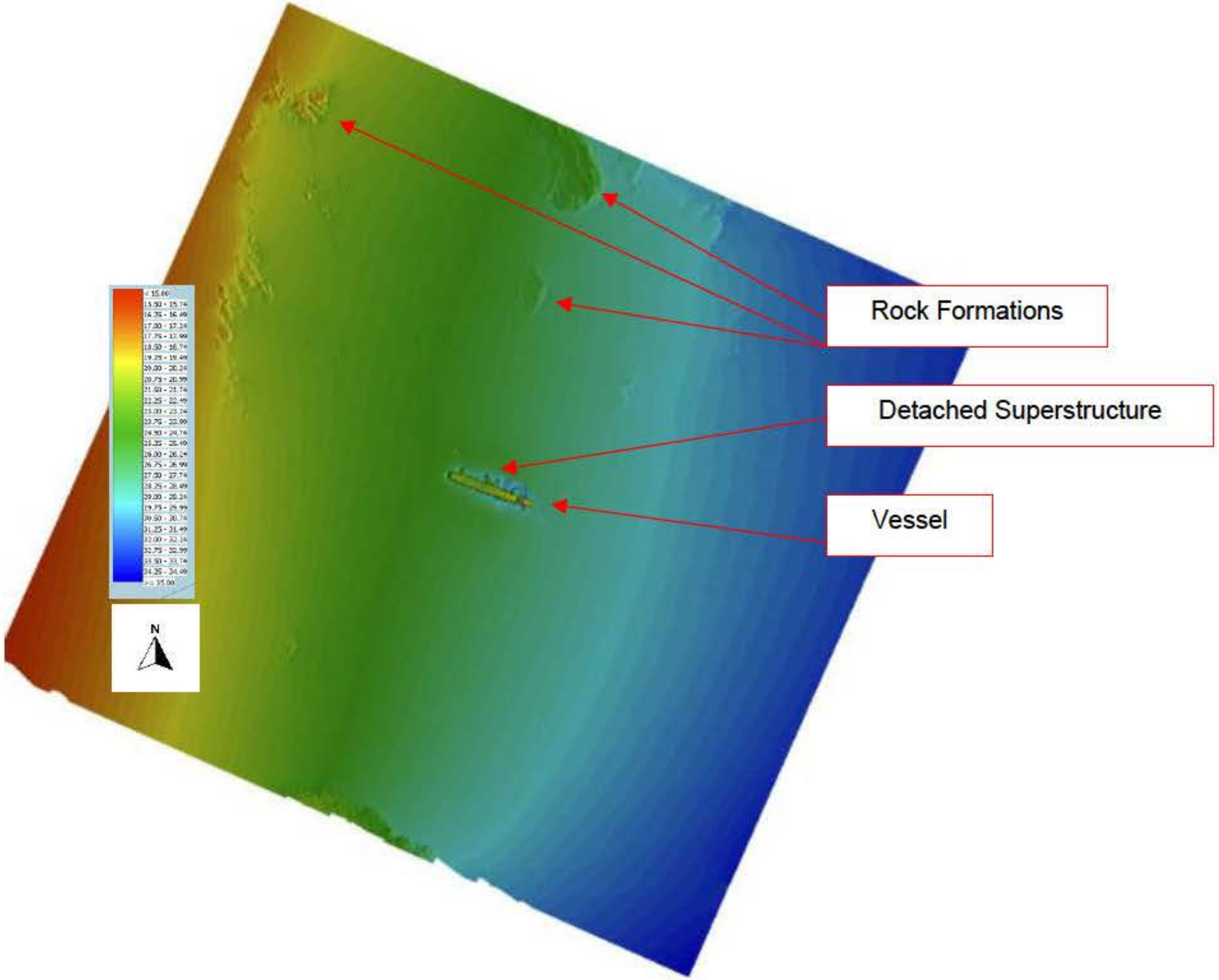

Figure 5 - Bathymetry Survey Coloured Model

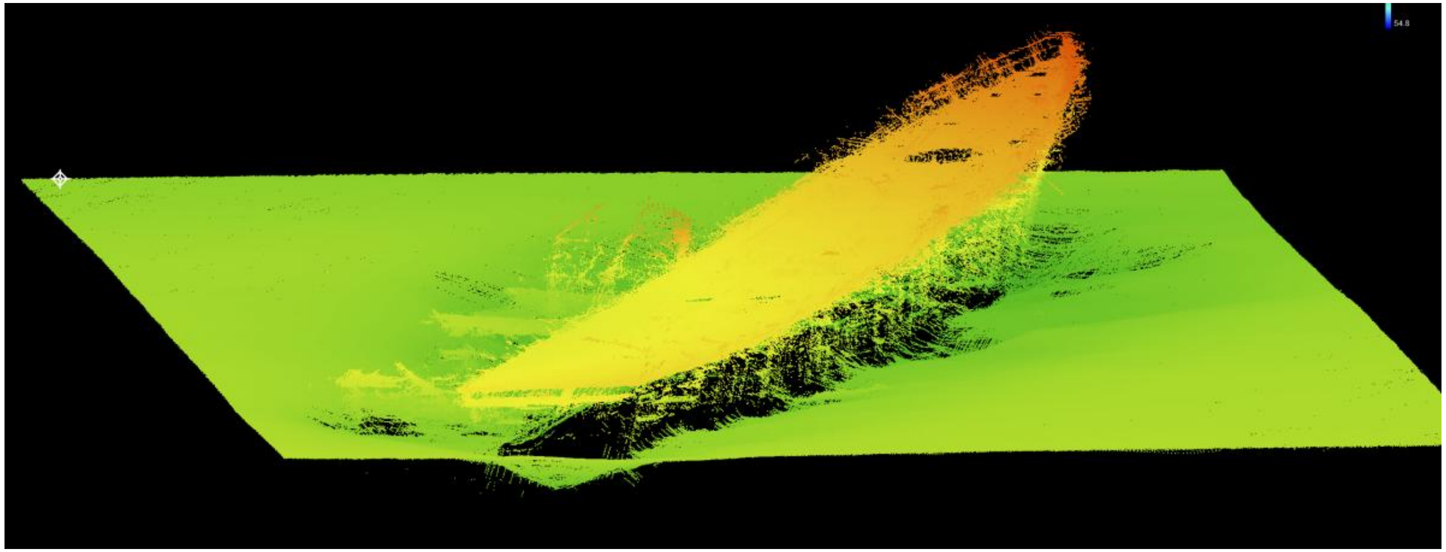

Figure 6 - View from Southern Side looking North East

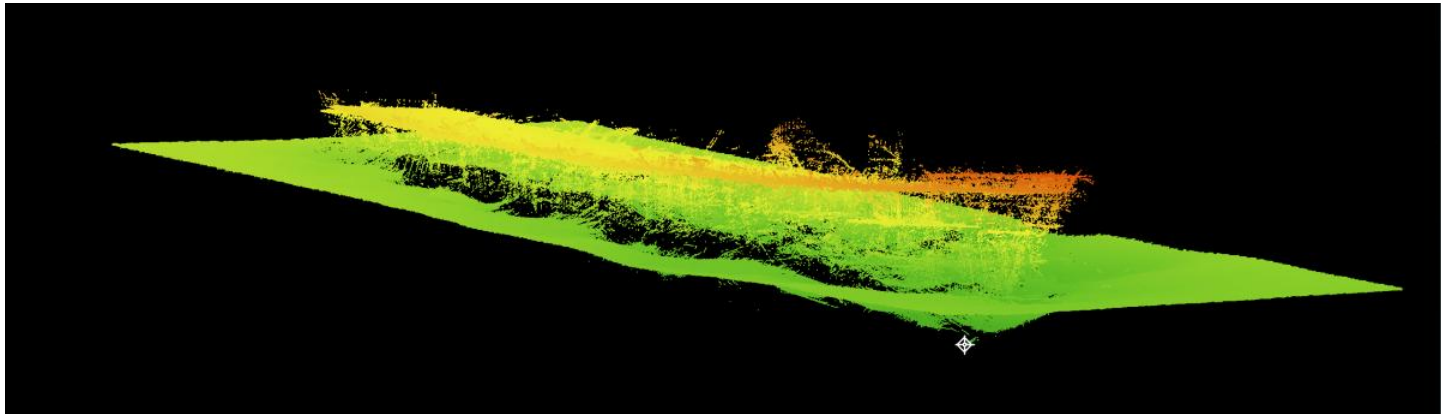

Figure 7 - View from Southern Side looking North West

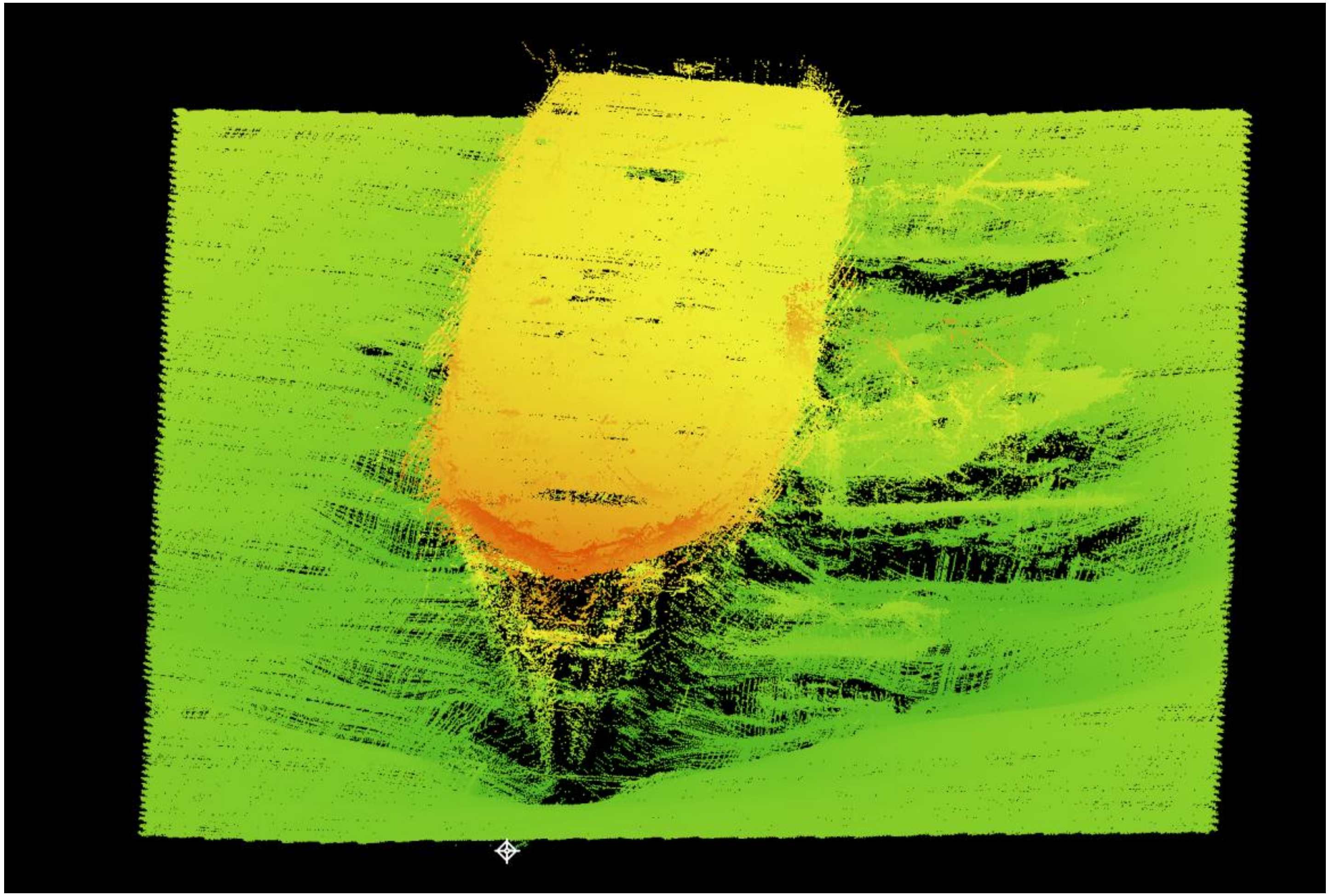

Figure 8 - View from Eastern looking West

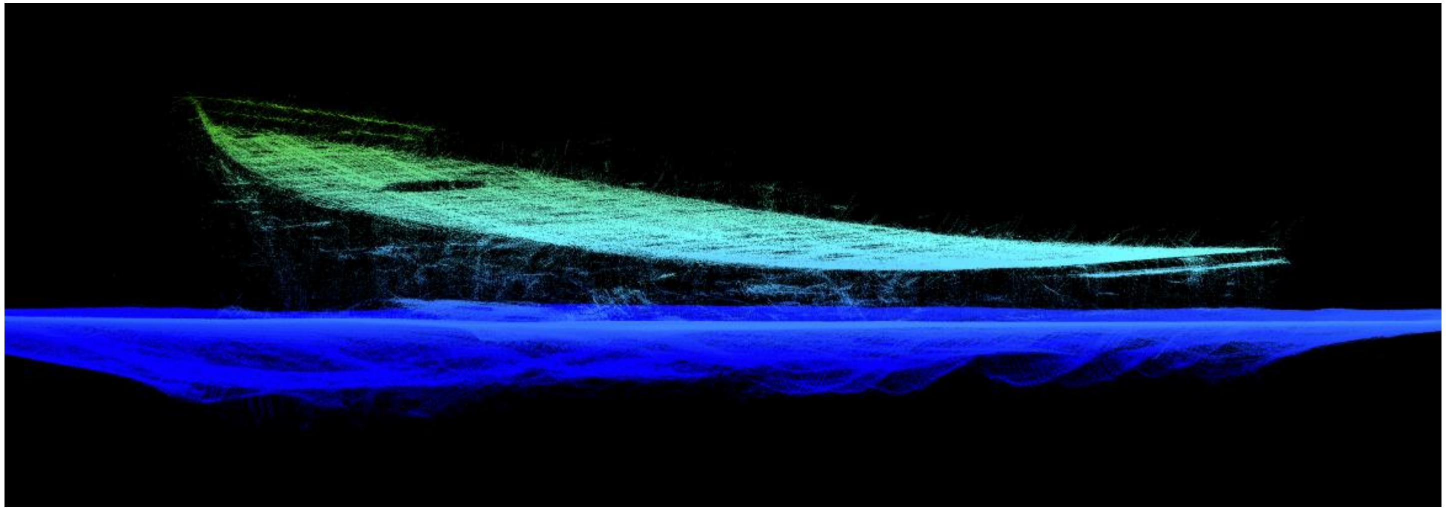

Figure 9 - View from North looking South

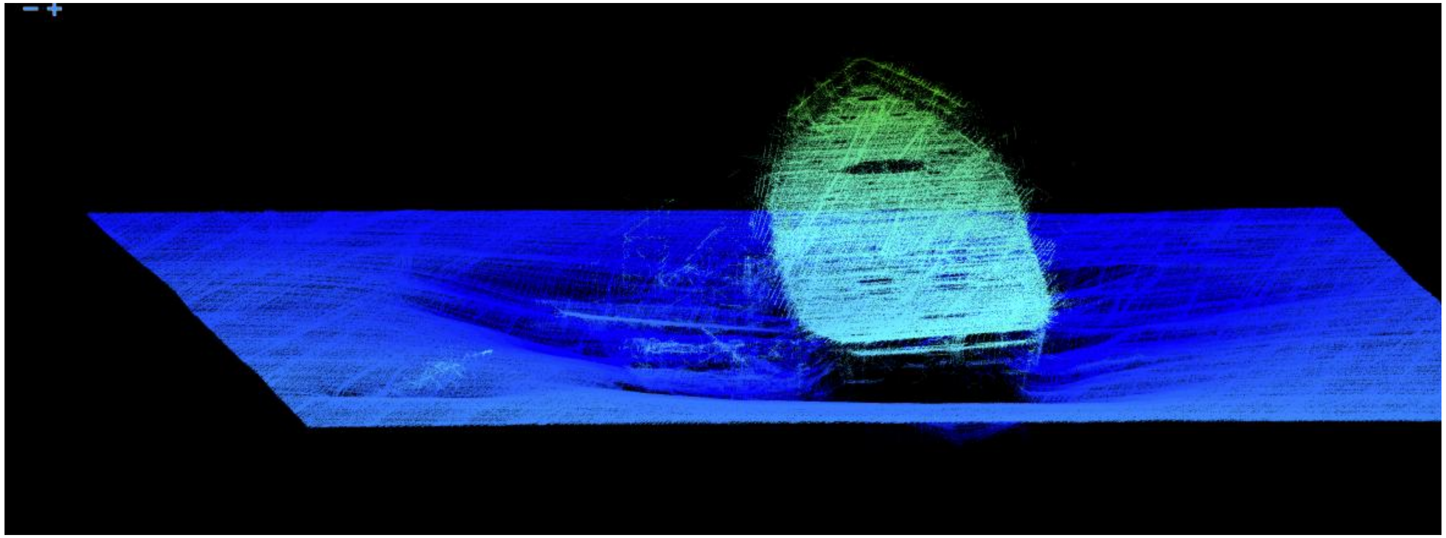

Figure 10 - View from West looking East

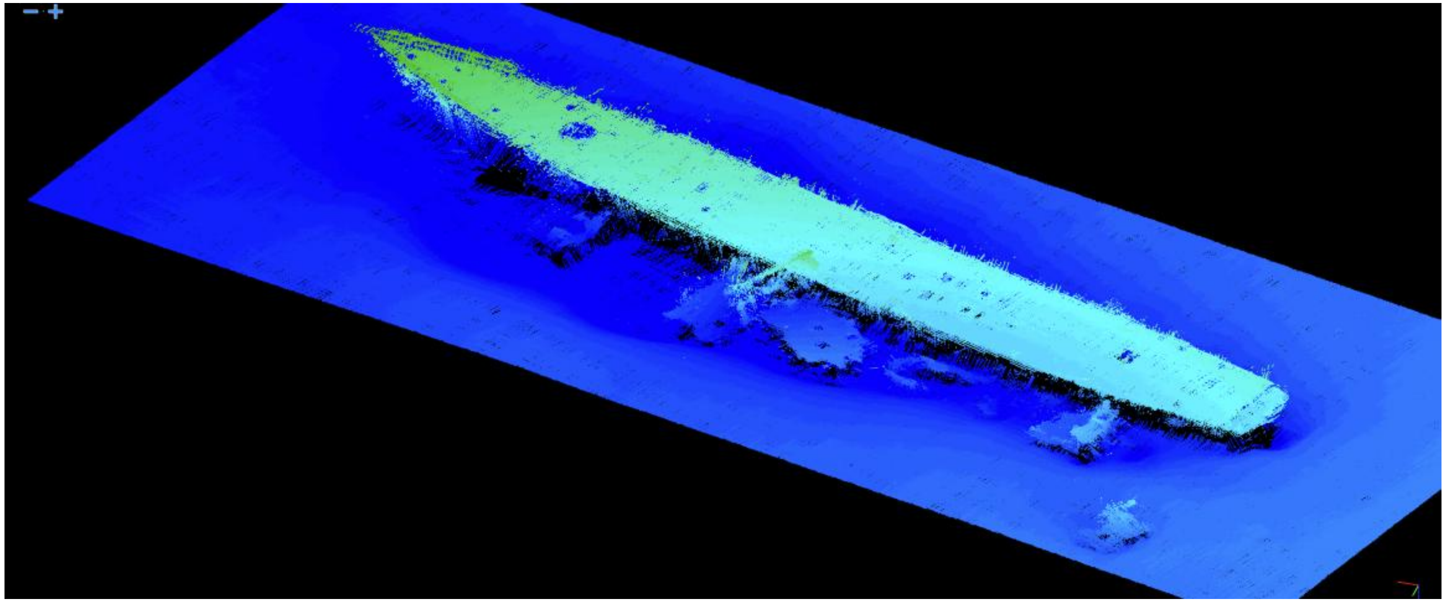

Figure 11 - View from Above looking at the Northern Side of the Vessel and Detached Superstructure

4.2 Dives and Findings

4.2.1 Summary of Dive Investigation

Sea Marine and Diving Services was engaged by BG&E to conduct a comprehensive assessment of the HMAS Adelaide, which sustained damage due to severe sea conditions and galvanic/bimetallic corrosion. The objective was to evaluate the wreck's structural integrity to determine if the damage sustained to the wreck precludes the wreck's reopening as a recreational dive site due to significant diver safety risks. The agreed methodology involved a series of dives conducted over five days to thoroughly inspect the wreck's condition. To optimise cost efficiency for the initial inspections, a maximum dive depth of 30 metres was established.

Dives were initialled planned for May-July 2025 however they were ongoingly delayed due to large winter swells and weather conditions.

The primary objective of the dive conducted on August 7, 2025, was to locate the vessel, install temporary ascent and descent lines for diver safety, evaluate the vessel's layout, and assess its overall condition. These activities were designed to inform the development of a comprehensive plan for subsequent dives to ensure an efficient and thorough site assessment.

The dive team observed that the vessel's superstructure had detached entirely from the main deck and collapsed to the port side. The main deck, situated at a depth of 30 metres, remains intact with minimal damage to both the deck and hull. However, loose debris was identified, lodged within hatches on the main deck. The separation of the superstructure has exposed multiple new penetration points into the vessel, which were previously inaccessible.

The dives completed by SMADS confirmed the findings of the scans from Astute Survey. The Main deck is in 28 to 31 metres of water at mean low water. Most of the debris is sitting lower than the main deck. The tower is laying on its side over on the port side of the vessel with the top sitting in 28 metres and the bottom on seabed. This is the highest point of the debris.

