Geophysical Survey at MIMA, The Bull Tavern Site
Lexington, MA 2010.

Draft

By

William A. Griswold, Ph.D., RPA
Archeologist, National Park Service
Northeast Region Archeology Program
Heritage Preservation, Planning & Compliance
4th Floor Boott Cotton Mills Museum
115 John St. Lowell, MA 01852
978 970-5145

2011

Management Summary

A limited geophysical investigation was undertaken at the Bull Tavern site at Minute Man National Historical Park (MIMA), Lexington Massachusetts, in October 2010. The wedge of land bounded on the south by Route 2A and on the north by Marrett Street is believed to contain the remnants of the Bull Tavern, a tavern purportedly raided by the British on April 19, 1775. Earlier archeological work done on the property by Charles Tremer was neither well-done nor conclusive in its assessment of the site. A geophysical survey was conducted on the grounds as a public demonstration for Massachusetts Archaeology Month over a three day period. Two areas of the site were investigated for remnants of the tavern using a combination of Ground Penetrating Radar (GPR), Resistance and Magnetometry. One foundation was located in Grid 2 and measures approximately 42' x 26' and appears comparable to other historic house sites in the park. Additional archeological work is recommended in Grid 2 to ground-truth the geophysical anomaly.

Acknowledgements

The author would like to thank a number of people for their help in completing this work including Terrie Wallace, MIMA Curator, Rachel Robinson, NRAP Archeologist, Jim Harmon, NRAP Archeologist, and Steven Pendery, NRAP Acting Manager. Without the help of these individuals, this project would not have been possible.

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I INTRODUCTION

A limited geophysical investigation was undertaken at the Bull Tavern site at Minute Man National Historical Park (MIMA), Lexington Massachusetts, in October 2010. The wedge of land bounded on the south by Route 2A and on the north by Marrett Street is believed to contain the remnants of the Bull Tavern, a tavern reportedly raided by the British on April 19, 1775.

Earlier archeological work done on the property by Charles Tremer was neither well-done nor conclusive in its assessment of the site. No notes, maps, photographs or report have been found for these excavations. Two sources of information are available about these excavations: 1) A 1984 phone conversation with Alan Synenki and 2) a short newspaper article about the excavations. Evidently, Tremer investigated a 40' x 40' foundation on site that appears to have dated to the nineteenth century.

Due to the potential importance of the tavern in the events of the Lexington and Concord battles, a geophysical survey was conducted on the grounds in an attempt to locate additional foundations. It was conducted as a public demonstration project for Massachusetts Archaeology Month and introduced many individuals from the Commonwealth to geophysical methods used in archeology. Two areas of the site were investigated for remnants of the tavern using a combination of Ground Penetrating Radar (GPR), Resistivity and Magnetometry.

II BACKGROUND AND HISTORY

According to the ACMP Volume 2 chapter on the Bull Tavern site, two historians have done work on the Bull Tavern site. Robert Ronsheim, MIMA Historian assembled the various deeds for the property as well as the property of the Whittemore house. Ultimately, he concluded from his research that there was probably not a tavern site in this location in 1775. Joyce Malcolm, a independent historian, reviewed the reports and deeds and came to a completely different conclusion, namely that there was strong circumstantial evidence that there was a tavern on site in 1775 (ACMP 1986:19-21).

Charles Tremer (Muhlenburg College) was the only archeologist to conduct excavations on the property. Due to lack of notes, report, maps, and photographs from the project, it is not certain where Tremer worked. The ACMP volume reports that Tremer uncovered an L-shaped foundation measuring approximately 40' x 40' (ACMP 1986: 33).

> Tremer recollected that the first three feet of fill of the foundation contained post-1890 artifacts. He believed these to be 1920s field trash thrown into the cellarhole during highway construction. Below three feet, the fill contained earlier materials, and at six feet he encountered partial remains of a floor. He felt that these materials did not conclusively identify the cellarhole as that of the Bull Tavern (Synenki 1984a cited in ACMP 1986: 33).

Rachel Robinson and I observed a foundation between the geophysical grids potentially matching the foundation description mentioned by Tremer. A foundation and spoil pile were visible on the surface of the ground in between Grids 1 and 2 and seemed to match the location for an earlier D.P.W. map showing structures still visible in 1946. The ACMP volume speculates that Tremer may have excavated in this foundation because it measured approximately 40' x 40' as had the foundation described by Tremer (ACMP 1986: 34). It is still uncertain, however, whether Tremer did any excavations within either of the two geophysical grids identified in Figure 2. The geophysical equipment used did not conclusively detect any earlier excavation units.

III GEOPHYSICAL METHODOLOGY

Two grids were laid out within the triangular wedge. The first grid was a 20 x 20 meter grid on the eastern portion of the property and straddles the trail (Figures 2 and 3). The second grid was a 20 x 20 meter grid laid out on the western edge of the property and was set up to incorporate a linear stone alignment, characteristic of a foundation (Figures 2 and 4). Plastic surveying flags were inserted into the ground every two meters across the grid. A Trimble GeoXT GPS recorder was brought into the field to record the corners of the grid. Nine-inch iron nails were driven into the corners of the grid so that the grid could be relocated for the ground-truthing. These nails will also serve to mark the corners of the grid so that the grid can later be expanded.

Several modern disturbances could be seen in both grids. Numerous small trees had been planted in Grid 1 and a pedestrian trail had been constructed across the grid in the 1990s. A very large utility (storm water drain could be seen to the northwest of Grid 2) and a suspected water outfall was visible to the east of Grid 2. Therefore, there was already a level of complexity seen in both grids as a result of previous disturbances.

