Ground Penetrating Radar Survey at the Beaufort National Cemetery, Beaufort, South Carolina

LAMAR Institute Publication Series, Report Number 110

The LAMAR Institute, Inc.
Savannah, Georgia
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Preface

The GPR survey project documented in this report was the second GPR survey for the proposed expansion of the Beaufort National Cemetery. A previous study, also conducted by Cypress Cultural Consultants (Battle 2003), employed different technology and technicians from this study. The two areas surveyed in these two studies were, for the most part, completely independent. For more background information on the project and the culture history of the project landscape, readers are directed to Battle’s 2004 report. She provides an excellent historical context for the property.

Ground Penetrating Radar (GPR) consulting services for the present study were provided by Rocquemore Research, Box Springs, Georgia, under subcontract to Cypress Cultural Consultants in June 2004. The results of this work were originally included as Appendix I in a report by Cypress Cultural Consultants to the engineering firm of MACTEC (Elliott 2004; Battle and Battle 2004). This LAMAR Institute publication contains a revised edition of the 2004 GPR survey for the Beaufort National Cemetery Expansion with additional comments.

Elliott (2004) identified many radar reflections within the sampled survey blocks that were suspected to be human burials. Using Elliott’s GPR data, Battle (2004) compiled a list of 46 possible burials (PBLs) in addition to the 27 PBLs that she identified in the previous survey (Battle 2003). Battle (2004) discussed many of the problems that hindered complete identification of potential human graves in the study area, including sinkholes, mortuary “practice” activity, tree roots and trash deposits. She recommended mechanical scraping of the shallow topsoil, prior to any extensive (deep) ground disturbance, in order to determine if additional human remains were present in the development tract.

Following the submission of the two research reports by Cypress Cultural Consultants, ground breaking for the cemetery expansion began. This work started by using heavy equipment to remove the asphalt pavement on the eastern end of President Street. Archaeologists with Cypress Cultural Consultants monitored this work and, almost immediately, human remains were discovered just beneath the pavement. The archaeologists recorded and unearthed a series of infant burials, which were discovered at very shallow depths. The results of this “ground truthing” are not covered by the present report.
Background and Methods

The study area is located in downtown Beaufort, South Carolina, immediately north of the existing Beaufort National Cemetery (Figure 1). The study also included portions of the existing cemetery.

Figure 1. Project Area (U.S.G.S. 1958).

Ground Penetrating Radar (GPR) was developed by the U.S. Department of Defense as an aid in remotely locating Viet Cong tunnels. Since then the technique has been extensively miniaturized and the technological capability enhanced to a point where today a single individual with a minimum of instruction can conduct a GPR survey with ease. The GPR device uses high frequency electromagnetic waves to acquire subsurface data. The device uses a transmitter antenna and closely spaced receiver antenna to detect changes in electromagnetic properties beneath them. The antennas are suspended just above the ground surface and the antennas are shielded to eliminate interference from sources other than directly beneath the device. The transmitting antenna emits a series of electromagnetic waves, which are distorted by differences in soil conductivity, dielectric permitivity, and magnetic permeability. The receiving antenna records the reflected waves for a specified length of time (in
nanoseconds). The approximate depth of an object can be estimated with GPR, by adjusting for electromagnetic propagation conditions.

The GPR sample blocks in the present study were composed of a series of parallel transects, or traverses, which yielded a two-dimensional cross-section or profile of the radar data. This two-dimensional image is constructed from a sequence of thousands of individual radar “pings” or traces. A succession of radar traces bouncing off a large buried object will produce a hyperbola, when viewed graphically in profile. Multiple large objects that are in close proximity may produce multiple, overlapping hyperbolas, which are more difficult to interpret. For example, an isolated historic grave may produce a clear signal, represented by a well-defined hyperbola. A cluster of graves, however, may produce a more garbled signal that is less apparent.

The GPR signals that are captured by the receiving antenna are recorded in array of numerals, which can be converted to gray scale (or color) pixel values. The radargrams are essentially a vertical map of the radar reflection off objects and other soil anomalies. It is not an actual map of the objects. The radargram is produced in real time and is viewable on the computer monitor, which is mounted to the GPR cart.

Ground penetrating radar signals cannot penetrate metal objects and the signals are also significantly affected by the presence of salt water. Metal was expected to be present in the project vicinity and it was anticipated that metal would have some effect on the data that was gathered. The soils were well drained, however, and salt water was not a significant problem at shallower depths. Excessive ground moisture during the survey may have affected the GPR signals. Whatever effect the moisture had, however, was probably equally distributed across the survey sample.

