



# **Douglas Partners**

*Geotechnics • Environment • Groundwater*

*Integrated Practical Solutions*

**REPORT  
ON  
SEISMIC AND SIDESCAN SONAR INVESTIGATION**

**SCUTTLING OF EX-HMAS ADELAIDE  
AVOCA, NSW.**

***Prepared for***  
**WORLEYPARSONS SERVICES PTY LTD**

***DP Project 45820***  
**NOVEMBER 2008**



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JL:pc  
Project 45820  
14 November 2008

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**REPORT ON**  
**SEISMIC AND SIDESCAN SONAR INVESTIGATION**  
**SCUTTLING OF EX-HMAS ADELAIDE**  
**AVOCA, NSW.**

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**1. INTRODUCTION**

At the request of WorleyParsons Services Pty Ltd (WorleyParsons), Douglas Partners Pty Ltd (DP) undertook a seismic reflection and sidescan sonar investigation offshore from Avoca, NSW, within an area (Figure 1 below) proposed for the scuttling of the ex-HMAS Adelaide and the creation of a dive site. The area measures approximately 750 m x 400 m, and lies in water depths of 29 - 34 m. A sandy seabed, with depths to rock of 5 – 10 m in the south of the area, were inferred by others.

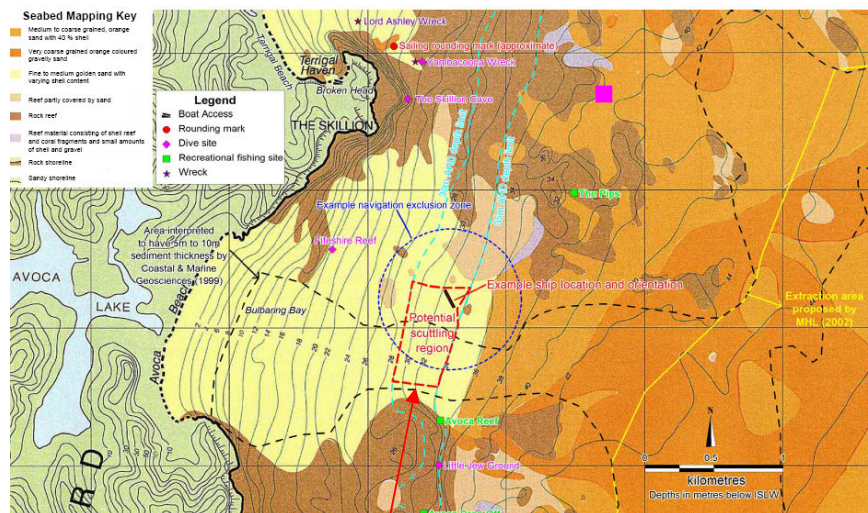


Figure 1 – Survey Location

The investigation aimed to provide detailed information on seabed materials and bedforms (e.g. sand waves which are indicative of sand movement) and on rock levels beneath the proposed scuttling area. This information was required to enable assessment by WorleyParsons of the optimum scuttling location within the area.

For these purposes, sidescan sonar mapping and seismic reflection profiling were carried out on 25 September and 17 October 2008 respectively, supervised by DP's Principal Geophysicist John Lean and Senior Hydrographic Surveyor Greg Halls of Hydrographic Surveys Pty Ltd (HS). Work was carried out from the 6.6 m HS Class 2C survey vessel "Alpha", launched in Pittwater.

Bathymetric data for the area were provided by the Department of Environment and Climate Change (DECC), in the form of an ascii grid file generated from a multibeam soundings survey.

This report presents the results of the investigation, together with figures, drawings and explanatory notes.

## **2. LOCAL GEOLOGY**

Reference to the Gosford 1:100,000 Geological Series Map indicates cliffs of the Terrigal Formation onshore to the northwest and southwest of the the investigation area, flanking Avoca Beach. The Terrigal Formation belongs to the Narrabeen Group of Triassic age and comprises interbedded laminite, shale and sandstone. Alluvium of Quaternary age infills a palaeochannel which trends eastward beneath the Quaternary sands of Avoca Beach.

## **3. PREVIOUS INVESTIGATIONS**

The brief for this investigation included Figure 1 (above), which refers to previous work understood to have comprised seismic profiling by Coastal & Marine Geoscience (1999) and seabed mapping by The Ecology Lab Pty Ltd. The other known previous investigation comprised multibeam soundings by DECC.

