HUNTER GEOPHYSICS

Specialists in the geophysical detection of unmarked graves

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GEOPHYSICAL SURVEY REPORT

SITE NAME	Former Anglican Church site in Huskisson
HUNTER GEOPHYSICS SURVEY NUMBER	2020-27
CLIENT NAME	Navin Officer Heritage Consultants
SURVEYORS	David Hunter, Shannon Hunter
SURVEY DATES	12th to 19th December, 2020
REPORT SUBMISSION DATE	31st March 2021
REPORT AUTHOR	David Hunter

Copyright notice

Front cover image: a view from the northwest corner of the site looking southeast towards the former church building.

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. Hunter Geophysics does not guarantee that the interpretations of geophysical data provided herein are accurate.

While Hunter Geophysics aims to provide accurate interpretations of geophysical data, 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. Please note that rocks, tree roots, and rabbit burrows are not included in the results section of this report where they could be confidently identified as including these would make the maps overly complicated and identifying these features is beyond the scope of work for this project.

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. Please note that the data processing techniques used by Hunter Geophysics to locate unmarked graves can obscure the visibility of buried utilities in the geophysical data. While the location of buried utilities may be shown in this report, they should not be depended upon as they may be inaccurate. 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).

An important disclaimer

The following disclaimer was provided to the client within the project contract, but it is worth repeating it here.

Ground-penetrating radar and other geophysical techniques have technical limitations that sometimes prevent them from detecting buried targets (such as unmarked graves, buried archaeology, etc.). For example, it is possible for the techniques Hunter Geophysics uses to completely miss an unmarked grave.

Geophysical techniques can only confirm the presence of a buried object/feature. They are not capable of proving the absence of a particular buried object/feature. For example, Hunter Geophysics can't say with 100% certainty that an area in a cemetery is empty of unmarked graves and is available for new burials. No geophysicist can.

Geophysical techniques work by collecting measurements of the physical properties of the soil and geology across a search area. These measurements can be affected by buried objects (such as unmarked graves or archaeological features), but they can also be affected by soil conditions (such as varying moisture content, rabbit burrowing, tree roots, geological features, and other factors). The measurements can also be affected by above-ground factors, such as nearby radio transmitters, the ground surface topography, and the weather at the time of data collection, among other factors. All of these factors can prevent the detection of a buried object by making the buried object's signature in the measurements ambiguous. The only thing a geophysicist can do is try to minimise these negative impacts in order to maximise the likelihood that a buried feature is detected. A geophysicist cannot ever guarantee they will be able to detect any particular buried feature.

It is important to note that ground-penetrating radar and other geophysical methods are capable of only providing confirmation of the presence of unmarked burials at a particular location. It is not possible to say with 100% certainty that an unmarked grave is not present if the geophysical data suggests that to be the case.

At the completion of the survey, Hunter Geophysics will provide the client with a report containing maps showing the location of any detected buried features. These maps do not necessarily show areas that do not contain buried features such as unmarked graves; the maps simply show where buried features were detected.

Understandably, you might wonder why you would bother contracting a geophysicist if they cannot guarantee the detection of a buried object. However, knowing the position of some (hopefully most or all) unmarked graves is better than not knowing where any unmarked graves are located.

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Executive summary

An intensive geophysical survey was undertaken by Hunter Geophysics at the Former Anglican Church site in Huskisson for the purposes of locating unmarked graves. The geophysical survey has determined the location of numerous anomalies suggestive of unmarked graves.

Introduction

Hunter Geophysics was commissioned by Navin Officer Heritage Consultants to undertake a geophysical survey covering specific areas at the Former Anglican Church site in Huskisson, 17-19 Hawke Street, Huskisson, New South Wales.

Aims

The geophysical survey was requested to determine the location of any unmarked graves within specified survey areas at the Former Anglican Church site in Huskisson.

Geography and topography

The Former Anglican Church site in Huskisson is located at the intersection of Hawke and Bowen Streets, Huskisson, New South Wales (approximately twenty kilometres southeast of the town of Nowra). The site is bounded by Hawke, Bowen, and Currambene Streets (to the east, south, and west, respectively), and an unnamed laneway to the north. The site is on a gentle slope; topographic corrections of geophysical data were required.

Figure 1: a satellite photograph (courtesy of NearMap) showing the Former Anglican Church site in Huskisson, New South Wales.

Site geology

Please refer to the geological map below. The site is situated on the Permian Shoalhaven Group sandstone/siltstone formation typical of the Nowra region. The local soil is likely a well-sorted loam.

