



Ground Penetrating Radar Survey  
Graveyard  
, BC for



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Attn: [REDACTED]

**Ground Penetrating Radar Survey at  
Graveyard [REDACTED], BC**

## BACKGROUND

On May 11, 2017 Terraprobe Geoscience Corp. (Terraprobe) was commissioned by [REDACTED] to perform a high frequency Ground Penetrating Radar (GPR) survey at the [REDACTED] Graveyard. The purpose of this survey was to determine the presence of burials associated with each headstone as well as potential unmarked graves.

## GPR TECHNIQUE

Ground penetrating radar is the general term applied to techniques that employ radio waves to profile structures and features in the subsurface. Although typically used for ground (soil) applications, GPR can be used to identify features beneath other surfaces. GPR method is based on emission, reflection and detection of electromagnetic waves. A short pulse of high frequency (10-2600 MHz) electromagnetic energy is produced and transmitted into the ground or other medium (i.e. concrete, asphalt). The pulse spreads into the subsurface materials and is affected by the properties of the surrounding material. Some of the energy is reflected at the interface between materials of different electrical properties (dielectric constant). A receiver records the reflected energy at the surface. Processed radar data are plotted as surveyed horizontal distance (metres) versus two-way travel time in nanoseconds (2D mode). When GPR data are collected in a grid, 3D data processing and interpretation can be applied.

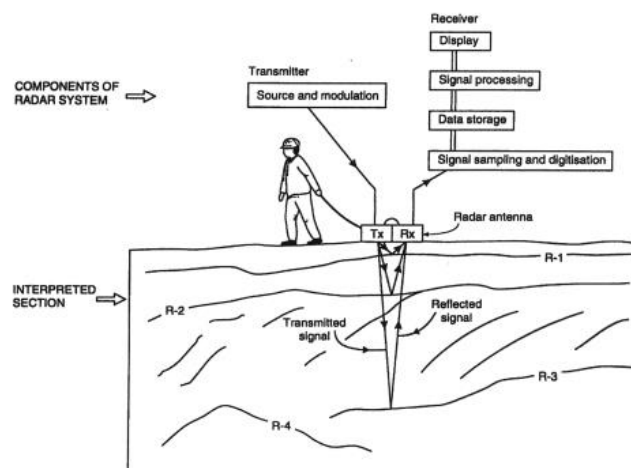


Figure 1: Schematic figure of GPR survey (Reynolds, 1997)

GPR can locate both metallic and non-metallic targets. Penetration depth and detectability of targets depend on antenna frequency, target orientation and the difference in electrical properties between the host material and the target.

The primary response of radar to buried point like features is the hyperbolic arch, formed by the interaction between the shape of the radar beam, depth to the target and the velocity of the radar energy. Radar energy from the antenna is sent out in a cone. As the antenna approaches the target the distance decreases, forming the ascending part of the apparent hyperbola centred over the anomaly. The width of the arch is a function of the velocity and depth. The descending arch is formed as the antenna moves away.

## GPR FIELD SURVEY

A GSSI SIR4000 system was used together with a 400MHz antenna for the data collection. Data processing and interpretation took place at Terraprobe office.

