



SOUTH WEST INDIGENOUS
SUPPORT SERVICES PTY LTD

Report of a Ground Penetrating
RADAR (GPR) survey of the proposed
Rottnest Lodge Redevelopment
Area, Wadjemup, Western Australia.

For Rottnest Island Authority

November 2019 | Dominic Howman, Dr Ian
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The results, conclusions and recommendations within this report are based on information available at the time of its preparation.

CO-ORDINATE CAPTURE

The authors advise that all coordinates for newly recorded sites quoted in this report were obtained using Nautiz X7 hand held GPS field computers in GDA 94 datum (MGA Zone 50).



ACKNOWLEDGEMENTS

The authors would like to acknowledge and thank the following people in this report:

- Whadjuk representatives: Jock Garlett, Brendan Moore, Noel Morich Jnr., Reg Yarran, Stan Headland, Jeremy Ugle, Joanne Jacobs, Garry Bennell, Tejhone Ugle, Peter Garlett and Greg Ugle.
- Rottnest Island Authority: Jane Skippington and Sarah Watson.



EXECUTIVE SUMMARY

- This report describes the results of a Ground Penetrating RADAR (GPR) survey (the Survey) within the proposed Rottnest Lodge Redevelopment Area (the Survey Area) as described in the Activity Notice submitted to SWALSC by the RIA. The Survey Area is located immediately to the southwest of the Quod (DPLH Registered Site ROTTNEST ISLAND/QUAD, DPLH ID 3540) and the east of Garden Lake, approximately 350 m west of Thomson Bay, in the northwest of Rottnest Island, Western Australia (see Map 1). Rottnest Island is referred to here as Wadjemup, the Noongar name for the island.
- The Survey Area lies wholly in an area covered by the Whadjuk People Indigenous Land Use Agreement (Tribunal No WI2017/015), and the Activity Notice was submitted under the Whadjuk Noongar Standard Heritage Agreement (NSHA).
- The Survey was co-ordinated by SWISS and undertaken by geophysicist Dominic Howman (Bsc Physics, Grad Dip Geophysics) from the 14th of October to the 17th of October 2019.
- The Survey was conducted with the full involvement and assistance of nominated Whadjuk People (the Whadjuk representatives).
- The objectives of the Survey were to:
 - conduct a GPR survey of the Survey Area; and
 - to identify, and document the location of, any anomalies likely to represent burials.
- **Five (5)** anomalies with no obvious explanation were identified within the Survey Area.
- **No** definite burial sites were identified within the Survey Area.



RECOMMENDATIONS

It is **recommended** that Rottnest Island Authority ensure that its employees and contractors (as appropriate) are:

1. advised that a ground penetration RADAR survey of the Rottnest Lodge Redevelopment Survey Area has been **completed**;
2. advised that **no** definite burial sites were identified during the Survey;
3. advised that **seven (7)** anomalies with no obvious explanation were identified during the Survey (Area 1, anomalies 1-5 and Area 2, anomaly 6 and anomaly 7);
4. advised that, although the anomalies recorded in Area 1, numbered 1-5, do not match the signatures of known burials from the Pioneer and Wadjemup cemeteries, they are located within an area that has been previously identified as a possible location of an earlier Aboriginal prisoner cemetery than the Wadjemup Aboriginal Prisoners Cemetery (DPLH ID 3781) (Randolph and Vinnicombe 1989, 14-16);
5. advised that, the anomalies in Area 2 grouped together as anomaly 6 and those grouped together as anomaly 7 do not match the signatures of known burials from the Pioneer and Wadjemup cemeteries but are located within 25 m of an area that has been previously identified as a possible location of an earlier Aboriginal prisoner cemetery than the Wadjemup Aboriginal Prisoners Cemetery (DPLH ID 3781) (Randolph and Vinnicombe 1989, 14-16);
6. advised that no ground disturbing activities below a depth of 30 cm should take place within 2.5 m of anomalies 1-5 in Area 1;
7. advised that no ground disturbing activities below a depth of 30 cm should take place within 2.5 m of the anomalies grouped together as anomaly 6 and anomaly 7 in Area 2;
8. advised that any ground disturbing activities below a depth of 30 cm between 2.5 and 10 m of anomalies 1-5 in Area 1 be undertaken with extreme caution;
9. advised that any ground disturbing activities below a depth of 30 cm between 2.5 and 10 m of the anomalies grouped together as anomaly 6 and anomaly 7 in Area 2 be undertaken with extreme caution;
10. advised that Rottnest Island Authority should ensure that a Cultural Heritage Management Plan is prepared for the location of anomalies 1-5 in Area 1 and the location of the anomalies grouped together as anomaly 6 and anomaly 7 in Area 2; and
11. advised that Rottnest Island Authority and the Whadjuk People should undertake further consultation regarding the progress of the proposed activities.



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REPORT FORMAT

The report is divided into two sections:

Section One contains the introduction, providing details of the project itself, and the environmental background of the Survey Area. The background summarises the history of the Wadjemup Aboriginal Prisoners Gaol and Cemetery and outlines the theory and method of the GPR.

Section Two details the results of the Survey. The results section provides a discussion of the Survey Area, the results of the Survey and the conclusions and recommendations of the report as well as the references and the appendices.



SECTION ONE – INTRODUCTION, BACKGROUND DATA AND METHODS

INTRODUCTION

Rottneest Island, referred to throughout this report using the Noongar name for the island, Wadjemup, was used as an Aboriginal prison during the 19th and early 20th century. The existence and location of the cemetery within which Aboriginal prisoners were interred on the island was not well documented. An accidental uncovering of several skeletons in 1970, by a workman digging trenches for sewerage infrastructure in an area then referred to as Tentland, indicated that this might be the area that had been used for the burial of Aboriginal prisoners. GPR surveys of this area were performed between 1990 and 1992 (Wilson 1991a, 1991b, 1992, 1993) and again in December 2004 to define the extent of the Aboriginal prisoners cemetery (Wilson 2005) (Registered Aboriginal Site Wadjemup Aboriginal Prisoners Cemetery, DPLH 3781).

In 2019 the RIA requested a GPR survey of the Rottneest Lodge Redevelopment Survey Area (the Survey Area) (see Map 1). The intent of the survey was to check for any further burials/ground disturbances within the Survey Area. SWISS were engaged to manage the survey and geophysicist Dominic Howman (Bsc Physics, Grad Dip Geophysics) was contracted to provide the RADAR acquisition and interpretation.

This report describes the results of a GPR survey (the Survey) within the Survey Area as described in the Activity Notice submitted to the SWALSC by the RIA. The Survey Area is located immediately to the southwest of the Quod (DPLH Registered Site ROTTNEEST ISLAND/QUAD, DPLH ID 3540) and the east of Garden Lake, approximately 350 m west of Thomson Bay, in the northwest of Wadjemup, Western Australia (see Map 1).

Wadjemup lies wholly within the area covered by Whadjuk People Indigenous Land Use Agreement (Tribunal No WI2017/015), and the Activity Notice was submitted under the Whadjuk NSHA.

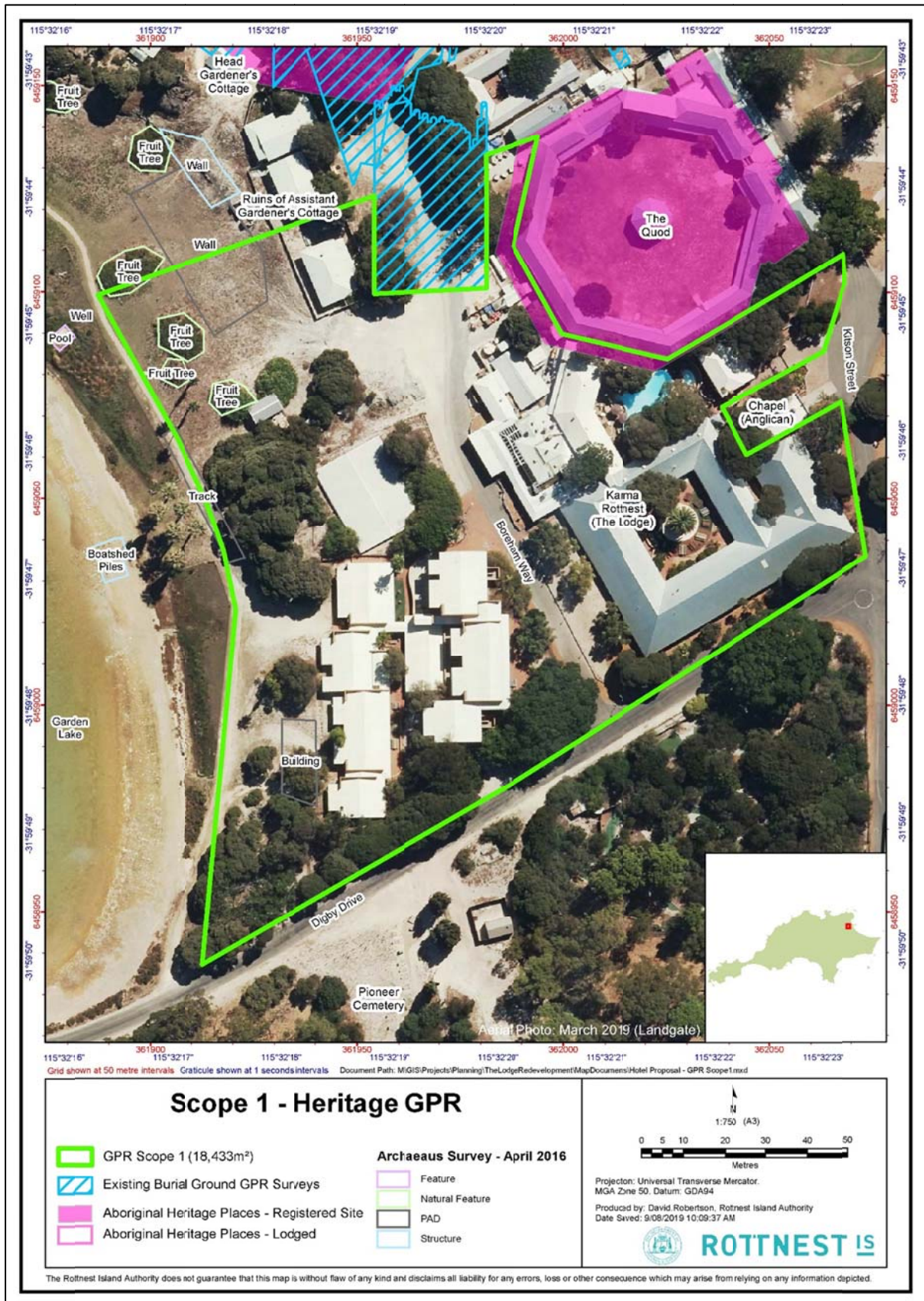
The Survey was co-ordinated by SWISS and undertaken by geophysicist Dominic Howman (Bsc Physics, Grad Dip Geophysics) from the 14th to the 17th of October, 2019. The Survey was conducted with the full involvement and assistance of nominated the Whadjuk representatives.

The objectives of the Survey were to:

- conduct a GPR survey of the Survey Area; and
- to identify, and document the location of, any anomalies likely to represent burials.



Map 1: SWISS_RIA_2019_2019_03 Rottnest Lodge GPR Assessment – Scoped Survey Area



THE SURVEY AREA

The Rottnest Lodge Redevelopment Area Survey Area is located immediately to the southwest of the Quod (DPLH Registered Site ROTTNEST ISLAND/QUAD, DPLH ID 3540) and the east of Garden Lake, approximately 350 m west of Thomson Bay, in the northwest of Wadjemup, Western Australia (see Map 1).

The Survey Area, as detailed in the Activity Notice provided by RIA, comprises a single area of 18,500 m². The Lodge is currently leased by the Karma Group, an international travel and lifestyle company. There is a current proposal to redevelop the Rottnest Lodge lease area between 2020 and 2025.