## 4. INVESTIGATION METHODS

### 4.1 Field Work

#### 4.1.1 Navigation

A Hemisphere Crescent VS110 Differential Global Positioning System (DGPS) provided 1 second updates of the vessel position during all profiling, which was carried out at a speed of approximately 3 - 4 knots. Positions with respect to the World Geodetic Spheroid 1984 (WGS84), subsequently transformed to the Geodetic Datum of Australia 1994 and Map Grid of Australia 1994 (GDA94/MGA94 Zone 56), were logged to the navigation computer via Trimble HYDRO navigation software, which also provided a real time helmsman's display of actual vessel positions against proposed run lines. Sidescan sonar and primary seismic traverses were carried out parallel to the long dimension of the survey area and seismic tie-lines were carried out in the perpendicular direction, as indicated on the Drawings 1 and 2 (Appendix A).

#### 4.1.2 Sidescan Sonar Mapping

In order to map the distribution of seabed materials, a dual channel C-Max CM2 325 kHz Sidescan Sonar towfish was towed with constant layback and depth. Digital data were displayed on a laptop and were recorded to laptop using 75 m slant ranges both port and starboard, with overlapping swathes and complete seabed coverage of the area. Geographical co-ordinates were provided by the navigation system and were logged with the sidescan sonar data.

#### 4.1.3 Seismic Reflection Profiling

Continuous seismic data were obtained using a towed high resolution "boomer" seismic system and other equipment as detailed in Table 1 (following page). Time-tagged positional data were logged to the navigation computer and to a seismic acquisition laptop, for direct positioning of interpreted seismic features.

**Table 1 – Seismic Equipment and Settings**

<b>240VAC power source</b>	Portable generating set
<b>Energy source</b>	EG&G 232A Power Supply and EG&G 231 Triggered Capacitor Bank
<b>Energy level</b>	200 Joules/pulse
<b>Firing rate</b>	3 pulses/second
<b>Sound source</b>	MonoPulse boomer
<b>Receiver</b>	Benthos 15/10S single channel hydrophone array
<b>Source/receiver layback</b>	18 m
<b>Source-receiver offset</b>	4 m
<b>Digital recording</b>	Laptop running Activesoft “DrGeo” seismic acquisition software

## 4.2 Processing and Interpretation

### 4.2.1 Navigation and Bathymetric Data

Logged co-ordinates were offset to the positions of the sidescan sonar and seismic systems for subsequent data processing. To enable reduction of the seismic data to Australian Height Datum (AHD), a 3D surface was fitted to the DECC sounding data and the soundings at each seismic data point were extracted from this surface using Discover 9 software within MapInfo. Drawing 1 (Appendix A) shows the soundings re-contoured at 1 m intervals relative to AHD.

### 4.2.2 Sidescan Sonar Data

Using C-Max software, recorded data were adjusted for towfish layback and corrected for height above seabed. Adjacent swathes were then merged and presented as a mosaic over the survey area (Drawing 1, Appendix A). Data from individual lines were also replayed in detail and examined for sonar shadows and patterns created by the seabed topography and bedforms. The few anomalies identified, within and surrounding the survey area, were extracted as bitmaps for addition to Drawing 1.

### 4.2.3 Seismic Reflection Data

#### 4.2.3.1 Seismic Velocities

In order to convert measured reflection times to depths, seismic velocities must be assigned to the materials between the seismic reflectors of interest, i.e. the seabed and the inferred bedrock

reflector. An average velocity of 1700 m/sec was assumed for the sediments, based on their sandy nature (inferred from previous investigations and confirmed at seabed by the current sidescan sonar data) and on published data for marine sand.

#### 4.2.3.2 Consistency and Reflector Digitizing

The digital seismic records were replayed using the DrGeo seismic software and reflectors having the form and character of an erosional interface were traced, digitized and re-scaled from seismic reflection times to depths using the assumed seismic velocity in the sediments.

Tracing of the reflectors took into account depths interpreted on intersecting seismic lines, which were found to be internally consistent. Figure 2 (below) is an example of interpreted seismic data.

