MNG SUBSPATIAL

REPORT:

GEOPHYSICAL INVESTIGATION TO IDENTIFY POTENTIAL UNMARKED BURIALS AND SUBSURFACE ASSETS (UTILITIES & INFRASTRUCTURE) ACROSS THREE AREAS ADJACENT TO THE WADJEMUP ABORIGINAL BURIAL GROUND ON ROTTNEST ISLAND, WESTERN AUSTRALIA.

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1. INTRODUCTION

The Wadjemup Project, led by the Rottnest Island Authority (RIA) engaged MNG SubSpatial (MNG) to execute a comprehensive geophysical investigation across three designated areas adjoining the recognised extents of the Wadjemup Aboriginal Burial Ground. The primary objectives of this investigation were to locate potential unmarked burials and identify underground assets, including utilities and infrastructure, within the proposed areas.

Conducted between the 12th and 14th of December 2023, this geophysical investigation utilised a combination of conventional utility locating techniques and state-of-the-art technology, specifically the 3D multi-channel Ground Penetrating Radar (GPR) system known as StreamDP. This advanced GPR system demonstrates capabilities in accurately and efficiently detecting both underground assets and anomalies associated with unmarked burials.

The task was undertaken by a three-person team from MNG, comprising of a qualified Geophysicist and two Locating Technicians. The team conducted the geophysical investigation and Quality Level (QL) B/C utility locating survey, encompassing the three proposed areas, covering a total area of approximately ~6,000 m^2.

The acquired GPR data yielded 2D radar-grams (cross-sections) and 3D depth slices of the subsurface, providing insights to a maximum uncalibrated depth of 6 meters below ground level (BGL). This report aims to present the findings of the survey and offer recommendations in the investigation summary.

2. SITE HISTORY

Wadjemup (Rottnest Island) was used as an Aboriginal prison between 1838 and 1903 (excluding a brief period of closure between 1849-1855) and a forced labour camp for both Aboriginal and non-Aboriginal prisoners until 1931. State records indicate that 4,000 Aboriginal men and boys from Australia were imprisoned on the island. At least 373 of these prisoners died in custody and were buried on Wadjemup.

The boundary for the Wadjemup Aboriginal Burial Ground has been mapped over multiple decades through collaboration between Aboriginal representatives, state government agencies and professional heritage practitioners (including anthropologists, historians, and scientists). The extents are based on evidence derived from historic records, GPR surveys and consultation with the Aboriginal community.

After the prison's closure, the island transformed into a holiday resort, including an area that became a budget camping ground (Tentland), which was built on the Wadjemup Aboriginal Burial Ground. After several occasions of human bones being exhumed, in 1985 the grounds gained official recognition under the Aboriginal Heritage Act.

The Quod building is perhaps the most recognisable symbol of the Island’s prison era history. The Quod was erected between 1863 and 1864 and served as the main prison building on the Island during the penal era. In 2007, Tentland closed, and in 2018, the Quod, closed its doors, marking a significant step toward recognition, reconciliation, and healing for Aboriginal people.

3. GEOPHYSICAL INVESTIGATION SITE

The extent of geophysical data capture across the three investigation areas are outlined below in Figure 1, greater detail of this is provided in *Drawings 80565-01 Site Plan* located in **Appendix A** of this report.

Details of each survey areas and the site conditions are as follows:

- Area 01: within the Quod consisted of flat internal grass.
- Area 02: recently demolished buildings now flat ground covered in mulch wood chips and a small western section of coastal sand with small limestone rocks / boulders.
- Area 03: recently demolished buildings now flat ground covered in mulch wood chips.

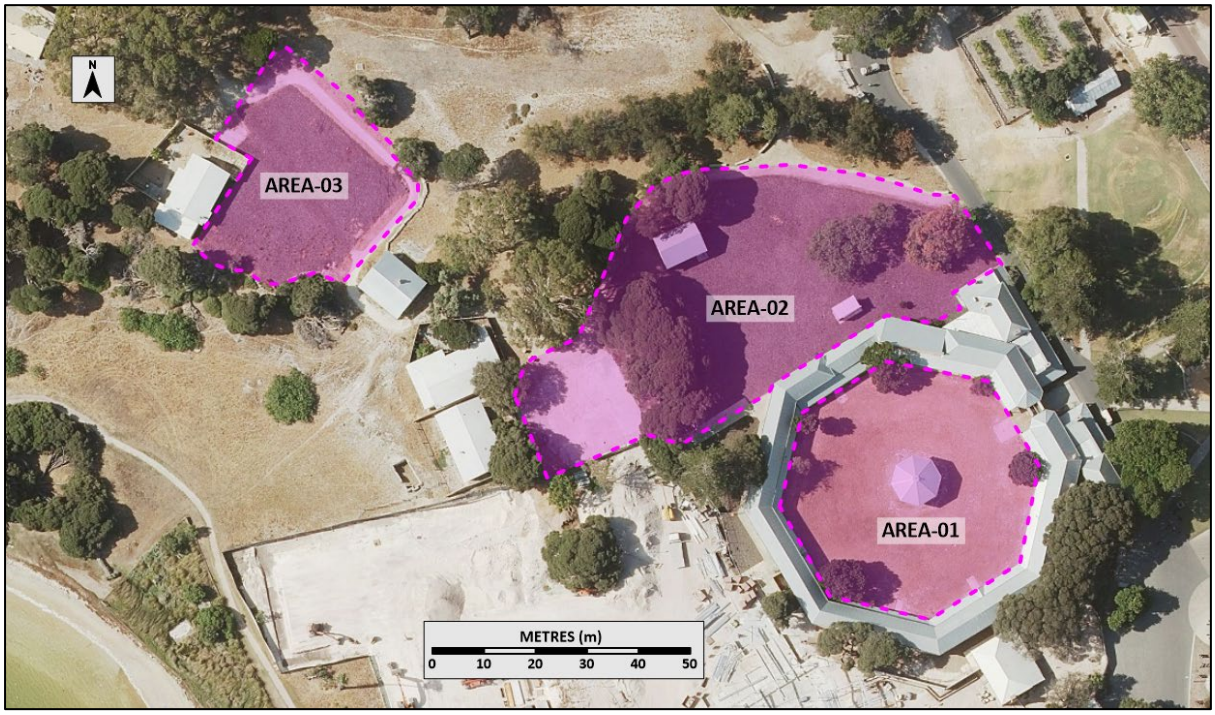

Figure 1: Illustrates the extent of the three investigations areas on Wadjemup (Rottnest Island), WA.

The geophysical investigation benefited from favourable ground conditions, with each area consisting of relatively flat surface topography, with ground cover consisting of either grass, mulch, or coastal sand. In all three areas surveyed, the surface was mostly cleared of any obstructions, except for some trees and small building infrastructure observed in Areas 01 and 02.

The natural ground conditions on Wadjemup (Rottnest Island) are mostly coastal sands overlying Tamala Limestone. This advantageous geological setting was consistently experienced across all three surveyed areas, contributing to the accuracy and reliability of the geophysical investigation.

Site photos of the typical site conditions are displayed in Figure 2.

Figure 2: Photographs illustrating the typical site conditions for the geophysical investigation in Area 02 (Left) and Area 01 (Right).

4. GEOPHYSICAL METHOD

Ground Penetrating Radar (GPR) is a non-destructive and non-invasive geophysical technique for rapidly imaging the shallow subsurface and producing high-resolution colour sections in real time. The method works by transmitting electromagnetic energy into the material being tested, most usually the ground.

The transmitted electromagnetic energy propagates through the subsurface as a function of the subsurface material's electrical properties, which are in turn dependent on its physical and chemical properties. Reflection of radar energy occurs at boundaries between differing stratigraphic layers or inclusions which have contrasting electrical properties. Conversely, no reflections occur from a homogenous material where there are no internal reflectors. The reflections are detected by the receiving antenna placed adjacent to the transmitter. The depth to the target is proportional to the time (in nanoseconds) taken for the signal to travel from the transmitting antenna at the surface to the target and back to the receiver – Figure 3.

The achievable depth of penetration depends on the frequency of the antenna used and is also influenced by the local subsurface conditions. GPR is generally effective in clean sands, which provide an optimal medium for radar waves to propagate through, enabling successful subsurface imaging and analysis.

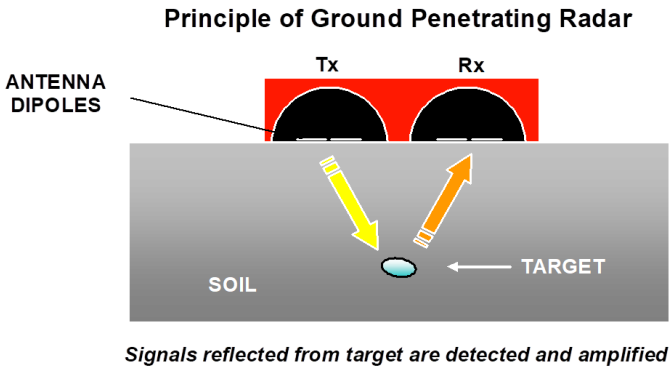

Figure 3: Schematic illustration of the principle behind ground penetrating radar.

