

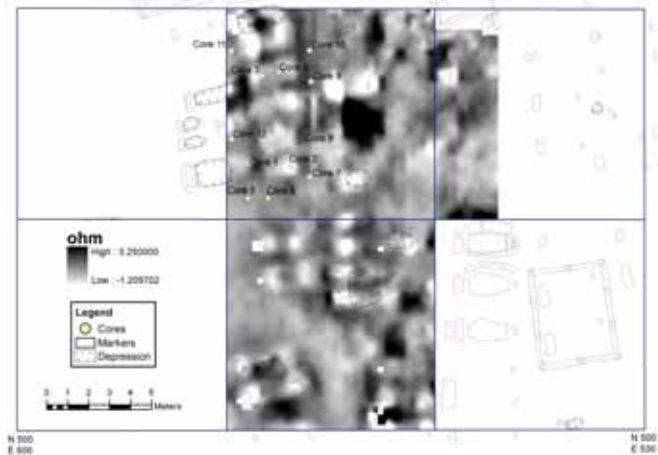
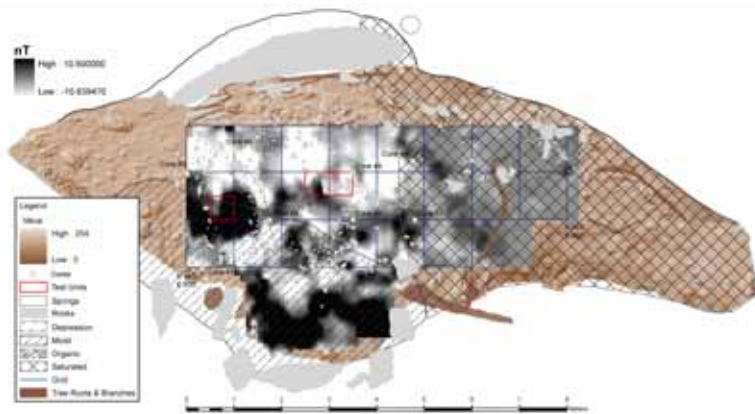
NON-INVASIVE BURIAL DETERMINATION USING NEAR-SURFACE GEOPHYSICAL SURVEY AND SOIL CHEMICAL TESTING AT FORT HOOD, TEXAS AND CAMP LEJEUNE, NORTH CAROLINA

by

Duane Simpson

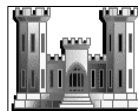
and

Ryan Peterson



United States Army Fort Hood
Archeological Resource Management Series
Research Report No. 55

December 2004



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Prepared for

Directorate of Public Works
Environmental Division
Fort Hood

by

AMEC Earth & Environmental
Louisville, Kentucky

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EXECUTIVE SUMMARY

Report Purpose

AMEC Earth & Environmental (Louisville, KY) prepared this report for the Directorate of Public Works, Environmental Management Office, Cultural Resource Management Program, Fort Hood. The work was completed under contract with the United States Army Fort Hood and funded by the Department of Defense Legacy Resource Management Program. The objective of this project was to develop a means to identify human burials with minimal disturbance. Field investigations were conducted at 12 sites including rockshelters, open-air sites, and historic cemeteries located at Fort Hood, TX and Marine Corps Base Camp Lejeune, NC. Sites that contained known burials and those that did not were selected to test the proposed techniques. The field investigations included two components, intensive geophysical survey and a combination of soil coring and limited test unit excavation.

Methodology

Intensive geophysical survey included electrical resistance and magnetometry at a minimal sample interval of 12.5 cm for the rockshelters and 25 cm for the open-air sites. Rockshelters included in the investigation were mapped to sub-centimeter level accuracy with a laser field scanner. Detailed hand drawn maps were also made of every site to facilitate data interpretations. All of the data listed above was analyzed and locations of suspected archaeological features were identified. Soil cores were extracted from known burial locations as well as control samples collected away from archaeological features. Limited test unit excavation (0.5-x-0.5-m and 1.0-x-0.5-m) was conducted on potential archaeological features identified in the geophysical data. Soil samples were also collected from the excavation units. All soil samples were analyzed for a suite of trace elements as well as total phosphorous content.

Results

Intensive geophysical investigation techniques were applied to rockshelters and historic cemeteries, as well as archaeological sites situated in very sandy soils. These site types have been very challenging in the past, but the present study produced usable to exceptional results. Archaeological investigations based on the results of the geophysical data resulted in the successful identification of cultural features and human burials. In multiple instances, the geophysical data was accurate to within five centimeters of the archaeological features boundaries. Application of soil chemistry techniques to confirm burial locations was more problematic. While trends in the trace element and total phosphorous data displayed some differences between burials, cultural features, and background samples, statistically sound results that would support more definitive identification of a burial location were not achieved. The functionality of the chemical testing appears to hold the greatest promise in historical burials.

Recommendations

Given the successes of this project, intensive geophysical investigation of rockshelters and historic cemeteries, as well as archaeological sites in extremely sandy soils is recommended in advance of the subsurface investigation at these sites. These techniques have proven particularly promising in managing rockshelter and historic cemetery resources. The application of trace element analysis and total phosphorous determination to verify burial locations produced inconclusive results. Further investigation into these and other chemical techniques will be necessary.

ABSTRACT

The objective of this project was to develop a non-invasive means to identify the location of prehistoric and historic human burials using geophysical and soil chemistry techniques. This research was conducted at Fort Hood, TX and Camp Lejeune, NC and began in January 2004 and concluded in May 2004. The research design required three essential tasks. The first task was to create a geophysical collection strategy that would ensure the best possible results within any environmental or physical site type. The second task involved the creation of a methodology to sample each of the geophysical anomalies with the least amount of disturbance. The third task was the creation of a chemical testing methodology that would produce a chemical signature capable of verifying that a geophysical anomaly was a human burial.

Field investigations were conducted at 12 sites including rockshelters, open-air sites, and historic cemeteries distributed between the two installations. Sites that contained known burials and those that did not were selected to test the proposed techniques. The field investigations included two components, intensive geophysical survey and a combination of soil coring and limited test unit excavation. Intensive geophysical survey included electrical resistance and magnetometry at a minimal sample interval of 12.5 cm for the rockshelters and 25 cm for the open-air sites. Laser field scanning and detailed mapping were also completed to facilitate data interpretations. All of the data listed above was analyzed and locations of suspected archaeological features were identified. Adequate to exceptional results were obtained from the geophysical investigations. Verification of the data through the excavation of small units confirmed the utility of applying these techniques to these difficult site types.

Small diameter soil cores were extracted from known burial locations as well as control samples taken away from archaeological features. Limited test unit excavation (0.5-x-0.5-m and 1.0-x-0.5-m) was conducted on potential archaeological features identified in the geophysical data. Soil samples were also collected from the excavation units. All soil samples were analyzed for a suite of trace elements as well as total phosphorous content. Application of soil chemistry techniques to confirm burial locations was more problematic. While trends in the trace element and total phosphorous data displayed some differences between burials, cultural features, and background samples, statistically sound results that would support more definitive identification of a burial location were not achieved. The functionality of the chemical testing appears to hold the greatest promise in historical burials.

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INTRODUCTION

Duane Simpson and Ryan Peterson

1

Project Overview

Archaeological investigations as well as other activities on military installations occasionally result in the accidental disturbance of human remains. Due to the sensitivity of such discoveries, the identification of the presence of human remains prior to excavation or other ground disturbing activities is very beneficial. This project was designed to evaluate methods for identifying the presence of human remains through non-invasive near-surface geophysical and chemical soil analyses.

The original scope of work established a set of tasks. The project focused on the creation of a methodology that would utilize non-invasive techniques to identify potential burial anomalies, sample soil from these anomalies, and return a chemical signature that would positively identify the anomaly as a burial. These goals had to be met in succession, in order to effectively create a reproducible methodology. Intensive geophysical data collection techniques were utilized to ensure that adequate data was collected for the chemical signature development phase of the project.

The original focus of the research centered on the investigation of rockshelter sites, given the fact that the majority of prehistoric burials at Fort Hood were located within these environments. As the research design progressed, additional sites and environmental types were added, broadening the research focus. These additional site types included prehistoric open-air sites and historic cemeteries.

Project Origination and Funding

The Department of Defense (DoD) Legacy Resource Management Program (Legacy) provided funding for the research presented in this document, based on a proposal submitted by Dennis Glinn, ORISE intern and Fort Hood Field

Archaeologist. The project was designed to focus on Fort Hood and include additional sites at Marine Corps Base Camp Lejeune. The ultimate goal was to create a technique that would be transferable to installations throughout the DoD.

Site Selection

Selection of sites at both Fort Hood and Camp Lejeune involved sites that contained known interments, which facilitated the interpretation process, as well as sites that may contain burials and other cultural features. Selection of known burial sites was essential to ensure that an adequate burial sample was achieved for the second focus of the project: soil chemical testing. While these sites produced multiple burial locations for chemical sampling, additional anomalies were necessary for sampling as well. Surveying known burials helped “tune” the geophysical instruments and subsequent data analyses to specific characteristics of burials, aiding in the identification of previously unknown interments.

Human interments are not the only cultural features that contain bone. Faunal material (non-human bone) can be recovered from a number of different cultural feature types, such as, hearths or trash pits. Given the final research goal of the project, the additional anomalies were tested to provide a means of differentiating human burials from other faunal concentrations, and thus create a true identification tool. Additional sites were added at both installations that had the potential to contain a greater variety of archaeological features. Given that the location of these potential features was unknown, more strenuous interpretation methods were needed to analyze this aspect of the data.

The original objective of the project was to investigate prehistoric rockshelter burials, but

open-air sites were added to the investigation to compare and contrast the results obtained from different site types and installations. In addition, historic burials were investigated to compare historic versus prehistoric interments.

Table 1.1 summarizes the sites that were investigated as part of this project. A total of eight sites were investigated at Fort Hood including five rockshelters (**Figure 1.1**). Three shelters contained known burials including 41BL69, 41BL744, and 41CV901. Rockshelter 41BL780 was chosen based on high surface artifact density that provided an indication that non-burial archaeological features might be present. Rockshelter 41BL844B was chosen due to previously reported human bone on the surface and the presence of dense artifact concentrations documented during previous investigations.

Table 1.1. Summary of Sites Investigated.

Installation	Site #	Site Type
Fort Hood	41BL69	Rockshelter
	41BL744	Rockshelter
	41BL780	Rockshelter
	41BL884B	Rockshelter
	41CV901	Rockshelter
	41CV1038	Open-air
	41CV1150	Historic Cemetery
	41CV1235	Open-air
Camp Lejeune	31ON71	Open-air
	31ON1019	Open-air
	31ON1236	Open-air
	Wards-Will	Historic Cemetery

In addition to the rockshelters, three open-air sites were investigated at Fort Hood. Site 41CV1038 was investigated with test units by Fort Hood staff as part of a separate investigation. A combination of soil samples from the unit walls and soil cores were collected from this site to supplement the number of samples from open-air sites. Site 41CV1235 was selected because it is an open-air site with a high probability of containing archaeological features. Walker Cemetery (41CV1150) was selected to provide a source of comparison between prehistoric and historic human burials.

A total of four sites were investigated at Camp Lejeune (**Figure 1.2**). Due to geological differences, Camp Lejeune does not contain rockshelter sites; therefore only open-air sites were investigated at this installation. Sites 31ON1019 and 31ON1236 were selected because they contain known prehistoric human burials that were documented during previous investigations. Site 31ON71, the Freeman Creek site, was selected because it is a large prehistoric/historic site that has a high potential to contain archaeological features. The final site investigated at Camp Lejeune was Wards-Will Cemetery. Investigation of this cemetery was undertaken to serve as a comparison to the Walker Cemetery investigated at Fort Hood.

Research Tasks

The first task was to create a geophysical investigation strategy that would ensure the best possible results within any environmental or physical site type. The central focus of the research had initially been the rockshelters located at Fort Hood. Rockshelters are challenging environments in which to work and have proven to be difficult to explore and interpret with geophysical instruments by previous researchers. Given this central focus, a more intense and improved combination of geophysical data sets were needed, offering the best chance to locate and sample a range of burial and cultural features. This methodology increased sampling density to a minimum of 12.5 cm between measurements. This dense sampling provided the level of detail necessary to define very small anomalies, as well as clarify the edges of larger anomalies, vastly improving data interpretations. In addition to increased sampling, multiple geophysical techniques were used, including a magnetometer and electrical resistance. Resistance data was collected at multiple narrow depth intervals. Laser field scanning and accurate mapping complimented the geophysical data and improved the resulting interpretations. This layering of information provided a substantial breadth of data that facilitated the effective interpretation of the rockshelter survey results.

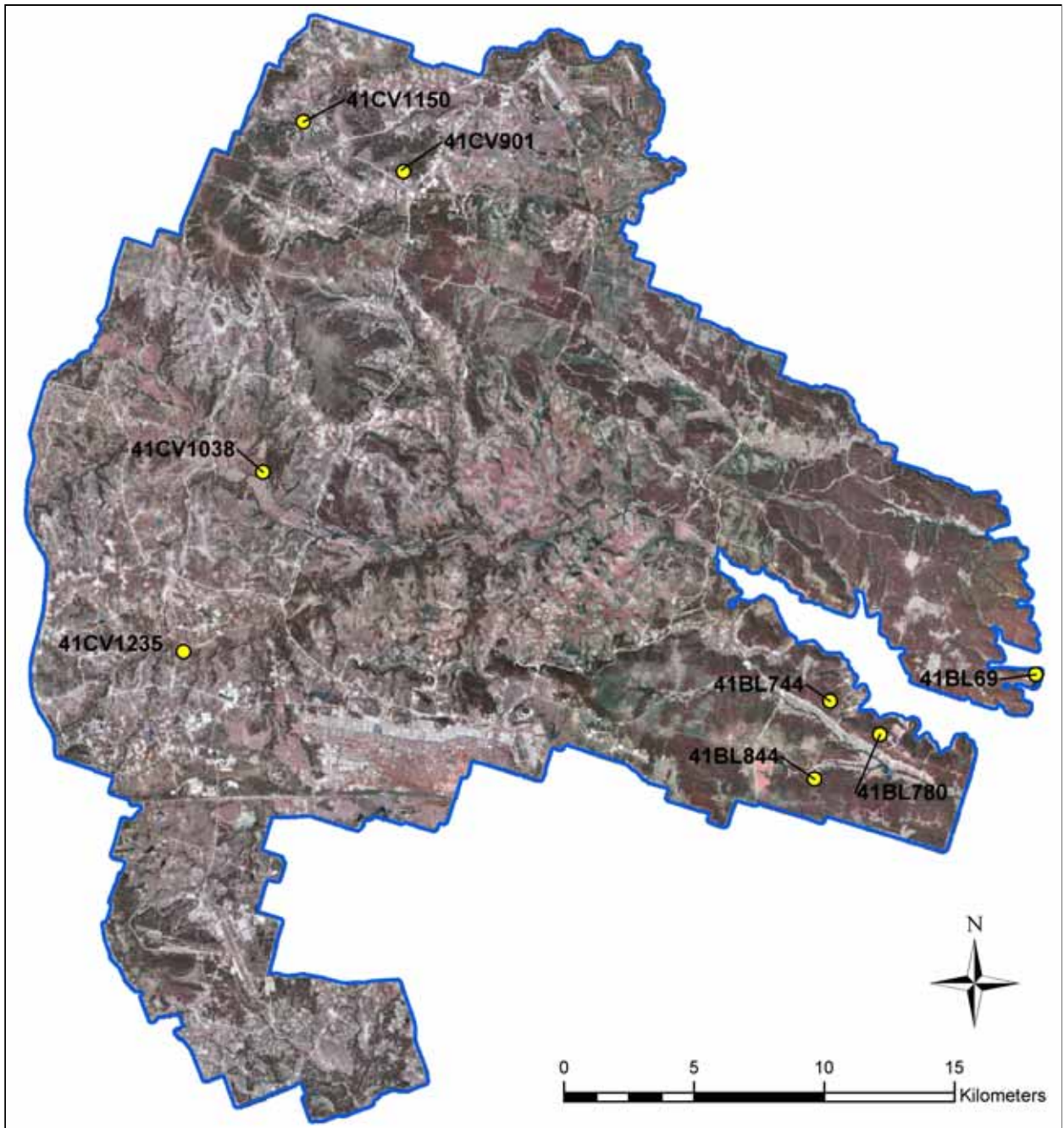


Figure 1.1. Sites investigated at Fort Hood.

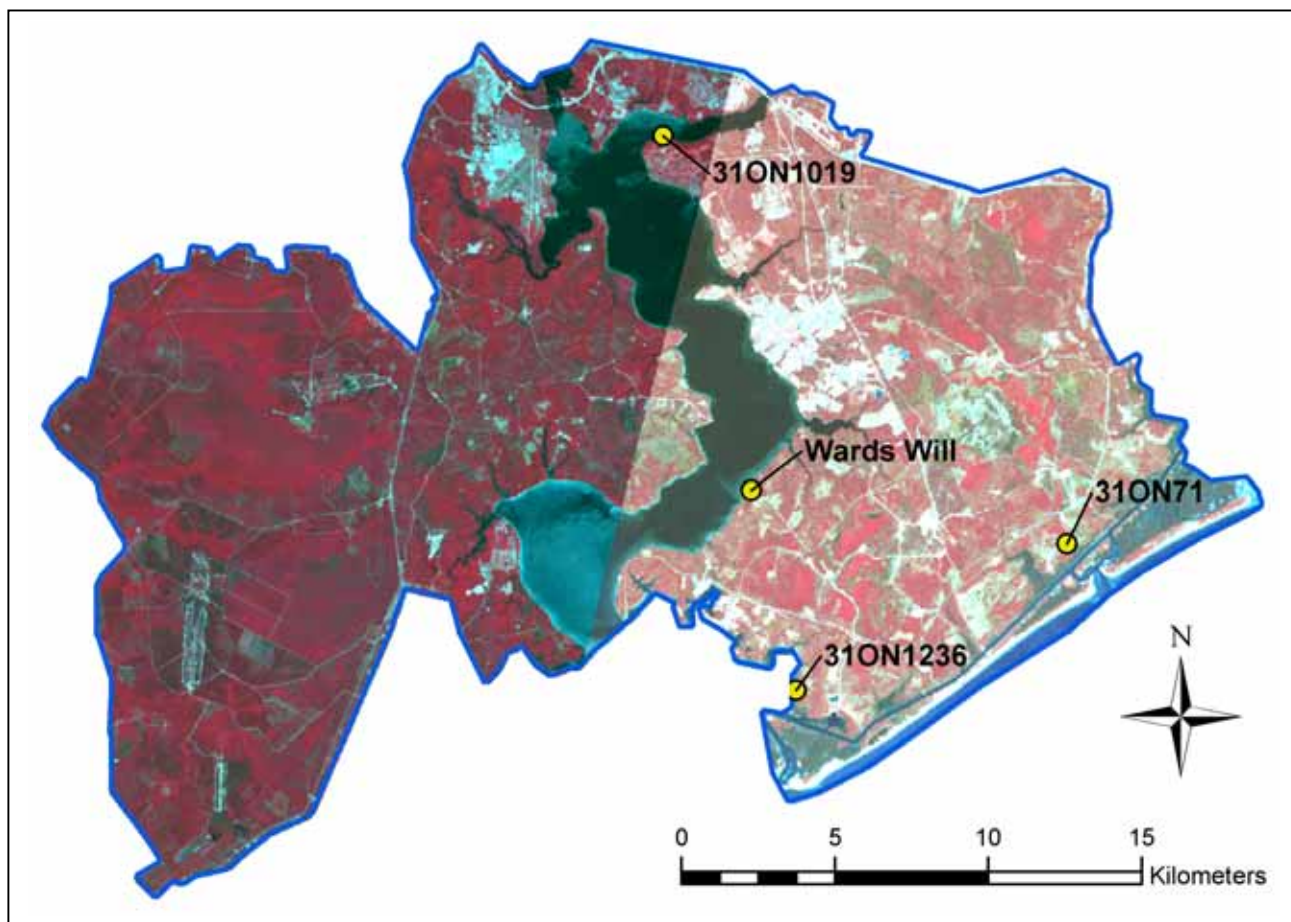


Figure 1.2. Sites investigated at Camp Lejeune.

This intense methodology was slightly reduced for investigation of the open-air sites. These sites required larger areas of investigation and some of the intense difficulties related to the rockshelter environments were not present within these sites. Data collection was reduced to a minimum of 25 cm intervals for the magnetometer and electrical resistance surveys, and laser field scanning was dropped as an investigative tool. Resistance survey was also limited to specific depths determined by environmental conditions or previous archaeological knowledge.

While the open-air sites were not as complex, they posed different difficulties. A series of historic cemeteries were chosen for investigation. Historic cemeteries are notorious for producing marginal if not questionable data, due to a multitude of problems. The intense open-air methodology produced adequate to excellent results at two cemeteries, providing the information necessary to complete the succeeding tasks. The inclusion of Camp Lejeune also complicated the geophysical survey task due to the fact that the majority of camp is underlain by sandy soils.

These types of soils are difficult to obtain high quality geophysical survey results, because the large particle size of the soils tends to mute differences between cultural features and the surrounding background. Again, the more intense survey methodology provided the information necessary to effectively investigate the various sites.

The second task involved the creation of a methodology to sample the geophysical anomalies with the least amount of disturbance. The importance of this step was to determine if sufficient quantities of soil could be collected from each of the various burial and cultural features to produce usable chemical results. In order to treat the burials with sensitivity and respect, the primary collection methodology used was core sampling with a small barrel, less than an inch diameter, soil core. A series of small excavation units were also included in the process. These were used to validate and investigate the nature of anomalies identified within the geophysical survey data. No test units were excavated in

areas containing previously documented burials. Both methodologies were used effectively to identify and sample a range of burial and non-burial features.

The third task was the creation of a chemical testing methodology. This task was the most difficult, due to the fact that background research had identified few cases in which chemical sampling had been used solely to identify a burial location. In fact, background research indicated that no definitive technique could be found to positively identify a human grave from other cultural features. Complicating this component of the research was that the chemical methodology had to be relatively easy to sample and not cost-prohibitive. Several options were considered, but the most feasible option available given current technological advances, cost, and the accessibility of facilities that can conduct the analysis, is trace element analysis and total phosphorous determination. All of these various issues and complications contributed to the development of the chemical testing methodology. The utilization of trace element testing and total phosphorous determination were selected to address these various issues. Both tests required limited sample size, making them easily recoverable from a small diameter soil core and resulting in minimal impact to the burials and other cultural features. Background research revealed an extensively researched history for both chemical processes, providing the basis on which to design a testing protocol.

The goal of the soil chemistry component of this project was to attempt to identify a chemical signature from soil samples collected from burial contexts. In addition to testing each anomaly, samples were run from across each site providing a baseline characterization of the environment for comparison. The results of the soil testing would allow for a probability statement to be made

regarding the likelihood that an anomaly identified in the geophysical data was a human burial.

Summary of Fieldwork

The fieldwork component of this project was conducted between January and May 2004. The first component of the field investigation involved on-site visits to both installations. During the initial visits, potential sites to be included in the investigation were identified, inspected, and background research conducted. The geophysical data was then collected from all of the sites at both installations, processed, and maps with the potential anomalies to be sampled/tested were generated. Both installations were then revisited to conduct the soil coring and test unit excavation. Following the conclusion of the fieldwork, soil samples were submitted for analysis.

Report Organization

This report has been organized into eight chapters and two appendices. **Chapter 1** provides a general overview and background of the project. **Chapter 2** provides an archaeological and environmental context for Fort Hood and Camp Lejeune. **Chapter 3** provides a discussion of the geophysical methods utilized and the theory behind them. **Chapter 4** discusses the methods and theory behind the soil testing component of the project. **Chapter 5** includes the results the survey and testing of the sites at Fort Hood. **Chapter 6** addresses the survey and testing conducted at Camp Lejeune. **Chapter 7** includes the results of the soil testing. **Chapter 8** concludes the report with interpretations and conclusions. **Appendix A** includes the information collected from soil probes and profiles during the investigation. **Appendix B** includes the data produced from the soil chemical analysis.

ENVIRONMENTAL AND ARCHAEOLOGICAL BACKGROUND

Duane Simpson and Ryan Peterson

2

INTRODUCTION

The project was conducted in two clearly different archaeological and environmental areas, central Texas (Fort Hood) and coastal North Carolina (Camp Lejeune). The archaeology of Fort Hood and Camp Lejeune has been discussed in detail in several research reports. The archaeology and environmental backgrounds of both installations are discussed briefly here. The following discussion is only intended to provide a general context for the project. More exhaustive studies relating to specific archaeological issues should be consulted if more detailed data is desired.

ARCHAEOLOGICAL BACKGROUND

As it is not the goal of this study to debate and refine the archaeological record for Fort Hood or Camp Lejeune, the cultural chronology is strictly intended to frame site discussions in the following chapters.

Fort Hood Archaeology

The Central Texas prehistoric sequence is divided into three general period included the Paleoindian, Archaic, and Late Prehistoric. Terms and time periods presented below are primarily based on the work of Collins (1995).

The earliest known prehistoric culture in North America is represented by the Paleoindian period (11, 500 – 8800 B.P.). Sites dating earlier than this time span have recently been documented in North America, but this date range represents the best dates available in Texas at the present time. Collins (1995) differentiates two sub-periods, early and late. The early period includes Clovis and Folsom projectile point styles. In addition to the diagnostic fluted points, Clovis artifact assemblages include various stone tools, bone/ivory points, and ochre. Folsom tool kits included Folsom points and several other bifaces

and scrapers thought to be specialized for bison and other large game.

The Archaic period follows the Paleoindian period and spans from 8800 B.P. through 1200 B.P. and is divided into Early, Middle, and Late Archaic periods. The Early Archaic spans from 8800- 6000 B.P. and is characterized by mobile groups with diverse tool assemblages (Prewitt 1974). A wider range of tool types is present compared to the Paleoindian period. The Early Archaic period marks the beginning of the use of rock hearths and ovens. These burned rock features are thought to be the predecessors of the large burned rock middens that develop later in the Archaic period (Collins 1995).

The Middle Archaic period (6000-4000 B.P.) is marked by an increase in site size and the number of sites documented. Burned rock middens become prevalent toward the end of the Middle Archaic period (Prewitt 1991). Collins (1995) recognized increasingly dry conditions during this period that may have caused an increase in yucca and similar plants that were prepared in rock hearths. Implying cultural change based on environmental change though is always a tenuous proposition without direct evidence. Research completed more recently by Black et al. (1997) indicated these accretional middens span thousands of years, with most being augmented to their greatest degree from 2000 to 400 B.P. Excavations at 41CV413 on Fort Hood indicated that the Middle Archaic occupations lie below and within the lower sections of the mound, with later Late Archaic and Late Prehistoric occupations creating the bulk of the midden deposits (Mehalchick et al. 2002).

The Late Archaic period (4000-1200 B.P.) is marked by continued population increase and the establishment of large cemeteries. A variety of projectile point intervals are part of this period as well as the continued use of burned rock middens. The increase in burned rock middens and decrease in projectile points suggests a change in

subsistence strategy (Prewitt 1981). Research completed at Fort Hood has indicated a separation of burned rock midden types, by the Late Archaic period including burned rock middens and mounds (Abbott and Trierweiler 1995; Kleinbach et al. 1999; Trierweiler 1996). Most middens are buried in aggrading slopes, toeslopes or alluvial terraces, and are considerably larger and substantively different from isolated burned rock mounds (Boyd and Mehalchick 2002:71). Burned rock mounds are typically found in upland settings across Fort Hood, and appear to relate to a single resource acquisition activity. The diversification of the midden types during this period may be linked to environmental conditions; forcing broader and more specific resource acquisition due to drier climatic conditions.

The Late Prehistoric period (1200-300 B.P.) is marked by the introduction of the bow and arrow and the introduction of ceramics. Subsistence practices do not appear to vary significantly from the Late Archaic period. (Prewitt 1985). The Late Prehistoric consists of two phases, Austin and Toyah. Scallorn-Edwards and Perdiz points are diagnostic of the Late Prehistoric period and are found throughout the state of Texas (Prewitt 1981). During the Austin phase, an increase in violence is documented by the presence of Scallorn and Edwards projectile points in burials that appear to be the cause of death. During the later, Toyah phase Perdiz points became common, group mobility increased due to increased bison availability, and development of burned rock middens diminishes or ceases (Collins 1995). The Late Prehistoric period continues until European contact. European contact occurs in Texas during the sixteenth century, but is not sustained until late seventeenth and early eighteenth centuries (Collins 1995).

Camp Lejeune Archaeology

The archaeology of the North Carolina Coastal Plain spans over 12,000 years and includes Paleoindian, Archaic, and Woodland periods. The Paleoindian period span from 12,000 to 10,000 B.P. Documentation of Paleoindian sites throughout the southeast is relatively sparse, consisting predominately of surface sites. This time period is generally thought to be dominated by highly mobile groups of people hunting large game, but excavations at a few sites, such as the Higgins site in the Coastal Plain of Maryland, have recovered a wide breadth of plant and animal

remains, indicating a more diverse settlement strategy, utilizing an array of small game animals and a wide selection of plants (Ebright 1992). The majority of sites from this period within the Coastal Plain environment have been found along smaller tributaries near poorly drained areas, noting an affinity to settle near highly productive wetland areas of the environment (Ebright 1992; Lichtenberger et al. 1994; McAvoy 1964). Population density is difficult to ascertain from the scant archaeological record known from this time period. As noted by Blanton (1996) the majority of the low lying areas within the Coastal Plain have been flooded. Given the affinity of these early groups to settle in these areas, it is quite possible that most sites now lie within the broad estuaries that typify the Coastal Plain. Local projectile points that are diagnostic of this period include Clovis, Hardaway, and Hardaway-Dalton (Phelps 1978).

The Archaic period (10,000-3000 B.P.) follows the Paleoindian period. The Archaic period is subdivided into Early, Middle, and Late Archaic. The Early Archaic is divided into two phases. The first spans 10,000-9000 B.P. and includes Palmer, Kirk corner notched, later stemmed points and hafted scrapers (Coe 1964). Numerous small sites located in a wider range of environmental zones characterize this phase, but the majority of sites still appear to be focused on wetlands within the Coastal Plain. The later tradition of the Early Archaic spans from 9000-8000 B.P. and is characterized by LeCroy, St. Albans, and Kanawha types (Oliver 1985). Sea levels were still increasing throughout this period, probably leading to the drowning of many low lying sites within the broad estuaries typical of Coastal Plain rivers.

The Middle Archaic period (8000-5500 B.P.) follows and is characterized by an increase in ground stone artifacts and a less diverse chipped stone assemblage. The inclusion of these ground implements may indicate a more extensive utilization of plant resources in the diet, possibly brought on by improved climatic conditions. Diagnostic projectile points include Stanly, Morrow Mountain, and Guilford types (Blanton and Sassaman 1989). Population is assumed to have increased during this period. Sites tend to be in the uplands near larger drainages with smaller sites scattered throughout the uplands. The greatest population concentration appears to be in the Piedmont, while the Coastal Plain has very few Middle Archaic sites (Sassaman and Anderson 1994).

The Late Archaic period spans from 5500-3000 B.P. and is generally thought to be a period of increased sedentism. Population is relatively dense and focused along major river systems. The most common diagnostic bifaces recovered from this period include Halifax and Savannah River and Otarre Stemmed (Coe 1964; Oliver 1985). The first pottery noted in the area (Stallings Island) also dates to the Late Archaic and has been found in association with Savannah River points (Sassaman 1993). There are indications that by the end of the Late Archaic period some degree of horticulture was beginning to be practiced in other portions of the Eastern U.S., but data within the Coastal Plain is lacking.

The Woodland period extends from 3000 to approximately 400 B.P., when the first European explorers appeared. Periods within the Woodland include Early, Middle, and Late Woodland. Generally, Woodland period sites display increased sedentism and improved food storage and preparation techniques. Ceramic production becomes more refined and regional variations begin to develop (Phelps 1983). Subsistence consisted of a mixture of the hunting and gathering practices of the Late Archaic and the advent of the cultivation of native plants. Increased ceremonialism, in the form of burial mounds, is also noted during the Woodland period (Coe 1964).

The Early Woodland (3000-2900 B.P.) in the south coastal region was designated the New River phase (Lofffield 1976). Ceramics associated with this period include, Stallings Island, Thoms Creek, Deptford, and New River wares. Little is known about the settlement and subsistence practices of the Early Woodland peoples. Phelps (1983) suggests that little changed in the way of settlement and subsistence from the Late Archaic.

The Middle Woodland period (2900-1200 B.P.) is referred to as the Cape Fear Phase and is identified by Cape Fear and Hanover series ceramics (Phelps 1983). Middle Woodland sites are generally more widely dispersed and focus on riverine or estuarine environments and usually salt water sounds. During this period, a shift in subsistence to shellfish occurs along the coastal site and shell midden sites first appear (Lofffield 1981). Increased horticulture also appears during the Middle Woodland, but becomes more developed during the Late Woodland.

During the Late Woodland (1200-400 B.P) period, sites are marked by increased sedentism, improved food processing technology, and increased political development in the form of complex tribes and chiefdoms. The Late Woodland Phase in the southeastern coastal region is referred to as the Oak Island Phase. This phase is characterized by Oak Island and White Oak style ceramics. Diagnostic projectile points consist of small triangular points (Lofffield 1976; South 1976). Late Woodland sites are generally in estuarine settings. Cultigens are in relatively low in abundance at these sites and the primary subsistence focus is on fish and shellfish (Lofffield 1981). Late Woodland peoples become year around residents of the coast and construct longhouses in these areas (Lofffield and Jones 1995). Burial techniques change to communal burials, or ossuaries, that contain up to 150 individuals (Phelps 1983). European contact in the area of Onslow County occurred a little over 400 years ago (Mathis 1995).

ENVIRONMENTAL BACKGROUND

This environmental background section is not an exhaustive discussion on either installation, but a cursory examination. It was created to provide a baseline of information in which later more site-specific discussions could be framed. Given the research focus of the projects on buried archaeological sites, the environmental background is centered on a discussion of geology, soils and to a lesser degree climate at both bases. These aspects of each installation's physiography are of the utmost importance in interpreting each site's geomorphologic record and environmental setting.

Fort Hood Physiography

Fort Hood is located in Bell and Coryell Counties, in east central Texas, covering an area of more than 217,000 acres. The base is located on the northeast edge of the Edwards Plateau, within the Great Plains Physiographic Province (Hayward et. al. 1990). Hill (1901) labeled the southern portion of this region the Lampasas Cut Plain, based on the prominent flat-topped, butte-like, ridges bounded by broad, low lying erosional stream valleys. Fort Hood spans the boundary between the subtropical subhumid climatic regime of central Texas and the subtropical humid climate of eastern Texas (Larkin and Bomar 1983). Intensive convectional rainstorms commonly develop at the boundary between the moist tropical air from the

Gulf of Mexico and the southerly flow of dry continental air, creating some of the largest magnitude flood events in the world (Nordt 1992). Topographically the base is typified by deeply incised erosional ravines along the western section of the base that flow into long narrow drainages within the eastern section of the base. Exposed bedrock, sparse vegetation and long narrow drainages exacerbate erosion within the steeper sections of the base, transporting substantial amounts of sediments into thick alluvial depositional packages. Given that erosion and flood event are localized phenomena, soil stratigraphy within the floodplains of the major drainages can vary widely. Nordt (1992) noted a great degree of variability in the depth and diversity of Holocene aged stratigraphy within his study of Cowhouse Creek floodplain deposits. Deposition along the floodplain extended in some locales to almost 10 m bs.

Nordt (1992) identified a sequence of alluvial units based upon a collection of radiocarbon dates recovered from various cutbank profiles within the Cowhouse Creek floodplain. From youngest to oldest these five alluvial units include: Ford, West Range, Fort Hood, Georgetown and Jackson. Radiocarbon dates bracket three of the five alluvial units recorded along Cowhouse Creek from 100 to 500 B.P. for the Ford unit, from 500 to 4200 B.P. for the West Range alluvial unit and from 5000 to 9000 B.P. for the Fort Hood unit (Nordt 1992:19). Radiocarbon samples were sparse within the oldest two alluvial units within the Cowhouse Creek drainage, recovering only a single sample for each unit. The Georgetown unit radiocarbon sample recorded a mean date of 9800 B.P., but additional samples collected from Owl, House and Henson Creek propose a range of approximately 8000 to 11,500 B.P. (Nordt 1992:172). The single radiocarbon sample recovered for the Jackson alluvial unit indicates a mean date of 15,000 B.P.

Fort Hood is located west of the Balcones Fault Zone on lower Cretaceous carbonate rock. During the Cretaceous Period, this region consisted of a broad shelf covered by a shallow sea. Material from the Cretaceous Period is mainly interbedded limestone and calcareous marl (Huckabee et al. 1977). These bedded limestones have undergone substantial erosion, creating a moderately dissected plain that slopes southeastward. Relief increases from east to west across the base. These soils form Soil depths that can range from extremely deep along Pleistocene and Holocene

aged sediments within drainages, to shallow along upland escarpments. Limestone bedrock is common at the surface throughout the base. Rockshelters and caves are common within the Edwards limestone that caps the underlying Comanche Peak limestone. The Edwards Limestone and Kiamichi Clay form the "High" surfaces noted by Hayward et al. (1990) and labeled as the Manning Surface by Nordt (1992). The Manning surface forms the cap rock on all of the upland ridges and buttes that run approximately east to west across the base. It is this high surface that the majority of the rockshelters are located within, including all five investigated within the current project.