Although radar does not penetrate metal objects, it does generate a distinctive signal that is usually recognizable, particularly for larger metal objects, such as a cannon or man-hole cover. The signal beneath these objects is often canceled out, which results in a pattern of horizontal lines on the radargram. For smaller objects, such as a scatter of nails, the signal may ricochet from the objects and produce a confusing signal. Rebar-reinforced concrete, as another example, generates an unmistakable radar pattern of rippled lines on the radargram. Conyers notes: “Ground-penetrating radar works best in sandy and silty soils and sediments that are not saturated with water. The method does not work at all in areas where soils are saturated with salt water because this media is electrically conductive and ‘conducts away’ the radar energy before it can be reflected in the ground” (Conyers 2002). The effectiveness of GPR in various environments on the North American continent is widely variable and depends on solid conductivity, metallic content, and other pedo-chemical factors. Generally, South Carolina’s coastal soils have moderately good properties for its application.

GPR has been successfully used for archaeological and forensic anthropological applications to locate relatively shallow features, although the technique also can probe deeply into the
ground. The machine is adjusted to best probe to the depth of interest by the use of different frequency range antennas. Higher frequency antennas are more useful at shallow depths, which is most often the case in archaeology. Also, the longer the receiving antenna is set to receive GPR signals (measured in nanoseconds), the deeper the search.

In Georgia, Ervan Garrison and his students have conducted numerous GPR surveys, including investigations at a number of aboriginal earthworks, including Little River mounds in Morgan County and Kolomoki mounds in Early County (Wynn 2002, Friends of Scull Shoals 2002). GPR also has been used to map portions of the Old Athens Cemetery in Clarke County (National Center for Preservation Technology and Training and USDA Forest Service, Southeast Region 2002). GPR has been used with success in the South Carolina interior coastal plain to map the stratigraphy of Carolina Bays. Carolina Bays, which are natural wetland features of undetermined origin, typically have deep sand deposits on their rims and these areas often contain deeply buried archaeological deposits (Brooks et al. 2002).

GPR is particularly well suited for the delineation of historic cemeteries, for example, the Bozeman site in Clark County, Arkansas (Kvamme 2002). Historic graves are often easy to recognize in radargrams, as evidenced by a pronounced hyperbola. When 3-D slices intersect these hyperbolas the graves are usually clearly evident in plan view. When a series of graves are closely spaced, however, the grave radar “signature” is less clear-cut. By slicing the radar data at various depths along the hyperbola, the aerial perspective can be refined for optimal viewing and recognition. Since not all graves were dug to the same depth, 3-D slices at different depths can often yield very different views of graves in plan by varying the slice only a few centimeters.

GPR was employed using the RAMAC X3M system to study 18th and 19th century archaeological resources at several sites in coastal Georgia. The first study was at the New Ebenezer town site in Effingham County, Georgia, as well as, the colonial-era Horton House site in Glynn County, Georgia (Elliott 2002; Rita Elliott et al. 2002). The results of the GPR work at New Ebenezer were quite exciting and included the delineation of a large portion of a British redoubt palisade ditch and the discovery of several dozen previously unidentified human graves. New Ebenezer is located on a high Pleistocene shoreline terrace immediately adjacent to the Savannah River, approximately 25 miles upstream from the town of Savannah. Soils at Ebenezer are derived from coastal sands.

At the Horton House on Jekyll Island, GPR was used to locate buried ditch work, possibly of a defensive nature, and to locate a probable cellar. The GPR was used within, and immediately outside of, a small family cemetery enclosure to search for unmarked graves. The soils at the Horton House, although considerably younger and less consolidated than New Ebenezer, were very sandy. A distinctive difference between the New Ebenezer and Horton House sites was the absence of oyster shell at New Ebenezer.

The equipment used for this study consisted of a RAMAC/X3M Integrated
Radar Control Unit, mounted on a wheeled-cart and linked to a RAMAC Monitor. A 500 megahertz (MHz) shielded antenna was used for the data gathering. MALÅ GeoScience’s Windows-based acquisition software program GroundVision (Version 1.3.6) was used to acquire and record the radar data (MALÅ GeoScience USA 2002). The radar information was displayed as a series of radargrams, or radar profiles of each transect. Easy 3D software (Version 1.2.1), which was developed by MALÅ GeoScience, and GroundVision (Version 1.4.1) were used in post-processing the radar data and 3-D imaging. This entailed merging the data from the series of radargrams for each block to generate time slices. Once this was accomplished, horizontal slices of the data were examined by Mr. Elliott for important anomalies and patterns of anomalies, which were likely of cultural relevance. These data were displayed as aerial plan maps of the sample areas at varying depths below ground surface. These horizontal views, or time-slices, display the radar information at a set time depth in nanoseconds. Time-depth can be roughly equated to depth below ground. This equivalency relationship can be calculated using a mathematical formula.

Upon arrival at the site, the RAMAC X3M Radar Unit was set up for the operation and calibrated. A series of test lines and test grid blocks were conducted to test the machines operational capability and to better understand the soil conditions and radar properties in the study area. These included GPR Block 19, which was a pipe calibration test. For this test a backhoe was used to excavate a small trench and a 1 inch diameter steel pipe was drive horizontally into the trench profile at 50 cm depth below ground surface. The GPR machine was then passed across the pipe in three transects. The RAMAC machine was set for wet sand conditions (velocity) during this test, and throughout the survey project. This setting proved to be on the mark, as the pipe was identified on the radargrams at approximately 50 cm depth.