Wadjemup lies wholly within the area covered by Whadjuk People Indigenous Land Use Agreement (Tribunal No WI2017/015), and the activity notice was submitted under the Whadjuk NSHA.



PERSONNEL

The following people and organisations participated in the Survey:

GEOPHYSICIST

Dominic Howman

WHADJUK REPRESENTATIVES

Jock Garlett (14th – 15th of October)

Noel Morich Jnr. (14th - 17th of October)

Brendan Moore (14th – 17th of October)

Reg Yarran (14th - 17th of October)

Stan Headland (14th - 17th of October)

Jeremy Ugle (14th of October)

Joanne Jacobs (14th - 17th of October)

Garry Bennell (14th - 17th of October)

Trejhone Ugle (15th – 16th of October)

Peter Garlett (16th – 17th of October)

Greg Ugle (17th of October)

ROTTNEST ISLAND AUTHORITY

Sarah Watson

Jane Skippington



PARTICIPATION OF THE WHADJUK REPRESENTATIVES

Wadjemup lies wholly within the area covered by Whadjuk People Indigenous Land Use Agreement (Tribunal No WI2017/015), and the Activity Notice was submitted under the Whadjuk NSHA. The participation of the Whadjuk representatives was facilitated by the SWALSC and follows agreement RIA and the Whadjuk People. In addition, it is a requirement of the professional anthropological and archaeological organisations (Anthropological Society of Western Australia Inc., the Australian Anthropological Society Inc. and the Australian Association of Consulting Archaeologists Inc.), that Aboriginal people (selected by the relevant Aboriginal organisations, in this case SWALSC) participate in heritage surveys.

SWALSC arranged the Whadjuk representatives who participated in all aspects of the Survey (see Personnel above). The Whadjuk representatives included people with traditional responsibility for the Survey Area. The Survey was, therefore, undertaken with the cooperation and involvement of Whadjuk representatives.



LEGISLATIVE CONTEXT

Aboriginal heritage places and objects are legally protected in Western Australia by the *Aboriginal Heritage Act 1972 (WA)* (the Act). The title of the Act states that it exists to:

‘...make provision for the preservation on behalf of the community of places and objects customarily used by or traditional to the original inhabitants of Australia or their descendants, or associated therewith’.

The Act refers to all types of Aboriginal heritage places as ‘Aboriginal sites’. A distinction is made on the Aboriginal Heritage Information System (AHIS), an online GIS system maintained by the Department of Planning, Lands and Heritage (DPLH) between places that have been reviewed by the Aboriginal Cultural Materials Committee (ACMC) and the Minister and assessed as constituting Aboriginal Heritage sites under the Act (Registered Sites) and those places that have been reviewed but found *not* to constitute sites (Other Heritage Place - Stored Data/Not a Site). A third status, Other Heritage Place – Lodged, includes places that have been reported to the Department but for which no assessment has been made. The extent to which this third category of places is protected by the Act is not clear.

Most Aboriginal archaeological sites in Western Australia listed on the AHIS were recorded in the context of Aboriginal heritage surveys undertaken to ensure that Aboriginal heritage sites protected by the Act are not disturbed during development activities. These surveys are mostly (but not exclusively) undertaken by a range of developers such as mining companies, Aboriginal prescribed body corporates and land councils, and by government departments.

What is an Aboriginal Site?

The Act provides a general definition of what constitutes an Aboriginal site under the Act and establishes a framework for control over the assessment, protection and recording of Aboriginal heritage sites. This framework is built around three interacting elements:

1. the current state government Minister for Aboriginal Affairs, an elected member of the Western Australian Legislative Assembly (of the party with a majority in the Assembly);
2. an advisory committee, the ACMC, often referred to in the text of the Act simply as ‘the Committee’, membership of which is determined by the Minister; and
3. the Registrar, a public servant drawn from the government department, also chosen by the Minister.

Section 5 of the Act defines the type of places to which the Act applies and states that there are four types of places considered to constitute Aboriginal sites under the Act. Section 5 state that the Act applies to;

- (a) any place of importance and significance where persons of Aboriginal descent have, or appear to have, left any object, natural or artificial, used for, or made or adapted for use for, any purpose connected with the traditional cultural life of the Aboriginal people, past or present;
- (b) any sacred, ritual or ceremonial site, which is of importance and special significance to persons of Aboriginal descent;
- (c) any place which, in the opinion of the Committee, is or was associated with the Aboriginal people and which is of historical, anthropological, archaeological or



ethnographical interest and should be preserved because of its importance and significance to the cultural heritage of the State; and

- (d) 'any place where objects to which this Act applies are traditionally stored, or to which, under the provisions of this Act, such objects have been taken or removed.'

Section 39(1)(a) states that one of the functions of the ACMC is to '...evaluate on behalf of the community the importance of places and objects alleged to be associated with Aboriginal persons'. That is, part of the role of the ACMC is to assess places that have been reported to the Registrar because they '...might reasonably be suspected...' to constitute sites under s. 5 of the Act.

Historically, the primary function of the ACMC has been predominantly exercised in relation to s. 18 of the Act. Under s. 18, the owner (or lease holder) of any land on which Aboriginal heritage sites are located can apply for Ministerial consent to disturb those sites. Applications to disturb Aboriginal sites are reviewed by the ACMC, as outlined in s. 18(2);

'...the committee shall...form an opinion as to whether there is any Aboriginal site on the land, evaluate the importance and significance of any such site, and submit the notice to the Minister... [and any] conditions upon which consent should be given'.

Section 39(2) of the Act offers a simple outline of what the ACMC should consider when assessing sites. The Act states that 'In evaluating the importance of places and objects the Committee shall have regard to —

- (a) any existing use or significance attributed under relevant Aboriginal custom;
- (b) any former or reputed use or significance which may be attributed upon the basis of tradition, historical association, or Aboriginal sentiment;
- (c) any potential anthropological, archaeological or ethnographical interest; and
- (d) aesthetic values.'

Section 18 applications are usually made following an Aboriginal heritage survey, the purpose of which is to record and assess archaeological and ethnographic sites to which the '...Act might reasonably be suspected to apply' and to provide sufficient information about Aboriginal sites to enable the ACMC to fulfil its functions under the Act.

The Heritage Information Submission Form (HISF)

In late 2012 the then Department of Aboriginal Affairs, now part of the DPLH, introduced a new site form, the Heritage Information Submission Form (HISF). Since that time the department has repeatedly stated that sites will only be reviewed by the ACMC if they are submitted using this form. The structure of the HISF informs the site assessments outlined in this Report.



BACKGROUND CONTEXT

WADJEMUP ABORIGINAL PRISONERS CEMETERY

In August of 1838, a prison was established on Wadjemup specifically to house male Aboriginal prisoners from all over Western Australia (Green and Moon 1997; Moredoundt 2015) and the island was formally designated a penal settlement from 1841 to 1849 and again from 1855 to 1902. The prison was initially named the Rottnest Island Prison and was renamed the Rottnest Native Prison in 1864 (Stasiuk 2015, 125). Initially the prison housed primarily Aboriginal men and boys from the southwest of the state but as European pastoralism (and later mining) expanded north, men from the Murchison, the Pilbara and the Kimberley were all incarcerated on the island (Randolph et al. 1994, 394). Aboriginal prisoners shipped to the island were convicted for a range of offences, including murder, assault, larceny and drunkenness, but with the most common crimes being ‘absconding’ (i.e. leaving or not returning to a pastoral station) and the killing of stock (Green 2011, 79). It is estimated that 3400 Aboriginal men and boys were imprisoned on the island between 1838 and 1903, when the Gaol became an annex of Fremantle Prison (Green 2011, 78).

The Aboriginal prisoners quarried limestone and used it to build most of the buildings made from this material on the island over the course of the 19th century, including the Governor’s cottage and the first Wadjemup Lighthouse (replaced in 1896), and provided labour for a salt works, installation of telegraph infrastructure and road clearing (Moredoundt 2015, 9). They also built the most prominent physical reminder of this period of Wadjemup’s history, The Quod, a large octagonal building that included cells, offices, kitchen, storage and warden’s accommodation, that was constructed in 1864-5 after the original prison was badly damaged by fire. The Quod is Registered Aboriginal Site ROTTNEST: LODGE/QUAD [sic] (DPLH ID 3540). Throughout most of these works the prisoners were supervised by Henry Vincent, Penal Establishment Superintendent between 1839-49 and again 1855-67, and a man whose name was synonymous in Australia at the time with colonial brutality.

The prison records state that 364 inmates died on Wadjemup between 1838 and 1902 (some Aboriginal men and boys also died during the subsequent years when the prison was annexed to Fremantle Prison) and it is thought that most of these people were buried on the island. The graves were dug by the prisoners and they buried at least some of the bodies in the traditional Noongar style, in which the grave would be dug in an east-west orientation and the body (wrapped in a blanket) would be positioned in a half-seated position facing toward the east (Stasiuk 2015, 127–128). This position was believed to ensure that the spirit of the deceased would see the first rays of the rising sun and be transported to the spirit realm by the light. It is likely, however, given the wide range of the state from which the Aboriginal inmates originated, that several different methods of burying the dead were practised.

Because of the cramped and unsanitary conditions of the cells of the Wadjemup Aboriginal Prison, and the fact that Aboriginal Australians had not developed immunity to many Old World diseases at that time, it was prone to epidemics of introduced diseases, including influenza, with 60 inmate deaths (around 40% of the entire prison population) in one outbreak of the disease in 1883 (Randolph et al. 1994, 394). The list of Aboriginal men who died in the Gaol 1838-1900 provided in Randolph *et al.* (1994) includes several clusters of deaths that, while no cause of death is provided, are likely to have occurred because of disease. Several other outbreaks are stated as caused by unspecified disease, for example, the death of at least 12 inmates (and probably 17) of ‘congestion [sic] of lungs’ in late July and early August, 1897. Additionally, seven prisoners were executed in the quadrangle of the prison (Randolph et al. 1994, 394) and it is considered highly likely that some prisoners



were beaten to death by Superintendent Henry Vincent over the period of his management of the facility, between 1839-1867 (Stasiuk 2015, 112–115).

Unfortunately, the exact location of the cemetery in which the Aboriginal prisoners were buried on Wadjemup was not well documented, in spite of it being, along with the Derby Leprosarium and the Moore River Settlement cemeteries, one of the largest Aboriginal cemeteries in Western Australia (Perkins 2008: 239). Indeed, it is one of the largest 19th and 20th century Aboriginal burial sites in Australia and the largest site of Aboriginal deaths in custody (Stasiuk 2015, 101). There are no known historic plans dating to the 19th century that show the location of the Aboriginal cemetery although several sources refer to it being separate from the European cemetery, which is shown on historic maps (Timperley 1885; Watson 1937). Moreover, the infamous outbreak of influenza in 1883 described above appears to have led to the closing of one cemetery dedicated to Aboriginal prisoners and the opening of another (Timperley 1885), assumedly because there was no longer sufficient room to bury deceased Aboriginal prisoners. As such, there are perhaps two separate cemeteries within which Aboriginal prisoners were interred, neither of which were marked with any grave stones.

In 1984 a researcher attached to the Rottnest Island Management Planning Group located an historic source that suggested a general location for the cemetery, an unpublished manuscript written c. 1937 titled *History of Rottnest* by E.J. Watson, later published as *Rottnest: Its Tragedy and Its Glory* in 1998 (Randolph 1985; Randolph et al. 1994). In an excerpt from Watson's c. 1937 manuscript, quoted at length in Randolph (1985, 1), he states that there are 'about seventy skeletons' buried in a cemetery located '...two hundred yards N.N.W of the prison...' and added that it was enclosed by a '...cobble stone wall'. It was also discovered at this time that a workman digging trenches for sewerage infrastructure in (or around) 1970 had disturbed between 10 and 20 burials in approximately the location that Watson mentioned, but that government authorities had decided to keep the information from the public. An investigation of the ground surface of this area, by this time used as a camping ground by tourists and referred to as 'Tentland', by Peter Randolph of the Department of Aboriginal Sites and others in 1985 failed to locate any trace of the cemetery. However, as a result of this research, a circular area with an approximately 90 m diameter was added to the Register of Aboriginal Sites (then administered by the Department of Aboriginal Sites) and given the name Wadjemup Aboriginal Prisoners Cemetery (DPLH ID 3781).