Following the establishment of the grids, geophysical data was collected using two or three different complementary instruments (SIR-3000 Ground Penetrating Radar with a 400 MHz antenna, the RM-15 Resistance Meter, and the GEM GSM-19 Gradiometer). Each of these geophysical instruments gathers a different type of data. On its own, each instrument can identify particular types of soil anomalies. However, when used together, these complimentary instruments provide a much more accurate representation of buried features than can any of the instruments used alone.

GPR

The SIR-3000 GPR system with a 400 MHz antenna, manufactured by Geophysical Survey Systems, Inc. (GSSI), was used for the survey, with readings taken along transects separated by a meter. Ground Penetrating Radar units introduce an electromagnetic signal through the antenna into the earth, parts of which are reflected back to the antenna and are recorded in the SIR-3000 controller. Data in Grid 1 was collected on S to N transects moving east while data was collected in Grid 2 along perpendicular X and Y transects. Each transect was collected as a different file. The files

were then uploaded and processed in RADAN 6.6, GSSI's post processing software. After initial processing and filtering, the files were converted into a three dimensional cube and various slices of the cube are illustrated in the figures of this report. These figures also contain interpretations of the data. Animations of time slices through the cube are available on the CD appended to the back of this report. The raw unprocessed data files are also appended to CD in the back of the report.

Resistance

The RM-15 Resistance meter, manufactured by Geoscan Research, was used for the resistance survey, with readings taken every meter along transects separated by 1 meter for a total of 400 readings per twenty by twenty meter grid. Resistance meters, like the RM-15, measure the electrical resistance of the soil. The A-spacing (distance between the probes on the frame) on the RM-15 was set at 1.0 meters apart. This A-spacing should provide readings down to approximately 1 meter of depth. A Twin Array survey was then conducted across the grid with the cable completely unspooled and the two remote probes placed approximately fifteen meters off of the grid. Theoretically, resistance readings will be higher as one passes over a feature like a stone or brick wall and lower when one passes over an in-filled trench or pit containing moist loam. The results were uploaded and processed by the Geoplot V. 3 software, also manufactured by Geoscan Research.

Gradiometer

The GEM GSM-19 Gradiometer is a highly sensitive Overhauser effect gradiometer designed to measure the magnetic field and correct for diurnal magnetic variations. The instrument is primarily designed to identify ferrous (magnetic) features and deposits. For this project, measurements were taken every meter with transects separated by 1 meter for a total of 400 readings for each grid. Theoretically, the magnetic readings will be much higher when one passes over or near ferrous objects and the larger the object, the higher the reading. The magnetic data were uploaded to the GEMLink 3.0 software and exported to Surfer 8.

IV CAUTIONS FOR GEOPHYSICAL DATA

Geophysical instruments like GPR, Magnetometers, and Resistance Meters have been very successful in locating subsurface archeological features. However, each of these instruments has its limitations and none of them should be seen as providing a complete below surface picture of underground remains. Even when used together, the instruments are sometimes wrong. Water and clay attenuate the GPR signal and often provide poor quality data; the GPR depth calculation is problematic[1]; the dielectric constant is rarely constant even though it is assumed to be; resistance meters have a limited depth range;

[1] Depth calculations for the GPR imagery is in my experience, often unreliable. The depth calculation is done after migration is applied to the raw data and the depth estimation is a theoretical calculation. In my experience, depth is usually less than half of the calculated values.

magnetometers are influenced by metals carried by the operators or by people walking around the operators. false positives (identification of anomalies where no features are present) and false negatives (non identification of features) are common as demonstrated through archeology; natural agents (tree roots and rodents) can move soils around and the remnants of these bioturbation agents often mimic cultural features and deposits making interpretation problematic; small features, while registering of high amplitude, are often lost in neighboring high amplitude anomalies; geologic and natural features often mimic cultural features.

At the same time, these geophysical instruments can identify numerous features below the ground that can be confirmed by archeology. Overall, the less complex the soil structure is below the ground, the better geophysics will work, under the right soil conditions and with the correct research design, to identify cultural features and deposits. All of these instruments rely on detecting a contrast between the anomalies and the background. If the features do not contain enough contrast with the background, then geophysics will not work. Archeological excavations, however, should always be done to ground truth the geophysical results. A geophysical assessment should be seen as providing additional data for the archeologist to work with in identifying areas of investigation. It should never be seen as a substitute for Phase I or Phase II excavation.

V GEOPHYSICAL RESULTS

Grid 1

The materials used to construct the path following the old Marrett Street significantly obstruct the ability of the instrumentation to see below it. Numerous utilities are observable in the GPR data running next to this trail on both sides of it. Other potential anomalies are difficult to interpret because the trail obscures much of the unit.

Grid 2

Numerous anomalies can be seen in Grid 2. The line of stones that can be seen on the surface appear to form a foundation. It appears to be approximately 42’ x 26’ comparable to the Meriam House in massing. This appears to be in accord with the 1828 sketch of the Bull Tavern. This anomaly is recommended for future testing.

At least one modern utility can be identified in the grid, running E-W. It appears to be part of a storm drain system, part of which flows to daylight just to the east of the grid. Another utility is also present in the GPR data at the northern end of the grid. This utility appears to terminate at another anomaly on the northern edge of the grid.

Another anomaly appears along the western section of the grid. It is difficult to tell if this anomaly is natural (i.e. bedrock) or cultural. The only metallic anomaly is one off of the western edge of the building foundation. It is difficult to tell its relationship to the

foundation (i.e. if it is outside or inside the foundation wall). This anomaly should also be investigated.

