Identification of Unmarked Graves at B.F. Randolph Cemetery Using Ground Penetrating Radar (GPR)

Richland County, South Carolina
Identification of Unmarked Graves at B.F. Randolph Cemetery
Using Ground Penetrating Radar (GPR)
Richland County, South Carolina

Report submitted to:
Historic Columbia Foundation • 1601 Richland Street • Columbia, South Carolina 29201

Report prepared by:
New South Associates • 6150 East Ponce de Leon Avenue • Stone Mountain, Georgia 30083

Shawn Patch – Principal Investigator and Author

June 17, 2009 • Final Report
New South Associates Technical Report #1748
ABSTRACT

New South Associates conducted a ground penetrating radar (GPR) survey of selected portions of B.F. Randolph Cemetery, in Richland County, South Carolina. This project was completed under a contract with Historic Columbia Foundation.

The purpose of the survey was to investigate the possibility for unmarked graves within property owned by the cemetery. Fieldwork was conducted over a two-day period, from April 27-28, 2009, under the direction of Shawn Patch, with assistance from Lauren Souther. GPR data were collected in nine separate grids spread over various parts of the cemetery.

Results of the survey are excellent. Approximately 164 unique targets consistent with historic graves were identified, some of which may represent multiple and/or overlapping graves. A small number of these targets are clearly associated with known graves based on marker location. However, the overwhelming majority of these targets are previously unknown graves.

Grave density in the cemetery appears to be approximately 410 per acre, which is significantly higher than previous estimates. The GPR data suggest that most open areas in the cemetery likely contain unmarked graves. New South Associates recommends that cemetery authorities carefully evaluate the possibility of closing the cemetery to future burials because of the high probability of disturbing earlier graves. Alternately, GPR survey should be completed for any locations selected for future interments.
ACKNOWLEDGEMENTS

Successful completion of any project is always due to the cooperative efforts of multiple individuals, and this one is no exception. Keilah Spann and Robin Waites, both with Historic Columbia Foundation, and Elaine Nichols, with the South Carolina State Museum, all provided information, logistical support, and contract management. Their enthusiasm for embracing GPR as an appropriate survey method deserves special mention.

At New South Associates, Lauren Souther assisted in all aspects of the fieldwork. Stacey Young and Staci Richey were on-site at various times and generously took photographs. All of these folks are sincerely thanked for their efforts.
TABLE OF CONTENTS

ABSTRACT ........................................................................................................................................ iii
ACKNOWLEDGEMENTS ................................................................................................................... iv
TABLE OF CONTENTS ....................................................................................................................... v
LIST OF FIGURES ............................................................................................................................. vi
LIST OF TABLES ................................................................................................................................... vi

I. INTRODUCTION ............................................................................................................................ 1
   Randolph Cemetery ........................................................................................................................ 1
   Ground Penetrating Radar (GPR) Survey ....................................................................................... 2

II. METHODS ......................................................................................................................................... 7
   Ground Penetrating Radar (GPR) ................................................................................................. 7
   Cemetery Issues ............................................................................................................................ 8
   Field Methods ............................................................................................................................... 8
   Data Processing ............................................................................................................................ 10

III. RESULTS AND RECOMMENDATIONS ....................................................................................... 13
   Discussion ...................................................................................................................................... 23
   Management Considerations ........................................................................................................ 24
   Burial Practices and Customs ....................................................................................................... 26
   GPR as a Tool for Investigating Unmarked Graves ................................................................... 27
   Summary and Recommendations ................................................................................................. 28

REFERENCES CITED .......................................................................................................................... 29

APPENDIX A: AMPLITUDE SLICE MAPS
APPENDIX B. SELECTED PROFILES FROM INDIVIDUAL TRANSECTS
LIST OF FIGURES

Figure 1. Location of Randolph Cemetery in Columbia, South Carolina. .................................................. 2
Figure 2. 2007 Map of Randolph Cemetery .......................................................... 3
Figure 3. Updated Randolph Cemetery Map in GIS Format .................................................. 5
Figure 4. GPR Survey and Total Station Mapping in Progress . .................................................. 9
Figure 5. Map Showing Location of Graves Identified During the GPR Survey. ......................... 14
Figure 6. General View of Conditions in Grid 1 .......................................................... 15
Figure 7. General View of Conditions in Grid 2 .......................................................... 16
Figure 8. General View of Conditions in Grid 3 .......................................................... 18
Figure 9. General View of Conditions in Grid 4 .......................................................... 19
Figure 10. General View of Conditions in Grid 5 .......................................................... 20
Figure 11. General View of Conditions in Grid 6 .......................................................... 21
Figure 12. General View of Conditions in Grid 7 .......................................................... 22
Figure 13. General View of Conditions in Grid 8 .......................................................... 24
Figure 14. General View of Conditions in Grid 9 .......................................................... 25