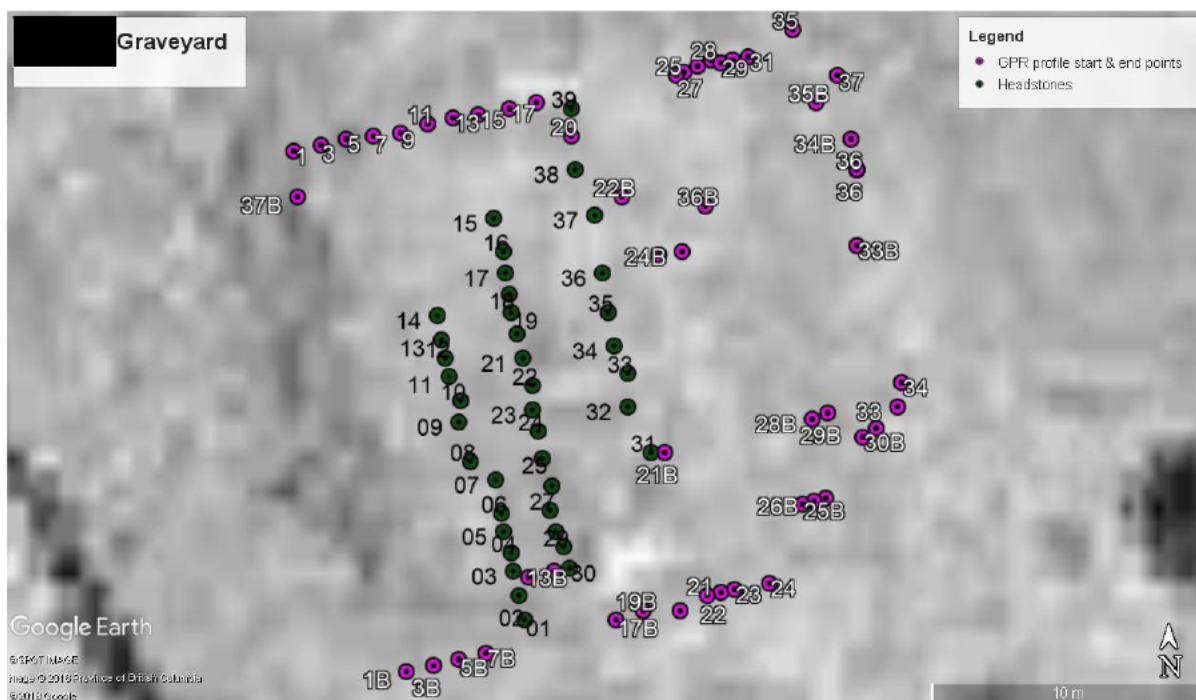
A total of thirty-seven (37) lines were collected and manual markers set during collection approximately at the centre of each grave marked by a head stone or bouquet.

The start and end points of all lines were marked temporarily on site and the GPS coordinates surveyed by [REDACTED] staff. Orientation of the profile lines was chosen to be perpendicular to the marked graves to achieve the best possible signal return.

The western half of the cemetery does contain the relocated headstones. GPR profile lines have been collected with 0.5m line spacing. GPS coordinates of every second line have been collected, but as all start points are in line and the profile lines parallel, missing start and end points can easily be reconstructed.

Since the most recent graves could not be crossed during data collection profile line orientation varies in the eastern part of the cemetery.

All profile lines start points are labelled with a number only and the end points carry the corresponding number and the letter B: The first profile starts at coordinate point 1 and ends at coordinate point 1B. A table of the coordinate points can be found in the appendix.



A larger version of this map with the lines marked can be found in the addendum



## GPR DATA PROCESSING and INTERPRETATION

Data processing was done using GSSI Radan 7 processing and analysis software package. Several processing steps were carried out:

- Temporal and 2D spatial filters
- Gain recovery
- Time-Depth conversion

## GPR RESULTS

The processed GPR profile lines have been carefully analyzed manually. GPR signal penetration depth was limited to about 2m to 2.5m.

Graves dating back to after the relocation of the graveyard show clear indication of there being a buried object/ground disturbance. Headstones dating back to before the relocation of the graveyard cannot be associated with a similarly strong GPR signal and the presence of graves therefore cannot be confirmed.

Five GPR profile lines crossing the graves are shown below. Dashed vertical lines are markers that were set during the data collection, indicating the center of a potential grave (based on the location of the headstone or other surface features). Headstone numbers are based on GPS survey by [REDACTED] and are located at the bottom of each profile marker.

