# Ground-Penetrating Radar Survey of a Jeffersonian Printing Press Plant
# Site 9MF914

McDuffie County, Georgia
July 10, 2008

Prepared for
Hickory Hill Historic Home of Thomas E. Watson
502 Hickory Hill Drive
Thomson, Georgia 30824

Sara Gale

___________________________
Principal Investigator

Georgia Department of Transportation
Office of Environment/Location
3993 Aviation Circle
Atlanta, Georgia 30336

**TABLE OF CONTENTS**

Page

**LIST OF FIGURES**

## Introduction

On July 10, 2008 volunteers from the Georgia Department of Tranportation (GDOT) helped with the advanced archaeology summer program at the Hickory Hill Historic House, Dig History. GDOT archaeologists worked with the middle school and high school students to geophysically survey site 9MF914. Archaeology camps excavated portions of the site in previous weeks and years. The students were involved in collecting ground-penetrating radar (GPR) data, mapping the surface features within the suvey grid, and tracking the survey's progress.

Site 9MF914 was designated an archaeological site in 2005 by the Watson-Brown Foundation, Inc. and is part of the Hickory Hill National Register of Historic Places property in Thomson Georgia (Appendix A). The site is an early 20$^{th}$ century printing press built by Thomas E. Watson in 1910 as the final destination for his publications. The plant employed thirty people and covered a 9,000 ft$^2$ area. Printing, stitching, and binding were all undertaken at the printing plant (Pierannunzi 2006).

This brief write-up about the geophysical survey includes sections on methods and results. The GDOT staff who volunteered for this project included, Pamela Johnson, Heather Mustonen, and Courtney Capps, a student from the University of West Georgia completing a summer internship with the Department. All of the GDOT staff are very appreciative to the staff at Hickory Hill for their invitation to partner and their help during the actual survey. The success of this partnership would have not been possible without motivated and inquisitive students. All of the teenagers who participated were actively engaged in the survey, which allowed for a very successful project. Our only regret is that an afternoon thunderstorm interrupted the student's hardwork and the opportunity to collect more data.

**Figure 1: GDOT staff and Archaeology Camp staff and students going over GPR equipment.**

## Ground-Penetrating Radar Theory

Ground-penetrating radar data are acquired by transmitting pulses of electromagnetic energy waves into the ground from a surface antenna, reflecting the energy off buried objects, features, or bedding contacts and then detecting the reflected waves back at the ground surface with a receiving antenna. When collecting radar data, surface antennae are moved along the ground in transects, typically within a surveyed grid. A large number of subsurface reflections are collected along each line. As energy waves move through various subsurface materials, the velocity of the waves will change depending on the physical and chemical properties of the material through which they are traveling (Conyers 2004). The greater the contrast in the physical and chemical properties between two materials at an interface, the stronger the reflected signal, also called amplitude, will appear (Conyers 2004). When travel times of energy pulses are measured, and their velocity through the ground is known, distance (or depth in the ground) can be accurately measured (Conyers and Lucius 1996). Each time a radar wave passes through a material with a different physical or chemical property, the velocity will change and a portion of the energy wave will reflect back to the surface and be recorded. The remaining energy will continue to pass into the ground to be further reflected, until it finally dissipates with depth.

Depths to which radar energy can penetrate, and the amount of resolution that can be expected in the subsurface, are partially controlled by the frequency (and therefore the wavelength) of the radar energy transmitted (Conyers 2004). Standard GPR antennae propagate radar energy that varies in frequency from about 10 megahertz (MHz) to 1000 MHz. Low frequency antennae (10-120 MHz) generate long wavelength radar energy that can penetrate up to 50m in certain conditions, but are capable of resolving only very large buried features. In contrast, the maximum depth of penetration of a 900 MHz antenna is about one meter or less in typical materials, but its generated reflections can resolve features with a maximum dimension of a few centimeters. A trade off therefore exists between depth of penetration and subsurface resolution. In this survey a 400 MHz antenna was used, which produced data of good resolution up to approximately 1.5 meters below the ground surface. Below this depth, extraneous background noise affected the signal, making resolution of any features difficult.