It is difficult to tell if the house foundations are the remnants of the old Bull Tavern site. It appears to be a good candidate for the earlier tavern. Its position on the landscape, the description of it in the historical records, and its size are suggestive that this may be the site. Additional archeological excavation is recommended for the site to ground truth the geophysical results.

Bibliography

Towle, Linda and Darcie MacMahon (ACMP Volume)
1986 Chapter 7 The Bull Tavern Site. In *Archeological Collections Management at Minute Man National Historical Park, Massachusetts, Volume 2*. ACMP Series No. 4, Division of Cultural Resources, North Atlantic Regional Office, National Park Service, Boston, Massachusetts.

Figure 1 Sketch of the Bull Tavern ca. 1828.

Figure 2 Photo-orthoquad illustrating the two project areas.

Figure 3 Photograph of the area in Grid 1. View to the south.

Figure 4 Photograph of the area in Grid 2. View to the north.

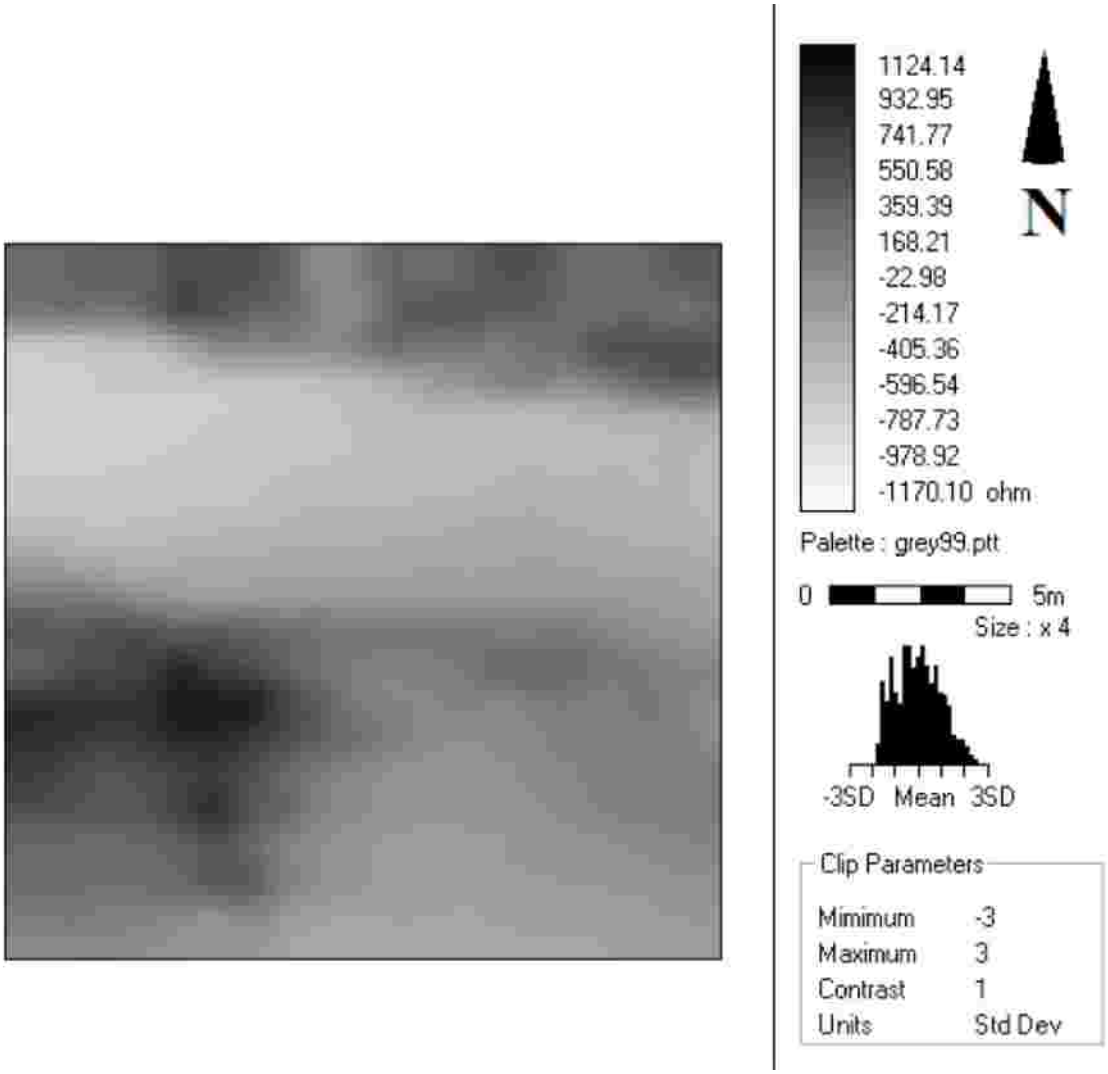
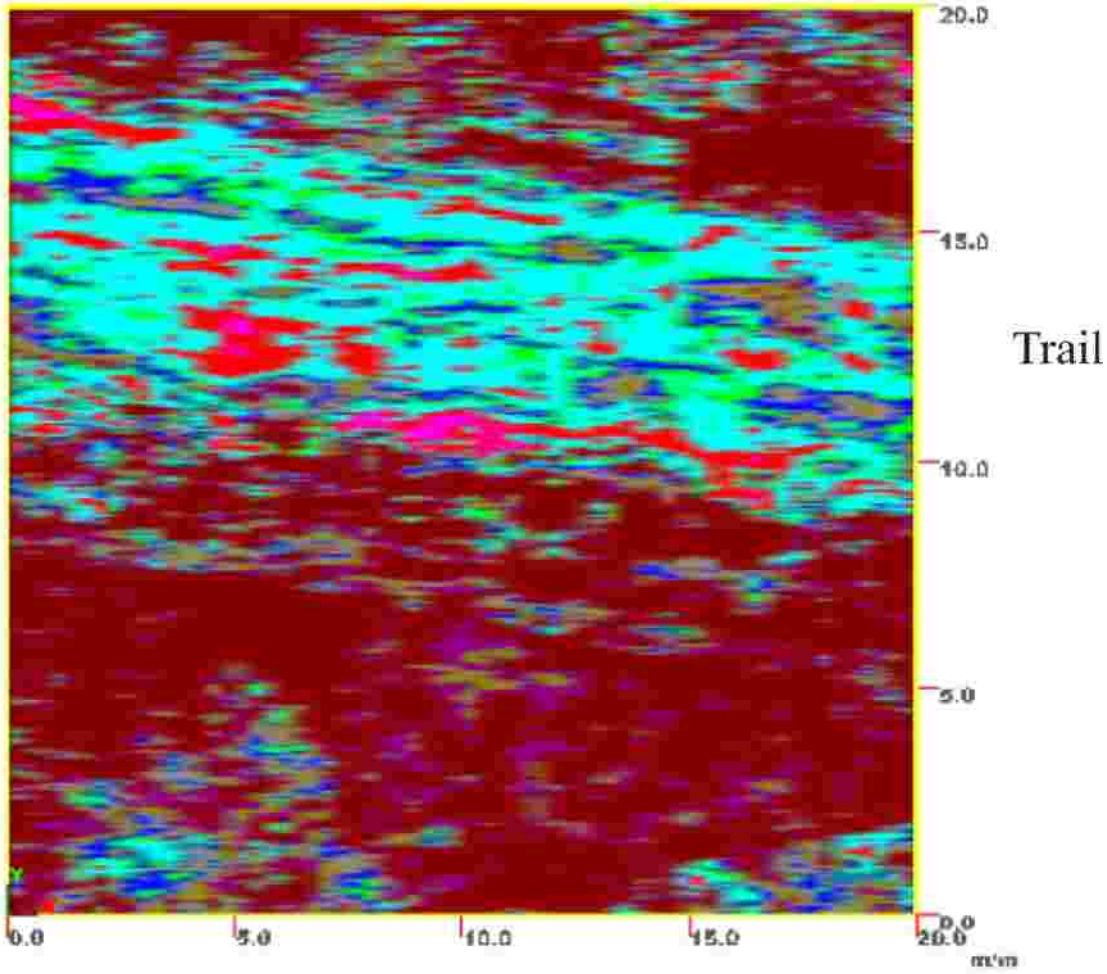