A wide variety of plant and animal resources can be found within the bounds of Fort Hood, but one of the most potentially important is the land snail genera *Rabdotus*. Land snail shells are common on most prehistoric archaeological sites investigated on the base. Debate continues on whether the snails were used by prehistoric peoples or represent natural colonization of organically rich middens and isolated prehistoric features. It is unimportant within the current research the nature of the *Rabdotus* utilization, but what is important is that they are consistently found within prehistoric features, providing in some aspects a hallmark for prehistoric features within Central Texas. Current investigations noted them at all sites investigated, occurring in various levels of concentration.

Rockshelter Environments

The majority of rockshelters at Fort Hood have formed as irregular cavities within the softer fissel beds of the Comanche Peak limestone to the harder beds of the overlying Edwards limestone that caps the upland ridge portions of the base (Abbott 1994). In Abbott's (1994) summary of rockshelters on Fort Hood, he notes that more than 150 rockshelters, caves and karstic sinks have been identified, ranging in size from 2 to 60 m in length, 0.75 to 15 m wide and 0.4 to 4 m in height. The rockshelters appear to have formed initially as solution cavities that were subsequently augmented by erosion and thermoclastism (freezing of water that completely fills up cavities contained in the rock causing its fragmentation).

The soil deposits within the rockshelter form by a number of methods including, thermoclastism, run-off or human occupation (Laville 1976). Thermoclastic deposits consist of small to large

pieces of fractured limestone within the fill. Abbott (1994:341) notes that the majority of rockshelters on Fort Hood were estimated to have less than 0.50 m of deposits, with only three having deposits greater than 1.0 m. Limestone inclusions can range from clay sized particles up to large pieces of roof-fall. Run-off from the surrounding upland can add sediments into the shelter environments, from both the mouth of the shelter or small conduits at the rear. The small conduits common of the rockshelters at Fort Hood do not appear to possess a large sediment load for transport into the shelter, thus run-off deposits primarily augment the mouth area of the shelter. Abbott (1994:346) did identify at least one shelter in which reddish-brown upland argillic sediments (Abbott's Type 4 deposits) were being deposited into a rockshelter from a conduit, but this does not appear to be the norm for most rockshelters identified on the installation, at least within the current climatic regime. Human occupation can add substantial amounts of debitage, river cobbles, bone and organic content to the deposits of a shelter.

In Abbott's (1994) examination of karstic features at Fort Hood, he identified six types of deposits characteristic of the 150 rockshelters, caves and sinks identified at the time of the study. The types identified sediment transport actions from internal spalling and granular disintegration within the rockshelters, incorporation of outside organics and external sources that transported sediments through slope wash and conduits into the rockshelters. Current investigations identified sediments akin to those identified by Abbott, with the exception of Types 5 and 6. Type 5 included tufa and travertine deposits that were probably more consistent with cave formation at Fort Hood. Type 6 included rockshelters that had been flushed of sediments or were characterized as having coarse lag deposits. Rockshelters investigated during the current research did not exist in areas where large scale erosion, probably attributed to active stream migration, would have been a possibility.

Sediments once deposited in the rockshelters experience secondary frost shattering, erosion, cryoturbation, chemical alteration and bioturbation from both plants and animals. These physical and chemical weathering forces alter the shelter deposits causing them to resort themselves and continue to breakdown into smaller and smaller particles. Silts and clays dominate the particle size constituent less than 2 mm in size. A large

proportion of fine sediment may be associated with sedimentation from run-off or chemical alteration of the products of thermoclastic fragmentation (Laville 1976). Larger roof slabs noted in many of the shelters have been dislodged by thermoclastic fragmentation. These larger pieces of roof slabs usually have an angular appearance. Smaller limestone fragments observed on and within the shelter deposits have become rounded, an indication that secondary chemical alteration also plays an important role in sediment creation. Human utilization of the shelters adds substantial amounts of organic material, creating a thick surficial A-horizon. Anthropogenically enhanced surface deposits were observed within all of the shelters investigated at Fort Hood. The accumulation of organic material of animal or vegetable origin contributes, in certain cases, to the precipitation of carbonates into solution in particular horizons (Laville 1976:143). While not specifically studied within the current research it is possible that the enhanced surface deposits are increasing chemical alteration to large clastic deposits in the shelter. It would appear that thermoclastic fragmentation, chemical alteration, and possibly, to a lesser degree, the accumulation of organics plays the dominant role in the formation of fill within the rockshelters at Fort Hood.

Camp Lejeune Physiography

Camp Lejeune is located in the embayed section of the Atlantic Coastal Plain physiographic province and in the tidewater section of North Carolina's Lower Coastal Plain (Fenneman 1938). The Atlantic Coastal Plain is underlain by unconsolidated deposits of gravel, sand, silt, clay and peat that range in age from the Miocene to recent Holocene alluvium on the floodplains. Topography within this portion of the Coastal Plain is nearly level, with elevations ranging from 5 to 15 ft above mean sea level. Numerous swamps, pocosins (Carolina Bays) and small inland lakes typify the area. Streams have low to medium energy due to low elevation gradients, creating highly sinuous meanders and poorly drained wetland areas (Barnhill 1992). Uplands are nearly level, representing Pleistocene aged or earlier alluvial deposits.

Geologically, the installation is underlain by a mixture of unconsolidated sediments, originating from the weathering of the Piedmont and Appalachian provinces. In general, the upland areas as well as portions of the floodplains are

Non-Invasive Burial Determination

typified by fine sands, with lower swampy areas being dominated by silty to clay loam soil types. Given the sandy nature of the upland soils, water drainage is good to excellent within these portions of the base, but lower swampy areas of the base show indications of poorly drained soil. Soil formation at many sites represents a patchwork of different types of deposition, including marine, fluvial, eolian and lacustrine (Barnhill 1992).

Camp Lejeune is located in the Southeastern Evergreen Forest region and contains a mixture of evergreen trees and shrubs (Braun 1950). The dominant conifer tree species include Longleaf and Loblolly pine. Intermixed with these dominant pine species are smaller constituents of deciduous Live, Swamp, White, Blackjack and Southern Red Oaks, as well as numerous other

species. The substantial amount of pines within the environment facilitated the creation of a thriving naval stores industry within the early Historic period, augmenting a plantation system of row crop agriculture.

A variety of fauna is present in the coastal and inland environments of the area. The most important fauna relating to the present project are the shellfish. They live in the estuarine environment along the coast. The two most important species to prehistoric people include two mollusks: the eastern oyster (*Crassostrea virginica*) and the quahog clam (*Mercenaria mercenaria*). These species of mollusks were noted on all three of the prehistoric sites investigated at Camp Lejeune.

GEOPHYSICAL METHOD AND THEORY

Duane Simpson

3

INTRODUCTION

This section provides a background of geophysical theory pertaining to both electrical and magnetic methods. This information is intended to provide the reader with a better understanding of the geophysical methods employed and how this provides a basis for the interpretation of the data. The section also summarizes the equipment used, survey collection methods and data processing techniques used to produce the final geophysical and mapping results.

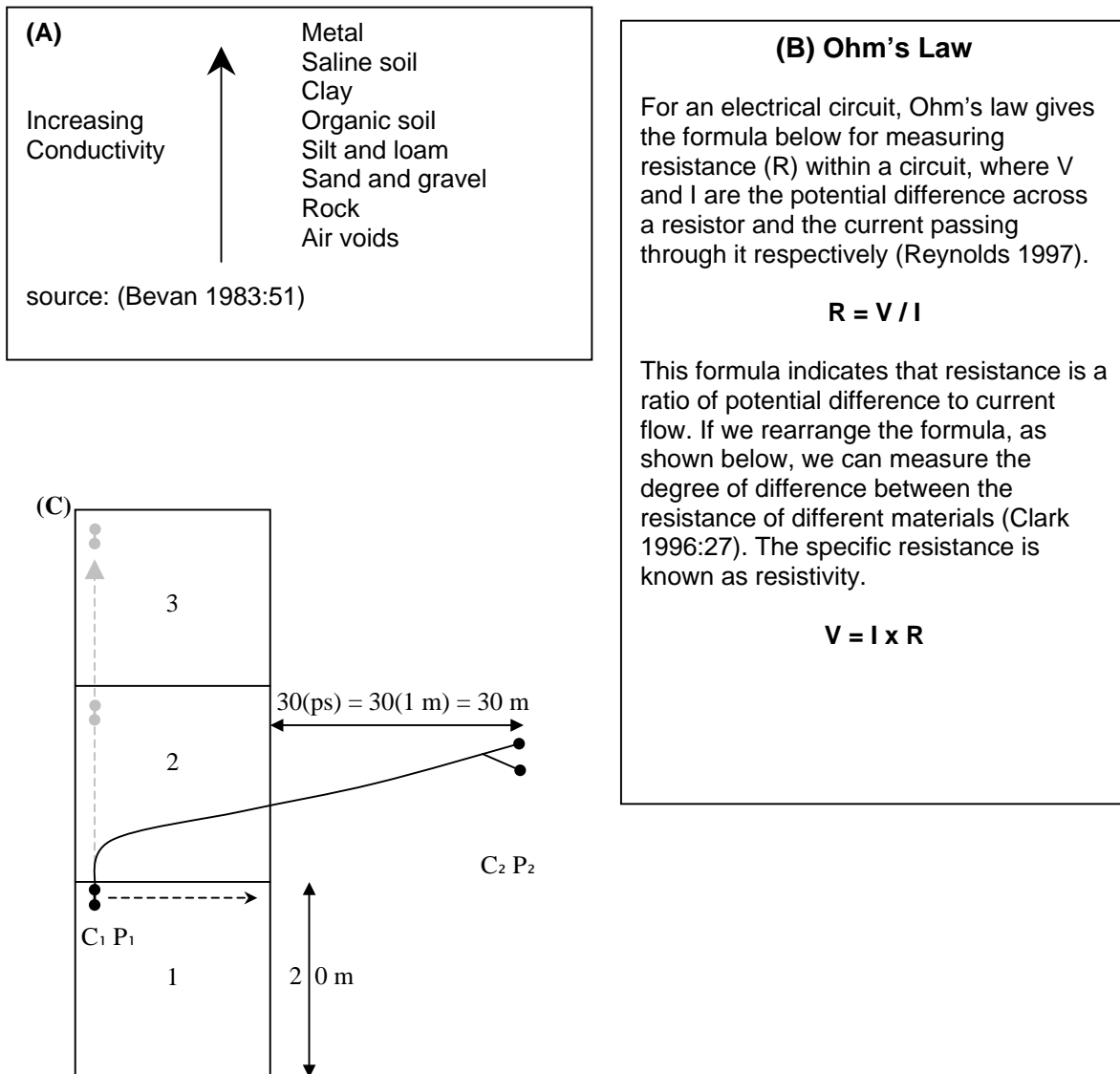
PRINCIPLES OF ELECTRICAL METHODS

This brief introduction to electrical resistance draws from various authors (Bevan 1983; Carr 1982; Clark 1996; Hasek 1999; Scollar et.al 1990; Weymouth 1986) who have discussed electrical methods in varying levels of detail. The principles described below provide a summary of electrical methods and a background for the interpretations that are offered within the following chapters.

All materials allow some movement of electrical charge (Scollar et.al. 1990:306). If the material easily transmits an electrical charge, it is considered conductive, but if the flow is impeded the material is considered resistant to the flow of electricity. Metals and electrolytes (salts) are extremely conductive, whereas insulators like glass, plastics, air, and ice are very weak in their ability to conduct electricity (Scollar et. al 1990). In the case of geophysical prospecting, the conductive medium for electrical current is soil. An understanding of the constituent parts of soils as well as particle size, structure, and macro versus micro capillary pores is necessary to determine the conductivity of different soil matrices.

Soils are comprised of three parts: air, water, and mineral. The mineral and air portions of soils are insulators offering little in the way of conductivity. Rainfall, however, contains dissolved carbon dioxide and carbonic acid from the atmosphere, forming positive and negative conducting electrolytes by reactions with the minerals in the soil (Clark 1996:27). Soils with higher amounts of conductive minerals, salts or clayey soils, will allow greater conductivity (**Figure 3.1A**). As particle size increases, so does the resistance of the soil. This increase in resistance is due to two reasons. As particle size constituents increase, there is a reduction in the amount of free electrolytes within the soil due to the more rapid movement of water through the matrix, as well as the increase of macrocapillary versus microcapillary pores. The loss of salts or free electrolytes reduces the ability of the soil water to conduct the electrical current. Macrocappillary pores allow for the soil to drain more rapidly, with these void spaces being filled with air. Since air is an insulator it does not allow good conduction. Therefore, sandy soils tend to be more resistant than clayey soils, since they are dominated by macro versus microcapillary pores. In the case of heavily saturated soils, macrocapillary pores are filled with water and therefore even coarse soils, such as sands, will become extremely conductive.

Soil properties are relatively homogenous within small areas, such as an archeological site, but isolated disturbances within the soil matrix will alter soil properties in confined areas, and can be recorded by their slight or pronounced contrast to the soil matrix. Since archeological features represent a type of disturbance to the soil matrix they can be measured along with other types of subsurface disturbances. Measurement of these disturbances is based upon a few basic electrical principles.



- A:** Chart indicating approximate degree of conductivity of various earth materials. This list would simply be inversed when referring to the resistance of these same materials.
- B:** Formula for Ohm's Law and the calculation of specific resistance or resistivity.
- C:** Twin array configuration showing the fixed probes (C₂P₂) and the mobile array (C₁P₁). The distance of the fixed probes from the nearest point of the mobile array is 30x the probe spacing (ps). This distance will minimize the degree of noise between the probes to less than 3%. The twin array splits the Wenner array configuration in half making collection and interpretation of subsurface anomalies easier.

Figure 3.1. Theory relating to electrical resistance .

Movement of charged particles through a conductive medium causes an electrical current. As Clark (1996:27) explains, an electrical potential difference, or voltage, is applied between the ends of an electrical conductor, in this case soil, and a current flows through it, the size of the current depending upon the resistance of the conductor. This resistance will be altered due to isolated soil characteristics, with the change being measured across a site utilizing Ohm's Law (**Figure 3.1B**). The measurement of resistance is the ohm, often represented as the Greek letter omega, Ω . In addition, the current is inversely proportional to the resistance of the medium, indicating the potential difference to current flow. Since the resistance is proportional, it can be compared across various mediums.

The raw resistance measurements can be converted into resistivity, a bulk property of soils and other materials. Resistivity is specific resistance, enabling the resistance of different materials to be compared in a standardized method and recorded using the ohm-m (SI) unit. All materials possess a specific range of resistivity to the passage of a current. Resistivity ranges from approximately 10,000 to 1000 ohm-m for dry sand to as little as 10 ohm-m for clay. As explained previously, heavily saturated soils will make more resistant soils more conductive. Soils saturated by salt water can fall to less than 10 ohm in resistivity. In the case of the current project, soil saturation ranged from moist to extremely dry within the rockshelter locales, leading to resistance ranges extending from 4 to 1958 ohm.

The application of current to a soil medium produces a potential field gradient (**Figure 3.2A**), which expands away from the current electrodes in a hemispherical pattern. The function of the current electrodes is to establish this field gradient, which is then sampled (**Figure 3.2B**) by the potential electrodes (Clark 1996:29). The distance between probes dictates the theoretical maximum depth penetration of the resistance meter, but differing amounts of soil moisture or rock inclusions can either increase or decrease the actual depth penetration. **Figure 3.2C** shows this hemisphere of detection, which relates to the heavy dashed line in **Figure 3.2A**. The more current that passes through the anomaly, the more easily delineated it becomes within the measurements. Thus the peak sensitivity of the

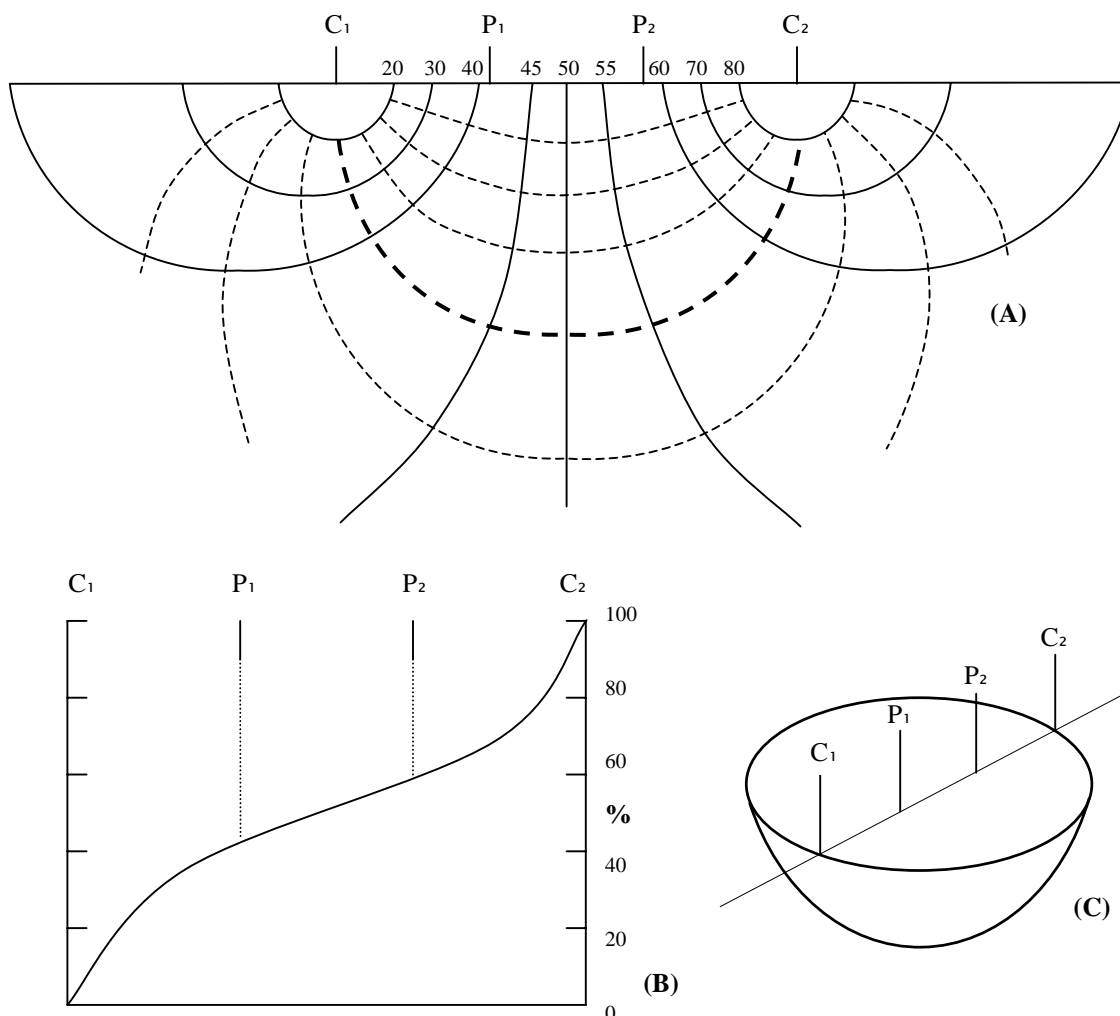
instrument usually lies above its maximum depth penetration.

The resistance data was collected using the RM15 resistance meter made by Geoscan Research. This instrument utilizes a series of frame mounted probes to inject electrical current into the ground. A twin array was utilized (**Figure 3.1C**). The twin array splits the Wenner configuration (**Figure 3.2A**) into two separate arrays that facilitate the collection of the data and improve interpretation of archeological features.

PRINCIPLE OF MAGNETIC METHODS

This basic overview of the core concepts of magnetism is based on work by various researchers (Bevan 1983; Breiner 1973; Clark 1996; Scollar et.al 1990; Weymouth 1986). In addition to these basic concepts, specific measurement types and instruments utilized in the data collections during the current project are also discussed.

The earth possesses a magnetic field ranging from approximately 30,000 nT at the equator to approximately 60,000 nT at the poles. This doubling in magnetic intensity at the poles as compared to the center is the same as a small bar magnet (Breiner 1973). This bar magnet concept with its positive and negative ends can be extrapolated to the smallest magnetic particle. The magnetic field surrounding the earth radiates in spherical lines of force away from the core, very similar to the local feature field depicted in **Figure 3.3**, with this field intersecting the ground surface at steep angles in the northern latitudes and decreasing to parallel with the surface at the equator. This angle is known as inclination, approximately 60° N at Fort Hood and 64° at Camp Lejeune (refer to the lines depicting the earth's magnetic field in **Figure 3.3**). The earth's magnetic field is constant but varies in intensity throughout the day, due to the effect of solar wind on the earth's magnetosphere. This variability is known as diurnal change. The magnetic field decreases as the effect of the sun increases, with its lowest intensity occurring at midday and returning to its normal level at night. Erratic sun spot activity can cause wild fluctuations in the magnetic field due to the increased amount of solar wind projected against the earth's magnetosphere. No erratic changes in the magnetic field were noted during either the survey at Fort Hood or Camp Lejeune.



- A:** Cross sectional slice through the ground showing potential gradient based on standard Wenner array, based on Clark (1996:29). The equipotential lines are marked with the percentage of the total potential difference they represent. Current flow is indicated by the dashed lines, which are orthogonal to the equipotential lines. The heavy dashed current line indicates the maximum extent of penetration. The peak sensitivity of this array is located above the heavy dashed line.
- B:** Plot of the potential gradient between the current probes (C), indicating the peak sensitivity area of the potential sample probes (P), based on (Clark 1996:29).
- C:** The hemisphere of detection for a standard Wenner array, based on Clark (1996:30). The twin array utilized for the investigations splits the Wenner into two C₁P₁ pairs. One pair is mobile and the other fixed, with the mobile pair acting as the detector probes. The twin probe array spacing can be half as wide as the Wenner and achieve the same depth penetration.

Figure 3.2. Electrical resistance theory - Wenner Array.

Iron constitutes approximately six percent of the earth crust, with the majority of this being dispersed as weakly magnetic compounds within soils and rocks (Clark 1996). These iron compounds are the principal source of magnetic properties in soils not developed from organics, such as limestone, where concentrations of iron in the soil are based on the decay of certain marine organisms (Scollar et.al.1990). The three principal iron compounds that play a role in soil magnetism are magnetite, maghaemite, and haematite. Magnetite is the most magnetic of the iron oxides but is rarely found in the soil due to oxidation processes. Haematite is the most common of the iron compounds within the soil, representing the red subsoil color of heavily oxidized soil types, but possesses a very weak magnetic susceptibility. Maghaemite is formed by the recombination of haematite into a more magnetic form. This recombination or fermentation occurs within the organic A-horizons of the soil, but to date is little understood by researchers. The fermentation process may include certain microbial organisms that concentrate the maghaemite in the A-horizon or relate to surfacial burning that drives the process. This concentration of maghaemite at the surface makes the A-horizon usually more magnetic than subsurface horizons. The concentration of maghaemite is especially important as an indication of human settlement (Clark 1996:100).

Past human activities alter and enhance these weakly magnetic compounds into definable cultural anomalies that slightly alter the local field. These slight alterations can be measured and quantified utilizing a magnetometer or magnetic susceptibility meter (similar to a metal detector). These two instruments utilize very different methods to record these changes in magnetic signatures across a site. Magnetometers are passive measuring devices, because they simply record the localized changes in the magnetic field versus the total ambient field of the earth. Magnetic susceptibility meters are active

measuring devices, utilizing an applied electromagnetic field to cause a response in subsurface anomalies. It is this applied response that the susceptibility meter records. The resultant measurements the two instruments produce are quite different due to the differing collection methods, as well as the way they resolve certain magnetic soil properties.

The degree of soil magnetization depends on the product of field strength and the magnetic susceptibility of the compounds contained within the soil (Weymouth 1986). The product of field strength relates to the combination of an induced localized field, or the total magnetic field of the earth, to the intensity of the localized field created by the anomaly (**Figure 3.3**). The magnetic flux or density is measured in nanoteslas (nT) = 10^{-9} tesla (T). Not all materials possess the same degree or nature of magnetic properties. Some materials maintain their own localized magnetic field in the absence of an external field, while others require an external field to become magnetized. Materials that do not require an external field to maintain magnetism are known as having remnant magnetism. The compounds of iron discussed above represent the major remnant magnetic materials in soils. Materials that do require an external field are known as possessing induced magnetism. The majority of metallic compounds do not possess remnant magnetism but can become magnetized in the application of a localized magnetic field. Thus, induced magnetic properties cannot be recorded by a magnetometer, since it does not create a localized magnetic field like the magnetic susceptibility meter or metal detector. Magnetometers therefore record only ferric metals contained within the soil, whereas all types of metallic compounds effect magnetic susceptibility meters. This forms one of the fundamental differences between the two measuring devices. In most cases, the prospecting of prehistoric sites centers on the concentration of ferric compounds in the soil.

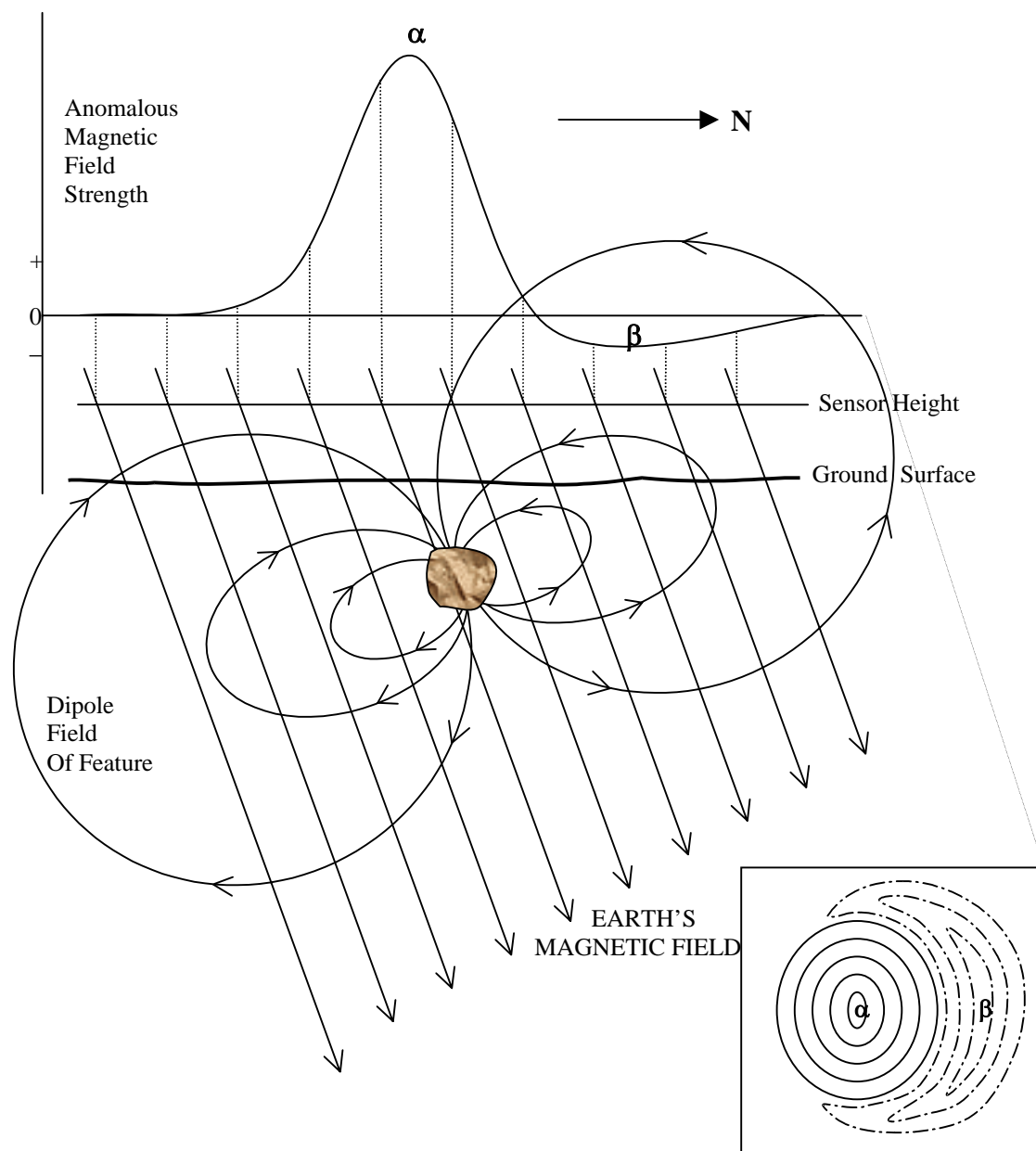


Diagram of south to north magnetic profile produced by the combination of the earth's magnetic field and the magnetic field of a local feature (From Weymouth 1986:345). The local feature produces a dipole, with positive pole (α) being located south of the negative pole (β). The small inset diagram shows a planview of a dipole anomaly. The majority of prehistoric features will be rectified as monopoles, with only a positive pole being recorded by the magnetometer.

Figure 3.3. Magnetic theory and recordation.

Every small ferric particle can be thought of as a small bar magnet, producing a weak and varied magnetic field (Scollar et.al. 1990). Three processes within the archeological record can intensify these particles' magnetic field. First, humans add increasing organic content to the soil, in the form of middens, that increases microbial activity on a localized basis and a resultant increase in magnetization occurs. Secondly, when humans fire the earth in localized areas they chemically alter the alignment of ferric compounds in the soil. This realignment is known as thermoremanence. The firing process has a greater effect on soils dominated by clay or fine silts due to the fact that a chemical process occurs forming a coherent chemical bond within these soil types. If the firing process reaches the Curie point, 675°C for haematite, 565°C for magnetite, the clays become demagnetized and when cooling they re-magnetize *en masse* to the existing geomagnetic field (Clark 1996). This realignment of the isolated ferric particles to one magnetic field causes a substantial increase in the magnetic intensity produced by these fired materials. Third, features created by humans concentrate more highly magnetic organic materials in the subsurface. This concentrating of organics increases the volume of magnetic materials in a confined locale. This confinement will increase the localized field and make the feature identifiable within the magnetometer data.

The magnetometer measures volumetric difference for magnetic material in the subsoil. The more defined the volume the greater alteration to the localized field. These sorts of anomalies are easily delineated within the magnetometer data sets, because they act as large bar magnets. If the magnetic intensity is great enough the anomaly creates a dipole signature, a signature possessing both a positive and negative aspect (**Figure 3.3**). This level of consolidation in the magnetic field is rarely seen in prehistoric features, but is a common aspect of ferrous metals. In the case of this project, any dipole signatures relate directly to historic iron and not possible prehistoric features, since these are much weaker in field strength. Prehistoric features produce what are known as monopole signatures, the majority of the time recorded only as positive alterations to the magnetic field. Magnetic susceptibility would not rectify such isolated anomalies since it measures a much different aspect of soil magnetism.

EQUIPMENT

A total of three different instruments, listed below, were used in the research. A magnetometer and resistance meter represent the two geophysical instruments. A laser field scanner was used for mapping, as well as identifying subtle surface depressions, and in some aspects acting as a remote sensing device. In addition to these geophysical and mapping devices, a GPS unit the TRIMBLE Pro XRS receiver, capable of submeter accuracy, was used to reference the arbitrary grids used at each site with specific coordinate bases and projections utilized at each facility. Mapping equipment, such as tapes, measured ropes, stakes and pin flags were used for mapping and ensuring proper placement of the geophysical instruments during the survey.

The following instruments are discussed below.

- ◆ Magnetometer
- ◆ Electrical Resistance Meter
- ◆ Laser Field Scanner

Magnetometer and Resistance Meter

Magnetic and electrical-based geophysical instruments have proven effective in numerous environmental and cultural site types around the world. Magnetometry can be effective in locating burials if the grave fill contains different sediments or a different sequence of deposits relative to background normal conditions that alter magnetic field properties detectable at the surface. Grave goods, ranging from ceramics to stone tools in prehistoric burials, to iron objects in protohistoric and historic burials, may also yield enhanced magnetic responses. Electrical resistance methods may also detect graves owing to differences in deposit materials, their compaction, porosity, or moisture content. Given the proven track record of these instrument types, both were utilized within the rockshelter and open-air sites. The preferred instruments were the FM256 magnetometer and RM15 electrical resistance meter produced by Geoscan Research. These instruments have a proven track record throughout the world, are specifically designed for archaeology, and are becoming recognized throughout the United States as effective non-invasive tools to determine the presence of burials. The universality of these two instruments will make the project methodology easier for other

facilities to integrate into their own management programs.

The FM256 magnetometer is actually a fluxgate gradiometer, possessing two magnetometer heads that record both the ambient magnetic field as well as the slight fluctuation of the magnetic field at ground surface (**Figure 3.4**). The machine records the difference between these two magnetometer heads, providing a gradient measurement of changes in the magnetic field. This meter is designed for a single individual to rapidly record measurements. The system is self-contained, with no leads or other encumbrances, making it highly adaptable to different obstruction patterns and surface topography that may exist in a survey area. The meter is fully computerized with data collection possible up to 16 samples per meter, and storage capabilities of up to 256,000 readings within the unit's memory. The FM256 also allows for digital averaging of between 4 to 32 readings per recorded measurement. This refinement over previous versions of the machine allows for a substantial reduction in the signal to noise ratio. The instrument is very sensitive, capable of less than 0.1 nT resolution, and with digital averaging this sensitivity is further reduced.



Figure 3.4. FM256 magnetometer.

The RM15 meter is a fixed frame unit (PA-5), with a number of different probe spacing alternatives (**Figure 3.5**). Theoretically the distance between probes is equal to the depth of penetration of the electrical current; hence the reason why the machine possesses different measured probe spaces, providing an array of different target depths from 0.25 to 2.0 m. The instrument utilizes a twin-probe array configuration. This configuration utilizes a pair of fixed probes within the PA-5 frame connected to a set of remote probes, creating a complete circuit. The RM15 resistance meter is fully computerized and is

capable of storing 30,000 measurements for later downloading. In addition to the standard PA-5 frame array, a multiplexer unit, the MPX15, can be attached. The multiplexer unit allows for multiple measurements to be recorded at a single point in either the vertical or horizontal plane.



Figure 3.5. RM15 resistance meter.

Laser Field Scanner

The final remote sensing technique used in the project was a laser field scanner that produced accurate mapping at select sites. The laser field scanner provided an exact representation of the surface features of the site at the time of the surveys, as well as document surface rocks, shape of the overhang and depressions on the surface. This surface was correlated with the geophysical results, helping to explain some features and improving interpretations of potential anomalies identified within the data sets. Given that interpretation within the rockshelters was difficult due to roof fall, bioturbation and historic disturbance, any means of improving interpretation was of great value. Hyper-accurate mapping has shown effectiveness at some sites in defining shallow surface depressions that directly relate to buried cultural features. Laser Field Scanners collect approximately 1000 to 4000 points per second with an error rate less than 6 mm. After review of the different sites at both bases, it was determined that the scanner be used at the rockshelter sites only due to the fact that surface vegetation at the open-air sites would severely hinder the applicability of the technique. The laser field scanner used on the project was

the CYRAX 2500 (Figure 3.6). This model collects approximately 1000 points per second.



Figure 3.6. CYRAX 2500 laser field scanner.

DATA COLLECTION METHODOLOGY

Survey methodology for this project was divided between two general prehistoric site types: open-air camps and rockshelters. Both general site types produced a range of different challenges for geophysical data collection, but the rockshelter environment was by far the most difficult to collect, interpret, and test. The open-air methodology used to survey the prehistoric camps was also applied to the two historic cemeteries investigated during the project.

Geophysical techniques have proven highly effective in defining subsurface anomalies in open-air sites, but cave or rockshelter environments have not been as thoroughly investigated, and when they have they have provided a number of difficulties for researchers. Due to the difficulty of interpreting and collecting data within rockshelter environments, it was necessary to modify existing techniques to maximize the potential of the geophysics. The proposed methodological techniques focused on collecting the maximum data resolution possible with all machines, as well as specific alterations to collection methodology, in order to contend with obstructions and potential differences in soil moisture. High spatial sampling densities increased detection probabilities of archaeological features, as well as increasing the accuracy of mapping the locations and shapes of subsurface features. Human burials, particularly infant burials, can be very small in size, measuring as little as one-half by one meter. Dense spatial sampling ensured that such features were characterized by multiple measurements, to help validate their presence, as well as guarantee accurate

representation of the feature's size, shape, and location. The rockshelter environment was difficult to interpret due to rock fall, moisture pockets, undulating depth, and animal bioturbation. The proposed method for improving the interpretative potential of the geophysical techniques was through utilization of multiple methods.

The utilization of multiple geophysical and remote sensing techniques has been shown to be the best way to define and interpret archeological sites, due to the fact that different feature types may be identified reliably only with certain methods. Multiple methods may also be complimentary in the definition of certain feature types improving final interpretation. In the case of the rockshelter environment, multiple techniques provided the additional information necessary to eliminate or confirm certain anomalies as cultural or natural in origin. Given the small size of the rockshelters and the interpretation difficulties related to them, quality of data collection, not quantity, was the rule with all the various geophysical techniques.

Rockshelter Methodology

The basic survey methodology for rockshelters entailed a four step process. This methodology was used consistently within all the rockshelters investigated at Fort Hood, with the exception of site 41BL69. The narrow nature of the shelter made it impossible to scan with the laser field scanner, but all other aspects of the methodology were utilized.