Previous Ground Penetrating RADAR Surveys

A series of four Ground Penetrating RADAR surveys were undertaken by Vern Wilson (then of Curtin University) on behalf of the then Department of Aboriginal Sites (DAS) between 1990 and 1992 in the hope of establishing the extent of the Aboriginal cemetery (Wilson 1991a, 1991b, 1992, 1993). During these surveys, data was collected from the area of the burials disturbed in 1970 to provide a reference GPR signal of known burials in order to aid the interpretation of new data. These surveys located several areas of disturbed subsurface deposit that were considered highly likely to represent grave sites (Randolph et al. 1994, 411) and a fence setup around the extent of disturbed ground found with the RADAR. Digging by the RIA in 1993 in a location 100 m west of the area that had been fenced uncovered more human remains. As a result, the additional area was fenced.

In December 2004 a GPR survey was commissioned by the Rottnest Island Authority (RIA) to properly define the extent of the Wadjemup Aboriginal cemetery. The survey was performed by Vern Wilson (URS Australia Pty Ltd) (Wilson 2005). It was considered at the time that this survey had established the extent of the cemetery by identifying some additional subsurface disturbance that was consistent with human burial and had identified areas *unlikely* to contain burials due to the low water table or surface limestone (Wilson 2005, 1–5).



GROUND PENETRATING RADAR THEORY AND METHOD

THEORY

GPR is a geophysical method where radio waves are transmitted into the earth from a set of antennae and any reflected waves are recorded (see Figure 1). The radio waves are reflected back to the surface if the ground shows a change in the dielectric constant. Changes in dielectric constant are due to differences in the amount of air and water in the soil, or the presence of metallic objects.

Figure 1: SWISS_RIA_2019_2019_03 Rottnest Lodge GPR Assessment – GPR and resultant radiogram



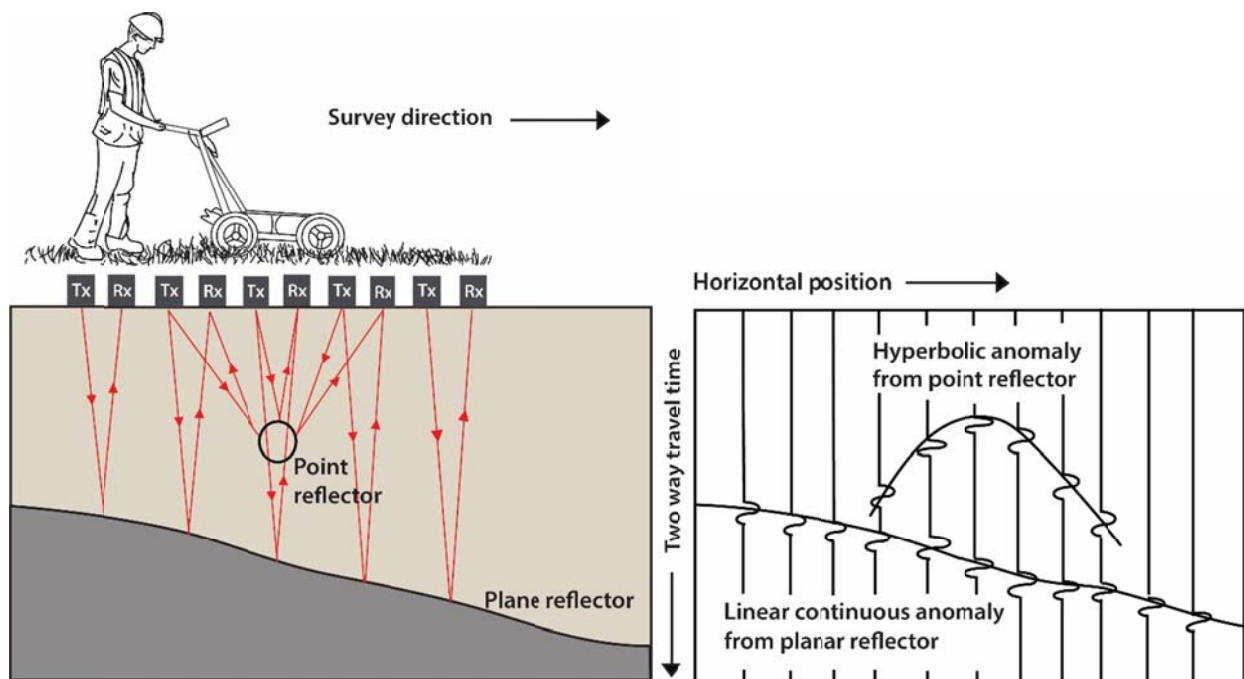
Depth Estimation

The GPR records the arrival of reflected waves in time. To get depth information, the velocity of radio waves must be known for the soil type. There are two ways this is commonly measured. One method is to perform a walkaway survey, where the RADAR antennae are moved apart by constant distance increments. This is the method Wilson used in his initial surveys in 1990 – 1992 (Wilson 1991a, 1991b, 1992, 1993). The second method is to fit a parabola to data from the survey area and a direct reading of ground velocity can be given from the acquisition software.

Theoretically Anomalies

A radio wave emitted from the RADAR transmitter antennae will travel in the ground, and if reflected, return to the receiver antennae. The travel time of the returned reflection depends on the distance the object is from the RADAR antennae. Therefore, when the antennae are some distance from the reflecting object, the travel time is long and the reflection will be plotted as a deep feature in the radiogram (see Figure 2). As the antennae move closer to the object, the travel time becomes shorter. Eventually when the antennae are directly over the object, the travel time will be the shortest. A characteristic hyperbolic shape is seen in the radiogram as a result. As the antennae are moved away from the object, the second part of the hyperbole is plotted. Note that continuous layers are readily imaged.

Figure 2: SWISS_RIA_2019_2019_03 Rottnest Lodge GPR Assessment – Radiogram from point reflector (Image courtesy of Scantech Geoscience)



Antennae Frequency

The nominal frequency of a RADAR antennae represents the centre frequency at which the radio energy will transmit. Practical Ground Penetrating RADAR operates at centre frequencies as low as 50MHz and as high as 1GHz. The transmitter frequency determines the penetration of the radio energy. A low frequency will penetrate further than a high frequency.

Resolution is also controlled by the centre frequency of the antennae. High frequency antennae resolve detail while low frequency antennae show poor resolution.

Antennae must be chosen to give enough penetration and resolution for the target depth of investigation.

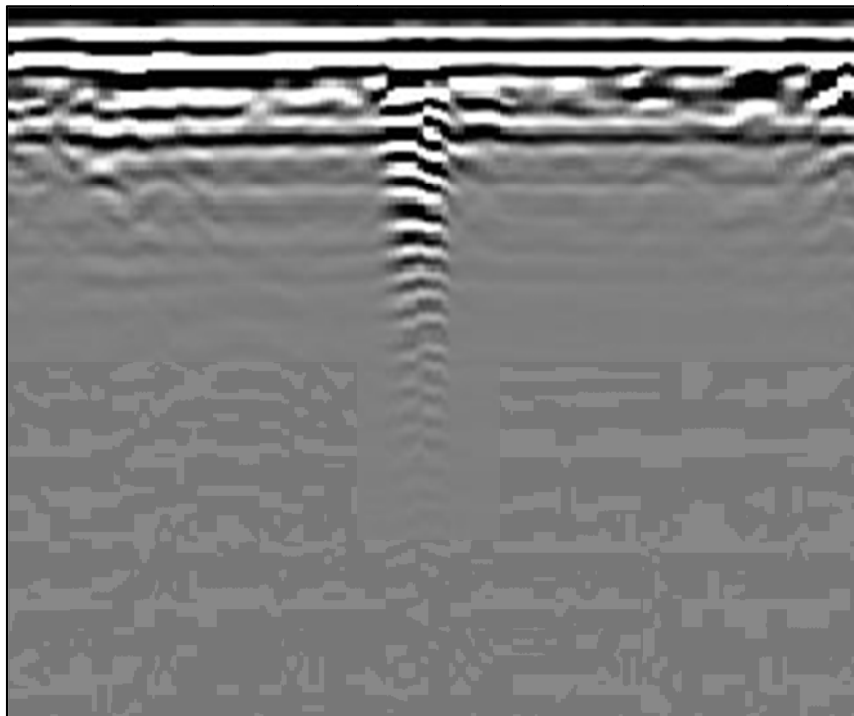
TYPES OF GPR ANOMALIES EXPECTED

A wide range of anomalies were expected around the Survey Area. These include services surrounding the buildings (water, gas, electrical), changes in surface conditions such as paths and roads, tree roots, geological structure within limestone and surface rubbish.

Metallic Pipes/Electrical Lines/Metallic Surface Rubbish

Due to the close proximity to buildings it was expected that the survey would locate pipes for water and drainage and electrical lines. Metallic pipes will give a characteristic ringing data and be a sharp anomaly over a short distance and are readily identified (see Figure 3). Discarded metallic objects on or in the near surface give similar responses.

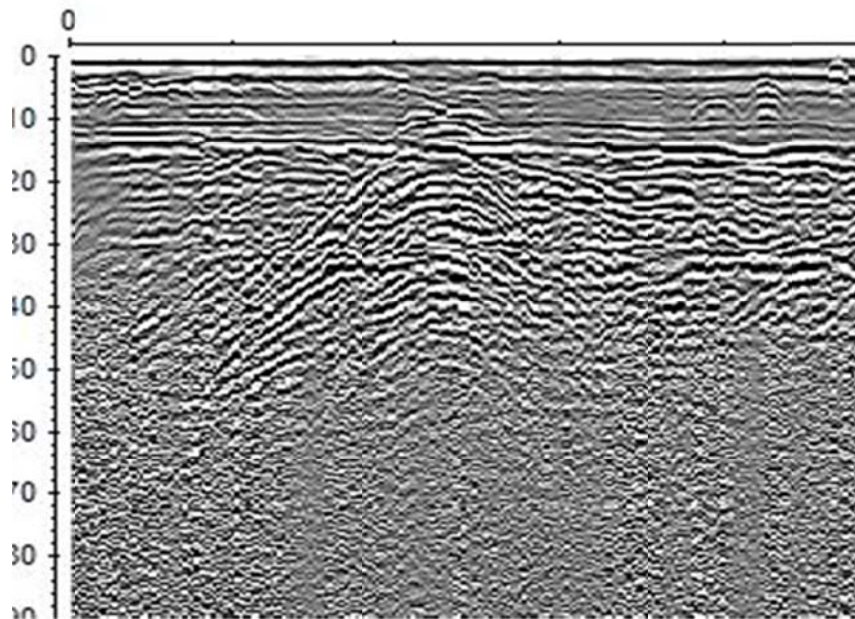
Figure 3: SWISS_RIA_2019_2019_03 Rottnest Lodge GPR Assessment – Ringing Data over a metallic pipe



Larger Drain Systems

Larger drainage systems will show a response from the edges of the trench as well as the pipe/pipes installed (see Figure 4). Such anomalies can be recognised as drainage or other major services due to their extent and linear shape when tracked over several lines of data.