Limitations: The quality of the acquired data may be compromised over certain surfaces which are directly related to the GPR method. These limitations are inherent to the geophysics of the technique and are listed below:

- Reduction of penetration is experienced in areas with high clay and/or water content. This is with reference to the dielectric properties of the materials which may result in a significantly higher absorption of radar wave energy.
- Soil with pools of water, soil after heavy rain, high salinity soil, and high mineral containing soil with iron ore.
- A requirement for good coupling between the antenna and the ground. GPR data cannot be collected where surface obstructions are present, including but not limited to infrastructure and vegetation.
- GPR collected over reinforced concrete slabs, or some paving materials may adversely affect the data, and hence the reliability of the information obtained may be compromised in such situations.

5. GEOPHYSICAL DATA ACQUISITION

5.1 INVESTIGATION LOGISTICS

The geophysical data acquisition was conducted between the 12th and 14th of December 2023, by a three-person team from MNG, comprising of a qualified Geophysicist and two Locating Technicians.

During the investigation 665 GPR swathes were acquired across all three areas, each swathe comprises of 19 channels inline with direction of movement (VV), which totals 12,635 individual GPR radar-grams (cross-sections).

5.2 GROUND PENETRATING RADAR – STREAMDP

GPR data was acquired using an IDS GeoRadar Stream DP system, employing a ground-coupled antenna with a centre frequency of 600MHz. Table 1 provides the acquisition parameters.

The GPR data acquisition involved manually pushing the unit at a deliberate and consistent pace along parallel profiles spaced at 0.5m intervals. Distances along these profiles was logged using a calibrated distance measuring device (odometer wheel) attached to the system.

Relocation referencing of the GPR data was achieved through a Global Positioning System (GPS) with live coordinates fed to the GPR control unit, ensuring accurate relocation along each GPR profile.

The StreamDP possess a multichannel 3D antenna with 30 channels in double polarization (19 channels in the vertical plane and 11 channels in the horizontal plane). The system essentially “paints” the floor in a swathe sense acquiring data both inline and orthogonal to the direction of movement.

The StreamDP also features Equalized scrambled Technology - EsT a new Patented Technology by IDS GeoRadar, that overturns the traditional definition of GPR. EsT brings out the deepest signal at the same level as shallow targets through noise rejection, both the clarity of shallow targets and high penetration depth are achieved. After equalization, the data is 'scrambled' together into a single radar trace, providing an extended depth range and an ultra-high resolution.

The StreamDP was release in July 2022 and represents the pinnacle of GPR technology in the industry at this current time.

Figure 4: StreamDP GPR data acquisition using the StreamDP within the Quod (Area-01).

Table 1 – Stream DP GPR Acquisition Parameters

Acquisition Parameter	Specification
Antenna centre frequency	600MHz
Sampling step	0.0397m
Sampling time	0.125ns
Polarization	Vertical and Horizontal
Uncalibrated radar wave velocity	0.1m/ns
Maximum apparent depth	6m

5.4 LOCATING AND POSITIONING

The StreamDP GPR system relies on an external GPS device, the Leica Zeno FLX100 Smart Antenna with SmartNet RTK technology was used for precise positioning. This GPS device is paired with a Wi-Fi-enabled tablet for data acquisition. The integration of Pulse-per-second (PPS) into the antenna ensures accurate synchronisation with the external GPS, facilitating precise positioning.

In areas with substantial tree canopy or near buildings, where the StreamDP's external GPS was hindered, a Total Station with multiple base station setups was employed to maintain enhanced accuracy in relocating the GPR data, with projected accuracies of:

- ±100mm Horizontally Accuracy, and
- ±200mm Vertically Accuracy

The requested datums from RIA used for this project are:

a) Horizontal: Perth Costal Grid 2020 (PCG 2020)
b) Vertical: Australian Height Datum (AHD)

6. UNDERGROUND UTILITY AND ASSET DETECTION

Underground utility location used a combination of Ground Penetrating Radar (GPR) and electro-magnetic induction (EMI) for non-destructive detection to a Quality Level (QC) B/C as per Australian Standard Classification of Subsurface Utility Information (AS 5488.1-2022).

MNG utilised the following field procedure when conducting the underground utility survey:

- A desktop study was completed before on-site data collection – plans and existing service provider infrastructure drawings were obtained and collated - mainly DBYD and any plans given by the client. These plans were used as a reference onsite during the data collection process for annotation and recording positions.
- Logical end points were investigated – available utility covers, and pit lids were opened and accessed. Pipes and conduits emanating from the pits were examined including orientation, depth, and diameter.
- Non-invasive electronic detection using GPR and Electro-magnetic locator – underground utilities were mapped to a maximum depth of 2.0m depending on local ground / soil conditions (Quality Level B/C - Tolerance: Horizontal +/- 300mm | Vertical +/- 500mm).
- Survey pickup of services.

7. GEOPHYSICAL DATA PROCESSING

The acquired geophysical datasets were processed and analysed with current industry standard software by qualified geophysicists using MNG standard processing routines.

7.1 GROUND PENETRATING RADAR - STREAMDP

The acquired GPR data was processed and interpretated using two industry standard software, Geolitix and IQMaps (IDS Software). Geolitix is a cloud computing GPR processing software and IQMaps seamlessly integrates StreamDP data, where both were utilised for this project. Each software provides post-processing application data analysis and allows 3D immersive visualisation. The following processing routine was used:

1. Correct Max Phase – Set GPR zero time to the first crossing of the reflection wavelet.
2. Manual Gain – Apply a gain curve function in the y-direction to account for GPR signal attenuation with depth.
3. 1D Bandpass Filtering – High-cut and low-cut frequency filter to improve signal to noise ratio.
4. 2D Filtering – Background removal and running average filters to suppress horizontally coherent energy, effectively emphasising signals which vary laterally.

Following the application of the above processing flow, the GPR data was predominately observed to be of high quality, with strong signal to noise ratio and expected penetration depth for the antenna frequency used. The processed GPR data was analysed to delineate interpreted subsurface features including high amplitude features. Analysis of the GPR data consisted of viewing and digitising the profiles sequentially with consideration to the:

- **Signal travel time** which, combined with the material radar-wave velocity, defines the depth of the target [1]
- **Amplitude and phase of the signal** which defines the dielectric contrast between different materials [2]
- **Continuity of the signal** which shows the general dimension, condition, and shape of the target

[1] With the GPR method, the depth to a given subsurface target is obtained by measuring the two-way travel time of the radar pulse from the antenna to that target and by multiplying this time by the radar wave velocity within the overlying layers. For this investigation, a bulk radar wave velocity of 0.1m/ns was used.

[2] The amplitude of the radar wave reflection signal is a function of the contrast in dielectric properties of the subsurface material. Near zero amplitude reflections occur where there is no or minimal change in the dielectric properties indicative of a homogeneous material. High amplitude reflections (either positive or negative) occur where there is a significant change in dielectric properties for example within an inhomogeneous material with multiple inclusions such as buried utilities or the interface between differing geological layers.

8. RESULTS

The results of the geophysical investigation carried out across three (3) investigation areas on Wadjemup (Rottnest Island), Western Australia are provided in both digital and PDF format.

8.1 DIGITAL DATA

All features identified were exported to AutoCAD (Autodesk) and generated as an AutoCAD DWG file, the results presented are as follows:

- *80565-003B_Underground Service Location_RIA_x3Areas*
- *80565-004A_Identified Features of Interest_RIA_x3Areas*

Listed below are the layers included in the DWG Drawing *80565-004A_Identified Features of Interest_RIA_x3Areas.*

- MNG-Extent of GPR Investigation
- MNG-Exclusion Zones Surface Obstructions
- MNG-Potential Unmarked Burial
- MNG-Identified Features of Interest
- MNG-Large Subsurface Feature Buried Pool Infrastructure
- MNG-Identified Soak Well
- MNG-UG Drainage to Soak Wells
- MNG-Unknown Redundant Utility Infrastructure
- MNG-TEXT

8.2 DRAWINGS

PDF drawings of the results are provided in the following Appendices of this report:

APPENDIX A – GROUND PENETRATING RADAR IDENTIFIED ANOMALIES

- ***80565-01 Site Plan***: Site overview of the three (3) investigation areas.
- ***80565-02 Investigation Area-01:*** Identified high amplitude features of interest.
- ***80565-03 Investigation Area-02:*** Identified high amplitude features of interest.
- ***80565-04 Investigation Area-03:*** Identified high amplitude features of interest.

APPENDIX B – MNG LOCATE REPORT

- *MNG Locate Report*

9. GROUND PENETRATING RADAR INTERPRETATION

Interpreting GPR data involves the analysis of radar signals reflecting from subsurface features to deduce details about the subsurface composition and geometry. The expertise of a qualified Geophysicist with a background in GPR investigations is crucial for accurate interpretation.

9.1 POTENTIAL UNMARKED BURIALS

When interpreting GPR data (radar-grams) for unmarked burials the following parameters need to be considered:

1. Vertical Discontinuities in Soil/Strata Profile: More pronounced for new burials, less evident in older burials.
2. Depressions in Soil Layers Above the Grave.
3. Mottled GPR Signal Above the Grave: Result of the unconsolidated nature of the fill material.
4. Typical Depth Extent: 1.5 to 3.0 meters below ground level.
5. Consistent Amplitude and Phase Across Multiple Parallel Profiles with a clear start and end.

These considerations are crucial when employing GPR for the identification of unmarked burials. Understanding these parameters enhances the accuracy of the analysis and increases the reliability of the results.

Figure 5 illustrates three potential grave like anomalies / unmarked burials in Area-03 annotated in green based on the GPR response. These occur within the footprint of the demolished building, however, the GPR response (shape and extent) is that of unmarked burials at approximately 2m below ground level. Figure 6 illustrates a 3D depth slice of GPR data, outlining the former footprint of the demolished building in black outline.

