GPR Reconnaissance East of Lovers Lane, Richmond County, Georgia

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I. Introduction

This report presents the Ground Penetrating Radar (GPR) reconnaissance of a portion of the Savannah River floodplain, north of New Savannah Bluff and east of Lovers Lane and the Augusta Levee in Richmond County, Georgia (Figure 1). This archaeological work was performed by researchers with The LAMAR Institute, Inc. for Cypress Cultural Environmental Consultants, LLC. The methods and results from this work are described.

Figure 1. Project Location.

II. Methods

Ground Penetrating Radar, or GPR, uses high frequency electromagnetic microwaves 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 (ns). The approximate depth of an object can be estimated with GPR by adjusting for electromagnetic propagation conditions.

The GPR sample blocks in this study area were composed of a series of parallel transects, or traverses, spaced approximately 100 meters apart, which yielded a two-dimensional cross-section or profile of the radar data. These samples are termed radargrams. This two-dimensional image is constructed from a sequence of thousands of individual radar 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.

The GPR signals that are captured by the receiving antenna are recorded as an 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 a computer monitor, mounted on the GPR cart. These raw data are later processed in the laboratory to provide additional interpretive information.

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 amount of time (ns) the receiving antenna is set to receive GPR signals, the deeper the search.

The effectiveness of GPR in numerous environments on the North American continent is widely variable and depends on solid conductivity, metallic content, and other pedo-chemical factors. Generally, Georgia's coastal plain soils have moderately good properties for its application (Elliott 2003a-b, 2006a-b).

GPR signals cannot penetrate large metal objects and the signals are also significantly affected by the presence of salt water. 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 cast iron 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. Larry 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 equipment used for this study consisted of a RAMAC/X3M Integrated Radar Control Unit, mounted on a wheeled-cart and linked to a RAMAC XV11 Monitor (Firmware, Version 3.2.36). A 500 megahertz (MHz) shielded antenna was used for the data gathering. MALÅ GeoScience's *Ground Vision* (Version 1.4.5) software was used to acquire and record the radar data (MALÅ GeoScience USA 2006).

Upon arrival at the site, the RAMAC X3M Radar Unit was set up for the operation and calibrated. Several trial runs were made on parts of the site to test the machine's effectiveness in the site's soils. Machinery settings and other pertinent logistical attributes included the following:

> **Machine Settlings**
> Time Window: 80.7 ns
> Estimated Signal Velocity: 60 m/microS
> Number of Stacks: 4
> Number of Samples: 512
> Antenna: 500 MHz shielded
> Sampling Frequency: 7462 MHz
> Antenna Separation: 0.18 m
> Radargram Spacing: 100 meters

Various adjustments to the GPR equipment were made in the field during the data collection phase. The time window that was selected allowed data gathering to focus on the upper two meters of soil, which was the zone most likely to yield archaeological deposits relating to human activity. 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.

The radar information was displayed as a series of radargrams. Output from the survey was viewed using the *GroundVision* software program developed by MALÅ GeoScience, which provided preliminary information about the suitability of GPR survey in the area and the effective operation of the equipment. These data were examined for important anomalies and patterns of anomalies, which were likely of cultural relevance. Time-depth can be roughly equated to depth below ground.

The survey was accomplished on December 8, 2009 by Daniel Elliott and Michael Benton. Weather conditions at the time of the survey were overcast. The reconnaissance survey was terminated at the onset of heavy rains. Four transects across the study area were completed.

The study area consisted of agricultural fields that had recently been harvested of its soybeans. Soybean stalks and stubble littered the ground. A field road crossed near the center of the tract. Remnants of an oxbow lake, marked by wetlands vegetation, were located within the field and this area is visible on the modern aerial photograph.

The project goals were to:

- Determine the effectiveness an applicability of GPR Technology in the Study Area;
- Search for Evidence of Buried Human Activity Zones, Objects or Features in the Floodplain;
- Search for Evidence of Buried Land Surfaces Capable of Containing Human Occupations.