Success of GPR surveys in archaeology is largely dependent on soil and sediment mineralogy, clay content, ground moisture, depth of burial, and surface topography and vegetation. Electrically conductive or highly magnetic materials will quickly attenuate radar energy and prevent its transmission to depth. The best conditions for energy propagation are therefore dry sediments and soil, especially those without an abundance of clay. The soils at 9MF914 consist of approximately 0-100 cmbs layer of sand underlain by clay. The contrast between the sand and clay should be readily apparent in the geophysical data.

The “time window” within which data were gathered was 30 nanoseconds. This is the time during which the system is “listening” for returning reflections from within the ground. The greater the time window, the deeper the system can potentially record reflections. In this survey, 30 nanoseconds is equivalent to about 1.5m in real depth. To convert time in nanoseconds to depth, it was necessary to determine the elapsed time it took the radar energy to be transmitted, reflected, and recorded back at the surface.

This amount of time is estimated by the post-processing software RADAN. All profiles and processed maps were then converted from time in nanoseconds (ns) to depth in meters using this average velocity.

**Data Processing Procedures**

The initial data processing involved the generation of amplitude slice-maps (Conyers 2004). Amplitude slice-maps are a three-dimensional tool for viewing differences in reflected amplitudes across a given surface at various depths. Reflected radar amplitudes are of interest because they measure the degree of physical and chemical differences in the buried materials. Strong, or high, amplitude reflections often indicate denser buried materials, such as cultural features. Amplitude slice-maps are generated through the comparison of reflected amplitudes at the same depth across all of the raw vertical profiles. The amplitudes of all traces are compared to the amplitudes of all nearby traces along that profile and between surrounding profiles. This database of amplitude reflections can then be "sliced" horizontally and displayed to show the variation in reflection amplitudes at a sequence of depths in the ground. The produced image is a map that shows changes in amplitudes at a given depth in plan view. Often when this is done changes in the subsurface related to disturbances such as the backfilled areas or middens can become visible.

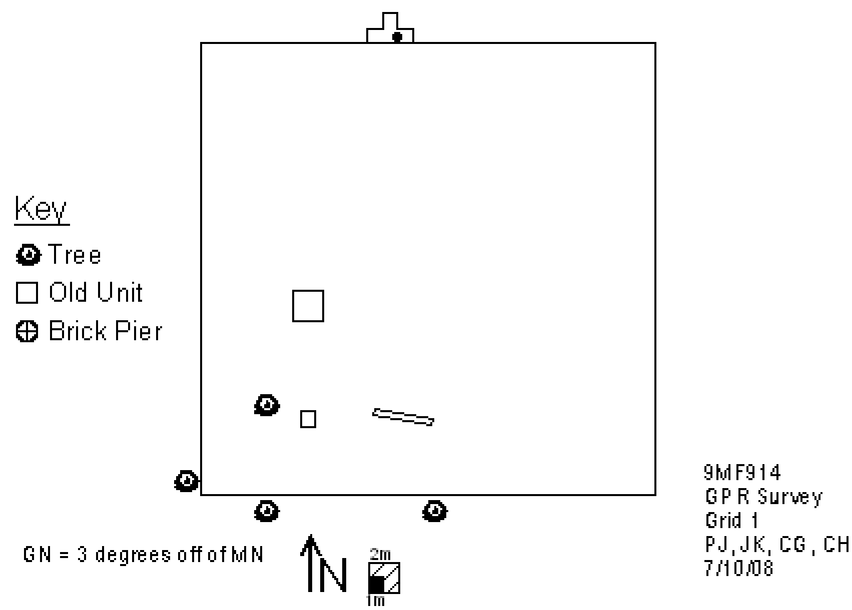
Slicing of the data generally begins with the reversal of even numbered profiles, to compensate for the data collection technique. This is needed because the data are collected in transects that move back and forth to create a grid. Since every other line is collected in the opposite direction, reversal is necessary prior to mapping the data. Following this step filters are applied to the raw profiles to remove background noise and other wavelengths that might interfere with the visibility of the wavelengths reflecting off of buried cultural features. The final step is generating amplitude slice-maps. Those slice-maps are a series of x,y,z values, with x and y being the location on the surface within each grid and z being the amplitude of the reflected waves at each depth in the ground. All of the processing to this point takes place using the GSSI software RADAN. Only once the slices are created in RADAN 5.0 can they be exported to a mapping software, such as *Surfer*.