Although the time zero was frequently reset, the other settings remained constant throughout the survey. This consistency allows for comparison between sample blocks. The number of stacks refers to trace stacking, which is a method of averaging traces to filter out noise. An automatic stacking feature was used for all data collection in the present study. The time window that was selected allowed data gathering to focus on the upper 1.5 meters of soil, which was the zone most likely to yield archaeological deposits. Additional filters were used to refine the radar information during post-processing. These include adjustments to the gain. These alterations to the data are reversible, however, and do not affect the original data that was collected.

This same combination of GPR equipment and radar imaging software was used previously at the cemetery sites in coastal Georgia, including New Ebenezer, Horton House, and Sunbury, with very satisfactory results (Elliott 2002; Rita Elliott et al. 2002; Elliott 2003).
Results

The ground penetrating radar survey was conducted from June 14 to 18, 2004 with post-processing conducted following the field survey in late June and early July 2004. Mr. Elliott was assisted by Daphne Owens Battle, Dan Battle, Mike Benton, and Rita Folse Elliott. The survey examined 28 sample areas (designated Blocks 1 through 28), covering an area of approximately 7,924.4 m². These locations, dimensions, and other attributes of these GPR Blocks are itemized in Table 1. Additional views of the GPR blocks are presented in Appendix 1.

<table>
<thead>
<tr>
<th>Block</th>
<th>Location</th>
<th>SW</th>
<th>Length (m)</th>
<th>Width (m)</th>
<th>Area (m²)</th>
<th>Axis</th>
<th>Field Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>National St., Intersection Rogers St.</td>
<td>6S 103E</td>
<td>50</td>
<td>5.5</td>
<td>275</td>
<td>EW</td>
<td>Asphalt surface</td>
</tr>
<tr>
<td>2</td>
<td>National St., West of Block 1</td>
<td>6S 53E</td>
<td>50</td>
<td>6</td>
<td>300</td>
<td>EW</td>
<td>Asphalt surface</td>
</tr>
<tr>
<td>3</td>
<td>National St., West of Block 2</td>
<td>6S 3E</td>
<td>50</td>
<td>6</td>
<td>300</td>
<td>EW</td>
<td>Asphalt surface</td>
</tr>
<tr>
<td>4</td>
<td>National St., West of Block 3</td>
<td>6S 47W</td>
<td>50</td>
<td>6</td>
<td>300</td>
<td>EW</td>
<td>Asphalt surface</td>
</tr>
<tr>
<td>5</td>
<td>National St., West of Block 4</td>
<td>6S 97W</td>
<td>50</td>
<td>6</td>
<td>300</td>
<td>EW</td>
<td>Asphalt surface</td>
</tr>
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<td>National St., West of Block 5</td>
<td>6S 147W</td>
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<td>6</td>
<td>300</td>
<td>EW</td>
<td>Asphalt surface</td>
</tr>
<tr>
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<td>National St., West of Block 6</td>
<td>6S 197W</td>
<td>50</td>
<td>6</td>
<td>300</td>
<td>EW</td>
<td>Asphalt surface</td>
</tr>
<tr>
<td>8</td>
<td>National St., West of Block 7</td>
<td>6S 247W</td>
<td>50</td>
<td>6</td>
<td>300</td>
<td>EW</td>
<td>Asphalt surface</td>
</tr>
<tr>
<td>9</td>
<td>Beaufort National Cemetery, Ft. Wagner graves</td>
<td>8</td>
<td>5.5</td>
<td>44</td>
<td>EW</td>
<td>19 wooden caskets, ca. 1988</td>
<td></td>
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<tr>
<td>10</td>
<td>Beaufort National Cemetery, Section 63 Row 4</td>
<td>19</td>
<td>2</td>
<td>38</td>
<td>EW</td>
<td>15 tombstones, most recent 1900</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Beaufort National Cemetery, Section 62 Row 1</td>
<td>13</td>
<td>2</td>
<td>26</td>
<td>EW</td>
<td>9 tombstones, most recent 1989</td>
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<td>12</td>
<td>Beaufort National Cemetery, Section 45 Row 9</td>
<td>5.5</td>
<td>2</td>
<td>11</td>
<td>EW</td>
<td>4 tombstones, most recent 2001</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Beaufort National Cemetery, Section 2 Row 3</td>
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<td>2</td>
<td>14</td>
<td>EW</td>
<td>5 tombstones</td>
<td></td>
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<td>Beaufort National Cemetery, Section 42 Row 2</td>
<td>9</td>
<td>2</td>
<td>18</td>
<td>EW</td>
<td>6 tombstones, most recent 1964</td>
<td></td>
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<td>15</td>
<td>Beaufort National Cemetery, Section 50 Row 6</td>
<td>20.5</td>
<td>2</td>
<td>41</td>
<td>EW</td>
<td>13 tombstones, most recent 1996</td>
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</tr>
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<td>16</td>
<td>Area North of 2003 GPR Survey</td>
<td>50N 0E</td>
<td>68.5</td>
<td>20</td>
<td>1370</td>
<td>EW</td>
<td>Wooded</td>
</tr>
<tr>
<td>17</td>
<td>North end of study area</td>
<td>20</td>
<td>8</td>
<td>160</td>
<td>NS</td>
<td>Wooded</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Area East of 2003 GPR Survey</td>
<td>0N 0E</td>
<td>50</td>
<td>40</td>
<td>2000</td>
<td>NS</td>
<td>Grassy field and dirt road</td>
</tr>
<tr>
<td>19</td>
<td>Calibration Pipe Test</td>
<td></td>
<td>5</td>
<td>1</td>
<td>5</td>
<td>EW</td>
<td>1 inch steel pipe at 50 cm depth</td>
</tr>
<tr>
<td>21</td>
<td>North of Block 2, West of Block 20</td>
<td>0N 103E</td>
<td>50</td>
<td>13.5</td>
<td>675</td>
<td>EW</td>
<td>Field</td>
</tr>
<tr>
<td>22</td>
<td>4 m North of Block 3, West of Block 21</td>
<td>4N 53E</td>
<td>50</td>
<td>8.5</td>
<td>425</td>
<td>EW</td>
<td>Field, trees along road edge</td>
</tr>
<tr>
<td>23</td>
<td>4 m North of Block 4, West of Block 22</td>
<td>4N 3E</td>
<td>12.8</td>
<td>8</td>
<td>102.4</td>
<td>EW</td>
<td>Field, trees along road edge</td>
</tr>
<tr>
<td>24</td>
<td>National St., Same path as Block 1</td>
<td>6S 103E</td>
<td>50</td>
<td>6</td>
<td>275</td>
<td>EW</td>
<td>Asphalt surface</td>
</tr>
<tr>
<td>25</td>
<td>Beaufort National Cemetery, Section 57 Row 12</td>
<td>23</td>
<td>3</td>
<td>69</td>
<td>EW</td>
<td>34 tombstones, most recent 1997</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>Area of 2003 GPR survey</td>
<td>32</td>
<td>3.5</td>
<td>112</td>
<td>NS</td>
<td>Wooded, PBLs 1, 2, 17, 33, and 37</td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>Area of 2003 GPR survey</td>
<td>32</td>
<td>3.5</td>
<td>112</td>
<td>NS</td>
<td>Wooded, PBLs 1, 2, 17, 33, and 37</td>
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</tr>
<tr>
<td>28</td>
<td>Area of 2003 GPR survey</td>
<td>13</td>
<td>4</td>
<td>52</td>
<td>NS</td>
<td>Wooded, PBLs 23 and 24</td>
<td></td>
</tr>
</tbody>
</table>