LIST OF TABLES

Table 1. GPR Survey Grids ........................................................................................................... 10
Table 2. Summary of GPR Grave Features By Grid ................................................................. 13
I. INTRODUCTION

New South Associates conducted a ground penetrating radar (GPR) survey of selected portions of B.F. Randolph Cemetery, in Richland County, South Carolina (Figure 1). This project was completed under a contract with the Downtown Columbia Cemetery Task Force. Fieldwork was conducted over a two-day period, from April 27-28, 2009, under the direction of Shawn Patch, with assistance from Lauren Souther.

RANDOLPH CEMETERY

Randolph Cemetery is located in the northwestern corner of downtown Columbia, South Carolina. It is bounded on the south by Elmwood Avenue, to the east and north by Elmwood Cemetery, and to the west by the Southern Railroad. Topography in the cemetery is gently sloping to the west, with a noticeable gulley on the north-central boundary and a steep bank near the railroad.

B.F. Randolph Cemetery was established in 1872 and served an important need in Reconstruction-era Columbia. Many prominent local citizens, including eight African-American state legislators, are interred there. The cemetery is an excellent example of South Carolina’s African-American community, and its landscape, layout, design, and mortuary styles reflect broad cultural practices and values.

After falling into disrepair in the twentieth century, the cemetery has undergone a renaissance in recent years thanks to the collective efforts of multiple stakeholders. Trusteeship of the cemetery is maintained by the Committee for the Restoration and Beautification of Randolph Cemetery (CRBRC). Preservation efforts have proceeded through a partnership between the CRBRC and the Downtown Columbia Task Force (DCCTF).

Like many other cemeteries, portions of Randolph have suffered from neglect, with overgrown vegetation, vandalism, and displaced grave markers. As a first step in developing a long-term management plan, New South Associates completed a conditions assessment of the cemetery in 2007 under a previous contract with DCCTF (Richey et al. 2007). Results of that effort included the first detailed map of all marked grave features and a corresponding database with an inventory of each grave marker (Figure 2). The original map has since been converted to a geographic information system (GIS) in ArcMap’s shapefile format (Figure 3). More detailed information on the cemetery’s history and context can be found in that document.

One of the major findings of the 2007 report was the potential for a large number of unmarked graves. A judgmental probe survey of selected areas resulted in the identification of approximately 230 unmarked graves, but it was not comprehensive. At that time, more sophisticated techniques such as ground penetrating radar, were suggested to provide a more accurate estimate of the extent of unmarked graves.
Figure 1.
Location of Randolph Cemetery in Columbia, South Carolina
IDENTIFICATION OF UNMARKED GRAVES AT B.F. RANDOLPH CEMETERY
USING GROUND PENETRATION RADAR (GPR)

Figure 2.
2007 Map of Randolph Cemetery

B.F. Randolph Cemetery
Columbia, South Carolina
April 2007

LEGEND

- Headstone
- Footstone
- Tomb, Vault, or Crypt
- Unmarked Grave
- Probable Unmarked Graves (multiple)
- Funeral Home Marker Only
- Funeral Home Marker and Grave Outline/Depression
- Map Station
- Fence Post
- Tree
- Tree Stump
- Concrete/Stone Marker, Post, Pillar

Scale
GROUND PENETRATING RADAR SURVEY

The current project is a direct outcome of the recommendations presented by Richey et al. (2007). The request for proposal (RFP) specifically called for a GPR study to investigate the extent, type, and number of unmarked graves that might be present. Two important questions were raised: (1) are unmarked graves present in the cemetery; and (2) is there evidence for multiple and/or overlapping graves. Because of the success of the GPR survey, it was also possible to provide some estimate of the total number of graves that might exist.

The remainder of this report discusses the Methods (Chapter II), and Results and Recommendations (Chapter III). Appendices A and B provide GPR Slice Maps and selected profiles.
Figure 3. Updated Randolph Cemetery Map in GIS Format.
II. METHODS

GROUND PENETRATING RADAR (GPR)

GPR is a remote sensing technique frequently used by archaeologists to investigate a wide range of research questions. The premise for using GPR in archaeological applications is simple: it is generally used to find buried features that might be of interest in a particular location. Because GPR is a remote sensing technique, it is non-invasive, non-destructive, relatively quick and efficient, and highly accurate when used in appropriate situations. These are the primary factors that explain why GPR is commonly used in cemeteries where there is a need to identify unmarked graves.