The first step was to create a survey baseline and a datum for each shelter. This datum point was given an arbitrary coordinate relative to the rest of the baseline, providing a coordinate base for the entire survey grid at each rockshelter. The arbitrary coordinate base was kept separate for each rockshelter, with no overlap in numbering between the different surveys. This measure ensured that no errors of placement occurred between the various shelter locales. Following the establishment of the baseline a sketch map was created of the shelter, focusing on depressions, obstructions, and any obvious exposed cultural material that may assist in the interpretation of anomalies.

The second step was to complete a laser field scan of each shelter. A CYRAX 2500 laser field scanner was used to perform this task. This instrument collects approximately 1000 points per

second, with an error rate of less than 6 mm within 50 m of the scanner. The instrument was set up so that multiple grid stakes could be identified and marked within each scan, providing the necessary correspondence between the scanner and the arbitrary grid established for the site. In order to maximize the remote sensing potential of the laser field scanner, a 1.0 cm resolution DEM (Digital Elevation Model) was created for each shelter from a minimum of 1.5 million surveyed points. This level of recordation required multiple measurement positions.

The third step was the completion of the survey grid, following the field scanner mapping. Each grid point was measured in and given a coordinate point. After the entire grid was laid in a collection of GPS points was taken, so as to facilitate the georeferencing the arbitrary collection grid into the base wide projection: Fort Hood, WGS84 UTM Zone 14 north and Camp Lejeune, NAD83 UTM Zone 18 north. This will allow the geophysical data to be added to the existing GIS database established at both facilities.



Figure 3.7. Photograph showing geophysical survey methodology for rockshelters.

The fourth step was the collection of the magnetometer and the resistance meter data sets. Both of these instruments were used at all of the rockshelters within the project. Both collect data in a series of transects within a predefined grid system. Accurate instrument placement was controlled by the use of measured ropes containing meter and sub-meter marks (**Figure 3.7**). In the case of the rockshelter surveys, these ropes were demarcated every 0.25 m, a measurement spacing far reduced from the normal 1.0 m spacing on ropes created for open-air collection. This smaller measurement interval

was necessary, given the level of data collection proposed for each shelter.

The FM256 magnetometer can collect up to 16 measurements per meter, a point approximately every 6 cm along a transect. In addition, it allows a digital average to be taken for each recorded point. The instrument allows as many as 32 measurements to be averaged at any single point. This averaging process substantially increases the signal to noise ratio by reducing the instrument's measurement variations at each locus. Although this averaging technique can substantially reduce collection error, a balance must be struck between error reduction and speed of data collection. By increasing the average cycles, the rate of data collection is slowed, as well as the potential samples that can be collected per meter. In order to make collection plausible, a reduced averaging rate of 8 measurements per recorded point was used. Given this level of data collection, the interval speed was also substantially reduced in comparison to normal collection speeds to approximately 2.8 seconds per 0.50 m traversed. This collection methodology still reduced collection noise by almost 2.8 times, and allowed for a slow and detailed survey. Sample interval per transect was kept at 16 per meter, with transects spaced every 12.5 cm. Each 5-x-5-m grid contained 3200 readings, with a final interpolated grid resolution of 6 cm in both the x and y directions, totaling 6400 readings per grid.

The RM15 collected at a sample interval of 8 per meter, or recording a point every 12.5 cm along a transect. Transect intervals were spaced every 12.5 cm as well producing an initial resolution of 12.5 cm in both the x and y directions. Final interpolated images produced a grid resolution of 6 cm in both x and y directions, for a total of 6400 readings within a 5-x-5-m grid. A series of different probe spacings or depths were collect in each of the rockshelters. Probe spacing ranged from 0.25 to 0.75 m depending on the previously defined depth or potential depth of soil deposits.

Open-air Methodology

The data collection at the open-air sites were less intensive, and utilized a more standard testing interval and methods. The survey of these sites required only a two step process.

The first step was the establishment of a 10-x-10-m survey grid at each site. This grid was given a similar non-overlapping arbitrary coordinate base

as those in the rockshelters. A collection of grid points was surveyed using the GPS unit. These GPS points were used to convert the arbitrary grid into the established projections for both Fort Hood and Camp Lejeune. The final portion of this step focused on the creation of a base map of surface conditions within the grids, focusing on above ground obstructions and depressions.

The second step was the collection of both the magnetometer and resistance meter data sets. The collection resolution was slightly reduced for both instruments, given the fact that the majority of the open-air sites are much larger in surface area than the rockshelters. Measured ropes marked every 0.25 m were used to guide the two instruments, ensuring proper placement throughout the data collection (**Figure 3.8**).



Figure 3.8. Photograph showing geophysical survey methodology for open-air sites.

The FM256 magnetometer survey utilized a transect interval of 0.25 m and sampling interval of 8 measurements per meter. Digital averaging of 8 cycles per measurement was used to improve signal to noise ratio. These transect and sampling intervals recorded 3200 readings per grid, following interpolation in the y direction only, a 12.5 cm resolution grid was established for each surveyed area totaling 6400 readings per grid.

The resistance surveys completed on the open-air sites were collected in an identical fashion as the magnetometer data with only one exception. The resistance data was collected at 0.25 m transect intervals, the same as the magnetometer methodology, but samples per meter were spaced every 0.25 m or a collection of 4 measurements per meter. This collection interval produced a total of 1600 reading per grid, with a final interpolation in both the x and y directions producing 6400 total readings. This collection methodology produced

identical resolution between the two geophysical data sets, facilitating interpretation and unit placement. The depth of investigation was determined on a site by site basis.

PROCESSING & SOFTWARE

The raw geophysical data was concatenated together in a matrix of cells or a raster. A raster can be treated the same as any image within a computer, allowing the utilization of an array of image processing techniques. The geophysical results though must be processed through a more standardized methodology prior to using these more general techniques to ensure accurate base data. The following standardized image processing techniques were completed within the GEOPLOT 3.0 software. This software package has been specifically designed to process a variety of geophysical data types, simplifying the initial data processing stage and maximizing the final processed result.

The standardized magnetometer process presented is outlined within the GEOPLOT 3.0 manual (Geoscan Research 2003). The process typically follows a series of order steps; (1) *clipping* the data values at about ± 10 nT, depending on the type of site being surveyed and the overall spread of the magnetic data; (2) *despiking* the data set by removing very high spikes in the data; (3) *zeroing* each traverse removes slope and drift problems that may have occurred during the data collection, basically placing the mean of each traverse at zero; (4) *filtering* by using low pass filters to remove unwanted data collection noise, this may not be necessary in all data collections; (5) *interpolating* may be necessary to produce equal resolution along both the x and y axes, effectively improving overall image quality and interpretability.

The standardized resistance process presented is also outlined within the GEOPLOT 3.0 manual (Geoscan Research 2003). The process typically follows a series of order steps; (1) *despiking* the data set by removing very high spikes in the data, usually related to metallic debris; (2) *edge matching* the individual grids to balance the overall data range and eliminate seams between grids; (3) *filtering* by using low pass filters to remove unwanted data collection noise; (4) *removing regional trend* by using a high pass filter to flatten the data, or remove the geological trend of a site; (5) *interpolating* along x and y axes,

effectively improving overall image quality and interpretability.

This basic magnetometer and resistance processes produce a usable image within an hour of data downloaded either in the field or following the day's data collection. In the case of this project, interpolation of the data was limited to a single time in the x and y directions for the resistance data, and in the y direction only for the magnetometer. This interpolation scheme allowed for both data sets to possess identical resolution, as well as maintaining a high percentage of actual to interpolated data values within each grid.

In addition to the initially standardized steps, a series of different advanced image processing techniques can be used to both filter and enhance the image quality. The geophysical data can be filtered, utilizing a wide array of different kernel filter types, stretched, improving image quality by stretching the data over a wider range of measurement space, and Fourier transformed. These more advanced steps require a substantial outlay of time and are always performed post-field. The overall post-processing of the geophysical data can be extensive, usually totaling in overall time twice the amount of field time required to collect the data itself.

Fourier transformation is an advanced processing step and is not required on all data collections. Fourier transformation breaks down an image into a complex series of component sine waves in a 2D or 3D space. IDRISI 32 was used to transform the previously processed geophysical data. IDRISI 32 supports a 3D Fourier module that allows for both forward and inverse transformation. This allows an image to be broken down into its component sine waves (forward transformation), filtered, and then reconstituted into the original image without the filtered or removed portions (inverse transformation). The Fourier technique serves well in identifying patterned sine waves, such as plow furrows or stripes related to data collection noise. Although the image has been transformed, it retains its original data values, producing an exact reproduction of the untransformed image lest the unwanted noise.

The laser field scanner data was post-processed using an instrument compatible software package called CYCLONE. This package allowed for the various sections of scanned mapping to be knit together, by using common points identified

during the survey of each shelter. The entire shelter area, including the floor, backwall and roof was mapped using the laser field scanner. Given the focus of the project on the basal shelter deposits the backwall and roof sections of the data were removed, leaving a point cloud of each shelter's floor. The data was exported from the CYCLONE software as ASCII space delimited text files. These files were then imported into ARCVIEW 9.0 as a cloud of point data. The large size of the data files made processing within ARCVIEW difficult. Standard operating processes usually used to create or transform point data into a DEM would not function due to the large size of the point data files. DEM creation was completed by sectioning the point cloud and creating a series of overlapping DEMs at a 1.0 cm resolution. These individual DEMs were then mosaiced together within ARCVIEW 9.0 to create a final shelter-wide DEM. This DEM allowed the creation of multiple hillshade images, as well as an array of other surface derived data layers.

At the completion of the project, the various geophysical data layers and the laser field scanner maps were given a common coordinate base and combined with the site installation mapping to complete separate GIS databases of each site. The report mapping utilized the site-specific arbitrary coordinate bases due to the fact that all excavation and testing records used this system. ARCMAP 9.0 was used to organize the various data layers. This methodology ensured the greatest degree of accuracy and comparability between the various geophysical data layers, and improved the final interpretations.

Software

A series of software packages were used in the processing and presentation of the data. GEOPLOT 3.0, by Geoscan Research, was used for the majority of the in-field and post-field processing. IDRISI 32, by Clark University Labs, was used for Fourier transformation, reclassification and georeferencing of the processed geophysical data sets. PATHFINDER software, by Trimble, was used to download the GPS points that provided the reference points to transform the arbitrary coordinate grid into the base mapping of each facility. ARCMAP 9.0, by ESRI, was also used to produce the final graphics and assist in georeferencing the geophysical results with other map layers collected at the site from the arbitrary coordinate base to the final facility-wide coordinate and projection bases.

Geophysical Interpretation

The methodology for interpreting the data collected from both Fort Hood and Camp Lejeune relied heavily on three main factors, including standard geophysical theory, site-specific geomorphology, and the regional archeological record. The first required no additional research, but the latter two required some degree of background work. Prior to data collection, each one of the sites was visited to ascertain the

geomorphology. This information not only improved final interpretations, but also improved the choice of which geophysical methods would be most appropriate. The review of the regional and site-specific archeological record helped to define the orientation and size of prehistoric burials from each locale. Site-specific review also helped to identify the potential depth at which burials were expected. This information was collected during the initial background meetings held at both Fort Hood and Camp Lejeune.

SOIL TESTING METHOD AND THEORY

Ryan Peterson and Duane Simpson

4

INTRODUCTION

As indicated in **Chapter 1**, the first goal of the project was the identification of potential cultural anomalies within a series of geophysical data. In most cases, selecting sites at both Fort Hood and Camp Lejeune that contained known interments simplified the interpretation process. This simplification was necessary to ensure that an adequate burial sample was achieved for the second focus of the project: soil chemical testing. While these sites produced at least one burial location for chemical sampling, additional anomalies were necessary for sampling as well.

Human interments are not the only cultural features that contain bone elements. Faunal material (non-human) can be recovered from a number of different cultural feature types, such as hearths or trash pits. Given the final research goal of the project, the additional anomalies tested may provide a means of differentiating human burials from other faunal concentrations, and thus create a true identification tool. Additional sites were included from both installations in order to provide a larger sample of occupational related features.

The chemical testing portion of the project needed to create a reproducible testing methodology that would be applied irrelevant of differing environmental or site types. In addition, this methodology would need to be as non-invasive and minimal as possible in order to meet the central research goal. This testing methodology would then be applied to a chemical sampling protocol. Background research into human bone and its preservation in the soil became of central importance in the identification of an investigative chemical technique.

SOIL TESTING BACKGROUND

Living bone is comprised of approximately 80 percent mineral and 20 percent protein, the majority of which is collagen. Bone mineral is a carbonate-hydroxyapatite (mineralogically termed

dahlite), which can accommodate a large number of trace elements (Millard 2001). Buried human bone, as well as the bones of other vertebrates, undergoes changes as a result of the chemical and physical environment of the burial. The process in which bone degrades in burial contexts is termed diagenesis. The diagenetic process is affected by many factors relating to the properties of the bone and surrounding sediments. Some of these factors include soil pH, burial context, primary versus secondary interments, age of the individual at the time of death, the amount of time elapsed since burial, moisture levels, etc. (Parker and Toots 1980). Inclusion of burial goods as well as the position of the burial (flexed or bundle burials vs. extended burials) can also affect the diagenetic process and the deposition of trace elements. Ultimately, the diagenetic change experienced by the bone will result in bone enriching the surrounding burial matrix with phosphorous and a series of trace elements that are contained in the bone (Parker and Toots 1980). The goal of this project is to attempt to detect the enrichment of the trace elements and phosphorous levels from background deposits to determine the presence of a burial with minimal disturbance.

The present analysis is focused on the determination of total phosphorous and trace element levels. This approach was favored because the analyses required are standard EPA techniques (described below) that can be completed by most commercial and academic laboratories. The processes necessary for these determinations are cost effective and can be integrated into future research.

Total Phosphorous

Phosphorous (P) testing was originally geared toward agricultural activities and only measured P that was available in the soil and could be utilized by plants. To accurately assess P alterations that are anthropogenic in origin, both available phosphorous and phosphorous that has formed

compounds in the soil must be measured. Phosphorous moves freely in the plant to animal system, but once it has reentered the soil, it will remain there until it is taken up as a plant nutrient. Once phosphorous is deposited in the soil, it is highly immobile and remains in the immediate environment into which it was deposited (Herz and Garrison 1998).

Phosphorous is most commonly deposited in soil as a component of Phosphate (PO_4^{-3}). Phosphate in the soil is derived from human and animal excrement, bones, and decomposing bodies. Phosphorous is a principal component of bone and is found in the mineral apatite that forms the principal mineral component of bone (Herz and Garrison 1998). The archaeological application of soil phosphorus is based on the premise that higher quantities of phosphorous will be associated with anthropogenic deposits. Elevated phosphorous levels associated with burials is due to the presence of calcium phosphate in bone and the organic phosphorous containing compounds in the soft tissue (Heron 2001). The body of a 68 kg man contains approximately 630 g of phosphorous, 86 percent of which is found in the skeleton (Proudfoot 1976). The present research recognizes that total phosphorous levels will be elevated in many types of anthropogenic features. To account for these factors, a variety of cultural features were analyzed to determine any differences in phosphorous levels between burials and other features. The confidence of separating a chemical signal that is anthropogenic in origin from natural variations in the soil matrix is a critical factor. Many surveys, like the one described in this report, take samples away from the archaeological deposits to be investigated. The potential human impact to the soils in the control areas provides an unknown potential source of error (Heron 2001). Total phosphorous data will be combined with the geophysical results and trace element analysis to assess the utility of using the techniques developed by this project to predict human burial locations.

Assessment of total phosphorous, as opposed to available or labile P, is essential because it provides a value that includes available phosphorous in the soil as well as the phosphorous that is bound in compounds such as mineral apatite that would be present in areas where bone has been buried (Herz and Garrison 1998). Soil pH effects the types of compounds that phosphorous will form, but the overall

phosphorous in the soil, as determined by total phosphorous testing, should not be affected.

Heron (2001) warns that geochemical prospecting should be conducted in conjunction with other forms of archaeological prospecting. Phosphates in high pH soils combine with Ca ions forming the apatite group of calcium phosphate minerals. Apatite is the most abundant and widespread natural phosphorous compound on earth. At lower pH, calcium phosphates dissolve, liberating the phosphorous ion. At lower pH, phosphorous can form compounds with iron or aluminum. Higher than background levels of phosphorous are associated with burials due to the presence of calcium phosphate in bone and organic phosphorous containing compounds in soft tissues.

Bethell and Smith (1989) used ICP quantities to determine concentrations of grave fill at Sutton Hoo. A number of elements appeared to be enriched in the burial matrix, but the greatest difference was noted in phosphorous levels. Exploratory research completed at Corrimony chamber cairn in Inverness-shire, Scotland, researched the potential in identifying a central stain as a burial (Johnson 1956). Total Phosphorus testing was completed throughout the cairn, providing comparative data for the central stain. The central stain contained approximately 7000 mg/Kg of total phosphorous, well beyond the normal background levels. Johnson (1956:203) estimated that the phosphorous levels within the stain were approximately the exact amount for a human burial, corroborating the belief that the stain was in fact the remains of a human burial.

Trace Element Analysis

The ultimate goal of the soil testing was to identify burials based on the enrichment of the burial environment of one or multiple trace elements. While previous research has supported the utility of testing phosphorous levels to identify burial locations, phosphorous alone is not adequate to differentiate between human interments and other cultural features, which would also exhibit elevated phosphorous levels. It was our goal to combine these results to make a more definitive statement of the probability of a geophysical anomaly actual being a human interment.

A literature review as well as consultation with numerous specialists in the field indicated that trace element analysis would be the most viable

option for the present study. Apatite, the calcium phosphate mineral that is the primary constituent of vertebrate bone, contains significant amounts of several trace elements (Parker and Toots 1980). The quantity of these trace elements varies between species and between individuals of the same species. These variations are the result of various biological and environmental factors including physiology, crystal chemistry, diet, and environment.

Many of the previous efforts to study trace element analysis has been directed toward issues relating to dietary change over time. The effects of bone diagenesis have been considered a negative factor in these pursuits. Most previous investigations extract samples directly from human bone. In studies where the surrounding soil has been tested, sampling was limited and focused on determining the diagenetic change associated with the bone. The present study attempts to identify those trace elements that are susceptible to diagenesis and are ultimately deposited in the burial matrix surrounding the bone. Despite an attempt to locate similar research with the objective of identifying the presence of human remains by using trace elements, no similar studies could be found. Similar to previous research utilizing trace elements, an attempt was made to analyze as many trace elements as possible to determine which elements had the greatest potential for identifying burial locations.

The literature review also revealed that many trace element studies produced contradictory results. Elements identified in one study as being significantly affected by diagenetic processes were described as minimally or not affected in others. Buikstra et.al. (1989) analyzed the results of more than 20 bioarchaeological studies that analyzed multiple trace elements from a variety of archaeological contexts. Samples were taken from bone, teeth and the soil surrounding the burial. Results varied but each study provided a list of trace elements that were believed to be deposited into the surrounding soil by diagenetic processes, elements that were enriched in the bone, and elements considered stable. Results of each investigation varies as well as the material tested including various bones, teeth, and soil. From the work of Buikstra et. al. (1989), Price (1989), Sillen (2001) and others, several factors were identified that could affect the proposed trace element analysis. Some of these factors include:

- 1) Length of time since burial was deposited
- 2) Soil pH of the burial as well as moisture levels
- 3) Age of the person at time of death
- 4) Presence of burial goods, fauna or midden deposits
- 5) Placement of the burial in deposits previously enriched by human or animal activities

The majority of trace element research has focused on 14 major and minor elements found in human bone including: Zinc (Zn), Strontium (Sr), Cadmium (Cd), Lead (Pb), Aluminum (Al), Iron (Fe), Manganese (Mn), Barium (Ba), Copper (Cu), Vanadium (V), Magnesium (Mg), Potassium (K), Sodium (Na), and Calcium (Ca). These elements have been recovered from both the bone and from the burial context. Given the focus of the current research on the soil surrounding the bone or those elements more prone to diagenesis, certain trace elements were not believed appropriate.

Human bone contains significant amounts of calcium, but the geology and site conditions at the site locations investigated contain large amounts of calcium. Price (1989) warns about using Ca in these instances. Strontium is frequently analyzed in trace elements studies that involve extraction of samples directly from human bone. Comparisons to the surrounding burial soil have determined that Sr is arguably the most stable of trace elements that are present in human bone. For this reason, Sr was not included in the present study due to the focus on elements prone to diagenesis.

Elements that have shown promise to satisfy the present research goals include: Al, Fe, and Mn (Buikstra et. al. 1989), Na (Parker and Toots 1980; Lambert et. al. 1985; Lambert et. al. 1984; Lambert et. al. 1982); and Mg (Lambert et. al. 1984; Parker and Toots 1980). Several previous studies have demonstrated increased Pb levels in historic burials due to its presence in ceramic glazes, culinary implements, and pollution associated with industrial development (Mays 1998; Aufderheide et. al. 1981). These six elements, as well as copper and zinc were utilized within the initial exploratory investigations. The results of this analysis were used to guide the selection of four elements that were investigated in samples from the remaining site (see **Chapter 7**).

EQUIPMENT

A set of standard Oakfield 13/16" diameter split-spoon cores were used to collect the soil samples. The different site locales meant a wide variety of core barrel lengths, extension rod lengths and tips were necessary to achieve samples. The rockshelter environments required the utilization of short 12" and 15" long barrels and short 12" extensions, as well as heavy duty tips, while the cemeteries required longer 18" barrels and 30" long extensions. The utilization of the Oakfield coring system allowed for maximum versatility.

Standard excavation techniques and equipment: such as shovels and trowels, were used to investigate the 0.50-x-0.50-m test units at the rockshelters and open-air sites. Cores were placed using the arbitrary grid established for each site, with placement error being less than 0.10 m.

SOIL CHEMISTRY TECHNIQUES

All soil samples were analyzed by Severn Trent Laboratories (STL) located in Burlington, VT. STL has a network of labs and extensive experience analyzing soil samples for AMEC and is accredited by the National Environmental Laboratory Accreditation Conference (NELAC). STL provided sterile containers for the collection of all samples and arranged for overnight delivery to the lab.

The first type of soil analysis included professional determination of total phosphorous. The STL laboratory's procedure is based on EPA Method 365.2, using the persulfate digestion procedure. This method is based on reactions that are specific for the orthophosphate ion.

Ammonium molybdate and antimony potassium tartrate reacts in an acid medium with dilute solutions of phosphorus to form an antimony-phospho-molybdate complex. This complex is reduced to an intensely blue-colored complex by ascorbic acid (persulfate digestion) that is proportional to the phosphorus concentration. The reporting limit is 2.00 mg/Kg for solids. Quality control samples were utilized throughout the process to ensure that accurate measurements occurred throughout the testing.

The second type of soil analysis included the determination of a suite of trace elements using the EPA standard test SW6010B for inorganic

metals. The 6010B procedure: Inductively Coupled Plasma-Atomic Emission Spectrometry (ICP-AES) was used for all the various inorganic metals testing (EPA 1986).

Samples are acid digested using the appropriate EPA defined procedures and then introduced to the ICP-AES, which measures characteristic emission spectra by optical spectrometry. An aliquot of sample is nebulized and the resulting aerosol is transported to a plasma torch. Element-specific emission spectra are produced by a radio-frequency inductively coupled plasma. The spectra are dispersed by a grating spectrometer and the intensities of the emission lines are monitored by photosensitive devices. Background correction is performed with the background measured adjacent to analyte lines on samples during analysis. The sample is analyzed by multiple integrations and the average integration is converted to a concentration from a calibration curve. The following table lists the reporting limit (RL) for the various elements investigated during the current project.

Table 4.1 Reporting Limits for Select Elements.

Metal	RL (mg/Kg)
Aluminum (Al)	20.0
Copper (Cu)	2.5
Iron (Fe)	10.0
Magnesium (Mg)	500.0
Manganese (Mn)	1.5
Sodium (Na)	500.0
Lead (Pb)	1.0
Zinc (Zn)	6.0

An Oakton Acorn Series pH5 meter was used to document the pH levels and soil temperature of each soil sample in the field. Determining pH values in the field was more accurate than sending them to a laboratory. This particular device allows for the sensor to be placed into a soil sample. The moisture levels of most samples were adequate for direct determination of temperature and pH, with only a few exceptions.

SOIL SAMPLING METHODOLOGY

The depth from which the soil samples were collected varied from site to site and feature to feature. The geophysical data collected provided limited guidance regarding depth, but

observations from the soil cores and profiles of the excavation units determined the precise depth from which each sample was collected. Samples ranged from approximately 25-50 g, and were placed into sterile sample jars provided by STL. Samples collected from excavation unit walls and thick soil stratums resulted in sample amounts near the maximum of the range. It was difficult to collect more than 25 g from thin stratums in the cores, but even this restricted volume provided ample amounts of material for the proposed total phosphorous and trace elements testing. A 10 g sample is all that is required for the total phosphorous 365.2 test. A 5 g sample was required to determine all trace elements using the 6010B procedure.

Samples were collected at shallower and deeper contexts where suspected feature deposits were located. This sampling technique resulted in vertical as well as lateral control in the area of investigation. This testing strategy provided information on both the vertical and horizontal chemical signatures across the investigated sites, as well as providing an understanding of the potential effect that the non-feature soil matrix may have played in the feature's chemical signature.

Datum points established in the initial mapping of the site were relocated and the precise location of the anomalies determined using tape measures. Areas from which soil samples were collected were determined by the analysis of the geophysical data. Specific anomalies expected to represent burials were the subject of the soil sampling strategy. Additional non-burial, cultural features were investigated to discern differences in the chemical signatures between burial and non-burial features. Feature sampling was dependent upon the size and shape of the feature. The majority of features were sampled twice to provide an understanding of internal chemical variation. Additional soil samples were collected from other portions of the site believed not to contain cultural features in order to determine background levels. A minimum of two background samples were collected for each feature investigated at a site. These samples were placed in a range of positions in relation to the feature locales, with at least a single core placed in all cardinal directions.

Soil samples were collected by two means, solid core probing and excavation units. Soil coring was conducted with an Oakfield split-spoon manual

soil core. Following the collection of each core, the device was thoroughly cleaned using deionized water. A trowel was used to collect samples from the excavation units. As with the core, the trowel was cleaned thoroughly following the collection of each sample, reducing the potential of contamination between samples.

The pH and temperature of each sample was determined with Oakton Acorn Series pH5 meter. The level of pH present in the soil can have a distinct effect on the levels of certain trace elements present in the soil as a result of bone degradation and organic material deposited during human occupation. The determination of pH for each soil sample was determined in the field at the time of collection. The Oakton pH5 meter was washed and dried following each sample. The meter was directly placed in the walls of excavation units and into the extracted cores (**Figure 4.1**). Measurements of pH appeared consistent between samples extracted from the unit wall or those within the cores, but temperature varied widely between the two contexts due to the fact that the cores heated much faster than the unit walls. These differences are evident within the soil coring logs (**Appendix A**), but did not provide any problems within the laboratory processing. Temperature of samples taken from the excavation unit walls averaged approximately 19.0°C, while temperature from cores ranged from approximately 18.0°C to as much as 34.0°C.



Figure 4.1. Photograph showing soil pH collection methodology for core samples.

In addition to total phosphorous levels and pH determination, soil samples were analyzed for a series of trace inorganic metals. Determination of specific trace elements to be analyzed was determined by two factors.

1. Soil sample pH: The pH values of the soil samples influenced the levels of specific trace elements present. This is acutely true in a burial context where pH can have specific effects on the diagenesis of bone.
2. If high background levels of specific trace elements were present, this may mask relatively small changes present in soil that is part of the burial matrix. One approach to address this problem was to test for a large number of trace elements both from feature locations and non-feature areas at a representative site. The data was reviewed and a determination made as to which elements would be most effective. This approach allowed for more samples to be processed because cost would be reduced due to fewer elements that would be assessed.

Quality Assurance/Quality Control

Data quality objectives are quantitative and qualitative statements that specify the quality of environmental data required to achieve the objectives of the project. One means of assuring accuracy is the inclusion of spike samples. Spike samples involve adding known amounts of target compounds and analyzing the sample with the samples collected in field. This allows for an assessment of the percent recovery. One of every 20 samples was spike analyzed. In addition, a soil chemist on staff with AMEC Earth & Environmental, reviewed the results of all soil analysis to ensure quality.

Soil Profile Descriptions

The coring and excavation units provided a sample of soil profiles from each of the archaeological sites. Each of these soil profiles was described based on color, texture, structure and notable inclusions. This base information pertaining to the components of each stratum was then used to define a specific soil horizon description. The depths of each of these horizons were also noted within the cores and excavation units logs. If samples were collected from specific strata, then pH, temperature and specific depths of collection were noted below surface (bs). **Appendix A** offers a complete list of all of these cores separated by individual sites.

The nomenclature used for these soil descriptions was based on the USDA soil classification

system, and may be unfamiliar to the reader (Schoeneberger et al. 1998). A summary is offered below to outline the various horizon nomenclatures used to describe the soils at the sites, as well as a description of the meaning of each. Additional information on describing and identifying soils can be found within a variety of different resources, including Vogel (2002) Schoeneberger et al. (1998) and USDA (1999).

In general, the soil horizons identified within the various cores can be separated into three classifications: A-horizons, B-horizons and C-horizons. These classifications are known as master horizons, denoting the dominant characteristic of each soil stratum. In addition to these dominant soil horizons, a number of strata were also identified based on a subordinate soil horizon classification scheme that defines the dominant soil forming processes that are occurring within a specific soil stratum. This subordinate classification scheme, such as Bt, Ab or Ap, was not utilized as frequently due to the fact that the small core size limited the degree of information necessary to make decisions about specific soil development characteristics.

An A-horizon is a stratum in which the concentration of organic material is the dominant characteristic. Such horizons usually have a dark black to yellowish brown color and occur at the surface. A series of A-horizons can be identified in succession from the surface, but if a stratum is identified with high amounts of organic matter and is located below any other type of horizon, then this stratum is denoted as an Ab-horizon. An Ab-horizon indicates a buried A-horizon, or an A-horizon that represents a period in which soil deposition was minimal and the landform was stable, allowing for increased amounts of organic material to collect within the previous surface horizon. Some of the surface horizons within the open-air sites had been plowed and were denoted as Ap-horizons, or A-horizons that had been plowed. On a limited basis, a few profiles were noted with a surficial O-horizon. This horizon, like the A-horizon, is dominated by organic material, but unlike the A-horizon this stratum usually consists of mostly organic material with a reduced percentage of mineral content.

B-horizons represent strata that have been weathered, losing the great majority of their organic content. These horizons represent the portion of the soil profile in which minerals and smaller particles leached out of the surface

horizons become concentrated. The type and degree of this concentration determines the subordinate classification of each B-horizon stratum. The two B-horizon subordinate classifications used within the project were Bw and Btk. A Bw-horizon denotes a weakly developed B-horizon. These horizons have begun to demonstrate early indications of clay and mineral accumulation. In addition, these soils usually have a weakly developed structure, forming as small angular or subangular blocks (called peds) within the soil. A Btk-horizon is a horizon that demonstrates a high degree of soil structure and has substantial accumulations of clay particles lining the area between individual peds. In addition, these horizons also have substantial concentrations, more than 5 percent of matrix, of calcium that forms as concretions or ribbons. This type of Bt-horizon is indicative of arid climatic regimes.

The small core size made the identification of specific soil processes difficult for many of the sites. Thus instead of defining specific soil formation processes, some strata were identified as transitional horizons, such as an AB, AC or BC. This nomenclature describes a soil that possesses characteristics of both master horizons, and is therefore moving from one dominant characteristic to another.

The final dominant soil horizon used was the C-horizon. A C-horizon represents mostly unaltered sediment. These horizons have undergone little if any weathering and therefore little if any soil development. The basal deposits at the rockshelters were indicative of C-horizon sediments, forming out of the limestone bedrock. In some instances, if rock content was high within a C-horizon, a subordinate Cr-horizon designation was added. This simply indicates that the C-horizon includes some percentage of degrading bedrock.

Rockshelter Methodology

The general methodology for the soil testing aspect of this project was outlined above. The rockshelter soil sampling required a few specific considerations. The majority of the rockshelters investigated within the current project contained a single known grave location. Given the focus of the project, these burial locations were of primary testing importance. Known burial locations were sampled using a coring regimen only, given that minimal disturbance to the known graves was of

the utmost importance. Even with the limitation of using only cores for testing as well as utilizing a very small barrel coring instrument, bone was recovered within some of the coring locations. This bone was noted and placed immediately back into the graves. The chemical testing was completely focused on the surrounding grave matrix and not the actual human bone.

Rock content within the rockshelters was substantial in comparison to the open-air sites. Due to the high rock content, a portion of the cores were attempted at least twice, if not three times, per successful core sampled. Even with the multiple core placements, disturbance was minimal due to the small barrel size. Approximately, 20 percent of all core locations needed to be cored more than once to achieve acceptable results.

Soil Probing of Features/Burials

Soil coring within the boundaries of features/burials included the extraction of one to two cores. A total of three samples were collected from each core where applicable, one above the feature, one within the feature, and one below the feature. The sample above the feature allowed the assessment of the chemical composition of the soil that is not within the feature matrix. The sample from the feature allowed for chemical characterization of the burial/feature matrix. Sampling below the feature provided an understanding of the amount of leaching that had occurred from the feature location. The number of samples from any feature location depended on the degree of disturbance. A few of the features were within previous excavation units. Due to the unit disturbance, samples were not collected from above the features.

Soil Probing to Characterize the Rockshelter

In order to determine the background levels of total phosphorous and the trace elements, several soil cores were extracted from the rockshelter in areas that did not contain features. Ideally, two to four times the number of samples collected from the features were collected for this purpose. Given the relatively small area that comprises the rockshelter sites, two background samples were collected per feature location. This was believed to be sufficient to characterize the background chemical signatures of the shelters.

While the geophysics was used to determine core placement within the shelters, certain physical aspects limited core placement. Narrow roof height and dry soil conditions in certain shelters determined core placement, or nullified potential testing locations determined by the geophysical results. Even with the wide variety of potential coring apparatus used, some roof heights were too narrow to adequately allow for coring, especially if the soils were extremely dry and loose. Dry soil conditions were also problematic, given the fact that solid cores were required in order to take pH and temperature readings. As noted above, some shelters also contained prodigious amounts of rock that severely limited core placement, making it necessary to investigate multiple potential areas prior to settling on the final background sample locations.

Open-air Methodology

Soil probing and excavation at the open-air sites closely followed the methodology described for the rockshelters. One to two samples were collected from the grave and feature locations. Twice as many background samples were collected for each feature from the open-air sites. While the open-air sites were much larger in size than the rockshelter environments the soils were much more homogenous. Thus it was deemed

sufficient to sample the same amount for the background on the open-air as it was for the rockshelter sites.

The sampling of the historic cemeteries produced a series of specific characteristics not experienced at the prehistoric sites. Current members of the various families interred in the cemetery still actively use the cemetery sampled at Fort Hood. Given the sensitivity issues from testing graves within a marked cemetery, graves chosen for testing were limited to those that were unmarked. These unmarked graves were only known within the geophysical data, and as such would require some degree of independent assessment to be determined a historic grave. Thus a limited coring program would offer the minimal amount of information necessary to determine if these anomalies were in fact graves, as well as sufficient soil for chemical signature development. As with the prehistoric graves, the testing of the historic graves was designed to produce the least amount of disturbance possible. Given that exact placement of the bodies within the graves could not be determined, it was impossible to not impact the burial within the grave shaft. A single core in one of the graves did produce bone. This bone was noted and immediately replaced back into the grave locale.

SURVEY AND TESTING OF SITES: FORT HOOD

Duane Simpson

5

INTRODUCTION

The initial portion of the research was the identification and validation of cultural anomalies from a series of geophysical survey data. This chapter describes both the results of the geophysical survey completed at each site as well as the validation efforts undertaken at each to confirm the identification of a limited sample of cultural features. Although the geophysical survey and subsequent excavations are separate methods of site investigation, and usually dealt with in individual chapters in other reports, they are inherently combined together as part of a common research goal within this project, and as such were combined into a single chapter. In an effort to subdivide a fairly lengthy portion of the report, the sites from Fort Hood and Camp Lejeune have been divided into two chapters.

SITE 41BL69

Rockshelter B Site 41BL69:

Aspect of shelter opening: East

Shelter dimensions (LxWxH): 20.4m x 5.0 m x 3.9 m

Talus development: None

Cultural affiliation: Unknown

Presence of known burials (depth): Yes; 32 cm below surface (bs)

Presence of known non-burial features (depth): possible hearth (25-32 cm bs)

Extent of site disturbance: Minimal (approximately 10 percent)

Investigation techniques: Resistance, Magnetometry

Site 41BL69 is situated on the top and flanks of an upland ridge spur that overlooks Belton Lake. The flanks of the upland are quite steep with a 20-25 m vertical scarp running along a portion of the

east side of the site. The site consists of three subareas: A, B and C. Subarea A includes the top and flanks of the ridge spur, as well as the rocky shoreline of the lake. Subareas B and C designate two individual rockshelters that lie along the east-facing scarp of the ridge spur. Rockshelter B (included in Subarea C) was the subject of the present investigation.

Rockshelter B is located just south of modern construction activity. This activity has severely impacted the northern ten percent of the shelter, by both cutting the scarp above the shelter and subsequently burying the majority of it under the debris. Given these disturbances, no investigations were attempted within the northern portion of the shelter. The southern section of the site was not directly disturbed by the construction activity, but its placement has increased traffic into the shelter and lead to a high degree of surficial disturbance. While surficially disturbed, the shelter does not appear to have experienced any deeper disturbance from looting or animal burrowing.