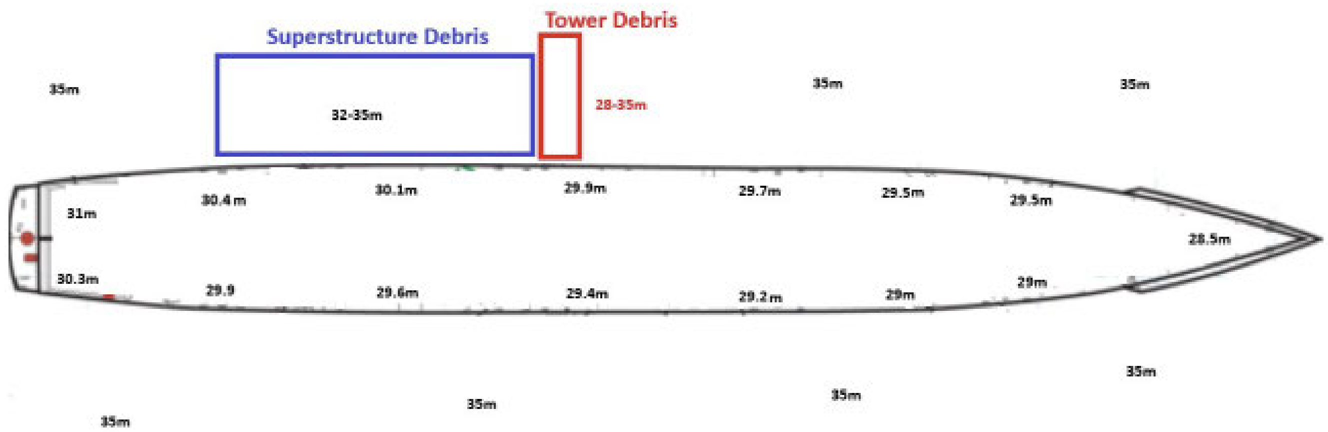

Figure 12 - Depth Profiles

4.2.2 Detached Superstructure

The entire superstructure of the vessel has detached and settled on the seabed along the port side. During the inspection, favourable visibility allowed for a thorough assessment of the debris condition from above. Between our initial and subsequent visits, notable movement of the debris was observed. Initially, the tower was leaning against the main deck of the vessel; however, during a later inspection, this tower had shifted, now resting against the vessel's side. This movement indicates that the debris field is unstable. Given this instability and the depth of the site, no attempts were made to enter the debris. Additionally, a small number of debris was observed on the starboard side of the vessel, all of which appeared to be flat on the seabed and in a stable condition. The main debris area is spread over a 250 sqm area from the middle of the ship to moving to the back of the ship. The highest point of the debris is the tower.

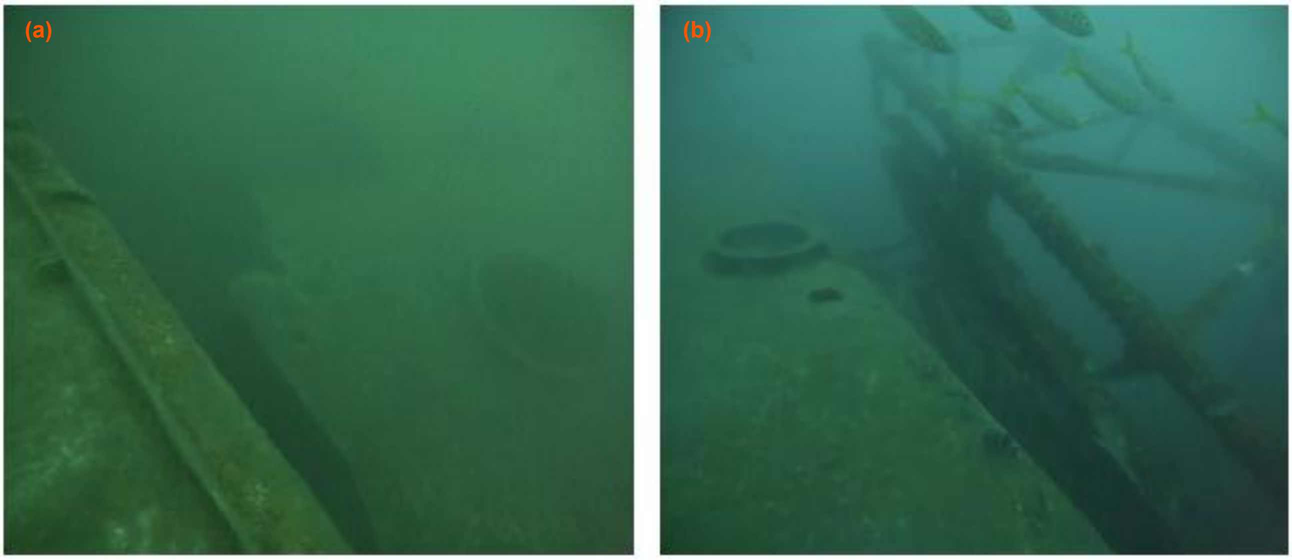

Figure 13 – Two Major Areas of Debris being Part of the Superstructure (a) and the Tower (b)

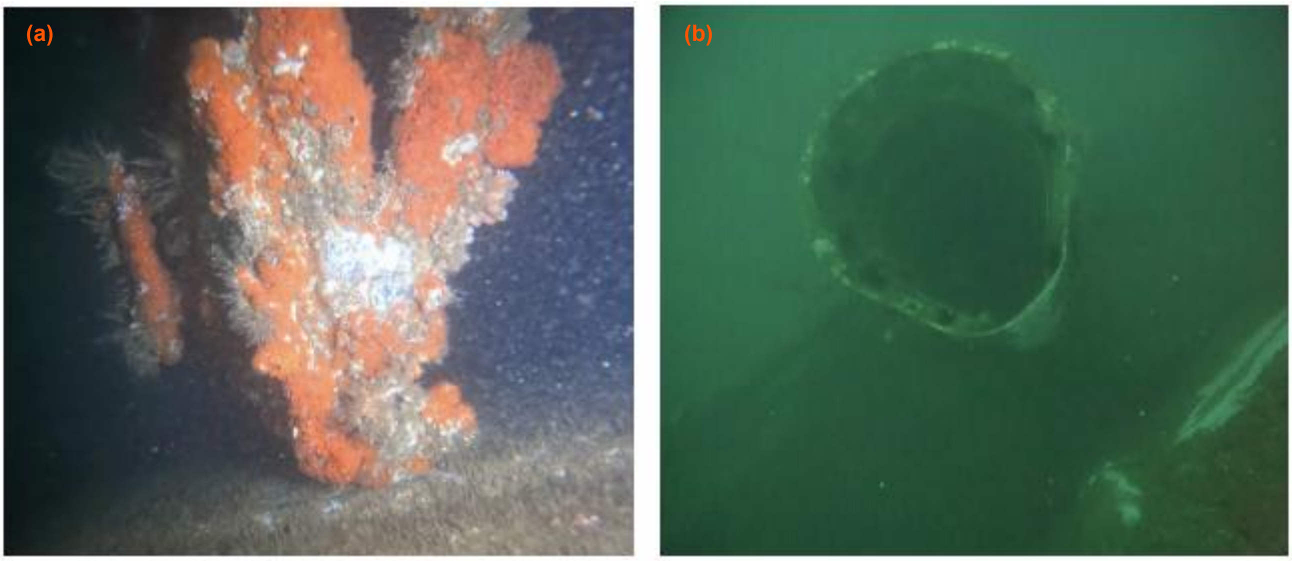

Figure 14 - Initial Dive Position of the Tower laying on the Main Deck (a) and Subsequent Dives Position where the Tower had Shifted (b)

4.2.3 New Penetrations

As the superstructure has detached, there are now new exposed penetrations and openings to the lower deck that were previously concealed by the walls of the superstructure. It is possible that new penetrations may pose an entrapment risk and thus were deemed unsafe to enter. Initially this was difficult to map out but then using a laminated copy of the map provided the diver and supervisor could clearly communicate and map out the new openings. Below is the map of main deck that was provided and zoomed in section where the superstructure was sitting. The red and green marks are the known openings. The map is marked with blue square showing all the new opening found.

Except for the forward starboard opening, all the remaining new penetrations marked in blue appear to pose an entrapment risk and without further investigation these should be closed off. Due to the debris and risk of entrapment divers were unable to enter the penetrations. Once debris is removed these rooms could be investigated further. The openings marked in red are known and previously mapped. Without removal of the debris and further dives these should be deemed unsafe.