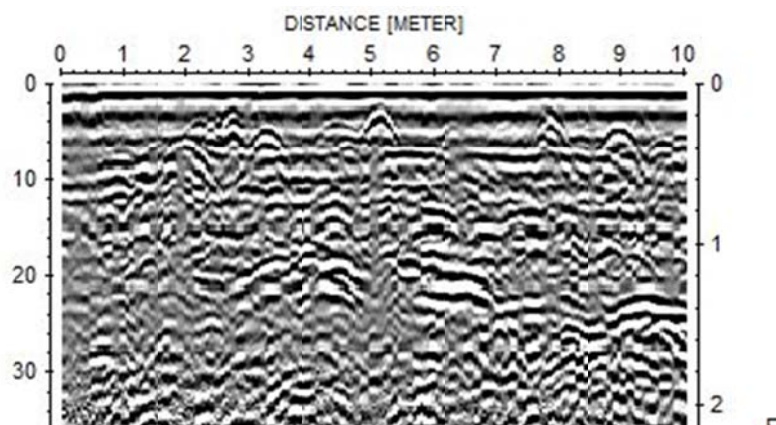
Figure 4: SWISS_RIA_2019_2019_03 Rottnest Lodge GPR Assessment – Response from larger drainage pipe/s



Tree Roots

The large number of trees around the site meant that tree roots would be readily imaged due to their water content. Tree roots are best identified by their proximity to trees; however, the small size of the anomaly associated with tree roots is also characteristic (see Figure 5).

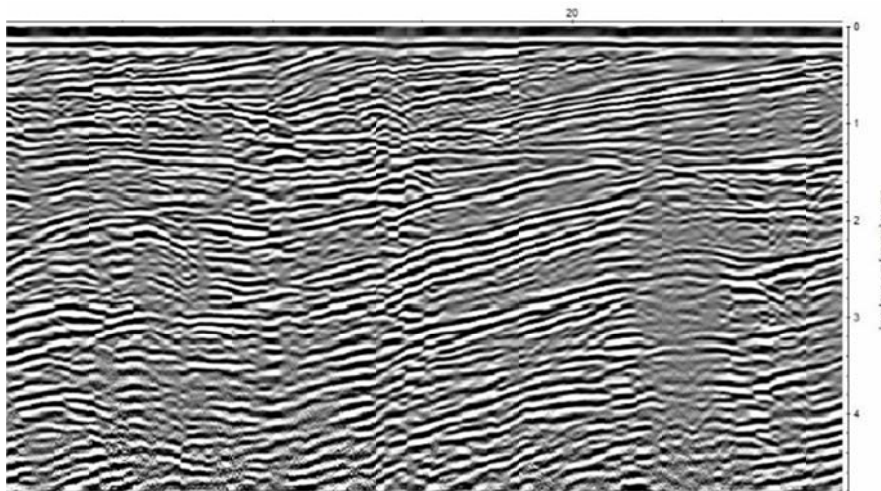
Figure 5: SWISS_RIA_2019_2019_03 Rottnest Lodge GPR Assessment – Tree roots at surface down to 400mm (scale to the right is depth in metres)



Limestone Structure

Limestone is formed by a bedding process where layers of sand are cemented in place. Limestone will show obvious bedding planes that can change direction depending on conditions when the sand is deposited (see Figure 6). Fractures in the limestone are common and can be seen as breaks in the layering.

Figure 6: SWISS_RIA_2019_2019_03 Rottnest Lodge GPR Assessment – RADAR response to limestone showing bedding and fracturing



GPR RESPONSES FROM WADJEMUP BURIALS

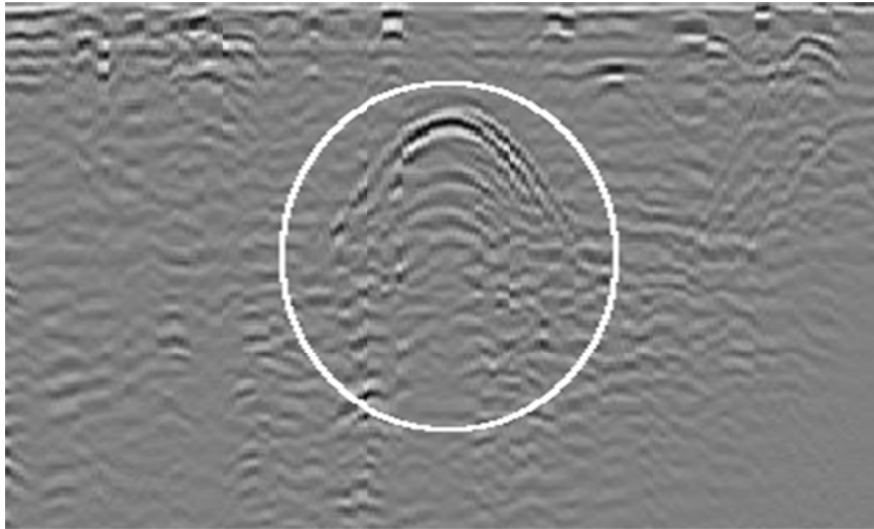
In order to recognise responses of burials, comparative data was collected over both the pioneer cemetery and the Registered Aboriginal Site Wadjemup Aboriginal Prisoners Cemetery (DPLH 3781). The pioneer cemetery has known burials that are easily located by the headstones, whereas the Wadjemup Aboriginal Prisoners Cemetery burials are unmarked and therefore cannot easily be located.

Pioneer graves

The first type of burial shows a series of hyperbola over a single location. Some evidence of layer disturbance can be seen (see Figure 7). The hyperbola is thought to be a response from the coffin.

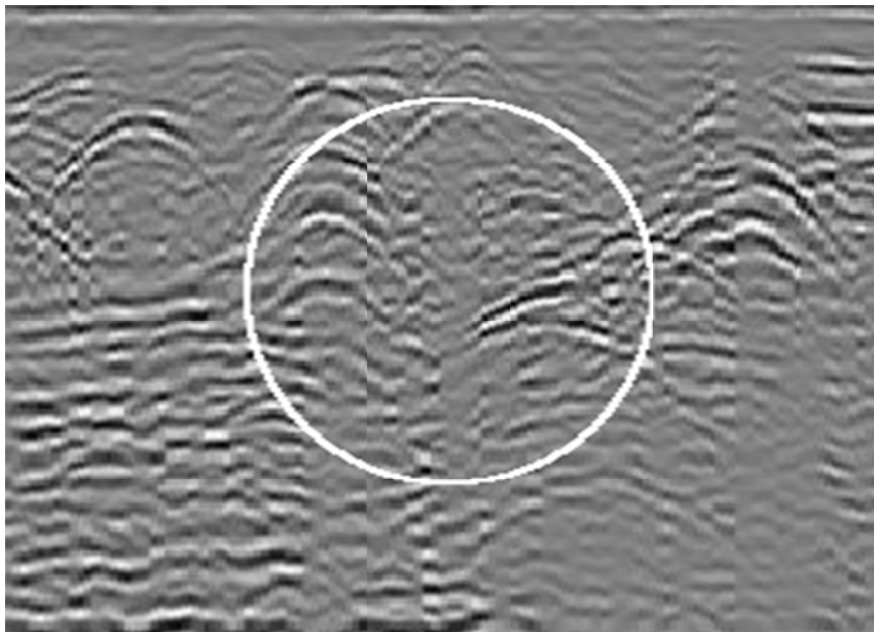


Figure 7: SWISS_RIA_2019_2019_03 Rottnest Lodge GPR Assessment – Response from Pioneer burial showing a series of hyperbola



The second type of burial in the pioneer cemetery shows much clearer evidence of trenching (see Figure 8). Hyperbola flank either side of the burial and little evidence of a response from the coffin is present.

Figure 8: SWISS_RIA_2019_2019_03 Rottnest Lodge GPR Assessment – Response from Pioneer burial showing obvious trenching

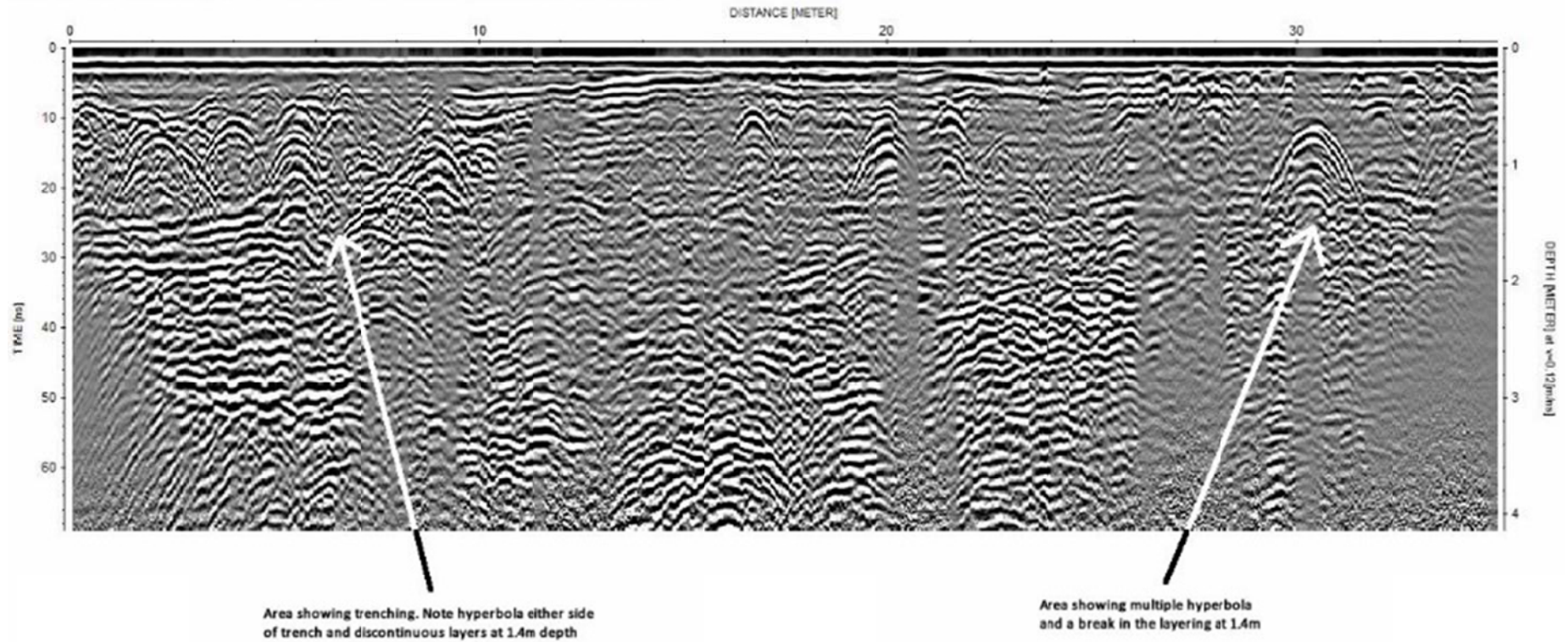


Wadjemup Cemetery

Several lines of data were acquired over the Wadjemup Aboriginal Prisoners Cemetery in order to find possible responses from burials. A prospective line is shown in Figure 9. Due to the fact that only a few profiles were collected, anomalies could be potentially from services as much as they could be from burials. However, the type of anomalies measured agree with the type of anomaly seen in the pioneer cemetery. The depths of the anomalies are also consistent with burial practices of the time.



Figure 9: SWISS_RIA_2019_2019_03 Rottnest Lodge GPR Assessment – Line of data from Wadjemup Cemetery



METHODOLOGY

Instrument

The RADAR used for the survey was a MALA Easylocator Pro Widerange – Dual Frequency (Plate 1). The instrument represents the latest advancements in RADAR technology. Of particular note is the extremely wide bandwidth of frequencies transmitted compared to other RADAR systems. The data show the benefits of low frequency penetration and high frequency resolution.

Digital stacking of the data means a high number of repeat measurements can be taken and averaged for every trace recorded. This increases signal to noise considerably. A nominal time window of 200nS which is ample time for reflections up to 6 meters to be imaged.

In addition, the Easylocator Pro Widerange has:

- a second low frequency antenna that collects data simultaneously with the high frequency antenna;
- an inbuilt GPS receiver so position can be logged; and
- an encoder on the cart wheel for accurate linear distance measurement.