The southern section of the shelter lies along a narrow bench area extending an average of 2.5 to 3 m from the scarp face (**Figure 5.1**). The shelter extends back into the scarp face as a series of broad constrictive alcoves. The largest of the alcoves extends back 4 m from the scarp face, but on average they extend back 1.5 to 2 m from the face. The majority of the alcove portions of the shelter are less than 0.5 m in height and therefore no geophysical survey was attempted due to the constrictive conditions. The geophysical survey was focused on the narrow bench portion of the site, where in the previous archaeological investigations had discovered a human interment



Photograph of 41BL69, looking grid north.

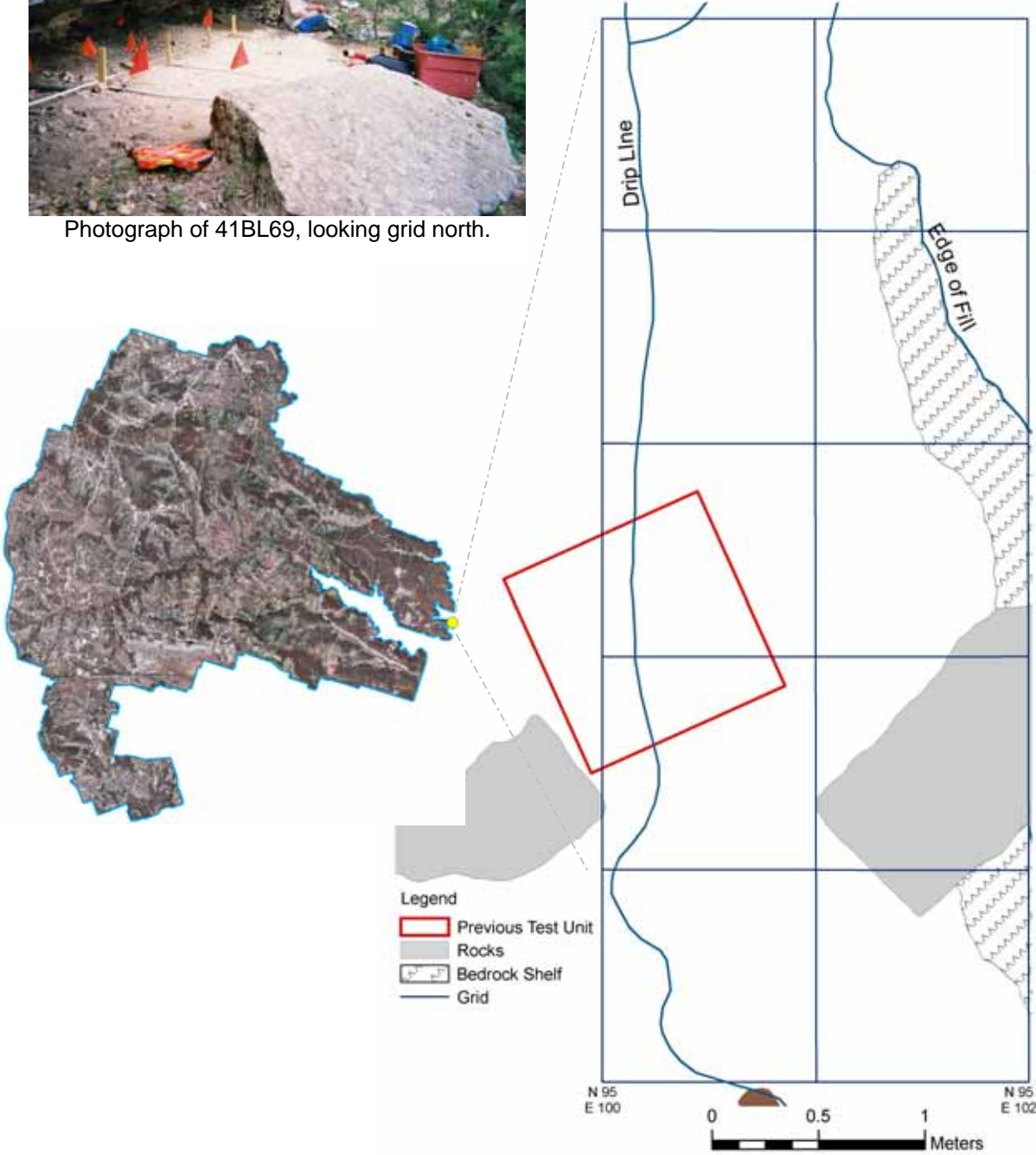


Figure 5.1. Site Map of 41BL69, Rockshelter B Planview.

A single 1.0-x-1.0-m test unit was excavated at the site during the 1995 site evaluation directly in front of a large alcove at the southern end of the shelter (Mehalchick et al. 1999). Excavation of the unit revealed a portion of a human burial encountered from 0.32 to 0.44 m below surface (bs). It measured 0.61-x-0.28 m in the northeast corner of the unit, and consisted of a cranium with its articulated mandible, four vertebrae, the left scapula with the articulated humerus, the left radius and ulna, two metacarpals and one phalange located above the radius and ulna, the articulated ball and socket of two unidentified long bones, one fibula and three unidentified bones (Mehalchick et al. 1999: 46). The burial was oriented from north to south, basically running parallel to the bench orientation portion of the shelter and extending out of the unit to the north. The burial was capped by a collection of flat limestone slabs. The body was semiflexed, with the individual interred on the left side facing west (toward the back of the shelter).

Excavation was halted and the human remains were reinterred in the unit and excavation terminated. As a result, the maximum depth of deposits in the shelter was not determined, but was estimated to extend to a depth of 0.50 m bs with the potential for deeper pockets of deposits. The unit recovered only a limited assortment of burnt FCR, debitage and mussel shell, all of which were placed back in the unit.

The size of the bones appears to indicate an adult, of unknown sex. Excavations did not indicate any burial pit. The fibula appeared to have been out of context from the rest of the burial, and may have been disturbed by possibly a later occupation of the site. The recovery of the burnt FCR from above the burial was interpreted as a possible hearth created during a later occupation. The creation of this feature may have impacted a minor portion of the burial (Mehalchick et al. 1999: 49).

41BL69 Geophysical Survey

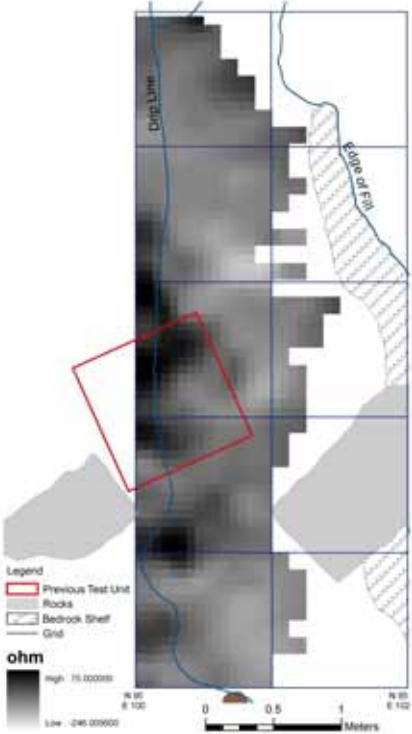
A 2 m wide by 5 m long grid was created along the southern end of the rockshelter (**Figure 5.1**). This grid extended from approximately the scarp

face on the west to exposed bedrock that ran along the eastern edge of the bench (**Figure 5.2**). The extent of the grid covered the entire bench portion of the shelter that retained any potential soil. The grid could not be placed any farther into the rockshelter due to the narrow height of the shelter's roof west of the scarp face. An additional hindrance to investigations west of the grid was the dry nature of soils. The lack of soil moisture would have been a severe limitation on the potential of the resistance meter to reliably record measurements on a consistent basis. The placement of the grid covers the majority of the excavation unit completed during the 1995 evaluation, therefore providing a signature of the intact burial.

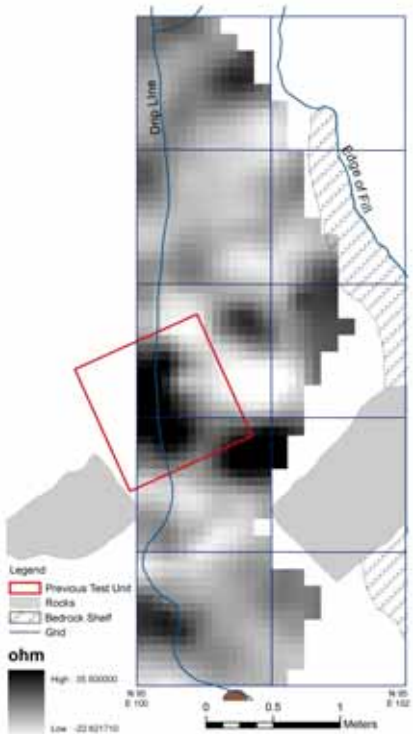


Figure 5.2. View of 41BL69 looking south.

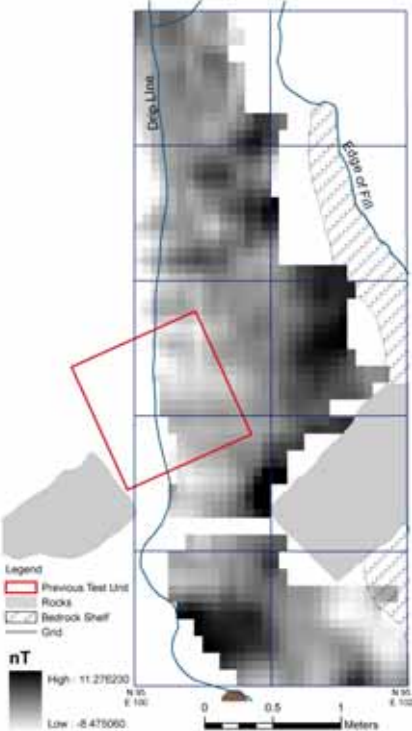
A magnetometer and two resistance meter surveys, one at 0.25 m and one at 0.50 m spacing, were completed at the site (**Figure 5.3**). All three of these surveys used the standard methodology proposed for rockshelters defined previously in **Chapter 3 (Figure 5.4)**. Although the deposits are estimated to be no greater than 0.50 m in depth across the shelter and could be easily investigated by one single depth, two closely spaced depth intervals were utilized as a means of screening out potential surficial disturbances and reinforcing interpretations of features expressed within both resistance data sets. The surface of the grid had only one large rock to act as an obstruction (**Figure 5.1**).



Resistance data, 0.25 m spacing



Resistance data, 0.50 m spacing



Magnetometer data

Figure 5.3. Magnetometer and resistance data sets collected at 41BL69.



Figure 5.4. Photographs of geophysical survey at 41BL69.

The resistance data sets identified a large anomaly between N97 and N98 along the west side of the grid (**Figure 5.5**). This anomaly appeared to approximate the location of the excavation unit. Based on the previous archaeological investigations, the burial should lie in the northeastern corner of the unit and extend to the north some unknown distance, and should be in part covered by a few large slabs of limestone roof fall. Surficial inspection of this portion of the grid indicated that it was extremely dry and had undergone some degree of disturbance, both characteristics that appeared typical of an excavation unit placed within a dry rockshelter (**Figure 5.6**). Based on these characteristics, sampling for the burial was conducted along the eastern edge of the anomaly.

Assessment of the resistance data around and north of the probable unit location produced a number of subtle anomalies that appeared to extend from the unit location (**Figure 5.5**). These subtle anomalies became the central focus of the validation efforts within the shelter. A review of the magnetometer data was not as effective. The proximity of the shelter to the modern construction activity severely affected the quality of the magnetometer data by exponentially raising the background magnetic field as the collection drew closer and closer to the northern edge of the shelter (**Figure 5.3**). A few subtle linear anomalies extended away from the probable unit area but these were not consistent enough to be reliably used for directing

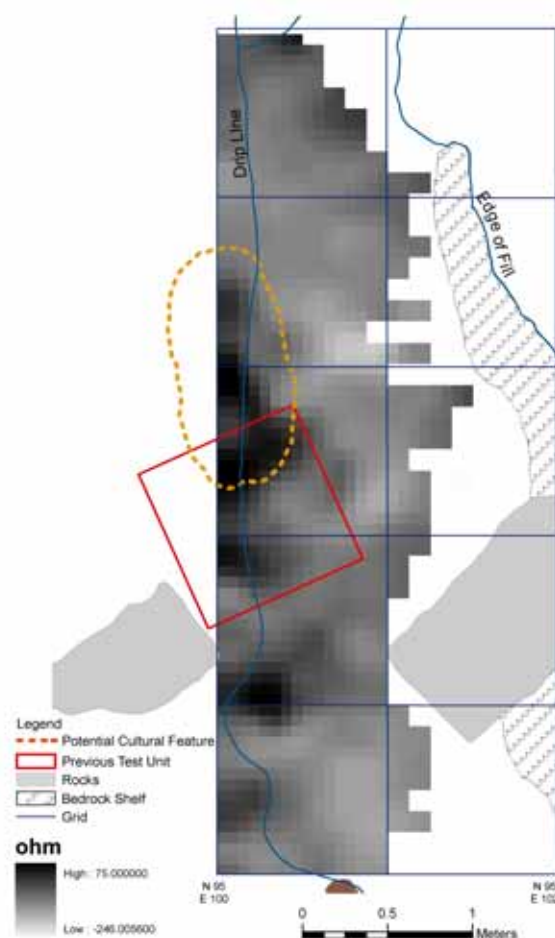


Figure 5.5. Resistance data (0.50 m deep) showing high resistant anomaly along the western edge of the grid at 41BL69.

test locations. The resistance data sets were relied upon to determine testing locations in the case of 41BL69.



Figure 5.6. Area of disturbance at 41BL69, located to the right of the large piece of limestone roof fall.

41BL69 Archaeological Investigations

The identification of a human burial during previous investigations at the site was the central focus of the research within Rockshelter B. Given that field observations had relocated the 1995 excavation unit and that geophysical results had indicated an anomaly within the general area, the necessity of opening up a small excavation unit did not seem warranted. Thus field testing of the shelter was limited to a coring program directed by geophysical results and field observations (Figure 5.7).



Figure 5.7. Core sampling at 41BL69.

A total of eight cores were placed across the rockshelter (Figure 5.8). Of the eight total cores, two were placed into the burial location, Cores 62 and 63 (Figure 5.8). The remaining cores were placed around the grave location to provide an accurate background sample for comparative purposes. Three of these core samples, Cores 27,

29 and 30, were placed outside of the grid. Given the location of the grave in relation to the grid, it was necessary to place some of the cores west of the burial location. A number of small conduits were located at the back of the large alcove west of the burial. These conduits provide some of the water that moves through the rockshelter, and therefore made it necessary that the samples be taken west of the grave location so that an accurate estimation could be made between soil formation within the shelter and those portions lying on the bench. This shelter was an anomaly from the aspect of testing, given these constraints. The majority of the remaining sites were all sampled from within the grid.

The six background cores placed at the site indicated that the soils were dry and shallow (Appendix A:170). The background cores had some degree of variability, but in general contained two strata.

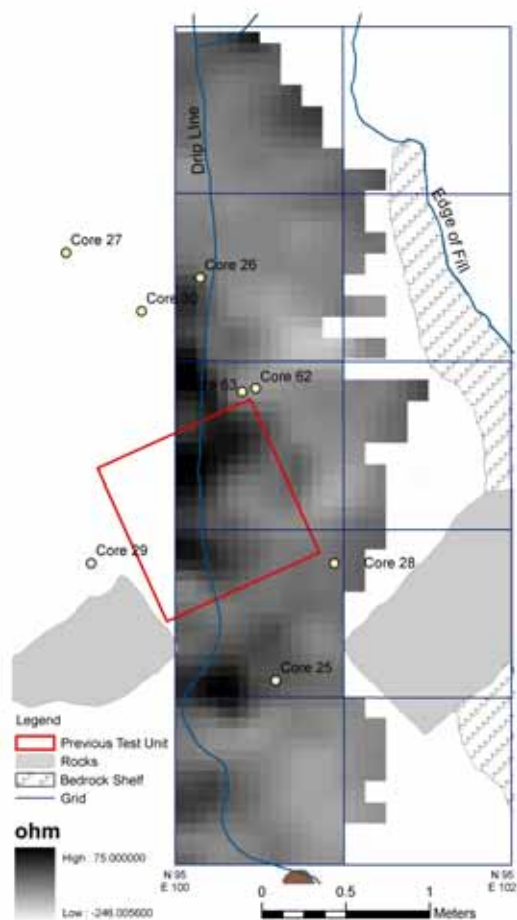


Figure 5.8. Core placement at 41BL69.

All of the cores contained a consistent A-horizon that extended from 0.12 to 0.29 m bs (**Figure 5.9**). In some cases, the A-horizon was divided based on moisture content, but in general a single undulating A-horizon covers basal C-horizon deposits across the shelter. The A-horizon ranged in color from a 10YR4/2 dark grayish brown to a 10YR7/3 very pale brown massive silt (Appendix A:170). The A-horizon was underlain by a C-horizon that ranged in color from a dark yellowish brown 10YR4/4 to a 10YR7/4 very pale brown (**Figure 5.9**). The C-horizon was a massive silty clay to silt with fluctuating amounts of degrading limestone. This stratum consistently extended to the shelter floor. The depth to the floor ranged across the shelter, but the majority of cores hit bedrock or a rock impasse at a depth between 0.25 and 0.35 m bs, but Core 25 extended to a depth of 0.50 m bs. This core was placed along the southern bench section of the shelter between two large pieces of roof fall. This portion of the bench section was higher than areas north of the test unit locale, thus the greater depth observed in this unit is due to higher elevation and not deeper deposits.

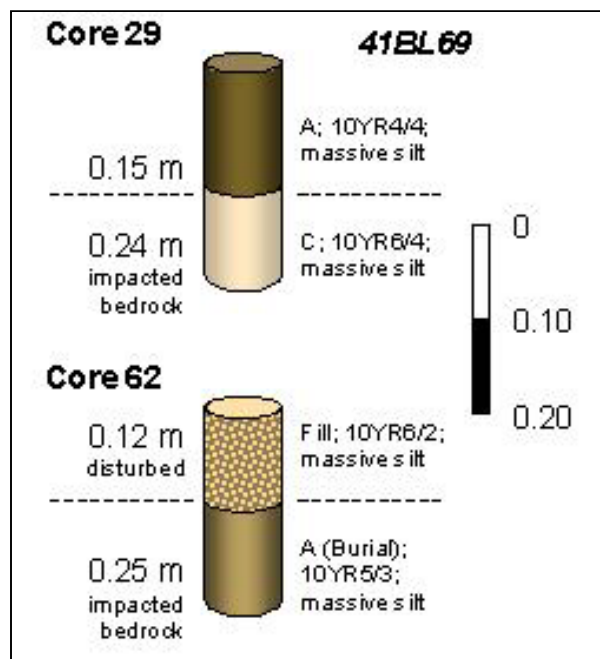


Figure 5.9. Representative soil core profiles from 41BL69.

The two cores placed into the previous test unit and the probable burial locale produced similar core samples (**Appendix A:170**). The upper section of each core was heavily mottled and disturbed by the previous archaeological excavation. These loose disturbed soils were

consistent until they abruptly stopped at a brown 10YR5/3 stain (**Figure 5.9**). The depth of stain extended from 0.12 to 0.25 m bs. Core 62 contained small fragments of bone (Appendix A:170). Both Cores 62 and 63 terminated at bedrock directly below the burial locale.

Based on the recovery of small bone fragments within Core 62 and the dark 0.13 m thick stain, the interpretation that the anomaly was in fact a burial locale was confirmed. The bone observed within Core 62 was immediately removed from the sample and returned to the core location. The placement of the burial is considerably less deep than that indicated during the 1995 excavations. This discrepancy is attributed to the fact that the backfilled test unit soils have collapsed or eroded substantially. It is believed that the depth of deposits noted in Core 25 is more than likely similar to those noted during the 1995 excavations.

Soil samples were recovered from the feature context only, given that the soils above had been heavily disturbed by previous excavation (**Appendix A:170**). Samples from the background cores were taken from each of the defined strata (**Appendix A:170**). These samples were taken from above, at and below the average depth of the burial. These depths were believed to be adequate to characterize the background soil strata at the depth of the burial. Results of the chemical samples are addressed in **Chapter 7**.

SITE 41BL744

- Rockshelter Site 41BL744:**
- Aspect of shelter opening:** East
- Shelter dimensions (LxWxH):** Approx. 26 m x 6 m x 2 m
- Talus development:** Yes
- Presence of known burials (depth):** Yes (53 cm bs)
- Presence of known non-burial features (depth):** No
- Extent of site disturbance:** approximately 20% of the site has been looted, some surficial disturbance
- Investigation techniques:** Laser field scanner, Resistance, Magnetometry

The site is located east of Belton Lake along the rim of a steep upland escarpment (Abbott and Trierweiler 1995). The site is divided into two subareas (Subareas A and B). Subarea A consists of a lithic scatter that extends across the

upland along the escarpment edge. Subarea B includes a single rockshelter that is located directly below the upland scatter. Subarea B was of central importance to the current investigations.

The rockshelter is located at the head of a steep drainage ravine that drains the upland ridge. The shelter is crescent shaped and covers both sides of the drainage ravine. Previous archaeological investigations have centered on the northern half of the shelter, and therefore, so were the current investigations. A surficial drainage empties directly over the center of the shelter, and two conduits were noted in separate alcoves along the back wall. These various drainages keep soil moisture high throughout the shelter, providing no limitations to the survey of the entire shelter with a resistance meter.

An extensive bedrock ledge exists at the shelter (**Figure 5.10**). This ledge is only loosely covered by sediments and larger clasts. It averages about 4 m into the shelter from the dripline. The shelter base drops approximately a meter from the ledge to the floor of the shelter within an average of 1 m. This substantial drop limited testing from the base of the slope to the dripline, or edge of the shelter. The outside edge of the shelter drops off prodigiously from the dripline, averaging from 100 to 110 percent across the entire face of the shelter, making geophysical survey impossible (**Figure 5.11**).



Figure 5.10. Shelf area south of collection grid at 41BL744.

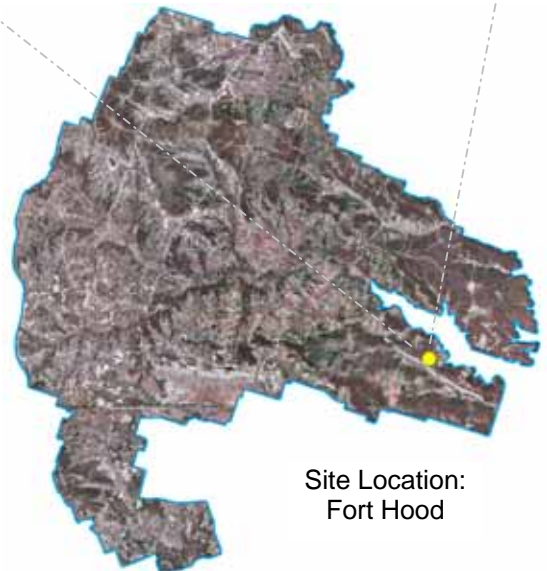
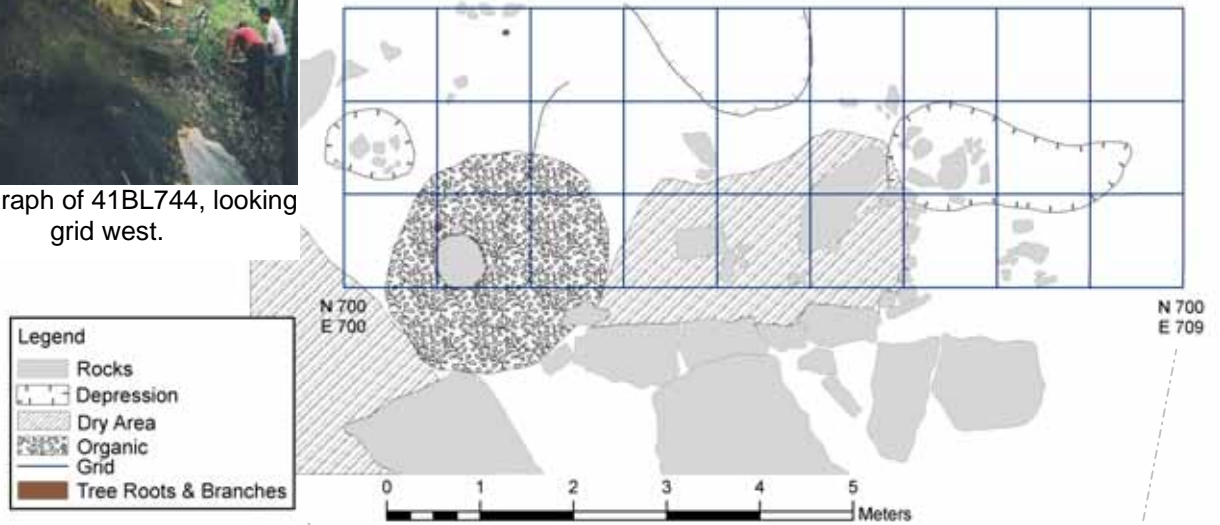
The shelter has undergone a series of investigations over the last ten years. In 1992, two shovel tests and a 0.50-x-0.50-m unit were excavated within the shelter. These units uncovered some limited cultural material contained within the upper 0.40 m of the shelter fill (Trierweiler 1994). This testing also noted that the shelter fill appeared to be a combination of internally and externally derived sediments. A total of four looter holes were noted during this survey, constituting approximately 20 percent of the shelter area. Due to the disturbance from looting, the 1992 survey could not determine if the cultural material was intact.

In 1993, more intensive excavations were completed at the site (Abott and Trierweiler 1995). A total of three 1.0-x-1.0-m test units were excavated within the shelter. Test Units 1 and 3 produced modest collections of cultural material, but Test Unit 2 produced an intact burial pit at 0.53 m bs. Test Unit 2 was located in the center of the shelter along the dripline and talus edge.

A circular pit was discovered in the northwest corner of Test Unit 2 measuring 0.40-x-0.25-m. Examination of the profile suggested the burial was placed in a pit excavated 0.30 m into the existing shelter fill, then backfilled with material removed from the excavation (Abott and Trierweiler 1995:256). Subsequent to the pit's creation a layer of 0.10 m of soil sealed the pit below the active surface of the shelter. The pit contained a collection of disarticulated human remains including a right femur, three ribs, both clavicles, and a calcaneus (Abott and Trierweiler 1995). The pit and all of its materials were documented and reinterred with no formal analysis of the remains. No diagnostic artifacts were recovered within the test unit, and therefore no definitive time period can be offered for the burial.



Photograph of 41BL744, looking grid west.



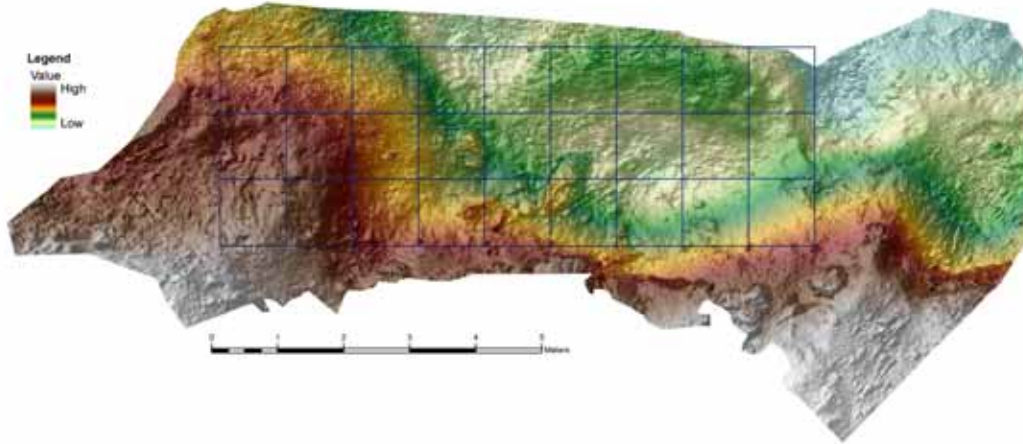
Site Location:
Fort Hood

Figure 5.11. Site Map of 41BL744, Subarea B (Rockshelter) Planview.

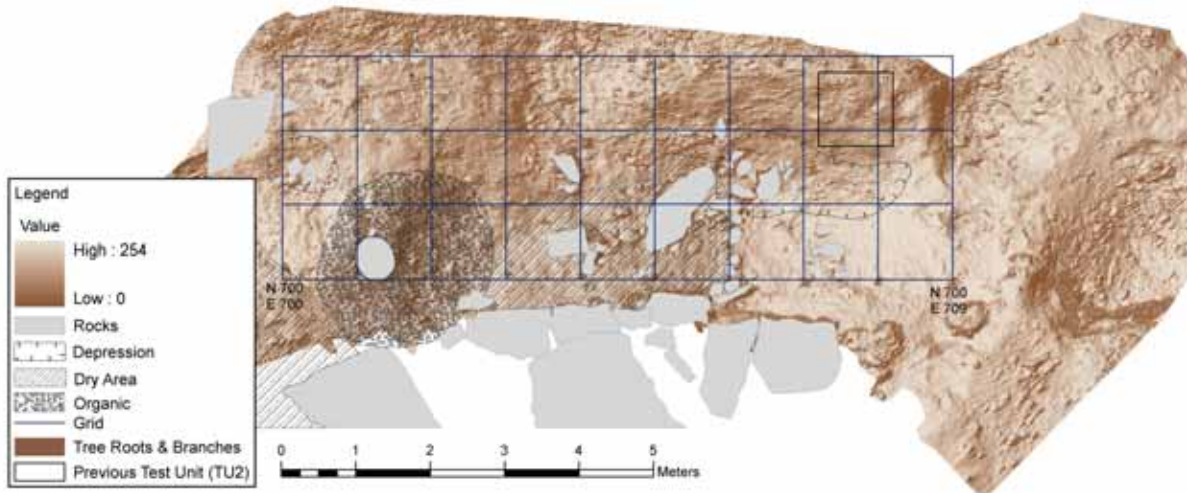
41BL744 Geophysical Survey

A 3 m wide by 9 m long grid was created along the northern end of the rockshelter, wherein the burial was located during the 1993 test excavations (Figure 5.11). The grid extended from the base of the bedrock ledge to the talus edge, including the location of Test Unit 2.

A magnetometer, three resistance meter surveys at 0.25, 0.50 and 0.75 m spacing, and a laser field scan were completed at the site (Figure 5.12, 5.13 and 5.14). All five of these surveys used the standard methodology proposed for rock shelters defined previously in Chapter 3.

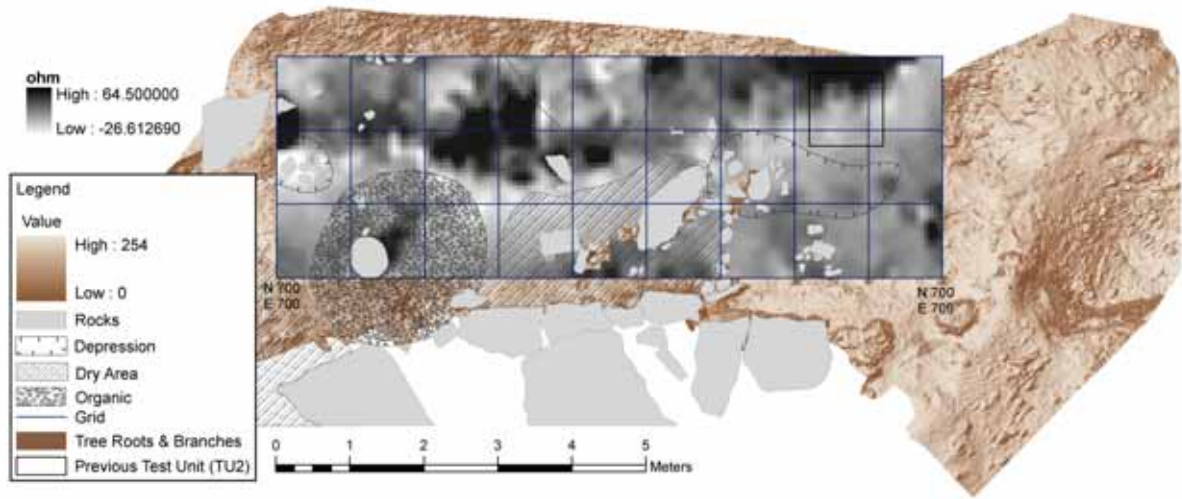


Laser Field scanner created DEM of 41BL744

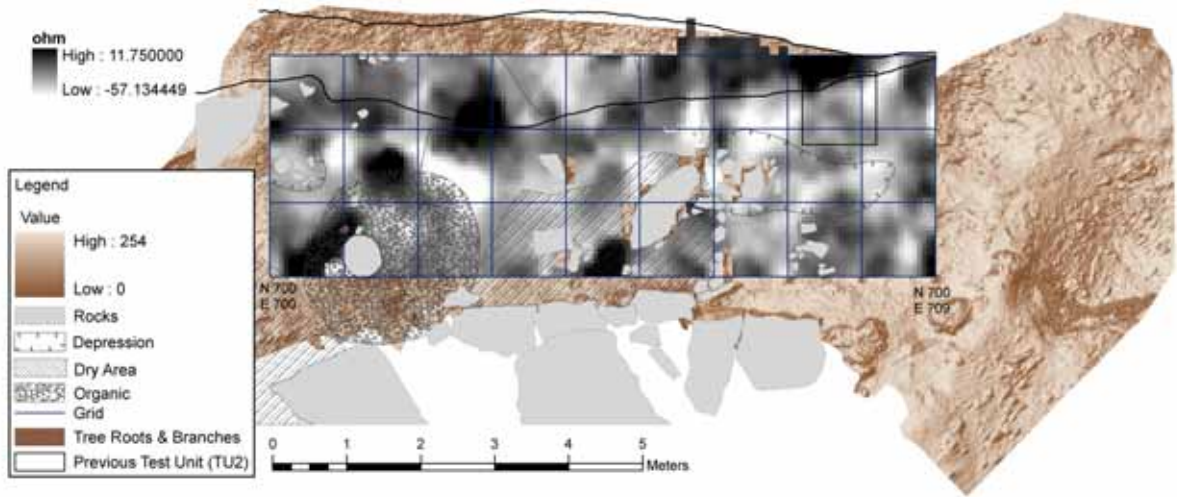


Hillshade relief map of Laser Field scanned DEM

Figure 5.12. Laser Field scanned base mapping of 41BL744.

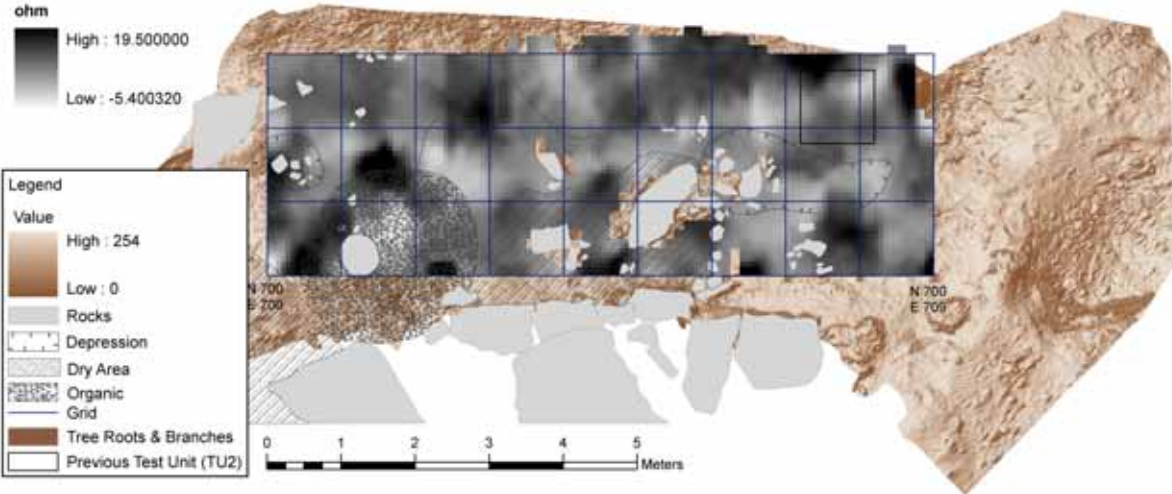


Resistance data, 0.25 m spacing

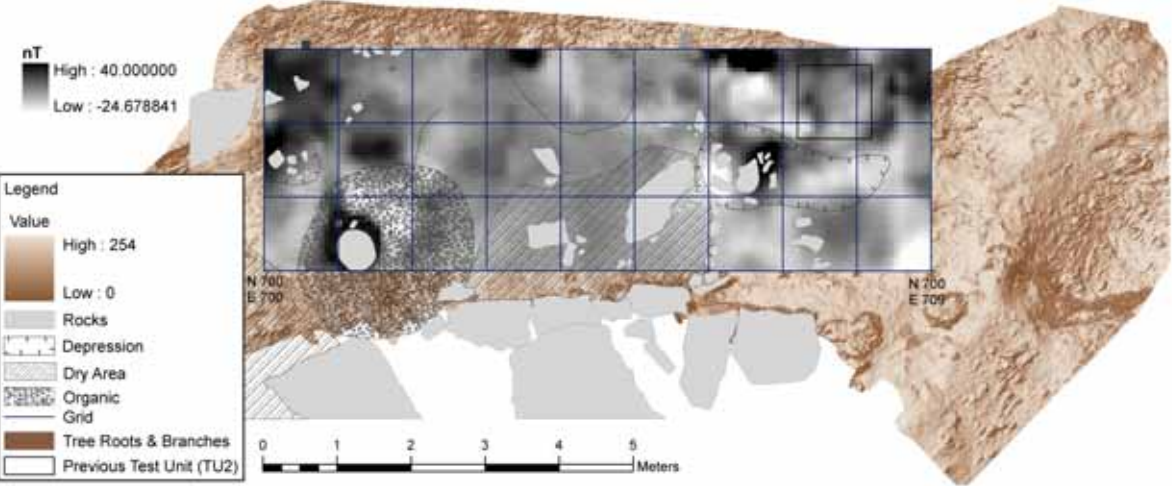


Resistance data, 0.50 m spacing

Figure 5.13. Electrical resistance survey results from 41BL744.