Total area of GPR coverage 7924
Total coverage (excluding resurvey) 7373
Total coverage (within National Cemetery) 536

GPR Blocks 1 through 8

GPR Blocks 1 through 8 formed a contiguous polygon, which had a maximum extent of 6 m North-South and 400 m East-West. Transects were made on East and West directions and survey transects progressed from South to North. The transect interval spacing used for all eight of these sample blocks was 50 cm.
East datum. GPR Block 1 comprised radar transects 27 to 36 (or Line 27 to 36). Two clusters of strong radar anomalies were evidenced in Block 1. One cluster was near the intersection of Rogers Street and National Street and the second cluster was located from 28 to 38 m to the north. An aerial view of Block 1 at approximately 60 cm below ground surface is illustrated in Figure 2. While subsurface disturbance near the street intersection may represent buried utilities or other modern disturbances, the possibility that some of these radar anomalies represent human graves cannot be ruled out. The western cluster of strong radar anomalies also may represent human burials. PBL Numbers 33 and 34 were assigned to suspicious anomalies in the eastern cluster and PBL Numbers 35 and 36 were assigned to suspicious anomalies in the western cluster. Additional archaeological testing of both portions of Block 1 to determine the presence or absence of human burials is recommended.

Figure 2. GPR Block 1, Aerial View at 60 cm B.S. Showing Strong Radar Anomalies.
GPR Block 2 was located immediately West of Block 1 and comprised radar transects 37 to 47. The southwest corner of Block 2 was at 6m South, 53 m East of the 0 North, 0 East datum. The GPR radargrams on the northern side of this block were strongly affected by the roots of large oak trees that fringe that side of National Street. No probable burials were identified within Block 2 from the radar data. An aerial view of this GPR block at 60 cm below surface is provided in Appendix 1.