Plate 1: SWISS_RIA_2019_2019_03 Rottnest Lodge GPR Assessment – MALA Easylocator Pro Widerange RADAR



Surveying Method

RADAR data must be collected in a grid pattern in order to differentiate linear features such as pipes etc from more discrete anomalies. The line spacing of the grid is chosen to ensure proper coverage of the ground depending on the type of object you are detecting. When surveying for burials, a line spacing of 0.5 m is appropriate. To ensure consistency of spacing of grid lines, tape measures were placed on the ground as a reference points (see Plate 2). A pink pin flag was used at each end as a visual guide.

Plate 2: SWISS_RIA_2019_2019_03 Rottnest Lodge GPR Assessment – Garden Lake showing tape measures for line spacing control

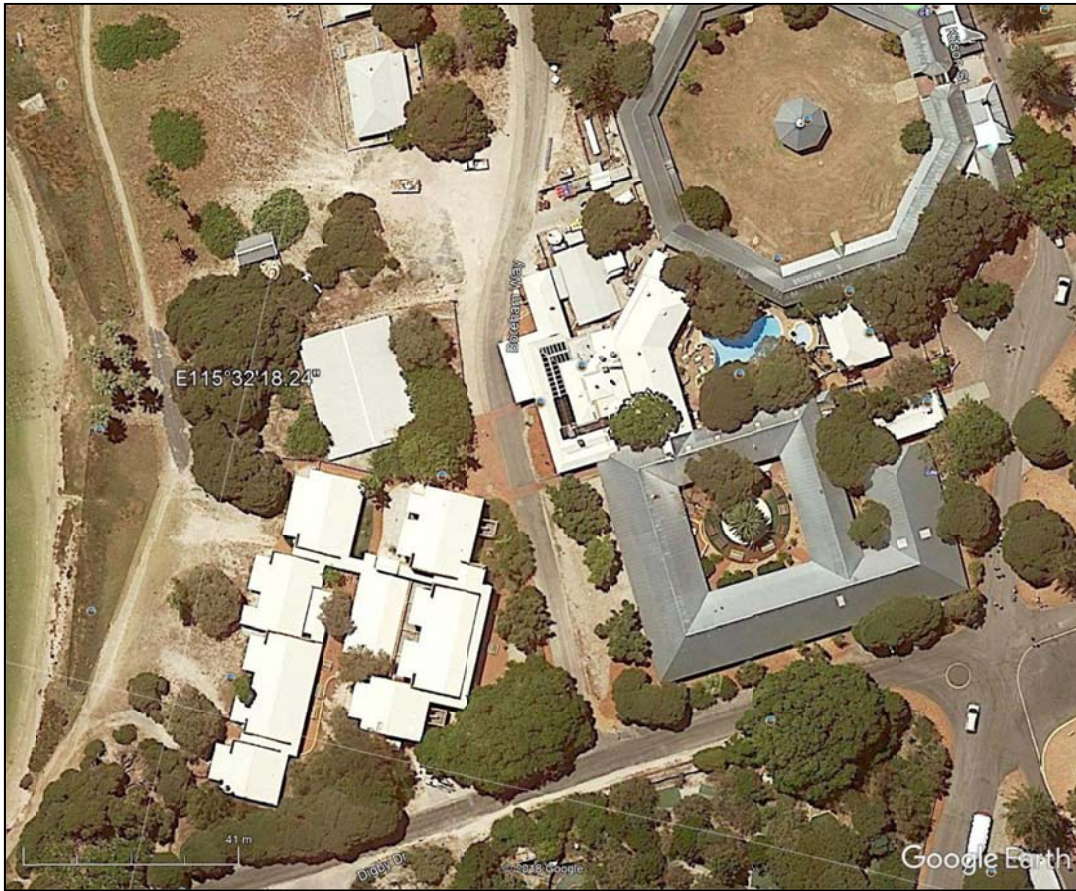


The linear encoder on the RADAR cart wheel was calibrated for the terrain and used to measure distance along the lines. The GPS is not accurate enough for this type of surveying. The GPS data was used to check the location of each line given the size of the site.

The Survey Area was divided into 13 areas that could be surveyed using grids of parallel lines (see Plate 3). Where a tree was encountered that couldn't be gone around, the RADAR was stopped, moved to the other side of the tree and a new line continued from that position. This was a particular problem in the Southern area of the site.



Plate 3: SWISS_RIA_2019_2019_03 Rottnest Lodge GPR Assessment - aerial photograph showing survey area



DATA INTERPRETATION

RADAR Velocity / Depth

The velocity of the radio waves at Wadjemup was measured to be 0.13m/nS by Vern Wilson in the previous RADAR surveys by using the walkaway method. This value was checked in this survey by identifying a point anomaly in the data and fitting it to a parabolic shape. The software calculates the velocity based on the shape of the parabola. A number of point anomalies were tested and all gave an agreement with previous work that the velocity can be estimated as 0.13m/nS.

Knowing the velocity of the radio waves enables a depth axis to be added to the radiogram. The depth of anomalies can therefore be found.

Classification of Anomalies

The majority of expected anomalies in the Survey Area were expected to be less than 1 m depth. These would include tree roots, services, surface rubbish and paths or roads. These anomalies were marked as "Shallow" on the RADAR sections and their position were logged.

It is assumed that any burials would occur at more than a meter depth, but not more than 2 m depth. Anomalies found between these two depths were marked as "Deeper" on the sections and their position were logged.

Data Processing

Due to the high quality of the data recorded, very little signal processing was done before interpretation. The start time of the record was adjusted and a suitable energy decay gain scheme was all that was needed.



SECTION TWO – RESULTS

THE SURVEY AREA

LOCATION

The Rottnest Lodge Redevelopment Area Survey Area is located immediately to the southwest of the Quod (DPLH Registered Site ROTTNEST ISLAND/QUAD, DPLH ID 3540) and the east of Garden Lake, approximately 350 m west of Thomson Bay, in the northwest of Wadjemup, Western Australia (see Map 1).

ENVIRONMENTAL CONTEXT

The Survey Area is located on the western margin of the Thomson Bay Settlement and is immediately east of Garden Lake. As such, the ground surface of the Survey Area comprises a mix of sealed roads and walkways, buildings and limestone gravels with some sections of introduced grasses and occasional native trees and shrubs including Rottnest Island Tea Tree (*Melaleuca lanceolata*) and Rottnest Island Pine (*Callitris preissii*).

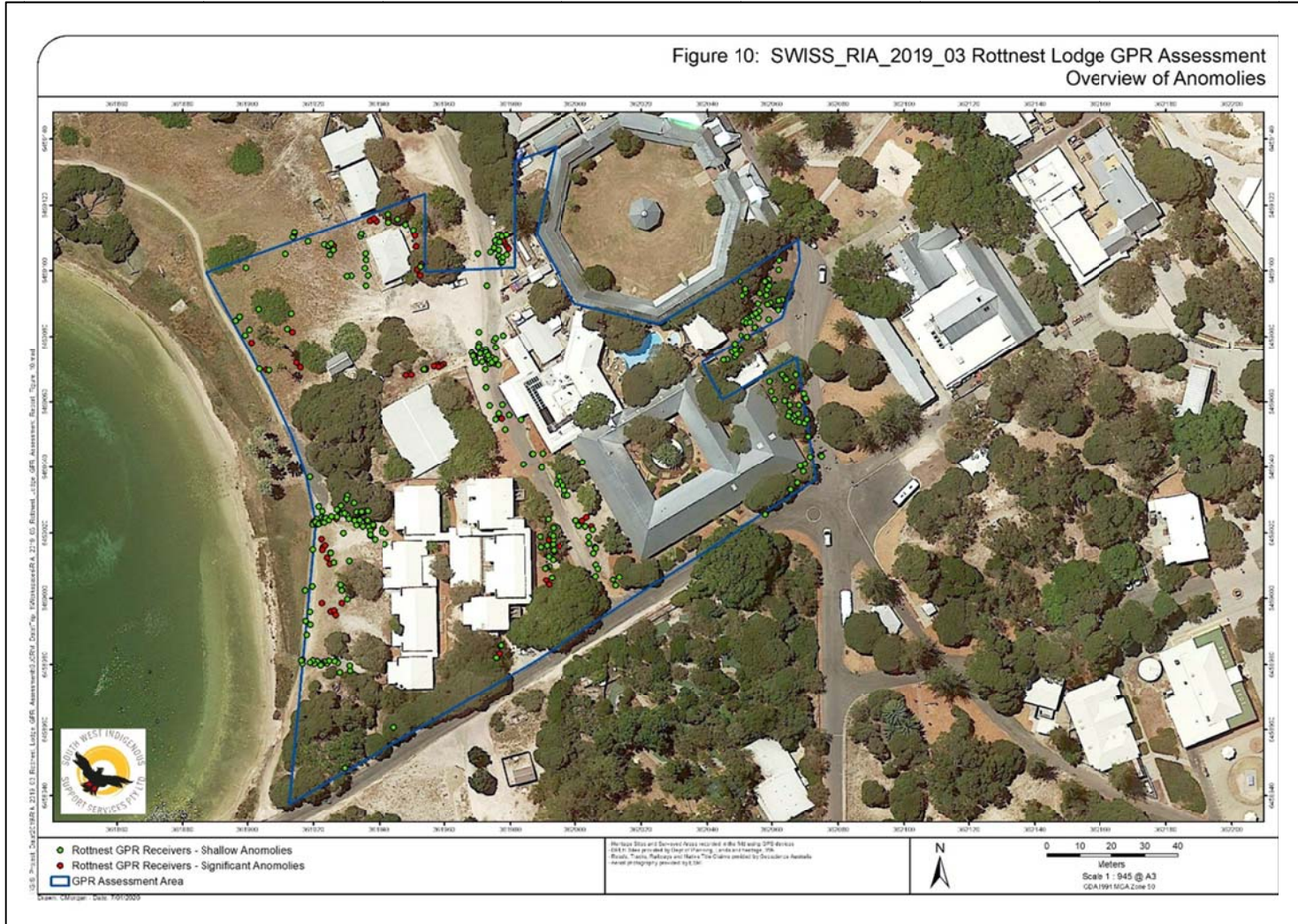
GROUND PENETRATING RADAR RESULTS

OVERVIEW OF ANOMALIES

An overview plan map of the entire site is shown in Figure 10. Green circles indicate shallow anomalies and red circles indicate significant anomalies between 1 m and 2 m.