A total of four (4) potential unmarked burials in annotated in green have been discovered, all are in Area-03 and formally within the building footprint.

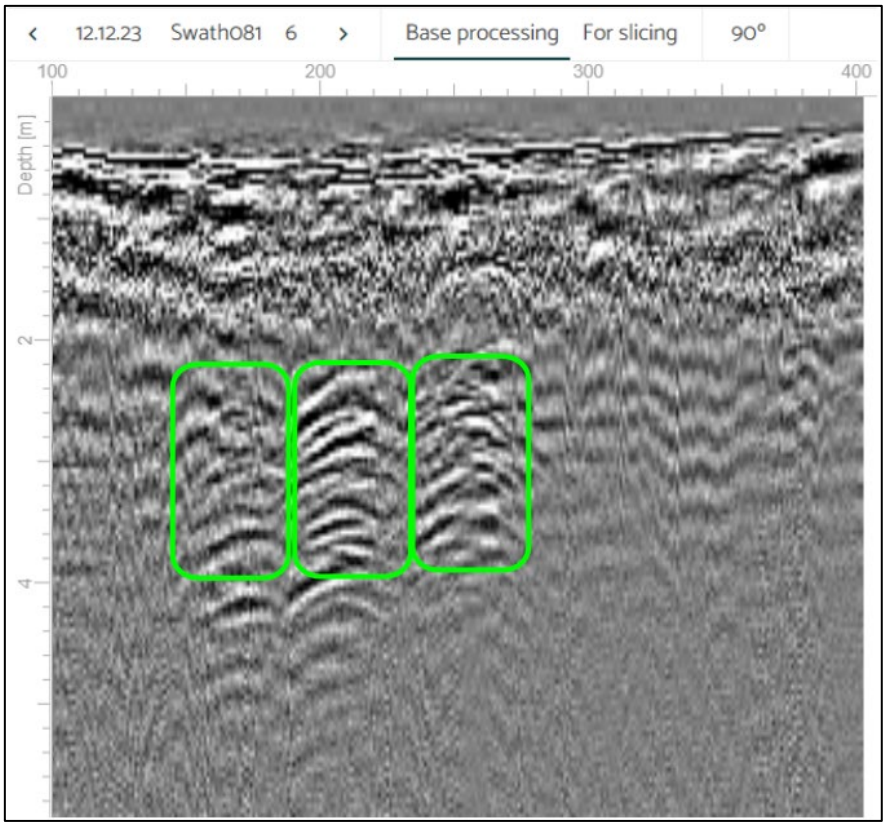

Figure 5: Processed radar-gram (2D cross-section) showing high amplitude responses (outlined in green) indicative of grave like anomalies / unmarked burials at 2m depth.

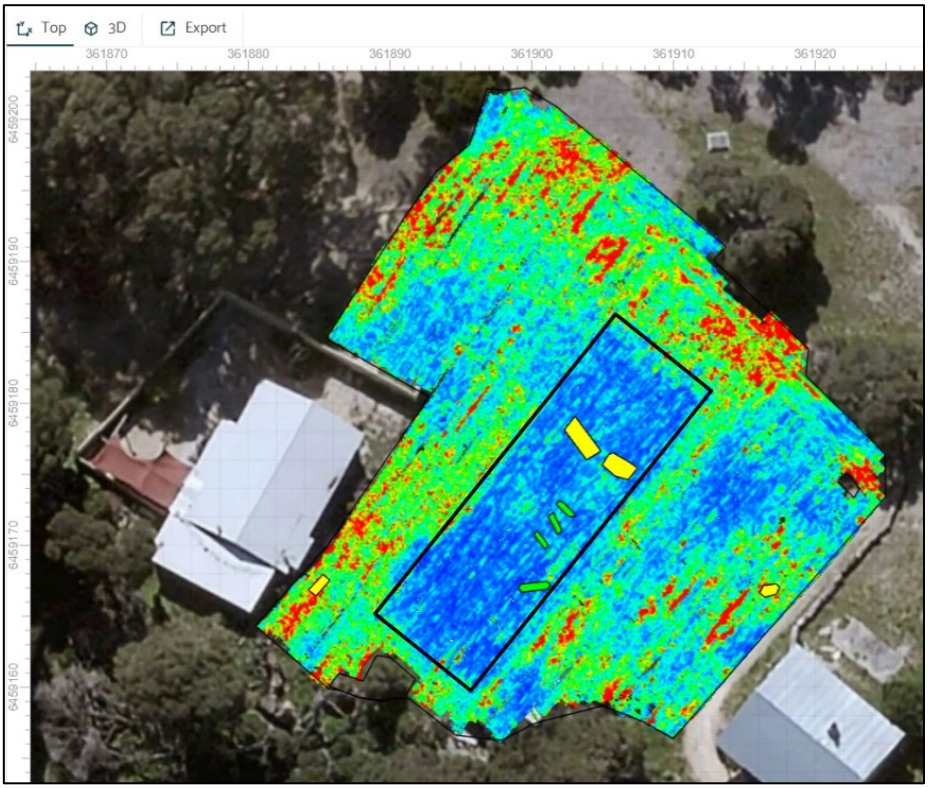

Figure 6: 3D depth slice of GPR data across Area-03, identified features in green and yellow, footprint of demolished building outlined in black.

9.2 IDENTIFIED FEATURES OF INTEREST

Other features of interest have been identified and annotated in yellow on the drawings located in Appendix A. These features are unlikely potential unmarked burials based on either their shape, depth, or nature of radar response, however, exhibit some similar attributes and therefore have been included. Figures 7, 8, and 9 illustrate the radar-grams of identified features of interest in each survey area.

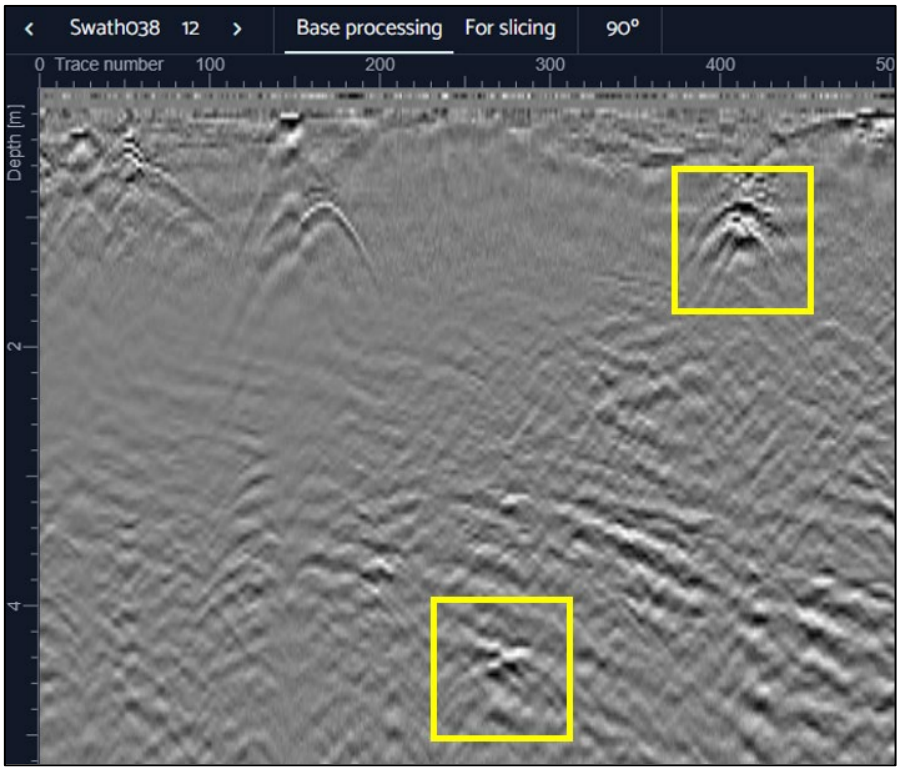

Figure 7: Processed radar-gram (2D cross-section) showing features of interest exhibiting high amplitude responses (outlined in yellow) within Area-01 (Quod).

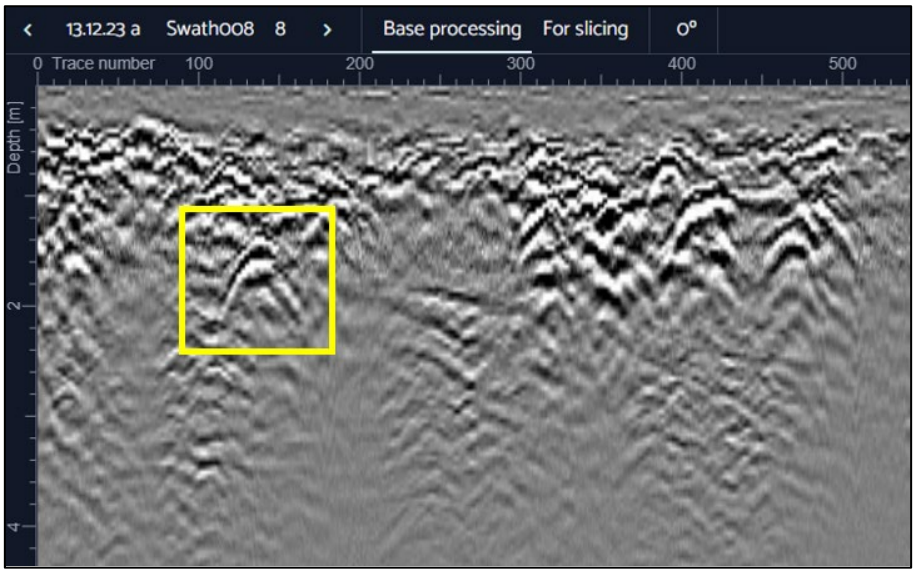

Figure 8: Processed radar-gram (2D cross-section) showing features of interest exhibiting high amplitude responses (outlined in yellow) within Area-02.