This method involves transmission of high-frequency radar pulses from a surface antenna into the ground (Conyers 2004:1). Measurements are collected from elapsed time between the pulse transmission and its reflection from buried materials and/or changes in sediments and soils. GPR maps the variation in the density of the subsurface environment. Collecting reflection profiles in a grid allows a user to construct a three dimensional map of sub-surface features.

The basic configuration consists of an antenna (with both a transmitter and receiver), a harness, and a wheel for calibrating distance. The operator then pulls the antenna across the ground surface systematically (a grid) collecting data along a transect. This data are then stored by the receiver and available for later processing and manipulation.

The success of any GPR survey depends on a variety of factors, including surface conditions, soils, and the particular targets that are being investigated. Under ideal conditions, a 400 MHz antenna generally provides radar penetration to between 2 and 4 meters. However, the exact depth varies considerably depending on local conditions. Clay can be challenging for GPR because it has a low relative dielectric permittivity (RDP). In practical applications, this generally results in shallower than normal depth penetration because the radar signal is absorbed (attenuated) by the clay regardless of antenna frequency (Conyers 2004).

However, the operator must be aware of the relationship between antenna frequency, resolution, and depth. There is an inverse relationship between frequency and depth. In general terms, a higher frequency antenna (e.g. 900 MHz) can resolve smaller targets but is limited to very shallow depths (e.g. less than 50 centimeters). This type of antenna is designed for applications such as scanning concrete for metal rebar. Conversely, a lower frequency antenna (e.g. 100 MHz) cannot resolve smaller targets but can penetrate to depths of 15 to 20 meters. This antenna is frequently used in geological applications where very large differences are expected. For archaeological applications, research over the last 30 years has demonstrated the effectiveness and utility of a 400 MHz antenna. It is a good compromise between target size and depth, and has been used successfully on a wide range of sites.
CEMETERY ISSUES

Most Judeo-Christian cemeteries share common characteristics with respect to burial of the dead. In general, bodies are oriented east-west, with the head facing east to face the rising sun on Judgment Day. Depths vary, but are typically between four and six feet, depending on local conditions and customs. Shapes tend to be oblong and rectangular because of coffins and caskets. Sizes can vary considerably, particularly between adults and infants, with most in the range of approximately six feet long and two feet wide.

Several factors influence the overall effectiveness of GPR for detecting graves. Soil conditions are the most important, with clay being the most difficult to penetrate. Its high conductivity causes the radar signal to attenuate much quicker, which in turns limits its overall depth and strength. Age of the graves is also critical, with older graves being more difficult because they have had more time to decompose and are less likely to have intact coffins or caskets (if they were present to begin with). When possible, it is helpful to calibrate the GPR to local conditions by passing it over a known grave and noting the overall strength or weakness of the associated signal.

FIELD METHODS

The survey was conducted with a Geophysical Survey Systems, Inc. (GSSI) SIR 3000 control unit with an attached 400mhz antenna (Figure 4 A). The first step was to calibrate the antenna to local conditions by walking over various areas of the project area and adjusting the instrument’s gain settings (Conyers 2004). This method allows the user to get an average set of readings based on subtle changes in the relative dielectric permittivity (RDP) (Conyers 2004). Field calibration was repeated several times as soil and/or moisture conditions changed throughout the cemetery. Effective depth penetration was approximately 1.5 meters, which is fairly typical for clay soils in the Piedmont. Signal attenuation (degradation) was not a major factor in this survey.

In order to effectively collect and process GPR data, it is necessary to establish a formal grid. In this case, grid layout was accomplished with two metric tapes and surveyor’s chaining pins. The actual size, orientation, and layout of the grid was determined by surface features and presumed orientation of the targets.

Because of the way radar energy is propagated in the ground, it is generally standard practice to collect data perpendicular to the long axis of targets (if known). Transect spacing was 50 centimeters, an interval that is well suited for identifying moderate to large sized features. For the cemetery, burials were assumed to be oriented east-west. All data were collected in the Y (north) direction from the southwest corner. The antenna was pulled from the baseline for each transect, which is useful for navigating around large surface obstacles and generally yields more accurate locations.