GPR Block 3 was located immediately West of Block 2 and comprised radar transects 48 to 58. The southwest corner of Block 3 was at 6m South, 3 m East of the 0 North, 0 East datum. The GPR radargrams on the northern side of this block were strongly affected by the roots of large oak trees that fringe that side of National Street. No probable burials were identified within Block 3 from the radar data. An aerial view of this GPR block at 60 cm below surface is provided in Appendix 1.

GPR Block 4 was located immediately West of Block 3 and comprised radar transects 59 to 69. The southwest corner of Block 4 was at 6m South, 47 m West of the 0 North, 0 East datum. The GPR radargrams on the northern side of this block were strongly affected by the roots of large oak trees that fringe that side of National Street. No probable burials were identified within Block 4 from the radar data. An aerial view of this GPR block at 60 cm below surface is provided in Appendix 1.

GPR Block 5 was located immediately West of Block 4 and comprised radar transects 70 to 80. The southwest corner of Block 5 was at 6m South, 97 m West of the 0 North, 0 East datum. Block 5 exhibited four strong anomalies that may represent human graves. These were designated PBL Numbers 37, 38, 39, and 52 (Figure 3). Additional archaeological testing of these anomalies is recommended to determine the presence or absence of human burials in Block 5.
GPR Block 6 was located immediately West of Block 5 and comprised radar transects 81 to 91. The southwest corner of Block 6 was at 6m South, 147 m West of the 0 North, 0 East datum. The GPR radargrams on the northern side of this block were strongly affected by the roots of large oak trees that fringe that side of National Street. Figure 4 shows an aerial view of Block 6 at 60 cm below ground. Additional archaeological testing of these anomalies is recommended to determine the presence or absence of human burials in Block 6.
GPR Block 7 was located immediately West of Block 6 and comprised radar transects 92 to 102. The southwest corner of Block 7 was at 6m South, 197 m West of the 0 North, 0 East datum. PBL Numbers 42 and 43 were assigned to strong anomalies in Block 7. These are shown in Figure 5. Additional archaeological testing of these anomalies is recommended to determine the presence or absence of human burials in Block 7.
GPR Block 8 was located immediately West of Block 7 and comprised transects 103 to 113. The southwest corner of Block 8 was at 6m South, 247 m West of the 0 North, 0 East datum. PBL Numbers 44, 45, 46, 47, 48, and 53 were assigned to strong radar anomalies in Block 8. These are shown in Figure 6. Additional archaeological testing of these anomalies is recommended to determine the presence or absence of human burials in Block 8.
**GPR Block 24**

GPR Block 24 was a resurvey of the same area encompassing GPR Block 1 but differed by using the use of an 800 mHz antenna and more transects with 25 cm spacing interval. This particular antenna is often more effective for identifying radar anomalies at very shallow depths. This sample block measured 50 m by 6 m. Its southwest corner was 6 m South, 103 m North. The results of this GPR sample were less informative than that observed in GPR Block 1. Consequently, the data from Block 24 provided little new information about the subsurface anomalies in this vicinity. This sample confirmed that the 500 mHz antenna was probably better suited to the soil conditions in the study area for detecting possible graves than the 800 mHz antenna. An aerial view of this GPR block at 60 cm below surface is provided in Appendix 1.
**GPR Blocks 18 and 21 through 23**

GPR Blocks 21 through 23 was located north of GPR Blocks 2 through 4. Blocks 22 and 23 were offset from the northern edge of National Street 4.5 m to 4 m, respectively, to avoid large tree obstacles that flanked the road. The western end of GPR Block 23 connected with the eastern end of GPR Block 18.

GPR Block 21 was located immediately North of Block 2. This sample measured 50 m by 13.5 m and encompassed an area of 75 m². The southwest corner of Block 21 was 0 m North, 103 m East of the 0 m North, 0 m East datum. No potential burial anomalies were identified in Block 21.

GPR Block 22 was located immediately West of Block 21. This sample measured 50 m by 8.5 m and encompassed an area of 425 m². The southwest corner of Block 22 was 4 m North, 53 m East of the 0 m North, 0 m East datum. No potential burial anomalies were identified in Block 22.

GPR Block 23 was located immediately West of Block 22. This sample measured 12.8 m by 8 m and encompassed an area of 102.4 m². The southwest corner of Block 23 was 4 m North, 3 m East of the 0 m North, 0 m East datum. No potential burial anomalies were identified in Block 23.

GPR Block 18 was located immediately West of Block 23. This sample measured 50 m by 40 m and encompassed an area of 2000 m². The southwest corner of Block 18 was at 0 m North, 0 m East. This sample block covered a large portion of the yard of the former South Carolina National Guard Armory. Consequently, soils in this vicinity have been extensively disturbed for various purposes. This area has been used as a training area for newly hired backhoe operators, in association with the Beaufort National Cemetery. Cemetery employees noted that numerous practice backhoe trenches have been excavated in this area in years past. In addition this area is riddled with a series of utility ditches connected with the Armory facilities. No PBL numbers were assigned to any of the GPR anomalies within Block 18.