From the original .dzt files (raw data), a series of image files were created for cross-referencing to the amplitude slice-maps that were produced. Two-dimensional reflection profiles are analyzed to determine validity of the features identified on the amplitude slice-maps. The reflection profiles show the geometry of the more continuous reflections, which can lend insight into whether the radar energy is reflecting from a flat layer (seen as a distinct band on profile) versus a single object or wall (seen as a hyperbola in profile). Using these profiles to confirm or refute ideas about the nature of buried materials seen in the three-dimensional slice-maps, features of potential cultural significance were delineated.

**Data Collection**

The GPR data were collected using the GSSI SIR-3000 unit with an attached 400 MHz antenna. Transects were spaced every 50 cm, which is the approximate width of this antenna. Transects started in the southwest corner of the grid. The placement of the first transect in the southwest corner allows for easier processing using RADAN.


**A**




**B**

**Figure 2: A) Field drawn sketch map. B) Digitized sketch map.**

The survey grid was laid out to be a 30x30 meter area, 900 $m^2$, to cover the majority of the site (Figure 2). Transects were collected in the Y direction, which was along the north/south axis. Therefore profiles for Grid 1 were 30 meters long. The area is relatively flat and covered in pine straw (Figure 3). The only obstacles encountered during the survey were old excavation units, one tree, a log, and several dirt piles. You will notice that Figure 2 shows the sketch map created by the students in the field. The digitized version (see Figure 2B) only includes the information collected while in the field. Unfortunately we did not have time while in the field to record all of the features located within the survey grid. **FOR DIG HISTORY STUDENTS: What features or annotations are missing from the map? What else would you add or could you add?**


**A**


**B**


**C**


**D**

E

F

**Figure 3: A) View of survey grid facing eastward with the log and two old test excavations. B) View of survey grid facing northward with tree, old test excavations, new test excavations, and dirt piles. C) Students collecting GPR data using a SIR-3000 and 400 MHz antennae. D) Students learning about GPR data collection and field procedures. E) Student moving the survey tape and taking notes of survey progress. F) Students learning to pace and create maps of the survey area.**

Time restraints allowed for only half of the grid to be surveyed. This meant that 31 .dzt files (GPR files) were collected from 0-15 meters along the X-axis (Figure 4). Although the entire site was not surveyed, cultural features were still readily visible in the data that were collected. Old excavation units from previous archaeology camps were located both within and outside of the area surveyed. Based upon features found in the excavation units to the east of the surveyed area, the Jeffersonian print was thought to extend further to the east. Therefore additional architectural features would likely have been revealed had the survey extended an additional 15 meters to the east.