All survey grids were mapped with a total station and then overlaid with the master cemetery map in ArcMap 9.3 (Figures 4 B and C). For this reason, grid corners were not marked with rebar, nails, stakes, or pin flags. Each point has both arbitrary and UTM coordinates, which means their locations can be easily plotted on the ground at any time in the future.
Figure 4.
GPR Survey and Total Station Mapping in Progress

A. GPR Survey in Progress

B. Total Station Mapping

C. Total Station Mapping
The GPR survey was conducted in nine discrete grids, totaling approximately 1,614 square meters (0.39 acres) (Table 1). Selection of particular survey areas was based on a variety of factors, including probability for unmarked graves, proximity to the paved cemetery road, and an absence of marked graves on the surface.

Table 1. GPR Survey Grids.

<table>
<thead>
<tr>
<th>Grid</th>
<th>X Length (m)</th>
<th>Y Length (m)</th>
<th>Area (m²)</th>
<th>Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>13</td>
<td>20</td>
<td>260</td>
<td>0.06</td>
</tr>
<tr>
<td>2</td>
<td>6.5</td>
<td>12</td>
<td>78</td>
<td>0.02</td>
</tr>
<tr>
<td>3</td>
<td>12</td>
<td>20</td>
<td>240</td>
<td>0.06</td>
</tr>
<tr>
<td>4</td>
<td>30</td>
<td>8</td>
<td>240</td>
<td>0.06</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>20</td>
<td>100</td>
<td>0.02</td>
</tr>
<tr>
<td>6</td>
<td>13</td>
<td>15</td>
<td>195</td>
<td>0.05</td>
</tr>
<tr>
<td>7</td>
<td>3</td>
<td>13</td>
<td>39</td>
<td>0.01</td>
</tr>
<tr>
<td>8</td>
<td>6.5</td>
<td>22</td>
<td>143</td>
<td>0.04</td>
</tr>
<tr>
<td>9</td>
<td>11</td>
<td>29</td>
<td>319</td>
<td>0.08</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>1,614</td>
<td>0.39</td>
</tr>
</tbody>
</table>

DATA PROCESSING

All data were downloaded from the control unit to a laptop computer for post-processing. GSSI has developed a proprietary program, RADAN, for analyzing and processing data. Radar returns are initially recorded by their strength and the elapsed time between their transmission and receipt by the antenna. Therefore, the first task in the data processing to set “time zero”, which tells the software where in the profile the true ground surface was. This is critical to getting accurate results when elapsed time is converted to target depth. The second step was to apply high and low pass filters, which essentially remove background noise above and below the frequencies of 800 Mhz and 200 Mhz, respectively. This filtering removes the horizontal banding that can result from a variety of sources and obscure smaller targets. The third and final step was to “migrate” the data, which allows the user to eliminate some of the distortion inherent in all reflection profiles and generate a more realistic view of the size, depth, and orientation of specific targets. The distortion is reduced using a linear regression analysis based on the selection of multiple targets of varying strengths and depths.

With the data processing complete, it was then possible to examine the grid in a three-dimensional viewer within RADAN. It is possible to rotate the grid, which appears as a block, in any direction; it can be viewed from above, in perspective, or from the X and Y axes. This is an exploratory technique and provides an overview of specific targets and possible patterning.

The next step involved “slicing” the data horizontally at specific depths. For example, a depth value can be entered (e.g. 20 cm), then exported as a CSV file. The result is a depth “slice” of the entire grid at that point. The thickness of the slice is adjusted to include as large or as small a portion of the profile as necessary.
Each sliced file was then imported into SURFER for additional manipulation. This program allows users to grid data with X, Y, and Z values. The results can then be displayed in a wide range of mapping formats including contours, wireframes, and surface plots. All data were gridded using the Kriging formula and then image maps were generated from the resulting files. It was then possible to change the color values and enhance the amplitudes for better interpretation.

The final step in the data processing is to integrate the depth slices with other spatial data. This was done using ArcGIS 9.3, which can display and manipulate all forms of spatial data created for this project including GPR results, total station data, GPS data, and base graphics such as aerial photography and topographic maps. Following the interpretation of the radar targets, the locations of the pertinent radar anomalies were converted into an ESRI shapefile, the proprietary file type used by ArcGIS 9.3.
III. RESULTS AND RECOMMENDATIONS

Results of the GPR survey are excellent. Amplitude slice maps of the processed GPR data for each grid are presented in Appendix A. Selected profiles from individual transects are presented in Appendix B. Approximately 164 unique targets were identified that have been interpreted as graves (Figure 5, Table 2). A small number of these (n=25) correspond to known graves because of their location adjacent to existing markers and others (n=12) to graves identified during probing. However, the remaining targets (n=128) represent previously unknown graves, including several that may contain multiple interments.