**GPR Blocks 16 and 17**

GPR Blocks 16 and 17 were located on the northwestern portion of the study area. GPR Block 16 was located immediately north of the area of the 2003 GPR survey. This sample measured 68.5 m East-West by 20 m North-South and encompassed an area of 2000 m². The southwest corner of Block 16 was 50 m North, 0 m East of the 0 m North, 0 m East datum. This area was forested and the understory vegetation was recently removed. This area also contained many pieces of discarded metal and other recent debris. GPR 16 did not yield any substantial GPR anomalies indicative of human burials.

GPR Blocks 17 was located in the woods on the northern end of the study area. This sample measured 20 m North-South by 8 m East-West. Several large depressions were noted by the archaeologists during clearing of the vegetation in the vicinity of Block 17. These depressions were tentatively considered to be potential graves and the area was designated for additional inspection as part of the 2004 GPR Survey. The GPR survey of this area identified many suspicious radar anomalies that may represented human burials. PBL Numbers 54, 55 and 56 were assigned to three of these anomalies. Additional archaeological testing these locations is recommended.
to determine the presence or absence of burials in Block 17.

**Figure 7. GPR Block 17, Aerial View at 60 cm B.S.**

**GPR Blocks 9 through 15 and Block 25**

Eight GPR grid blocks were surveyed within the confines of the existing Beaufort National Cemetery. These samples covered area of known burials from various time periods since the cemetery was established. None of the radar signatures for Blocks 9-15 and 25 were assigned any PBL Numbers, since these sample blocks are within the existing National cemetery. The first area to be examined was in GPR Block 9.

GPR Block 9 examined an area where a reburial of soldiers who were exhumed...
from the Fort Wagner vicinity was exhumed in the late 1980s. These veterans were reburied in 19 wooden caskets within an area measuring no larger than 8 m by 6 meters. GPR Block 9 measured 8 meters by 5.5 meters and covered an area of approximately 44 m². An aerial view of this sample block at approximately 60 cm below ground shows a concentration of radar anomalies that probably correlate to these graves (Figure 8). These graves appear to form a tight cluster on the western one-half of the sample block.

**Figure 8. GPR Block 9, Plan View at 60 cm B.S.**

GPR Block 10 examined Section 63, Row 4 of the cemetery. It measured 19 m by 2 m and covered a total of 38 m². This sample was marked by 15 military tombstones with the most recent dated 1900. Three views of Block 10 are illustrated in Appendix 1. The first shows an aerial view of the block at approximately 60 cm below ground. In that view, no more than 10 anomalies correlate to probable graves. In the 3-D view the numerous radar anomalies that are visible from 60 to 90 cm below ground are most apparent. The third view shows a front view of the sample block profile and at least five probable burials are pointed out (Figure 9). One of these probably represents a coffin with strong metal content. The broken surface soils on this view are also indicative of the burial activity.
Figure 9. Front View of Block 10 Showing Probable Burial Anomalies.

Block 11 examined Section 62, Row 1 of the cemetery. It measured 13 m by 2 m and covered a total of 26 m². This sample was marked by 9 military tombstones and the most recent was dated 1989. In the aerial view at 60 cm below ground, however, only 3 to 5 possible burials are apparent (Appendix 1).

Block 12 examined Section 45, Row 9 of the cemetery. It measured 5.5 m by 2 m and covered a total of 11 m². This sample was marked by four military tombstones and the most recent was dated 2001. In the aerial view at 60 cm below ground, at least 3 possible burials are apparent (Appendix 1).

Block 13 examined Section 2, Row 3 of the cemetery. It measured 7 m by 2 m and covered a total of 14 m². This sample was marked by five military tombstones. In the aerial view at 60 cm below ground, at least 5 possible burials are apparent (Appendix 1).

Block 14 examined Section 42, Row 2 of the cemetery. It measured 9 m by 2 m
and covered a total of 18 m². This sample was marked by 18 military tombstones and the most recent was dated 1964. In the aerial view at 60 cm below ground, fewer than 8 possible burials are apparent (Appendix 1). A front view of this sample block, however, shows four strong probable burial anomalies (Appendix 1).

Block 15 examined Section 50, Row 6 of the cemetery. It measured 20.5 m by 2 m and covered a total of 41 m². This sample was marked by 41 military tombstones and the most recent was dated 1996. In the aerial view at 60 cm below ground, fewer than 15 possible burials are apparent (Appendix 1).

Block 25 examined Section 57, Row 12 of the cemetery. It measured 23 m by 3 m and covered a total of 69 m². This sample was marked by 34 military tombstones and the most recent was dated 1997. This GPR sample differed from the others conducted in the National Cemetery by the use of an 800 mHz antenna, instead of the 500 mHz. GPR Line 520 revealed approximately 15 strong anomalies that probably represent graves. GPR Line 522 revealed approximately 10-15 strong anomalies.