The GPR reconnaissance survey was supplemented by limited shovel testing and extensive backhoe testing, which was directed by Daniel Battle. The results of that effort are reported separately. No archaeological sites were previously known within the study property prior to this study and none were identified by the present investigations.

III. Results

Thirty-two radargrams were collected in the GPR reconnaissance of the study tract, which represent a total linear coverage of 2,706 meters. These radargrams were spaced along four parallel, east-west transects, spaced approximately 100 meters apart on a north-south axis (Figure 2). The GPR data was collected in two directions along these four transects (GPR1-4). On the east-west collection (Grid West was 280 degrees) transects were sampled in 50 m sections. One the return (west-east) direction, the same transects were sampled with a single continuous radargram, except for GPR3, which was divided into two sections leaving a gap at the former oxbow lake. These radargrams were grouped as follows:

- GPR1 (300 m total length)—Radargrams 1-6, collected in 50 m sections east-west; Radargram 7, collected as one 300 m section west-east.
- GPR2 (250 m total length)—Radargrams 8-12, collected in 50 m sections east-west; Radargram 7, collected as one 300 m section west-east.
- GPR3 (550 m total length)—Radargrams 14-24, collected in 50 m sections east-west; Radargram 25, collected as one 302 m section west-east, Radargram 26, 34 m gap of oxbow lake, collected as one 214 m section west-east
- GPR4 (253 m total length)—Radargrams 27-31, collected in 50 m sections east-west; Radargram 32, collected as one 253 m section west-east.


Figure 2. Approximate Locations of GPR Transects 1-4.

GPR1

GPR1 was the northernmost sample. It displayed the least interesting GPR information. No buried soil surfaces were identified within this sample.

