Deebing Creek Mission Cemetery, Deebing Heights, QLD
Ground Penetrating Radar Investigation

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Contents

EXECUTIVE SUMMARY.................................................................................................................................................1
1.0 INTRODUCTION.......................................................................................................................................................2
2.0 METHODS..................................................................................................................................................................5
   2.1 GPR Theory..........................................................................................................................................................5
   2.2 Ground Penetrating Radar ...............................................................................................................................5
3.0 RESULTS..................................................................................................................................................................6
4.0 CONCLUSION AND RECOMMENDATIONS........................................................................................................10
5.0 REFERENCES...........................................................................................................................................................11
Figures

Figure 1 Location of GPR survey. .................................................................3
Figure 2 Amplitude slice maps from 800MHz antenna.........................................................6
Figure 3 Amplitude slice maps from 300MHz antenna.........................................................7
Figure 4 800MHz antenna overlay image 50-130 cmbs with interpretation..............................8
Figure 5 Typical radargram for an area that is undisturbed. ..................................................9
Figure 6 Radargram for area interpreted to have burials. .......................................................9
Executive Summary

RPS was engaged by the Department of Aboriginal and Torres Strait Islander Partnerships to undertake a ground penetrating radar (GPR) survey at the Deebing Creek Mission cemetery near Deebing Heights, QLD. The survey was conducted for the purpose of identifying the location of unmarked burials believed to exist within the cemetery lot.

The GPR survey has successfully imaged an area where burials associated with the Mission are likely to occur though the location of individual burials is not currently possible. The burial area appears to extend to and likely across the northern boundary, but, appear to be restricted to the eastern half of the gazetted cemetery lot.

Any future works in these areas should fully consider the results of this survey. Ground disturbing activities should proceed with caution and stop if archaeological and/or human remains are discovered.

**Recommendation 1**

Future ground disturbing works in the eastern portion of the cemetery as gazetted should be avoided as this area is most likely to contain human burials.

**Recommendation 2**

If continued use of the cemetery is to occur, future activities are least likely to disturb unmarked extant burials in areas of no GPR reflection (blue areas of above figures).

**Recommendation 3**

If following a principle of avoidance is to be implemented, ground disturbance should not occur anywhere strong GPR reflections occur (orange and red anomalies in above figures).

**Recommendation 4**

As it appears that the burial area extends into the adjoining property to the north, additional GPR investigation in this area should occur if ground disturbance is proposed, or if the full extent of the cemetery is to be identified.
1.0 Introduction

RPS was engaged by the Department of Aboriginal and Torres Strait Islander Partnerships (DATSIP) to undertake a ground penetrating radar (GPR) survey at the Deebing Creek Mission cemetery near Deebing Heights, QLD. A GPR survey has been implemented to image the subsurface with the intent of identifying unmarked human burials to inform the long term management of the cemetery. The GPR survey has identified an area where human burials exist, but, a determination of individual burials is not currently possible.

Deebing Creek Mission is listed on the Department of Environment and Historic Protection (DEHP) Queensland Heritage Register (Place ID 602251). It was listed due to significance under Criterion A, C and G, as it illustrates patterns in Queensland history, holds the potential to inform our understanding of Mission life and burial practice and is an important place for Aboriginal Peoples. The register entry also indicates the mission was officially used from 1892-1915, but, early work to establish a mission in the area may have begun as early as 1887. It also asserts that possibly as many as 13 burials occurred in the cemetery. Some of these were marked by cairns (none appear to remain today) and a headstone for Mrs Julia Ford remains.

A report detailing the history of the cemetery (Cook 2015) indicates somewhere between 63 and 231 graves may be located within the cemetery. She also indicates that it is unclear if all of these are within the current fenced boundary, or if some burials are located outside the gazetted boundaries. Estimations of the number and location of unmarked graves appears be based on oral tradition as no burials records for the Mission have been relocated. However, there are known burials from 2009 and 2015 and a cremation burial from 2015 present (Cook 2015:11).

Previous geophysical investigation of the site is reported by Stanley (1985). He conducted a magnetometer survey with a data density of 4 readings per m², suitable for identifying human graves (and a substantial amount of work with the equipment available at time). It should be noted that today it would be common to have 16 readings per m². He concluded that modern metal adversely affected his survey, but, there was a small possibility that the magnetometer was able to detect the location of human burials. Unfortunately, the precise location of his surveys are not known eliminating the possibility of comparing them to the current GPR results.

