HUNTER GEOPHYSICS

Specialists in unmarked grave detection and shallow sub-surface geophysics

PO Box 1445, Central Park, Victoria 3145
Ph.: (03) 9913 2259 or Mob.: 0488 501 261

david.hunter@huntergeophysics.com
www.huntergeophysics.com

GEOPHYSICAL SURVEY REPORT

PUBLIC VERSION
SITE-IDENTIFYING DETAILS HAVE BEEN REDACTED TO MAINTAIN SITE PRIVACY

SITE NAME	[redacted] Cemetery
HUNTER GEOPHYSICS SITE CODE	2018/14
CLIENT	[redacted] Cemetery Trust
SURVEYORS	David Hunter, Shannon Hunter
SURVEY DATES	30th June 2018, 2nd to 4th July, 2018
REPORT SUBMISSION DATE	28th August, 2018
REPORT AUTHOR	David Hunter
HERITAGE VICTORIA ARCHAEOLOGY REPORT NUMBER	[redacted]

Copyright notice

Statement of indemnity

The results and interpretation of the geophysical surveys described herein should not be considered an absolute representation of the underlying soil or archaeological features, but instead as a hypothesis yet to be verified. Confirmation of geophysical interpretations is only possible through careful (preferably archaeological) excavation. Every effort is made to ensure that these risks are minimized, but Hunter Geophysics does not guarantee that the interpretations of geophysical data provided herein are accurate.

While Hunter Geophysics aims to produce accurate interpretations of geophysical surveys, numerous unforeseeable issues may arise that may limit the accuracy of interpretations. These may include unforeseen soil or geological conditions, the presence of rabbit or other animal burrowing, the presence of tree/plant root systems, ploughing, site drainage and interference caused by variations in the Earth's magnetosphere and ionosphere, or interference caused by nearby radio transmitters or solar weather.

Of particular importance is the similar appearance of tree roots and rabbit burrowing with unmarked graves. These factors may have influenced the geophysical data described in this report.

Other areas of unknown soil disturbance may be noted in the report. These areas generally do not exhibit the same characteristics as unmarked graves; however, it is possible that these areas actually contain multiple burials, at different depths and on different alignments, which may obscure individual graves. Therefore, these areas should also be treated as if they are unmarked graves.

Important notice: the precision of the location of detected features within all survey areas is within 0.2 metres.

This survey was specifically designed for the detection of unmarked graves. The location or nature of any other detected buried feature, especially buried utilities, cannot be guaranteed. The client is advised to employ a buried utility/pipe/cable locator should they require the precise mapping of buried utilities (especially prior to any excavation the client may undertake). Hunter Geophysics can provide this service if required under a separate contract.

Front cover image: sunrise at [redacted] emetery, July 2018.

Table of contents

Executive summary

An intensive geophysical survey was undertaken by Hunter Geophysics at [redacted] Cemetery for the purposes of locating unmarked graves. The geophysical investigation has determined the location of numerous unmarked graves.

Introduction

Hunter Geophysics was commissioned by [redacted]Cemetery Trust to undertake a geophysical survey covering specific areas at [redacted]Cemetery, Cemetery Road, [redacted]Victoria.

Aims

The geophysical survey was requested to determine the location of any unmarked graves within specified survey areas at th[redacted]Cemetery.

Geography and topography

Th[redacted]Cemetery is located on the northern side of Cemetery Roa[redacted] Victoria (approximately 4.5km northwest of [redacted] and 12km east of [redacted]). The cemetery is on a gentle slope; topographic corrections of geophysical data were required.

Site geology

Please refer to the geological map on page 5. The site is situated on the Quarternary Newer Volcanic bedrock typical of Western Victoria (basalt and scoria); an extinct scoria volcano is present to the immediate northeast of the cemetery. The local soil is a silt-clay matrix with scoria/basalt cobbles and boulders suspended in the soil matrix.