GPR2

GPR2 was south of GPR1. This line also displayed mostly homogeneous radar returns at depth. Radargram DAT_0010, which extended from 100-150 m from the eastern end of GPR2, displayed some strong returns that may be geologic in character. The eastern end of radargram DAT_0010 is shown in Figure 3.
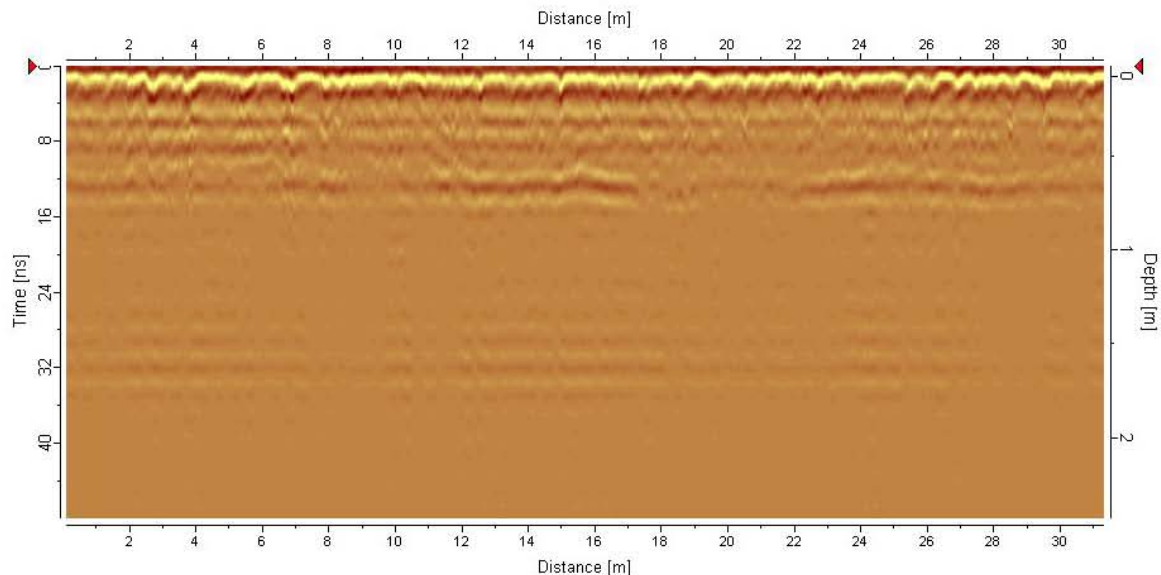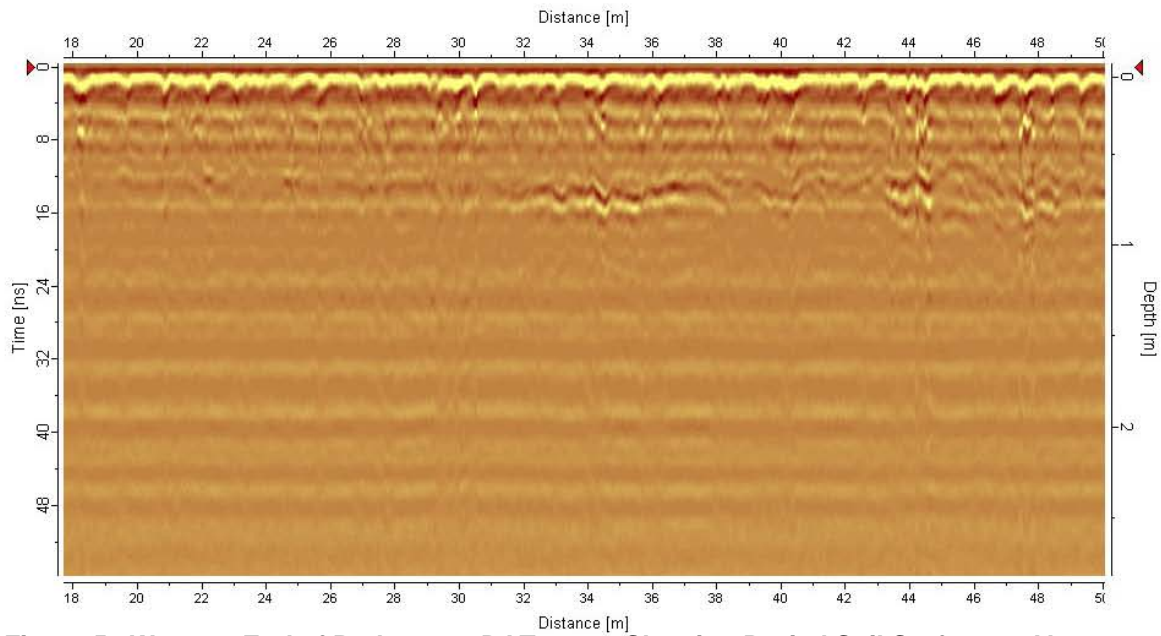

Figure 3. Western End of Radargram DAT_0010, Showing Poorly Defined Buried Soil Surfaces at About 70-80 cm Depth.