Figure 5 Resistivity plot of Grid 1.

MIMA Geophysical Survey
Bull Tavern Site Grid 1



GPR at 0.1 m

Figure 6 GPR of Grid 1 at approximately 0.1 m.

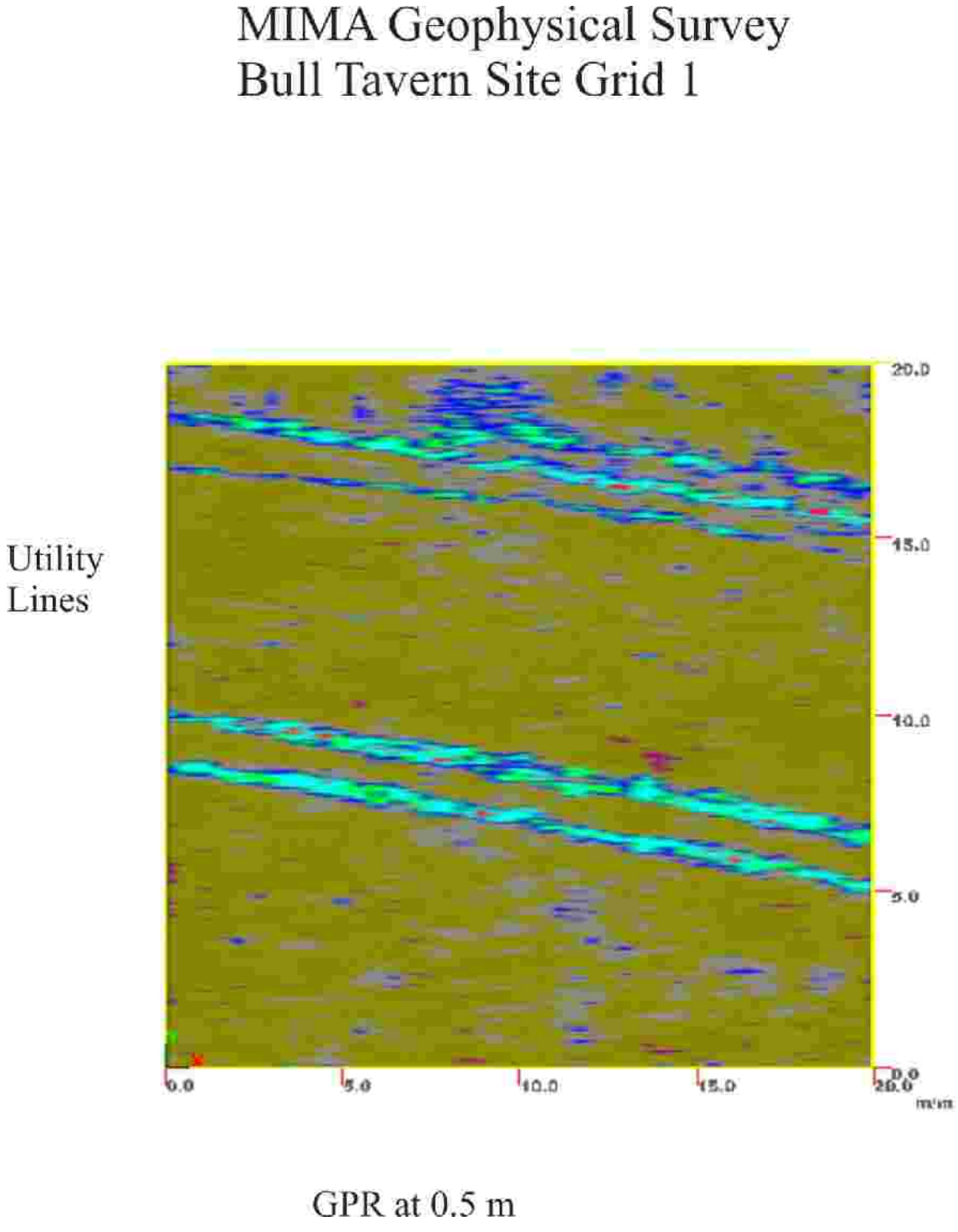


Figure 7. GPR of Grid 1 at approximately 0.5 m

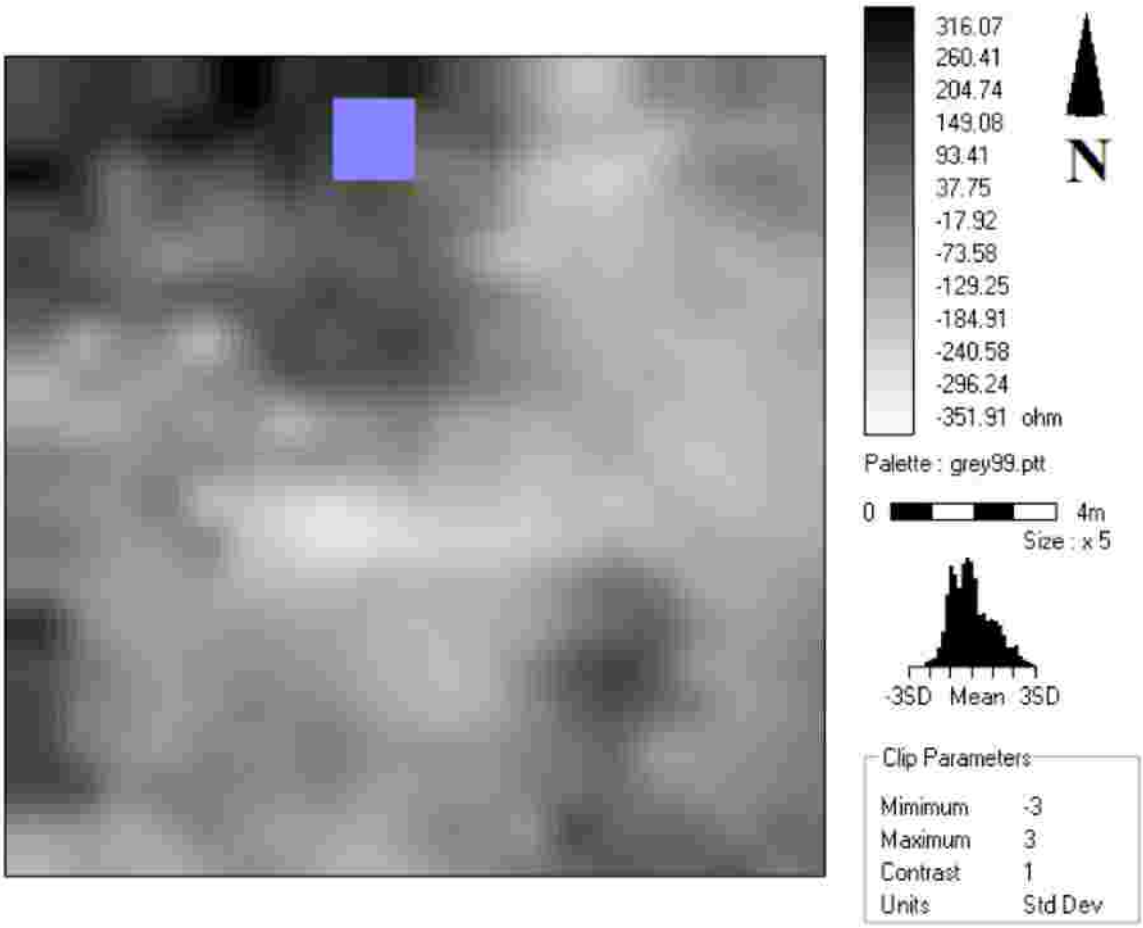
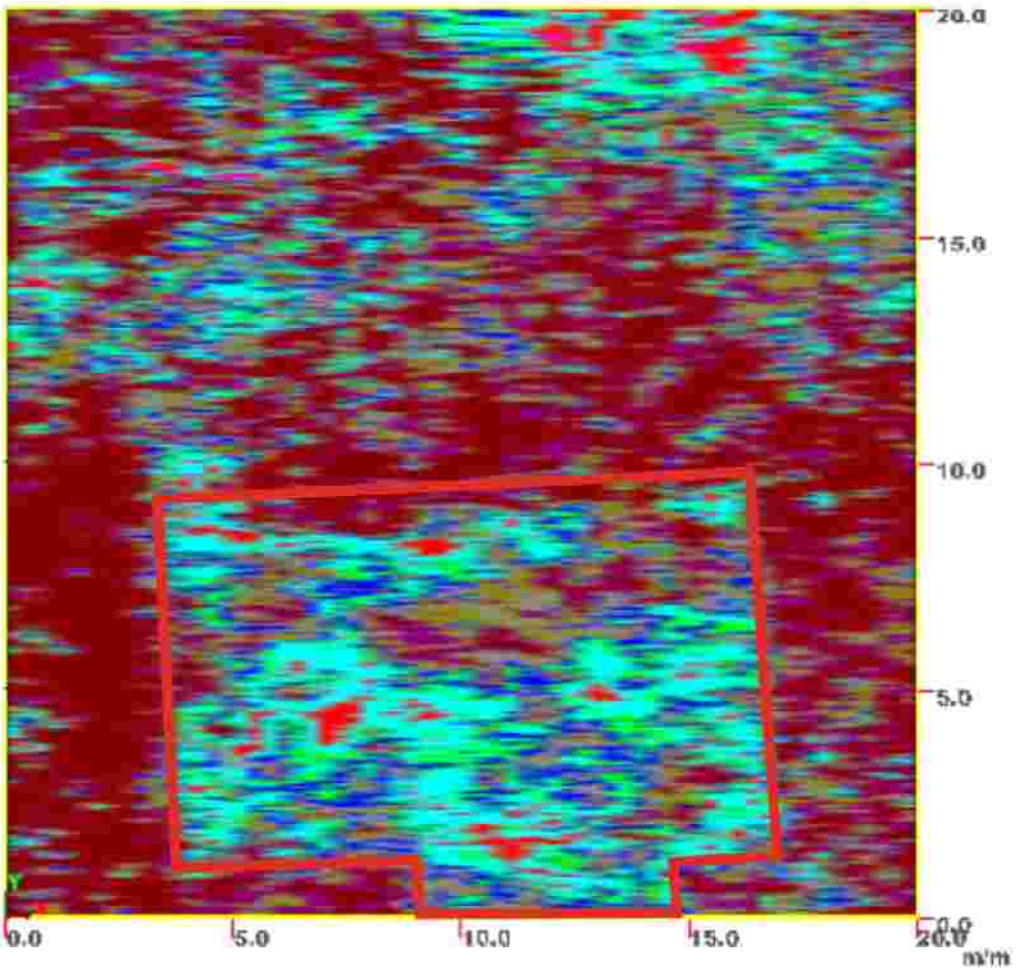