The GPR survey was performed 13 March 2016 and was led by Aaron Fogel (Senior Geomatics Specialist). Data processing, imaging and reporting was completed by Aaron Fogel. Stephen Nichols (DATSIP) and Christine Medved (DATSIP) were present throughout the survey. Louise Bonner and members of her family were present for part of the survey.

The survey area is west of Deebing Creek and north of the Centenary Highway, Lot 228 CC290, Ipswich City Shire (Figure 1). The area slopes upward away from the creek and is covered with manicured lawn and a few sporadic trees (Plate 1 and 2). Vegetation management had occurred prior to the survey creating a relatively smooth and uniform surface suitable for GPR data collection. The survey area is an irregular polygon with a maximum width of 75 metres (approximately east-west) and maximum length of 37 metres (approximately north-south). GPR data were collected throughout the entire area excluding areas where survey was prevented by above ground features. This included a large area on the western margin of the property due to buildings, rubbish and areas disturbed by erosion/tracks. Along the northern margin of the property a few trees and a trailer prevented survey. Lastly, for cultural reasons, one small area where a recent human burial occurred was also not surveyed.
Deebing Creek Mission Cemetery, Deebing Heights, QLD
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Figure 1 Location of GPR survey.
Plate 1 Looking northeast at the survey area.

Plate 2 Looking southwest at the survey area with extant headstone in foreground.
2.0 Methods

2.1 GPR Theory

GPR is an active method of geophysical investigation. That is, the instrument actively emits electromagnetic energy into the soil and then measures returning waves that have reflected back to the surface. The energy is reflected when it encounters a layer or object that has a sufficiently different conductivity (also referred to as dielectric permittivity) from the material above or surrounding it. Thus, the greater the difference in dielectric permittivity between adjacent materials the greater the reflection and easier it is to image subsurface features of interest. When archaeological features exhibit regular and repeatable GPR reflections, they can be readily identified during data interpretation and spatially mapped, leading to more effective long-term management of important cultural heritage.

2.2 Ground Penetrating Radar

The GPR survey used a Geophysical Survey Systems, Inc (GSSI) Utility Scan DF. This instrument utilises two separate digital antennas (300 and 800MHz) contained within the single unit. This allows two separate data sets to be collected simultaneously. The 800MHz antenna provides higher resolution of near surface features and the 300MHz antenna provides the ability to image more deeply buried features, though at the expense of some resolution.

Instrument set up parameters included a time window of 22 nS (800MHZ) and 66 nS (300MHz), 512 samples per scan, 50 scans per metre and a stacking value of 5. Survey transects utilised a local grid and were conducted in a roughly north-south alignment. Data were collected using a zigzag survey style spaced 0.5m apart totalling 4,790 metres of linear survey coverage. GPR survey was completed in all suitable locations where obstructions did not prevent access covering an area of approximately 2,500 m².

GPR data were processed using GPR Slice v7 to remove noise and highlight the subsurface features of interest. This included setting of time zero, determination of Relative Dielectric Permeability (RDP) using hyperbola fitting, a background filter, bandpass (notch) filter and gain enhancement. After completing these processes, the data were converted from a set of vertical radargrams to horizontal amplitude slices to produce maps of the survey area.
3.0 Results

The identification of human burials depends on pattern recognition in the GPR amplitude slices and analysis of the reflection profile in the 2D radargrams. Factors used to assess individual GPR anomalies included shape, size, depth, strength of reflection, alignment and association with other anomalies. For all imagery, here in, a rainbow spectrum was used with red representing high amplitude (strong) reflections and blue representing low amplitude (weak) reflections. Archaeological features are expected to produce high amplitude reflections.

Prior to conducting the survey, the Brisbane/Ipswich area experienced several days of spotty rain showers. Significant rain fall events were uncommon during shower activity but the survey was delayed over concern of too much moisture in the soil. This can cause reduced penetration of GPR energy limiting the effectiveness of a survey. This is especially problematic for identifying human burials which can be located much deeper than archaeological deposits associated with human occupation of an area. Fortunately, the soils at Deebing Creek cemetery are somewhat sandy and likely well-drained. The surface was completely dry upon arrival for the survey. Suitable depth of penetration occurred and no negative effects of recent rainfall were observed in the GPR data.