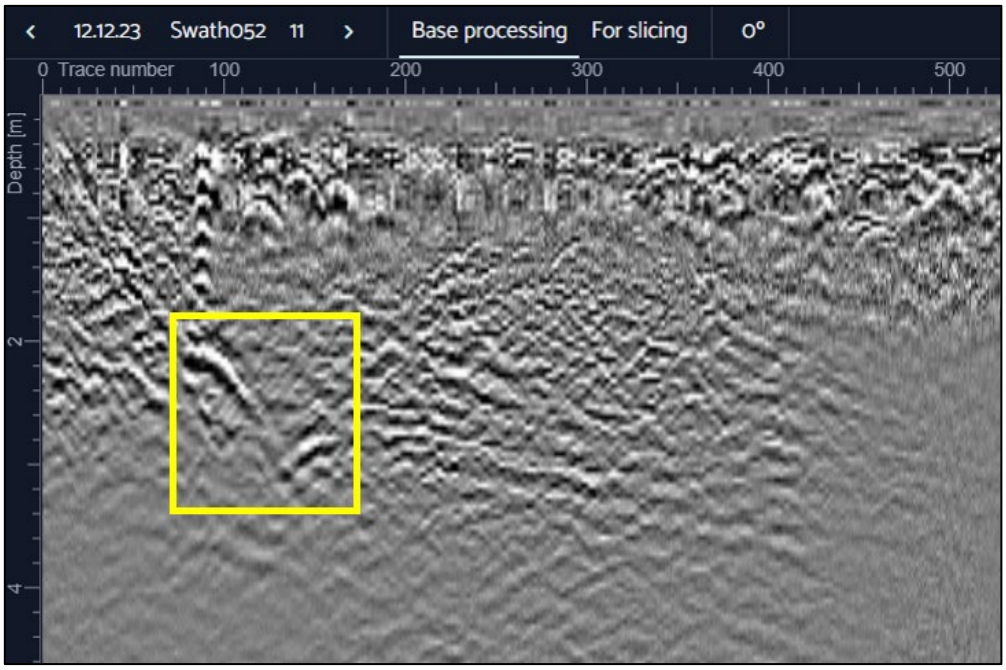

Figure 9: Processed radar-gram (2D cross-section) showing features of interest exhibiting high amplitude responses (outlined in yellow) within Area-03.

9.3 IDENTIFIED UNDERGROUND ASSETS AND INFRASTRUCTURE

RIA has recently demolished buildings to the south and west of the current extent of the Wadjemup Aboriginal Burial Ground, in particular Area-02 and Area-03. Additionally, underground infrastructure was installed in the grassed area within the Quod (Area-01), with notable features including an unfinished pool that within its initially construction stages, but was eventually relocated outside of the Quod. As a result, numerous underground features have been identified.

Figure 10 illustrates a 3D depth slice of GPR data within the Quod, with identified features illustrated by the high amplitude responses in green/yellow and red. Blue illustrates no amplitude response and consequently homogenous material.

SOAK WELLS:

Four (4) soak wells have been identified in the north-east corner of the Quod annotated in yellow circles on Figure 10. The radar-gram (2D cross-section) in Figure 11 illustrates the radar response of one identified soak well, the top of which is approximately 0.7m BGL.

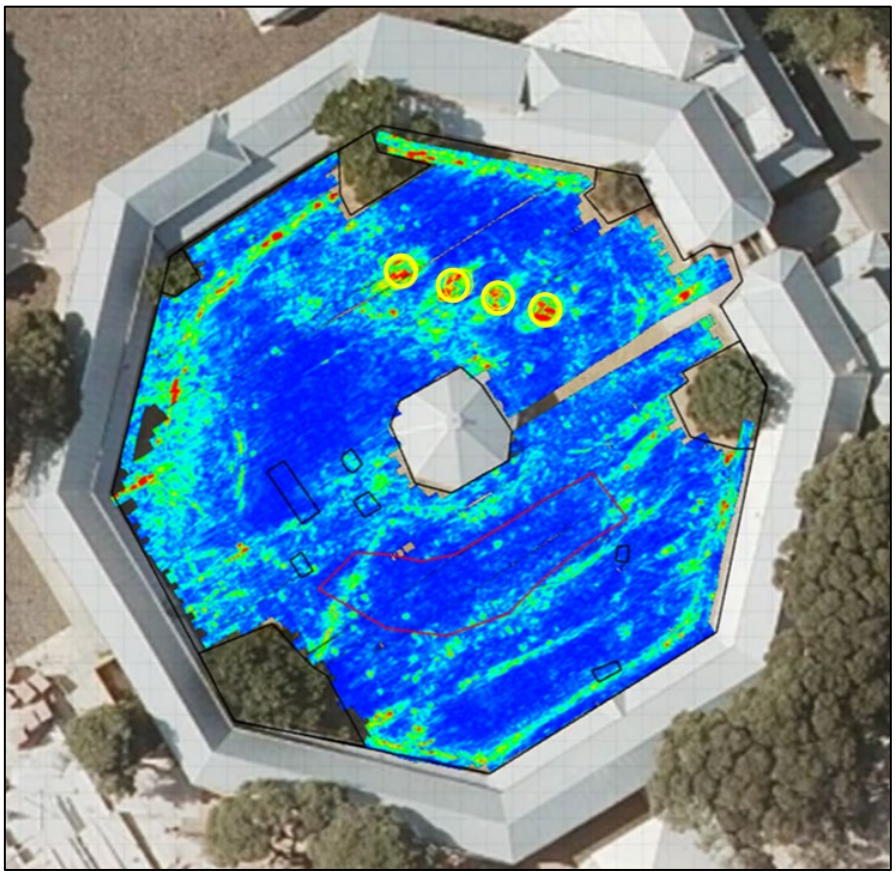

Figure 10: 3D depth slice of GPR data within the Quod, identified features illustrated by high amplitude responses in green/yellow and red. Blue illustrates no amplitude response and consequently homogenous material. This slice is at 0.7m below ground level (BGL).

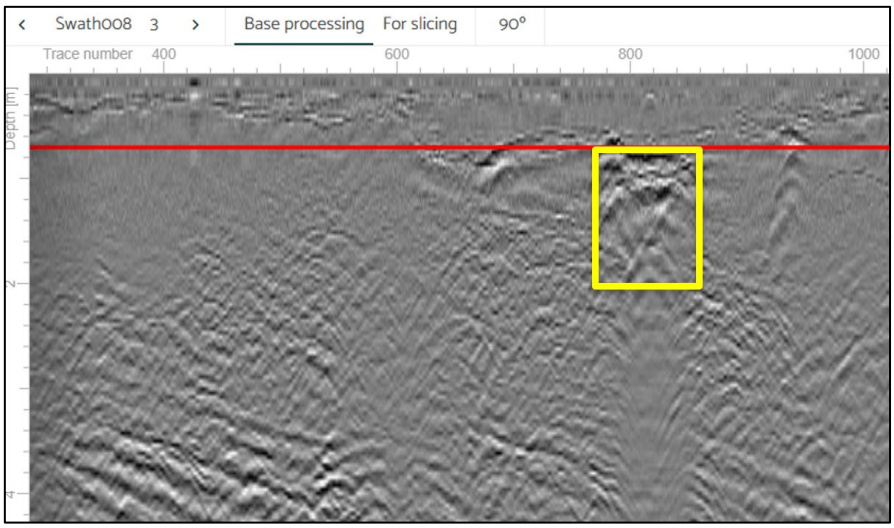

Figure 11: Processed radar-gram (2D cross-section) of the identified soak well feature at depth. The red line sits at a depth of 0.7m.

QUOD SWIMMING POOL INFRASTRUCTURE:

A large feature of interest was identified within the southern section of the Quod. Upon discussion with RIA after preliminary results were issued, it's understood that a swimming pool was once proposed within the same location. Figure 12 illustrates the construction drawings of the proposed swimming pool outlined in red as part of the Rottnest Lodge Resort.

It is believed construction of this was started but then ceased. This is reinforced by the GPR data as identified buried infrastructure for this pool exists within the proposed area. Illustrated in Figures 13, 14, and 15.