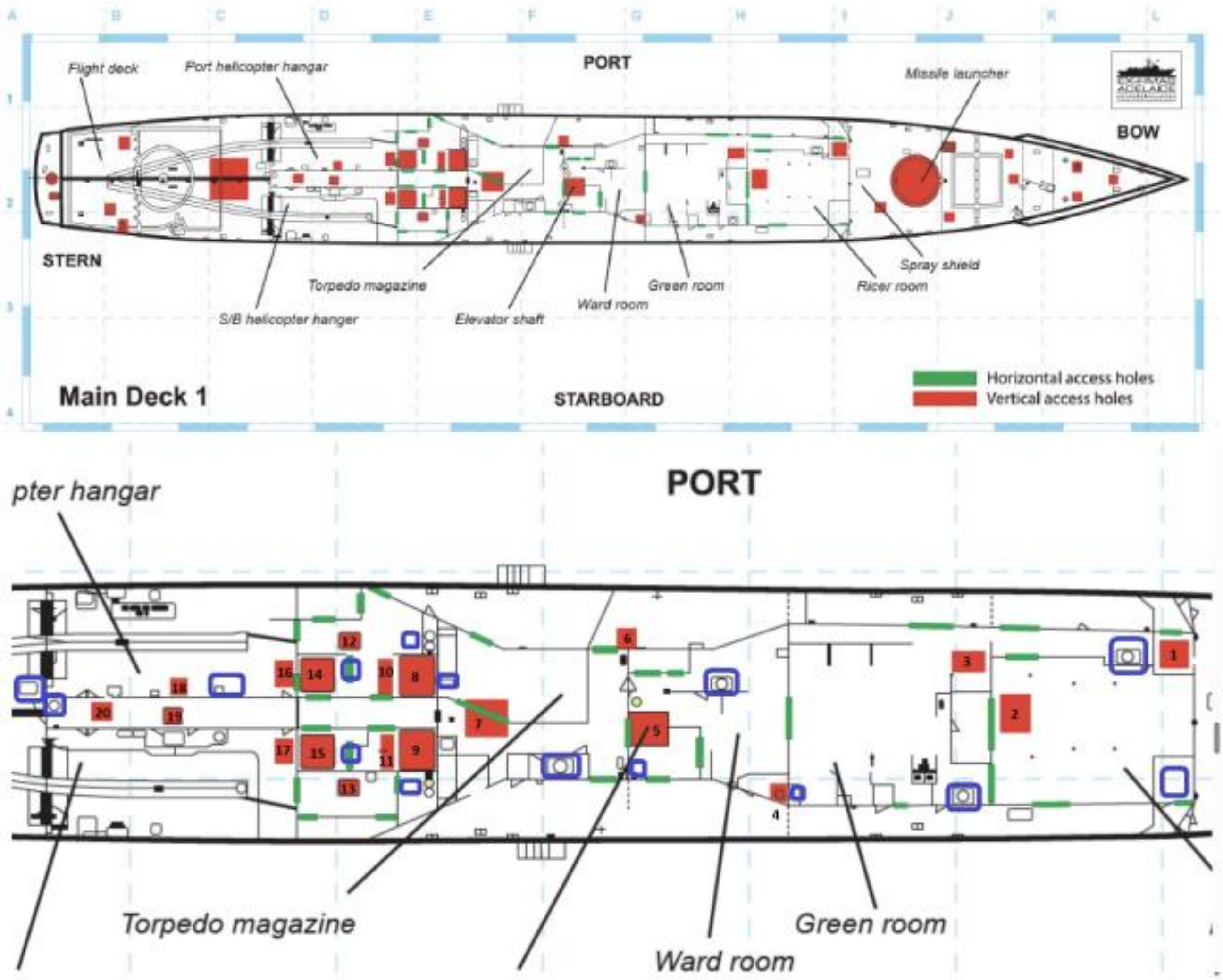

Figure 15 - New Penetrations Map

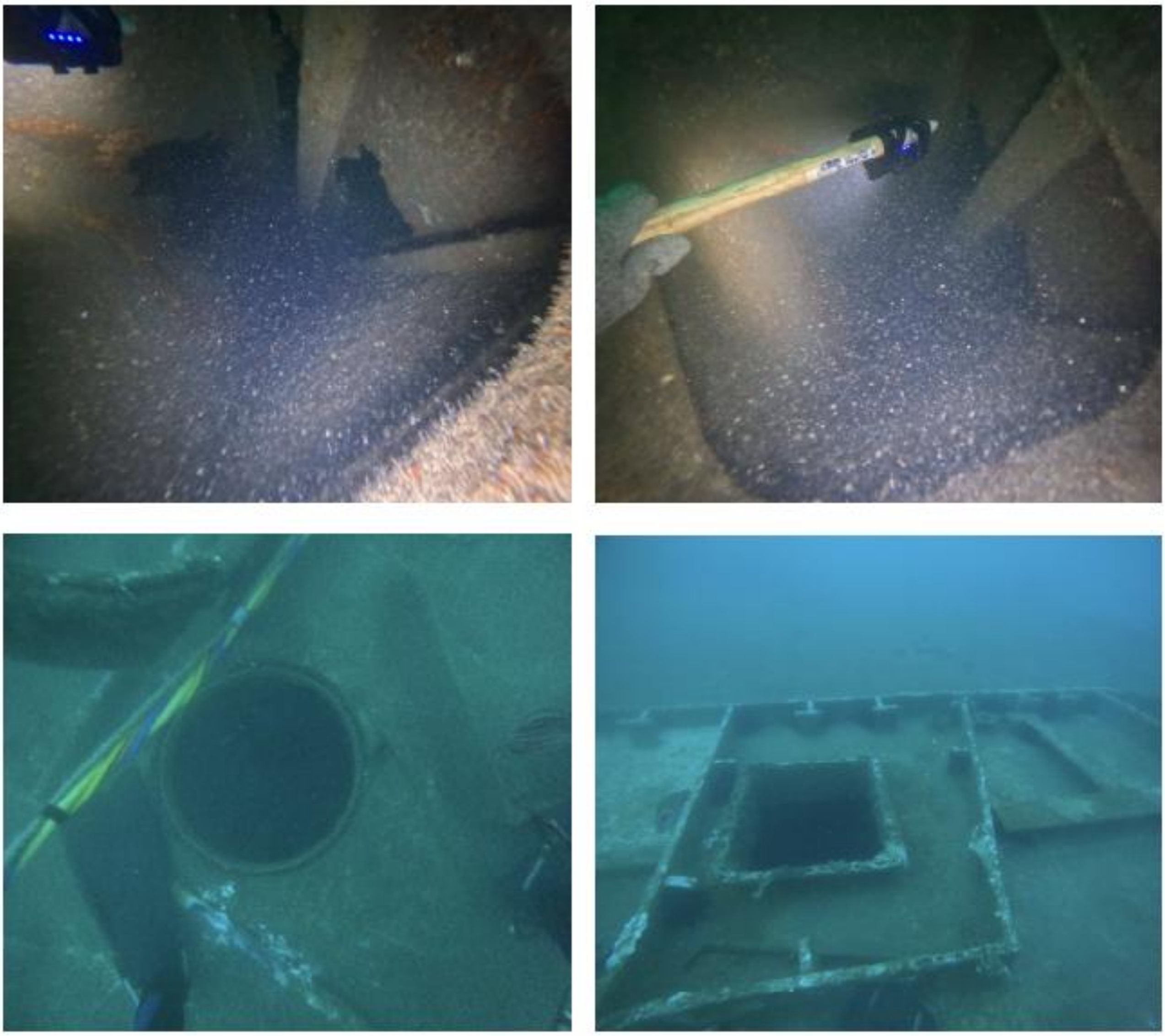

Figure 16 - New Penetrations in Deck

4.2.4 Deck Debris

While most of the debris has fallen to the port side of the vessel, there are a few areas on the deck where metal debris have become lodged on the deck. Some of the debris pose a risk of moving and trapping a diver if they weren't to be removed. Also, as these are torn metal, some of these have sharp edges. The separation of the super structure from the main deck is a clean break and has not created sharp edges, it is only a few isolated areas where the debris would need to be removed. Below the areas of debris have been marked in purple with the photos showing the materials to be removed.

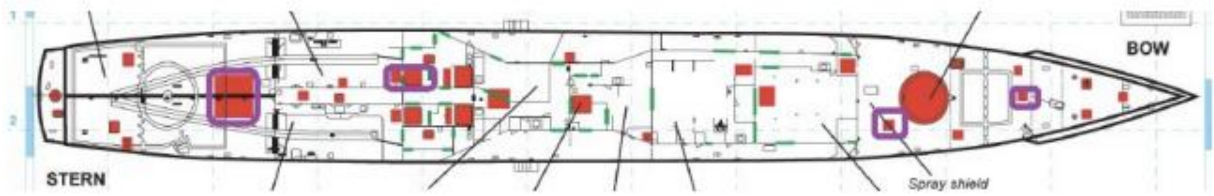

Figure 17 - Debris Removal

Figure 18 - Examples of Debris on the Deck

4.3 Metocean Assessment

4.3.1 Summary of Metocean Investigation

HMAS Adelaide is located 1.8 km offshore in 34 metres water depth. This position is affected by both waves, which have greater influence towards shore, and ocean currents, which increase towards the edge of the continental shelf. Near the seabed, effects of waves and ocean currents are similar, and they can interact with each other.

The wreck is located on the coastal margin of the continental shelf, part way down the ‘coastal slope’ between Avoca Beach bathymetry and the deeper continental shelf plain (Figure 19). This slope is sedimentary, with isolated rock formations apparent on local bathymetry, 500 m towards Terrigal Head from the wreck. Typical grades are 1:80 to 1:100. Bed scour is apparent adjacent to the wreck. Scour is more advanced on the northern side than the southern side, being about twice the width and almost 1 m deeper. This is possibly due to dominant swell wave direction but may also be caused by local flow turbulence around debris on the north side of the wreck.

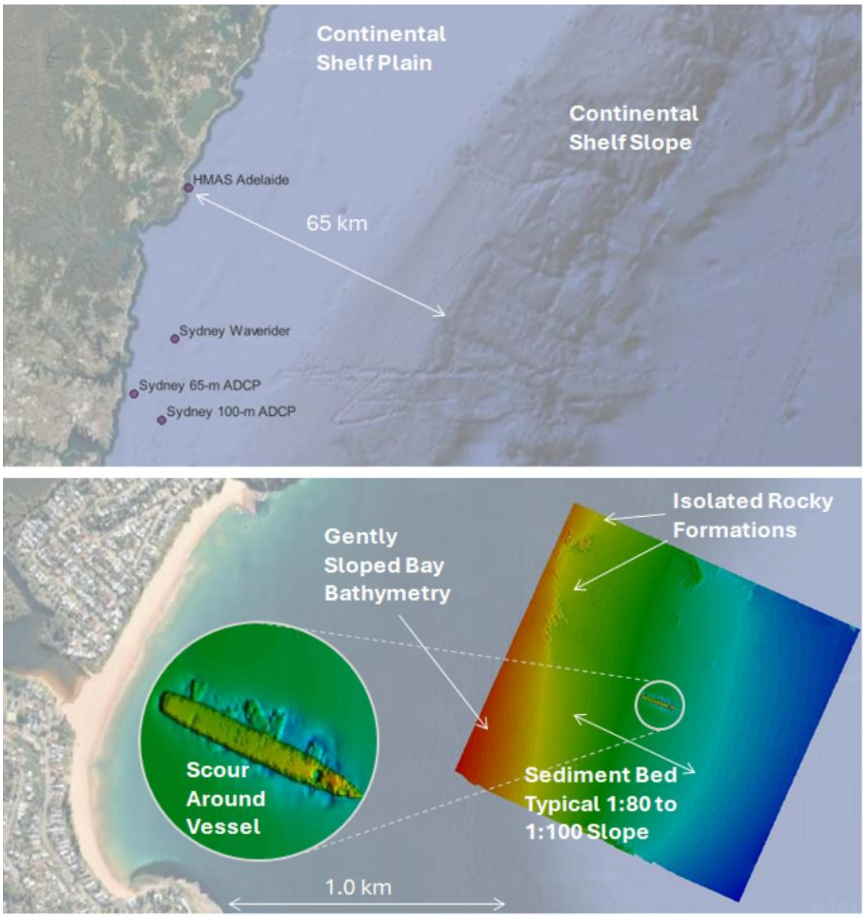

Figure 19 - Wreck Position on Shelf and Coastal Slope

The scale and shape of seabed features closer to shore are consistent with being rock formation typically occurring along the New South Wales shelf. The features adjacent to the wreck, on its north side, are characteristic of debris.

4.3.1.1 Wave Conditions

Wave conditions have been assessed using long-term data from offshore and nearshore wave buoys, providing insights into typical and extreme conditions. Characterisation of Sydney oceanography has been developed through a combination of oceanographic moorings, ocean glider deployments, satellite observations and operational modelling (Griffin 2007, Kerry & Roughan 2020), including programs actively undertaken by UNSW and BOM. Effects of waves travelling from offshore to the HMAS Adelaide site has been considered, along with variation of wave motion from the surface down to the seabed. At the wreck site, ‘significant’ wave height ranges from 2.1m (10% per annum) to 6.1m (1% likely in any year). These conditions can cause near-bed currents of 0.38 m/s (10% per annum) to 1.27 m/s (1% likely in any year).