Figure 1: an aerial photograph (courtesy of Google, Inc.) showing t[redacted]Cemetery, Cemetery Road, [redacted], Victoria

Site weather conditions

The geophysical survey was conducted on the 30th June, 2018 to the 4th July, 2018. The Bureau of Meteorology records the following weather data for [redacted], a nearby town considered indicative of weather at the site:

Date	Minimum temperature (°C)	Maximum temperature (°C)	Rainfall (mm)
28th June 2018	0.2	15.5	0
29th June 2018	1.6	12.6	0
30th June 2018	4.9	13.5	1.8
1st July 2018	-1.5	12.6	0.2
2nd July 2018	-1.5	12.2	0
3rd July 2018	1.8	10.6	0
4th July 2018	5.2	15.1	0

Weather has not negatively affected the viability of the employed geophysical methods at this site.

Geophysical data from discrete survey areas were processed and interpreted individually rather than as a whole in order to prevent any degradation (e.g. mosaic noise) in data.

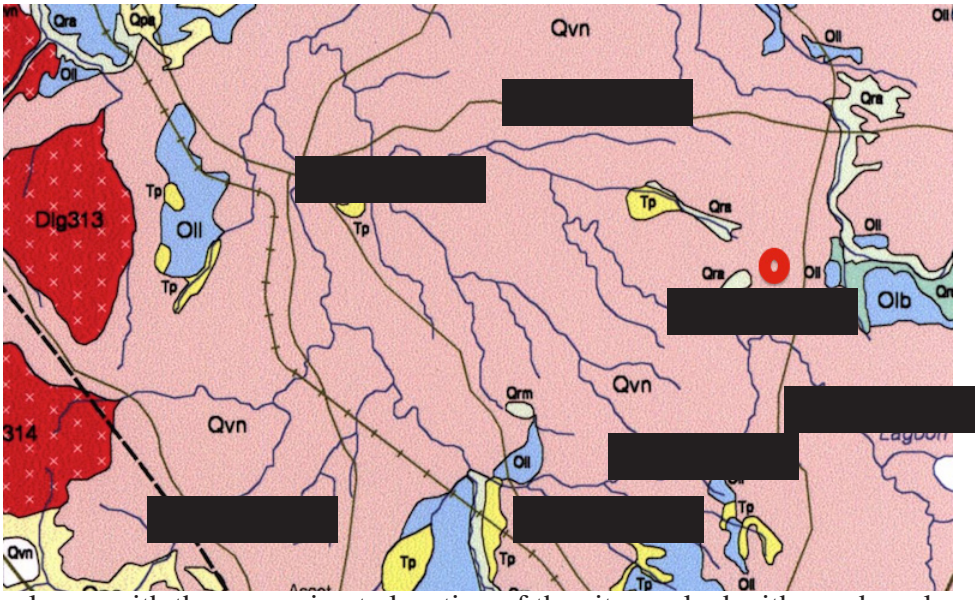

Figure 2: geological map with the approximate location of the site marked with a red marker.

Geological map © State of Victoria, Department of Mineral Resources 1995 and Department of Environment and Primary Industries 2016. Reproduced with permission.

DEPI disclaimer: the advice provided in this publication is intended as a source of information only. Always read the label before using any of the products mentioned. The State of Victoria and its employees do not guarantee that the publication is without flaw of any kind or is wholly appropriate for your particular purposes and therefore disclaims all liability for any error, loss or other consequence which may arise from you relying on any information in this publication.

Methodology

Data collection

The client requested specific areas to be covered by the geophysical survey (as seen in figure 4).

Ground-penetrating radar (GPR) data were collected by Hunter Geophysics using a Sensors and Software Noggin Utility SmartCart system and a Noggin antenna with a central transmitting frequency of 250MHz. Survey areas were staked-out using a Leica GS-16 GNSS receiver; a Leica TS-16 robotic total station was used to collect geographic data pertaining to every fourth ground-penetrating radar trace (i.e. latitude, longitude and elevation values were collected for every fourth geophysical measurement) where sufficient line-of-sight was possible.

All survey traverses were staked-out using brick-layers string to ensure complete survey grid coverage. Traverses were spaced at 25cm intervals, with each GPR trace being recorded at 5cm intervals along each traverse. Each GPR trace was recorded with a time-window of 85.2 nanoseconds.