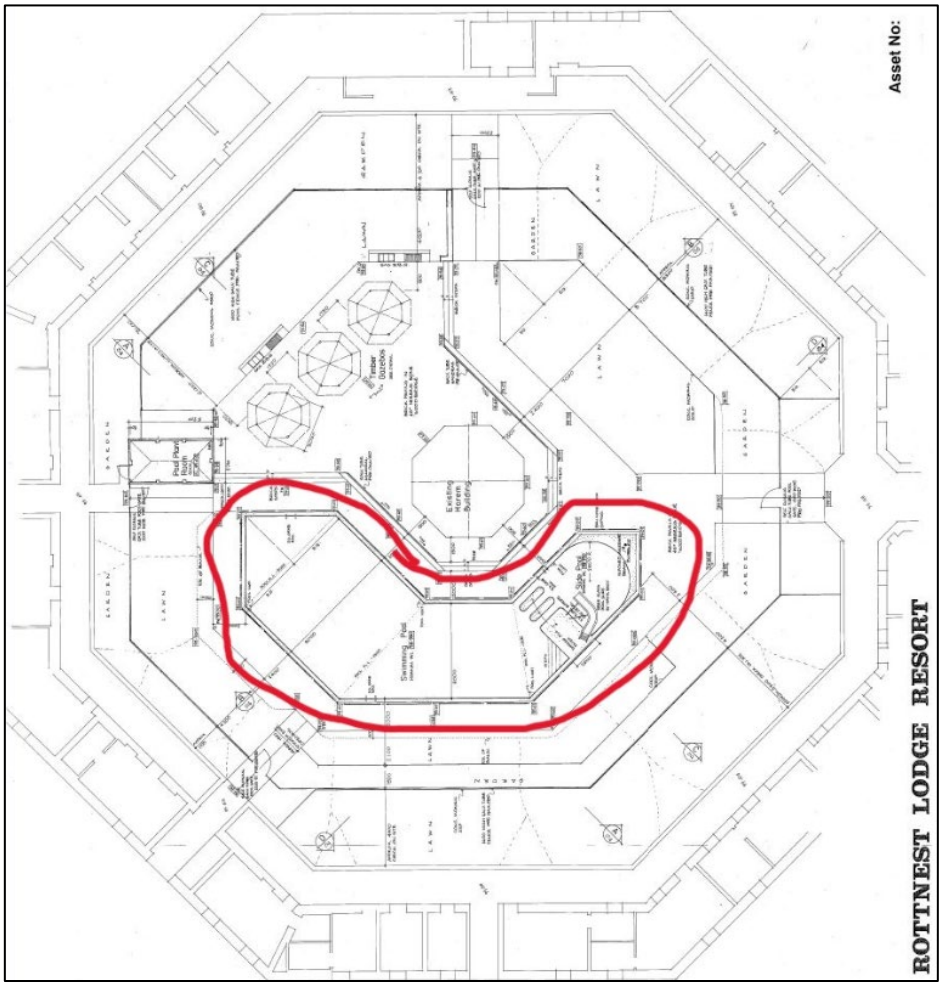

Figure 12: Drawing of the proposed swimming pool within the Quod, outlined in red. (Source: Richenda Prall of RIA).

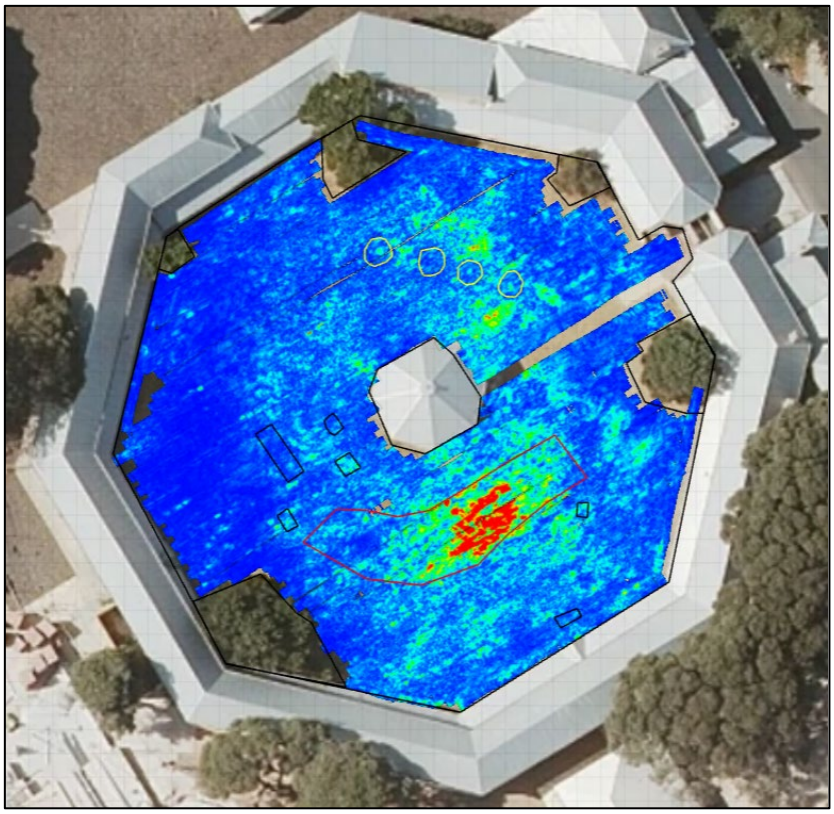

Figure 13: 3D depth slice of GPR data within the Quod with identified anomalous features in red. This depth slice is at 2.0m BGL.

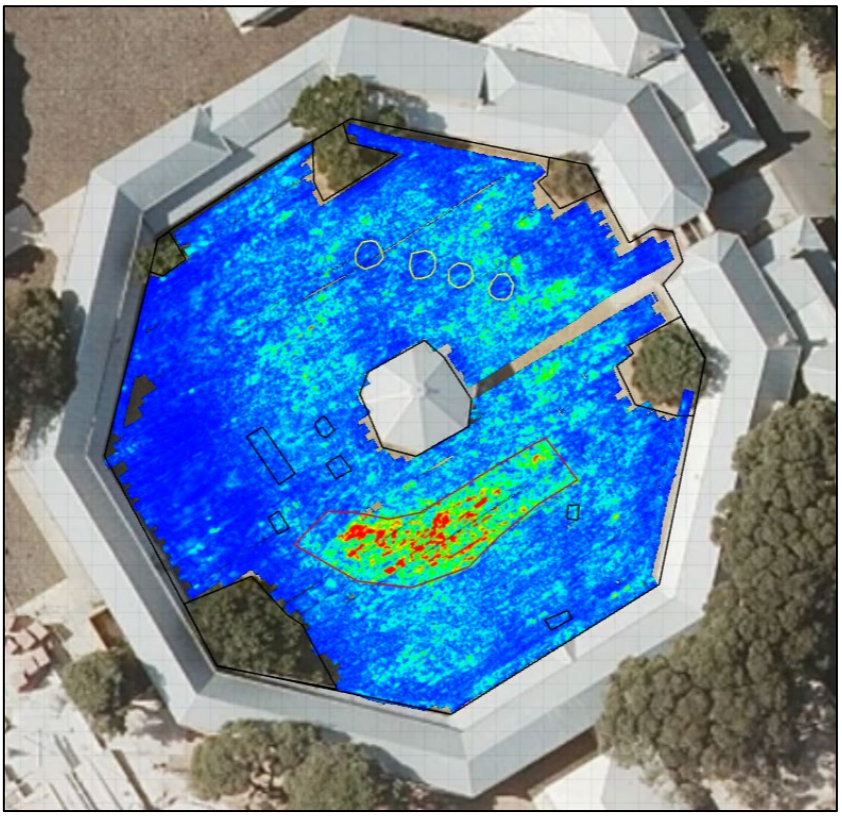

Figure 14: 3D depth slice of GPR data within the Quod with identified anomalous features in red. This depth slice is at 2.4m BGL.

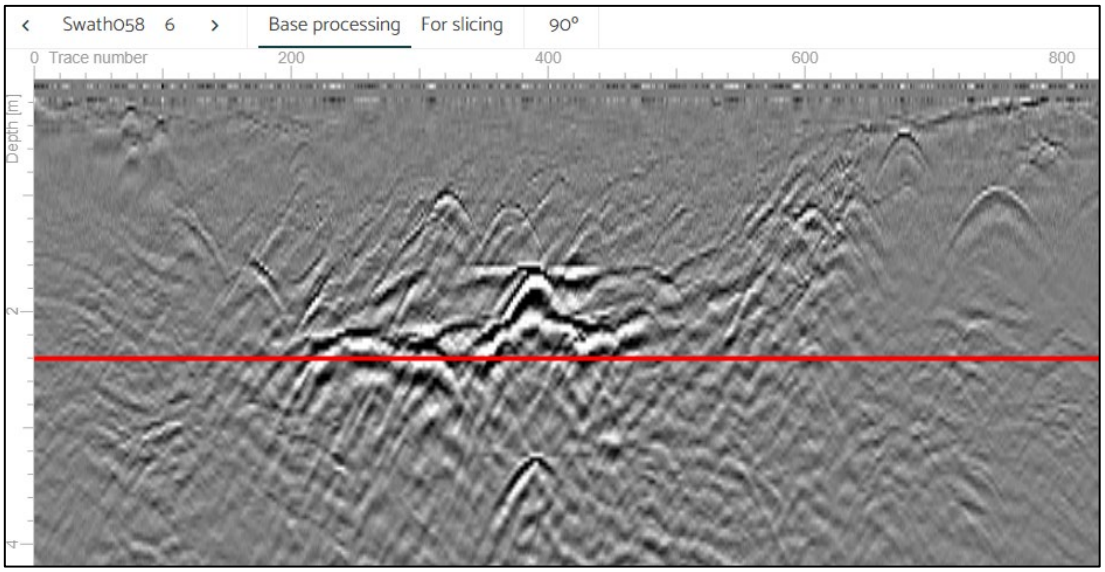

Figure 15: Processed radar-gram (2D cross-section) of high amplitude (black) features the identified within the pool footprint in the Quod.