Resistance data, 0.75 m spacing



Magnetometer data

Figure 5.14. Electrical resistance and magnetometer results from 41BL744.

The surface of the shelter was open with only a few large pieces of limestone roof fall to negotiate (**Figure 5.15**). This roof fall led to the exclusion of a few isolated areas during the collection of the resistance data sets and laser field scanner mapping. Previous archaeological work completed at the site indicated that the depth of soil deposits ranged from 0.30 m to as much as a 1.0 m along the eastern edge of the shelter and into the talus deposits. The three resistance meter spacing intervals were believed to adequately investigate the portions of the soil profile that had the potential to contain archaeological deposits.



Figure 5.15. Surface conditions at 41BL744.

Previous archaeological investigations in the shelter had identified a burial along the eastern

talus edge. It was this burial location that was the intended focus of the current investigations. Assessment of the resistance and magnetometer data sets identified a number of circular anomalies along the eastern extreme of the grid. The magnetometer data defined the probable burial location, a circular anomaly measuring approximately 1.0-x-0.50-m, with the greatest degree of clarity (**Figure 5.16**).

In addition to the probable burial location, another subtle anomaly was identified along the far western edge of the grid (**Figure 5.16**). This large circular anomaly was identified within the magnetometer and 0.75 m deep resistance surveys, and to a lesser degree within the 0.50 m deep resistance survey. The anomaly was located on the side of an older looter hole that covers a large portion of the south central section of the grid (**Figures 5.11 and 5.12**). The placement of the anomaly in relation to the disturbance placed the integrity of the possible cultural feature into question. This portion of the grid was troweled, exposing a subtle circular anomaly. A series of investigative cores were placed across the anomaly indicating the basal remnants of a circular basin. Given the disturbance noted in relation to the feature, no formal testing was completed during the testing phase.

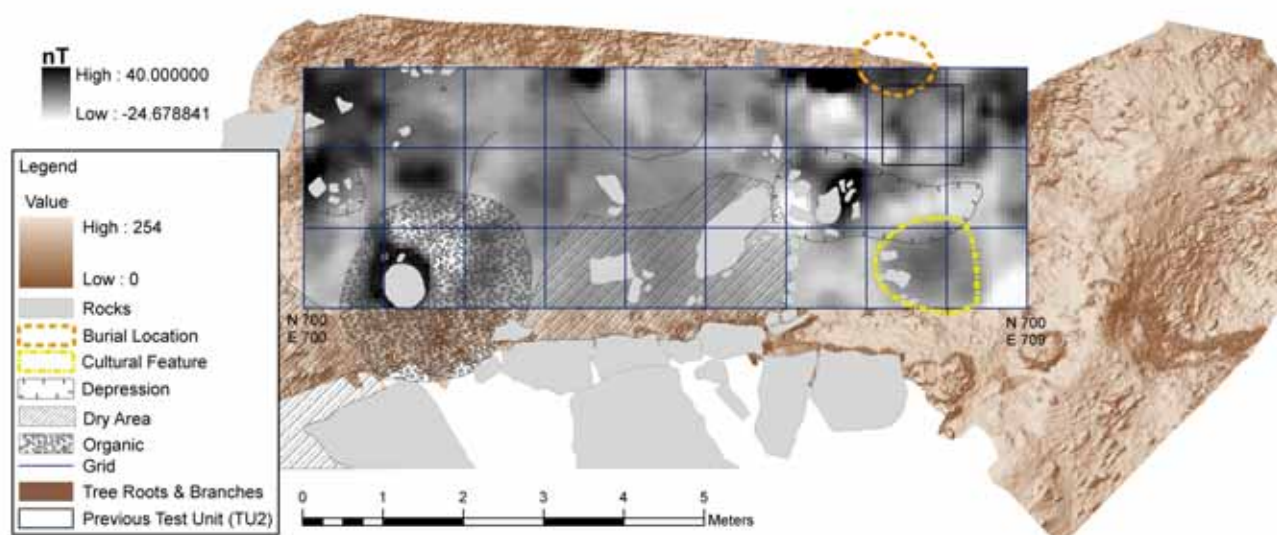


Figure 5.16. Interpretation of potential cultural features from 41BL744, overlaid on the magnetometer data set.

41BL744 Archaeological Investigations

The identification of a human burial during previous investigations at the site was the central focus of the research within the rockshelter. Initial investigations at the site identified the general area in which Test Unit 2 was located. Geophysical results also indicated an anomaly within the general area of the test unit locale. Given the correlation between the geophysics and location of Test Unit 2, it was not necessary to open up a small excavation unit. Field-testing of the shelter was limited to a coring program directed by geophysical results and field observations (**Figure 5.17**).

A total of eight cores were placed across the rockshelter (**Figure 5.18**). Of the eight total cores, two were placed into the burial location, Cores 54 and 55 (**Figure 5.18**). Core 54 was placed into the steep talus deposits that run along the eastern edge of the shelter, and Core 55 was taken from a cleaned profile of the talus deposits. The remaining cores were placed throughout the rockshelter to provide an accurate background sample for comparative purposes (**Figure 5.18**).



Figure 5.17. Coring sampling at 41BL744.

The six background cores are discussed first, in order to provide a context of soils across the site to compare the feature results against (**Appendix A:171-172**). The background cores had some degree of variability but in general contained two strata: an A-horizon and a C-horizon.

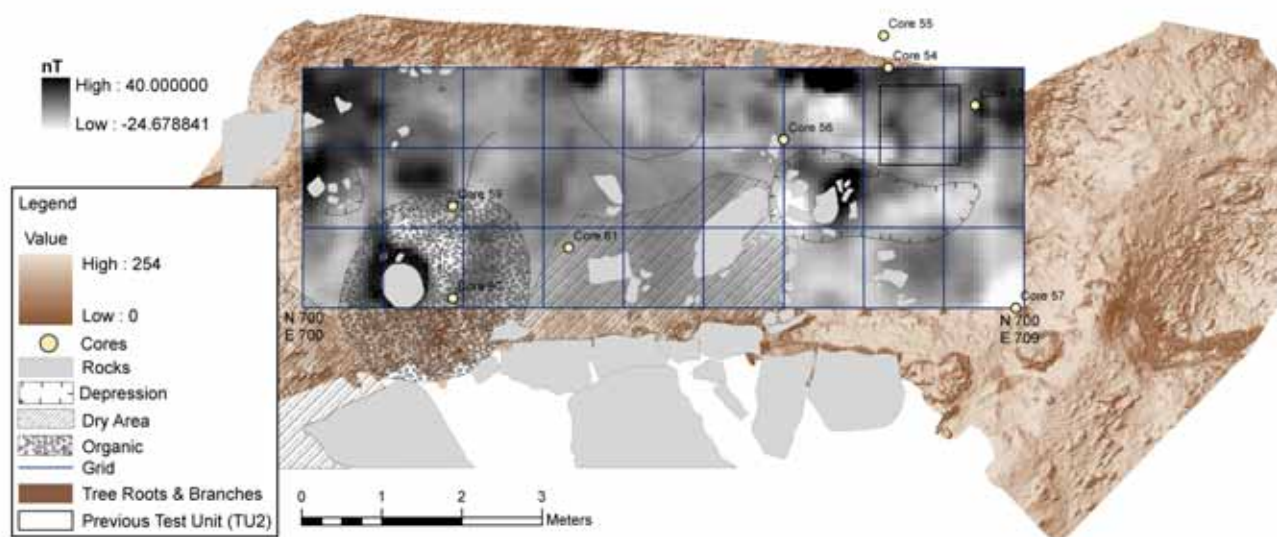


Figure 5.18. Placement of cores at 41BL744, overlaid on the magnetometer data set.

The depth and nature of the A-horizon differed between tests, due mostly to previous looting activities. While cores were not placed in obvious areas of disturbance, many were placed through areas that contained varying amounts of soil that had come from these looter holes. Cores 56 and 57 contained these loose disturbed deposits (**Appendix A:171**). The remaining background cores did not have this second layer of disturbed A-horizon. Even with this layer of disturbed A-horizon, depth of A-horizon deposits extended from 0.25 to 0.40 m bs (**Figure 5.19**). The color ranged from a very dark brown 10YR2/2 to a

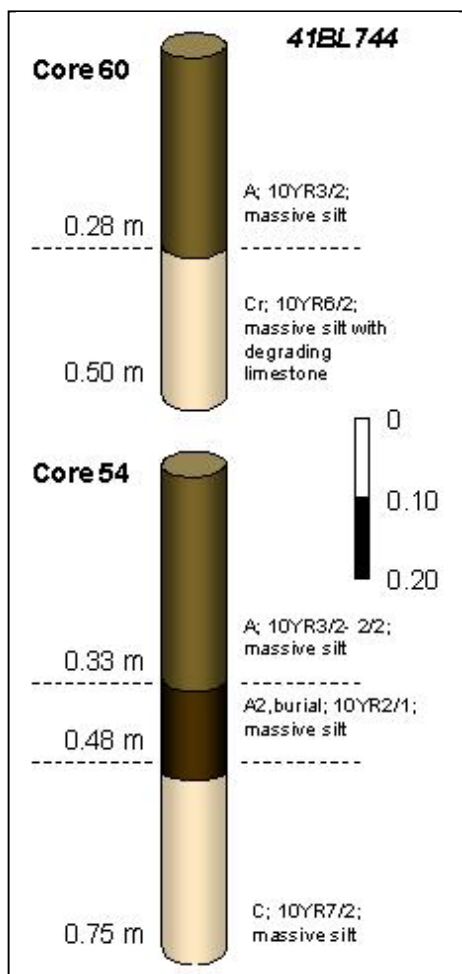


Figure 5.19. Representative soil core profiles from 41BL744.

10YR3/2 very dark grayish brown. In general, the A-horizon was a loose to firm massive silt with varying amounts of organic content and limestone. A C-horizon or Cr-horizon, depending on the amount of degrading limestone noted in the core, consistently underlay the A-horizon. The cores extended to an average depth of 0.48 m bs

into the basal C-horizon deposits. The C-horizon is a 10YR6/2 to 10YR7/2 light brownish gray to light gray massive silt. Those cores with greater amounts of the lower Cr-horizon were typified by the inclusion of a 10YR8/6 yellow silt representative of degrading limestone bedrock (**Figure 5.19**).

The previous test unit was placed into the talus deposits, approximately 0.50 m from the edge of the talus slope. The burial was located in the northeast corner of the unit extending toward the talus slope edge. Based on the position, it was possible that part of the burial pit would be exposed within the bank of the talus slope. Geophysical survey indicated a circular pit extending out of the grid toward the talus edge that would appear to extend to the talus slope. A small window was cut into the loose talus deposits covering the front slope of the rockshelter (**Figure 5.20**), the majority of this loose material was not in primary context, but represented a wash of soil that had eroded or was thrown there from the previous looting activity. The profile window was cut from approximately the top of the slope to a depth of 0.67 m bs (**Figure 5.19**).



Figure 5.20. Profile window at 41BL744, showing the edge of the burial pit as a dark lens in the center of the window.

As with the background cores, a series of A-horizons, A1: 10YR2/2 very dark brown loose massive silty clay and A2: 10YR3/2 very dark grayish brown granular silty clay, cap the burial locale. These probably relate to the original

shelter surface, A2-horizon, and augmentations of disturbed fill from the looter holes that exist within the center of the shelter, A1-horizon (**Figure 5.19**). At a depth of 0.37 to 0.47 m bs within the profile window, a 0.10 m thick lens of black 10YR2/1 clayey silt was noted. Contained within this same lens, 0.15 m east of the profile window, were a few fragments of bone. Based on the lens color and the presence of bone, this was interpreted as the burial pit identified within the previous test unit. The base of the burial pit possesses an abrupt smooth break with the underlying massive silt C-horizon, indicating that the pit had been excavated into the underlying stratum. The C-horizon was a 10YR7/2 light gray, with a 10YR4/3 brown root disturbance transecting the profile window at a depth of 0.55 to 0.60 m bs. The C-horizon's color and texture observed in the profile window was identical to that noted within the background cores. An additional core, Core 54, was placed 0.40 m from the profile window (**Figure 5.18**). This core produced almost identical strata as those observed within the profile window (**Appendix A:171**).

The 10YR2/1 black stratum is interpreted as being the same burial pit observed during the 1993 unit excavation. The fragments of bone were too small to positively identify as human, but given their placement with the stratum they were interpreted as such. The depth of the proposed burial is approximately 0.15 m higher than that noted in the 1993 excavations. This discrepancy is believed to relate to the fact that the surface of the shelter begins to fall at the talus edge, making the position of the core and profile window slightly lower than the position of the previous test unit. Even with the height discrepancy, the feature matrix color, thickness of the feature, and presence of bone all correspond to the aspects noted during the 1993 excavations, appearing to corroborate the interpretation that this stratum is the burial pit.

Samples were collected from the feature locale, as well as from the overlying A-horizon and underlying C-horizon strata (**Appendix A:171**). Samples from the background cores were taken from the lowest A-horizon strata and from the underlying C-horizon (**Appendix A:171-172**). The average depth of samples were taken from above and either at or below the depth of the burial. These depths were believed adequate to

characterize the background soil strata contained within the shelter. Results of the chemical samples are addressed in **Chapter 7**.

SITE 41BL780

Rockshelter A Site 41BL780:

Aspect of shelter opening: West

Shelter dimensions (LxWxH): Approx. 16 m x 7 m x 1.5 m

Talus development: Yes

Cultural affiliation: Archaic

Presence of known burials (depth): No

Presence of known non-burial features (depth): No

Extent of site disturbance: Minimal (approximately 7 percent)

Investigation techniques: Laser field scanner, Resistance, Magnetometry

Site 41BL780 consists of a series of three rockshelters (A, B and C) that lie along an escarpment edge that faces west, overlooking the Cowhouse Creek valley and a portion of Belton Lake. The shelters are linked together by a 2 to 3 m tall rock face that extends along the majority of the escarpment. A gradual talus slope extends away from the shelters. Steeper drainage ravines that run into Belton Lake dissect the talus slope.

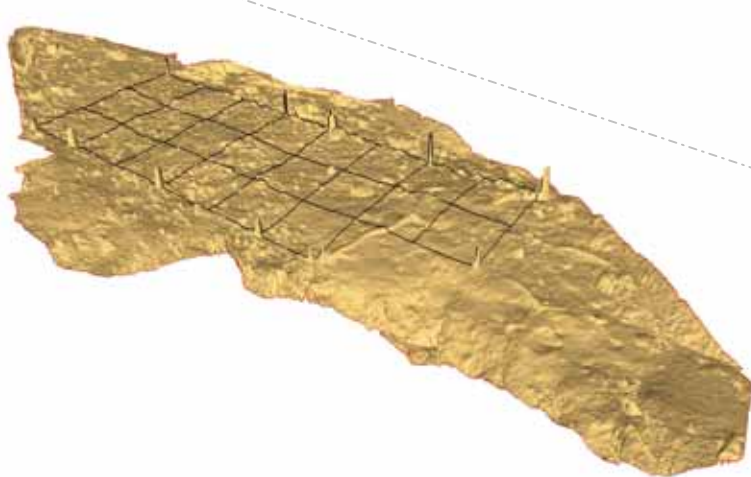
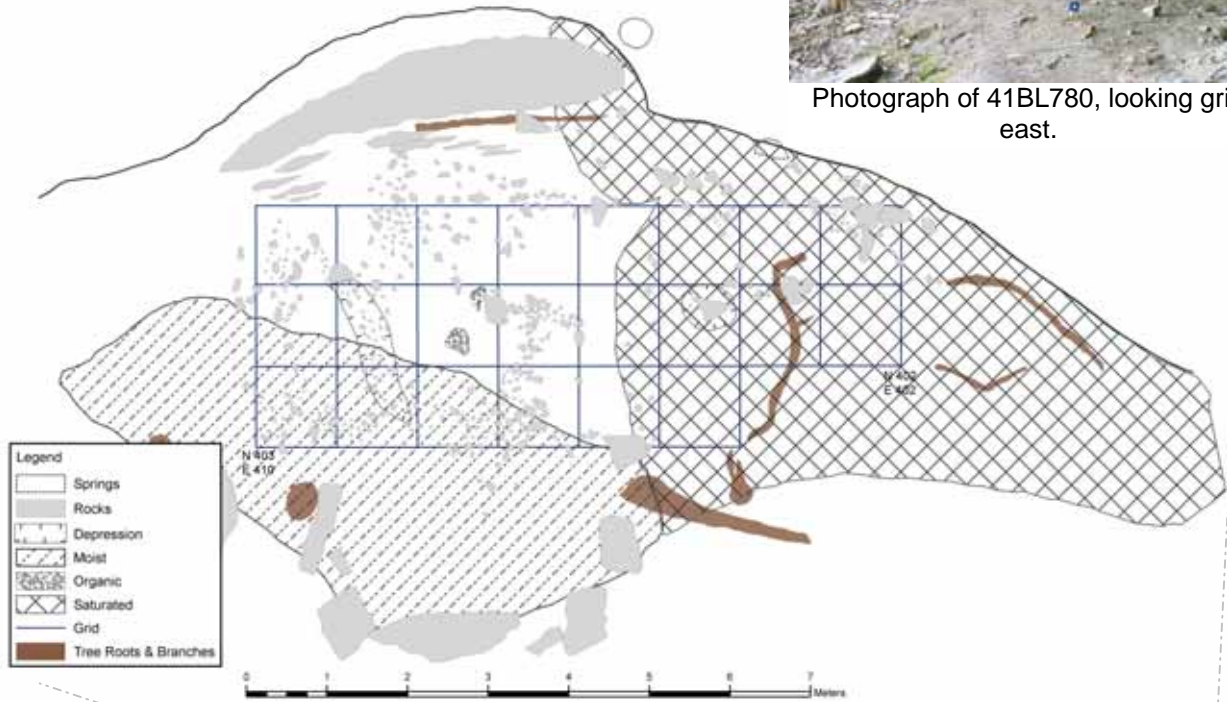
One of the drainage ravines that dissect the broad talus slopes begins along the western edge of Shelter A. A seep spring flows from two conduits along the back wall of the shelter, keeping the majority of the western end saturated throughout the year (**Figure 5.21 and 5.22**).



Figure 5.21. Photograph of 41BL780, looking grid east.



Photograph of 41BL780, looking grid east.



3D Image of 41BL780, looking grid southeast.



Site Location:
Fort Hood

Figure 5.22. Site map of 41BL780, Rockshelter A Plan view.

The site was first recorded during the 1984 field season by Carlson et al. (1987). Surface inspection of the three shelters identified a range of lithic artifact types including: Type I and III bifaces, biface scapers, blanks, retouched flakes and blades, cores, hammerstones, choppers, flakes and manos. In addition to these artifacts, charcoal, bone, mussel shell and moderate amounts of fired rock were also noted within the shelter and talus deposits. The only diagnostic artifacts collected included three untyped dart points, classifying the site as General Archaic (Carlson et al. 1987).

High artifact density was observed on the surface of the western section of shelter A and shelter B, consisting of lithics, charcoal, shell, and bone. These areas of high artifact density corresponded to portions of the shelter that have undergone substantial amounts of vandalism demarcated by deep looter holes. Assessment of the eastern section of Shelter A indicated a much-reduced amount of similar cultural material on the surface. The reduction of surface material was interpreted to indicate that the shelter had experienced minimal or no vandalism, making it of primary importance to the current investigations.

41BL780 Geophysical Survey

All of the shelters chosen for investigation within the project had at least one confirmed cultural feature or burial identified during previous excavations. It was determined that one additional rockshelter should be added that had undergone no previous archaeological investigations to act as a test case for the effectiveness of the geophysical survey and interpretations.

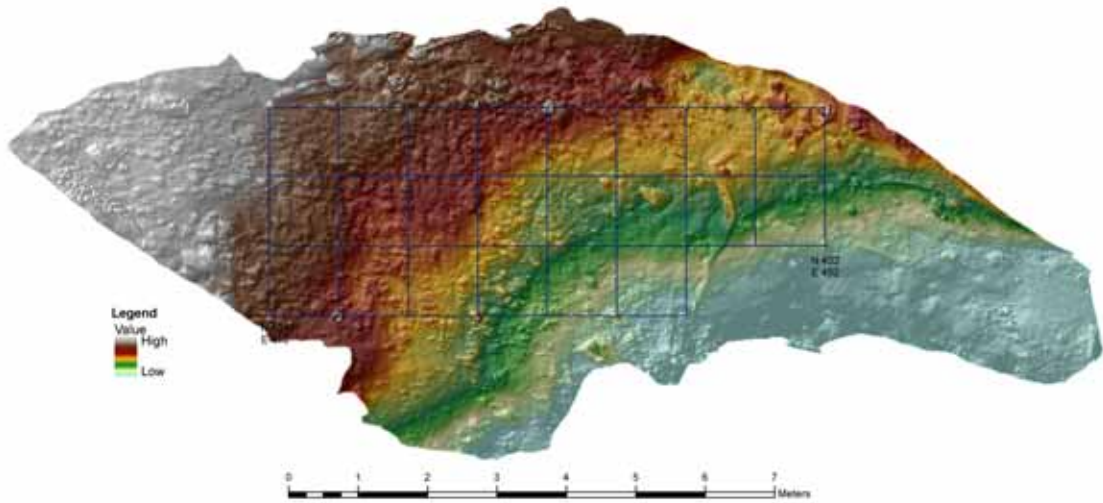
Rockshelter A at site 41BL780 was chosen for investigation for two main reasons. First, it appeared to have excellent potential to contain intact prehistoric features. Surficial observations of the shelter indicated a limited amount of cultural material on the surface, indicative of a shelter that had experienced minimal, if any, modern disturbance. Secondly, the shelter appeared to have a minimum of at least 0.50 m of soil deposits, certainly sufficient to contain cultural features.

A 5 m wide by 9 m long grid was established across the majority of the rockshelter (**Figure 5.22**). The grid extended from the backwall and large piece of roof fall lying along the back of the shelter to the talus edge.

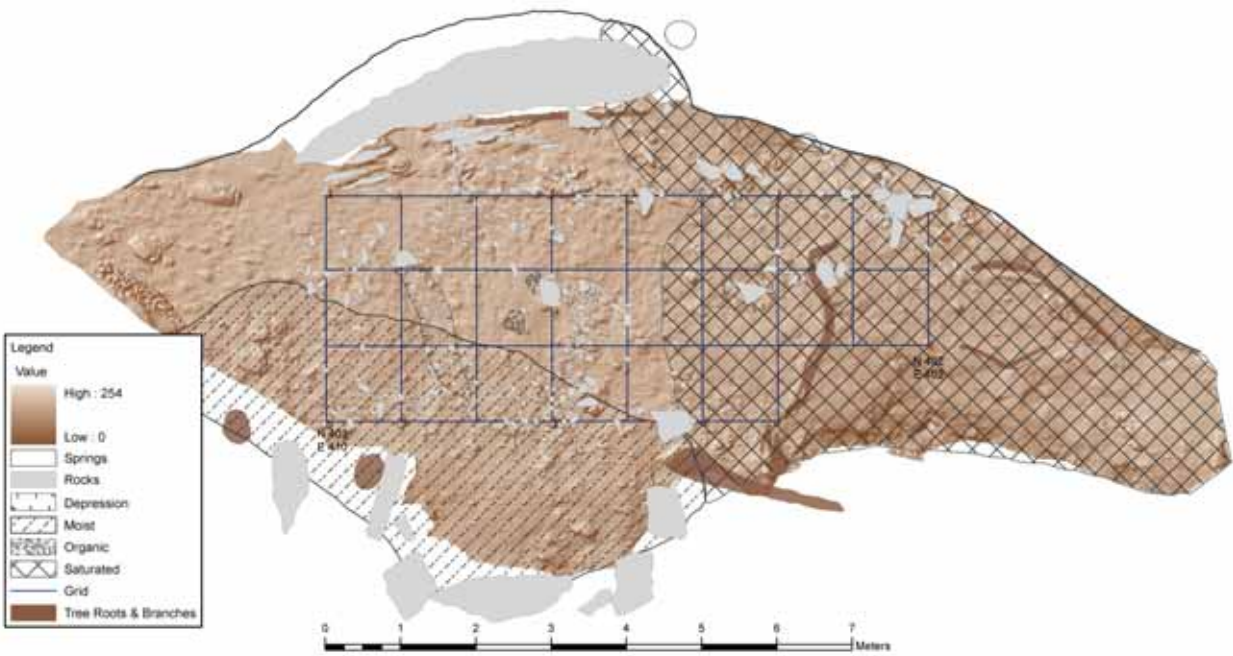
The roof height, ranging from approximately 1.5 m at the dripline to an average of 0.75 m in height within the shelter, made collection of the geophysical surveys difficult but not impossible (**Figure 5.23**). A magnetometer, three resistance meter surveys at 0.25, 0.50 and 0.75 m spacing, and a laser field scan were completed at the site (**Figure 5.24, 5.25 and 5.26**). All five of these surveys used the standard methodology proposed for rockshelters defined previously in **Chapter 3**. The southern end of the shelter contained an active seep spring that made this portion of the shelter extremely wet. The difference in soil moisture is obvious within all three of the resistance surveys, demarcated by a very conductive line running across the collection grid at approximately the E406 line (**Figure 5.25 and 5.26**).



Figure 5.23. Photographs of geophysical survey at 41BL780.

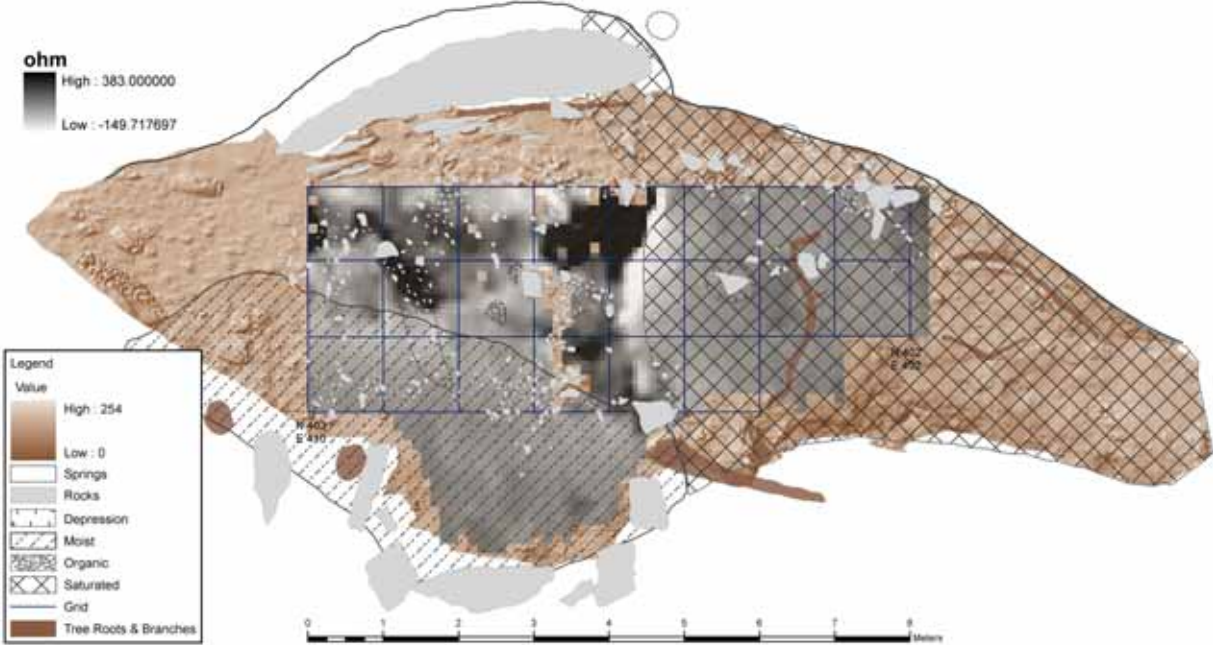


Laser Field scanner created DEM of 41BL780

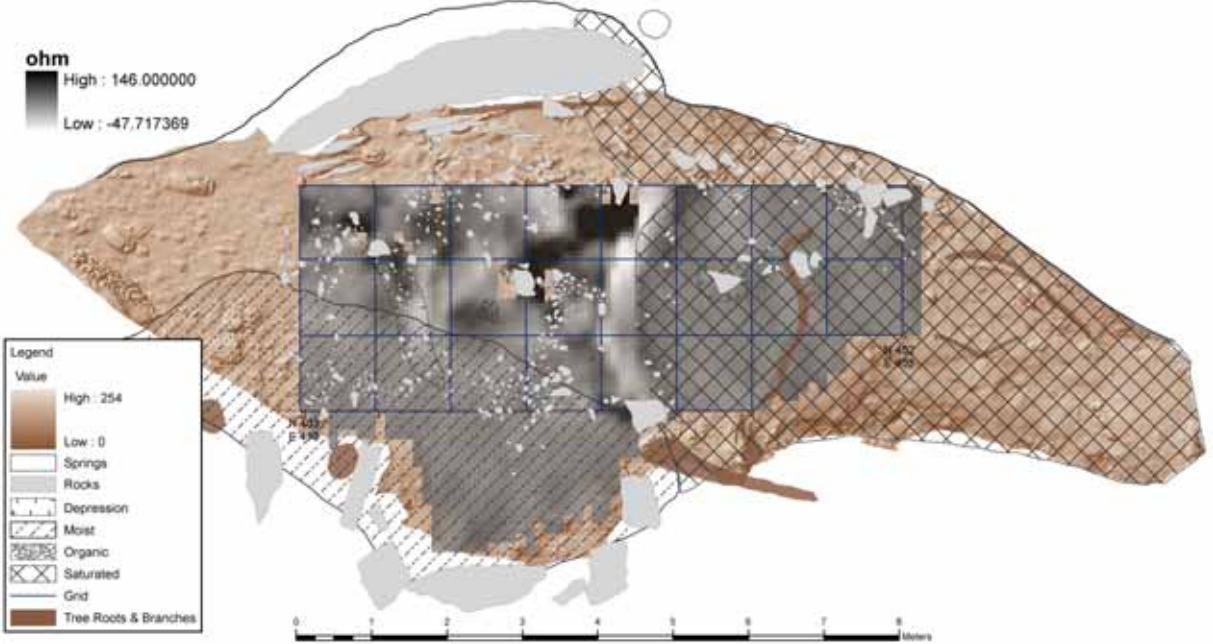


Hillshade relief map of Laser Field scanned DEM

Figure 5.24. Laser field scan DEM of 41BL780.



Resistance data, 0.25 m spacing



Resistance data, 0.50 m spacing

Figure 5.25. Electrical resistance survey results from 41BL780.

Non-Invasive Burial Determination

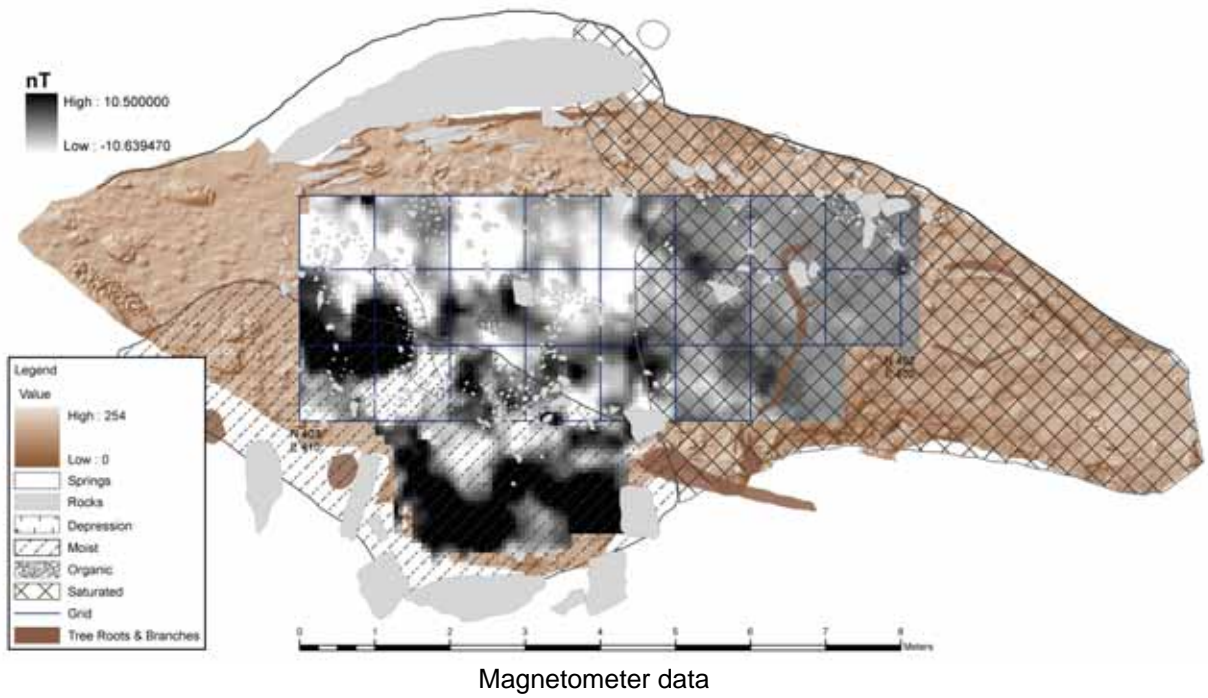
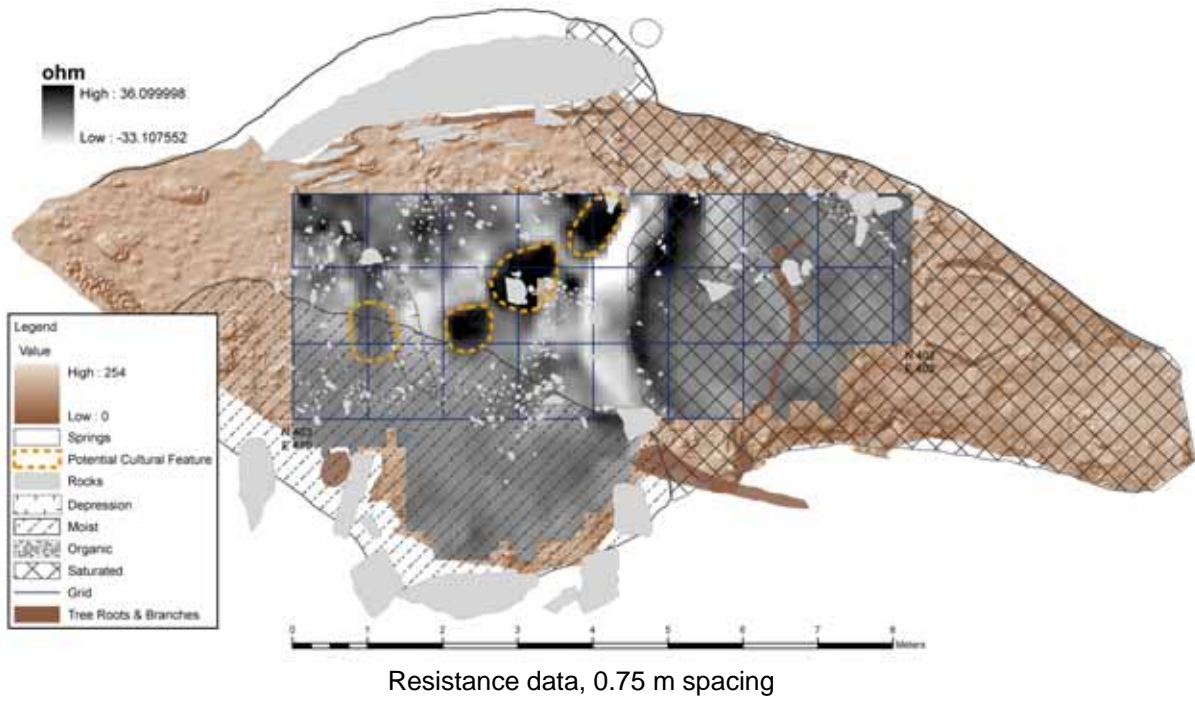


Figure 5.26. Electrical resistance and magnetometer results from 41BL780.