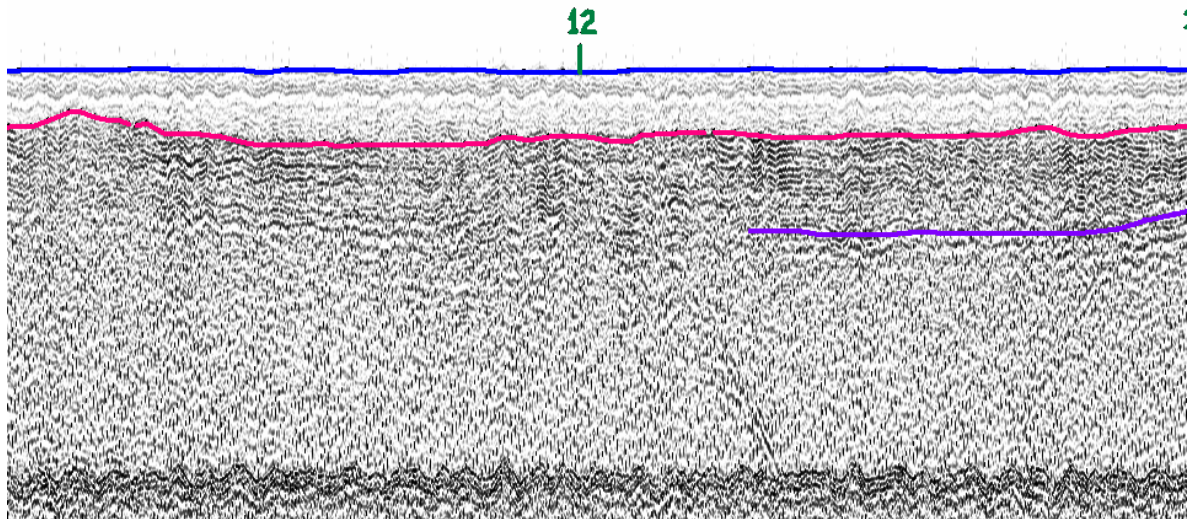


Figure 2 – Interpreted Seismic Line 3 (NS) at intersection with Line 12 (EW)

- Upper (blue) line traces the seabed reflector (approx 32m bsl)
- Magenta line traces the interpreted bedrock reflector (approx 5m below seabed at Line 12 intersection)
- Purple line traces an interpreted sub-bedrock reflector
- The first multiple seabed reflector appears at the base of the record.

#### 4.2.3.3 Gridding and Contouring

Seabed and bedrock reflectors were interpreted and traced on all lines. Digitized bedrock reflector depths and seabed depths were subtracted in the DrGeo software for line-by-line

export of co-ordinates and total sediment thicknesses in ascii format, for gridding and contouring (Drawing 2, Appendix A) using Discover software embedded in MapInfo. DECC seabed levels were extracted at all seismic data points, for combination with sediment thicknesses, leading to a grid of reduced levels of the interpreted bedrock surface relative to AHD. This grid was contoured for presentation in Drawing 3 (Appendix A).

## 5. RESULTS

### 5.1 Bathymetry and Sidescan Sonar Mapping

Drawing 1 shows DECC soundings varying from approximately 31 m below AHD along the western area boundary, to approximately 35.5 m below AHD along the eastern area boundary. Contours are approximately parallel and regular, consistent with the generally uniform, featureless, sandy nature of the seabed (i.e. “blanket” sands) shown by the sidescan sonar mosaic.

The only bedforms observed within the investigation area are inferred to represent low sand banks in the southwest of the area, as shown by the lower sonargram extract on Drawing 1. Other bedforms observed include:

- sand waves outside the area to the northwest, oriented perpendicular to the prevailing southeasterly swell direction, with wavelengths of the order of 1 m and heights of the order of 0.2 m or less;
- low reef and low reef or gravel outside the area to the northwest and northeast respectively; and
- scour marks or a rough seabed surface outside the area to the northeast.

The reef and scour marks/rough seabed are close to some of the previously inferred reef, outside the investigation area, although the previously inferred reef inside the northern area boundary was not identified on the DP data.

It is likely that sand waves and ripple marks of low amplitude (< 0.2 m) occur in some places within the investigation area but were not identifiable, due to slight degradation of the sonar data in the choppy seas prevailing during the DP investigation.