**GPR Blocks 27 and 28**

GPR Blocks 27 and 28 reexamined areas that were previously surveyed in 2003. The purpose of this exercise was to gain a better understanding of the comparability of the two surveys. This comparison was deemed necessary because different hardware, software, and machine operators were used in the two studies. Block 27 was selected because it crossed a series of obvious grave depressions. While this survey was underway, one tomb marker was discovered buried beneath the humus, which substantiated the presence of human burials in this grid block. An aerial view of Block 27 at 60 cm below surface is provided in Appendix 1. It shows numerous large anomalies that probably correspond to human burials. These were also clearly apparent in the radargrams from this block. Clearly, this part of the study area contains many human burials, including some that are not apparent from surface topography.

Block 28 was placed over an area where the 2003 survey had identified two PBLs. This area contained no surface evidence of any graves. An aerial view of Block 27 at 60 cm below surface is provided in Appendix 1. This map shows at least two strong anomalies that are possible human graves. Others also may be present in this area. The reexamination of this part of the study area confirms the need for additional archaeological testing to determine if human burials are present in this vicinity.

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Summary

Ground Penetrating Radar (GPR) survey of major portions of an area north of the Beaufort National Cemetery in Beaufort County, South Carolina completed in June 2004. The results of this work were successful and indicate that this technique has useful application for archaeological sites in this environment.

The survey examined 28 sample blocks, which covered an area of approximately 7,924.4 m². These blocks were numbered and selected images and unprocessed radar data from these blocks are contained in Appendix 1.

Blocks 1, 5, 6, 7, 8, and 17 revealed 24 strong radar anomalies that may represent human burials. These were assigned PBL Numbers 33 through 56. Additional archaeological study was recommended in the vicinity of these PBLs by this author. The locations of these anomalies were provided earlier in this report. These PBLs are summarized in Table 2.

Battle (2004) interpreted these GPR data, employing a more cautious approach for identifying potential burials (PBLs). A plan map showing the extent of GPR survey coverage and numbered PBLs is reproduced here as Figure 10.

<table>
<thead>
<tr>
<th>Block</th>
<th>Possible Burial Locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>33; 34; 35; 36</td>
</tr>
<tr>
<td>2</td>
<td>None identified</td>
</tr>
<tr>
<td>3</td>
<td>None identified</td>
</tr>
<tr>
<td>4</td>
<td>None identified</td>
</tr>
<tr>
<td>5</td>
<td>37; 38; 39; 52</td>
</tr>
<tr>
<td>6</td>
<td>40; 41; 49; 50; 51</td>
</tr>
<tr>
<td>7</td>
<td>42; 43</td>
</tr>
<tr>
<td>8</td>
<td>44; 45; 46; 47; 48; 53</td>
</tr>
<tr>
<td>9</td>
<td>N/A within existing National Cemetery</td>
</tr>
<tr>
<td>10</td>
<td>N/A within existing National Cemetery</td>
</tr>
<tr>
<td>11</td>
<td>N/A within existing National Cemetery</td>
</tr>
<tr>
<td>12</td>
<td>N/A within existing National Cemetery</td>
</tr>
<tr>
<td>13</td>
<td>N/A within existing National Cemetery</td>
</tr>
<tr>
<td>14</td>
<td>N/A within existing National Cemetery</td>
</tr>
<tr>
<td>15</td>
<td>N/A within existing National Cemetery</td>
</tr>
<tr>
<td>16</td>
<td>None identified</td>
</tr>
<tr>
<td>17</td>
<td>54, 55, 56</td>
</tr>
<tr>
<td>18</td>
<td>None identified</td>
</tr>
<tr>
<td>19</td>
<td>N/A Calibration Test Only</td>
</tr>
<tr>
<td>20</td>
<td>N/A within existing National Cemetery</td>
</tr>
<tr>
<td>21</td>
<td>None identified</td>
</tr>
<tr>
<td>22</td>
<td>None identified</td>
</tr>
<tr>
<td>23</td>
<td>None identified</td>
</tr>
<tr>
<td>24</td>
<td>None identified</td>
</tr>
<tr>
<td>25</td>
<td>N/A within existing National Cemetery</td>
</tr>
<tr>
<td>26</td>
<td>N/A within existing National Cemetery</td>
</tr>
<tr>
<td>27</td>
<td>N/A within previously surveyed area (Battle 2003)</td>
</tr>
<tr>
<td>28</td>
<td>N/A within previously surveyed area (Battle 2003)</td>
</tr>
</tbody>
</table>
The GPR survey of the study area was hampered by a number of factors, which made the identification and interpretation of significant radar anomalies difficult. Several of these were previously noted in the report on the previous GPR survey for the project (Battle 2003). These previously recognized factors included:

☑ machine decoupling or other hardware malfunctions,
☑ abundant metal debris scattered over the site,
☑ dirt piles and rocks,
☑ depressions and holes,
☑ large trees and their roots and,
☑ snags created by recent bush-hogging of the wooded understory.