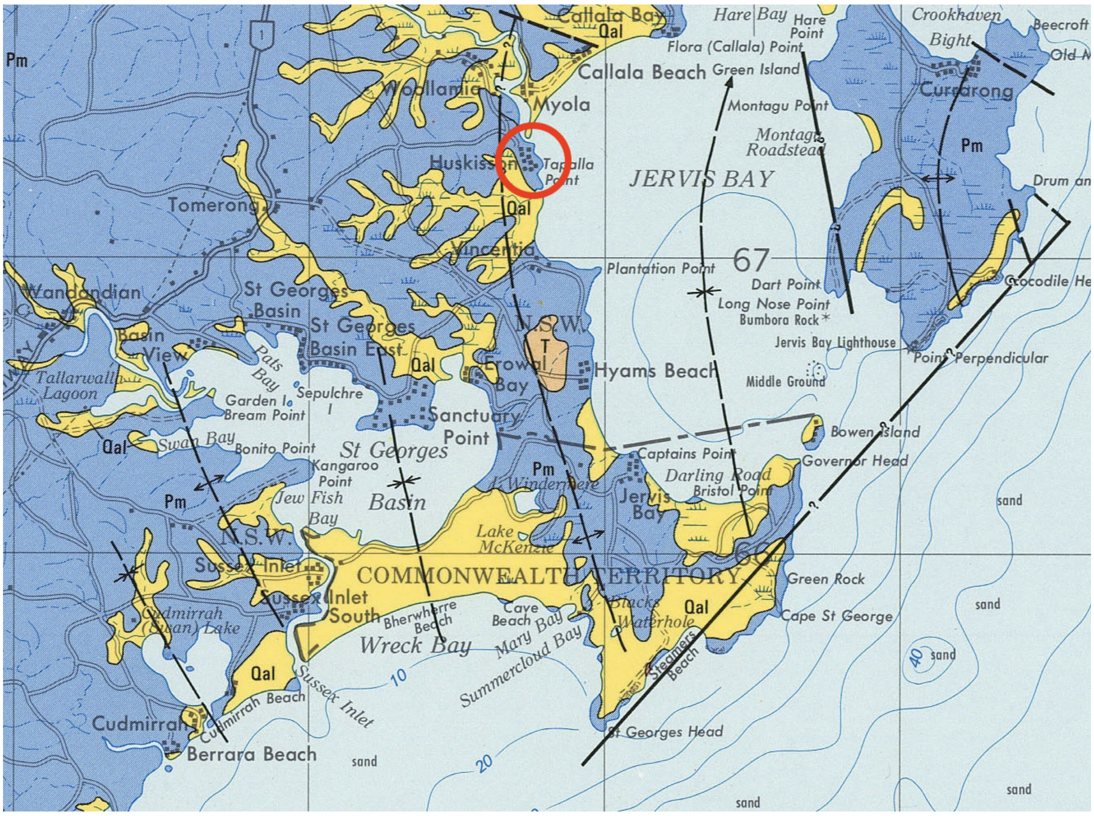

Figure 2: the Ulladulla 1:250,000 Metallogenic Sheet geological map with the approximate location of the site marked in red.

Site weather conditions

The on-site data collection phase of the geophysical survey was conducted on 12th to 19th December, 2020. The Bureau of Meteorology records the following weather data for Point Perpendicular (13km southeast of the site), considered indicative of weather at the site during data collection:

Date	Minimum temperature (℃)	Maximum temperature (℃)	Rainfall (mm)
10th December 2020	16.7	19.7	0.0
11th December 2020	15.6	19.8	0.0
12th December 2020	16.6	20.1	0.0
13th December 2020	15.5	23.1	5.4
14th December 2020	16.8	25.4	0.4
15th December 2020	18.5	25.2	0.4
16th December 2020	20.3	24.2	32.8
17th December 2020	20.3	28.2	10.6
18th December 2020	21.3	29.3	1.6
19th December 2020	17.5	18.5	0.0
20th December 2020	16.0	22.8	0.4

Local weather is not expected to have negatively affected the viability of the methods employed during this geophysical survey.

Figure 3: a map of the Former Anglican Church site in Huskisson created by Hunter Geophysics.

Methodology

How ground-penetrating radar works

Ground-penetrating RADAR (GPR) is a relatively fast technique for remotely detecting buried objects. Radiowaves are sent into the ground and are reflected, refracted or absorbed by buried objects. A receiver antenna detects and records the time taken for signals to be reflected back to the surface, which can then be used to determine the depth to the reflective feature below the ground (Conyers, 2004:25).

The GPR equipment is mounted on a push-cart with an electronic odometer attached to one of the cart's wheels, which measures the distance the system has been pushed. The controlling computer (using the odometer data) automatically transmits a *pulse* of radiowaves every time the GPR system has been pushed five centimetres along the ground.

As radiowaves travel very quickly through soil (approximately 60-120cm per one hundred billionths of a second), it is possible for the GPR to transmit radiowaves and also record reflected radiowaves without stopping every five centimetres.

Signals that are reflected by buried objects induce Eddy currents within the receiving antenna (to overly-simplify: reflected signals create electricity within the receiving antenna), and the GPR system measures the voltage of the electrical current created within the receiving antenna over a brief period (known as the "time window"). In the case of this survey, the time window was set to 96.4 nanoseconds, and the system automatically recorded the voltage 241 times within that time window. Each voltage measurement is recorded alongside the time within the time-window that the measurement was taken.

Each group of 241 voltage measurements (which relate to the reflected signals received at one specific location on the ground) is known as a GPR trace or GPR scan.

As the GPR is pushed, it collects a GPR trace every five centimetres along the ground. For instance, if the GPR is moved one meter, it will collect a total of twenty-one GPR traces. As each GPR trace contains 241 voltage measurements, that one-metre-long collection of GPR data contains 5,061 voltage measurements. A 50m x 50m area would contain at least 12,652,500 voltage measurements!

A group of GPR traces collected along one line can be used to construct what is known as a radargram. A radargram is a visual representation of the varying voltage measurements recorded by the GPR system within each GPR trace. A basic radargram can be seen in figure 4.

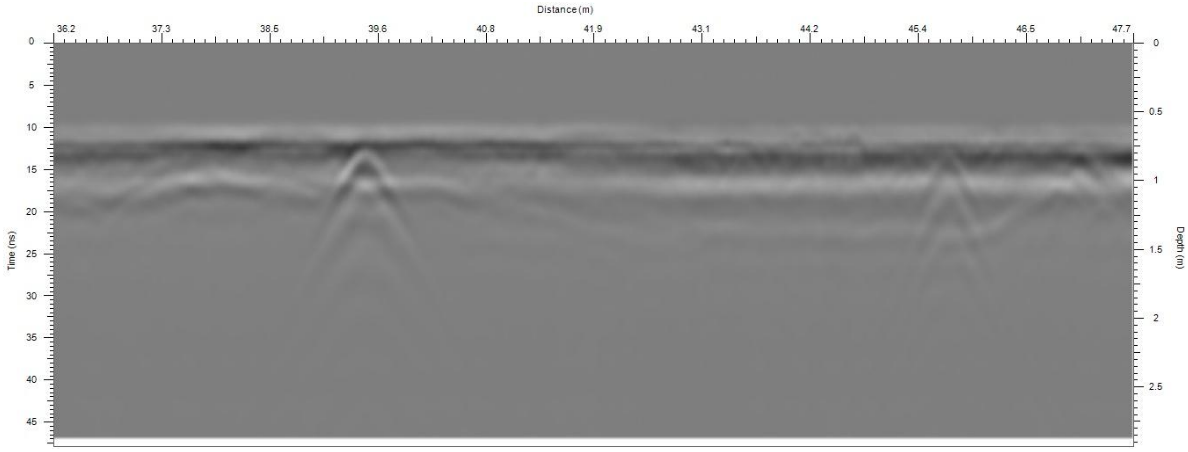

Figure 4: a basic radargram.