Table 2. Summary of GPR Grave Features by Grid.

<table>
<thead>
<tr>
<th>Grid</th>
<th>Existing (marked)</th>
<th>Additional Identified by Probing</th>
<th>Newly Identified by GPR</th>
<th>Total Known Graves</th>
<th>Gravest per Square Meter (density)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>3</td>
<td>25</td>
<td>30</td>
<td>1.87</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>1</td>
<td>10</td>
<td>11</td>
<td>1.71</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>1</td>
<td>21</td>
<td>24</td>
<td>1.10</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>2</td>
<td>22</td>
<td>28</td>
<td>1.86</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>6</td>
<td>1.67</td>
</tr>
<tr>
<td>6</td>
<td>7</td>
<td>0</td>
<td>21</td>
<td>28</td>
<td>1.7</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>7</td>
<td>1.56</td>
</tr>
<tr>
<td>8</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>1.71</td>
</tr>
<tr>
<td>9</td>
<td>6</td>
<td>1</td>
<td>21</td>
<td>28</td>
<td>1.11</td>
</tr>
<tr>
<td>Total</td>
<td>25</td>
<td>12</td>
<td>128</td>
<td>164</td>
<td>1.98</td>
</tr>
</tbody>
</table>

**Grid 1** measured approximately 13 x 20 meters in size and was located at the edge of the road in the northeast portion of the cemetery (Figure 6). At least 30 unique grave features are present. Of this total, three are associated with existing markers on the surface (confirmed graves), three are associated with graves identified during probing, and 25 are newly identified. Density is approximately one grave per 8.7 square meters.

One target, in the southwest corner of the grid, closest to the road, is large enough to suggest it might contain multiple graves. The reflections are so strong and large that it is not possible to delineate individual graves. Its open area and easy access to the road make this a strong candidate for intrusive graves.

**Grid 2** measured approximately 6.5 x 12 meters in size and was located in the north-central portion of the cemetery, between four well-defined plots with walls (Figure 7). At least 11 unique grave features are present, one of which is associated with a grave identified during the probing, and 10 others that are newly identified. There is no direct evidence of multiple and/or overlapping graves in this grid. Density is approximately per 7.1 square meters.
Figure 5.
Map Showing Location of Graves Identified During the GPR Survey

Legend
- GPR Graves
- GPR Grid
- Grave
- Grave Outline
- Marker
- Tree
- Railroad ROW
- Railroad
- Wall
- Road
- Post

0 12.5 25 50 Meters
0 55 110 220 Feet
Figure 6.
General View of Conditions in Grid 1 (Looking West)
Figure 7.
General View of Conditions in Grid 2 (Looking Northwest)
Grid 3 measured approximately 12 x 20 meters in size and was located in the north-central portion of the cemetery (Figure 8). The southern edge of this grid is very close to the cemetery road. The grid was oriented to capture as much open area as possible between well-defined plots bounded by walls. At least 24 unique grave features are present. Of this total, two are associated with existing markers, one with a grave identified during probing, and 21 are newly identified. Density is approximately one grave per ten square meters. There is no evidence for multiple and/or overlapping graves in this particular area.

Grid 4 measured approximately 30 x 8 meters in size and was located parallel to the road near a large ditch/gulley in the north-central portion of the cemetery (Figure 9). There is a single plot surrounded by chain link fence on the western boundary. Four separate bone fragments were observed on the surface in northwest portion of the grid.

At least 28 unique grave features are present in this area, four of which are associated with existing markers, one with a grave identified during probing, and 22 that are newly identified. Density is approximately one grave per 8.6 square meters. There is direct evidence for multiple and/or overlapping graves, particularly in the western edge of the grid and close to the road. The presence of displaced bone on the surface is a definite indicator that earlier graves have been impacted.

Grid 5 measured approximately 5 x 20 meters in size. It was placed adjacent to the northern edge of Grid 4 and oriented to capture a long and narrow open area (Figure 10). At least six unique grave features are present, one of which is associated with an existing marker, two with graves identified during probing, and three that are newly identified. Density is approximately one grave per 16.7 square meters. There is no evidence for multiple and/or overlapping graves in this particular area.

Grid 6 measured approximately 13 x 15 meters in size and was located near the cemetery's northwestern corner (Figure 11). This is a marginal area characterized by steeper topography and overgrown vegetation. At least 28 unique grave features are present, making this one of the densest areas surveyed for this project. Of that total, seven are associated with existing markers and 21 are newly identified. Density is approximately one grave per 7.0 square meters.