10.INVESTIGATION SUMMARY

As part of the Wadjemup Project led by the Rottnest Island Authority (RIA), MNG SubSpatial (MNG) conducted a comprehensive geophysical investigation across three (3) designated areas adjacent to the known Wadjemup Aboriginal Burial Ground. The investigation employed conventional utility locating methods and advanced 3D multi-channel Ground Penetrating Radar (GPR). The purpose of the geophysical investigation was to identify any potential unmarked burials and detect underground assets (utilities and infrastructure) within the specified areas.

During the geophysical investigation conducted from December 12th to 14th 2023, a total of 665 GPR swathes were acquired across the three areas. This resulted in 12,635 individual GPR profiles or transects (cross-sections) of the subsurface, reaching a maximum uncalibrated depth of 6 meters below ground level (BGL).

The results of the investigation have been supplied in both digital and PDF drawings, which should be used in conjunction with this report. Two digital AutoCAD DWG files include:

- *80565-003B_Underground Service Location_RIA_x3Areas*
- *80565-004A_Identified Features of Interest_RIA_x3Areas*

A summary of the results includes:

- Four (4) potential unmarked burials /grave like anomalies.
- Twelve (12) identified features of interest.
- Four (4) soak wells within the Quod.
- One (1) large feature of interpreted buried infrastructure associated with the former swimming pool, in the Quod.

The methods used during the investigation are geophysical and as such the results are based on indirect measurements and the processing and interpretation of electrical signals. The findings in this report represent the professional opinions of the authors, based on experience gained during previous similar surveys and with correlation to known and assumed subsurface ground conditions at the site.

We trust that this report and the attached drawings provide you with the information required. If you require clarification on any points arising from this geophysical investigation, please do not hesitate to contact the undersigned on (03) 7002 2207.

For and on behalf of

MNG SubSpatial

TAVIS LAVELL

Manager, MNG SubSpatial / Senior Geophysicist

APPENDIX A – GROUND PENETRATING RADAR IDENTIFIED ANOMALIES

GEOPHYSICAL INVESTIGATION - WADJEMUP ABORIGINAL BURIAL GROUND

SITE PLAN

LEGEND:

GPR Data Acquisition
(Acquired by MNG December, 2023)

No Data Acquisition Due to Surface Obstruction

The contents of this drawing are current and correct as of the date stated within the revision panel. All consultants and persons wishing to utilise this data should ensure this is the most up to date version, by contacting McMullen Nolan Group.

Rev.	Description	Drawn	Date	Checked
A	Initial Issue	MIDS	12/01/2024	TLA

Scale: 1:700
Meters (m): 0 10 20 30 40
Paper Size: A3

Drawing to be used in conjunction with Report 80565.
Image Source: MetroMap 06/04/2023

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Title: GEOPHYSICAL INVESTIGATION TO IDENTIFY UNMARKED BURIALS AT WADJEMUP ABORIGINAL BURIAL GROUND, ROTTNEST ISLAND, WA.

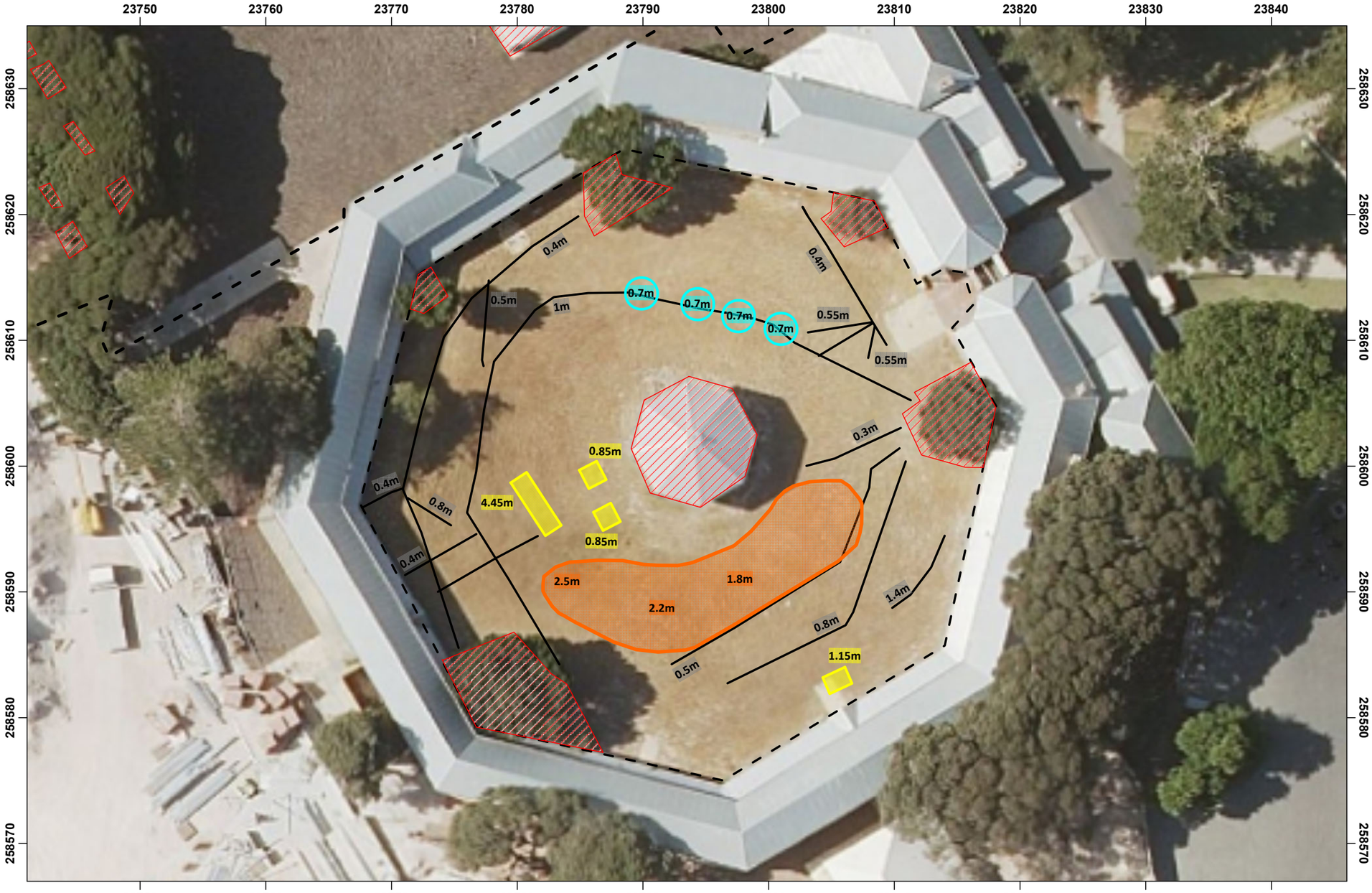
Client: ROTTNEST ISLAND AUTHORITY

Proj. Mngr.	TLA	Datum	PCG1994 / AHD

Drawing: 80565-01

GEOPHYSICAL INVESTIGATION - WADJEMUP ABORIGINAL BURIAL GROUND

INVESTIGATION AREA 01



LEGEND:

- GPR Data Acquisition (Acquired by MNG December, 2023)
- No Data Acquisition Due to Surface Obstruction
- Unknown/Reduntant Service Line and Depth
- Previously Existing Pool Structure (Identified through James Christou & Partners Architects Plans)
- Identified Features of Interest and Depth
- Identified Soak Wells and Depth

The contents of this drawing are current and correct as of the date stated within the revision panel. All consultants and persons wishing to utilise this data should ensure this is the most up to date version, by contacting McMullen Nolan Group.

Rev.	Description	Drawn	Date	Checked
A	Initial Issue	MIDS	12/01/2024	TLA

Scale: 1:350

Meters (m): 0 5 10 15 20

Paper Size: A3

Drawing to be used in conjunction with Report 80565.
Image Source: MetroMap 06/04/2023

ISO 9001 - ISO14001 - ISO45001 Global-Mark.com.au

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Title: GEOPHYSICAL INVESTIGATION TO IDENTIFY UNMARKED BURIALS AT WADJEMUP ABORIGINAL BURIAL GROUND, ROTTNEST ISLAND, WA.

Client: ROTTNEST ISLAND AUTHORITY

Proj. Mngr.	TLA	Datum	PCG1994 / AHD

Drawing: 80565-02

GEOPHYSICAL INVESTIGATION - WADJEMUP ABORIGINAL BURIAL GROUND

INVESTIGATION AREA 02

LEGEND:

- GPR Data Acquisition (Acquired by MNG December, 2023)
- Identified Features of Interest and Depth
- No Data Acquisition Due to Surface Obstruction
- Unknown/Reduntant Service Line and Depth

Rev.	Description	Drawn	Date	Checked
A	Initial Issue	MIDS	12/01/2024	TLA

Scale: 1:350

Meters (m): 0 5 10 15 20

Paper Size: A3

Drawing to be used in conjunction with Report 80565.
Image Source: MetroMap 06/04/2023

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Client: ROTTNEST ISLAND AUTHORITY

Proj. Mngr.	TLA	Datum	PCG1994 / AHD

Drawing: 80565-03

GEOPHYSICAL INVESTIGATION - WADJEMUP ABORIGINAL BURIAL GROUND

INVESTIGATION AREA 03

LEGEND:

- GPR Data Acquisition (Acquired by MNG December, 2023)
- No Data Acquisition Due to Surface Obstruction
- Unknown/Reduntant Service Line and Depth
- Identified Unmarked Burial and Depth
- Identified Features of Interest and Depth

Rev.	Description	Drawn	Date	Checked
A	Initial Issue	MIDS	12/01/2024	TLA

Scale: 1:350

Meters (m): 0 5 10 15 20

Paper Size: A3

Drawing to be used in conjunction with Report 80565.
Image Source: MetroMap 06/04/2023

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Title: GEOPHYSICAL INVESTIGATION TO IDENTIFY UNMARKED BURIALS AT WADJEMUP ABORIGINAL BURIAL GROUND, ROTTNEST ISLAND, WA.