In the above radargram, two upside-down-V -shaped reflections are visible: one at about 40m along the radargram, and another at about 46m along the radargram. These are known as *point-source hyperbolic reflectors* and are indicative of a sudden change in voltage within a small volume below the ground. For instance, these could be reflections from buried rocks or air gaps within coffins or pipes. They could also indicate the presence of tree roots or rabbit burrows. To make things particularly challenging, some graves don’t even generate this sort of obvious reflection.

Other reflections are also present within the radargrams, such as the almost-flat dark-grey and light-grey alternating lines about a quarter of the way down the radargram. These are *planar reflectors* and are indicative of something that is flat and constant (in this example, it’s the ground surface itself, and a layer within the soil beneath the surface).

It is very difficult to correctly interpret a radargram without knowing the context of the voltage measurements and the surrounding area. Therefore, it is standard practice to collect many radargrams across an entire area, and then look for reflections in adjacent radargrams. However, an even better option is to generate *time slices* based on the GPR data.

Given that each GPR trace contains a group of voltage measurements along with the time each measurement was taken within the time window, it is possible to extract all of the voltage readings recorded at a specific time from all GPR traces collected within an entire site, and then simply colour-code the voltages and create a map of these voltages. This is the essence of a time slice.

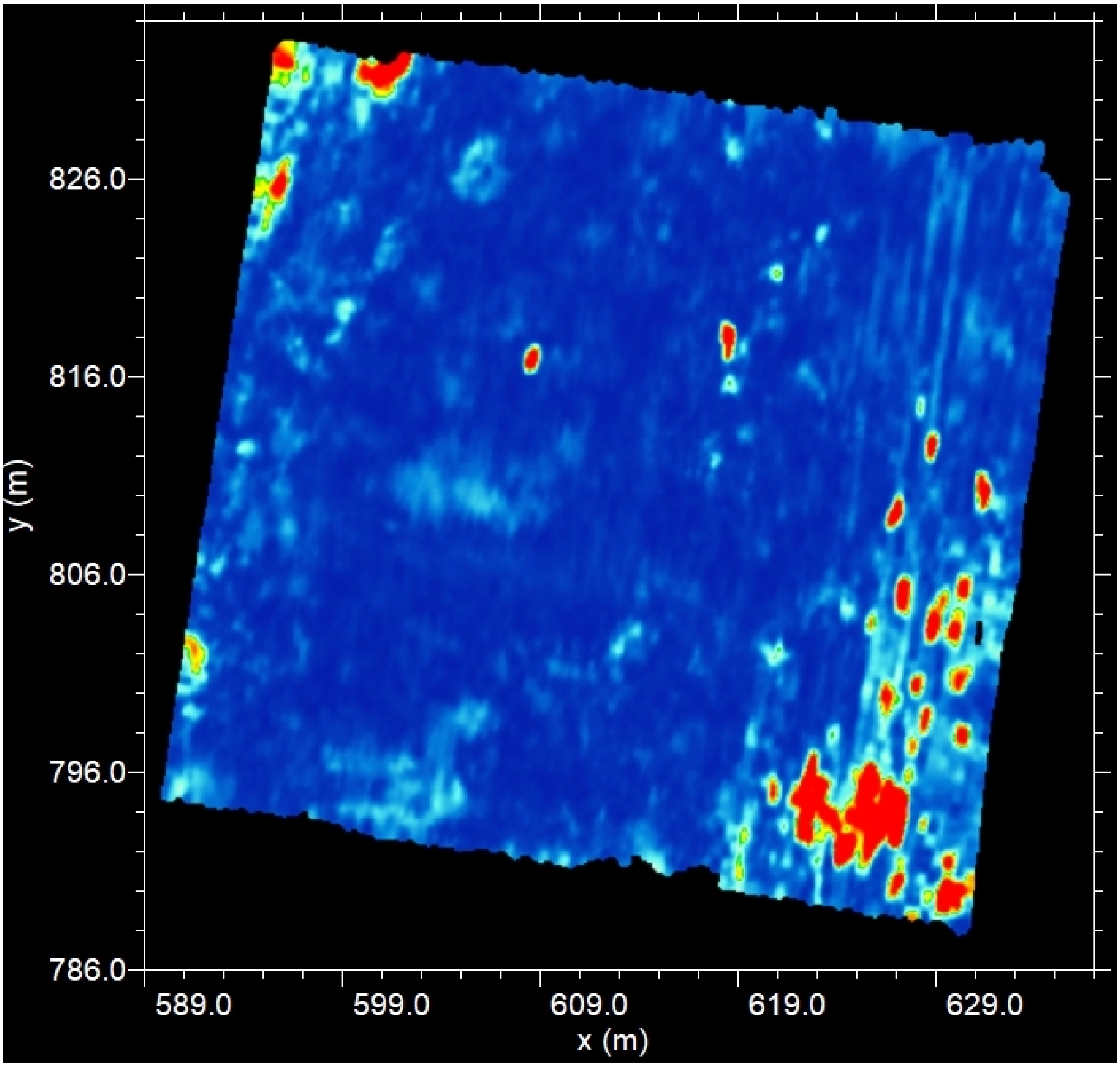

Figure 5: a time slice showing the variation of voltages across a 40m x 40m area within a cemetery recorded by a GPR system at about 18 nanoseconds into the time window within each GPR trace.