For both data sets (the 300 and 800MHz antennae), data are displayed in standard amplitude slice maps with each slice representing the reflections from successively deeper layers (Figures 2 and 3). Analysis of these amplitude slice maps has resulted in several generalised statements. First, there are numerous anomalies near the surface 0-30 centimetres below surface (cmbs) that are likely caused by local disturbances from animals, tree roots and non-burial human activity. Second, there are two areas with several anomalies each at the western edge of the survey area. Third, in the eastern section of the survey area (nearest to Deebing Creek) several linear anomalies are present, but, they are too long to be associated with individual human burials. However, this is the area most likely to be the location of burials and thus, these anomalies may represent burials interred using a non-standard burial tradition.
Figure 3 Amplitude slice maps from 300MHz antenna.
The GPR data for the 800MHz antenna is also displayed as an overlay image (Figures 4). Overlay images are very effective at combining the strongest GPR reflections from several depths enabling them to be displayed in one image. The two areas of anomalies near the left edge of the survey area marked with grey boxes are unlikely to represent human burials. Though unlikely, they do have a small chance of representing burials and if ground disturbing works are to occur, these are should be avoided or a monitoring program should be utilised. The area of strong reflections on the right side of the image is the area most likely to contain human burials. The black box outlining this area demarcates a section of the cemetery where ground disturbing works are not recommended due to the likelihood of disturbing these burials. If a principle of avoidance is to be implemented, anywhere that orange/red anomalies are present should be avoided. Thus, areas of blue (no GPR reflection) are least likely to contain human burials and may be areas where continued use of the cemetery could occur.

Figure 4 800MHz antenna overlay image 50-130 cmbs with interpretation.
Analysis of a typical 2D radargram for the survey area is displayed in Figure 5. A strong reflection marking a soil boundary can be seen as a black line between 20 and 40 cmbs extending across most of the radargram. This same soil boundary is present in the left half of the radargram depicted in Figure 6 too. However, a very different series of reflections are present in the right side of the image indicating a disturbance to this soil boundary. These reflections in the right side of Figure 6 between 40 and 100 cm below surface are likely to be human burials. These likely burials occur within the right half of Figure 4 above demarcated by the black boundary box.

![Figure 5 Typical radargram for an area that is undisturbed.](image)

![Figure 6 Radargram for area interpreted to have burials.](image)
4.0 Conclusion and Recommendations

The GPR survey conducted at Deebing Creek Mission Cemetery has successfully imaged the likely area within the broader cemetery where burials have occurred. This area extends to the northern edge of the cemetery and likely cross this boundary to the adjacent land parcel. It has also indicated two areas where anomalies are grouped together. These areas have a low likelihood of containing human burials.

It is important to note that no geophysical method is capable of mapping all subsurface features of interest 100% of the time. Identification of human burials in GPR data is dependent upon those features being significantly different from the soil surrounding them, thus creating a radar reflection. It is also dependent upon the physical properties of local soils and the resultant energy penetration. While the survey has resulted in the identification of likely human burials related to the cemetery, additional burials may be present but not identified in the GPR data. Thus, caution should be utilised if ground disturbing activities are to occur.

**Recommendation 1**

Future ground disturbing works in the eastern portion of the cemetery as gazetted should be avoided as this area is most likely to contain human burials.

**Recommendation 2**

If continued use of the cemetery is to occur, future activities are least likely to disturb unmarked extant burials in areas of no GPR reflection (blue areas of above figures).

**Recommendation 3**

If following a principle of avoidance is to be implemented, ground disturbance should not occur any where strong GPR reflections occur (orange and red anomalies in above figures).

**Recommendation 4**

As it appears that the burial area extends into the adjoining property to the north, additional GPR investigation in the is area should occur if ground disturbance is proposed or if the full extent of the cemetery is to be identified.
5.0 References

Cook, Margaret 2015 Aboriginal Cemetery at Deebing Creek.

Stanley, John M 1985 A very high resolution magnetometer survey, Deebing Creek Aboriginal Cemetery. Armadale, University of New England.