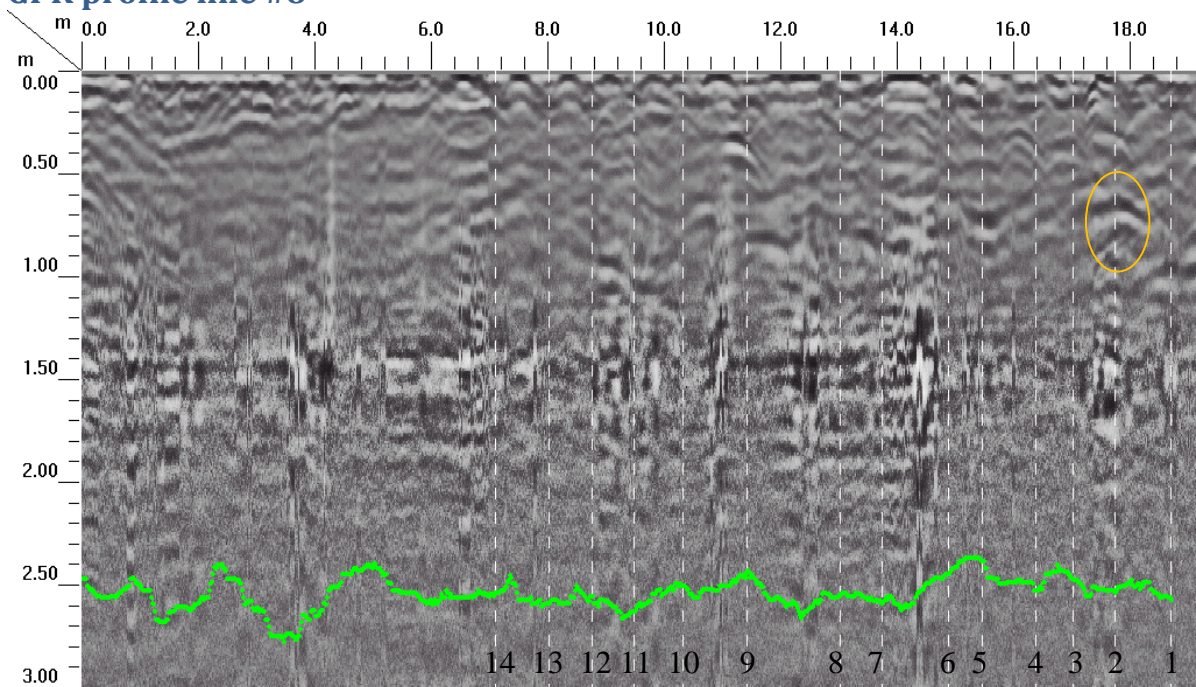
The green line represents the maximum GPR signal penetration depth calculated during data collection based on the signal to noise ratio.

Two levels of confidence were applied:

- RED: high confidence; grave confirmed and/or strong GPR signal
- ORANGE: Lower confidence; grave potentially present and/or GPR signal of lesser quality

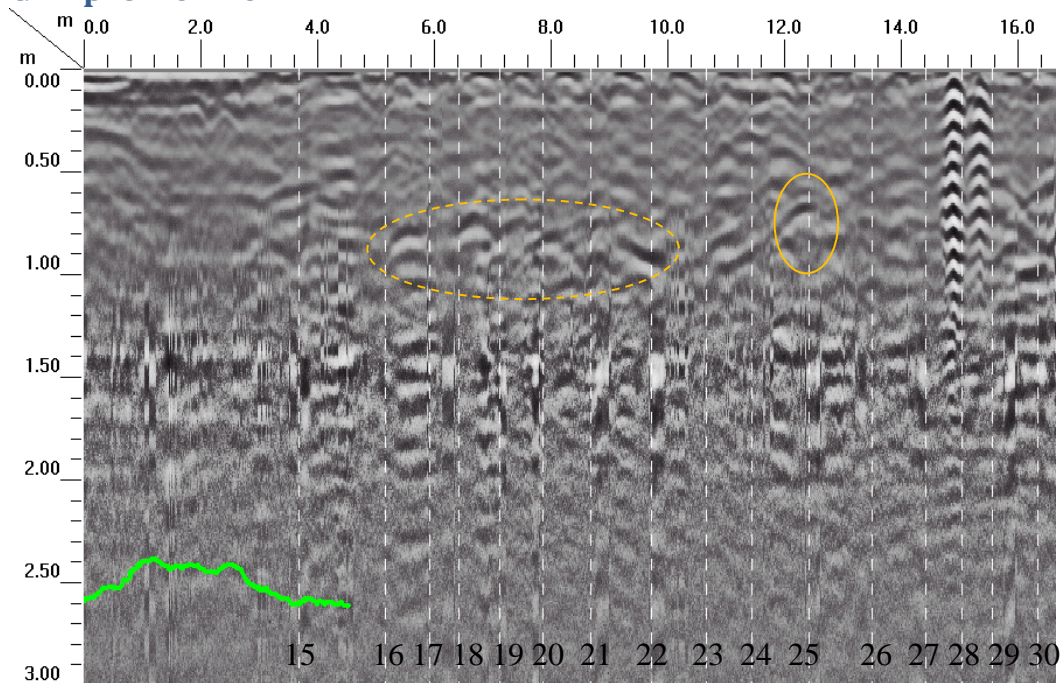
Profile lines #19 and #23 show clearly what kind of signal return can be expected from the more recent graves. Profile lines #8 and #14 only show similar but weaker signal return associated with headstones 2 and 25. Graves with headstones 16 through 22 (profile line #14) show a horizon slightly less than 1m deep. This could be caused by stratigraphy but could also be interpreted as an indication of a potential mass burial.