It was determined that two anomalies would be identified and tested within the 41BL780 shelter. Anomaly 1 was identified primarily within the 0.75 m resistance surveys (Figure 5.26). This anomaly was one of a string of high resistance anomalies that run along the center of the shelter. Data collection in this area noted a large concentration of limestone roof slabs. Assessment of the magnetometer data indicated low magnetic readings corresponding to the high resistant anomaly, interpreted to indicate that low-magnetic limestone was predominant in this location (Figure 5.27). The magnetometer also contained a high magnetic anomaly that formed a crescent around the low magnetic limestone slab signature. It was believed that this crescent shape was indicating a more magnetic A-horizon filled pit

capped by less magnetic limestone rock (Figure 5.27). Assessment of the field scan data indicated a subtle depression to the east of the surficial rock concentration (Figure 5.24).

Anomaly 2 was identified as a high magnetic anomaly, averaging between 6.0 and 7.0 nT, within the magnetometer data (Figure 5.27). Assessment of the resistance survey data did not indicate any anomalous signature in the location (Figure 5.25 and 5.26). The signature was interpreted as a possible prehistoric hearth with few limestone rock inclusions (Figure 5.27). The laser field scanner data did not indicate any sort of subtle depression in the area of the possible hearth anomaly (Figure 5.24).

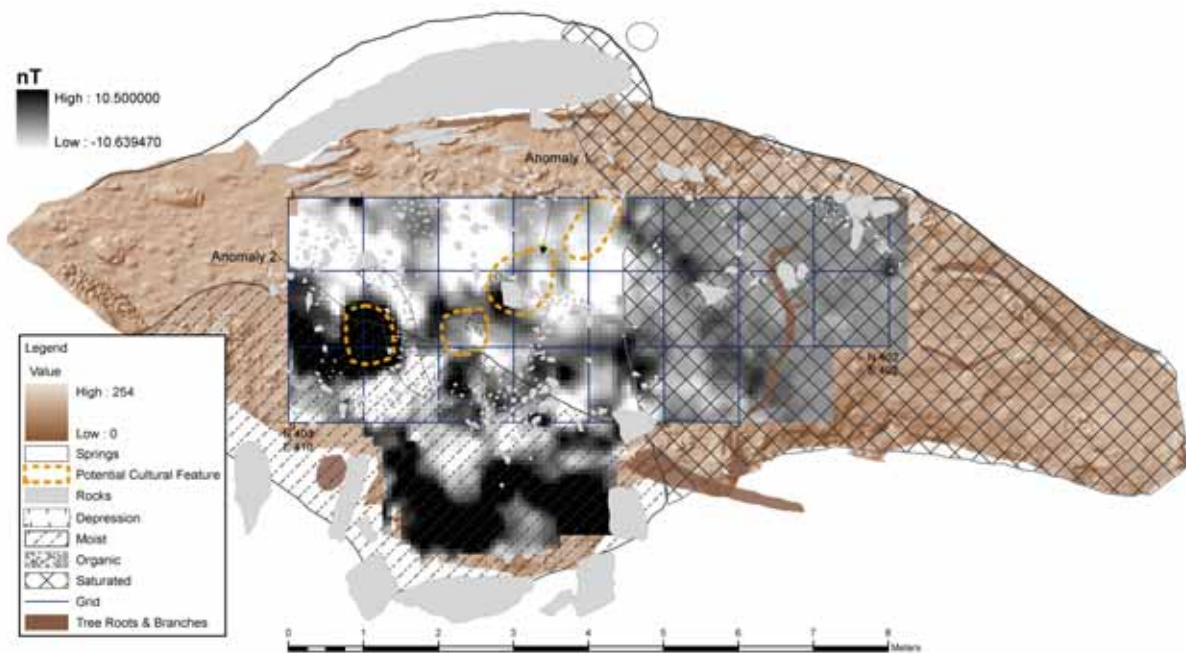


Figure 5.27. Interpretation of potential cultural features from 41BL780, overlaid on the magnetometer data set.

41BL780 Archaeological Investigations

The archaeological investigations at 41BL780 were focused on the two excavation units determined through the geophysical survey. In addition to these excavation units, a series of eight core samples were completed across the site to provide background soil characterization for soil samples collected from each excavation unit. The results of the background coring are discussed prior to the archaeological excavations in order to offer an understanding of the soils at the site.

Core Samples

A total of eight cores were placed across the site (**Figure 5.28**). These cores, as with the previous sites, were placed in areas that appeared culturally sterile based on the assessment of the geophysical results. A complete list of all of the core logs and samples recovered from these background cores can be found in **Appendix A** on pages 172 and 173. The background cores indicated that in general only two horizons exist at the site: an A-horizon and a C-horizon. The depths and characteristics are not consistent across the site due to changes in isolated organic content and differential amounts of rock inclusions.

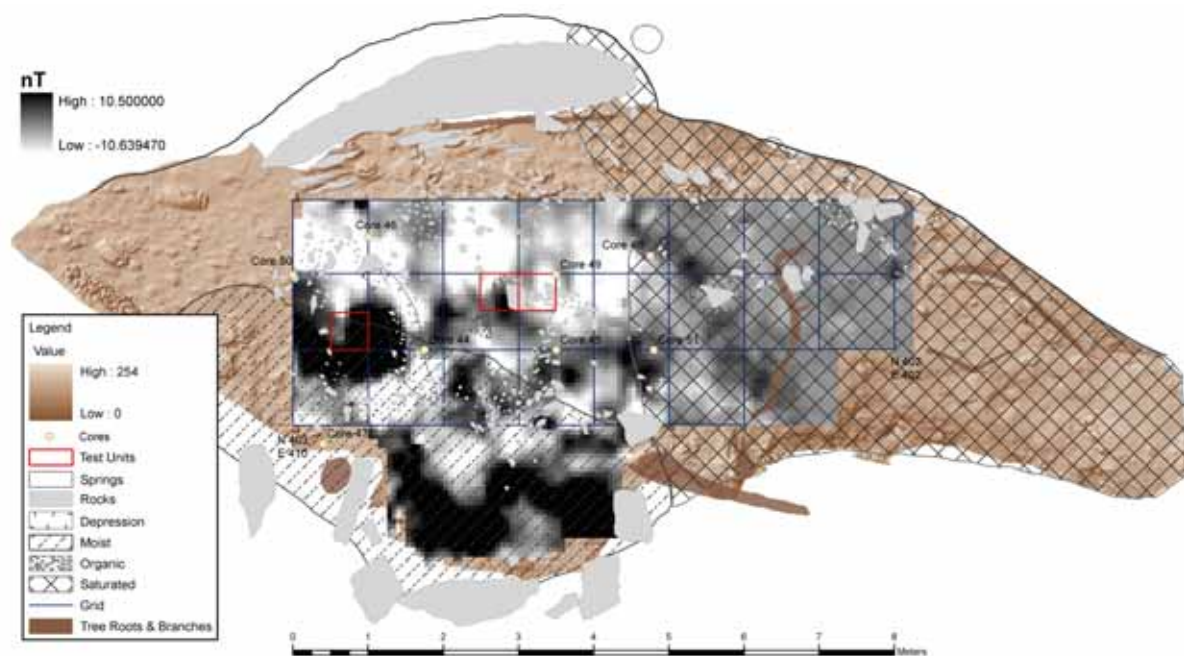


Figure 5.28. Placement of cores and test units at 41BL780, overlaid on the magnetometer data set.

All of the cores contained a surficial A-horizon stratum. These strata range in characteristics from a 10YR2/1 black granular silty clay to a 10YR3/2 very dark grayish brown silty clay. The depth of this surface A-horizon ranged from 0.09 m bs in Core 49 to as deep as 0.20 m bs in core 50 (**Appendix A:172-173**). Five of the cores (44, 45, 47, 48, and 51) have a second A-horizon stratum below the surficial A-horizon. These second A-horizon stratum ranged in characteristics from a 10YR2/1 black to a 10YR4/2 dark grayish brown granular silty clay. The majority of these terminated at bedrock or a rock impasse at an average depth of 0.22 m bs. Core 51 contains this second A-horizon stratum to a depth of 0.22 m bs, which is underlain by a 10YR6/2 light brownish gray C-horizon extending to a rock impasse at 0.28 m bs (**Figure 5.29**). It is probable that all of these cores that contain the two A-horizon strata probably did not reach sufficient depth to impact the deeper C-horizon deposits.

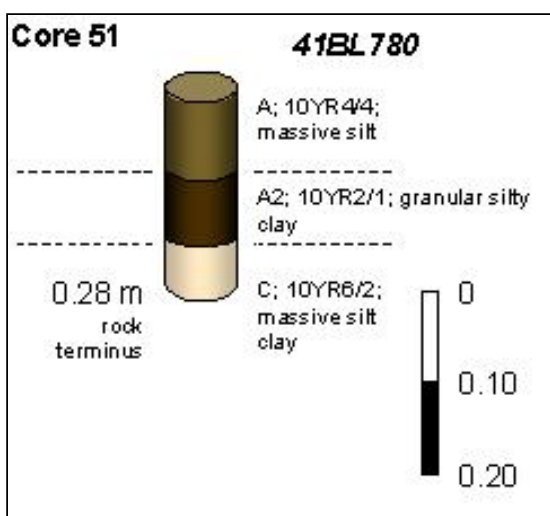


Figure 5.29. Representative soil core profile from 41BL780.

Cores 46, 49 and 50 possessed only a single A-horizon stratum underlain by either an AC or C-horizon (**Figure 5.28**). Cores 46 and 49 had a 10YR2/1 black granular silty clay A-horizon, which is typical of cores placed in the central section of the shelter, but the A-horizon in Core 50 was a 10YR3/3 dark brown granular silty clay (**Appendix A:172**). Based on these coring results, it appears that the A-horizon has been organically enriched, probably by prehistoric occupation of the shelter, diagonally through the grid from approximately Core 47 to Core 48. This corresponds to the majority of the potential cultural anomalies identified within the magnetometer and resistance

data sets. These three cores' A-horizons are underlain by massive silty clay C-horizons that range in color from 10YR4/4 dark yellowish brown to 10YR6/2 light brownish gray to a 10YR6/6 brownish yellow (**Figure 5.29**). The alterations in color are attributable to differences in organic content within the surficial A-horizon, rock content and location within the shelter.

Soil samples from the background cores were taken from each of the identified strata (**Appendix A:172-173**). These samples were believed to be adequate to characterize the soils across the site. Results of the chemical samples are addressed in **Chapter 7**.

Test Unit Investigations

A total of two anomalies were identified for testing at 41BL780. The first anomaly was defined within the magnetometer data set as a high monopole anomaly (**Figure 5.26**). Test Unit 1 was placed so as to lie along the southern edge of the anomaly (**Figure 5.28**). The second unit focused on an anomaly that possessed both a high resistance and magnetic signature in the center of the shelter. Test Units 2 and 3 were placed across the center of this anomaly (**Figure 5.28**).

Test Unit 1 measured 0.50-x-0.50-m with its southwest corner located at N401.50 E409.00. Excavation of Test Unit 1 was completed in 0.05 m arbitrary levels within greater natural strata (**Figure 5.30**). Level 1 consisted of a 10YR2/2 very dark brown granular silty clay with a few rock inclusions (approximately 2%) along the southern edge of the unit. The level produced 19 pieces of debitage, 6 pieces of shell and 8 pieces of bone. Charcoal flecking increased at the base of the level from 0.04 to 0.05 m bs. The charcoal flecking noted at the base of Level 1 increased in Level 2 causing the soil color to darken to a 10YR2/1 black across the northern portion of the unit. Along the south wall the soil remained a lighter 10YR2/2 very dark brown. Soil structure became denser changing to massive silty clay with approximately the same amount of rock percentage as the level above. The level produced 36 pieces of debitage, 10 pieces of shell and 1 bone fragment. Level 3 possessed identical characteristics as Level 2 with the exception that the lighter soil along the south wall continued to increase in width across the floor. Artifact counts decreased to 19 pieces of debitage and 2 shell fragments, all of which were recovered from the darker 10YR2/1 black portion of the unit.

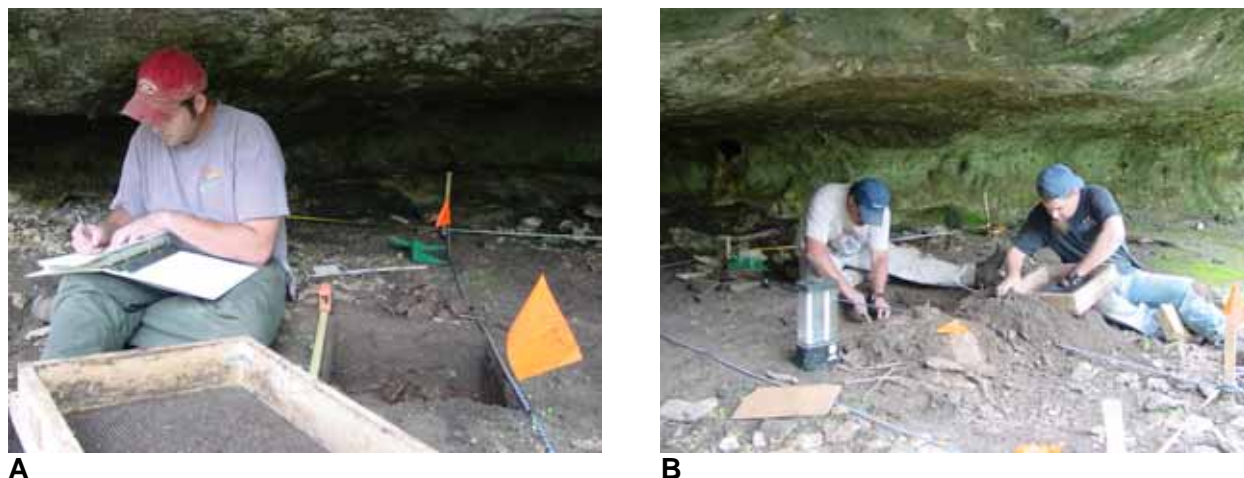
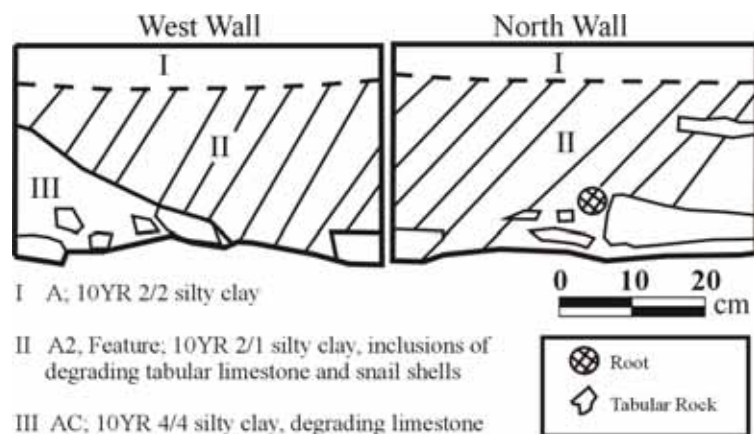


Figure 5.30. Excavations of test units at 41BL780, (A) Test Unit 1, (B) Test Unit 2.

Level 4 in Test Unit 1 showed substantial change compared to the past two levels. The northern portion of the unit continued to consist of 10YR2/1 black massive silty clay but charcoal concentrations decreased to almost none. Rock inclusions increased substantially, both in number and size, consisting of as much as 25 percent of the matrix. A total of 8 pieces of debitage and 1 shell fragment was recovered from the level. The lighter soil noted along the southern edge of the unit began to form a distinct edge, running diagonally across the unit (Figure 5.31). This lighter soil, a 10YR4/4 dark yellowish brown, appears to be an unaltered AC-horizon with at least 20 percent limestone rock inclusions. The

definition of an edge to the 10YR2/1 black matrix was interpreted to indicate that the black matrix was in fact feature fill. The excavation of Level 5 confirmed this interpretation. The diagonal line between the feature and the AC-horizon increased north, indicating that the feature base was dipping to the north. At the base of the level, large pieces of roof fall were noted across the majority of the northern portion of the unit (Figure 5.31). These rocks appear to form the base of the feature, constituting from 70-80 percent of the unit floor. The feature matrix produced a total of 10 pieces of debitage and 2 pieces of shell. Given that the base of the feature was determined the excavation of the unit was terminated.



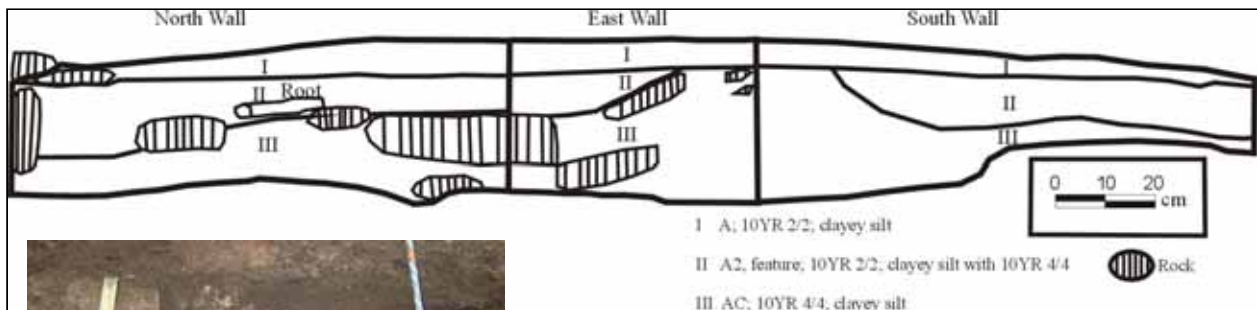
Photograph of Test Unit 1 floor, looking grid east.

Figure 5.31. Photograph and wall profiles of Test Unit 1 (Feature 1) at 41BL780.

Test Unit 2 measured 0.50-x-0.50-m with its southwest corner located at N401.00 E407.00. Excavation of Test Unit 2 was completed in 0.05 m arbitrary levels within greater natural strata (**Figure 5.30**). Level 1 was characterized as a 10YR2/2 very dark brown silty clay with several large slabs of roof fall lying along the western edge of the unit. A total of 22 pieces of debitage, 6 shell fragments and 4 pieces of bone were recovered from the level. The edge of a feature was noted within the excavation of Level 2. The 10YR2/2 very dark brown matrix formed a distinct diagonal line across the unit extending from the east wall to the south, and became mottled with 10YR4/4 dark yellowish brown silty clay. The soil contained in the southeast corner of the unit was the same 10YR4/4 dark yellowish brown AC-horizon noted in the excavation of unit 1. The feature portion of the unit contained large rock slabs within and over the feature locale, as well as 23 pieces of debitage. Some charcoal was noted within the feature matrix. Level 3 saw the termination of the feature at the base of the level

(**Figure 5.32**). The feature stain terminated at a series of large rock slabs that extended into the western wall. Artifacts recovered from the level came solely from the feature fill, consisting of 7 pieces of debitage and 8 shell fragments. The large slabs of rock noted at the base of Level 3 were pulled and a final 0.10 m thick level excavated into the underlying AC deposits (**Figure 5.32**). Level 4 produced no cultural material. The excavation of the unit was terminated.

The excavation of Test Unit 2 impacted only a limited portion of a shallow basin that contained a substantial amount of large rock slabs. The rock slabs appeared to cap the feature along the western wall of the unit. The rock cap appeared similar to that noted in the burial excavation at 41BL69. Based on the possibility that the feature may contain a burial, an additional 0.50-x-0.50-m unit was placed west of Test Unit 2, producing a 0.50-x-1.0-m contiguous unit (**Figure 5.28**).



Photograph in plan of base of Feature 2, looking grid north.



Photograph of west wall profile and floor of Test Unit 2, looking west toward Test Unit 3.

Figure 5.32. Photograph and wall profiles of Test Unit 2/3 (Feature 2) at 41BL780.

Level 1 in Test Unit 3 was very similar to that described in unit 2. The rock cap in this unit was slightly more substantial than that removed within Level 1 in Test Unit 2. The level produced 33 pieces of debitage, 1 complete projectile point, 7 shell fragments, and 1 piece of bone. The projectile point was identified as a possible Fresno point, placing it within the Late Prehistoric (1100-500 BP) time period (**Figure 5.33**). Level 2 consisted of the feature fill noted in Test Unit 2. The only noticeable difference was that the rock size was reduced in comparison to those observed within Test Unit 2. The feature produced 33 pieces of debitage, 4 shell fragments and 3 pieces of charcoal. The base of the feature was noted within Level 3 (**Figure 5.32**). Rock content and size continued to increase within the feature to the base of the stain. The feature produced 31 pieces of debitage, 3 shell fragments and 1 piece of charcoal. A final 0.05 m level was excavated into the underlying AC-horizon. Rock content and size increased throughout this level, constituting from 40-60 percent of the overall matrix (**Figure 5.32**). Level 4 produced no cultural material.



Figure 5.33. Fresno projectile point recovered from Feature 2, shown in plan and profile. (illustration scale of 1:1)

Feature 1 recovered in Test Unit 1 appears to be a basin hearth, based on the amount of charcoal noted throughout the feature matrix. The feature produced a total of 91 pieces of debitage, 21 pieces of shell and 9 pieces of bone. Specific analysis was not completed of the shell or bone fragments. The feature did not produce any diagnostic material, and as such no temporal or cultural period can be determined. A total of three soil samples were collected from each of the strata identified within the feature profiles and labeled Core 52, N402.00 E409.15 (**Appendix A:173**).

Feature 2 recovered in Test Units 2 and 3 appears to be a shallow ovoid basin, with a partial rock cap. The feature produced a total of 149

pieces of debitage, 28 shell fragments, 4 pieces of bone and 1 projectile point. As with Feature 1, no specific analysis was completed of the shell or bone fragments. The projectile point was identified as a possible Fresno point dating the feature to the Late Prehistoric period (1100-500 BP). The point was located in Level 1 above the main feature matrix, and as such its association with the feature is not direct. It is probable that the material recovered from above the feature within Level 1 is associated with the creation of the feature, and as such the projectile point is interpreted as associated with the feature, providing a tenuous date for the feature to the Late Prehistoric. A total of three soil samples were collected from each of the strata identified within the feature profiles and labeled Core 53, N401.00 E407.10 (**Appendix A:173**).

SITE 41BL844

Rockshelter B Site 41BL844:

Aspect of shelter opening: West

Shelter dimensions (LxWxH): 15 m x 5 m x 1.6 m

Talus development: Yes

Cultural affiliation: Unknown

Presence of known burials (depth): Yes (25-30 cm bs)

Presence of known non-burial features (depth): Yes (0.20-0.50 m bs)

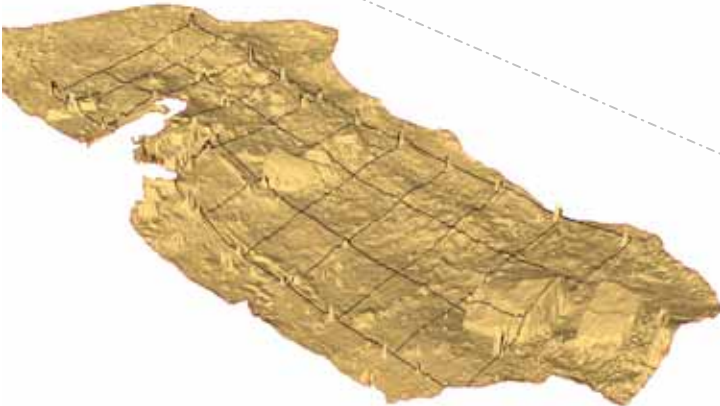
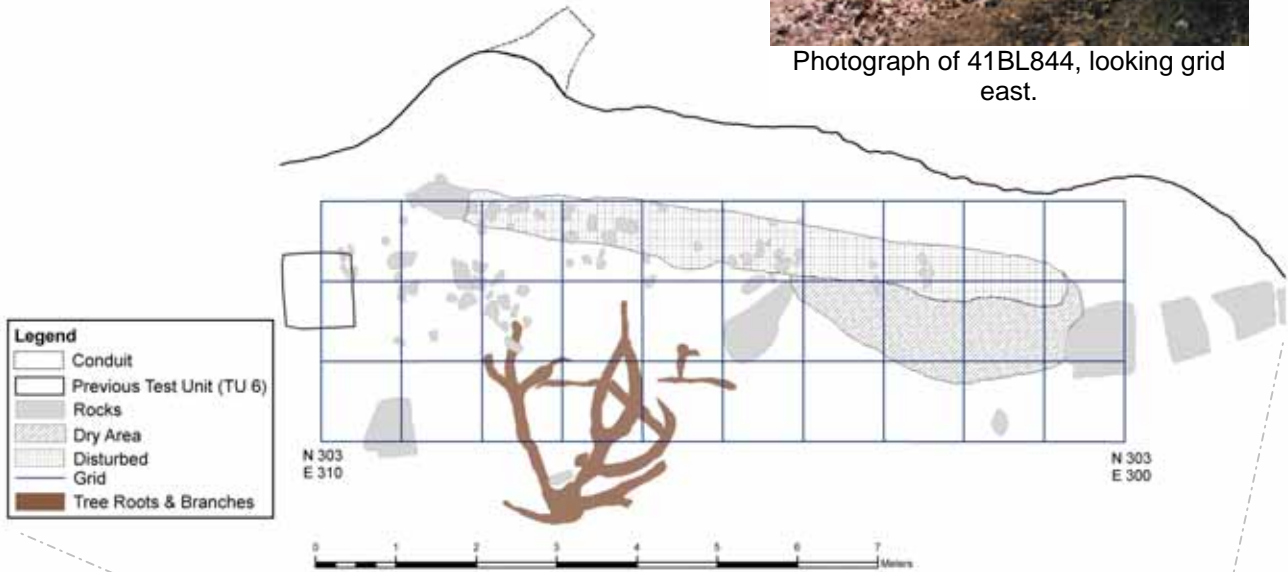
Extent of site disturbance: Minimal (approximately 10% due to looting)

Investigation techniques: Laser field scanner, Resistance, Magnetometry

Shelter B is one of five shelters (including A,B,C, D, and E) that compose site 41BL844 (Figure 5.34). The shelter is approximately 15 m long, 5 m deep and has a maximum height 1.6 m, though the roof is much lower in many parts of the shelter making standing impossible. The shelters occur along a deeply inset drainage that runs northwest towards a confluence with North Nolan Creek. The drainage valley is very constricted averaging less than 50 m wide. Shelters occur at different elevations along the drainage, with Shelter B located at the top of the slope into the drainage. The placement of the shelter in relation to the drainage indicates the majority of soil deposits within the shelter have been created by limestone reduction or roof fall and erosional deposits from the surrounding upland.



Photograph of 41BL844, looking grid east.



3D Image of 41BL844, looking grid southeast.



Site Location:
Fort Hood

Figure 5.34. Site map of 41BL844, Rockshelter B Planview.



A



B

Figure 5.35. Photographs of 41BL844, looking grid west (A) and grid south (B).

Two conduits occur along the backwall of the shelter. These conduits, as well as surface runoff keep the majority of the shelter moist throughout the year. A few dry patches were noted during initial observations, but these were limited. A large tree was located in the shelter's dripline (Figure 5.35). Roots from the tree did extend into the center of the shelter and the collection grid. These roots acted as a hindrance to survey, and probably have led to disturbance of the archaeological deposits within proximity to the tree.

Approximately 10 percent of the site has been disturbed by looting in the past. The majority of this vandalism has occurred between the talus to the dripline. The deeper portions of the shelter appear to be relatively intact, with disturbances appearing to be no more than surficial. As noted above, portions of the central section of the shelter have been disturbed by root and animal activity.

The site was initially recorded in 1986, consisting of a broad upland lithic scatter that extended to an escarpment edge, and a total of four rockshelters that lay within the escarpment (Koch and Mueller-Willie 1989). This initial survey noted a human femur lying along the back wall of Shelter B. In 1992, the site was tested on a limited basis, a single 0.50-x-0.50-m test unit and additional shovel testing were excavated in Shelter B (Trierweiler 1994). This testing indicated that Shelters A, B and D contained potentially intact cultural deposits.

In 1994, testing was conducted on a larger scale within the three shelters to determine National Register of Historic Places eligibility (Trierweiler

1996). During this testing, a fifth shelter was identified and designated Shelter E. Testing of Shelter B consisted of the excavation of two 1.0-x-1.0-m units. Test Unit 6 was placed inside the eastern end of the shelter, while Test Unit 10 was placed on the western end within the talus deposits. Test Unit 6 appeared disturbed by looting activity, but at a depth of 0.25 to 0.30 m bs human remains were identified within a 0.25 m diameter pit. The context of these remains was suspect due to the potential looting activity noted during the excavations. The remains were reinterred into the unit and backfilled. Test Unit 10 contained a feature measuring 1.00-x-0.60-m and extended from 0.20 to 0.43 m bs. This unit produced over 850 artifacts, with a Scallorn and a Bonham projectile points recovered from within the feature. The feature dates to approximately 800 BP based on the diagnostics recovered (Trierweiler 1996:109).

41BL844 Geophysical Survey

A 3 m wide by 10 m long grid was established across the majority of the rockshelter (Figure 5.34). A baseline was established along the backwall of the shelter and extended grid east to encompass the proposed location of Test Unit 6. A stake labeled "Test Unit 6" remains intact, but it is not known which corner this stake marked within the 1994 excavation. The grid was terminated at this point due to the fact that surface observations and previous archaeological work had indicated that looting had disturbed the eastern end of the shelter.

The roof height of the shelter made collection of the geophysical surveys difficult but not impossible (Figure 5.36). Although approximately

1.6 m at the dripline, the shelter averaged closer to 0.70 m in height within the majority of the collection grid area. The laser field scan of the site was also difficult due to the large tree located in the center of the shelter. The placement of the tree made it impossible to survey some portions of the shelter, leading to voids within the data in the area surrounding the tree. This area of the grid was also difficult to survey with the other

geophysical techniques as well, and as such was excluded from potential testing. A magnetometer, three resistance meter surveys at 0.25, 0.50 and 0.75 m spacing, and a laser field scan were completed at the site (Figure 5.37, 5.38 and 5.39). All five of these surveys used the standard methodology proposed for rockshelters defined previously in Chapter 3.



Figure 5.36. Photographs of geophysical survey at 41BL844.

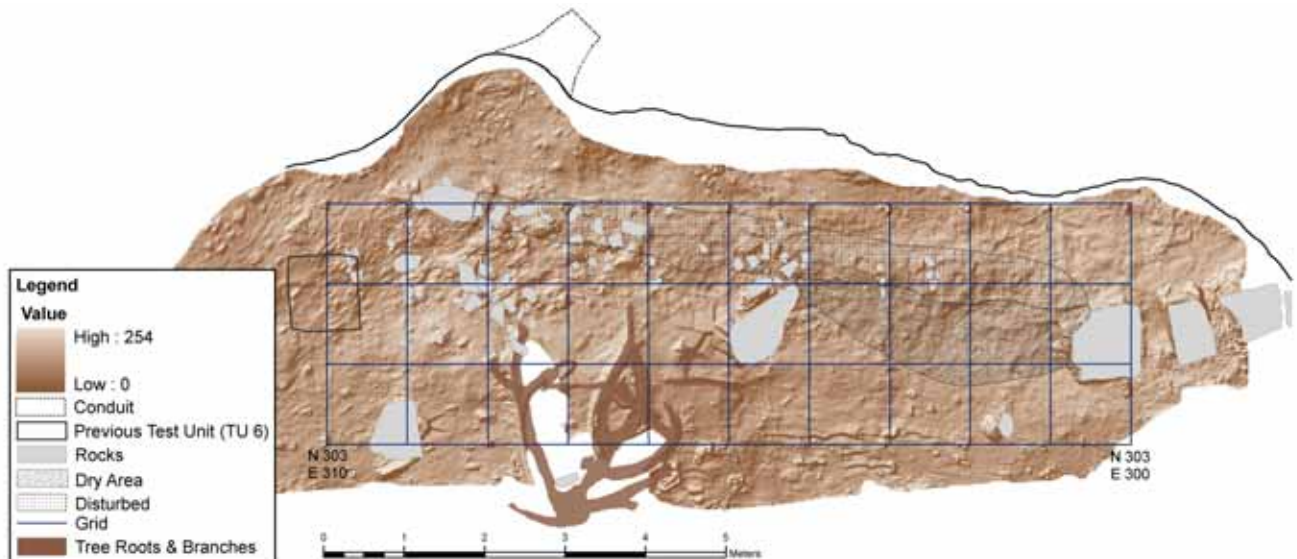


Figure 5.37. Laser field scan DEM of 41BL844.

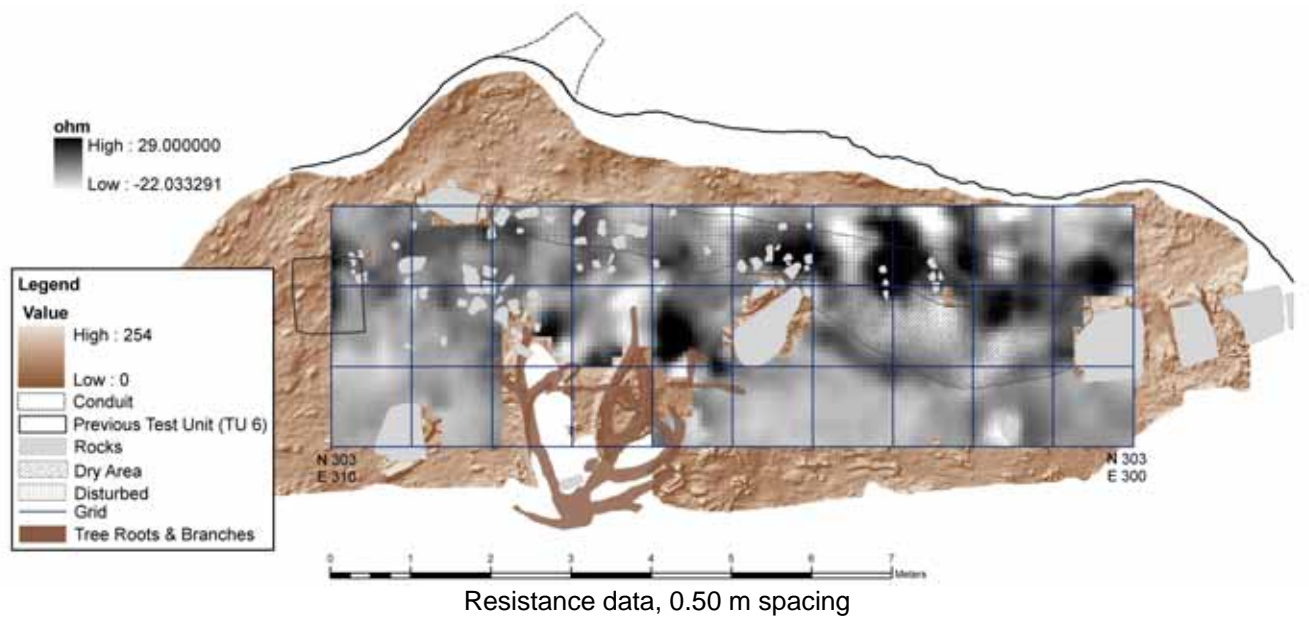
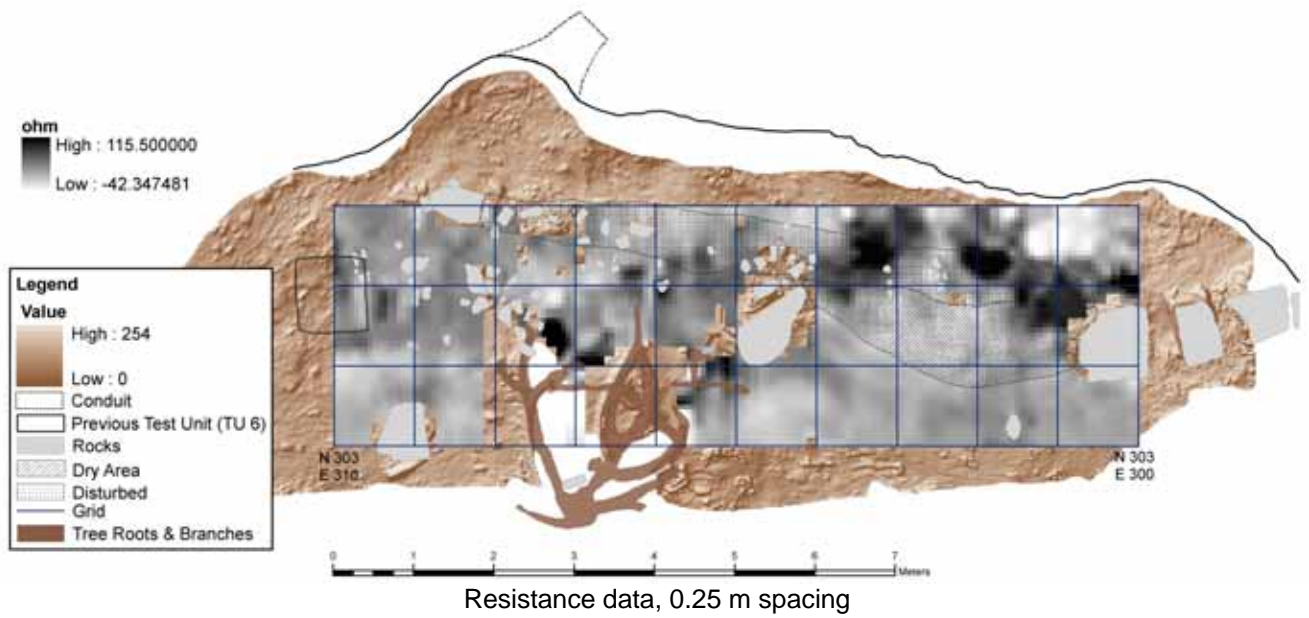


Figure 5.38. Electrical resistance survey results from 41BL844.