GPR3

GPR3 was south of GPR2. This was the longest transect and it contained the most interesting GPR information of the group. This line crossed the remnant of an oxbow lake, which is evident on the modern aerial photograph as an area of vegetation. This wetland feature was sufficiently dry to allow GPR survey across it. On the return trek, however, the wetland feature was avoided in the interest of time. The GPR data collected in GPR3 suggests one, and possibly two, buried stable land surfaces. These surfaces were observed in radargrams DAT_0014, 15, 16, and 17. The eastern end of radargram DAT_0014 is shown in Figure 4 and the western end of radargram DAT_0016 is shown in Figure 5.
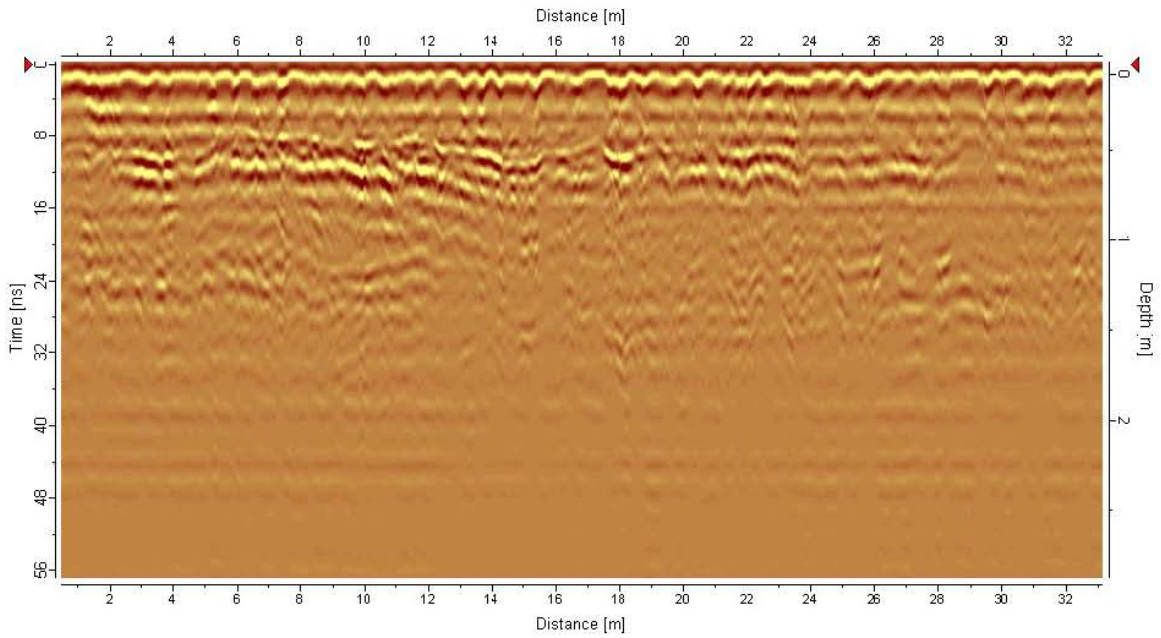
Figure 4. Eastern End of Radargram DAT_0014, Showing Buried Soil Surfaces at 50-80 cm Depth and Another Poorly Defined Surface at About 130 cm Depth.
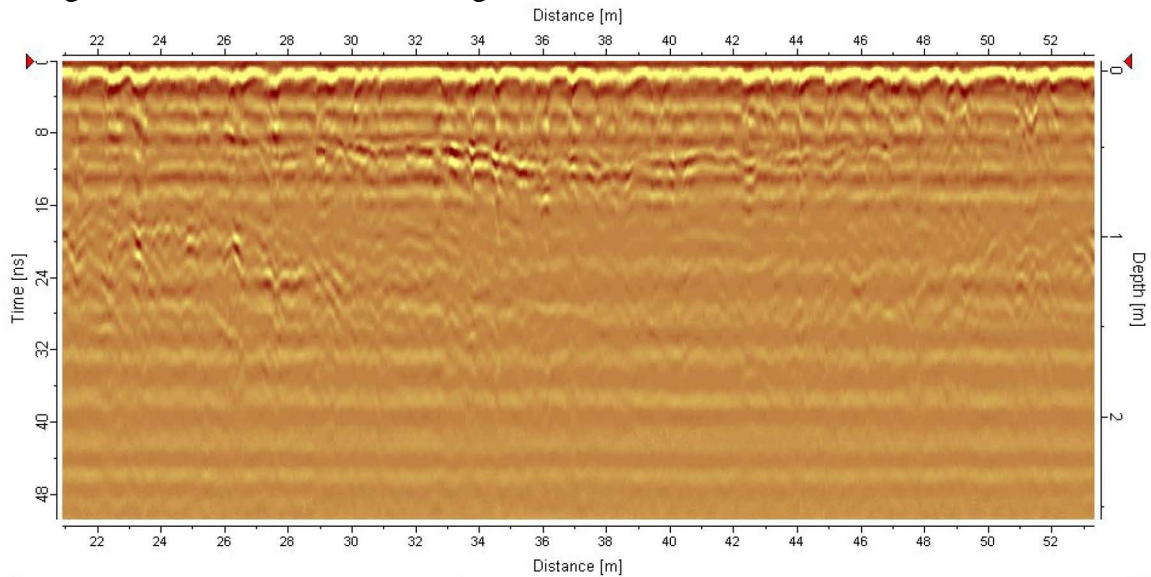