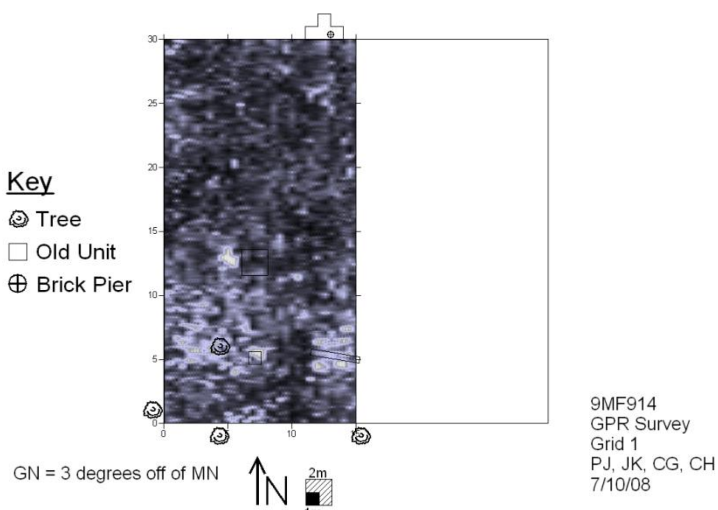



**Figure 4: Sketch map overlain onto GPR data.**

## Results

Grid 1 was placed over the Jeffersonian print in an attempt to locate both the eastern and western walls. The north and south walls have been previously identified by students during the archaeology camps. While no definite edge is visible in the geophysical data, several interior walls and rooms were identified (Figure 5).