Data were collected automatically by a computer using an odometer wheel calibrated at the beginning of the survey. In this manner, GPR traces are recorded autonomously as the surveyor pushes the GPR system along the traverse. The data were stored in an internal data logger and downloaded to a field computer via the system's memory card.

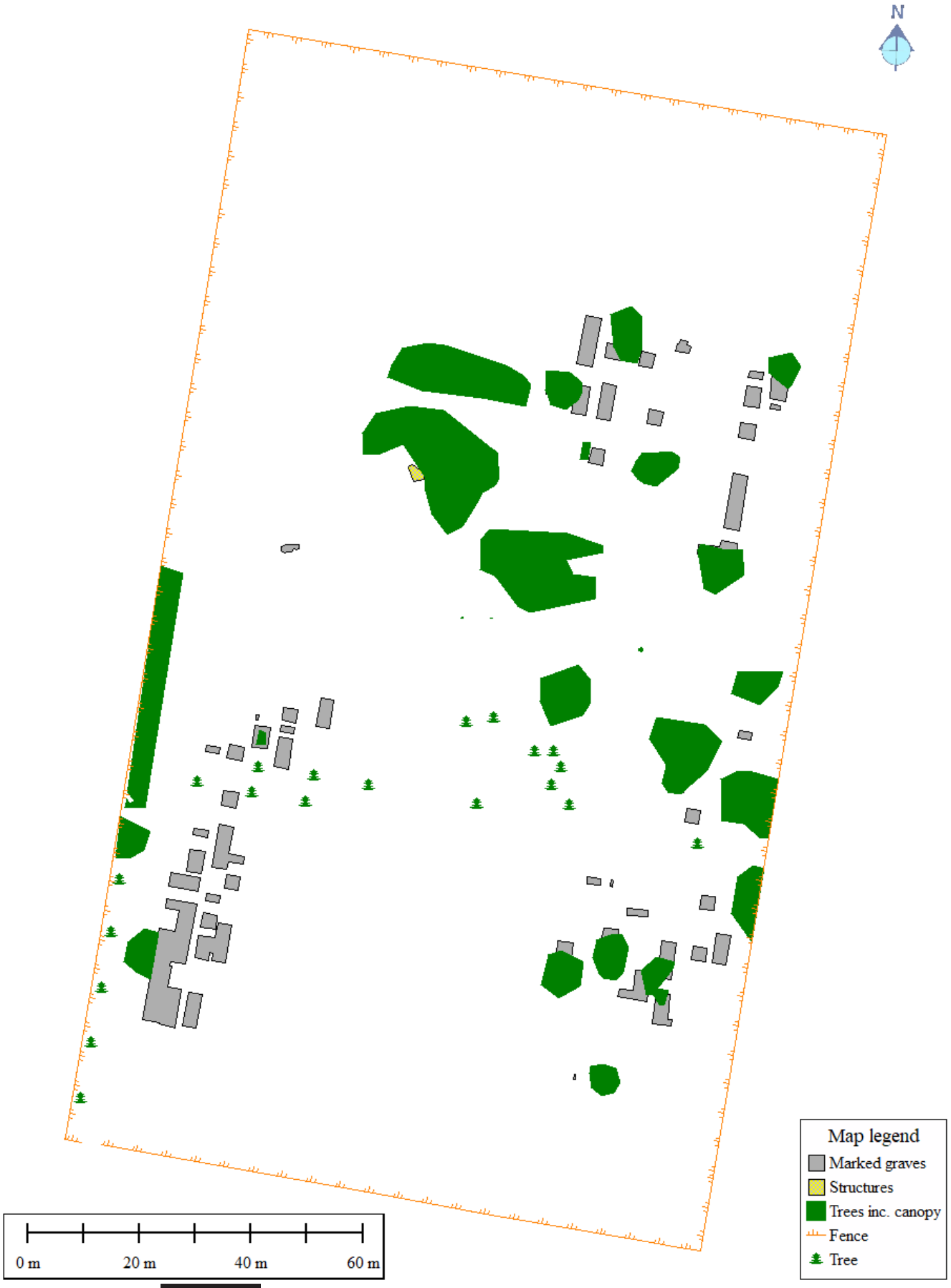

Figure 3: a map of t[redacted]Cemetery.