Along with normal storm waves, long period waves provide an additional, comparatively frequent source of moderate-high near-bed currents. These can arrive from distant origins and sometimes occur when conditions otherwise appear calm.

4.3.1.2 Ocean Currents

Ocean currents have been evaluated using long-term data from offshore moorings, considering the transition from the edge of the continental shelf toward the coast. The record has shown a range of different conditions can cause strong ocean currents, including winter storms, ocean eddies, tropical cyclones, high pressure systems and deepwater density gradients. Ocean currents have been assessed to cause near-bed currents of 0.27 m/s (10% per annum) to 1.07 m/s (1% likely in any year), with capacity for local acceleration due to turbulence or interaction with structures such as the wreck.

4.3.1.3 Wave Induced Currents near the Vessel

Wave-induced near-bed currents derived from wave theory range from 0.21m/s (10% per annum) to 1.36m/s (1% likely in any year).

4.3.1.4 Metocean Investigations

Hydrodynamic loads have been estimated to support evaluation of the structural elements comprising HMAS Adelaide. Estimated hydrodynamic pressure from short-term loading ranges from 0.11 kPa (10% per annum) to 5.27 kPa (1% likely in any year). Application to design should consider appropriate factors of safety, as well as the capacity for local flow acceleration due to interactions with the hull.

Both waves and ocean currents can cause seabed movement, resulting in a seasonally active seabed. Flow interactions with the wreck cause flow deflection and acceleration, which has caused scouring of the seabed by as much as 2m. This seabed change possibly explains previous disturbance to HMAS Adelaide, as it will have caused an internal redistribution of both the hydrodynamic loads and the vessel self-weight.

4.3.1.5 Design Loads for the Vessel

Evaluation of structural elements on HMAS Adelaide should consider typical loading patterns associated with their shape and configuration. It is suggested to apply equivalent pressure loads, based on the drag force loading part of Morison’s equation:

F = Inertial Load + Drag Load

= Cm Vol. aF + Cd r/2 Area uF2

Simplified, due to the scale and phase difference, to:

F ~ Cd r/2 Area uF2

P ~ Cd r/2 uF2

Where drag coefficient Cd is a function of shape (typically 0.6-0.9 for circular members and 1.2-1.5 for rectangular members). r refers to fluid density.

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Design factors of safety should be applied, and it is recommended to consider a load combination which assumes simultaneous wave and current loading. As there is partial correspondence between waves and currents, it is recommended to combine a selected recurrence event with one recurrence step down for the other parameter.

Applying a safety factor of 1.5 to oceanographic currents, to account for their short-term variability, and a general Cd of 1.5, loading pressures have been estimated for fatigue and peak instantaneous loads (Table 7).

Table 3 - Estimated Load Pressures

Above Seabed	10% per annum	3% per annum	1-yr ARI	10-yr ARI	100-yr ARI
Pressure from Sustained Loading					
4-m	0.04 kPa	0.23 kPa	0.48 kPa	0.79 kPa	1.44 kPa
6-m	0.05 kPa	0.24 kPa	0.53 kPa	0.94 kPa	1.65 kPa
8-m	0.06 kPa	0.28 kPa	0.63 kPa	1.10 kPa	1.89 kPa
Pressure from Short-term Loading					
4-m	0.11 kPa	0.59 kPa	1.27 kPa	2.13 kPa	4.12 kPa
6-m	0.12 kPa	0.66 kPa	1.41 kPa	2.53 kPa	4.72 kPa
8-m	0.14 kPa	0.74 kPa	1.64 kPa	2.91 kPa	5.27 kPa

Based on the LTMMP monitoring locations for thickness testing, the nominal record thicknesses range from about 6.5mm to 10mm around the main deck. The hydrodynamic pressures from the above table (up to 5.27 kPa short-term and 1.89 kPa sustained at 100-year ARI) pose no failure risk to mild steel outer hull plating in the 6.5-10 mm thickness range. These low drag/shear loads induce maximum bending stresses of 12.6-29.9 MPa (assuming 400 mm stiffener spacing), well below the ~250 MPa yield strength, with safety factors exceeding 8 for short-term peaks and over 23 for sustained loads.

5. Discussion

5.1 Outputs from Marine Surveying

Marine survey outputs from the ex-HMAS Adelaide wreck assessment directly support ship integrity evaluation and long-term monitoring. The hydrographic survey provides high-resolution bathymetric and imaging data essential for tracking structural changes.

- Multibeam echosounder data: Generates detailed point clouds and 3D models of the wreck, capturing topside damage, debris positions, and seabed scour around the hull. These enable precise volume calculations and change detection over repeat surveys.
- Side scan sonar imagery: Produces high-resolution images of the seafloor and wreck surfaces, identifying debris fields, structural displacements, and small objects for integrity risk assessment.
- Drop camera videos and coordinates: Documents specific features like special markers and penetration points, confirming depths (main deck at 28-31m) and visual conditions for corrosion and stability checks.

5.2 Diver Safety in and Around the Main Hull

If the site is reopened following debris removal and internal structural assessment, discussed in Section 4.2.3 and 4.2.4, the main deck would be suitable for a PADI advanced open water diver, and the penetrations and sides of the vessel would be suitable for divers with a deep diving certification.

5.3 Interaction with the Vessel

The wreck of HMAS Adelaide provides a substantial barrier to flows, which will cause deflection and focusing of flows, particularly those directed towards (and along) the main hull structure. How flows across or along the wreck may be modified is shown schematically (Figure 20). Allowance for these processes has not been fully derived, which would require CFD analysis, but approximate scaling has been considered.

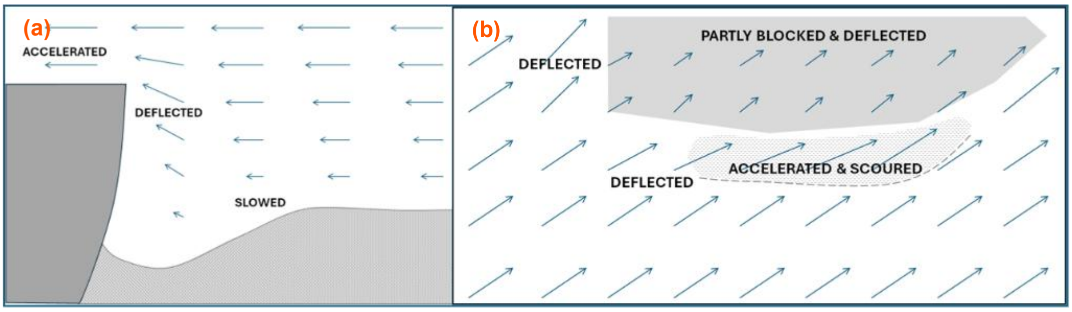


Figure 20 - Schematic Illustration of Flow Interactions
(a) Deflection and acceleration of flow across the vessel bow (cross-section) and (b) Deflection and flow streaming along the side of the vessel (plan view)

Significant flow acceleration is expected to occur along the edges of the deck, decreasing towards the centre of the hull. An allowance of 3-5x the ‘flat’ seabed currents is recommended when considering stability of fittings on the edge of the deck. It is noted that deflection due to the hull is expected to cause increased vertical motion, compared to currents measured on ‘flat’ seabed, which are typically less than 5% of the horizontal flow speed.

Flow along the wreck is also accelerated by interaction with the hull. Using scaling and geometry of the scour next to the wreck, an allowance of 2x the ‘flat’ seabed currents is recommended when considering flows along the side of the vessel.

5.4 Hull Mobility

The wreck of the HMAS Adelaide is a massive structure. Identified hydrodynamic loads are unlikely to directly cause motion of the hull. However, the occurrence of scour adjacent to the vessel (Figure 21) indicates some potential mechanisms for hull disturbance:

1. Undermining, particularly where it occurs deeply on one side, can allow the wreck to rotate.
2. Uneven scour can cause more settlement of one end of the vessel than another. This provides an internal redistribution of the vessel self-weight.
3. Substantial scour can lead to water flowing underneath the hull. This accelerates flow and further enhances the scour. This can cause redistribution of vessel self-weight and hydrodynamic loads (i.e. the hull acts like a beam between two points of contact) and acts to reduce the passive restraint provided by the hull connection to the seabed.

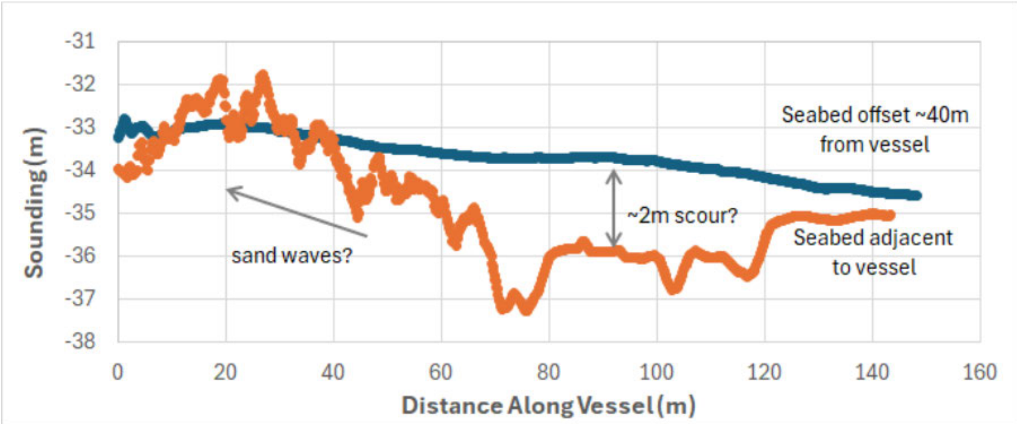


Figure 21 - Indication of Seabed Change Next to Vessel

No precise timeline can be provided for when scour might become an issue without site-specific sediment models (e.g., grain size, cohesion), but hydrographic surveys can track changes. Direct hull motion from loads is unlikely due to mass Based on the available data scour-induced instability could manifest in 5 years under frequent storms based on the conducted bathymetry survey. We would recommend CFD (computational fluid dynamics) modelling or ongoing ROV surveys for quantitative predictions.

5.5 Seabed and Debris Mobility

Wave orbitals and currents around 0.2-0.4 m/s for 10% per annum conditions suggest that seabed mobility is generally not a day-to-day occurrence. However, estimated currents above 0.5 m/s for 1-year ARI conditions suggest seabed mobility is likely to occur on a seasonal basis. This is further supported by the overall planar structure, and occurrence of 0.2-0.3m ripple formations visible from drop cameras during the hydrographic survey.