Figure 8 Resistivity plot for Grid 2.

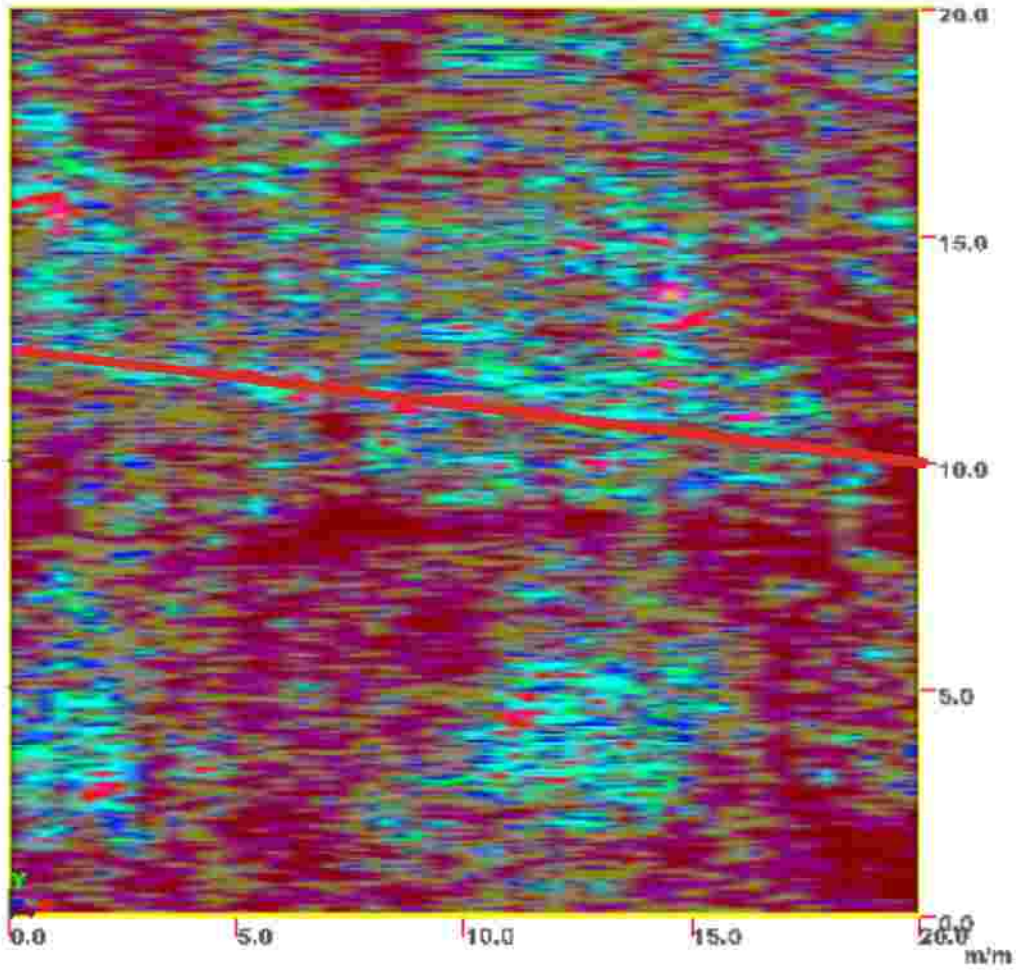
MIMA Geophysical Survey
Bull Tavern Site Grid 2



GPR at 0.4 m

Figure 9 GPR slice at approximately 0.4 m.

MIMA Geophysical Survey
Bull Tavern Site Grid 2



GPR at 0.75 m

Figure 10 GPR slice in Grid 2 at approximately 0.75 m.