Time slices such as that shown in figure 5 can make it significantly easier to identify unmarked graves with GPR datasets: simply examine all the time slices across a site (at every depth from the ground surface all the way down to the deepest reflection several metres below ground), identify any red blobs that start close to the ground surface and continue to at least one metre depth (preferably more), and then narrow it down further to any red blobs that are the right size and shape to be a grave (the very large red blob in the lower-right corner of figure 5 is too large to be a grave and is probably an old gold mine shaft, whereas the smaller red blobs are roughly two metres long and a meter wide and extend down about two meters below the ground surface, and are probably graves). However, it can take several weeks to months of processing the GPR data to obtain time slice images, and they are usually nowhere near as clear as what is shown above, as rabbit burrowing, tree roots, and buried rocks will also reflect radiowaves and will appear in time slices as well.

The best possible method - which Hunter Geophysics employs - is to examine all radargrams and all time slices across the site before and after each filter is applied to ensure that nothing is missed. It is for this reason that GPR data interpretation can take months.

Data collection

The geophysical survey covered areas as defined in figure 6 (on the next page).

Geospatial (mapping) data were collected with a Leica GS-18I Imaging GNSS receiver and/or a Leica Geosystems TS-16 robotic total station. The Geodetic Datum of Australia 2020 was used as the site datum; the site is located within Map Grid of Australia zone 56.

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 Geosystems GS-18T GNSS receiver or a Leica Geosystems TS-16 robotic total station.

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. In the event of ground surface obstacles (such as trees), survey traverses deviated around the obstacles to ensure maximum coverage of the area.

Each GPR trace was recorded with a time-window of 96.4 nanoseconds and 241 antenna voltage samples per trace.

Data collection was triggered automatically by a computer using an odometer wheel calibrated prior to collection of data in each discrete survey area in order to minimise the risk of wheel miscalibration. 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.

A Leica Geosystems TS-16 robotic total station was used to collect geographic data pertaining to every fourth ground-penetrating radar trace (i.e. northing, easting, and elevation values were collected for every fourth geophysical measurement) where line-of-sight was achievable.

A robotic total station works by pointing a laser at a reflective prism, recording the time taken for the laser to travel between the total station and the reflective prism and back to the total station, the known speed of the laser, and recording the direction the total station is facing, in order to calculate the distance, bearing, and vertical angle to the reflective prism. The system then uses this information and the total station's known position to calculate the geographic coordinates of the reflective prism.

The reflective prism was mounted 90cm above the centre of the ground-penetrating radar antenna, such that the robotic total station was able to track the ground-penetrating radar system during GPR data collection. Coordinates were sent automatically from the robotic total station via a long-range Bluetooth (wireless) connection to a Leica Geosystems CS20 handheld computer (which was also mounted on the ground-penetrating radar system). The Leica Geosystems CS20 handheld computer was pre-programmed to automatically correct the data for the 90cm vertical offset of the reflective prism to the GPR antenna, and to then send the coordinates received in real-time to the ground-penetrating radar computer via an RS-232 cable. The geographic data were saved alongside the ground-penetrating radar data by the GPR controller computer.

Figure 6: a map showing the location of all areas covered by the geophysical survey.

Data processing

Geospatial (map) data collected with a Leica GS-18T GNSS receiver and/or a Leica Geosystems TS-16 robotic total station were loaded into Leica Infinity desktop software, and then exported into ESRI Shapefile format. They were then imported into Global Mapper GIS software and stylised to form the site maps presented throughout this report.

The ground-penetrating radar 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. Specifically, the following processes were used:

1. **Delete double-TS**
   Total station navigation data saved alongside the ground-penetrating radar data (hereafter referred to as the "GPR TS dataset") were searched for any duplicate sets of geographic coordinates (which may be erroneously saved by the GPR computer multiple times due to a variety of reasons). Duplicate sets of coordinates were removed from the dataset.

2. **Time lag correction**
   As explained earlier in this report, the GPR TS dataset used a Leica Geosystems CS20 handheld computer as a relay between the robotic total station and the GPR computer. This introduced a lag of 0.4 seconds between when the GPR system collected a GPR trace, and when the total station coordinates would be received by the GPR. This *time lag* was corrected to ensure correct positioning.

3. **Resample in range**
   Many trees and other obstacles were present at the site, which prevented the total station from being able to track the GPR at all times (for instance, when the GPR was pushed behind a tree, the total station was unable to track the reflective prism). This introduced gaps in the GPR TS dataset, which would cause incorrect positioning of the GPR data. As the GPR survey traverses were straight lines and bricklayers' string was used for survey guidance, it was possible to interpolate new coordinates to fill in the gaps in the GPR TS dataset. This *resample in range XY* procedure was used such that a new interpolated coordinate set was generated every 0.2 metres along the GPR survey traverse wherever gaps existed within the GPR TS dataset.

4. **Time-zero correction**
   Subtle variations in GPR antenna temperature throughout the day causes the slight expansion or contraction of parts within the antenna (particularly the plastic outer casing). This results in a varying distance between the transmitting antenna and the ground surface over the course of a day which, in-turn, can result in GPR data at a

specific depth in one survey traverse not being comparable to GPR data at the same depth in a different survey traverse. This can result in very noisy time-slices and correcting for this is critical. To correct for this, the GPR data were searched for the strongest reflection within each trace - which is the reflection of the GPR signal off the ground surface - and everything before that reflection was discarded. This resulted in radargrams beginning at the ground-surface, rather than at the antenna, thereby correcting this issue.

Figure 7: an example unprocessed radargram.

Figure 8: a radargram with time-zero correction applied.

5. **Gaining**
The GPR data was gained (amplified) such that the strongest reflector within the entire dataset was not overgained. Data gaining is used to amplify reflected signals within the GPR dataset in order to make subtle buried features more readily-apparent. This is a relatively new method of data gaining introduced in 2019 known as AGC2. Its predecessor, AGC (Automatic Gain Control), would only examine one GPR traverse/"radargram" for its strongest reflector, and then gain the entire dataset based on that. AGC2 differs in that it searches the entire dataset for the strongest reflection, rather than only one GPR traverse. The benefit of the AGC2 method is that data can

never be over-gained to the point of introducing new noise into the dataset.