These conditions consequently imply that debris from the HMAS Adelaide might be intermittently mobilised, particularly if it has low density, or a shape that may allow it to act as a hydrofoil (i.e. plate-shaped debris). The likelihood is reduced for high density debris, which is more likely to be buried over time. Due to the significance of wave-induced currents, and prevailing waves from the south, a general northwest travel direction is considered most likely to occur, if debris is mobilised. Based on the geometry of the tower it is not expected to mobilise but rather sink into the sand. The debris at risk of mobilisation is the outer shell of the bridge and funnel as it they could be classified at thin, ‘plate’ like elements. The quantity of material subject to potential mobilisation is unknown as the detached superstructure will continue to deteriorate into small pieces from corrosion and seabed forces.

5.6 Durability of the Main Hull

Prior to the detachment of the aluminium superstructure, the steel hull was protected from corrosion by the aluminium superstructure. The superstructure acted as a sacrificial metal. A sacrificial metal is a type of metal that is purposely placed in contact with another metal that needs protection from rusting or corroding. In simple terms, it's like a "bodyguard" metal that takes the damage itself, so the other metal stays safe. The sacrificial metal (aluminium superstructure) will slowly wear away or "sacrifice" itself by rusting or corroding first, instead of the steel hull.

As the aluminium superstructure has detached from the main hull, there is no longer a sacrificial metal diverting corrosion mechanism away from the steel hull. When a steel ship hull is underwater in the ocean, it acts like part of a big battery. Different chemical reactions happen on the metal depending on what kind of metal it is and the surrounding conditions. The seawater, full of salty minerals, helps carry tiny, charged particles called ions. These ions let the chemical reactions happen and complete the electric circuit, just like how a battery works. Certain areas of the steel hull (due to microstructural differences, oxygen variation, or stress points) become anodic. At these points, iron oxidises into ferrous ions.

Cathodic regions don't corrode themselves, but they receive the electrons and complete the circuit. Over time, this natural battery effect causes pitting at anodic zones, especially where oxygen access is limited (crevices or under sediments). For a shipwreck resting underwater without managed cathodic protection:

- The steel hull naturally develops a patchwork of anodes and cathodes across its structure.
- Differential aeration (variation in oxygen concentration between exposed surfaces and buried areas) drives corrosion patterns—buried sections often go anodic and waste away faster.
- Over decades, this natural cell process can thin hull plating, create perforations, and eventually collapse structure.

AS 4997-2005 sets a conservative 0.05 mm/year corrosion allowance for untreated mild steel in permanently submerged temperate seawater (south of 30°S), applicable to structures like the HMAS Adelaide hull. Real-world rates for protected steel range 0.03-0.1 mm/year fully immersed, lower with depth and oxygen depletion

The ex-HMAS Adelaide steel hull exhibits negligible corrosion after 15 years, with original paint intact, suggesting actual rate <<0.05 mm/year due to protection. For 6.5-10 mm plating, cumulative loss <0.75 mm leaves >90% thickness retained, far from failure.

5.7 Risk Assessment

BG&E have conducted a risk assessment of the items discussed in this report as per the DPHI Risk Management Guide. This guide has been attached in Appendix B. The risk assessment conducted in the structural condition report from 2024 is still relevant and will not be repeated in this document.

Table 4 - Risk Assessment for Detached Superstructure Collapse while Divers are Present

Item	Likelihood	Consequence	Risk
Detached superstructure collapse while divers are present	Almost Certain	Extreme	Very High
	Control	Collapse the detached superstructure to the seabed.	
	Control Design	Control Implementation	Control Effectiveness
	Strong	Strong	Substantially Effective
Comment	Whilst the collapse of the detached superstructure is a 'make safe' option for divers. The risk of debris mobilisation increases. However, this might also give opportunity to remove debris that could mobilise.		

Table 5 - Risk Assessment for New Penetrations Entrapping Divers

Item	Likelihood	Consequence	Risk
New penetrations entrapping divers	Possible	Extreme	High
	Control	Assess and block off new penetrations with entrapment risk.	
	Control Design	Control Implementation	Control Effectiveness

	Adequate	Strong	Partially Effective
Comment	If only some penetrations are blocked it will require ongoing inspections to determine if the ones open to divers, are structural sound. This opens the risk profile.		

Table 6 - Risk Assessment for Debris on Main Hull Mobilising or Injuring Divers

Item	Likelihood	Consequence	Risk
Debris on main hull mobilising or injuring divers	Possible	Major	High
	Control	Remove debris from the main hull.	
	Control Design	Control Implementation	Control Effectiveness
	Very Strong	Very Strong	Effective
Comment	This action would remove the risk entirely. However, ongoing inspections would be recommended to ensure further debris has not mobilised from, or onto, the deck.		

Table 7 - Risk Assessment for Main Hull Scour and Movement.

Item	Likelihood	Consequence	Risk
Main hull scour and movement.	Possible	Moderate	Medium
	Control	Ongoing monitoring of scour around the main hull and monitoring the position of the main hull.	
	Control Design	Control Implementation	Control Effectiveness
	Adequate	Limited	Partially Effective
Comment	Annual inspections do leave gaps in data and information particularly around storm events. If the hull's centre of gravity was to shift due to seabed scour, then the hull could move and potentially rotate.		

Table 8 - Risk Assessment for Main Hull Deterioration from Corrosion Mechanisms

Item	Likelihood	Consequence	Risk
Main hull scour and movement.	Unlikely	Moderate	Medium
	Control	Ongoing monitoring of hull via visual inspection and thickness measurements	
	Control Design	Control Implementation	Control Effectiveness
	Adequate	Strong	Substantially effective
Comment			

Table 9 - Risk Assessment for Debris Mobilising and Washing Ashore

Item	Likelihood	Consequence	Risk
Detached debris mobilising due to wave action and currents towards the shore.	Likely	Moderate	High
	Control	Remove plate like debris what has detached from the vessel and superstructure.	
	Control Design	Control Implementation	Control Effectiveness
	Very Strong	Very Strong	Effective
Comment	The risk is that plate like (flat, plate shaped) debris could mobilise easily. It is unlikely other shaped debris will mobilise easily.		

Table 10 - Risk Assessment for Detached Superstructure Mobilisation

Item	Likelihood	Consequence	Risk
Detached superstructure further movement and mobilisation due to wave action and currents.	Almost Certain	Minor	High
	Control	Demolish or remove the detached superstructure.	
	Control Design	Control Implementation	Control Effectiveness
	Strong	Adequate	Substantially Effective
Comment			

Table 11 - Risk Assessment for Detached Superstructure Mobilising and Washing Ashore

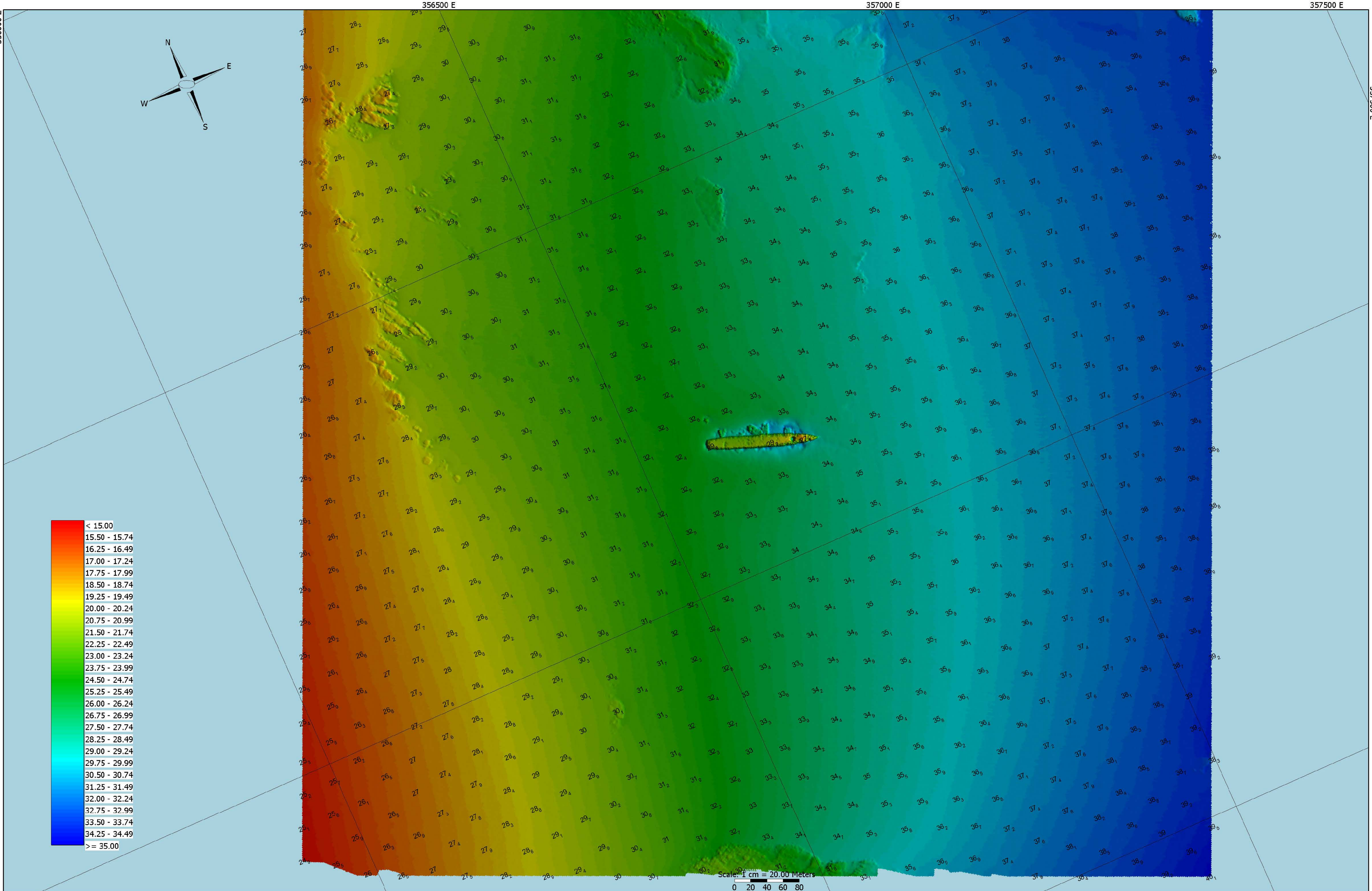
Item	Likelihood	Consequence	Risk
Detached superstructure debris mobilising towards the shore.	Rare	Moderate	Low
	Control	If the detached superstructure is demolished and not removed, ongoing monitoring will be required to establish if debris is mobilising. Ongoing monitoring however has significant time gaps and debris could move and be unknown. Debris will obviously not mobilise if removed.	
	Control Design	Control Implementation	Control Effectiveness
	Limited	Limited	Ineffective
Comment			