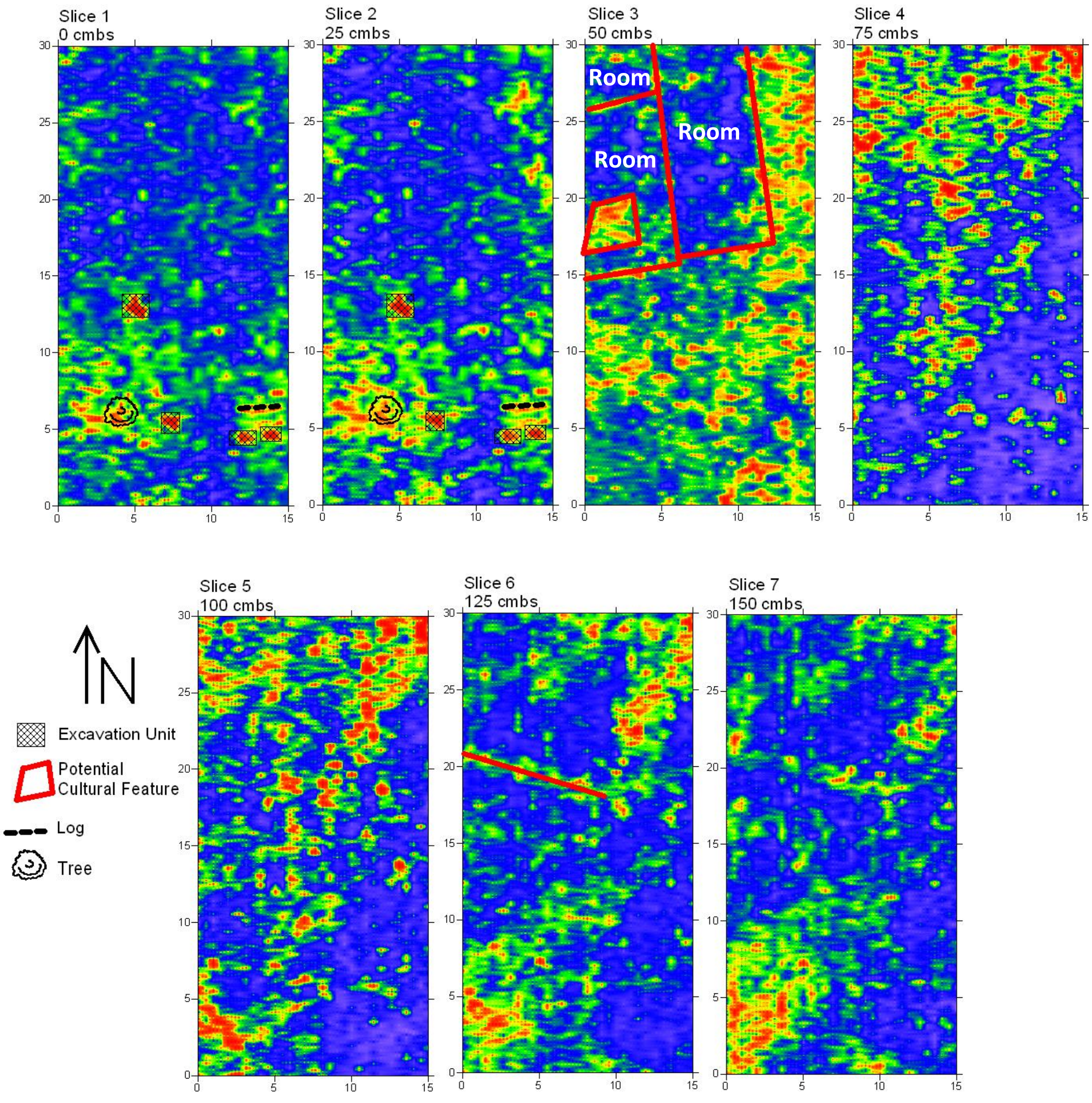



**Figure 5: GPR amplitude slice-maps and some interpretations.**

Areas of red, yellow, and orange indicate highly reflective materials buried beneath the ground surface. These materials could be cultural or natural in origin. The main cultural features visible in this 15x30 meter area are walls likely associated with the plant structure. There appears to be at least three different rooms, two small rooms to the west of a larger room. An area of highly reflective material can be seen in the southwestern room and is outlined in red. This surface was very easily seen in the GPR profiles (Figure 6).