Client: ROTTNEST ISLAND AUTHORITY

Proj. Mngr.	TLA	Datum	PCG1994 / AHD

Drawing: 80565-04

APPENDIX B – MNG LOCATE REPORT

Area Of Works

Technician	Date
Amanda Gates	12-Dec-23

MNG Job #	80565	Plan #	2	Revision:	A

CLIENT: Rottnest Island Authority

REV	DESCRIPTION	DBYD #	DATE	CHECKED
A	3x Service Locate areas		12-Dec-23	ALD

ELECTRONIC DEPTHS ARE IN METERS - (QL-B)
POTHOLE DEPTHS ARE IN METERS - (QL-A)
The 'MNG LOCATE PLANS' that have been provided are purely schematic and NOT to scale and cannot be used as a survey document. The plans indicate the approximate location of underground utilities. Please reference last page for product disclaimer

Please note that plans received are based on the most current BYDA inquiry which is valid for 30 days.
You may need to consider planning your BYDA inquiries in stages that coincide with your works management plan

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This locate survey adheres to the AS-5488 Classification of Subsurface Utility Information
Quality Class A: Pothole for construction - Horizontal Accuracy ± 50mm, Vertical Accuracy ± 50mm
Quality Class B: Horizontal tolerance ± 300mm; Vertical tolerance ± 500mm

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Utility Checklist

MNG Job #	80565	Plan #	2	Revision:	A

UTILITY	MATERIAL / SIZE	LOCATED	QUALITY LEVEL	COMMENTS
Power Service - Property	Unknown	✓	QL-B	LV Power
Power Service - Property	P150	✓	QL-B	Empty P150
Comms Service - Property	Direct Buried	✓	QL-A/B	Buried Neat
Sewer Service - Property	150VC	✓	QL-A	

Additional Comments

MNG Job #	80565	Plan #	2	Revision:	A

MNG Locate have been tasked with locating all services within the 3 proposed work locations highlighted in pink on the cover page.

To complete each scan we have utilised a electro magnetic induction locator to assist with identifying metallic/ conductive services via direct connection induction, ring clamp induction and spillage induction methods. We have also conducted passive sweeping on both radio and power frequencies to assist with identifying possible unknown services that are metallic or can carry the current we are emitting from the electro magnetic induction locator (EMI). Using the passive sweeping we are able to then apply different techniques around the identify lines to fine tune positioning and depth on unknown services within the area.

We have also utilised the ground penetrating radar (GPR) to assist with identifying possible no conductive services within the works area. We scan in the grid formation too align any consistency with hyperbolers and then mark these up for further investigation. The poor ground conditions can affect the visibility of the scan and a mis location error can occur because of this. Sometimes tree roots and rock in the ground also affect quality of the scan which is why we always advise that each potential unknown service is potholed prior to any excavation works.

Please refer to the following abbreviations when referring to this locate plan for clarification.

TB = To Bottom of asset
TT = To Top of asset
LV = Low Voltage
P or PVC = Polyvinyl Chloride
VC = Vitrified Clay

Please read and understand the following hashtag bullet points carefully, and apply caution when undertaking any earthworks within the area. Each comment is specific to the areas marked on the plan with corresponding hashtag and number

#1. Please note that technicians attempted to use tracer rods to locate several down pipes inside this work area however, were unsuccessful due to blockages. The proximity of the pipes in relation to the concrete wall prevented any data being collected with the GPR.

#2. Please note previous locate data has been collected for this Sewer main.

#3. Attempts to use tracer rods on these 2x drains were unsuccessful due to debris and blockages.

#4. Please note previous data for Drainage and down pipes in this area has been collected. Please refer to previous plan.

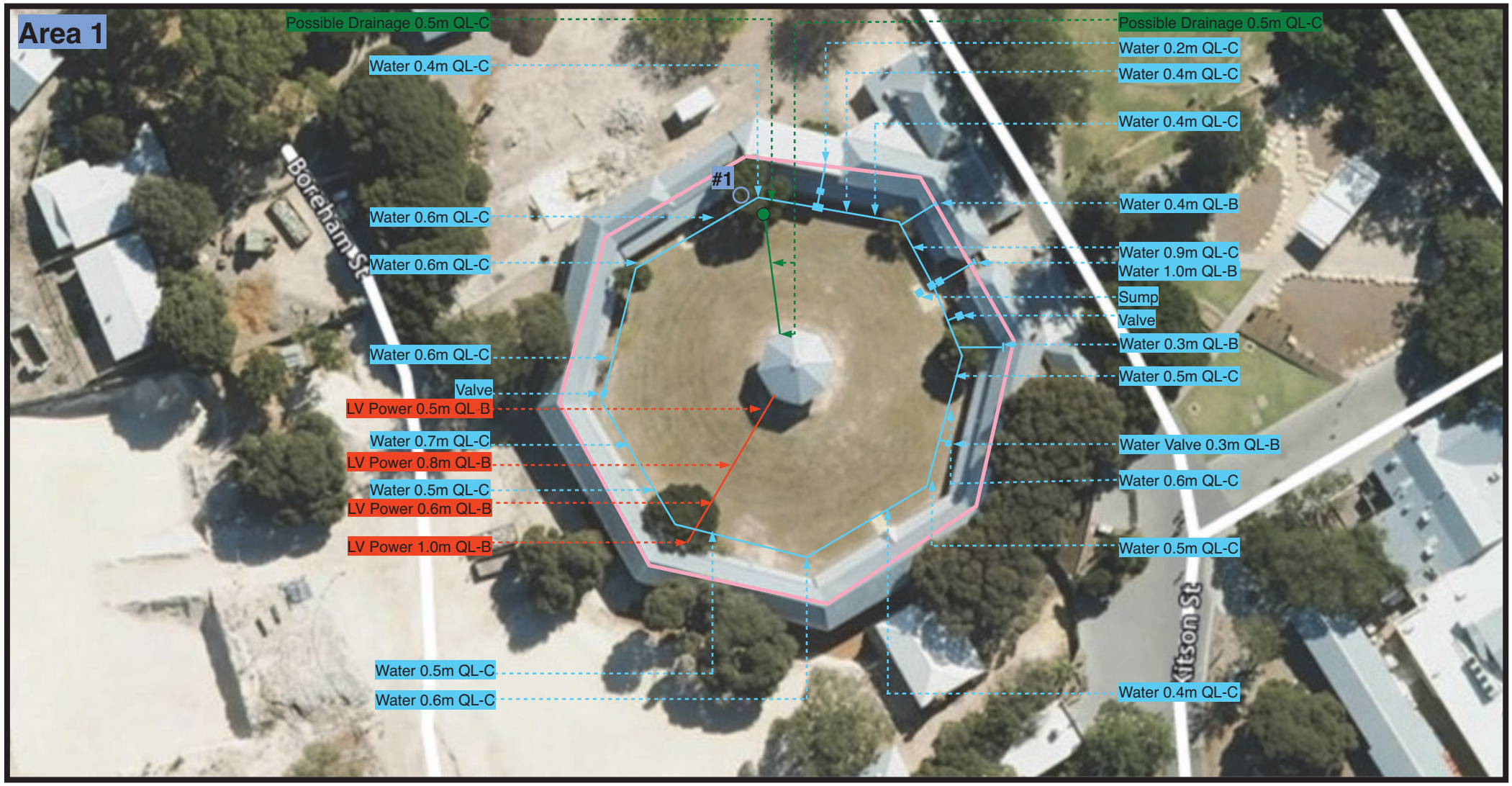
MNG.LOCATE

Legend

Area of works | LV Power | Water | Drainage | Optic Fibre
Gas | HV Power | Communications | Sewer | Unknown