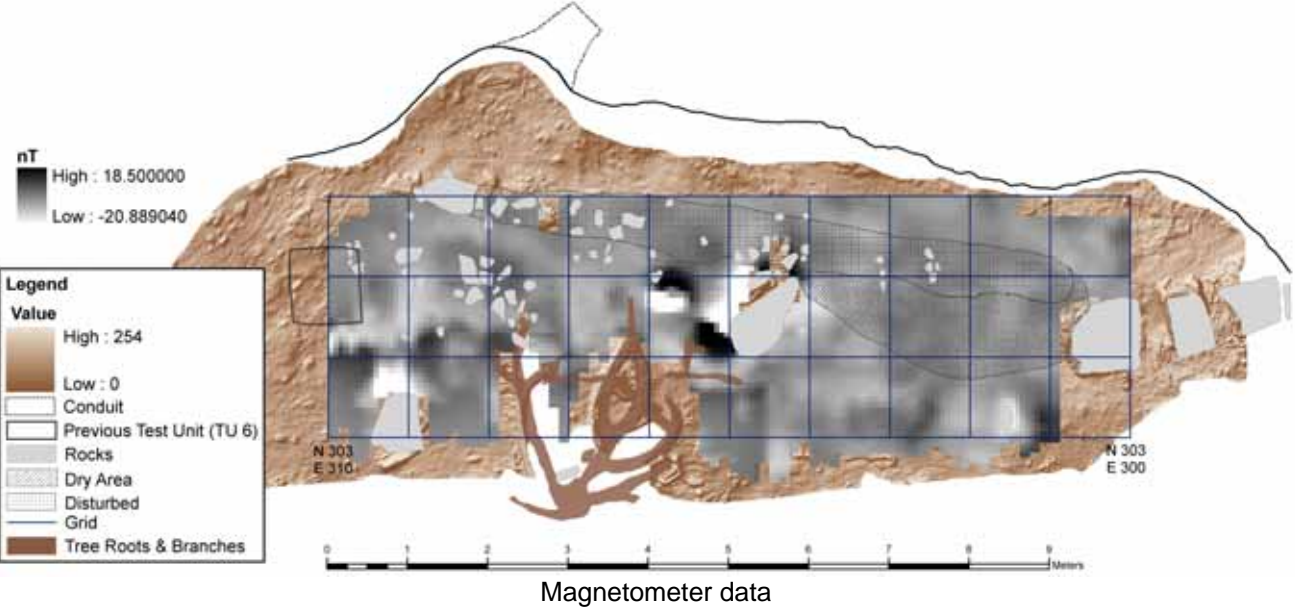
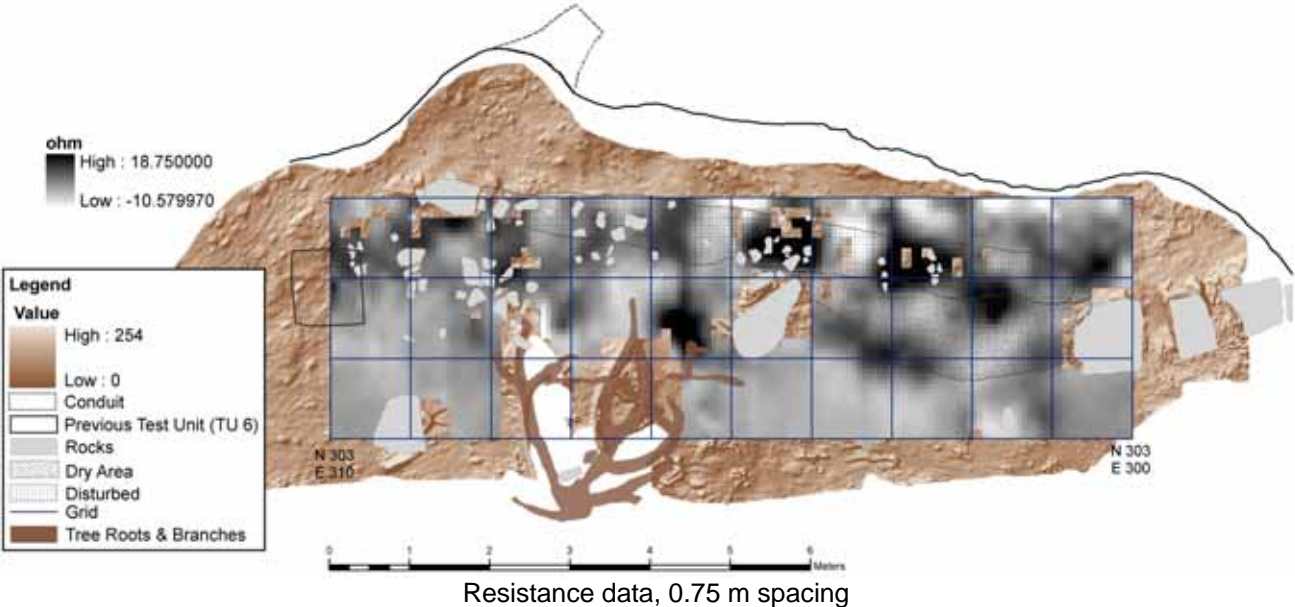


Figure 5.39. Electrical resistance and magnetometer results from 41BL844.

Interpretation of the data indicated a number of potential anomalies within the geophysical data (**Figure 5.38** and **5.39**). The resistance data sets possessed a high degree of variability between corresponding anomalies. Based on this variability, the magnetometer data set was utilized as a means of identifying and focusing the investigations to just a few potential anomalies (**Figure 5.40**).

Based on the identification of human elements during the 1994 investigation, an assessment of the area around the Test Unit 6 stake was undertaken. A subtle magnetic anomaly approximately 0.50 m in diameter was identified directly to the east of the stake. Assessment of the resistance data from the 0.25 and 0.50 m deep surveys contained a high resistance anomaly of approximately the same size as the magnetometer anomaly. Based on the correspondence between the two geophysical methods and the proximity to Test Unit 6, this

anomaly was chosen for testing. Test Unit 1 was placed directly over the anomaly (**Figure 5.40**).

The magnetometer contained two subtle magnetic anomalies along the southern section of the grid (**Figure 5.40**). Both anomalies possessed similar ranges that extended from approximately 1.5 to 5.5 nT. Although the one along the E406.50 line has been obscured by metallic debris, both appear to have an ovoid shape approximating 1.0 m long by 0.75 m wide. Assessment of the resistance data for these two anomalies indicated correspondence only to the anomaly along the E408 line. The 0.50 and 0.75 m deep resistance surveys show anomalies that appear to correspond to the eastern portion of the anomaly (**Figure 5.38** and **5.39**). Based on this correspondence, the anomaly along the E408 line was chosen for investigation. Test Unit 2 was placed along the southern edge of the anomaly with the hopes of finding a definable feature edge (**Figure 5.40**).

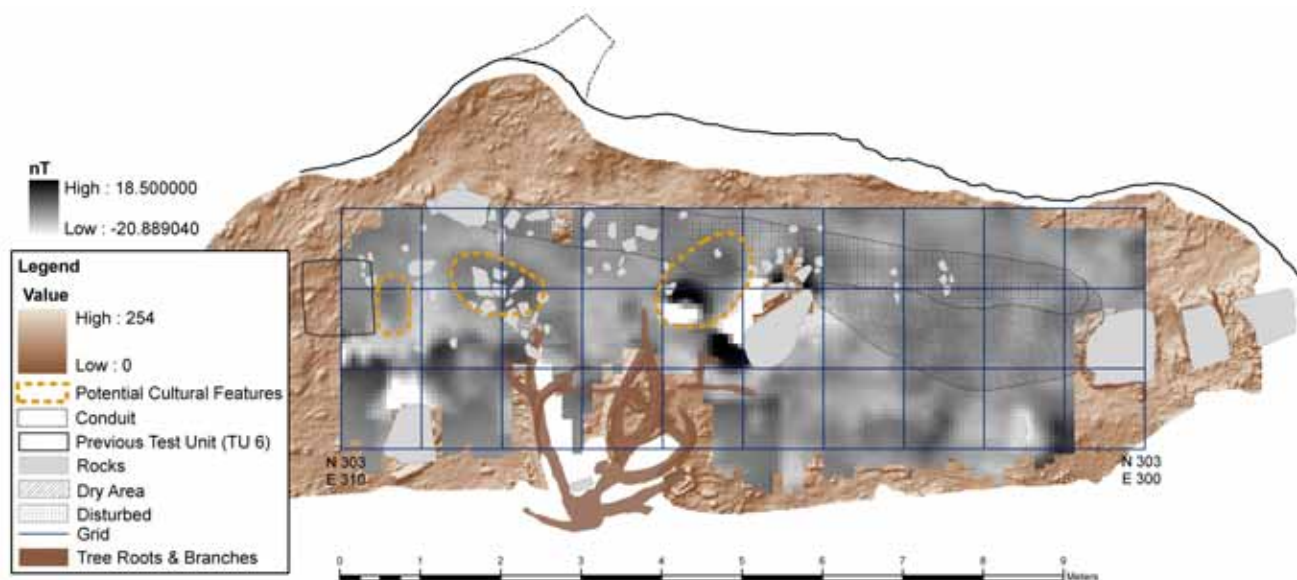


Figure 5.40. Interpretation of potential cultural features from 41BL844, overlaid on the magnetometer data set.

41BL844 Archaeological Investigations

The archaeological investigations at 41BL844 were focused on the two excavation units determined through the geophysical survey. In addition to these excavation units, a series of eight core samples were completed across the site to provide background soil characterization for soil samples collected from each excavation unit (Figure 5.41). The results of the background coring are discussed prior to the archaeological excavations in order to offer an understanding of the soils at the site.

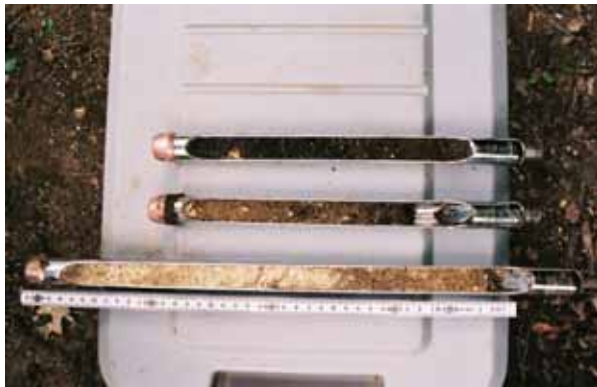


Figure 5.41. Standard background core sample recovered from 41BL844, Core 32 shown with depth increasing from top to bottom.

Core Samples

A total of eight cores were placed across the site (Figure 5.42). The majority of the cores were placed in areas that appeared culturally sterile based on the assessment of the geophysical results. A core was placed south of the collection grid in order to assess the soils in front of a major conduit that drains into the shelter from the back of a small alcove (Figure 5.42). A complete list of all of the core logs and samples recovered from these background cores can be found in Appendix A on pages 173 to 175. The background cores indicated that the shelter deposits were stratified based on placement within the shelter. Those cores, 34, 35, 37 and 39, placed more than 2 m inside the dripline, or deep in the shelter, possessed an A/C stratigraphic sequence (Figure 5.42). Those cores placed within a meter of the dripline, Cores 32, 33, 36 and 38, possessed an A/AB/C stratigraphic sequence (Figure 5.42). The difference in stratigraphy is attributable to difference in sediment sources for the two areas of the shelter.

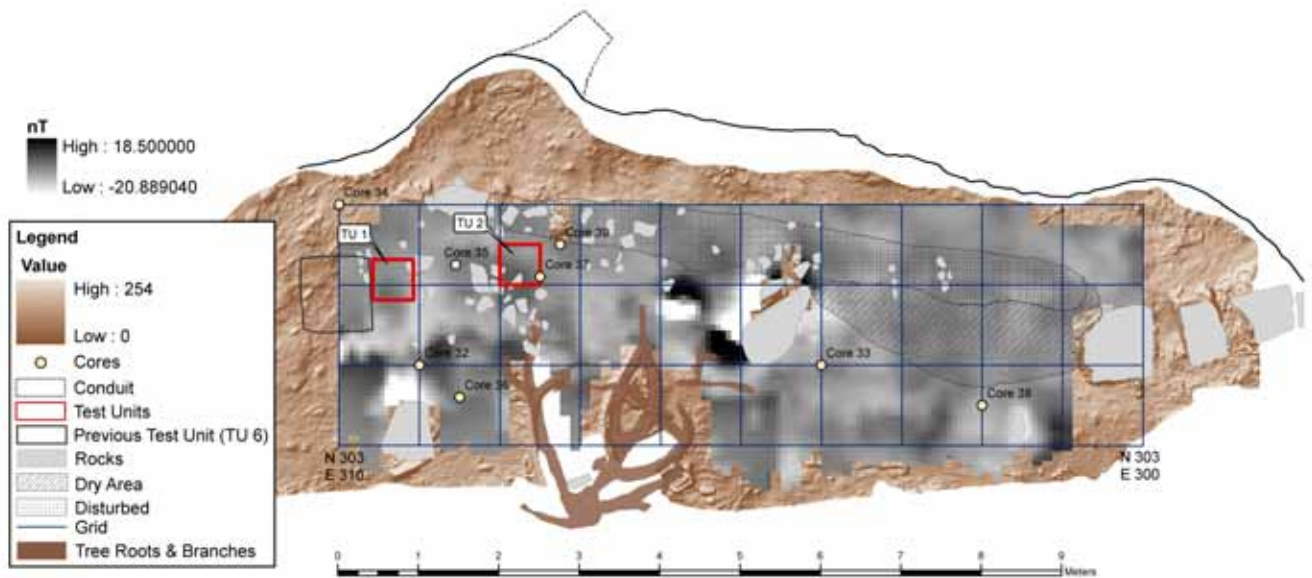


Figure 5.42. Placement of cores and test units at 41BL844, overlaid on the magnetometer data.

The deep shelter core samples possessed a granular silty clay 10YR4/2 dark grayish brown to a 10YR4/4 dark yellowish brown A-horizon that ranged in depth from 0.14 to 0.25 m bs (**Figure 5.43**). This surface horizon was underlain by a 10YR7/2 light gray massive silty clay C-horizon (**Figure 5.43**). Samples into the C-horizon extended to bedrock or rock impasses for all four core samples, with depths ranging from 0.22 to 0.54 m bs (**Appendix A:173-174**). This stratigraphic sequence was interpreted as a standard rockshelter deposit, consisting of degrading limestone and bedrock derived sediments.

The four cores placed around the dripline edge of the shelter contained a variety of surface horizons. The variability between the four cores is attributable to looter disturbance that has led to the stripping of certain areas while other areas have been augmented by soil excavated from looter holes. Cores 32 and 33 possess a surficial granular silty clay 10YR2/1 black to 10YR2/2 very dark brown A-horizon that extends to depth of 0.18 and 0.28 m bs (**Appendix A:173**). It is believed that these two cores represent the relatively undisturbed natural depth of the A-horizon along the dripline edge (**Figure 5.43**). The looting of some areas of the shelter has in some way disturbed the other two cores.

Core 36 contains a series of A-horizons, the first is a 10YR3/2 very dark grayish brown granular silty clay that extends to a depth of 0.21 m bs, and the second is a 10YR2/1 black granular silty clay that extends to a depth of 0.35 m bs (**Appendix A:174**). The first A-horizon is believed to be the result of augmentation from looter fill being moved. The second A-horizon is believed to correlate to the A-horizon noted in Cores 32 and 33. Core 38 does not possess a surface A-horizon, starting instead with the AB-horizon that underlies the other three cores A-horizon strata. The lack of a surface A-horizon was interpreted to indicate that this area had been stripped probably related to disturbance from looting.

The second stratum for the cores in the dripline area was consistent. A granular 10YR4/4 dark yellowish brown to 10YR5/3 brown silty clay AB-horizon underlies all of the surface A-horizon strata (**Figure 5.43**). The depth of the AB-horizon fluctuated between the different tests ranging from 0.37 to as deep as 0.72 m bs. The AB-horizons gradually graded into the massive silty clay 10YR7/2 light gray C-horizon deposits that

constitute the basal sediments within the shelter (**Figure 5.43**). The depth of investigation within the C-horizon ranged from 0.65 to 1.05 m bs. The majority of the cores terminated at a rock or bedrock impasse. The AB-horizon is interpreted to indicate a second source of sediment, attributed to erosion of surficial deposits outside of the shelter.

Soil samples from the background cores were taken from each of the identified strata (**Appendix A:173-175**). These samples were believed to be adequate to characterize the soils across the site. Results of the chemical samples are addressed in **Chapter 7**.

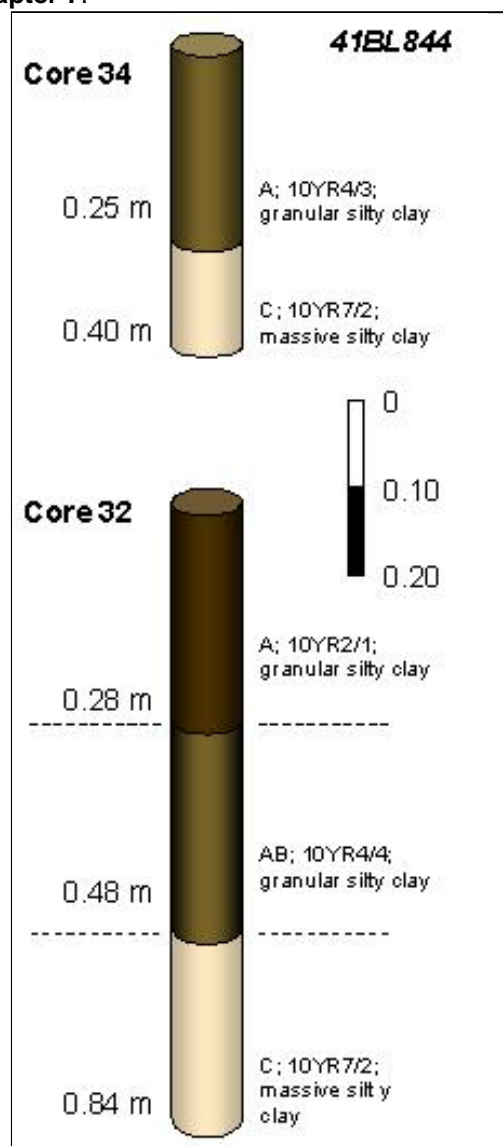


Figure 5.43. Representative soil core profiles from 41BL844.

Test Unit Investigations

A total of two anomalies were identified for testing within the shelter. The first anomaly was identified in the magnetometer and shallower resistance surveys, and was believed to possibly relate to a potential burial pit identified within Test Unit 6. Test Unit 1 was placed directly grid west of the older test unit over this potential anomaly (**Figure 5.42**). The second unit focused on a subtle ovoid anomaly approximately 1.0-x-0.75-m in size identified within the magnetometer and deeper resistance meter surveys. Test Unit 2 was placed on the south side of the potential anomaly (**Figure 5.42**).

Test Unit 1 was placed over the potential anomaly and directly west of the older stake related to Test Unit 6 (**Figure 5.44**). The exact orientation of the older unit was not known, but limited investigative coring indicated that it should lie east of the proposed 0.50-x-0.50-m test unit. This location placed the unit just east of the E309 line, with its southwest corner lying exactly N300.70 E309.08. Excavation of the unit was conducted in arbitrary 0.05 m levels from the surface.

Level 1 in Test Unit 1 consisted of a loose 10YR3/2 very dark grayish brown massive clayey silt. Charcoal flecking was noted within the matrix. The level was excavated to 0.05 m bs along the north and west walls, but taken to a depth of 0.13

m bs along the southwest corner in order to level the unit base. The upper portion of the level was loose and appeared to have undergone some degree of disturbance.



Figure 5.44. Unit excavation at 41BL844, Test Unit 1 in background, Test Unit 2 in foreground.

The level produced a total of 34 pieces of debitage and 3 pieces of bone. The bone was fragmented and not identifiable to any specific species. At the base of the level, a distinct line was noted extending from the eastern wall to the northwest corner of the unit, forming an arc (**Figure 5.45**). The soil along the southern wall had lightened through the excavation of the level. At the base of Level 1, the southern portion of the unit was a 10YR4/3 brown granular clayey silt.



Photograph of Feature 1 north wall profile.

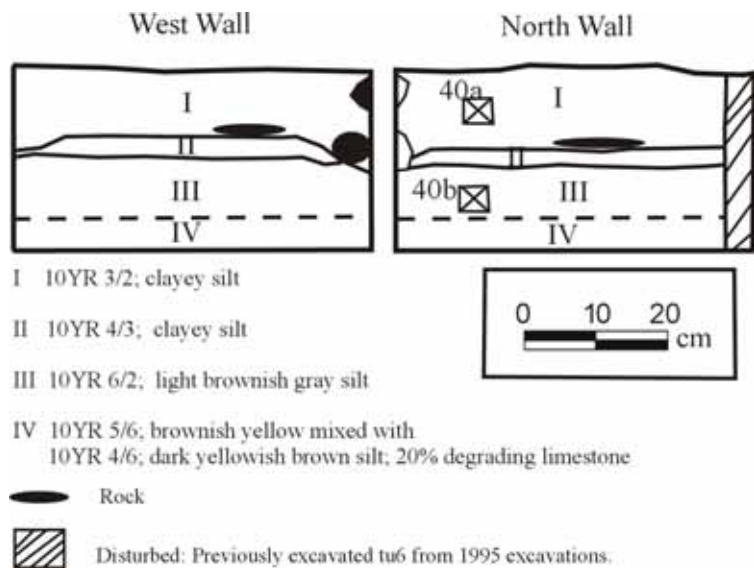


Figure 5.45. Photograph and wall profiles of Test Unit 1 (Feature 1) at 41BL844.

The excavation of Level 2 within Test Unit 1 was segmented with the 10YR3/2 fill matrix being screened separately from the 10YR4/3 matrix. The 10YR3/2 very dark grayish brown matrix continued to retreat toward the northeastern corner of the unit. The matrix of the feature became more compact and intact than the upper portions within Level 1. At the base of Level 2, the darker stain measured 0.40 m along the north wall and 0.20 m along the east. The 10YR4/3 brown matrix continued to gradually lighten to a 10YR6/2 light brownish gray by the base of the level. Level 2 was excavated to a depth of 0.10 m bs. The darker matrix produced all of the cultural material from within the level, including 6 pieces of debitage and 1 piece of unidentifiable bone. The darker 10YR3/2 matrix terminated into the north and east walls at a depth of 0.12 m bs above a few isolated pieces of tabular limestone. These pieces of limestone appear to be associated with the darker stain. The stain produced a total of 4 pieces of debitage. The level was excavated to 0.15 m bs. The 10YR6/2 light brownish gray clayey silt C-horizon covered the entire floor at the base of the level. Degrading limestone increased in size and amount throughout the excavation of Level 3. The excavation of Levels 4 and 5 saw a continuation of the increasing amounts of degrading limestone. The soil color changed to a 10YR6/6 brownish yellow mottled with 10YR4/6 dark yellowish brown. Based on the increasing amount of degrading limestone, Levels 4 and 5 were characterized as a Cr-horizon. Neither level produced any cultural material. Based on the lack of cultural material within the last two levels and the increasing amount of degrading limestone the excavation of the unit was terminated based on the interpretation that the unit was approaching basal shelter deposits that were below the culturally impacted strata.

Test Unit 2 measured 0.50-x-0.50-m with its southwest corner located at N301.00 E307.60. Excavation of Test Unit 2 was completed in 0.05 and 0.10 m arbitrary levels (**Figure 5.44**). Level 1 was characterized as a 10YR2/2 very dark brown granular silt A-horizon. A total of 52 pieces of debitage, 1 projectile point and 15 pieces of bone were recovered from the level. The bone fragments were too small to allow any level of analysis. The projectile point was identified as a Scallorn point (**Figure 5.46**), diagnostic of the Late Prehistoric period (1100 to 500 BP). The level was excavated down 0.10 m bs. At the base of the level, the 10YR2/2 very dark brown matrix

appeared to be darkening to a 10YR2/1 black color along the northern portion of the unit. Due to the potential that a feature may be emerging, the excavation level was reduced to 0.05 m.



Figure 5.46. Scallorn projectile point recovered from Test Unit 2, shown in plan and profile. (illustration scale of 1:1)

Level 2 saw the increasing definition of a 10YR2/1 black matrix occurring along the northern portion of the unit. This darker portion of the unit was a massive clayey silt compared to the massive silty soil occurring along the southern portion of the unit. At the base of the level, an edge resolved running approximately through the middle of the unit from east to west (**Figure 5.47**). The southern portion of the unit gradually changed to a 10YR5/2 grayish brown massive silt by the base of the unit, and was interpreted as a Cr-horizon. Based on the edge identified within the unit, the dark black 10YR2/1 massive clayey silt portion of the unit was treated as a feature. Level 2 produced 12 pieces of debitage and 1 fragmentary piece of bone.

Level 3 within Test Unit 2 was excavated to a depth of 0.20 m bs. The feature edge slightly moved north of its position at the base of Level 2 (**Figure 5.47**). The 10YR5/2 grayish brown massive silt began to have increasing amounts of degrading limestone throughout its matrix. Level 3 produced 67 pieces of debitage, 27 pieces of bone and 1 shell fragment, the majority of which were recovered from the feature matrix. The bone fragments were small and therefore could not be identified to any specific species.

Level 4 was excavated to a depth of 0.25 m bs. The two matrices identified within Level 3 continued to be represented within the level. Larger pieces of limestone were noted along the southern and western walls of the unit at the base of the level. The level produced 34 pieces of debitage and 7 pieces of bone. As with the preceding levels, the bone pieces were highly fragmented and could not be identified to any specific species.



Photograph of Feature 2 in plan, looking grid north.

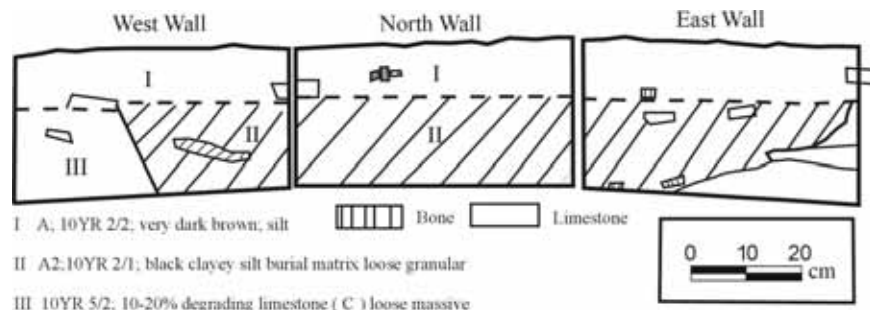


Figure 5.47. Photograph and wall profiles of Test Unit 2 (Feature 2) at 41BL844.

Level 5 was excavated to a depth of approximately 0.30 m bs. The level produced 182 pieces of debitage, 1 projectile point, 1 shell fragment, and 42 pieces of bone. The projectile point was identified as a Scallorn point, diagnostic of the Late Prehistoric period (**Figure 5.48**). The majority of the bone pieces were highly fragmented and could not be positively identified as human, but two pieces of a human rib bone were identified along the eastern wall at the edge of the 10YR 2/1 feature matrix at an elevation of 0.30 m bs (**Figure 5.47**). Based on the positive identification of the human bone, the excavation of the feature was halted.



Figure 5.48. Scallorn projectile point recovered from Feature 2, shown in plan and profile. (illustration scale of 1:1)

Upon cleaning the walls for photos and mapping, fragmented pelvic bone was identified in the profile. All of the bone fragments recovered from

the unit were reinterred into the unit prior to backfilling. A core was placed prior to backfilling in order to recover a sample from below the feature. Both of these cores indicated that the base of the pit was within 0.02 m below the base of the unit. The core indicated that the same 10YR5/2 grayish brown Cr-horizon deposits mapped on the southside of the unit underlay the pit, to a depth of 0.50 m bs.

Feature 1 recovered in Test Unit 1 contained a shallow basin type feature that had been excavated into the underlying C-horizon sediments. The upper portion of the feature appears to be disturbed; based on the loose nature of the soil matrix, but from 0.05 m bs the matrix appears to be intact. The nature of the feature is difficult to determine. Like the previous Test Unit 6 testing, the feature may represent looter excavations that have disturbed a great majority of the eastern section of the shelter, or may be shallow prehistoric features that have been in part disturbed by this activity. The integrity of the burial pit identified within the original test unit was never completely determined. Feature 1 does possess some degree of integrity within its basal portion, and as such was interpreted as being a truncated shallow basin. The feature produced a total of 44 pieces of debitage and 4 pieces of bone. Specific analysis was not completed on the bone fragments. Given the

recovery of human bone within Test Unit 6 and within the current Test Unit 2 locale all of the bone fragments were reinterred into the unit prior to backfilling. The feature did not produce any diagnostic material, and as such no temporal or cultural period can be determined for its creation. A total of four soil samples were collected from within the feature matrix and directly below, and labeled Core 40, N301.20 E309.18 and Core 41, N300.70 E309.08 (**Appendix A:174**).

Feature 2 recovered in Test Unit 2 was interpreted as a burial pit. The exact dimensions of the pit was not determined but based on the geophysics the pit probably measures 1.0 m east-west and 0.75 m north south. The pit appears to have been excavated into the underlying C-horizon, originating within the basal deposits of an A-horizon that appears to cover the surface of the shelter. The first Scallorn point was recovered from this surface horizon, indicating that the surface A-horizon contained Late Prehistoric deposits. The second Scallorn was recovered within the base of the feature, indicating a temporal link between the burial pit and the Late Prehistoric occupation within the surficial shelter deposits. All of the bone fragments recovered from each level were reinterred into the unit prior to backfilling. A total of six soil samples were collected from within the surficial A-horizon, the burial pit and directly below, labeled Core 42, N301.00 E307.60 and Core 43, N301.00 E307.90 (**Appendix A:174-175**). Both core locations were mapped on the unit profile and plans of the feature (**Figure 5.47**).

SITE 41CV901

Rockshelter Site 41CV901:

Aspect of shelter opening: Southeast

Shelter dimensions (LxWxH): 18 m x 20 m x 2.0 m

Talus development: Yes

Cultural affiliation: Late Prehistoric

Presence of known burials (depth): Yes (12-17 cmbs)

Presence of known non-burial features (depth): Yes (possible hearth at surface)

Extent of site disturbance: Approximately 25 to 40 percent (erosion, animals, looting)

Investigation techniques: Laser field scanner, Resistance, Magnetometry

Site 41CV901 is located at the head of an unnamed tributary of Henson Creek along the east end of Royalty Ridge (**Figure 5.49**). An

upland drainage flows over the center of the shelter overhang providing water to the floor of the shelter. In addition, a few small seeps exist along the eastern end of the shelter's back wall. The combination of these seeps and the overhang drainage has severely eroded the thin soils that cover the eastern end of the shelter, reducing the potential that this section will retain any intact deposits (**Figure 5.49**). In addition to the erosion, the site has undergone significant disturbance due to looting and burrowing animal activity. An estimate of 25 to as much as 40 percent disturbance was recorded during the previous investigations at the site (Trierweiler 1996:394).



Figure 5.49. Photograph of 41CV901, looking grid east, eroded area in foreground.

Initial field visits at the site discovered that a large beehive was located on the west central section of the shelter's roof (**Figure 5.50**). The hive is approximately 0.50 m in diameter, extending from the roof approximately 0.50 m. The bees were found to aggressively protect the shelter, and in fact made it impossible to enter and assess the shelter and its deposits on the initial field visit on 28 October 2003.



Figure 5.50. The beehive at 41CV901.

In order to deal with the bees for geophysical data collection, the shelter was slated to be surveyed during the winter, where in the bees may not be as active. The geophysical survey at the shelter was completed on 21 January 2004, and as hoped the bees only limited survey along the far western end of the grid. This limitation was not that problematic given the fact that the western end of the shelter progressively becomes drier and drier, severely limiting the collection of resistance data.

The rockshelter is much drier than those investigated along the eastern section of the

Base. This is due to shelter orientation that is protected from prevailing wind patterns, as well as drier climatic regime, which is the norm for the western portion of the base. Given this drier moisture regime the deeper section of the shelter was extremely desiccated, making resistance survey impossible or at least unreliable. Thus investigations were limited to a 5 m long area in the center of the shelter, placed between the heavily desiccated soils and the thin eroded soils along the eastern section of the shelter (**Figure 5.51**). Although the placement of the grid is limited, it did cover the areas previously tested by Trierweiler (1996).

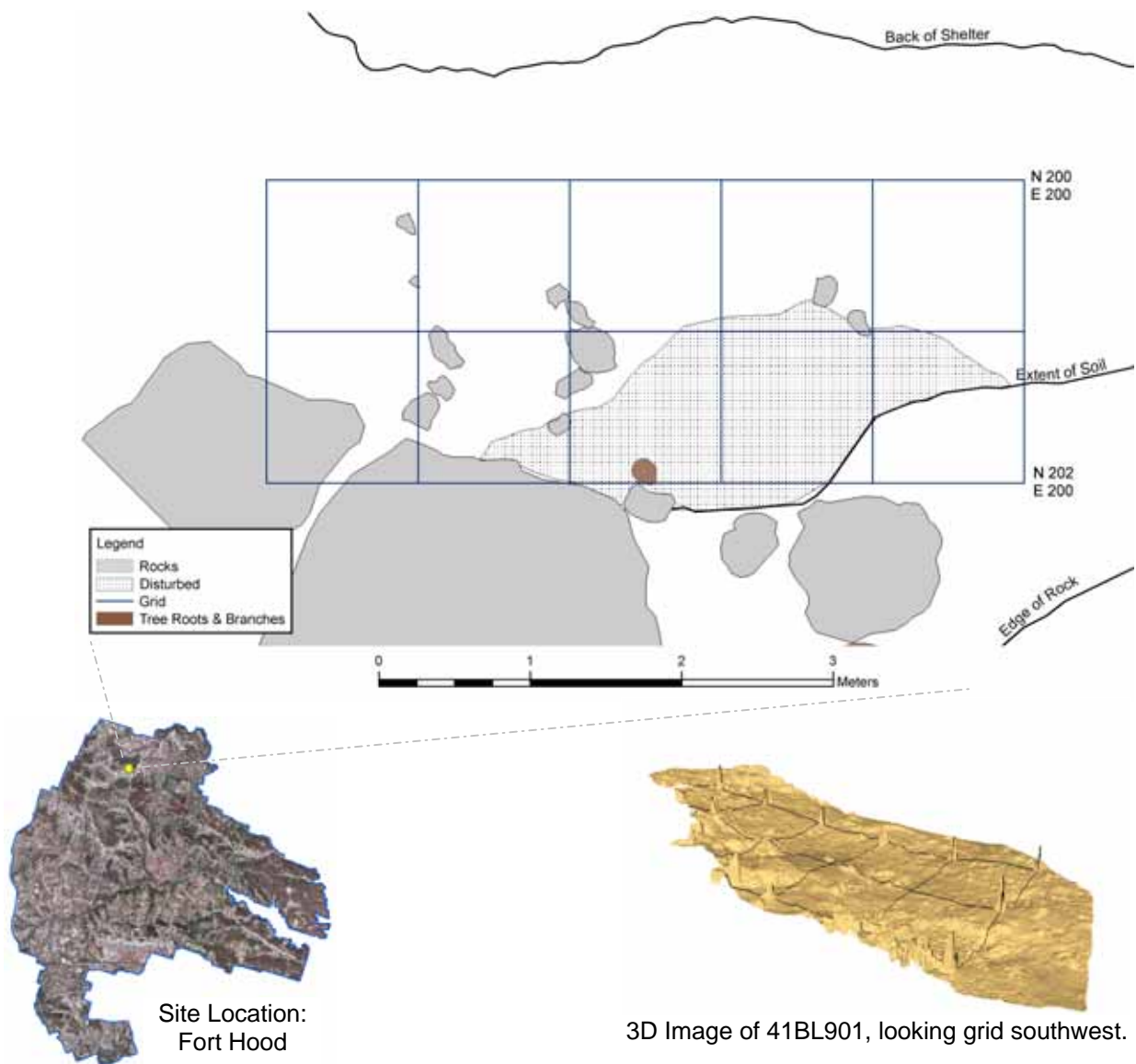


Figure 5.51. Site map of 41CV901.

A series of documentary visits were paid to the site prior the NRHP testing completed in 1995 (Trierweiler 1996). These previous visits identified cultural material and “ashy” type soil deposits that indicated that potentially intact cultural deposits might exist at the site, in spite of the levels of disturbance. The 1995 testing was limited to a single 1-x-1-m excavation unit. The unit was placed in the west central portion of the shelter directly west of a disturbed area that possessed a substantial amount of prehistoric cultural material lying on the surface (Figure 5.51). This area had been previously identified as having cultural material, burned slabs of limestone roof fall and ashy deposits.

The unit produced over 50 pieces of debitage, mussel shell, a Perdiz point (Late Prehistoric 300-600 BP), two large burned slabs and three burned rocks from the upper 0.10 m of the unit (Trierweiler 1996:396). At a depth of 0.12 to 0.17 m bs, human elements were encountered, including an articulated pelvis, femur, tibia and fibula. The bones appeared within a 0.40-x-0.15-m area lying directly below the large burned slabs identified during the previous visits. The bones were positioned to indicate the body was lying on its left side with the legs tightly flexed (Trierweiler 1996:396). The burial appeared to be contained within a well-defined pit that had been excavated into the underlying unaltered sediments. The unit excavation was terminated and backfilled. Trierweiler visited the site following the investigations and noted that the area on either

side of the unit had been extensively vandalized, but that the unit area appeared to have remained undisturbed.