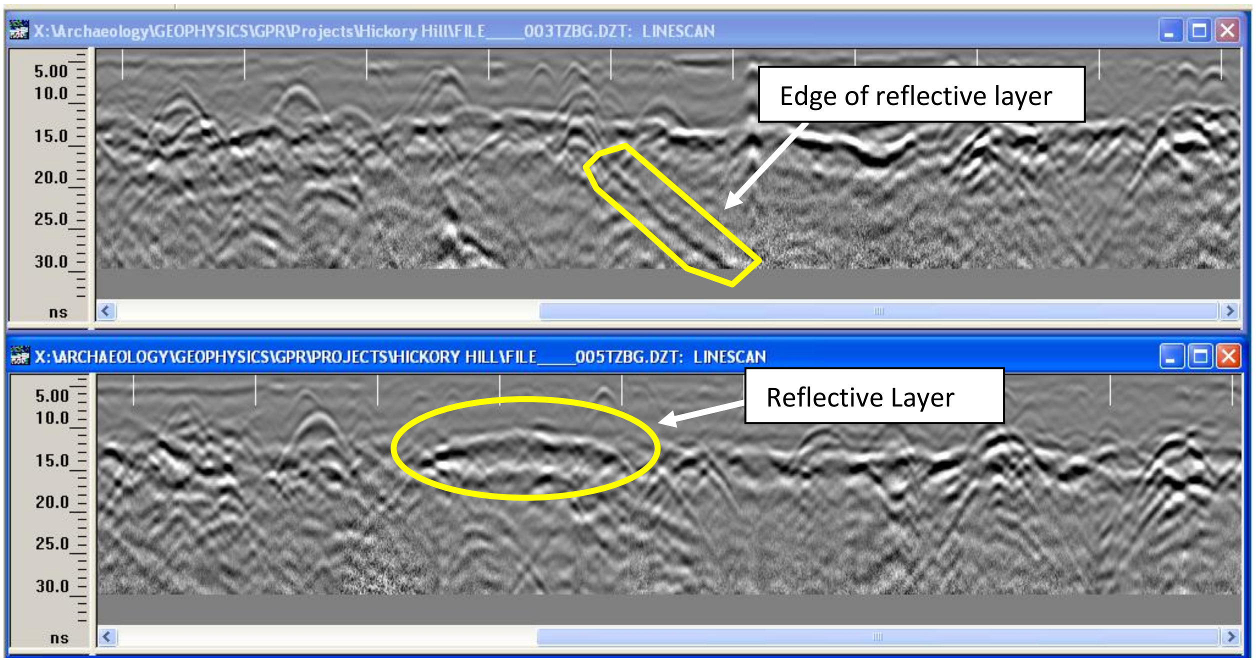



**Figure 6: Profiles 3 (top) and 5 (bottom) from 12 to 30 meters along the Y-axis. The highly reflective layer in the southwestern room is annotated.**

The walls of the different rooms were also very visible in the profiles. Figure 7 shows the same amplitude slice-maps as above, but with the walls annotated. The walls were seen in at least eleven profiles (1-10). Since transects were collected along the Y-axis from south to north the walls oriented in the east to west direction were easier to see. However, two walls running parallel to the transects were still visible in the amplitude slice-maps (Figure 5). **FOR DIG HISTORY STUDENTS: How do you interpret the data? What cultural features do you see buried beneath the ground at site 9MF914?**

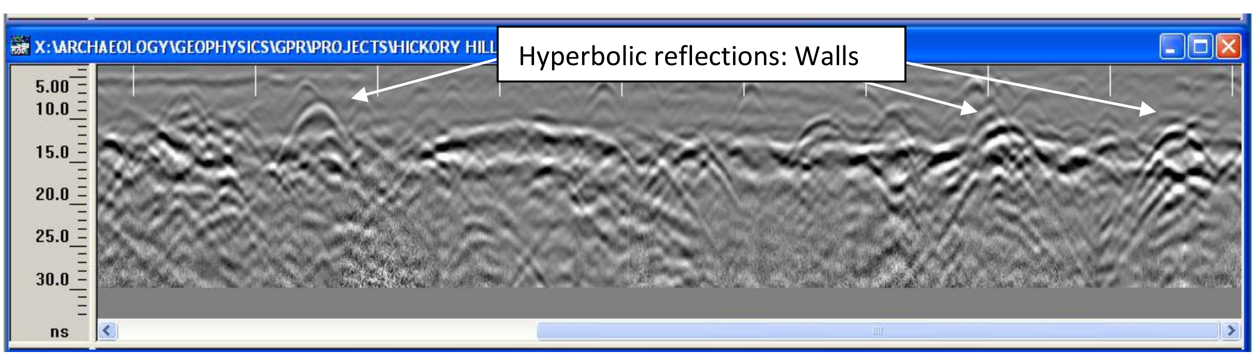



**Figure 7: Profile 5 from 12 to 30 meters along the Y-axis. Three walls are annotated.**

## Conclusions

Several cultural anomalies were visible in the GPR data collected by the students of the Hickory Hill Historic Home archaeology camp, Dig History. Students with the camp were involved with GDOT archaeologists in all aspects of data collection, including mapping, note keeping, and the geophysical survey. The students also participated in the initial data interpretation. Interpreted anomalies include walls and rooms, which make up portions of the Jeffersonian plant that Thomas E. Watson built at his home. If any of the students with the camp are interested in enhancing this report with their own interpretations please send them to the principal investigator for incorporation into the report.