To this list can be added:

☑ Extensive utility trenches
☑ Practice backhoe trenches

In an effort to minimize the impacts of the unsatisfactory field factors, some large pieces of metal and other debris were removed prior to the survey and large trees were dodged by “bending” the radar transects around them. While this bending distorts the radar map to a certain extent, the locations of these trees were recorded along each radargram and were recorded in the field notes. In areas where the standing trees were too numerous to dodge, small blocks of the site grid were eliminated from the GPR survey.

The experience with GPR Survey within the Beaufort National Cemetery, where many known graves are located and marked by tombstones yielded mixed results. Generally, approximately one-half of these graves were apparent in plan view (at 60 cm depth). In profile, however, many more probable burials were indicated by strong hyperbolic anomalies. These anomalies probably represent the coffins. Many of the hyperbolic anomalies that were identified as coffins also contained strong metal content, which was marked by distinctive narrow bands of horizontal radar interference. The radargrams within the military cemetery suggest that burials were interred at a variety of depths. These probable burials are visible in profile from about 50 cm to 1 meter below ground. One reason for the inability for the GPR data to account for every grave known to be within these sample blocks is the close spacing of the graves. Graves that are tightly spaced create overlapping radar signals, which tend to mask the buried objects.

The GPR radargram profiles revealed numerous anomalies across the site, particularly in the upper 60 cm of soil. Previous GPR survey in the study area by Schneider noted that potential graves were recognized from 70 cm to 1 m depth below ground (Battle 2003). The GPR information at depths of 0 to 50 cm below ground is heavily affected by tree roots, metal debris, other debris, and the uneven soil conditions. GPR information below one meter is strongly affected by the natural geology and possibly by groundwater conditions.

Several locations in the study area were identified that may contain unmarked graves. These locations should be examined archaeological to test whether they represent graves or some other type of disturbance. Many other areas of the study area do not appear to contain any graves, although GPR survey does not
guarantee the chance discovery of graves. Given the soil conditions and the multitude of factors affecting the radar signals that were recovered, the possibility of graves in areas covered by the present study cannot be totally eliminated. This work does serve, however, to narrow the search and focus future study on those areas that demonstrate a higher probability to contain human remains.

Figure 10. GPR Coverage and Possible Burials as Interpreted by Battle (2004:48).
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National Center for Preservation Technology and Training and USDA Forest Service, Southeast Region

Wynn, Jack T.
Appendix 1.

Selected GPR Images
GPR Block 1, Aerial View at 60 cm B.S.
GPR Block 1, Part 1, 3D View.
GPR Block 2, Aerial View at 60 cm B.S.
GPR Block 3, Aerial View at 60 cm B.S.
GPR Block 4, Aerial View at 60 cm B.S.
GPR Block 5, Aerial View at 60 cm B.S.
GPR Block 6, Aerial View at 60 cm B.S.
GPR Block 6, Part 1, Front View.
GPR Block 7, Aerial View at 60 cm B.S.
GPR Block 7, Part 2, Front View.
GPR Block 8, Aerial View at 60 cm B.S.
GPR Block 9, Aerial View at 60 cm B.S.
GPR Block 10, Aerial View at 60 cm B.S.
GPR Block 10, 3D View at 60 cm B.S.
GPR Block 10, Part 1, Front View.
GPR Block 11, Aerial View at 60 cm B.S.
GPR Block 12, Aerial View at 60 cm B.S.
GPR Block 13, Aerial View at 60 cm B.S.
GPR Block 14, Aerial View at 60 cm B.S.
Probable coffins

GPR Block 14, Front View.
GPR Block 15, Aerial View at 60 cm B.S.
GPR Block 16, Eastern 45 m, Aerial View at 60 cm B.S.
GPR Block 16, Western 23 m, Aerial View at 60 cm B.S.
GPR Block 16, Aerial View at 60 cm B.S.
GPR Block 17, Aerial View at 60 cm B.S.
GPR Block 17, Front View.
GPR Block 19, Front View, Pipe Calibration Test.

1 inch steel pipe at 50 cm B.S.
GPR Block 18, Part 1, Aerial View at 60 cm B.S.
GPR Block 18, Part 2, Aerial View at 60 cm B.S.
GPR Block 18, Parts 1 and 2, Aerial View at 60 cm B.S.
GPR Block 21, Part 1, Aerial View at 60 cm B.S.
GPR Block 21, Part 2, Aerial View at 60 cm B.S.
GPR Block 22, Aerial View at 60 cm B.S.
GPR Block 22, Part 2, Front View.
GPR Block 23, Aerial View at 60 cm B.S.
Possible backhoe trench or major fill zone

GPR Block 23, Front View.
GPR Block 26, Front View.
GPR Block 27, Aerial View at 60 cm B.S.
GPR Block 28, Aerial View at 60 cm B.S.
GPR Block 28, Front View.