The center of this grid contains a short row of grave markers and coping, as well as several markers that appear to have been displaced from their original locations. Radar results in this grid show possible evidence for multiple and/or overlapping graves. Radar linescans and transects indicate that several of these may be at variable depths.

Grid 7 measured approximately 3 x 13 meters in size and was located adjacent to the road north of the B.F. Randolph monument (Figure 12). Seven unique grave features are present, with one related to an existing marker, two associated with graves identified during probing, and four that are newly identified. Density is approximately one grave per 5.6 meters, which is the highest value of any area surveyed for the current project. This figure is not surprising given its location immediately adjacent to the road. At least one of the grave features appears to extend beneath the road. If this is the case, additional graves might also be present under the road in some areas of the cemetery. Other sections farther west show surface depressions and funeral home markers scattered over a broad area. It seems likely that this area has been subjected to repeated intrusive burials over time.
Figure 8. General View of Conditions in Grid 3 (Looking Northeast)
Figure 9.
General View of Conditions in Grid 4

A. General View of Conditions in Grid 4 (Looking East)

B. General View of Conditions in Grid 4 (Looking West)
Figure 10.
General View of Conditions in Grid 5 (Looking North)
Figure 11.
General View of Conditions in Grid 6

A. General View of Conditions in Grid 6 (Looking Northeast)

B. General View of Conditions in Grid 6 (Looking Northwest)
Figure 12.
General View of Conditions in Grid 7 (Looking North)
Grid 8 measured approximately 6.5 x 22 meters in size and was located in and around the B.F. Randolph monument (Figure 13). This is an area with no other existing markers or surface indications of unmarked graves. A portion of the grid extended over the road to the other side. Somewhat surprising, only two grave features are present. The first is in the northwest portion of the grid and is not associated with any markers.

The second is located on the northeast corner of the Randolph monument. However, its size, shape, and orientation are not consistent with other signatures for unmarked graves, making this target more difficult to interpret with high confidence. It is further complicated by the sensitivity of possibly being associated with the Randolph monument. There is widespread interest in the question of whether or not a grave might actually be present at this location. While the radar data do indicate an anomaly of considerably strong reflection, it is impossible to say whether or not it is actually a grave feature. It is unclear what sub-surface preparations were undertaken prior to installation of the monument. A substantial footing could partially mask an existing grave or could cause the reflection observed in the radar data. At this point, the GPR anomaly is inconclusive.

There is no evidence for multiple and/or overlapping graves in this particular area. Density is approximately one grave per 71.5 square meters, which is the lowest of any area surveyed for the current project. The relative lack of unmarked graves stands in stark contrast to other areas of the cemetery, particularly given the amount of open space available and its proximity to the road. Perhaps the proximity of the Randolph monument has served as a deterrent for more recent burials.

Grid 9 measured approximately 11 x 29 meters, and was located near the main cemetery entrance (Figure 14). The total number of grave features in this area is estimated to be at least 28. However, the radar signals were not as clear as in other areas, and there was some interference from root systems from earlier trees, particularly in the western half of the grid. Therefore, the number of identified graves is not absolute, but likely reflects a realistic assessment of the area.

Of the 28 grave features, six are associated with existing markers, one with a grave identified during probing, and 21 are newly identified. Density is approximately one grave per 11.4 square meters. There is some evidence for multiple and/or overlapping graves, especially on the eastern edge of the grid near the entrance.

DISCUSSION

It is clear from the GPR survey that unmarked graves are a feature of the B.F. Randolph Cemetery. A range of issues are raised as a result of this work, some of which bear directly on management of the cemetery, others that relate more to burial customs and practices, and others that are largely methodological. Several important points are worth discussing in greater detail below according to broad themes.
Figure 13.
General View of Conditions in Grid 8 (Looking North)
Figure 14.
General View of Conditions in Grid 9 (Looking West)
MANAGEMENT CONSIDERATIONS

The high number of unmarked graves is not at all surprising for a number of reasons. First, there are very few open areas in the cemetery that do not have existing markers or other surface indications for graves. Second, it was not uncommon historically for some graves to be marked with wood or other non-permanent objects such as household items. Third, a moderate to large number of displaced grave markers are located in the wooded area on the cemetery’s northern boundary. Other markers are still in the cemetery, but clearly displaced from their original locations. Although the number of all displaced markers is currently unknown, it could be relatively high. While they can never again be directly associated with their original grave, the total number should provide at least some indication of the probable universe of unmarked graves.