## 5.2 Seismic Reflectors

Bedrock reflectors were interpreted from their slightly erosional form, over most of all lines. Some weak, dipping reflector segments were interpreted as sub-bedrock strata on some lines (e.g. Figure 2, above), consistent with the interbedded nature of the Terrigal Formation visible on nearby cliff faces.

## 5.3 Interpreted Sediment Thicknesses and Interpreted Bedrock Levels

Sediment thicknesses (Drawing 2, Appendix A) of the order of 1 m or less are inferred locally in the far northeast of the area, where previous investigations indicated a reef. This sediment thickness is at the limit of resolution of the seismic system and some low/patchy reef may occur in the area, unrecognized in both the sidescan sonar and seismic data. Inferred thicknesses increase to over 6 m in the centre of the investigation area, where the previous investigation indicated 5 – 10 m of sediment.

The interpreted bedrock surface (Drawing 3, Appendix A) varies in level from approximately RL-33 to approximately RL-41 with respect to AHD, deepening to the east-southeast in a broad palaeochannel or basin, with its axis approximately through the centre of the investigation area.

## 6. SUMMARY

- Sidescan sonar mapping and seismic reflection profiling were completed within the area of proposed scuttling of the ex-HMAS Adelaide, offshore from Avoca.
- Seabed levels of 31 m to 35.5 m below AHD were indicated by DECC multibeam sounding data over the investigation area, increasing in a regular fashion to the east-southeast.
- A generally uniform, sandy seabed was inferred from sidescan sonar data, with one area of low sand banks inferred in the southwest of the area and small areas of sand waves

and low reef outside the area. Some low (<0.2 m) sand waves may occur within the area, unrecognised on the sidescan sonar data.

- A thin veneer (<1 m) of sediment or low, patchy reef (unresolved on the seismic records), was interpreted locally in the far northeast of the area. Inferred thicknesses increase to over 6 m in the centre of the investigation area, where a previous investigation indicated 5 – 10 m of sediment.
- Bedrock levels were interpreted to vary from approximately 33 m to approximately 41 m below AHD throughout the investigation area, with deepest bedrock in a broad palaeochannel or basin underlying the centre of the area.