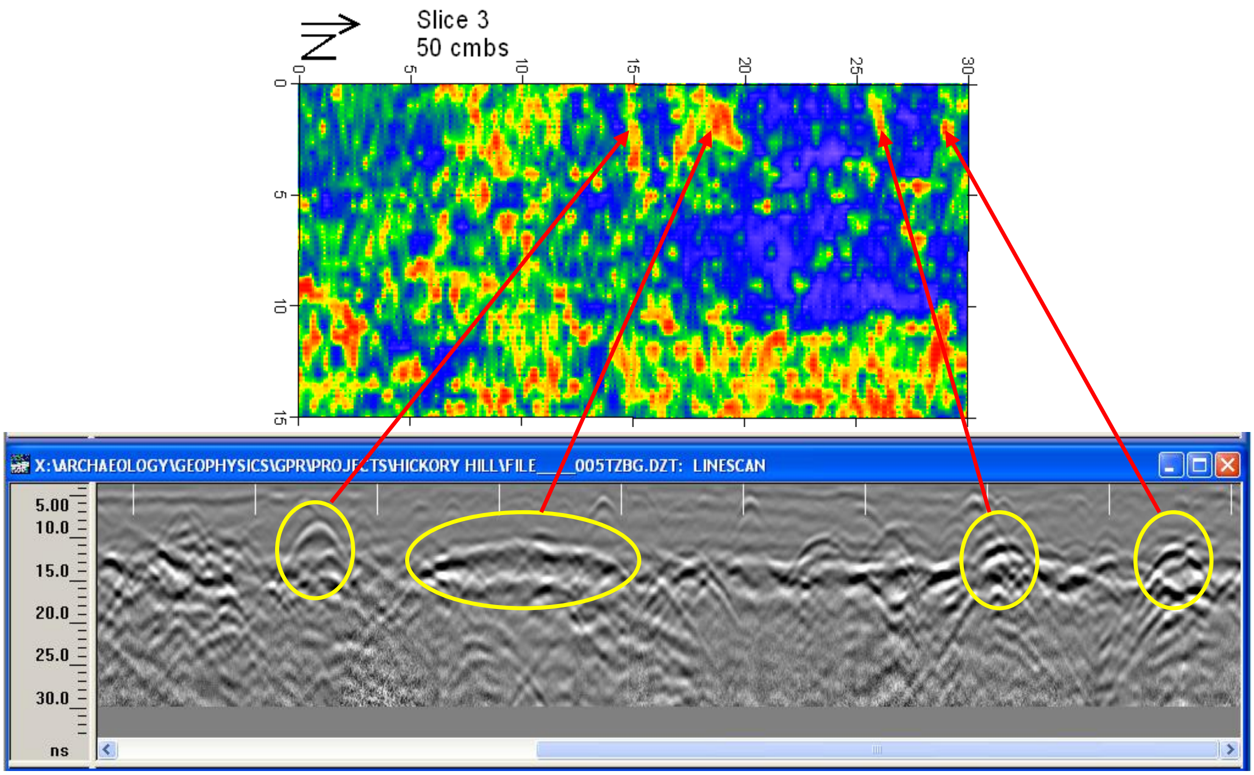



**Figure 8: Amplitude slice-map of approximately 50 cmbs.**

GPR profiles and amplitude slice-maps were used to identify buried cultural features associated with the Jeffersonian plant. Additional geophysical surveys at the plant could help map buried architectural features associated with the plant. While time allowed for only a portion of the site to be surveyed, the field conditions (soil type and feature type) were highly suitable for geophysical methods.

**REFERENCES CITED**

Conyers, Lawrence B.

2004 *Ground-Penetrating Radar for Archaeologists*. AltaMira Press, Walnut Creek, CA.

Conyers, Lawrence B., and Jeffrey E. Lucius

1996 Velocity Analysis in Ground-Penetrating Radar Studies. In *Archaeological Prospection* 3:25-38.

Pierannunzi, Carol

2006 New Georgia Encyclopedia: Thomas E. Watson information. Electronic document, http://www.georgiaencyclopedia.org/nge/Article.jsp?id=h-2540&hl=y, accessed July 15, 2008.