Figure 10: SWISS_RIA_2019_2019_03 Rottnest Lodge GPR Assessment – Overview map of Survey Area, showing interpreted anomalies. Green circles indicate shallow anomalies and red circles indicate significant anomalies between 1 m and 2 m



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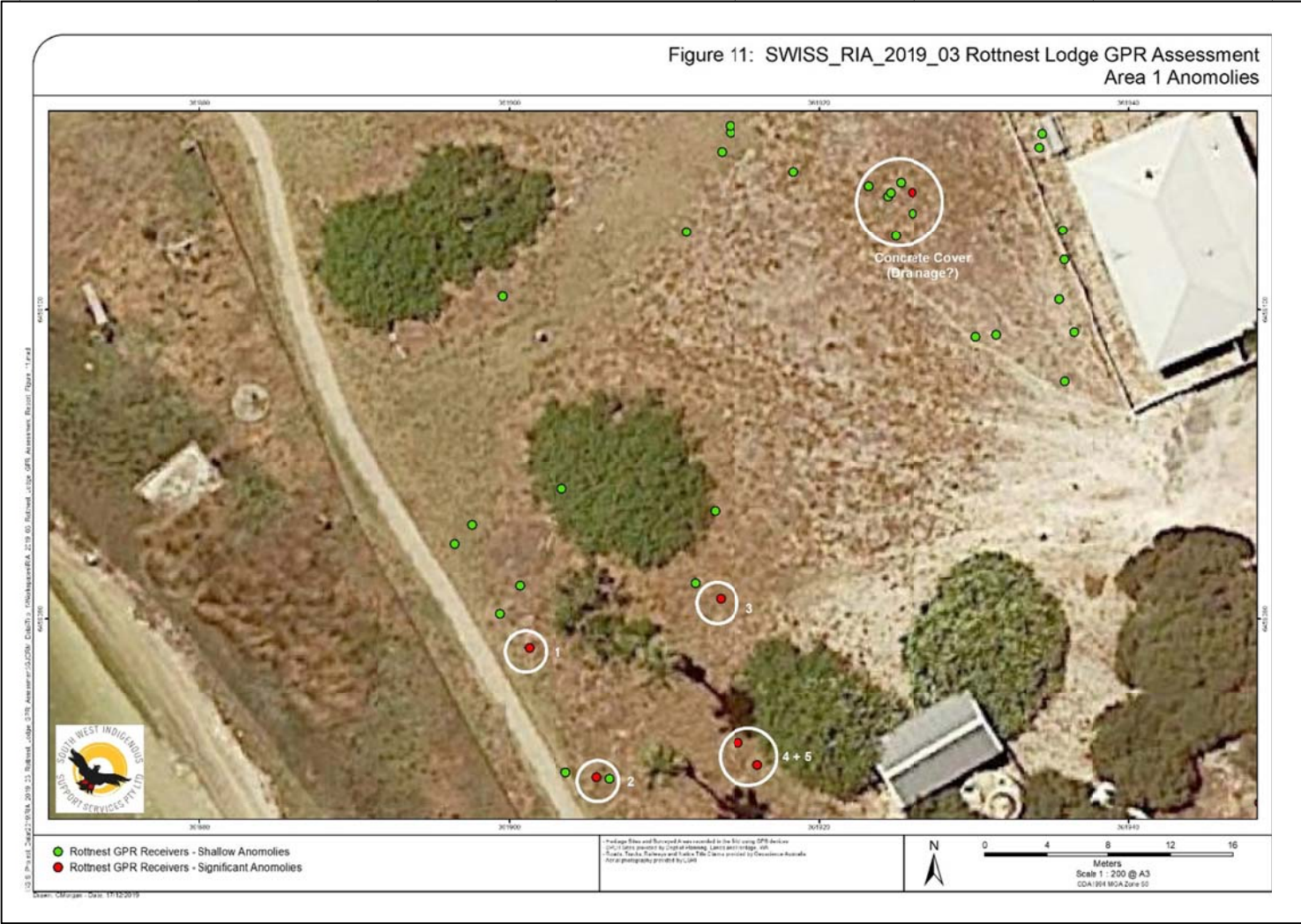
Detailed Analysis – Area 1

The north east corner of the survey area is an area historically used for a vegetable garden and keeping of livestock. Figure 11 shows the area with interpreted anomalies marked. The anomalies near the house appear to be some sort of structural feature within the hard limestone. A concrete structure gave rise to a deep anomaly and is possibly drainage related.

A set of anomalies, numbered 1 – 5 in Figure 11, are near to the shore of Garden lake. The source of the anomalies is unclear and they are discussed further below.



Figure 11: SWISS_RIA_2019_2019_03 Rottnest Lodge GPR Assessment – Area 1, showing interpreted anomalies. Green circles indicate shallow anomalies and red circles indicate significant anomalies between 1 m and 2 m



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Figure 12 shows the line of data with anomalies 1 and 2. Both anomalies are just over 1.5 m deep. Anomaly 2 shows signs of trenching.

Figure 12: SWISS_RIA_2019_2019_03 Rottnest Lodge GPR Assessment – Area 1, Anomalies 1 and 2

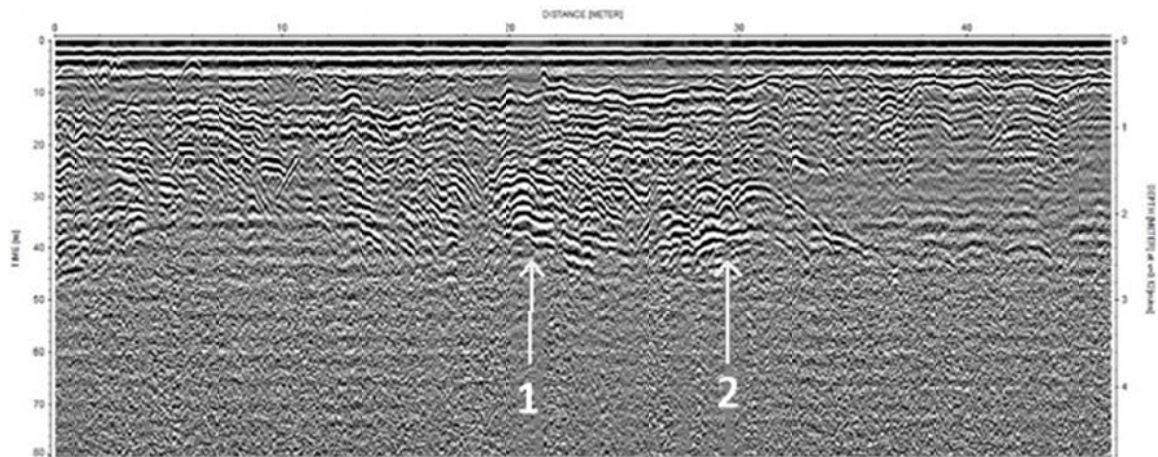


Figure 13 shows the line of data with anomaly 3. A disruption of the layers above the anomaly is evident.

Figure 13: SWISS_RIA_2019_2019_03 Rottnest Lodge GPR Assessment – Area 1, Anomaly 3

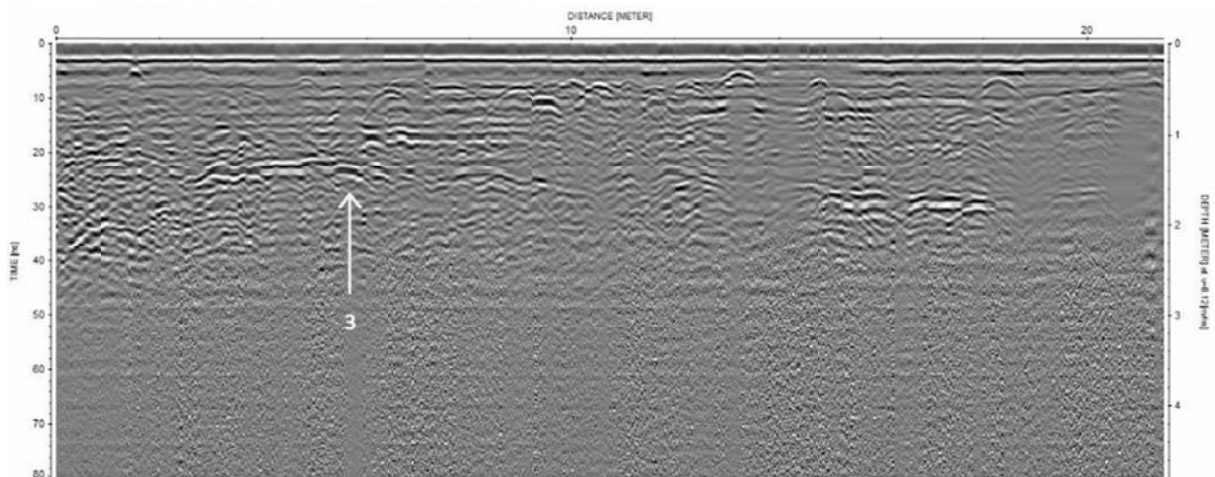
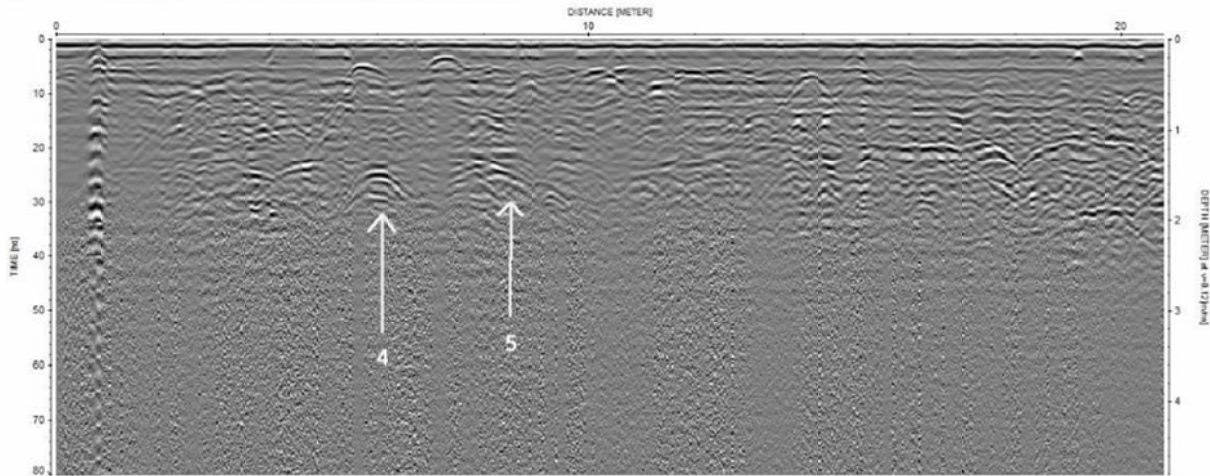


Figure 14 shows the line of data with anomalies 4 and 5. Anomaly 4 shows a response from the top and bottom of the object.

Figure 14: SWISS_RIA_2019_2019_03 Rottnest Lodge GPR Assessment – Area 1, Anomalies 4 and 5



Detailed Analysis - Area 2

Area 2 is the South West corner of the survey area. It consists of an open area adjacent to Garden Lake and a heavily wooded area to the South of that (see Figure 15). Very little response was obtained from under the wooded section and the results from this section has been omitted from the analysis.

Drainage was imaged on the north and south of the open grassed area. The northern drainage passes through a concrete structure on the surface which is clearly part of the system. The Southern drainage has no surface features but does appear to drain into Garden Lake.

The sealed path gave shallow anomalies which can be ignored.

Two sets of anomalies grouped together here as anomaly 6 and anomaly 7 (see Figure 15, Figure 16). These are clusters of narrow anomalies and appear to represent short trenches. The source of these anomalies is unclear. The depth below ground surface of both these anomalies is 1.2 m. Given the linear extent, shallow depth and narrowness of the anomalies, it is unlikely they are associated with a burial. It is possible that these are disturbances related to the Lodge Manager's house, a building that was located in the area and was relocated during the 1980s when the adjacent accommodation buildings were constructed. The footprint of the Lodge Manager's house is shown in the south west corner of the Survey Area in Map 1 and is labelled as 'building'. Anomaly 7 is particularly close to the footprint of this building.