**DOUGLAS PARTNERS PTY LTD**

Reviewed by

**John Lean**

Principal Geophysicist

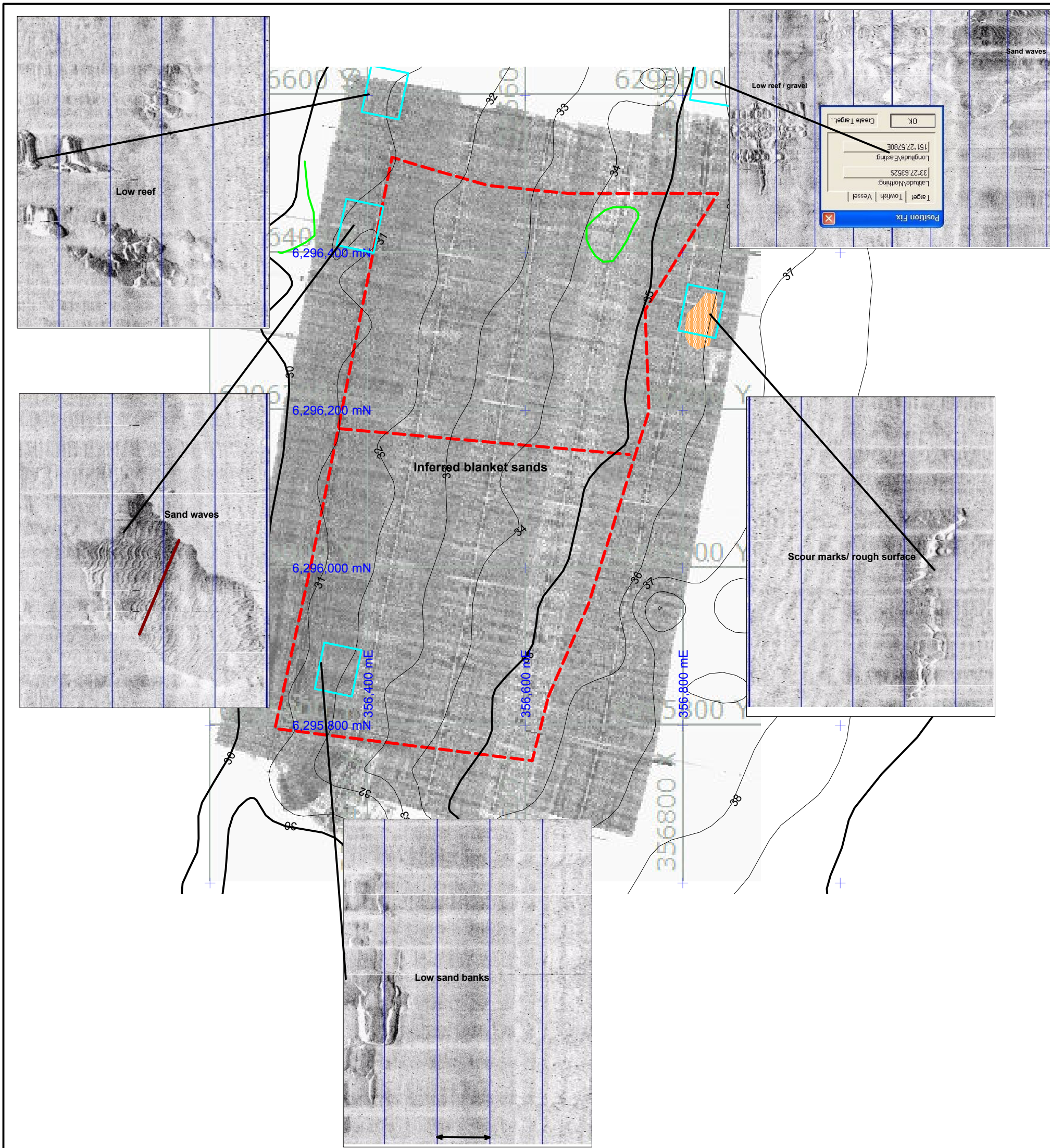
**G R Wilson**

Principal




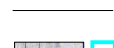
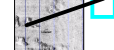

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***APPENDIX A***  
***Notes Relating to this Report***  
***Drawings 1 to 3***

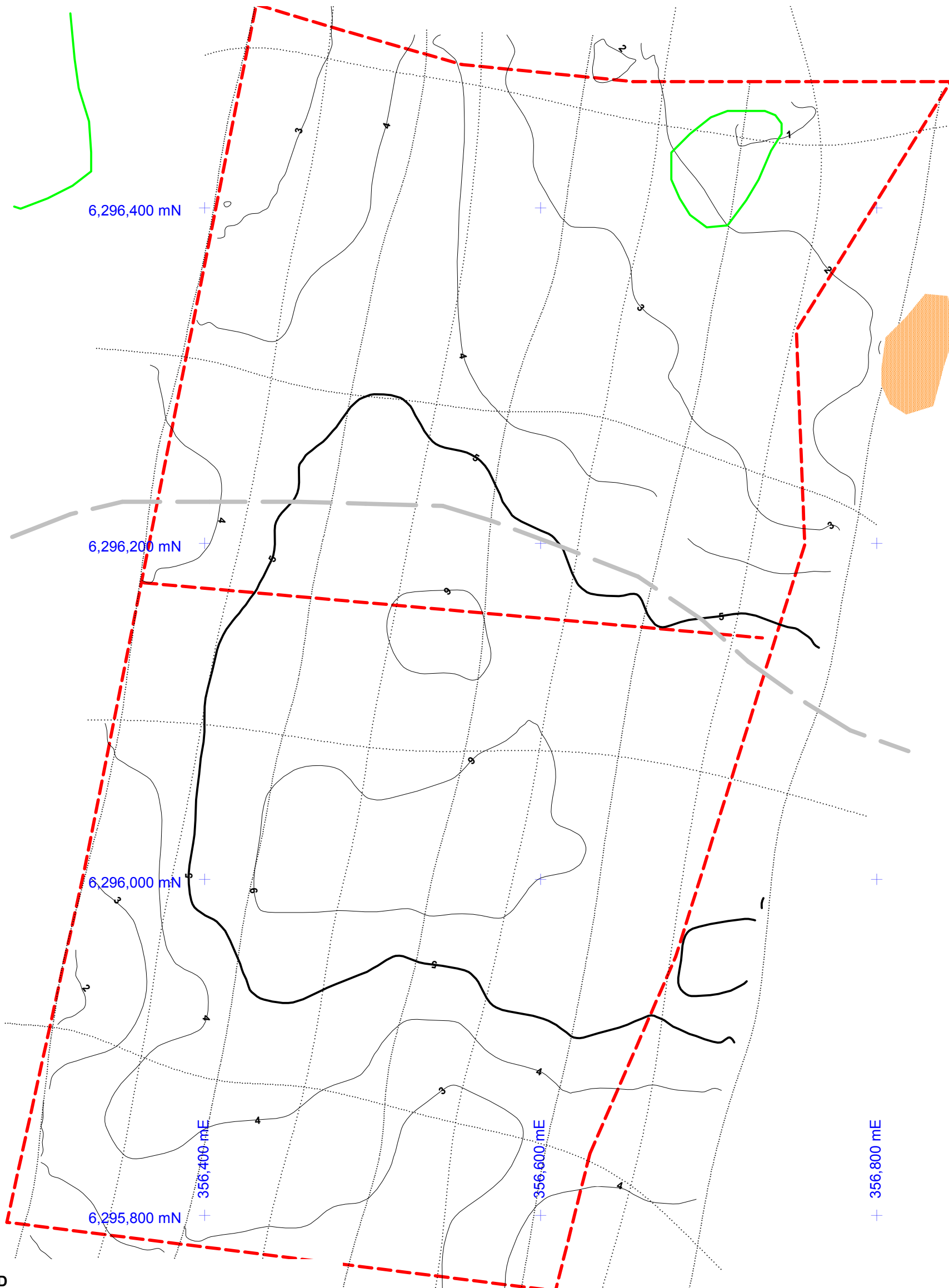
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Sonargram scales: 10m per division.