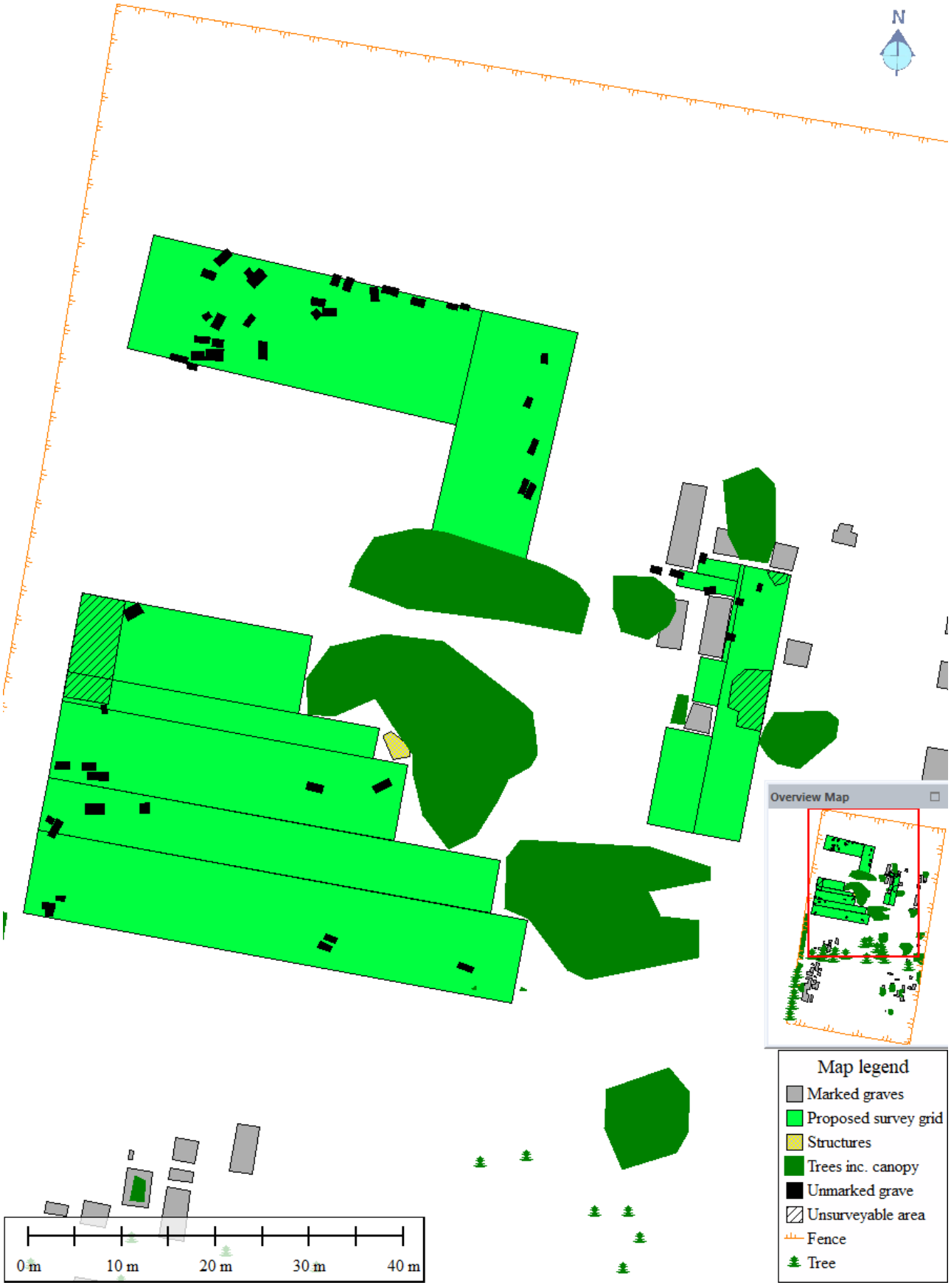

Figure 4: site map showing the location of all areas covered by the geophysical survey (in green). Please note that some areas were not surveyable due to surface obstacles.

Data processing

The ground-penetrating radar data were downloaded onto a computer and were arranged into separate folders based on the survey grid number.