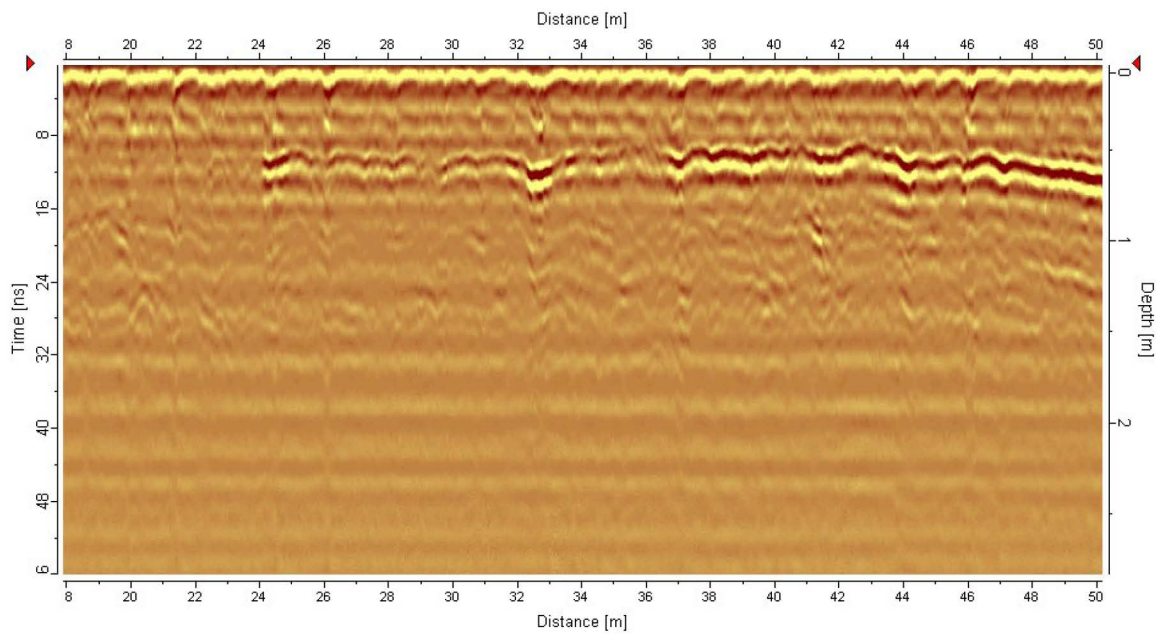**Figure 5. Western End of Radargram DAT_0016, Showing Buried Soil Surface at About 70-80 cm Depth.**

GPR4

GPR4 was south of GPR3. This transect extended from the woodland adjacent to the Savannah River to the woods line at the aforementioned oxbow lake. This transect also crossed some strong radar returns, particularly in radargrams DAT_0027, 28, 29 and 30.

The western end of radargram DAT_0027 is shown in Figure 6 and the western end of radargram DAT_0028 is shown in Figure 7.

**Figure 6. Western End of Radargram DAT_0027, Showing Buried Soil Surfaces at About 50-70 cm Depth.**

Figure 7. Western End of Radargram DAT_0028, Showing Buried Soil Surfaces at About 60-70 cm Depth.

Interpretations

The GPR reconnaissance of the study tract consisted of four, evenly spaced sample lines of varying lengths that covered the northern 2/3 of the study property. Heavy rains began before the final two lines were collected. Consequently, the reconnaissance did not completely cover the field as was the original plan. Nevertheless, the GPR evidence provides some insight into the buried soil deposits within the study tract. Evidence for cultural features, or other large point radar reflections, was not readily apparent in the data. The GPR sample did show one, and possibly two, buried land surfaces that are irregular apparent across the property. One may speculate that this zone conforms to flood deposits that accumulated in 19th and 20th centuries as large acreage in the Savannah River valley were denuded for agricultural use. This unconsolidated soil deposit has a low organic content and it may represent the deposit from one or more major freshets, such as the 1908 or 1924 flood.