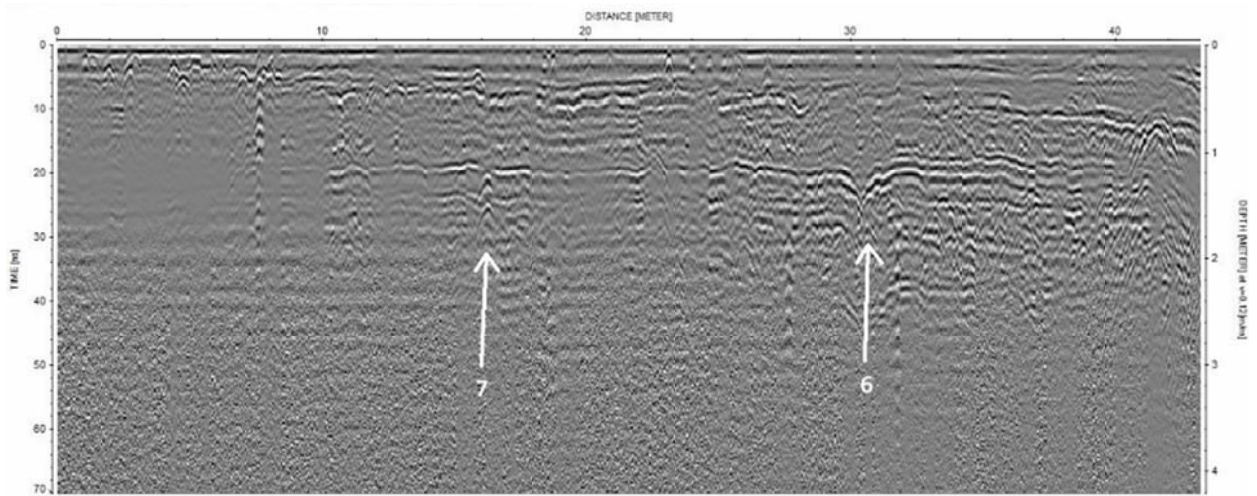


Figure 15: SWISS_RIA_2019_2019_03 Rottnest Lodge GPR Assessment – Area 2, showing interpreted anomalies. Green circles indicate shallow anomalies and red circles indicate significant anomalies between 1 m and 2 m



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Figure 16: SWISS_RIA_2019_2019_03 Rottnest Lodge GPR Assessment – Area 2, Anomalies 6 and 7



Detailed Analysis - Area 3

Area 3 is adjacent to the Quod in the north part of the site. It is raised up above the shore of Garden Lake on a limestone outcrop (see Figure 17). A series of deep anomalies, 1 m depth, extend roughly North South adjacent to the wall of the Quod. The depth indicates it might be some sort of drainage or other subsurface infrastructure. Several shallow anomalies run parallel to the road in this same area (Figure 17). This is interpreted to be an extension of the excavations associated with the 1 m deep trench. The shape of the anomalies suggests pipes and thus could be associated with drainage.

A few deeper anomalies were found in the house at the north west corner of Area 3. Most are interpreted as tree roots; however, three anomalies stand out in the centre of the backyard (labelled Anomaly 8). These have been interpreted as a possible soak well (Figure 18).

The southern part of Area 3 shows linear features interpreted as drainage. This is consistent with surface features such as pipes from buildings. In addition, a large water tank exists to the west of the interpreted drainage.



Figure 17: SWISS_RIA_2019_2019_03 Rottnest Lodge GPR Assessment – Area 3, showing Interpreted Anomalies. Green circles indicate shallow anomalies and red circles indicate significant anomalies between 1 m and 2 m



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Figure 18: SWISS_RIA_2019_2019_03 Rottnest Lodge GPR Assessment – Area 3, Multiple Anomalies between the Road and Quod

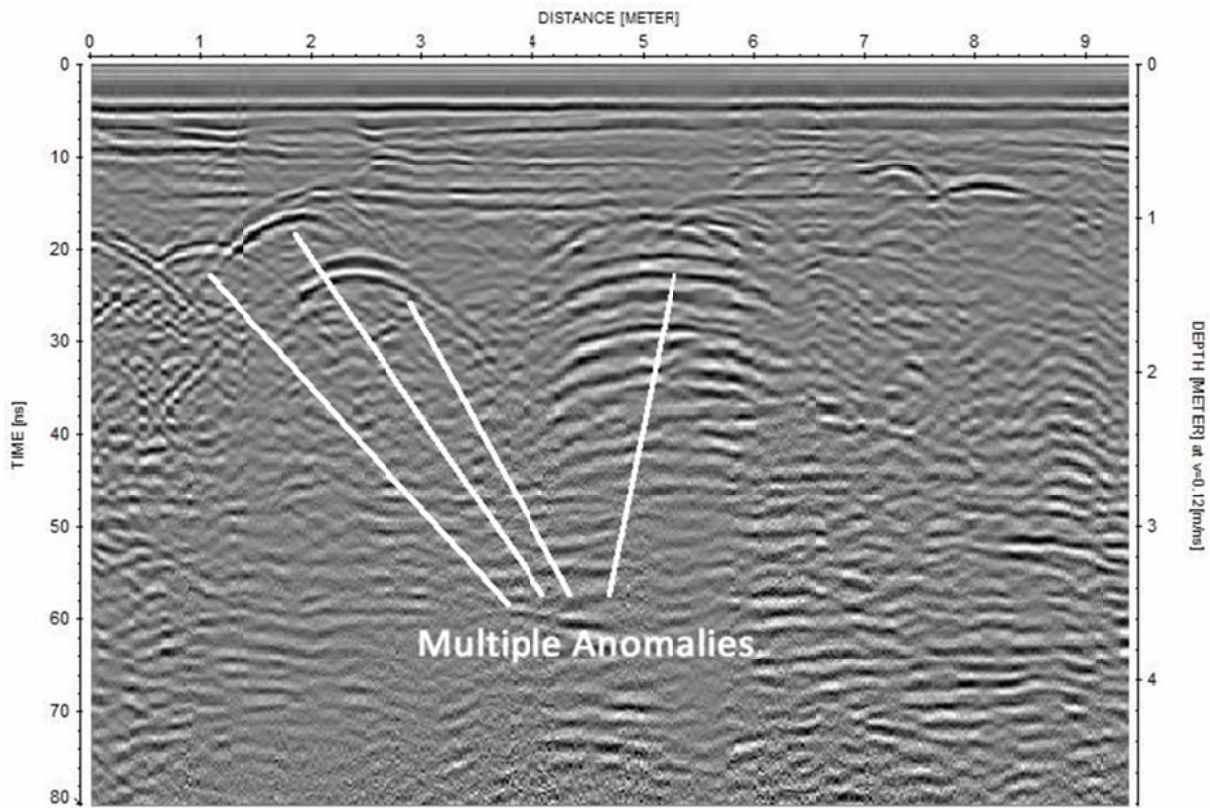
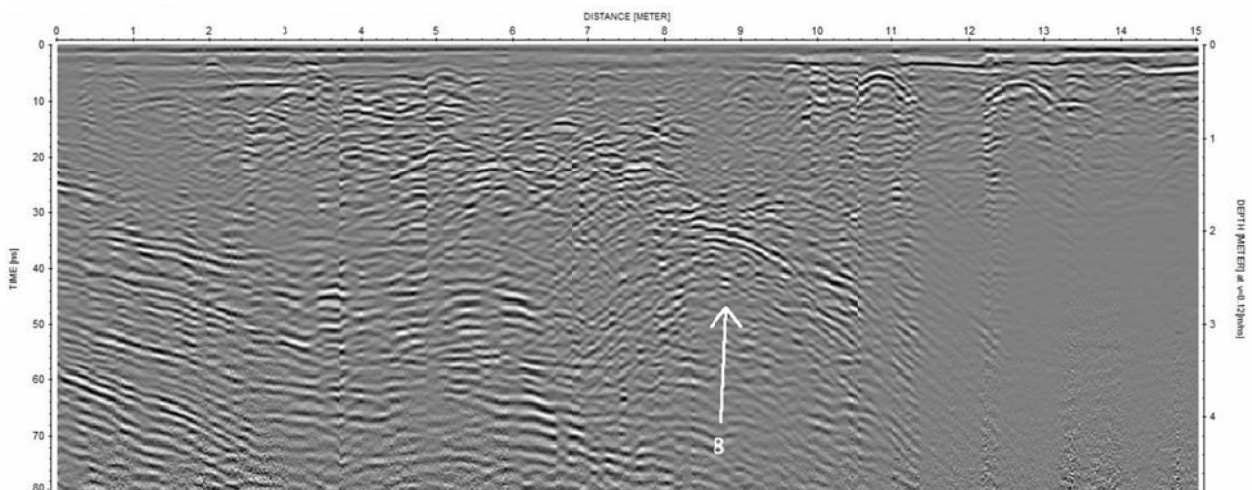


Figure 19: SWISS_RIA_2019_2019_03 Rottnest Lodge GPR Assessment – Area 3, Anomaly 8, Interpreted to be a possible soakwell



Detailed Analysis - Area 4

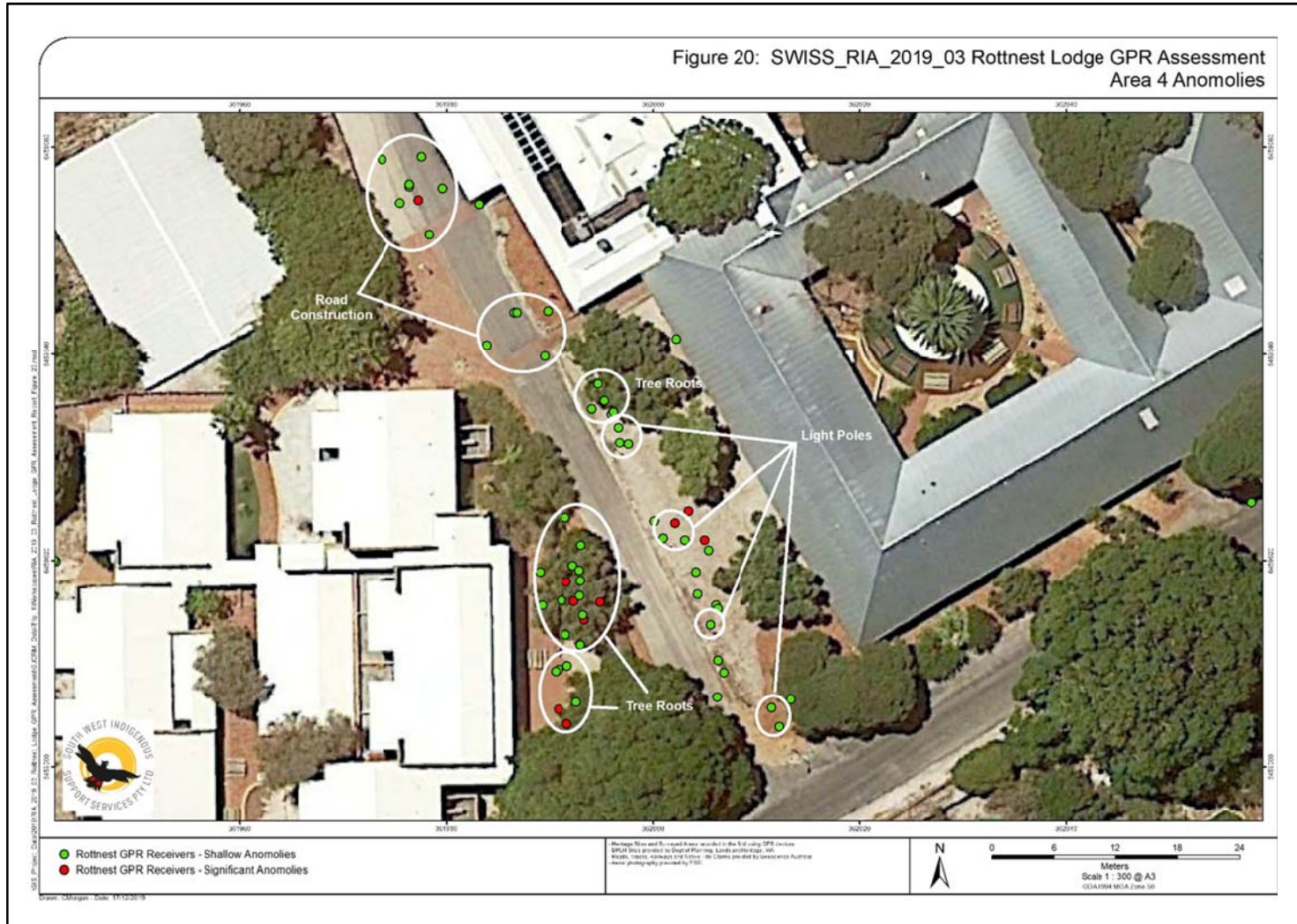
Area 4 is bounded by the boys Reformatory to the east and the accommodation to the west. A road runs through the centre of the area roughly north to south. The eastern side of the road contains several light poles (see Figure 20).

Anomalies found on the road in the northern part of Area 4 are interpreted to be part of the road construction as they primarily occur on the edge of the road. Changes in velocity due to the tarmac produce anomalies that appear deeper on the radiogram. The deep anomaly in the north of Area 4 is an example of this.