Please refer to figure 4 on the previous page, or to the GIS data on the accompanying USB memory stick (refer to page 14), for a map showing where each survey grid was located.

The data were processed in the Geophysical Archaeometry Laboratory's GPR-SLICE software. Data processing routines were applied to the raw data in order to remove noise and enhance clarity. Topographic corrections were then applied to the processed radargrams, which were then sliced horizontally and plotted into XYZ tables.

Image maps ("depth slices") were created from the tables and were used to create a three-dimensional volume of the data, which was then interpreted, using the radargrams, depth slices, and X- and Y-slices as an aid. Interpretations were drawn onto the three-dimensional data volume in GPR-SLICE and then exported to DXF files, which were then imported into Global Mapper GIS software for inclusion in the site map.

Reporting, mapping and archiving

The geophysical survey and report follow the recommendations outlined in the English Heritage Guidelines (David 1995) and IFA Paper No. 6 (Gaffney et al. 2002) as a minimum standard. Mapping was performed using a Leica GS-16 real-time kinematic global navigation satellite system (RTK GNSS), and/or a Leica TS-16 robotic total station, providing a precision of less than one centimetre in the horizontal plane, and less than two centimetres in the vertical plane. This is of a higher precision than that required by the English Heritage Guidelines and Aboriginal Affairs Victoria requirements (both of which require a half-metre precision as a minimum).

Geophysical data, figures and text are archived in-house following the recommendations of the Archaeology Data Service (Schmidt 2001). All data, figures and text are also provided to the client and are submitted to Heritage Victoria for archival.

Results

Ground-penetrating Radar survey

The ground-penetrating radar survey revealed the location of unmarked graves within the survey areas. A total of 53 unmarked graves have been located. Please note that these interpretations are subject to a level of uncertainty as explained on page 2.

The following pages contain maps which show the location of all detected features. An accompanying memory stick contains digital maps and GIS mapping data. Please refer to page 14 for details.

Figure 5: map showing all unmarked graves detected within the searched areas in th[redacted] Cemetery.

Figure 6: a detailed map showing all detected features in the west of the cemetery.

Figure 7: a detailed map showing all detected features in the northeast of the cemetery.

Acknowledgments

Fieldwork: David Hunter
Shannon Hunter
Report: David Hunter

Conclusion

Satisfaction of objectives

The geophysical survey undertaken for this project has successfully located the unmarked graves present within the areas searched at th[redacted] Cemetery (as defined in figure 4 on page 8).

Summary of results

The survey has located 53 areas of disturbed soil most likely to be associated with unmarked grave shafts and funerary urn burials.

Dissemination

This report was submitted to th[redacted] Cemetery Trust in August 2018.

Recommendations

Hunter Geophysics recommends the marking out of detected unmarked graves on the ground surface as such will make the results of this survey more readily accessible to those excavating new graves in future. Hunter Geophysics are capable of meeting this recommendation should the client so desire under a separate contract. We also recommend expanding the search for unmarked graves to the north of the cemetery.

What's on the USB

A Universal Serial Bus v3 (USB) memory stick is included with this report. The following files may be found on the memory stick in digital form:

All figures included in this report.
The report itself in Adobe InDesign v8 format and also in Adobe Portable Document Format (PDF).
Site map file (with a .gmp file extension) for use with Global Mapper v19 or later.
All geophysical datasets in their own proprietary digital formats.

N.B.: A demonstration version of Global Mapper - which allows viewing of site map .gmp files - is available from the Blue Marble Geographics website at http://www.bluemarblegeo.com/products/global-mapper-download.php.

Should GIS data be required in other formats, please contact Hunter Geophysics directly.

References

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GAFFNEY, Chris, GATER, John. and OVENDEN, Susan, 2002, 'The use of Geophysical Techniques in Archaeological Evaluations', IfA Paper No. 6. Institute for Archaeologists.

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SCHMIDT, Armin, 2001, 'Geophysical Data in Archaeology: A Guide to Good Practice.' Archaeology Data Service, Oxford, Oxbow.

Hunter Geophysics - PO Box 1445, Central Park, Victoria 3145
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