6. **Bandpass/frequency filter**
   Being in the time domain, GPR data can be converted using a Fourier transform into the frequency domain. Once in the frequency domain, it is possible to identify the frequency of specific signals that were recorded by the GPR system, to eliminate unwanted/interfering signals, and then convert the resulting dataset back into the time domain. The Sensors and Software Noggin GPR antenna used for this survey detected a range of signals from approximately 5MHz to approximately 1,250MHz. The antenna itself has a manufacturer-specified central transmitting frequency of 250MHz (meaning that the majority of energy emitted by the antenna is at 250MHz, but some of the energy will be transmitted at frequencies within the range of approximately 100MHz to 500MHz). Signals outside of the 100-500MHz range are most likely originating from nearby radio transmitters rather than from the GPR system. Similarly, signals from 100-120MHz are expected to be emanating from local FM radio stations, and signals above 500MHz are likely originating from mobile phone or television towers. All of these interfering signals can overwhelm the GPR dataset and can make it difficult to detect buried features. The GPR dataset collected for this survey was filtered such that only signals within the range of 128MHz to 485MHz were retained.

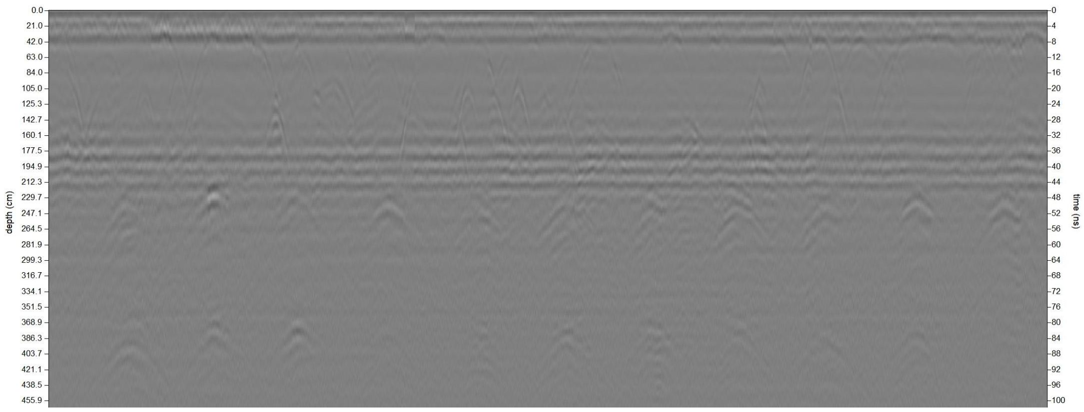

Figure 9: a radargram with a AGC2 gaining and a 128-485MHz bandpass filter applied.

7. **Scan gain normalization**
   Scan gain normalization may be used when there is inconsistent ground-surface coupling (that is, it may be used to correct for when the GPR antenna might be slightly raised off the ground surface to handle a small bump on the ground surface such as a rock, or when there are small puddles of water on the ground surface in an otherwise dry environment). In this instance, scan gain normalization was not required as ground-surface antenna coupling was excellent.

8. **Background subtraction filter**
As shown in figure 4 earlier in this report, radargrams usually contain planar reflectors from the ground surface and from layers within the soil profile and bedrock. They can also contain planar reflectors from antenna noise. The data was subjected to a trace average subtraction filter, which detected and removed any planar reflectors from the dataset. It is important to note that reflections from flat surfaces running parallel to GPR survey traverses (such as buried pipes or cables) will have been removed from the dataset. It is for this reason that the results of this survey cannot be depended upon for detecting buried utilities (as explained in the disclaimer at the start of this report).

Figure 10: a radargram with a background subtraction filter applied.

9. **Diffraction stack migration**
The upside-down V-shaped hyperbolic reflectors shown in figure 4 are formed as radiowaves travel downward and outward in a conical shape from the GPR into the ground. As the GPR approaches a point-source reflector (such as an air gap inside a coffin), even before the GPR is directly above the reflector, radiowaves will propagate forward in front of the GPR and will reflect off buried objects ahead of the GPR. As the signal is travelling further (instead of straight-down), the travel-time to the reflector is longer. As the GPR gets closer to the reflector, the travel-time for the radiowaves decreases, until the GPR is directly above the reflector, when the travel-time is at its shortest. As the GPR moves away from the reflector, the travel-time then increases once more. This process results in the hyperbolic reflectors typical of radargrams.
It is preferable to reduce these hyperbolic reflectors to a single point at the top of the hyperbolic reflector (where the reflector itself actually is), rather than having tails that can overlap other reflectors and confuse matters. This process is known as diffraction stack migration.
Diffraction stack migration requires a precise and robust definition of the radiowave velocity within the surveyed areas. GPR-SLICE's hyperbola search functionality

yielded an average velocity across the site of 0.096 metres per nanosecond. Having a defined signal velocity makes it possible to convert time slices into *depth slices* (horizontal slices of the GPR voltage measurements across a site at a defined depth, rather than at a defined time).

Figure 11: a radargram with diffraction stack migration applied.

10. Hilbert Transform

The purpose of a Hilbert transform is to convert the alternating darker- and lighter-grey layers in radargrams to varying shades of darker grey. This makes it significantly easier to see migrated point-source reflectors and also improves the visibility of these reflectors in time/depth slices.