The courtyard of the accommodation to the west of Area 4 is dominated by large trees with extensive root systems. The large number of anomalies in this area are attributed to the root systems of the trees. Between the road and the Boys Reformatory in the garden bed, anomalies coincide with the position of the light poles. A large number of tree roots can be observed on the surface. Any anomaly not associated with the light poles would be a tree root. The three deeper anomalies marked are at 1 m depth and most likely cabling for the light poles.



Figure 20: SWISS_RIA_2019_2019_03 Rottnest Lodge GPR Assessment – Area 4, showing Interpreted Anomalies. Green circles indicate shallow anomalies and red circles indicate significant anomalies between 1 m and 2 m.



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Detailed Analysis - Area 5

Area 5 is the area east of the Boys Reformatory and south of the Quod (see Figure 21). The area leading into the Karma Lodge reception shows linear features consistent with electrical or water services. Just to the north of that are anomalies interpreted as tree roots. These anomalies do show some linear trends consistent with services. Interpretation of them is difficult due to tree roots also present.



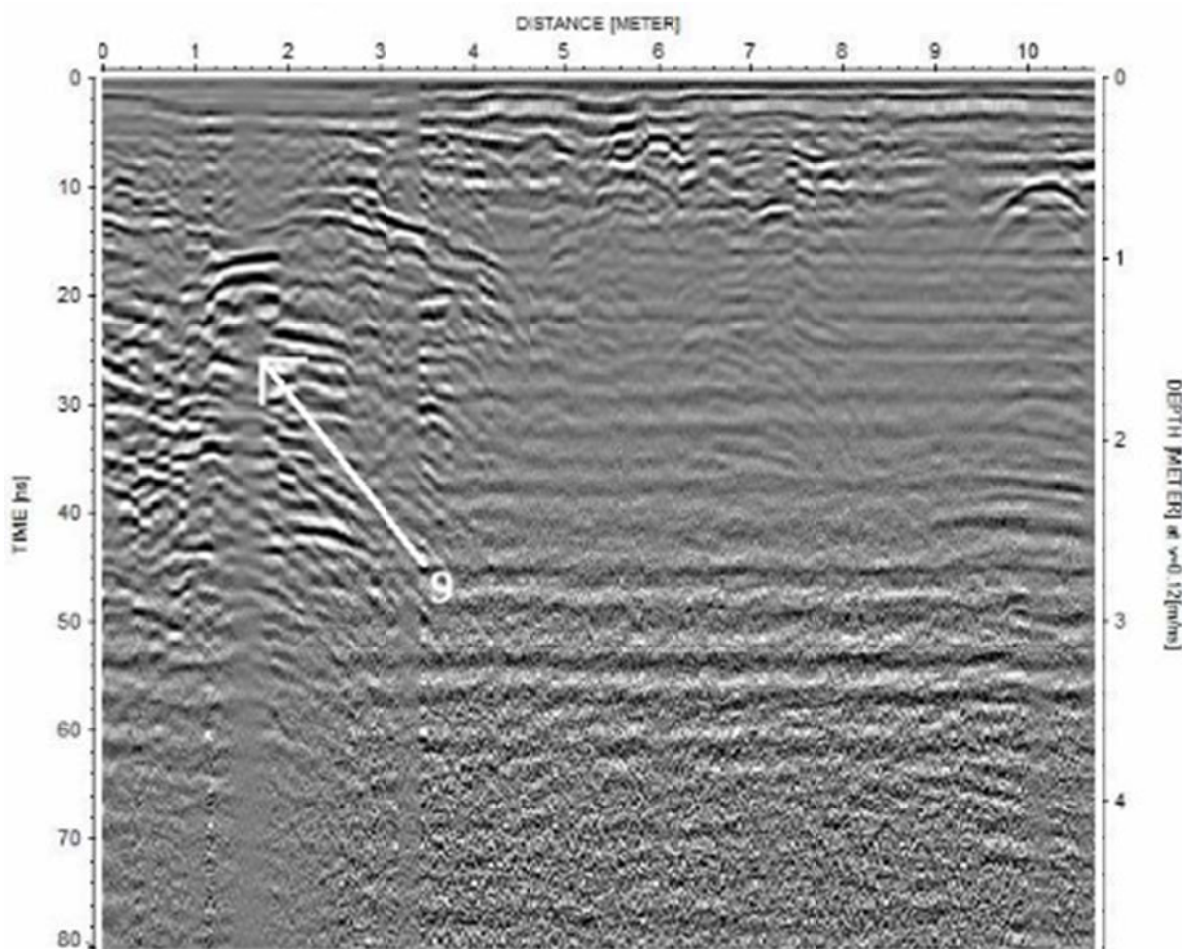
Figure 21: SWISS_RIA_2019_2019_03 Rottnest Lodge GPR Assessment – Area 5, Showing Interpreted Anomalies. Green circles indicate shallow anomalies and red circles indicate significant anomalies between 1 m and 2 m



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The area in front and to the side of the Boys Reformatory shows many anomalies due to tree roots. There is a deeper anomaly interpreted as drainage near the road (see Figure 22). The depth is just over 1 m and shows a tabular shape.

Figure 22: SWISS_RIA_2019_2019_03 Rottnest Lodge GPR Assessment – Area 5, Anomaly 9 near road interpreted as drainage or a soak well



SUMMARY AND CONCLUSIONS

A Ground Penetrating RADAR survey of Survey Area was completed. Ground Penetrating RADAR provided an effective means to image subsurface objects around the Rottneest Lodge Redevelopment Survey Area. With advancements in RADAR technology, the MALA Easylocator Pro Widerange shows superior signal to noise data compared to previous technology. Urban sites require RADAR with shielded antennae to reduce the amount of surface reflections from above ground objects. The MALA Widerange shows very good rejection of above ground objects. Coupled with its widerange bandwidth it gives impressively clean data.

It was anticipated that a Ground Penetrating RADAR of an area with trees and subsurface infrastructure services such as water and electricity would be dominated by anomalies related to these ground disturbing activities. This has been the case in the Rottneest Island Lodge Redevelopment Survey Area. However, some features are present in areas where interference from trees or infrastructure services are not present. In particular, the anomalies in Area 1 numbered 1-5 (shown in Figure 11) and Area 2 numbered 6 and 7 have no obvious explanation.

It should be noted that a report prepared by the then Department of Aboriginal Sites at the Western Australian Museum by Randolph and Vinnicombe (1989, 3) quoted a pers. comm. from a source with 'considerable historic knowledge' who stated that there was an 'earlier' Aboriginal burial ground near a former pig sty located to the north of Garden Lake, i.e., that was not encompassed within the boundary of the Wadjemup Aboriginal Prisoners Cemetery (DPLH ID 3781). As outlined above, the existence of a second earlier cemetery was also mentioned by W.H. Timperley, Superintendent of the prison 1884-1890, who stated that the outbreak of influenza in 1883 led to the closing of one cemetery dedicated to Aboriginal prisoners and the opening of another (Timperley 1885). The area that Randolph and Vinnicombe (1989, 14-16) suggest might be the location of the earlier Aboriginal cemetery is stated as being 50-100 m north of the Lodge extensions, some of which can be seen in Figure 15. The anomalies in Area 1 numbered 1-5 are therefore located within the area of the possible earlier Aboriginal prisoner cemetery.

There are some factors that could be considered to undermine the interpretation of the area where anomalies 1-5 were recorded as the location of an earlier Aboriginal prisoner cemetery outside the boundary of the Wadjemup Aboriginal Prisoners Cemetery (DPLH ID 3781). Firstly, the area that Randolph and Vinnicombe (1989) suggest might be the location of the earlier cemetery features a limestone subsurface. Although limestone is a relatively soft sedimentary rock, it would require significant time and effort to dig a 1-2 m deep hole in this material. The fact that Aboriginal prisoners were forced to dig the graves, and that the Superintendent at the time was almost certainly the sadistic Henry Vincent, may mean that the difficulty of the task was irrelevant. Secondly, it is assumed that the anomalies detected by the Ground Penetrating RADAR in the area of interest (anomalies 1-5) are on or very near the water table. We suggest that it is unlikely that human remains would have been buried in contact with the water table given the potential for contamination of the available potable water.

The anomalies identified in Area 2 grouped together as anomaly 6 and anomaly 7 are located approximately 25 m to the south east of anomalies 1-5. As such, they would appear to be slightly outside of the area suggested by Randolph and Vinnicombe (1989) as a possible location for the earlier Aboriginal prisoner cemetery. Nevertheless, the anomalies are at the depth of interest and share some characteristics with known burial anomalies. It is possible that these are disturbances related to the Lodge Manager's house, a building that



was located in this general area and was relocated during the 1980s when the adjacent accommodation buildings were constructed.

In any case, we caution that the Survey Area has been in use for around 180 years with a variety of activities undertaken here over that time and that, without a systematic ground disturbing excavation, we can only speculate on what these anomalies represent.

In conclusion, no definite burial sites were imaged in the Survey Area. Signatures of burials from the Pioneer and Wadjemup cemeteries were imaged to provide an understanding of what a burial might look like. None of the anomalies recorded during this survey produced a match with the known burial RADAR profiles. As outlined above, however, some of the anomalies identified in Area 1 (anomalies 1-5) are located within an area that has been previously identified as a possible location of an earlier Aboriginal prisoner cemetery than that of the Wadjemup Aboriginal Prisoners Cemetery (DPLH ID 3781) Randolph and Vinnicombe (1989, 14-16). Similarly, the anomalies identified in Area 2 and grouped together as anomaly 6 and the nearby anomalies grouped together as anomaly 7, are located approximately 25 m to the south east of anomalies 1-5 and might also represent burial locations.



FINAL RECOMMENDATIONS

It is **recommended** that Rottnest Island Authority ensure that its employees and contractors (as appropriate) are:

1. advised that a ground penetration RADAR survey of the Rottnest Lodge Redevelopment Survey Area has been **completed**;
2. advised that **no** definite burial sites were identified during the Survey;
3. advised that **seven (7)** anomalies with no obvious explanation were identified during the Survey (Area 1, anomalies 1-5 and Area 2, anomaly 6 and anomaly 7);
4. advised that, although the anomalies recorded in Area 1, numbered 1-5, do not match the signatures of known burials from the Pioneer and Wadjemup cemeteries, they are located within an area that has been previously identified as a possible location of an earlier Aboriginal prisoner cemetery than the Wadjemup Aboriginal Prisoners Cemetery (DPLH ID 3781) (Randolph and Vinnicombe 1989, 14-16);
5. advised that, the anomalies in Area 2 grouped together as anomaly 6 and those grouped together as anomaly 7 do not match the signatures of known burials from the Pioneer and Wadjemup cemeteries but are located within 25 m of an area that has been previously identified as a possible location of an earlier Aboriginal prisoner cemetery than the Wadjemup Aboriginal Prisoners Cemetery (DPLH ID 3781) (Randolph and Vinnicombe 1989, 14-16);
6. advised that no ground disturbing activities below a depth of 30 cm should take place within 2.5 m of anomalies 1-5 in Area 1;
7. advised that no ground disturbing activities below a depth of 30 cm should take place within 2.5 m of the anomalies grouped together as anomaly 6 and anomaly 7 in Area 2;
8. advised that any ground disturbing activities below a depth of 30 cm between 2.5 and 10 m of anomalies 1-5 in Area 1 be undertaken with extreme caution;
9. advised that any ground disturbing activities below a depth of 30 cm between 2.5 and 10 m of the anomalies grouped together as anomaly 6 and anomaly 7 in Area 2 be undertaken with extreme caution;
10. advised that Rottnest Island Authority should ensure that a Cultural Heritage Management Plan is prepared for the location of anomalies 1-5 in Area 1 and the location of the anomalies grouped together as anomaly 6 and anomaly 7 in Area 2; and
11. advised that Rottnest Island Authority and the Whadjuk People should undertake further consultation regarding the progress of the proposed activities.



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