-  Specified investigation area
-  Zone marked as "Reef 2008" in the brief for this investigation
-  Zone marked as rock reef in the seabed map accompanying the brief.
-  5m contours of seabed levels (m below AHD), from data supplied by DECC.
-  1m contours of seabed levels (m below AHD) from data supplied by DECC.
-  Extract from raw sonargram and area of sidescan sonar mosaic which it displays. Sonargrams and mosaic are annotated with seabed materials and features interpreted from the sidescan sonar data, unconfirmed by sampling or inspection.

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<i>Geotechnics . Environment . Groundwater</i>					
TITLE:					
<b>INTERPRETED SEABED FEATURES</b>					
SEISMIC AND SIDESCAN SONAR INVESTIGATION SCUTTLING OF EX-HMAS ADELAIDE AVOCA, NSW					
CLIENT: WorleyParsons Pty Ltd					
DRAWN BY: GWH/JL	SCALE: 1:5000 @ A3	PROJECT No: 45820	OFFICE: SYDNEY		
APPROVED BY:		DATE: 28 Oct 2008	DRAWING No: 1		



**LEGEND**

- Grid: GDA94 / MGA94 (Zone 56)
- Specified investigation area
- Interpreted sediment thickness (5m contour intervals)
- Interpreted sediment thickness (1m contour intervals)
- Track of survey vessel during seismic (boomer) survey
- Northern boundary of zone inferred to be underlain by 5-10m of sediment (Coastal & Marine Geoscience, 1999)
- Zone marked as "Reef 2008" in the brief for this investigation.
- Zone marked as rock reef in the seabed map accompanying the brief.