7. References

BG&E (2024). ex-HMAS Adelaide – Structural Condition Report. Department of Planning, Housing, and Infrastructure – Crown Lands. Available at: https://www.crownland.nsw.gov.au/sites/default/files/2025-06/ex-hmas-adelaide-structural-condition-report.pdf

Appendices

Appendix A – Survey Plan



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Notes

1) Editing of soundings have been carried out to preserve the shoalest soundings in their surveyed position
2) The weeding interval for heights - 40m
3) RTK GPS, Multibeam Echo Sounder checked and calibrated before surve
4) Copyright Astute Surveying Pty Ltd. This drawing and the information shown hereon has been created solely for a particular use and may not be copied without the consent of Astute Surveying Pty. Ltd.
5) Survey is correct at time of survey.
6) Open Street Maps - Background

Horizontal Datum	MGA2020 Zone 56
Corrections	AUSCORS base station used - KNBC
Vertical Datum	PLAN IS TO AGD
Tide Notes:	Tide Calculated from RTK Tides

Depth Tolerance	0.15	Horizontal Tolerance	0.25m	Weather	Moderate

Vessel	Coastal Explorer
Echo Sounder	Norbit i77h
Heavemeter	Ocean Master
Horizontal Positioning	Ocean Master
Data Collection Processing	Hysweep 2025
Tide Reference	RTK Tides

Soundings		
Depth	1_1	
Drying Height	$\underline{0}_3$	
Levels (m)		
Above Datum	5.3	
Below Datum	-5.3	

Paper Size	A1
Soundings as	DEPTHS
CLASS	A

Scale - 1:2000 @ A1

Client

356000 E

Hydrographic Surveyor	BG
Drawn By	BG
Checked By	BG
Supervising L1 Surveyor	
Name	[redacted]
Signature Date	

356500 E
6295500 N

ASTUTE SURVEYING
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New South Wales
Avoca
HMAS Adelaide
Hydrographic Survey
2/06/2025

© Astute Surveying Pty Ltd

Date of Plan	18/06/2025
Plan Number:	202500602 - HMAS Adelaide Plan 001
Plan Revision 001	Sheet 1 of 1

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Appendix B – Risk Management Guide

Assessing Control Effectiveness

Table 5: Control Design Effectiveness

Rating	Control Design
Very Strong	Designed in such a way that will reduce risk substantially. High degree of automation or documented formalised processes.
Strong	Designed in such a way it will reduce risk substantially. Very automated or documented formalised processes. Rare exceptions. Places reliance on knowledge/ actions of key persons.
Adequate	Designed in such a way it will reduce risk. Expected to fail at times, however within acceptable appetite. Places reliance on knowledge/actions of key persons.
Limited	Designed in such a way it will reduce some aspects of risk. Likely to fail requiring remedial effort and actions. Places heavy reliance on knowledge/actions on persons to manually address exceptions/incidents.
Weak	Poor design even when used correctly. It provides little or no protection. Only addresses part of the risk requiring additional work arounds or manual processes to make up for deficiencies. Extreme reliance on knowledge/actions of key persons.

Table 6: Control Implementation Effectiveness

Rating	Control Implementation
Very Strong	The control operates consistently as intended and is being correctly applied by the vast majority of users. Never known to fail in the past, highly unlikely to fail in a short to mid-term.
Strong	The control operates on a mostly consistent basis and is being applied correctly by most users. Control is mature and unlikely to fail significantly within 12-month period. Has significantly addressed the risk.
Adequate	The control operates as intended at least half of the time by sections of control users. The control has experienced a failure in the past 12 months but is not expected to experience more in the immediate future.
Limited	The controls are not operating consistently and/or effectively or have not been implemented in full. The control has experienced failures in the past 12 months and is expected to experience more, potentially more frequently. Rates of failure are deemed to be unacceptable.
Weak	Consistently not operating as intended, immature, operating inappropriately or inconsistently. Rates of failure are significant and deemed unacceptable.

Table 7: Control Effectiveness Matrix

		Control Implementation				
		Very Strong	Strong	Adequate	Limited	Weak
Control Design	Weak	Partially Effective	Partially Effective	Ineffective	Ineffective	Ineffective
	Limited	Partially Effective	Partially Effective	Partially Effective	Ineffective	Ineffective
	Adequate	Substantially Effective	Substantially Effective	Partially Effective	Partially Effective	Ineffective
	Strong	Effective	Substantially Effective	Substantially Effective	Partially Effective	Ineffective
	Very Strong	Effective	Effective	Substantially Effective	Partially Effective	Partially Effective

DPHI Risk Management Guide

This guide summarises the Risk Management Procedure and is an important reference for staff involved in the management of risk. It contains the Department's risk criteria and outlines a simple four-step process to support all staff with identifying, assessing, managing and reporting on risk. Appropriate risk management helps us become more effective in achieving our goals and can assist in avoiding crises that can shift the focus away from delivering our programs and services.

The management of risk is a continuous process. It requires us to monitor and collaborate continuously on the actions implemented to mitigate risk and to ensure our controls are effective and responsive. This provides stakeholders with increased confidence that our objectives and outcomes can be achieved.

If you have additional questions, please email the Risk & Resilience team at riskandresilience@dpie.nsw.gov.au.

The DPHI Risk Process

DPHI's risk management process requires us to consider four main questions:

1. **What must go right?** Establish the scope and context. Understand what the business wants to achieve, this could be at enterprise, group, directorate, divisional or branch level.
2. **What could go wrong?** Look at internal and external factors that may impact operations and objectives.
   - **Identify the risk**: Collaborate with stakeholders to identify risks that may impact your ability to achieve your objectives/outcomes. When defining your risk, consider the sources and potential consequences.
   - **Describe the risk**: Provide a clear description of the risk event the organisation needs to manage. The risk description should be as brief as possible but with enough information to be easily understood by others.
   - **Identify risk sources and consequences**: While the risk description references the source and consequence of the risk, it only covers the major factor of each. Every risk will have more than one contributing factor and impact, and this is your opportunity to identify these "secondary" factors.
   - **Identify the risk owner and risk manager**: Risk owners are accountable for ensuring a risk is effectively managed, while risk managers are responsible for monitoring, reporting on and treating a risk.
3. **What are we doing about it?** Consider how the business unit is reducing the likelihood or consequence of these risks to better achieve its objectives.
   - **Analyse inherent consequences**: Identify the consequence category (Table 1) and determine the most likely worst-case scenario of the risk occurring with no controls in place (Table 2).
   - **Analyse inherent likelihood**: Determine the likelihood of the risk occurring with no controls in place (Table 3). If the information is available, consider the probability of the risk occurring or the frequency of historical incidents of a similar nature as part of analysing the likelihood.
   - **Determine inherent risk rating**: Using the Risk Matrix (Table 4), plot the inherent consequence and likelihood ratings to determine the inherent risk rating, which is the risk rating with no controls in place.
   - **Identify controls and determine control effectiveness**: Consider the effectiveness of any actions currently being taken to reduce the consequence and/or likelihood of a risk occurring (Tables 5-7).
   - **Analyse the residual consequence and likelihood**: Re-assess the consequence and likelihood of the risk occurring based on the level of effectiveness the controls are operating at (Tables 2-3).
   - **Determine residual risk rating**: Using the Risk Matrix (Table 4), determine the residual risk rating, which includes the impact of controls.
4. **Who are we talking to about it?** Determine who the stakeholders are and what information needs to be distributed or received. Consider when to communicate with them and how are the risks being reported.

Consequence Categories

Consequence categories deal with the impacts of risk and help us assess risk by the type and severity of possible consequences for business units if the risk is realised.

Table 1: Consequence Categories

Consequence Category	Description
Business Disruptions	Impacts threatening the function or viability of the business unit or wider Department.
Business Objectives	Any impact on the ability of the business unit to achieve its stated objective. This can include programs, projects and BAU operations.
Compliance	Any impact threatening the Department's ability to meet its legislative & compliance obligations.
Environment, Conservation & Heritage	Any impact to the natural environment or to conservation programs/activities.
Financial/Built Assets	Consequences involving a direct financial impact to the business unit or wider Department. This can include costs (repair or increased maintenance) associated with built assets.
Health, Safety & Wellbeing	Any consequence threatening the safety or wellbeing of staff, volunteers, contractors or the public at department worksites.
Reputation & Trust	Any impact resulting in a loss of trust or in the department's reputation being diminished.
Stakeholders & Community	Impacts felt by the public or other stakeholders (including businesses) and the reaction to those impacts.
Workforce	Impacts resulting in a loss of engagement or workplace morale among staff.

Assessing Risk Likelihood & Rating

Table 3: Risk Likelihood

Likelihood	General Description	Historical	Probability
Almost Certain	Expected to occur in most circumstances involving normal operations.	Large number of known incidents in the department. Occurs regularly in the industry.	Predicted to occur in almost every operation of this kind (>90%)
Likely	Considerable opportunity and means to occur. Could happen at any time.	Regular incidents known within the department. Has occurred many times in the industry	Likely to occur in more than 1-in-2 operations of this kind (50%-90%)
Possible	Some opportunity and means to occur.	Few infrequent, random occurrences recorded within the department. Has occurred several times in the industry.	Likely to occur between 1-in-2 and 1-in-4 operations of this kind (25-50%)
Unlikely	Little opportunity or means to occur. Might happen, but not expected to occur.	No known incidents recorded or experienced within the department. Has occurred once or twice in the industry	Likely to occur between 1-in-4 and 1-in-20 operations of this kind (5%-25%)
Rare	Almost no opportunity to occur. Might happen, but probably never will.	Not known or reported to have ever occurred in the industry.	Highly unlikely to occur (<5%)

Note: The three columns above are listed to provide alternative contexts to help you identify your likelihood rating. You do not need to meet the requirements for all three to select a rating.

Table 4: Risk Matrix

		Consequence				
		Insignificant	Minor	Moderate	Major	Extreme
Likelihood	Almost Certain	Medium 11	High 17	High 20	Very High 23	Very High 25
	Likely	Low 7	Medium 12	High 18	High 21	Very High 24
	Possible	Low 4	Medium 9	Medium 13	High 19	High 22
	Unlikely	Low 2	Low 5	Medium 10	Medium 14	High 16
	Rare	Low 1	Low 3	Low 6	Medium 8	High 15

Note: The primary use of the numbering is to serve as a guide to assist with prioritising risk treatment actions and resource allocation.