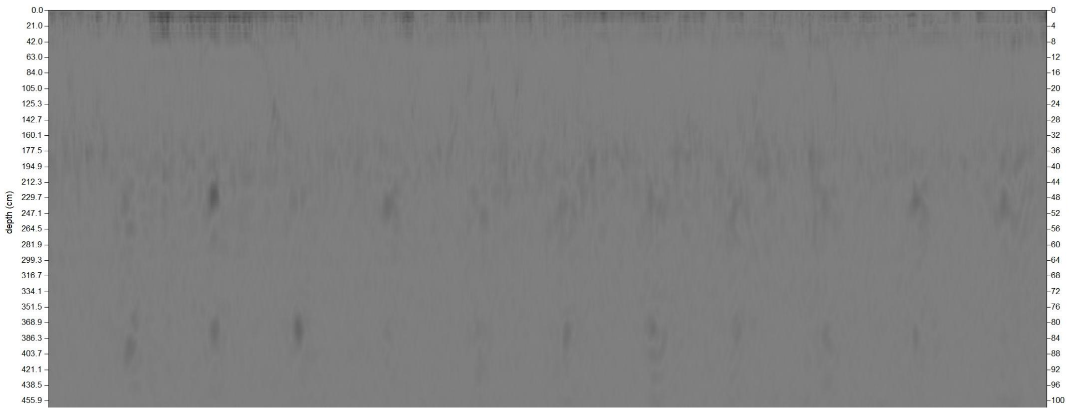

Figure 12: a radargram with a Hilbert transform applied.

11. Depth slice creation

After each of the above processes was performed, the resulting dataset was sliced horizontally (resulting in forty slices) and plotted into XYZ data tables. Depth slices were created from the tables using an interpolation distance of 0.4 metres. The resulting depth slices were then subjected to a 3 x 3 pixel low-pass image convolution to smooth the depth slices and enhance clarity.

12. **3D data cube compilation**
The depth slices were then interpolated four times between slices in order to improve image quality, and then the entire dataset was compiled into a 3D data cube, which could then be visualised in a three-dimensional environment.

13. **Vector imaging for topography, tilt, yaw, and roll correction**
Finally, topographic corrections were applied to the 3D data cube in order to correct for varying topography and GPR antenna tilt, yaw, and roll. This was done by using GPR-SLICE's Vector Imaging capabilities to project the GPR data into a topographically-corrected three-dimensional environment.

This corrected 3D data cube 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 Geosystems GS-18I Imaging real-time kinematic global navigation satellite system (RTK GNSS) receiver, and/or a Leica Geosystems TS-16I imaging robotic total station, providing a precision of less than two centimetres in the horizontal plane and less than two centimetres in the vertical plane. This is of a significantly 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.

Results

Ground-penetrating radar survey

The ground-penetrating radar survey revealed the location of probable unmarked graves within the survey areas.

A total of fifty-eight areas have been identified that are likely to be unmarked graves, along with an additional fifteen areas that may also be unmarked graves but are irregularly-shaped and so their interpretation is less certain. Furthermore, seven areas of unknown soil disturbance were also identified.

Please note that these interpretations are subject to a level of uncertainty as explained in the section ‘Statement of Indemnity’ on page 3.

Please refer to the maps in the ‘Site maps showing survey results’ section later in this report, which show the location of all areas interpreted as unmarked graves (high-confidence in black, low-confidence in light blue). The maps also show the location of unknown soil disturbances (shown in light red).

An accompanying memory stick contains digital maps and GIS mapping data. Please refer to the ‘Conclusion’ section later in this report for details. The client has also been provided with a larger printed copy of the site map.

Discussion

The western section of the site has two dirt tracks running through the area. The tracks were highly-visible in the ground-penetrating radar data and may have obscured the presence of any unmarked graves beneath and in the vicinity of them. This section also had a very high volume of tree roots.

Two potential burials are present in the northwest corner of the site, which are surrounded by tree roots and may actually represent tree roots as well. However, the anomalies are of the right size and shape to be burials.

There is a roughly grave-sized mound visible in the southwest corner of the site (as shown on the maps on the following pages). There is no evidence in the ground-penetrating radar data for a burial beneath this mound. However, it is possible that the mound’s smaller size had minimal impact on the total station navigation dataset collected alongside the ground-penetrating radar data and, therefore, it may have not been possible to properly correct the ground-penetrating radar data for this variation in topography, which - in turn - may have obscured any signals reflecting from any unmarked grave that may have been beneath the mound. It is possible that there is a burial beneath the mound. The client is advised to treat the mound as a suspected burial.

Four square anomalies were located beneath the gravel driveway immediately west of the church. It is not known what these anomalies represent. The southern pair are approximately one metre deep; the northern pair are approximately fifty centimetres deep.

Two small anomalies were identified in the northwest corner of the gravel driveway, southwest of the house. These are too small to be unmarked graves. They may be foundations or post-holes from the structure that was previously in this location.

A linear feature runs north-south from the house along the eastern edge of the gravel driveway. The nature of this anomaly is unknown, but it may be a drain or some other buried utility.

Several anomalies were located in the southeast of the site, between the church and the fences along Hawke and Bowen Streets:

- an anomaly along the eastern fence, which is surrounded by trees and may be tree roots, but is the right general size and depth (approximately 1.5 metres) for an unmarked grave,
- an anomaly near the southwest corner of the church, which is probably just ground disturbance due to the construction of the church, but again is the right general size and depth (approximately 1.5 metres) for an unmarked grave,
- two areas of disturbed soil to the south of the church which are relatively shallow, of irregular shape, and are likely to not be unmarked graves. These may be the remnants of old trees.

An anomaly was located within the sand pit along Hawke Street which extends from the ground surface to approximately 1.2 metres below ground surface. It is not known what this anomaly represents.

A linear feature runs north-south from the church along the eastern edge of the gravel driveway. This is most likely dried soil associated with a concrete footpath that was present in photographs within a report by Peter Ellsmore and Associates.

A number of anomalies were detected between the church and the house, roughly where a structure previously stood. The southeastern-most of these anomalies (shaded brown on the maps in this report) is most likely disturbed soil associated with a flagpole previously in this location (as seen in a photograph within a report by Peter Ellsmore and Associates). Other anomalies in the area may be unmarked graves, but may also be foundations of the structure previously in this location. An anomaly in the northwest of this area may be the remnants of shrubs previously in this area (again as per photographs within a report by Peter Ellsmore and Associates).

Numerous linear features were located around the house, which are likely to be buried utilities. A large anomaly was detected beneath the lean-to shelter immediately northwest of the house, but the presence of the lean-to prevented sufficient coverage of this area. It is not possible to determine the nature of this anomaly. However, the presence of a very large tree immediately south of this anomaly suggests that the anomaly could simply be tree roots.