### GPR profile line #8

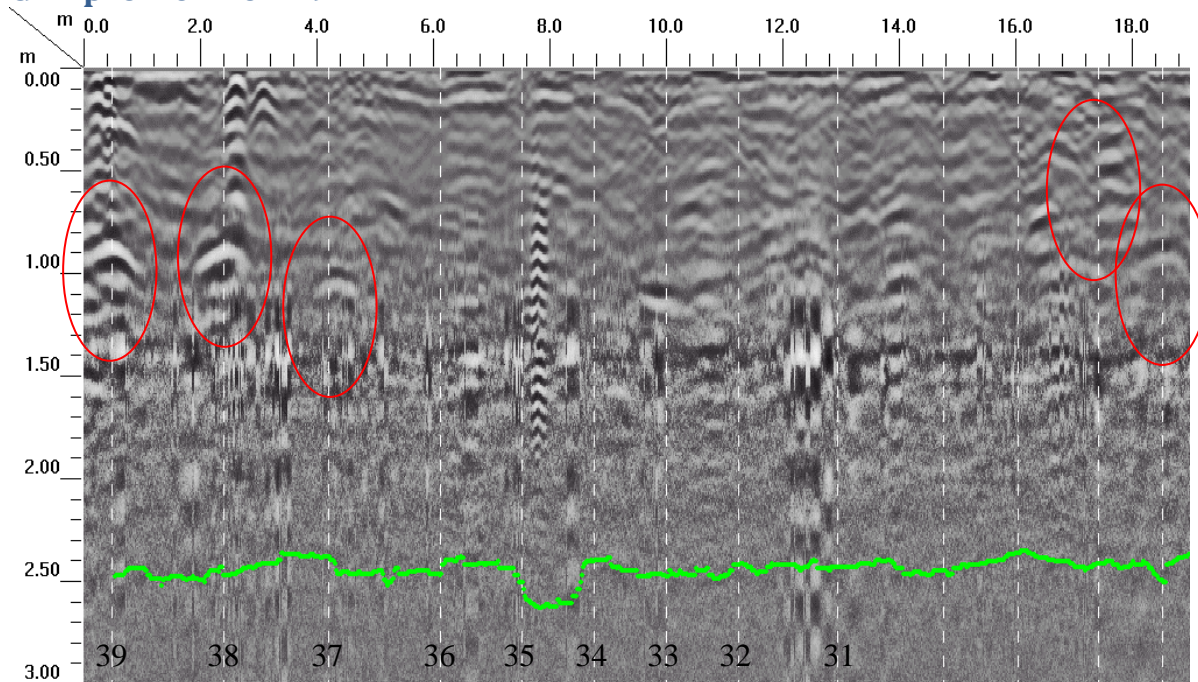


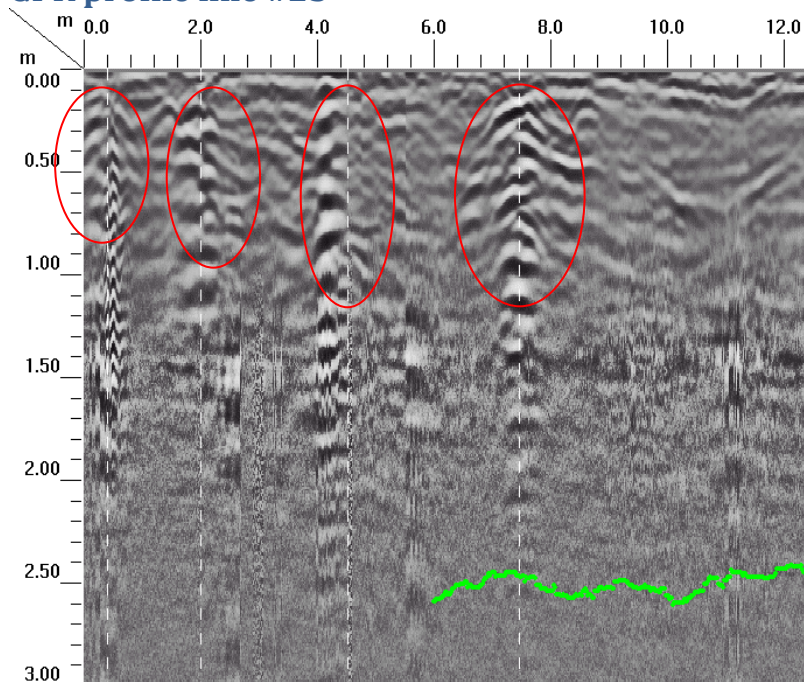
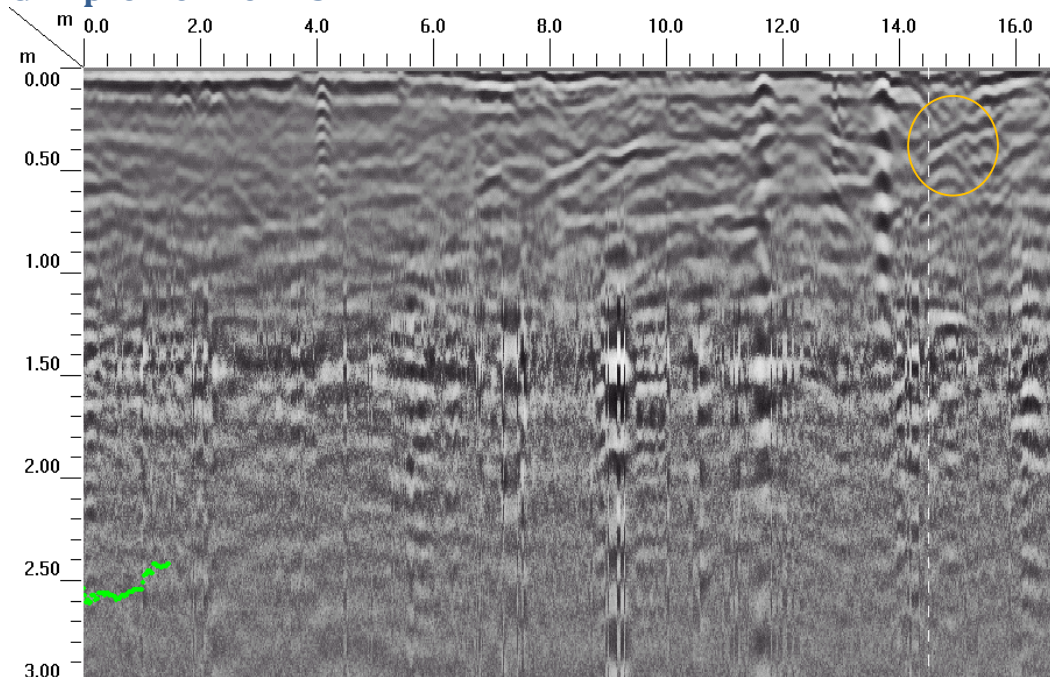


**GPR profile line #14**



**GPR profile line #19**



**GPR profile line #23****GPR profile line #25**

All other GPR profile lines are available upon request.

## LIMITATIONS

Please note that the depth to subsurface features derived from ground penetrating radar surveys are generally accepted as accurate to within ten to twenty percent of the true depths to the boundaries unless otherwise noted. Since the depth scale was calculated using average velocities and the material is not homogeneous, it could only be used as a guideline and not as exact measurement. The results are interpretive in nature and are considered to be a reasonable accurate presentation of existing conditions within the limitations of the radar profiling method. Since GPR provides indirect evidence, drilling and/or excavation are recommended to verify the interpretation.