The issue of recent burials on top of earlier graves is probably the single most important consideration to the cemetery’s long-term management. Grids 1, 4, 6, and 9 all show evidence of multiple and/or overlapping graves. In some instances, the radar data indicate both horizontal and vertical overlap of graves. In plan view it can be difficult to isolate individual graves. In profile, however, it is sometimes possible to see graves at different depths.

In cases where multiple graves appear at different depths, it is not necessarily straightforward to state which one is younger. For example, it might be possible for an earlier grave to be deeply buried and a later grave placed on top at a shallower depth. Or, conversely, it might be possible for an earlier grave to be relatively shallow and a later grave to impact it when buried deeper. Unfortunately, there is no way to know which case might be more accurate from radar data alone.

Grids 4 and 9 both have exposed bone on the surface, which offers direct evidence of impacts to at least some earlier graves. The extent of impacts is not known. However, these same grids also show evidence of multiple and/or overlapping graves. It is clear that for some reason these two areas, and possibly others, have been the focus of more recent interments.

Only Grid 7 showed direct evidence for graves beneath the paved cemetery road. A portion of Grid 8 included the road, but the instrument was calibrated for soil, rather than pavement. Additional survey work in other areas over the road might yield a more complete assessment of unmarked graves in those locations.

Although inconclusive, there is an indication of a buried target at the northeast corner of the Randolph monument. Interpreting this target is difficult, however, because of the monument’s placement and the size, shape, and orientation of the target itself. It does not resemble other grave features, but is a high amplitude target that cannot be ignored.

BURIAL PRACTICES AND CUSTOMS

As the final resting place for many prominent local citizens and its importance to the African-American community, interment at B.F. Randolph Cemetery carries a high level of prestige. In addition, cultural forces likely influence the desire to be buried with family members and in traditional areas. Finally, legal and social restrictions of the late nineteenth and early twentieth centuries limited the burial places available to African Americans. These factors may help explain why multiple and/or overlapping burials have occurred.
The issue of multiple and overlapping burials is important for the long-term management of Randolph Cemetery. In light of the radar results, it is clear that earlier graves in several areas of the cemetery have been impacted by more recent burials. Balancing the needs and desires of community and family members with the reality of grave disturbance is delicate and should be considered carefully. There can be no doubt that earlier graves have been, and continue to be, impacted by new interments.

Most people are familiar with the expression “six feet under”, and it is frequently assumed that graves are always buried at that depth. The radar data from this project clearly indicate not only variations in depth, but also indicates that very few graves that are buried greater than 3-4 feet deep. From an anthropological perspective, it might be worth considering the possibility of different burial practices through time and across cultures. For example, does burial depth vary with the time of interment? In other words, are there differences in depth between burials from the nineteenth, twentieth, and twenty-first centuries? If so, what factors might have affected depth? Does burial depth relate to grave shafts that are excavated by hand or with machine assistance?

Richey et al. (2007) recorded 1,670 unique graves during an earlier mapping and inventory of the cemetery. At that time, fieldwork consisted of a limited probe survey of selected areas. It was not meant to be exhaustive, but rather to assess the overall potential for unmarked graves. Probing can be an effective tool for identifying unmarked graves, but is highly subjective and depends on a variety of factors. However, even with these limitations, a large number of unmarked graves was identified.

Assuming that the GPR survey grids are representative of the rest of the cemetery, it is possible to estimate the overall density and total number of graves that might be present. The average value for the nine survey grids is approximately one grave per ten square meters (1:9.8) (Table 2). The values in Table 2 were calculated individually for each grid using its size and the number of grave features. Randolph Cemetery is estimated to be approximately 5.6 acres (22,662 square meters). Using the ratio obtained from the GPR survey (Table 2), the total number of graves in the cemetery is estimated to be approximately 2312, with a range of 1988 to 4046, depending on the density values used in the calculations (11.4 and 5.6, respectively). Realistically, the true number of graves is probably in the middle of that range.

Given the history of Randolph Cemetery and anecdotal information from other urban cemeteries, the true density of graves is probably on the high side. If that is the case, then it is reasonable to expect most areas of the cemetery contain unmarked graves, particularly those that lack other surface indications such as headstones or depressions.