One anomaly was located underneath the car port, which extends from 0.4 to 2.5 metres below the ground surface. However, its shape is not typical of unmarked graves. Further, the reinforcing bars within the concrete in the car port may have introduced interference in the dataset.

Conclusion

Satisfaction of objectives

The geophysical survey undertaken for this project has successfully located buried subsurface features that may be indicative of unmarked graves within the areas searched at the Former Anglican Church site in Huskisson (as defined in figure 6).

Summary of results

The survey has located seventy-three areas of disturbed soil most likely to be associated with unmarked grave shafts and/or funerary urn burials.

Dissemination

This report was submitted to Navin Officer Heritage Consultants in March 2021.

Recommendations

Hunter Geophysics recommends expanding the search for unmarked graves along the nature strip in Bowen Street adjacent to lot 9 (in the southwest of the site) as many potential unmarked graves were located within lot 9. It may also be worthwhile searching for unmarked graves in the location of the house and church once these buildings are moved or demolished.

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 Portable Document Format (PDF).
- Site map file (with a .gmp file extension) for use with Global Mapper v22 or later.
- All geophysical and geospatial datasets in their own proprietary digital formats.
    - Individual time/depth slices are available within the 'JPG' folder inside each GPR-SLICE project directory.
- 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.

Site maps showing survey results

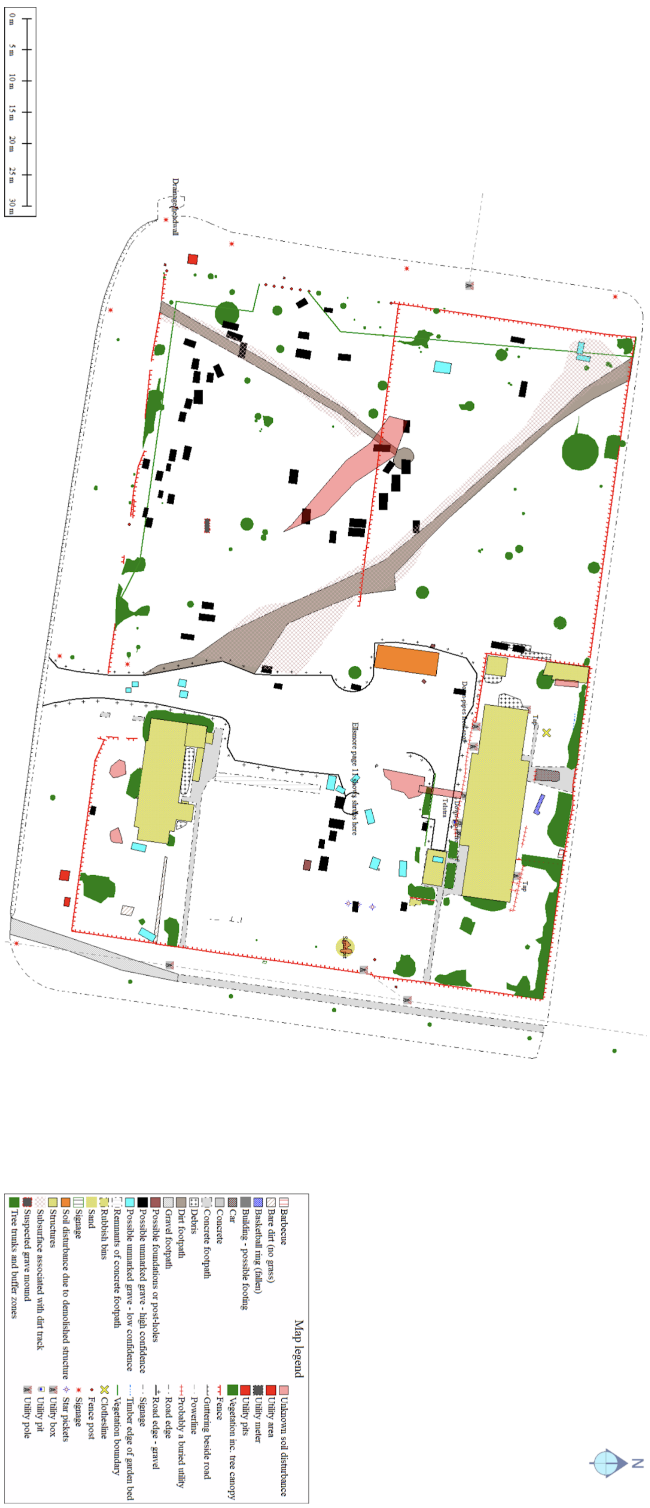

Figure 13: a map showing all detected features within the areas searched for unmarked graves at the Former Anglican Church site in Huskisson.

 For Navin Officer Heritage Consultants

Figure 14: a map showing all detected features within the areas searched for unmarked graves in the southeast corner of the Former Anglican Church site in Huskisson.

 For Navin Officer Heritage Consultants

Figure 15: a map showing all detected features within the areas searched for unmarked graves in the northeast corner of the Former Anglican Church site in Huskisson.