Table 2: Consequence Matrix

Category	Insignificant Minimal impact requiring marginal remediation activities/ management	Minor Small, local effects easily contained	Moderate Some impact or impact requiring remediation	Major Significant impacts/ costs with some objectives not met	Extreme Catastrophic event threatening viability of function and objectives
Business Disruption	Minimal impact on non-critical business activities able to be managed through standard operations within a day	Minor disruption of non-critical business activities for up to 1 week	Disruption of non-critical business activities for up to 1 month.	Disruption of non-critical business activities for over 1 month OR Disruption of identified critical business activities for up to 3 days.	Extended disruption of identified critical business activities exceeding 3 days.
Business Objectives	Isolated, internal or minimal impact on business objectives	Contained impact on business objectives with short term significance	Measurable impact to business objectives involving investigation & remediation	Significant impact to business objectives with long term significance. Potential failure to meet elements of business objectives.	Extensive impact leading to total failure to meet business objectives. Intervention from Leadership
Compliance	Isolated, low-level non-compliance with standards and policy with negligible impact on local business activities	Minor non-compliance with legislation, regulation or policy with minimal impact on branch-wide activities.	Repeated non-compliance with legislation, regulation or policy; reportable noncompliance requiring rapid remediation.	Significant non-compliance with legislation, regulation or policy resulting in substantial regulatory responses issued against the agency.	Systemic and substantial non-compliance with legislation, regulation or policy. Prosecution with referral to external agencies such as Police or ICAC.
Environment, Conservation & Heritage	Negligible and temporary impact on the environment, including flora, fauna, ecosystems or heritage sites (including buildings). Will recover naturally with no remedial works required	Minor, localised, short-term environmental impacts such as damage to flora, fauna, ecosystems or heritage sites (including buildings). Will recover with minor/short-term site-based remedial action.	Moderate, short term environmental impacts. Damage to flora, fauna, ecosystems or heritage sites (including buildings). Will recover in a medium to long-term period with moderate & sustained remedial action.	Significant environmental harm requiring comprehensive and sustained remedial action. Loss of local populations of particular flora, fauna or heritage sites (including buildings).	Severe and unrecoverable environmental harm. Extinction, loss of species diversity, ecosystem collapse or total loss of heritage sites (including buildings).
Financial/ Built Assets	Barely noticeable financial impact easily absorbed within project or program budget	One-off loss, under or overspend up to $10M or 5% of your budget OR Ongoing annual impact up to $5M or 5% of your budget	One-off loss, under or overspend up to $25M or 15% of your budget OR Ongoing annual impact up to of $10M or 15% of your budget	One-off loss, under or overspend up to $100M or 25% of your budget OR Ongoing annual impact up to $50M or 25% of your budget	One-off loss, under or overspend over $100M or 30% of your budget OR Ongoing annual impact over $50M or 30% of your budget
Health, Safety & Wellbeing	Physical or psychological Injury/ Illness requiring notification or treatment up to First Aid only.	Physical or psychological Injury/ Illness requiring professional medical treatment	Physical or psychological Injury/ Illness resulting in moderate temporary impairment or disability (up to 6 months).	Physical or psychological Injury/ Illness resulting in partial permanent disability or long-term temporary impairment (more than 6 months)	Single or multiple fatalities. Physical or psychological Injury/ Illness resulting in irreversible, total permanent impairment or disability
Reputation & Trust	Barely noticeable impact on goodwill or trust recoverable with little effort or cost	Some community and stakeholder complaints. Confidence and trust dented but satisfactorily resolved with consultation and negotiation. Modest cost within existing budget and resources.	Large volume of community or stakeholder complaints, short-term negative media coverage. Confidence and trust diminished but recoverable. Written advice to Deputy Secretary or Secretary.	Extensive negative media coverage. Confidence and trust damaged but recoverable at considerable cost, time and employee's effort. Written advice and follow up with Minister's Office.	Sustained media coverage. Potential removal of political/department leadership. Total breakdown of trust in the department, with full recovery questionable and costly.
Stakeholders & Community	Minimal impact. Primary acceptance and approval exist.	Some small distress to the community. Small disruption to a group of businesses in the community	Considerable disruption or distress to sectors of the community. Some businesses in the community put at risk.	Large public protests or widespread disengagement. Potential for significant harm to sectors of the community. Damage to relationships and loss of support.	Civil commotion & riot. One or more major industry within the state threatened
Workforce	Minimal impact to employee engagement and productivity. Some complaints, but employees still proactively contribute to meeting objectives.	Short-term impact on employee engagement with temporary effect on productivity. Employees largely only 'doing what needs to be done'.	Mid-term impact on employee engagement affecting productivity. Employees not willing to proactively engage. Increase of people related issues, individual incidences of excessive absenteeism.	Major, long term employee engagement decrease. High employee turnover rates. Widespread absenteeism, increased misconduct, grievances and industrial disputes.	No confidence and trust from employees. High employee turnover. Stress and absenteeism levels extremely high. Ongoing industrial disputes/strike action

Appendix C – 2024 Risk Assessment

[redacted]

6.2 Risk Assessment

The following details focus primarily on the aluminium superstructure that has detached from the main hull and secondly on the main hull, which, from BG&E's document review, poses a low risk.

As described in the dive inspection reports from 2024, following the storm event, the risk to divers moving around and through the aluminium superstructure is high. Whilst the mast remains intact currently, the load transferred through the structure during the detachment event likely caused cracking of connections and further deterioration around corrosion pits. This applies to all three sections of the aluminium superstructure, the bridge, the mast, and the funnel/hanger.

BG&E provide the following risk assessment based on our document review and structural engineering experience. It should be noted, we are not professional divers, and commentary regarding safe diving practices has only been included as a reference and should be confirmed by professionals.

6.2.1 Blocked or Impeded Diver Entry and Access Points

This items mainly relates to the established diver entry and access points. As there are no established entry and access points on the detached superstructure, this item will focus on the main hull. BG&E believe the aluminium superstructure, including the Main Mast, the Bridge, and the Funnel and Hanger to have no safe access points.

Aluminium Superstructure
Whilst the aluminium superstructure remains in a state of continued settlement, deterioration, and unknown arrangement, the risk to divers moving around and through the features is Very High.

Risk	Undefined or structurally compromised entry and exit points.
Likelihood	Almost Certain
Consequence	Extreme
Risk Rating	Very High
Recommended Control	Isolate the detached superstructure and provide communication to divers to avoid the area. It is not recommended to dive within or near the aluminium superstructure.
Control Design	Very Strong
Control Implementation	Strong
Control Effectiveness	Effective

Main Hull
The main hull has predefined entry and exit points. These, according to dive reports, have not been compromised, nor do they show signs of deterioration.

Risk	Defined and structurally sound entry and exit points.
Likelihood	Unlikely
Consequence	Moderate
Risk Rating	Medium
Recommended Control	Continue to monitor the main hull entry and access points for deterioration.
Control Design	Adequate
Control Implementation	Adequate
Control Effectiveness	Partially Effective

6.2.2 Risk of Structural Damage or Failure

This item relates to three sections of the aluminium superstructure that have detached from the main hull.

Aluminium Superstructure
As the detached superstructure remains unstable, due to settling in the sand, corrosion of the aluminium elements, and unknown impacts by large sea swells, the risk of the structural continuing to fail is Very High. The risk of entrapment and elements falling on divers in and around the aluminium superstructure is Very High.

Risk	The aluminium elements further deteriorating, settling in the sand, becoming unstable, or failing due to ongoing corrosion and sea swell.

Likelihood	Almost Certain
Consequence	Extreme
Risk Rating	Very High
Recommended Control	Isolate the detached superstructure and provide communication to divers to avoid the area. It is not recommended to dive within or near the aluminium superstructure.
Control Design	Very Strong
Control Implementation	Strong
Control Effectiveness	Effective

6.2.3 Risk of Entrapment

This item relates to three sections of the aluminium superstructure that have detached from the main hull.

Aluminium Superstructure
As the detached superstructure remains unstable, due to settling in the sand, corrosion of the aluminium elements, and unknown impacts by large sea swells, the risk of the structural continuing to fail is Very High. The risk of entrapment and elements falling on divers in and around the aluminium superstructure is Very High.

Risk	Elements fall and block entry and exit points. Entry and exit points are narrow and unstable.
Likelihood	Almost Certain
Consequence	Extreme
Risk Rating	Very High
Recommended Control	Isolate the detached superstructure and provide communication to divers to avoid the area. It is not recommended to dive within or near the aluminium superstructure.
Control Design	Very Strong
Control Implementation	Strong
Control Effectiveness	Effective

6.2.4 Stability of the Wreckage

This item relates to three sections of the aluminium superstructure that have detached from the main hull. The main hull remains stable.

Aluminium Superstructure
As the detached superstructure remains unstable, due to settling in the sand, corrosion of the aluminium elements, and unknown impacts by large sea swells, the risk of the structural continuing to fail is Very High. The risk of entrapment and elements falling on divers in and around the aluminium superstructure is Very High.

Risk	The stability of the superstructure is unknown given the detachment from the main hull has recently occurred and it is currently sitting in sand that settles easily and can easily be altered by large swells.
Likelihood	Almost Certain
Consequence	Extreme

Risk Rating	Very High
Recommended Control	Isolate the detached superstructure and provide communication to divers to avoid the area. It is not recommended to dive within or near the aluminium superstructure.
Control Design	Very Strong
Control Implementation	Strong
Control Effectiveness	Effective

6.2.5 Risk to Divers posed by Loose or Jagged Metal Objects

This item relates to three sections of the aluminium superstructure that have detached from the main hull.

Aluminium Superstructure
As the detached superstructure continues to corrode, and elements detach there is a high risk that jagged and sharp edges will be exposed.

Risk	Further deterioration causing sharp, jagged edges with narrow access.
Likelihood	Likely
Consequence	Major
Risk Rating	High
Recommended Control	Isolate the detached superstructure and provide communication to divers to avoid the area. It is not recommended to dive within or near the aluminium superstructure.
Control Design	Very Strong
Control Implementation	Strong
Control Effectiveness	Effective

6.2.6 Depth of the Wreckage

This item relates to three sections of the aluminium superstructure that have detached from the main hull.

Main Hull
The main hull currently sits in approximately 30m of water. This territory is a high risk for divers for the following reasons:

- Nitrogen narcosis - A feeling of dizziness that can occur when divers absorb too much nitrogen. This can impair reasoning, decision making, and motor skills, which can lead to harmful mistakes.
- Increased pressure - The pressure on the body increases from 1 atmosphere at the surface to about 4 atmospheres at 30 meters. This is equivalent to around 40 T per sq.m.
- Decompression sickness (DCS) - Can occur if nitrogen doesn't return to the lungs before they expand, causing bubbles to form in the body. This can be caused by physiological factors like dehydration, fitness level, age, or cold, or by ascending too quickly.

Aluminium Superstructure
The top of the aluminium superstructure is in 19m of water.

Risk	The depth of the superstructure could change due to sea swells

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	and settlement of the ground. The mast is likely very unstable.
Likelihood	Likely
Consequence	Minor
Risk Rating	High
Recommended Control	Isolate the detached superstructure and provide communication to divers to avoid the area. It is not recommended to dive within or near the aluminium superstructure. Monitor the depth of the detached superstructure.
Control Design	Very Strong
Control Implementation	Strong
Control Effectiveness	Effective

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