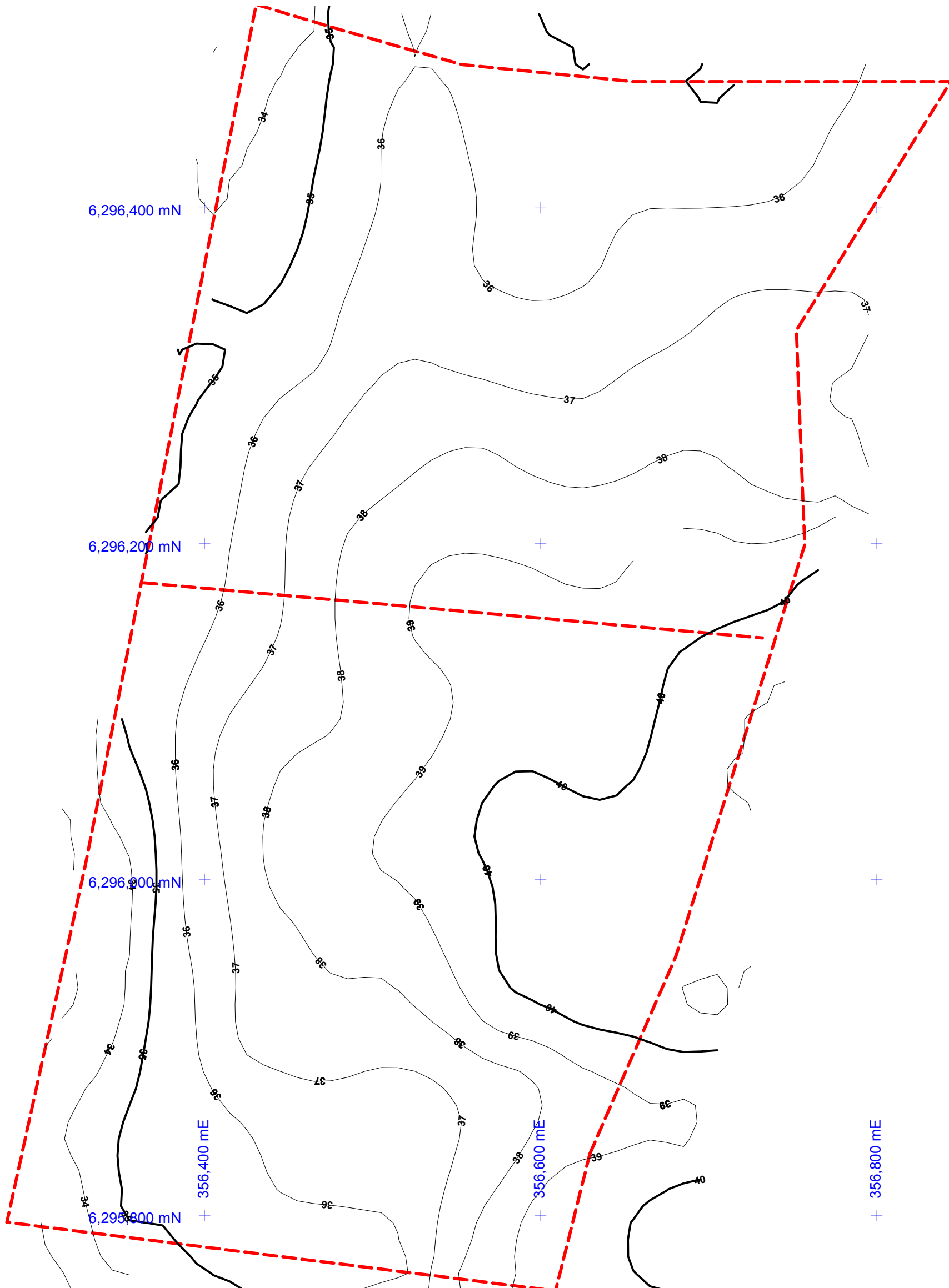


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 Townsville, Cairns, Wollongong

TITLE:  
**INTERPRETED SEDIMENT THICKNESSES**  
 SEISMIC AND SIDESCAN SONAR INVESTIGATION  
 SCUTTLING OF EX-HMAS ADELAIDE  
 AVOCA, NSW

CLIENT: WorleyParsons Pty Ltd			
DRAWN BY: JL	SCALE: 1:2500 @ A3	PROJECT No: 45820	OFFICE: SYDNEY
APPROVED BY:		DATE: 28 Oct 2008	DRAWING No: 2



**LEGEND**

- + Grid: GDA94 / MGA94 (Zone 56)
- Specified investigation area
- Interpreted reduced bedrock level (5m contour intervals)
- Interpreted reduced bedrock level (1m contour intervals)



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 Wyong, Campbelltown, Canberra  
 Townsville, Cairns, Wollongong

TITLE:

**INTERPRETED REDUCED BEDROCK LEVELS**

SEISMIC AND SIDESCAN SONAR INVESTIGATION  
 SCUTTLING OF EX-HMAS ADELAIDE  
 AVOCA, NSW

CLIENT: WorleyParsons Pty Ltd

DRAWN BY: JL	SCALE: 1:2500 @ A3	PROJECT No: 45820	OFFICE: SYDNEY
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APPROVED BY:	DATE: 28 Oct 2008	DRAWING No: 3
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