The buried surface, which varies in depth from about 60-80 cm below ground, may represent a soil layer, such as an A-horizon. When compared to the evidence from the shovel testing and backhoe tests, this buried zone appears to correspond with the soil zone lying beneath the thick mantle of modern clay silt alluvial. Despite its depth, this zone may be plow-disturbed. Excavated evidence for deeply buried agricultural fields, which contained 19th century artifacts, was documented in previous test excavations in the general vicinity (Elliott and Doyon 1981).

Evidence for a more deeply buried land surface was spotty and inconclusive. Radargram 14 displays some evidence for a buried surface at about 1.3 m below ground, although this zone is discontinuous and poorly defined (Figure 8).
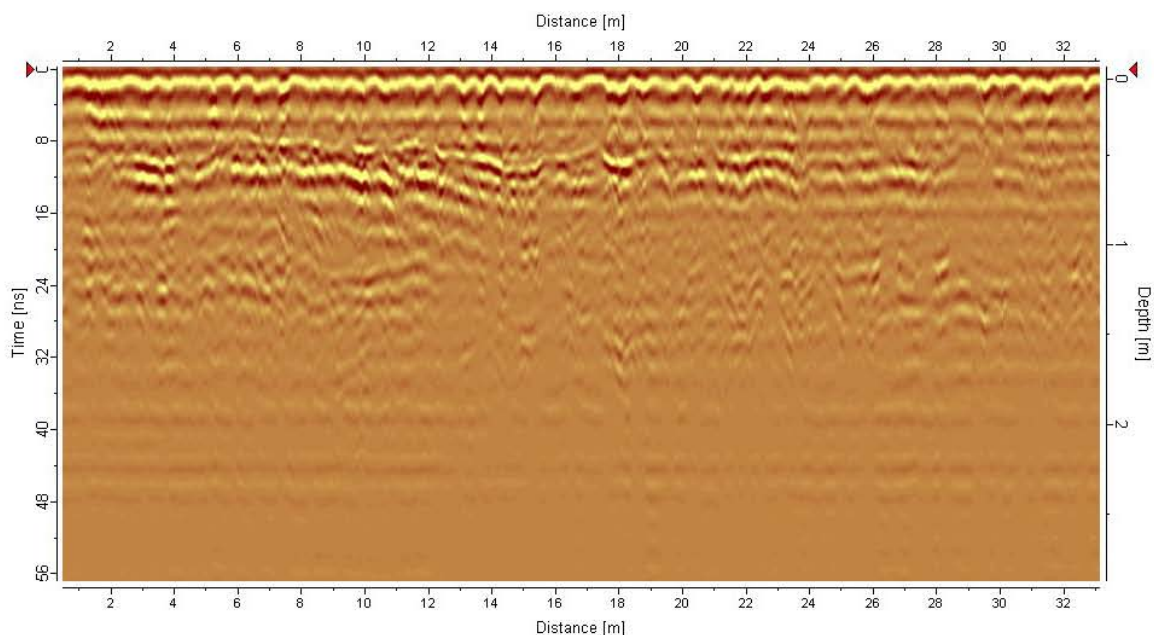
Figure 8. Eastern Portion of Radargram DAT_0014, With Suspected Soil Surfaces Highlighted by Blue and Green Dashed Lines.

GPR evidence for large buried objects, or clusters of objects that may represent cultural features was not observed in any of the radargrams that were collected by the reconnaissance. A more thorough coverage of the property with additional GPR mapping may identify areas within the study tract that have cultural importance. The area surrounding Radargram DAT_0014 on GPR3 is one such area. The areas not sampled on the southern 1/3 of the tract also could be surveyed to complete the original research plan. The dearth of cultural material, as observed in the present GPR sample however, was corroborated by the shovel tests and backhoe tests. These two lines of "negative evidence" for cultural resources suggest that this environment was not conducive for long term human occupation. Since no "archaeological site" was previously recorded within the study property, and no artifacts emerged from the extensive backhoe tests and the more limited shovel tests, further testing may not be warranted. GPR survey may be useful in defining the geomorphology of the Savannah River floodplain, which is useful information to scholars attempted to follow the historical development within the river system, but the study area appears to have extremely limited potential for artifacts, features, or habitation areas.

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