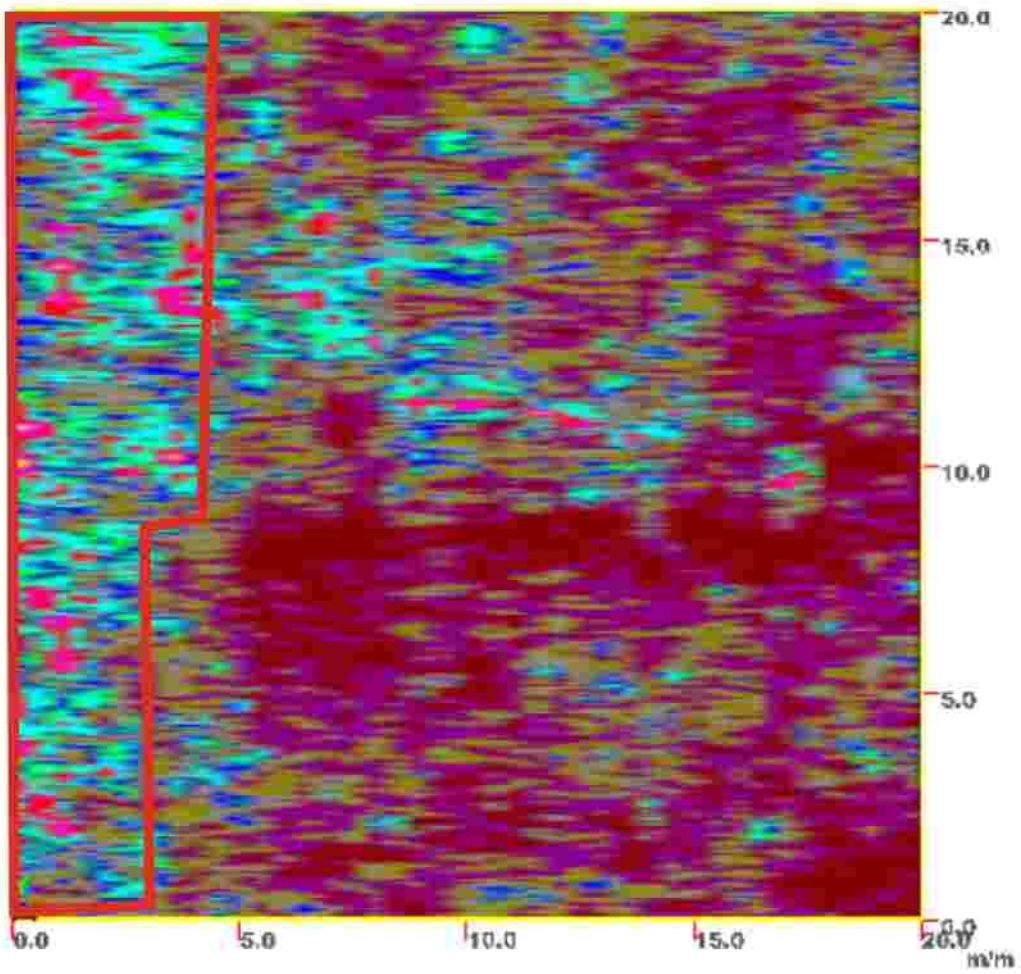


Figure 11 GPR slice in Grid 2 at approximately 1.0 m.