**APPENDIX A**

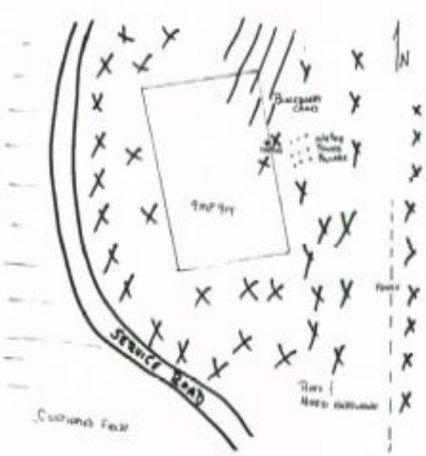
Official State
Site No. 9MF914

**GEORGIA ARCHAEOLOGICAL SITE FORM**
1990
Official Site Number. 9MF914

Institutional Site Number. HH001 Site Name: Jeffersonian
County: McDuffie Map Name: Thomson West, GA **USGS** or USNOAA
UTM Zone: 17 UTM East: 359-320 UTM North: 3704-446
Owner. Watson-Brown Foundation, Inc. Address: 310 Tom Watson Way, Thomson, GA 30824
Site Length: +30.5 meters Width: +27.5 meters Elevation: +167.6 meters
Orientation: 1. N-S 2. E-W 3. NE-SW **4. NW-SE** 5. Round 6. Unknown
Kind of Investigation: 1. Survey 2. Testing **3. Excavation** 4. Documentary 5. Hearsay 6. Unknown 7. Amateur
Standing Architecture: 1. Present **2. Absent**
Site Nature: 1. Plowzone **2. Subsurface** 3. Both 4. Only Surface Known 5. Unknown 6. Underwater
Midden: 1. Present **2. Absent** 3. Unknown Features: **1. Present** 2. Absent 3. Unknown
Percent Disturbance: 1. None 2. Greater than 50 **3. Less than 50** 4. Unknown
Type of Site (Mill, Mound, Quarry, Lithic Scatter, etc.): early 20th century printing plant

Topography (Ridge, Terrace, etc.): hilltop
Current Vegetation (Woods, Pasture, etc.): grasses surrounded by pine and mixed hardwood forest

Additional Information: site is part of the Hickory Hill National Register of Historic Places property




SKETCH MAP
(Include sites, roads, streams, landmarks)


OFFICIAL MAP
(Xerox of proper map)

State Site Number: 9MF914 Institutional Site Number: HH001

Public Status: 1. National Historic Landmark 2. National Natural Landmark
3. Georgia Register 4. Georgia Historic Trust 5. HABS 6. HAER

National Register Standing: **1. Determined Eligible** 2. Recommended Ineligible
3. Recommended Eligible 4. Nominated 5. Listed 6. Unknown 7. Removed

National Register Level of Significance: 1. Local 2. State **3. National**

Preservation State (Select up to Two): 1. Undisturbed 2. Cultivated 3. Eroded
4. Submerged 5. Lake Flooded 6. Vandalized 7. Destroyed 8. Redeposited
**9. Graded** **10. Razed**

Preservation Prospects: **1. Safe** 2. Endangered by
3. Unknown

**RECORD OF INVESTIGATIONS**

Supervisor: Michelle Zupan Affiliation: Watson-Brown Foundation, Inc. Date: 8/17/2006
Report Title:

Other Reports:

Artifacts Collected: windowglass, bottle glass, roofing nails, roofing materials, brick, foundation remnants, lines of type, printing plates, linotype slugs, equipment fragments

Location of Collections: Hickory Hill, 502 Hickory Hill Drive, Thomson, GA
Location of Field Notes: Hickory Hill, 502 Hickory Hill Drive, Thomson, GA
Private Collections: no other collections identified

Name: Michelle Zupan Address: 502 Hickory Hill Drive, Thomson, GA 30824

**CULTURAL AFFINITY**

Cultural Periods: Historic – early to mid-20th century, Anglo

**FORM PREPARATION AND REVISION**

| Date | Name | Institutional Affiliation |
| --- | --- | --- |
| 1/15/2005 | Michelle Zupan | Watson-Brown Foundation, Inc. |
| 8/17/2006 | Michelle Zupan | Watson-Brown Foundation, Inc. |