N

MNG Job #	80565	Plan #	2	Revision:	A



ELECTRONIC DEPTHS ARE IN METERS - (QL-B)
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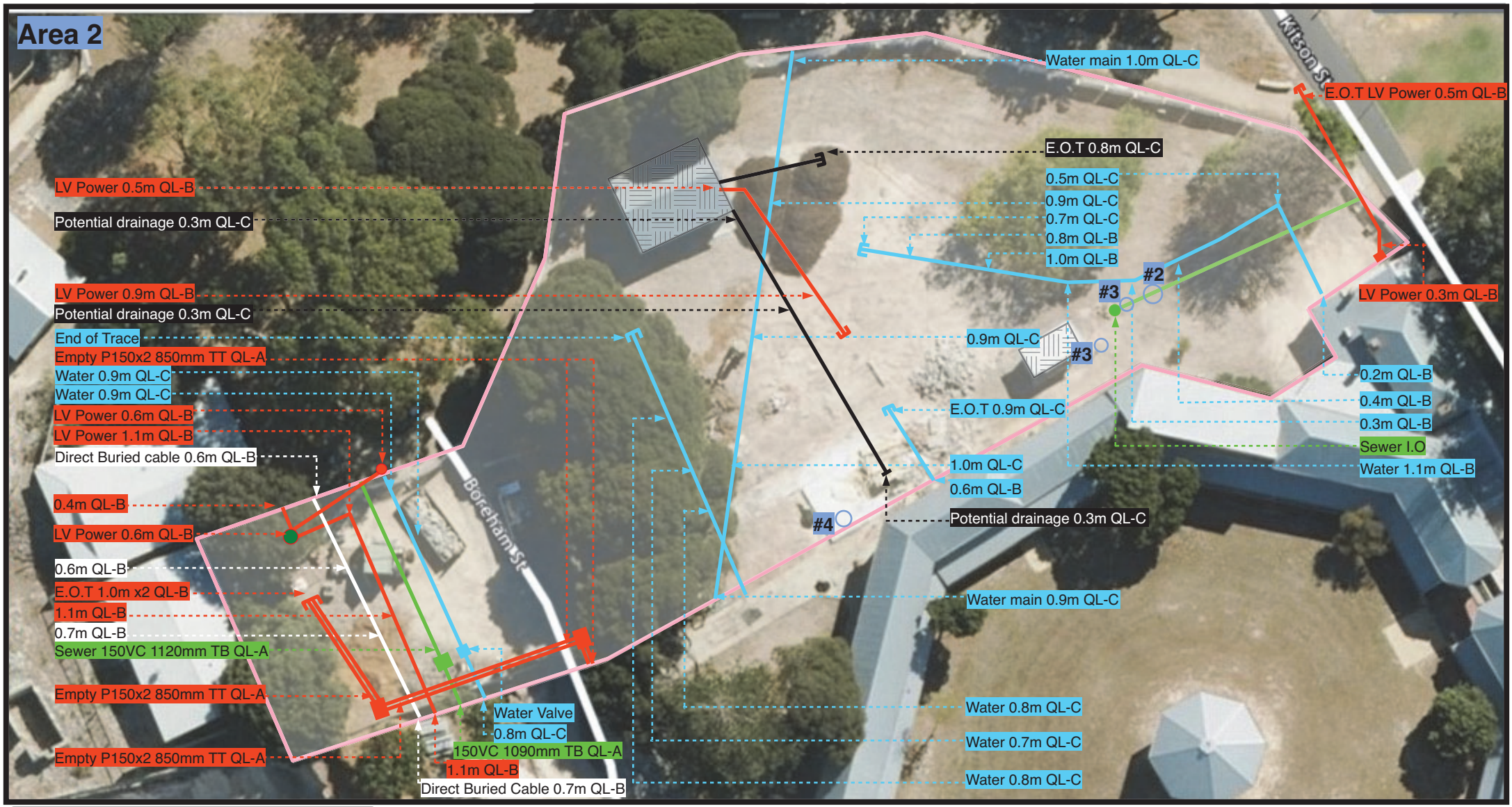
MNG.LOCATE

Legend

Area of works | LV Power | Water | Drainage | Optic Fibre
Gas | HV Power | Communications | Sewer | Unknown

N

MNG Job #	80565	Plan #	2	Revision:	A



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MNG.LOCATE

Legend

Area of works | Gas | LV Power | HV Power | Water | Communications | Drainage | Sewer | Optic Fibre | Unknown

N

MNG Job #	80565	Plan #	2	Revision:	A

ELECTRONIC DEPTHS ARE IN METERS - (QL-B)
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Product Disclaimer

MNG Job #	80565	Plan #	2	Revision:	A

MNG Locate assume the Client is educated and aware of their Duty of Care under the 'Utility Providers Code Of Practice For WA', with specific reference to; Prevention of Damage to Services, including but not limited to the summary items; Plan, Pothole, Protect and Proceed as detailed in the Code. The MNG Locate plans that have been provided are purely schematic and not to scale unless referenced. The plans indicate the approximate location of underground utility and services only.

You have a duty and obligation when working in the vicinity of underground utility and services to prevent damage to the underground utility. Notwithstanding that an on-site location of underground utility has been provided to you please note: all utility and services should be exposed by hand (machinery of sharp tools should not be used) when working in the vicinity of the underground utility or when planning to work across the underground plan as per the Utility Provider Code of Practice for WA, Item 6.3 Duty of Care and Prevention of Damage to Services. Exposed underground utility should be protected and supported if necessary.

Never assume the depth of cable; depth can vary significantly for many reasons - grading, local authorities' works, erosion or landfill. The depth must always be determined using hand tools or vacuum excavation and you must never assume that underground utility will remain at ascertain depth from one location to the next. You must be aware that some cables may be just below the surface. Route alignment of underground utility may also vary. Never assume constant distances to fences or boundary lines.

Even with pothole markers erected by MNG Locate, it is recommended before any ground disturbance works, you must still expose the underground utility by hand or other safe excavation methods.

Please see overleaf for methodology, quality levels of locating, field procedure, and capabilities of the locating equipment.

Product Disclaimer

MNG Job #	80565	Plan #	2	Revision:	A

METHODOLOGY

MNG Locate proposes carrying out an underground utility investigation using a combination of Ground Penetrating Radar (GPR) and electro-magnetic induction (EMI) for non-destructive detection. A combination of those tools can produce a Quality Level B and Quality Level C locate. If potholing is required, we can offer that service for a Quality Level A, as per Australian Standard Classification of Subsurface Utility Information (AS 5488.1-2022).

Underground utility locating will not take place within buildings, areas with dense vegetation such as garden beds, stepped or steeply dipping areas, and areas with obstructions such as infrastructure, lay down material or parked vehicles.

Locates near or on roads / footpaths that require high level traffic management plans and rigorous traffic management to carry out the works safely and to the approval of Main Roads WA. This is to be arranged by the client.

AUSTRALIAN STANDARDS: CLASSIFICATION OF SUBSURFACE UTILITY INFORMATION AS5488.1-2022

Quality Level A (QL-A)
Highest level, positive identification of the utility in three dimensions at a point to an absolute spatial position. It defines the utility as verified. The utility is electronically located, potholed and confirmed. Tolerance Horizontal and Vertical +/- 50mm

Quality Level B (QL-B)
Provides only relative utility location in three dimensions with relative spatial position by tracing (EMI locating) and visual inspection of the site for evidence of pits, valves etc. Survey measurements can also be used as a method for information required. The utility is not verified as no potholing is undertaken. The utility is located from point to point with indicative information. Electronic detection (EMI) should not be used for obtaining accurate depth information due to the potential of interference from other adjacent services or due to geological conditions. Tolerance: Horizontal +/- 300mm | Vertical +/- 500mm

Quality level C (QL-C)
Provides an interpretation of the approximate location of the utility using available existing records such as BYDA plans or site records along with a visual inspection for of surface features (such as pits and valves covers). Ground Penetrating Radar (GPR), acoustic, photographic and other methods can also be used to obtain proof of the existence of an undefined service that do not utilize physical measurements of tracing that satisfy QL-B or QL-A tolerances. Tolerance: Horizontal +/- 300mm

Quality level D (QL-D)
Is the lowest level providing the gathering of information such as BYDA or any existing site plans showing the indicative position of the utility. No equipment used to locate, and no potholing is carried out. Broad indication of any utility presence with no site verification.

Product Disclaimer

MNG Job #	80565	Plan #	2	Revision:	A

FIELD PROCEDURE

MNG Locate utilizes a four-stage approach when conducting underground utility investigations:

- Desktop study before on-site data collection – plans and existing service provider infrastructure drawings are obtained and collated - mainly DBYD and any plans given by the client. These plans are used as a reference onsite during the data collection process for annotation and recording positions.
- Utility covers / pit lids – available utility covers and pit lids are opened and accessed. Pipes and conduits emanating from the pits are examined including orientation, depth and diameter.
- Non-invasive electronic detection using Ground Penetrating Radar and Electro-magnetic locator – underground utilities are mapped to a maximum depth of 2.0m depending on local ground / soil conditions.
- If requested - vacuum potholing for safe exposure of underground utilities – carried out at spot locations in order to confirm and calibrate the results of the electronic detection. Exposed utilities are marked with PVC standpipe. As per the client's request a limited number of potholes to be allowed.

GROUND PENETRATING RADAR (GPR)

GPR data will be acquired using a Leica DS2000 data collection system (or similar). Ground coupled antennae in the mid-frequency range will be used to provide high resolution images of the subsurface to a maximum depth of 2.0-3.0m depending on subsurface conditions – see notes below. Antennae of high frequency provide high resolution data with shallow imaging depth, whilst low frequency antennae provide greater imaging depths with decreased resolution. As a result of this only larger utility are detectable at depth, with the detection of smaller utility being more difficult at depth.

Whilst the latest GPR technology is a useful tool, there is limitations due to many reasons. Pending on soil conditions non-conductive assets in PVC conduits such as gas / water / sewerage and direct buried optic fibre is difficult and, in some cases, unable to view using GPR technology. Vacuum excavation based on a Quality C Level locate will always be recommended if no data can be obtained on the target. Always proceed excavation with caution. GPR is limited and can be of no avail in some ground conditions such as: Soil with pools of water, soil after heavy rain, high salinity soil, high density soils such as clay, high mineral containing soil with iron ore.

ELECTRO-MAGNETIC INDUCTION (EMI)

Electro-magnetic induction will be carried out using vLoc-Pro 3 locator (or similar). This technology can locate metallic pipes or cables from either power frequencies emitted from the utility itself or by inducing a signal into the utility. The technique cannot detect non-metallic utilities such as concrete, clay and plastic pipes. The detection of such utilities requiring the insertion of a signal transmitter into the pipe and tracing that if access is possible and safe to do so. The effective depth of investigation with this technique is typically 2m in good soil conditions with depth resolution of targets being significantly reduced as depth increases.