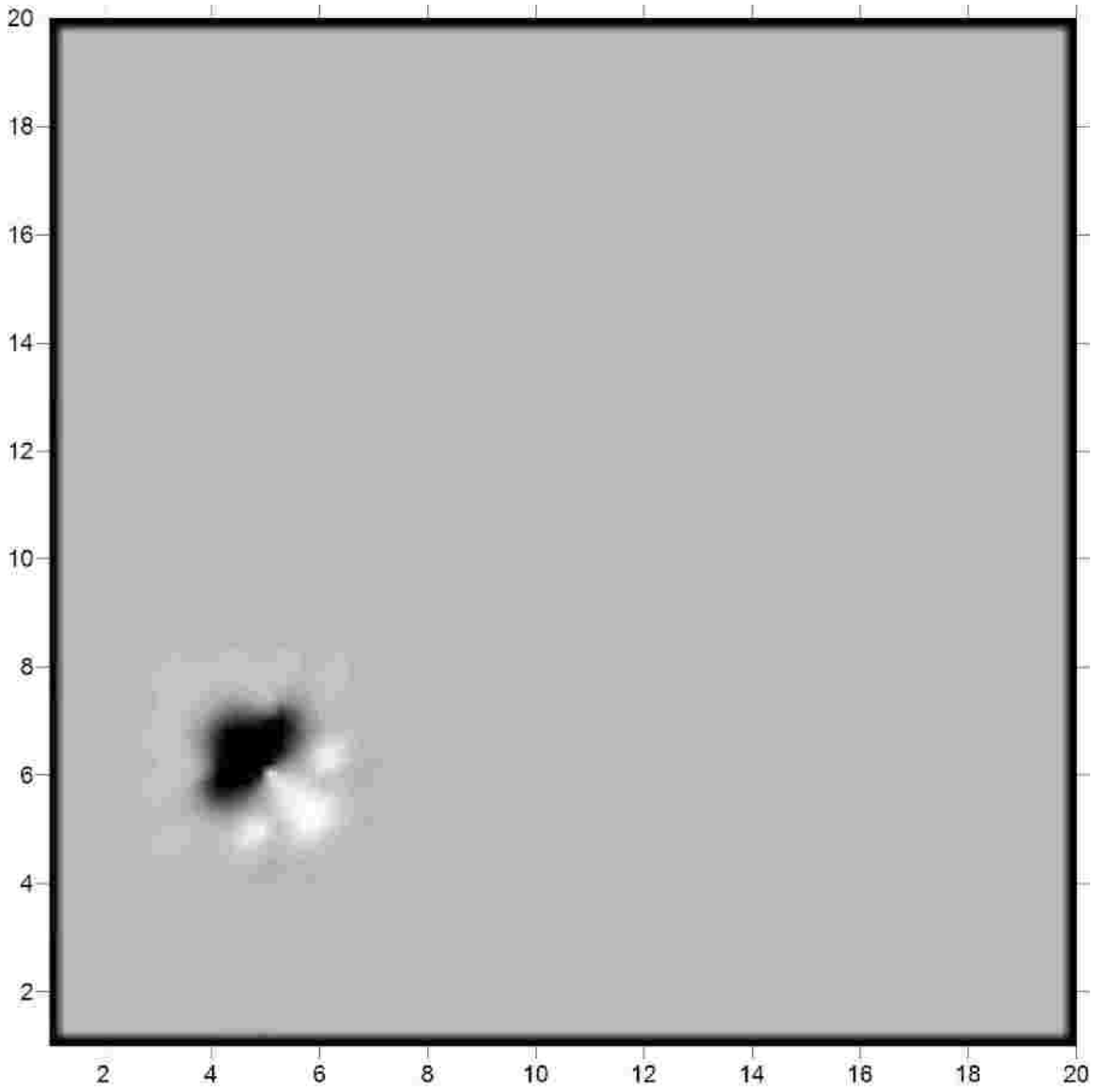


Figure 12. Magnetic plot for Grid 2.

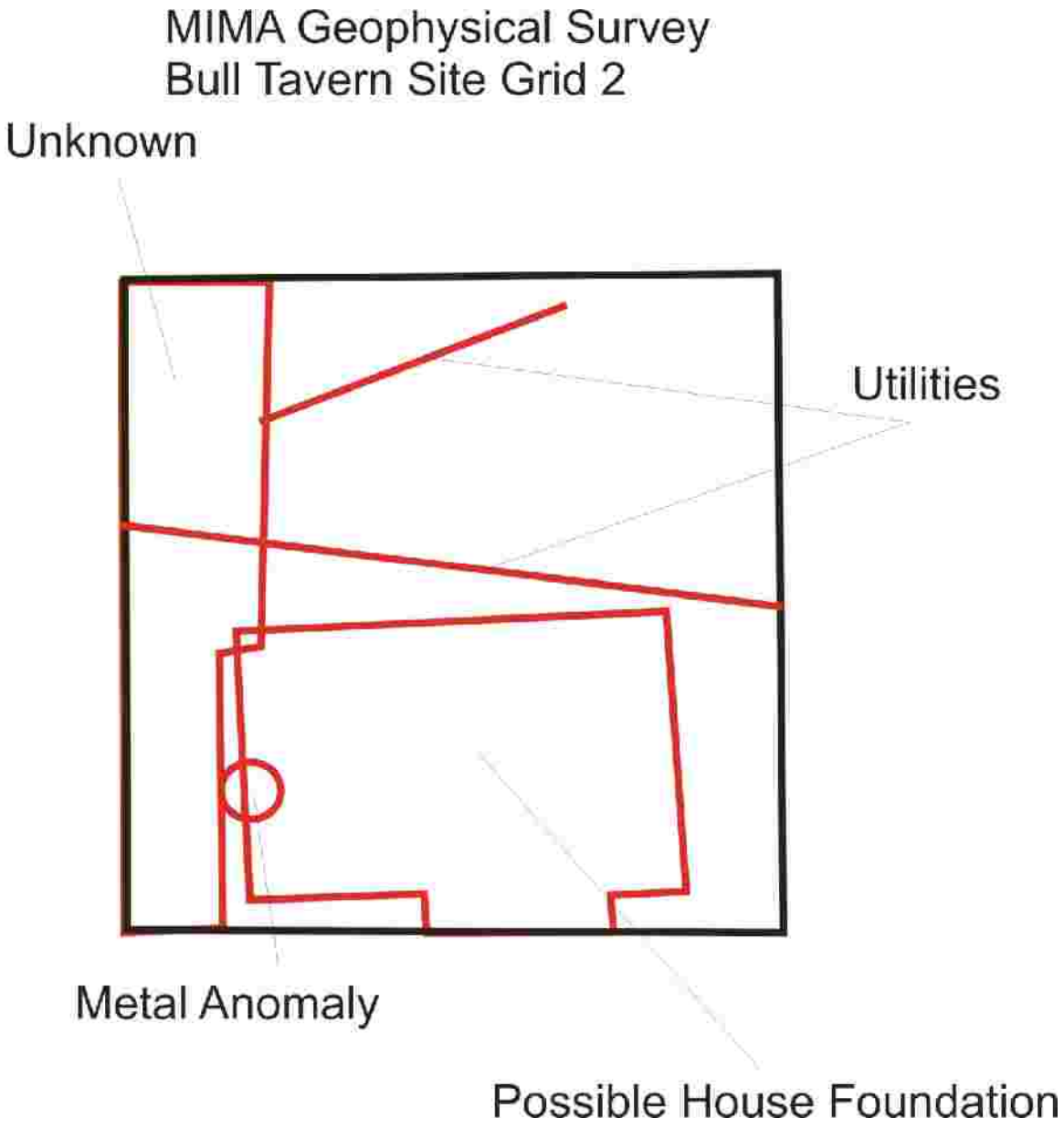


Figure 13 Interpretive map Grid 2.