Thank you for choosing Terraprobe, and if you have further questions please feel free to contact us.

Kind regards,

Valesca Schaefer (Dipl. Geol.)  
Senior GPR Technician

Addendum



# ADDENDUM

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## Pictures taken during data collection







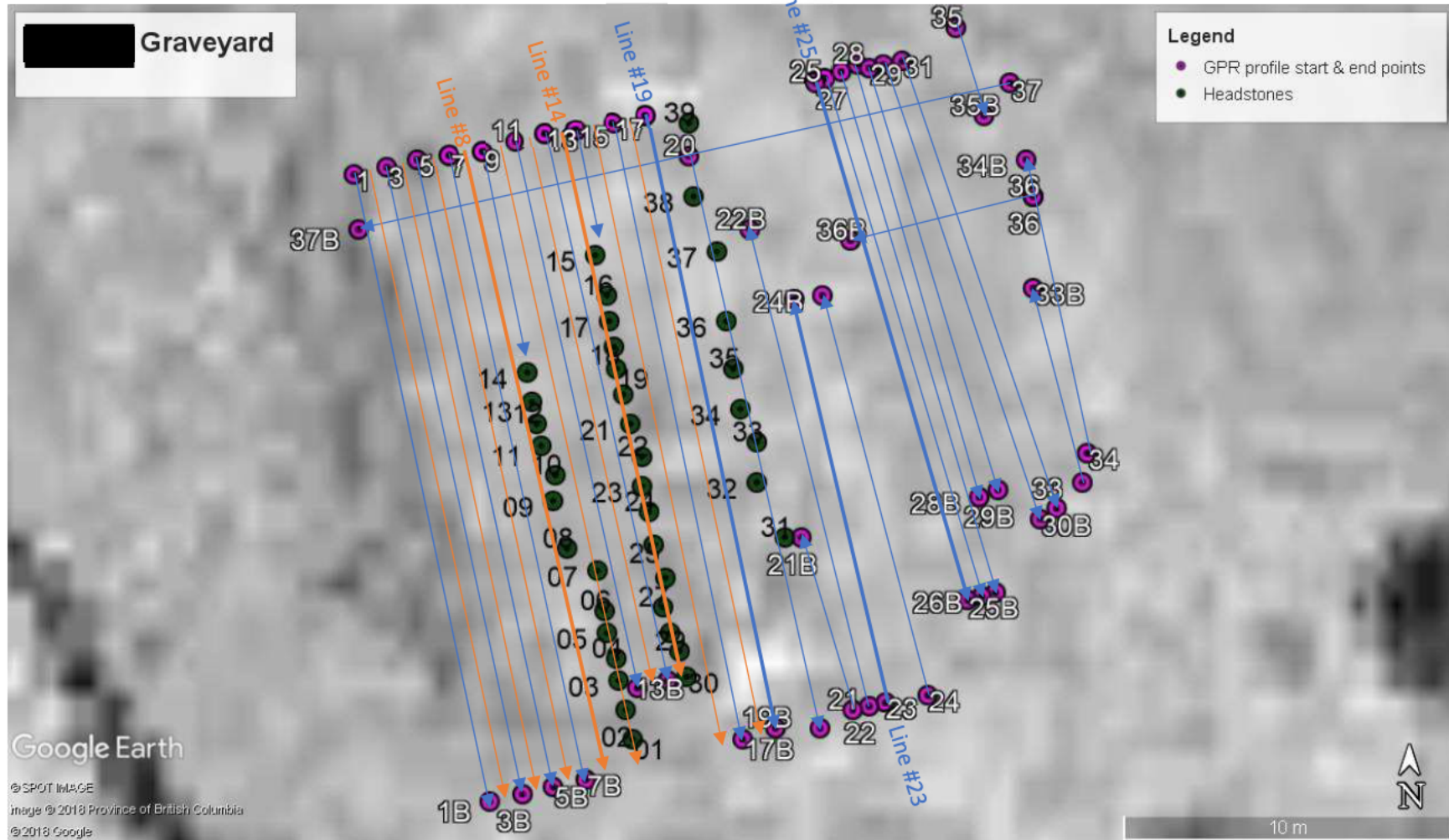








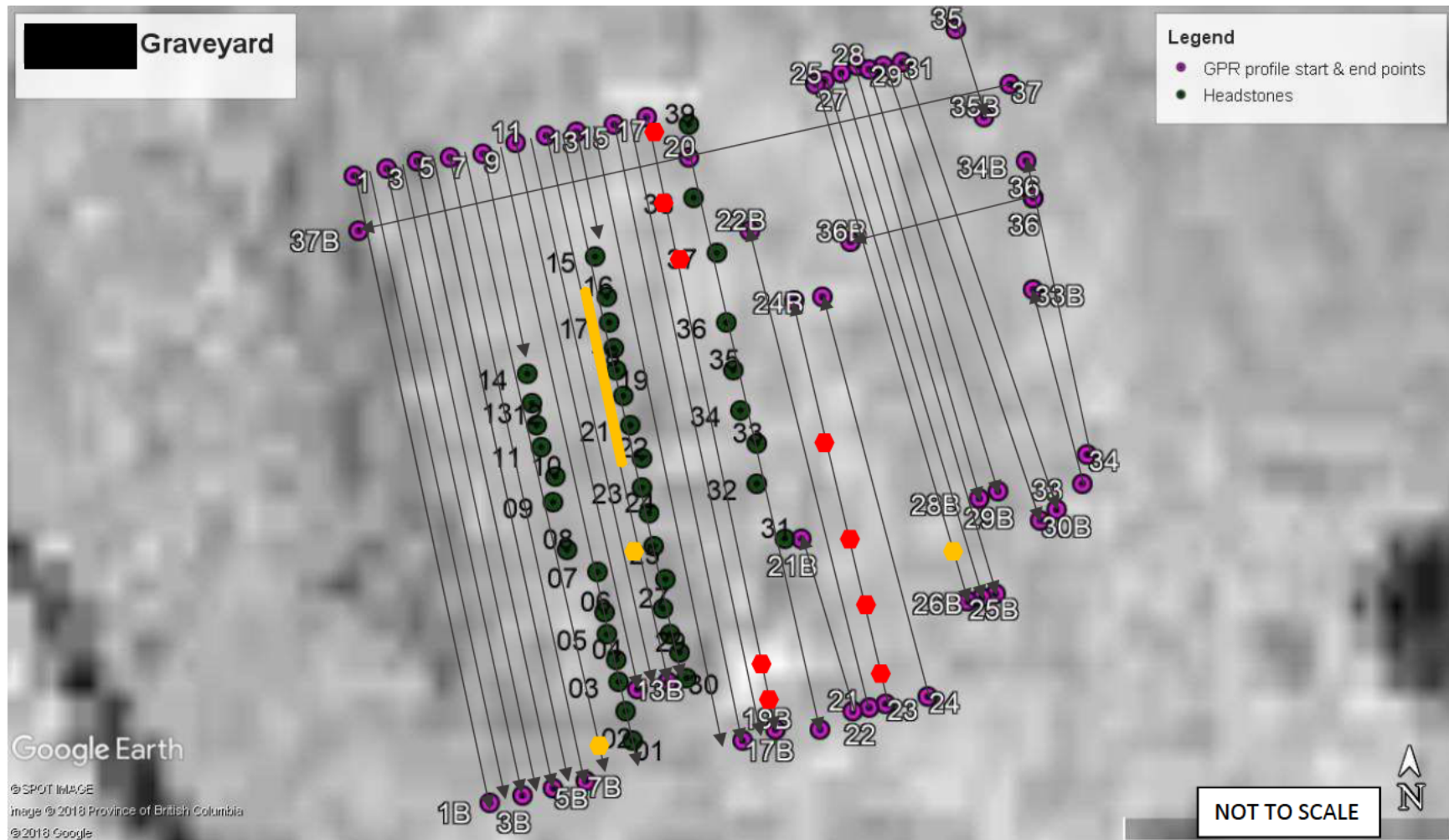
Map with GPR profile line location and headstones



**Note:** GPR profile lines and their directions shown with blue arrows. Profile lines without GPS coordinates have been drawn in orange. Profiles shown in the report are highlighted by a thicker line and labelled at their start point.



## Map with GPR profile line location and interpretation of results overlay



**Note:** See Report page 3ff for details and explanation