**GPR AS A TOOL FOR INVESTIGATING UNMARKED GRAVES**

The radar results from this project are stunning, and likely due to a variety of factors. First, there can be no doubt that many of the unmarked grave features are characterized by caskets and/or burial vaults. These types of objects are typically made of durable material such as metal or concrete. Those types of materials are high contrast and easily detected with GPR. However, other grave features appear to be characterized by coffins. While these are generally lower contrast, they still show up well in the radar data.
Another important variable is likely the age of the unmarked graves. In addition to materials differences, more recent graves are higher contrast because they have had less time to decompose in the ground. In general, the older a grave is, the more difficult it is to see. Previous experience has repeatedly demonstrated that radar surveys in Piedmont cemeteries with graves older than 75-100 years can be frustratingly imprecise. It has nothing to do with the equipment and more to do with age, burial container, and soil conditions.

Soils are always an important factor for any radar survey. Although portions of Randolph Cemetery are clearly characterized by compact, hard, eroded, red clay, other areas are not as bad. In general, the radar signal for this project was penetrating to a depth of 1.5 meters without attenuation. It was necessary to re-calibrate the instrument in different grids, but that is not uncommon. Close inspection of the amplitude slice maps for each grid will show large areas of dark blue values that correspond to radar energy passed successfully into the ground, but where no targets were identified. That is an indication of favorable subsurface conditions.

In evaluating the success of GPR for identifying unmarked graves, a variety of factors must be weighed and balanced, including costs, time, total survey area, reliability of results, and project goals. In this case, GPR was an excellent choice because it provided a high return and excellent results. Although only a small fraction of the overall cemetery was surveyed, enough of the area was sampled to make inferences about conditions in the rest of the cemetery. Most important of all, it was non-invasive and required no ground disturbance.

SUMMARY AND RECOMMENDATIONS

The GPR survey conducted for this project was successful in identifying a large number of unmarked graves. Although only a small portion of the cemetery was sampled, the results can be extrapolated to the rest of the cemetery and it is possible to make inferences about additional unmarked graves. Overall grave density is expected to be high, with at least 2,312 and possibly as many as 4,000.

While conducting the GPR survey, human bones were observed on the surface in two discrete locations (Grids 4 and 9). These were mapped and recorded to document their locations. As required by South Carolina law, New South Associates contacted the Richland County coroner and reported the remains. Apparently, the presence of human remains on the surface is not uncommon at Randolph Cemetery.

New South Associates recommends that cemetery officials carefully evaluate the possibility of prohibiting future burials. There is a strong probability that any future interments will directly impact existing graves. Stakeholders should be aware of these issues and informed of the potential conflicts.

Alternately, it is recommended that GPR survey be completed of all cemetery areas under consideration for future interments. The placement of future interments should avoid all GPR targets that are consistent with unmarked graves. Even if conducted in a piecemeal fashion over several years, the GPR data can be added to the GIS map of the cemetery and would create a strong management tool. In cases where there is the need to inter an individual in an area that has not yet been surveyed by GPR, a rapid-deployment, small-area GPR survey can be conducted to find a suitable location for the interment.
REFERENCES CITED

Conyers, Lawrence B.
2004 Ground Penetrating Radar for Archaeology. Altamira Press, Walnut Creek, California.

Richey, Staci, Shawn M. Patch, Joe Joseph, and Hugh B. Matternes
APPENDIX A: AMPLITUDE SLICE MAPS
Randolph Cemetery
GPR Grid 1
Amplitude Slice Maps
Randolph Cemetery
GPR Grid 2
Amplitude Slice Maps

70 cmbs

90 cmbs

130 cmbs
Randolph Cemetery
GPR Grid 3
Amplitude Slice Maps

High Amplitude

Low Amplitude
Randolph Cemetery
GPR Grid 4
Amplitude Slice Maps
Randolph Cemetery
GPR Grid 5
Amplitude Slice Maps

41 cmbs

82 cmbs
Randolph Cemetery
GPR Grid 6
Amplitude Slice Maps

53 cmbs

69 cmbs

100 cmbs

High Amplitude

Low Amplitude
Randolph Cemetery
GPR Grid 7
Amplitude Slice Maps

61 cmbs

80 cmbs

High Amplitude

Low Amplitude
Randolph Cemetery
GPR Grid 8
Amplitude Slice Maps

70 cmbs

103 cmbs
APPENDIX B. SELECTED PROFILES FROM INDIVIDUAL TRANSECTS
Randolph Cemetery
Grid 1
GPR Linescans
Randolph Cemetery
Grids 3 and 5
GPR Linescans
Randolph Cemetery
Grid 6
GPR Linescans
Randolph Cemetery
Grid 7
GPR Linescans