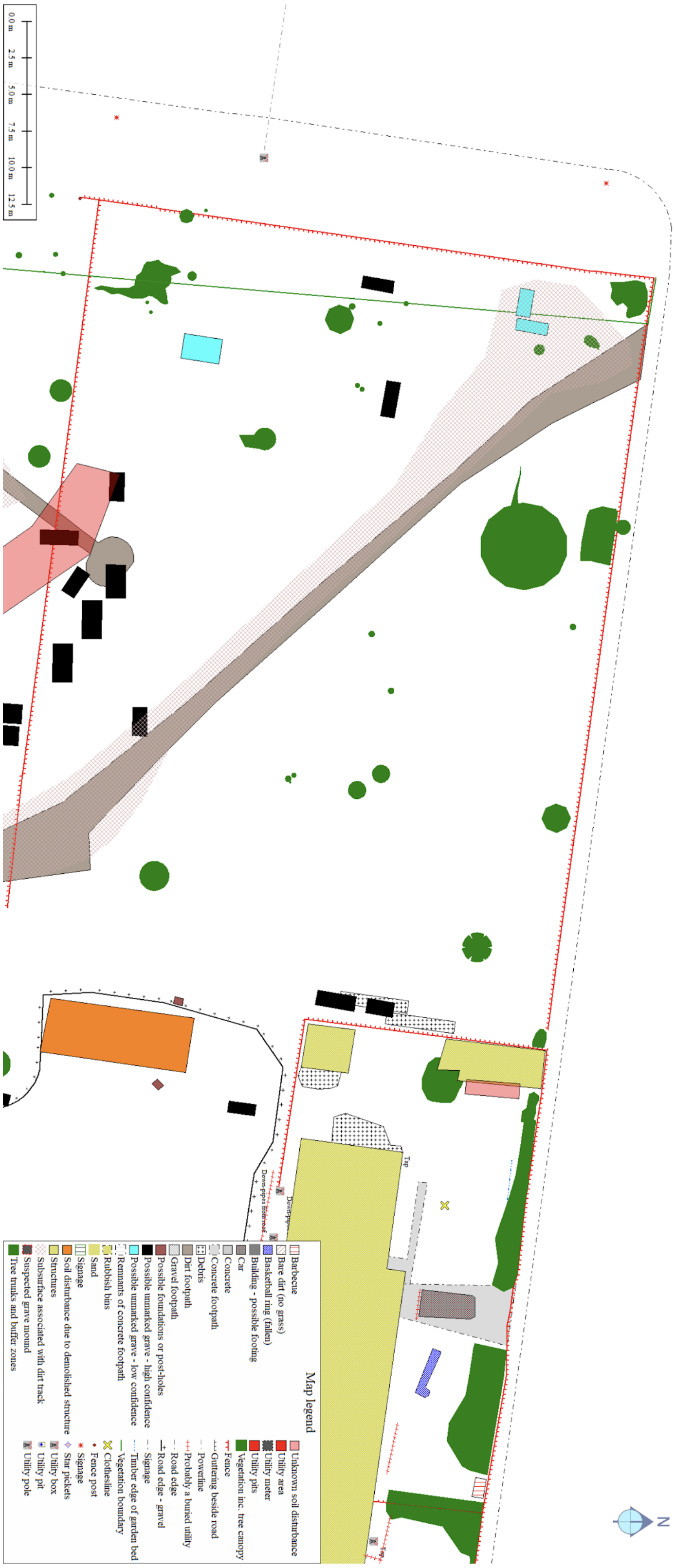

Figure 16: a map showing all detected features within the areas searched for unmarked graves in the northwest corner of the Former Anglican Church site in Huskisson.

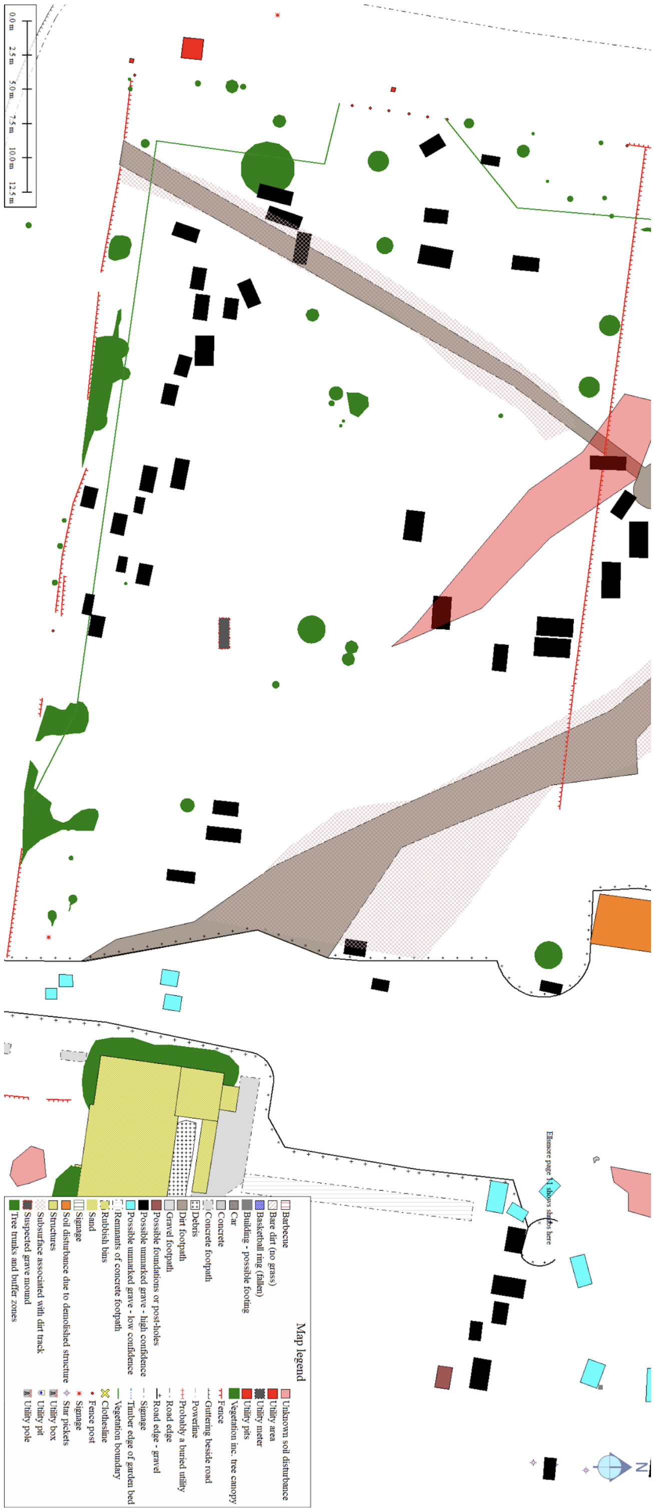

Figure 17: a map showing all detected features within the areas searched for unmarked graves in the southwest corner of the Former Anglican Church site in Huskisson.

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