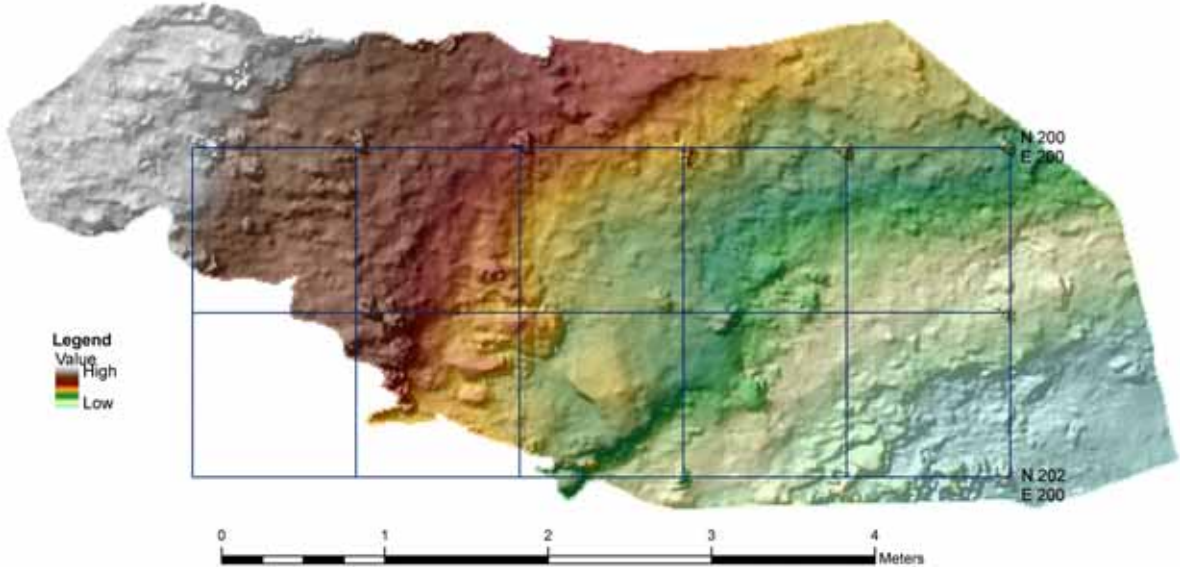
41CV901 Geophysical Survey

A 2 m wide by 5 m long grid was created along the west central section of the rockshelter, where the burial was located during the 1995 test excavations (Figure 5.51). The grid extended from the back wall to the talus edge of the shelter, including the location of the test unit. A number of pieces of limestone roof fall were lying on the surface of the shelter floor (Figure 5.52). These rocks impeded the collection of a small portion of the resistance data, but the majority were moved prior to the survey and replaced following data collection. During the removal process, a human pelvic bone was discovered lying directly under a large limestone rock. This bone was essentially lying on the surface of the shelter. No other bones were noted and the rock was left in place. This rock and the underlying pelvic bone were located within the proposed footprint of the previous excavation unit.

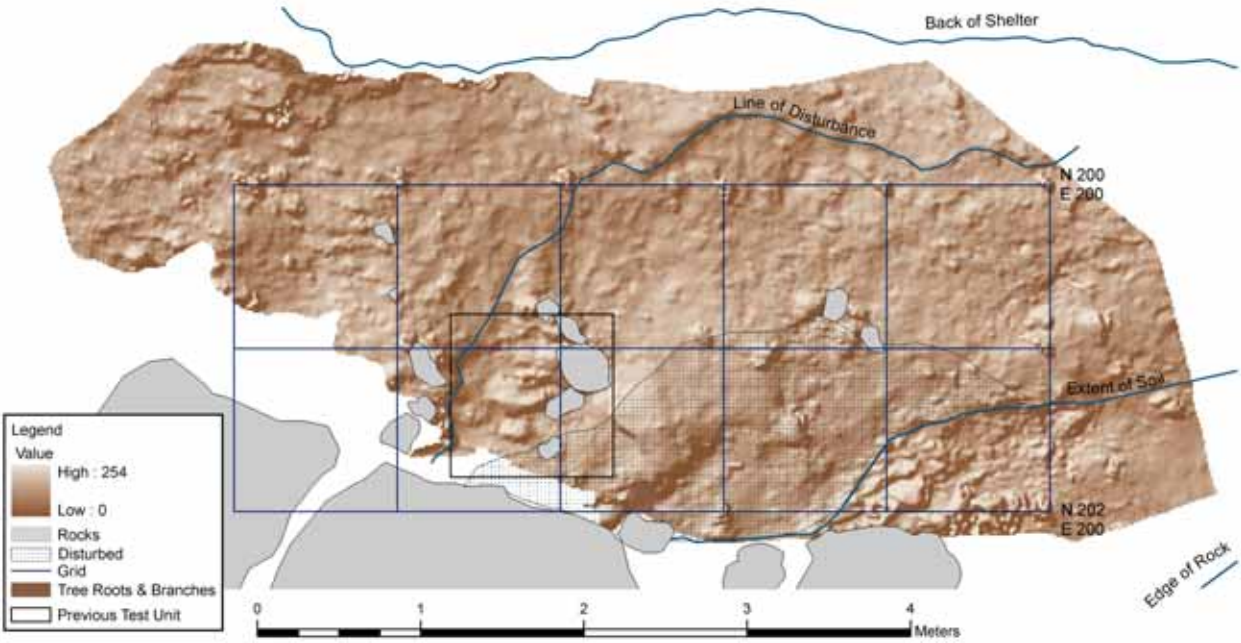
A magnetometer, two resistance meter surveys at 0.25 and 0.50 m spacing, and a laser field scan were completed at the site (Figure 5.53, 5.54 and 5.55). All four of these surveys used the standard methodology proposed for rockshelters defined previously in Chapter 3.



Figure 5.52. Photographs showing magnetometer data collection (A) and site conditions (B) at 41CV901.

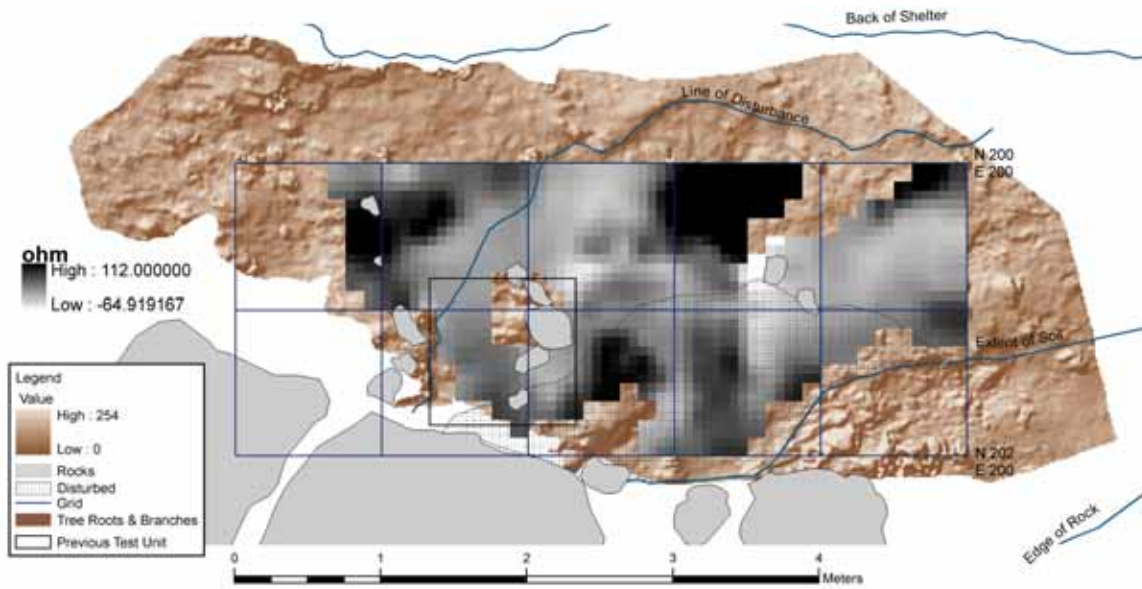


Laser Field scanner created DEM of 41CV901

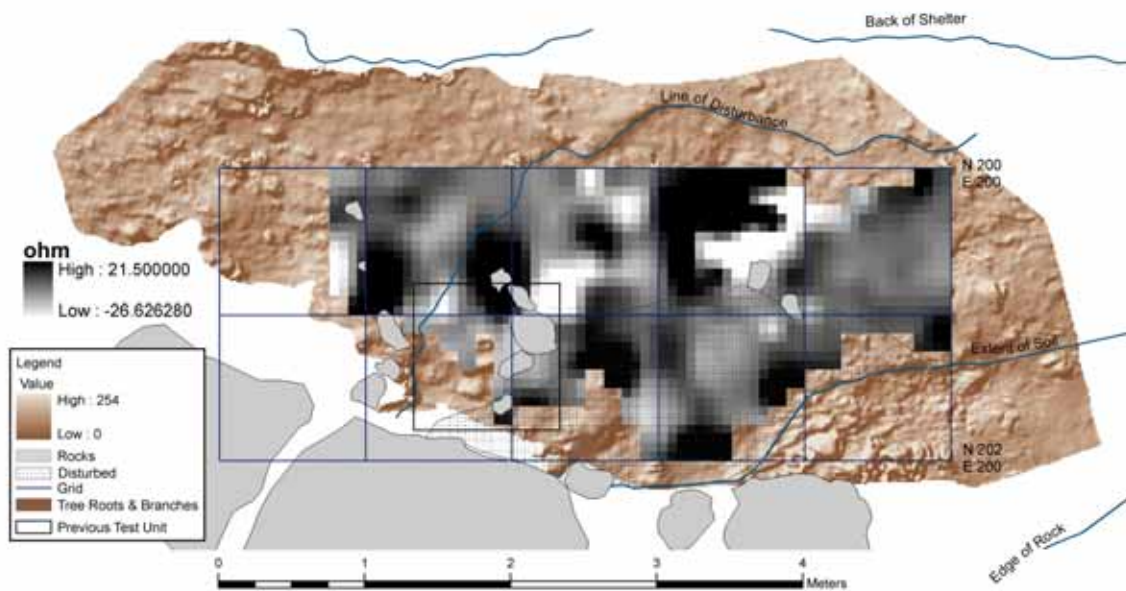


Hillshade relief map of Laser Field scanned DEM

Figure 5.53. Laser field scanned base mapping of 41CV901.



Resistance data, 0.25 m spacing



Resistance data, 0.50 m spacing

Figure 5.54. Electrical resistance survey results from 41CV901.

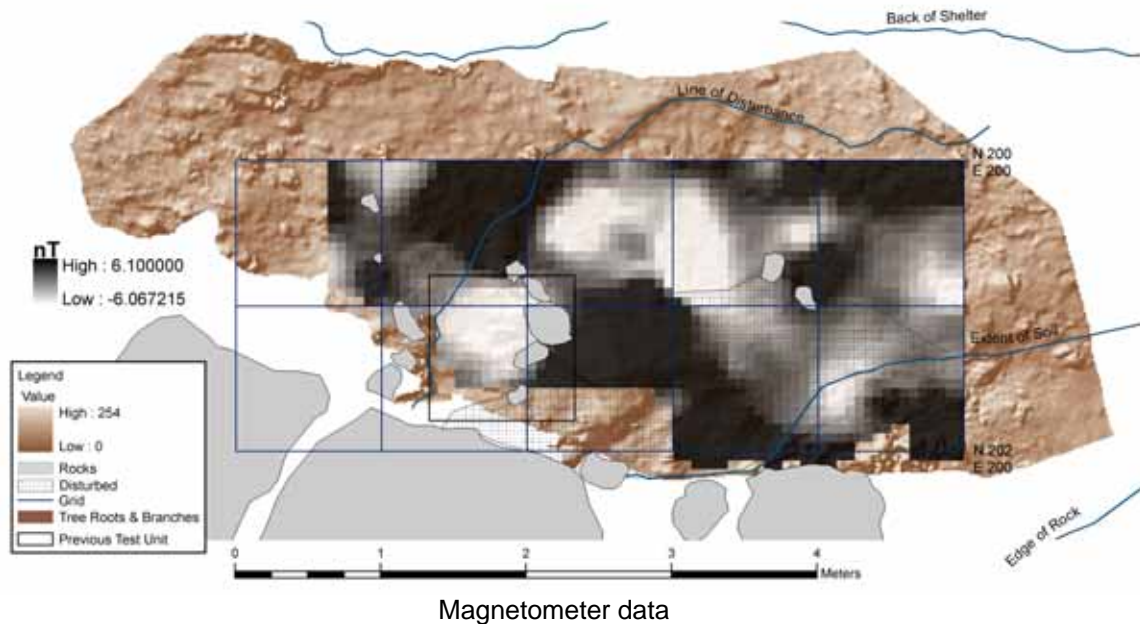


Figure 5.55. Magnetometer survey results from 41CV901.

An assessment of all three geophysical datasets indicated an anomaly existed in the area of the previous test unit along the western end of the grid (**Figures 5.54 and 5.55**). The anomaly was not consistent with depth based on the differences noted between the 0.25 and 0.50 m deep resistance surveys. This sort of inconsistent signature would be consistent with disturbance related to previous excavation. This portion of the grid was proposed to be the focus of the archaeological investigations. The laser field scan of the shelter documented the level of disturbance. A line running along the northern and western sides of the grid demarcates the extent of the previous vandalism (**Figure 5.53**). This disturbance appears to extend past the previous excavation; possibly indicating that disturbance from looting was more substantial than originally proposed by Trierweiler (1996). The discovery of the pelvis in such close proximity to the surface appears to support the proposal that the previously intact burial has been in part disturbed by later looting activities at the shelter.

41CV901 Archaeological Investigations

The shelter was not archaeologically tested due to two reasons. The first, and least consequential,

was the location of the grid in relation to the beehive. The archaeological testing was completed in the early Spring, at which time the bees were highly active, making entrance to the shelter a difficult prospect. The second, and the most consequential of the problems, was the observation that the vandalism noted by Trierweiler (1996:296) may have been much more extensive than originally believed. During the completion of the geophysical survey, it was observed that human skeletal elements were discovered on the surface covered only by a few large rocks. These elements were located within the footprint of the test unit. The identification of the bones within such proximity to the surface was interpreted to indicate that, at the very least, the burial context was highly questionable. Given these two reasons, the testing of the burial at 41CV901 was believed to be highly tenuous and as such a replacement site was used in its stead.

SITE 41CV1038

Open Site 41CV1038:

Cultural affiliation: Middle Archaic to Late Prehistoric

Site dimensions (LxW): 140 m x 130 m

Presence of known burials (depth): No

Presence of known non-burial features (depth): Yes (rock hearths: 0.31-0.54 mbs)

Extent of site disturbance: track vehicles have disturbed surficial deposits.

Investigation techniques: Resistance, Magnetometry

Site 41CV1038 is a prehistoric open camp situated on and within a series of alluvial terraces on the north side of Cowhouse Creek. The site was formally tested and determined to be eligible for listing in the NRHP by Mariah and Associates in 1994, at which time material remains representative of a complex series of occupations ranging from the Middle Archaic through Late Prehistoric were discovered. Five burned rock features were identified in backhoe trenching and testing units. A full description of the investigations can be found in Abbott and Trierweiler (1995: 552-567).

Archaeo-Physics, LLC, through Geoscan Research USA, conducted geophysical investigations at the site in 2003. A 20-x-20-m grid was established on a relatively level portion of the terrace adjacent to a previously excavated test unit in which an intact hearth had been discovered and removed at 31 to 54 cm below the ground surface. A magnetic field gradient survey and a resistivity survey were conducted in the grid. Six potential hearth feature locations were identified (Somers et al. 2004:47). However, these may also represent buried iron objects such as fragments of wires or nails. Further ground-truthing would be required to verify presence of prehistoric features.

41CV1038 Geophysical Survey

The geophysical survey of the site, completed during a previous survey (Somers et al. 2004), discovered a total of six potential 2 nT level monopole anomalies within the magnetometer data that were interpreted as possible prehistoric hearths. The resistance survey indicated that two

areas of high resistance had the potential to be broad rock clusters. Three of the potential prehistoric hearths correspond with these potential high resistance rock clusters.

Limited ground-truthing was attempted along the southeast corner of the 20-x-20-m grid. This testing was focused on a pair of potential hearth anomalies identified at N0.5 E18 and N1.5 E18 within the geophysical survey mapping (Somers et al. 2004:46). Prior to the ground-truthing stage the grid corners of the original geophysical survey were lost, making it difficult to accurately define the specific positions of the potential hearth features. Based on best guesswork, a pair of 1-x-1-m units was placed within the approximate area of the signatures by Fort Hood staff archaeologists. One of these tests units identified a rock cluster at a depth of 0.70 m bs.

41CV1038 Archaeological Investigations

The investigations at 41CV1038 were focused on the feature identified within the test unit excavated by Fort Hood staff in 2004. Given that the feature was still exposed at the time of the testing phase, a series of core samples was all that was required (Figure 5.56). A pair of background cores were placed in proximity to the test units to characterize the stratigraphy of the site, and a series of soil samples taken from the southern wall profile of the test unit (Figure 5.57).



Figure 5.56. Photograph of collecting core samples from 41CV1038.

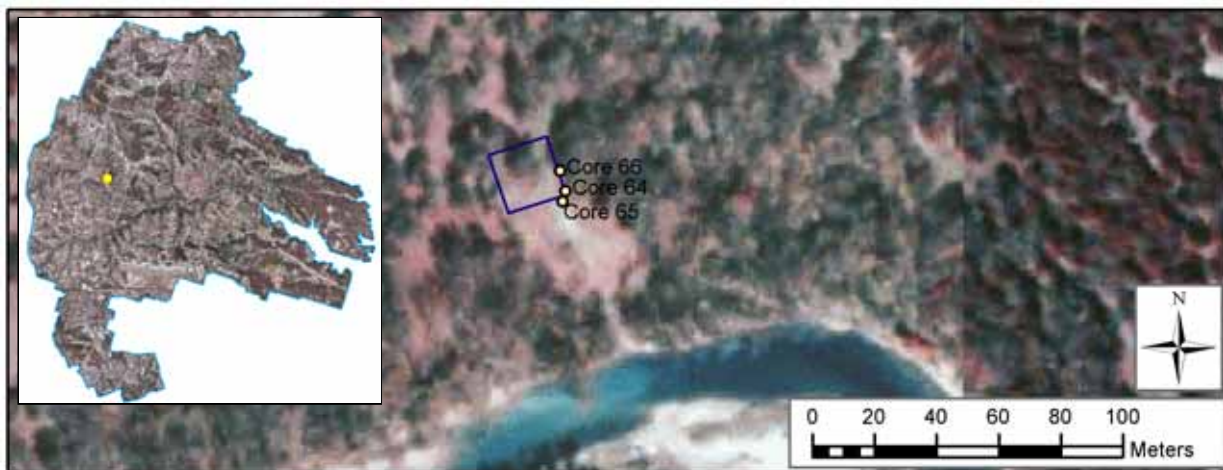


Figure 5.57. Site map of 41CV1038, showing core and test unit locations.

The two background cores, Cores 65 and 66, expressed different soil profiles (**Appendix A:175**). Core 65 noted a 0.75 m thick 10YR3/2 very dark grayish brown A-horizon that appeared to be undifferentiated within the core sample (**Figure 5.58**). This deep A-horizon was underlain by a 10YR4/2 dark grayish brown AB-horizon that extended to a maximum depth of 1.24 m bs within the core. Core 66 possessed a similar basal AB-horizon stratum, but the upper A-horizon stratum possessed a greater degree of differentiation than that of Core 65.

The upper 0.16 m of Core 66 had a 10YR3/2 very dark grayish brown silty clay A-horizon. This surficial horizon is underlain by a 10YR4/2 dark grayish brown silt AB-horizon that extends to a depth of 0.34 m bs. This third stratum appears to be a 10YR3/1 very dark gray silty clay Ab-horizon (**Figure 5.58**). The horizon extends to a depth of 0.85 m bs. The Ab-horizon is underlain by what appears to the same AB-horizon noted in Core 65.



Planview of rock cluster feature, looking grid north. Profile wall is at bottom of the photograph.

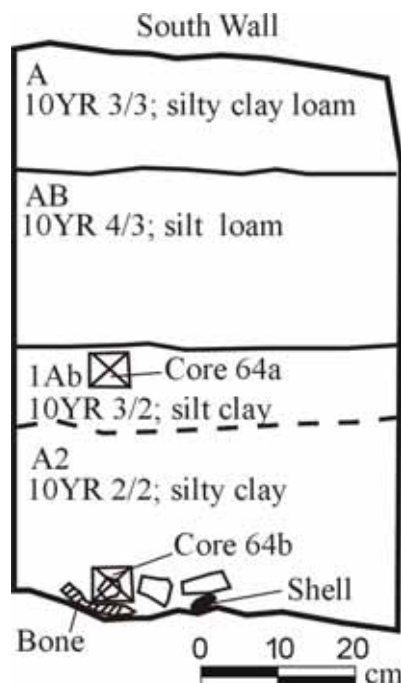


Figure 5.58. Profile and plan of feature discovered at 41CV1038.

The south wall profile of the test unit and a plan of the floor at a depth of 0.70 m bs was drawn (**Figure 5.58**). This profile is very similar to that of Core 66. The unit wall has a 10YR3/3 dark brown silty clay loam surface horizon that extended to a depth of 0.16 m bs. This surface horizon was underlain by a 10YR4/3 brown clayey silt loam AB-horizon that extended to a depth of 0.40 m bs (**Figure 5.58**). The central portion of the wall profile contains a series of buried A-horizons that extend below the excavation unit to an approximate depth of 1.0 m bs (**Appendix A:175**). A core was placed in the bottom of the test unit in order to sample the stratum that lies underneath the A-horizon that contains the feature. As indicated above, the lower 10YR2/2 very dark brown A-horizon in which the feature is contained extended to a depth of 1.0 m bs. This horizon was underlain by a 10YR3/3-10YR4/3 dark brown to brown silty clay AB-horizon to a depth of 1.60 m bs. This AB-horizon is probably the same as noted in the two background cores.

Samples were collected from the buried A-horizon above the feature, within the rock cluster feature and in the AB-horizon at a depth of 1.30 m bs (**Appendix A:175**). A total of five samples were collected from the background cores (**Appendix A:175**). These were placed at depths above, at and below the feature depth of 0.70 m bs. These depths were believed to be adequate to characterize the background soil stratums at the depth of the feature within this limited section of

the site. Results of the chemical samples are addressed in **Chapter 7**.

SITE 41CV1150

Open Site 41CV1150 (Walker Cemetery):

Cultural affiliation: Historic Cemetery; late nineteenth to twentieth century

Site dimensions (LxW): 59 m x 68 m

Presence of known burials (depth): Yes

Presence of known non-burial features (depth): No

Extent of site disturbance: Minor surface erosion

Investigation techniques: Resistance, Magnetometry

Walker Cemetery is located on a broad upland slope that extends down to Shoal Creek in the far northwestern corner of Fort Hood (**Figure 5.59 and 5.60**). The majority of the cemetery was covered in tall grass with isolated live oaks and junipers dotting its extent. It contains 143 marked graves, of which 25 are marked but have no identifiable name labeled on the headstone. A metal hurricane fence encloses the area. The fence boundary measures 59-x-68-m, but the actual extent of marked graves covers an area of approximately 50-x-48-m. An area located in the center of the cemetery is void of graves, but surface indications, such as stones and slight depressions, were observed within this section of the cemetery. It is believed that the cemetery may contain older unmarked graves in this central void area.



Unmarked grave area located in the upper right corner of photograph, looking grid northwest.



Eastern end of collection grid, looking grid northwest.

Figure 5.59. Photographs of site conditions at 41CV1150 (Walker Cemetery).

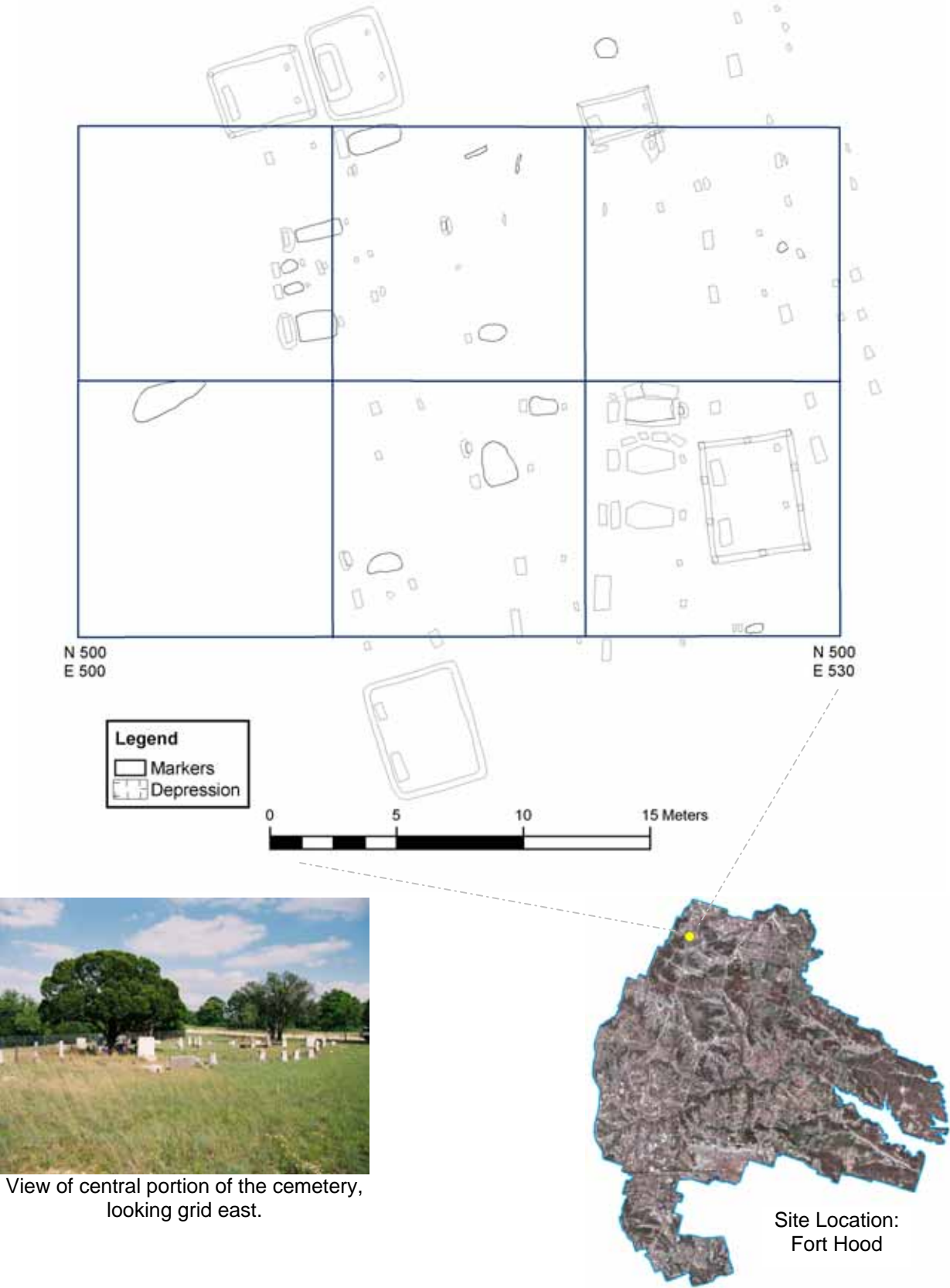


Figure 5.60. Site map of 41CV1150 (Walker Cemetery).

The previous work at the cemetery has focused on surface mapping of features, with no subsurface investigations. Death dates documented from headstones within the cemetery range from the 1860s to 2003. The oldest dated graves lie in the central and southeastern section of the cemetery. The majority of the marked but undated stones lie approximately in the center of the cemetery. Depth of deposits was assumed to extend to approximately 6 ft bs (1.8 m bs). Given the interpretation that the central void area may contain a number of early and unmarked graves, this area became the central focus of the geophysical survey.

41CV1150 Geophysical Survey

A 20 m wide by 30 m long grid was placed over the center of the cemetery, covering the central void area and all of the marked but undated graves (**Figure 5.60**). The placement of the collection area in the center of the cemetery nullified any affect that the encircling hurricane fence would impart to the magnetic data (**Figure 5.61**). A number of the grid corners and headstones were mapped in using the GPS, allowing for placement of the arbitrary geophysical grid into the facility base mapping projections and coordinate base.

A magnetometer and a resistance survey at a 0.50 m probe spacing were completed over the entire grid area (**Figure 5.62** and **5.63**). The shallow resistance survey identified a majority of the marked graves, as well as a number of anomalies within the central void area. The

magnetometer data was deleteriously affected by the extensive use of metal in the headstones, crypts and reinforced concrete enclosures that had been constructed across the cemetery. Although large portions of the magnetometer data were marginalized or obscured by the large metal dipoles, a number of anomalies were also identified in the central void area of the site.



Figure 5.61. Resistance data collection at 0.50 m spacing, looking grid south. Note fence in farground of photograph.

An additional limited resistance survey with a 1.0 m probe spacing was completed over the central section of the grid, focusing on the central void area and the majority of the marked but undated headstone portions of the cemetery (**Figure 5.64**). This deeper 1.0 m survey was completed due to the results identified in the shallower 0.50 m resistance and magnetometer surveys that indicated a number of highly defined burial shafts within the central void area.

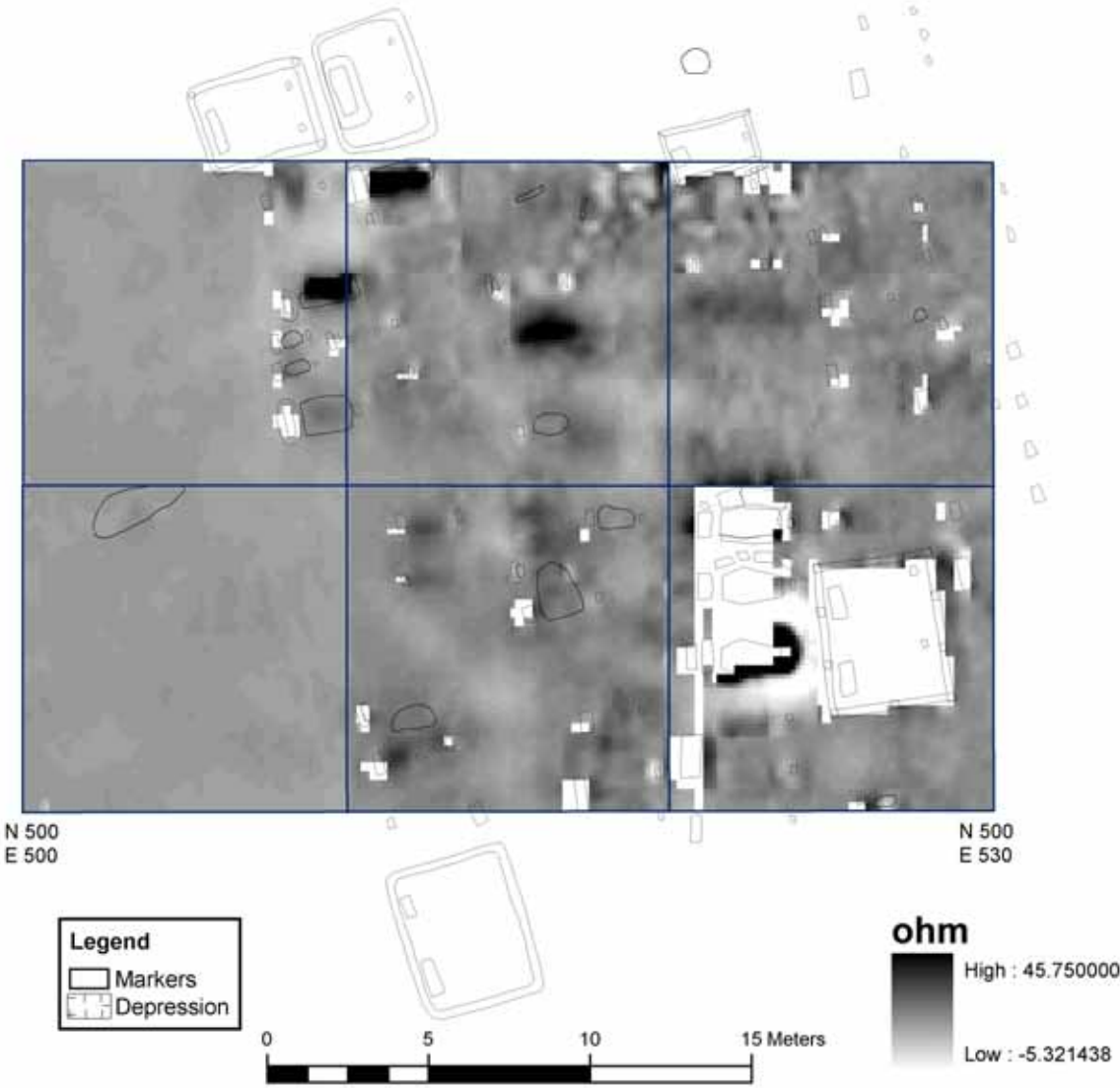


Figure 5.62. Electrical resistance survey of 41CV1150 (Walker Cemetery) at a 0.50 m probe spacing.

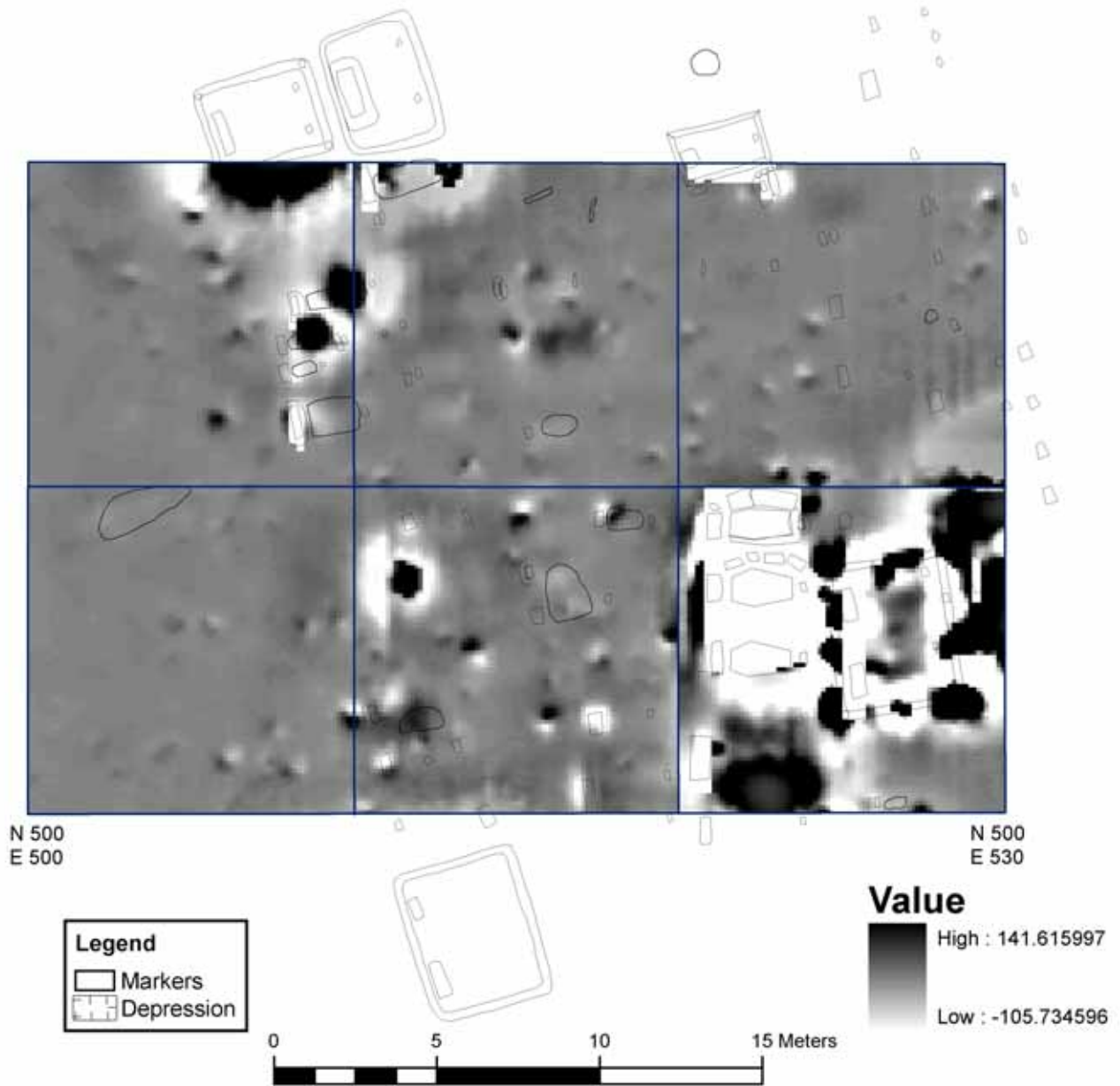


Figure 5.63. Magnetometer survey of 41CV1150 (Walker Cemetery).

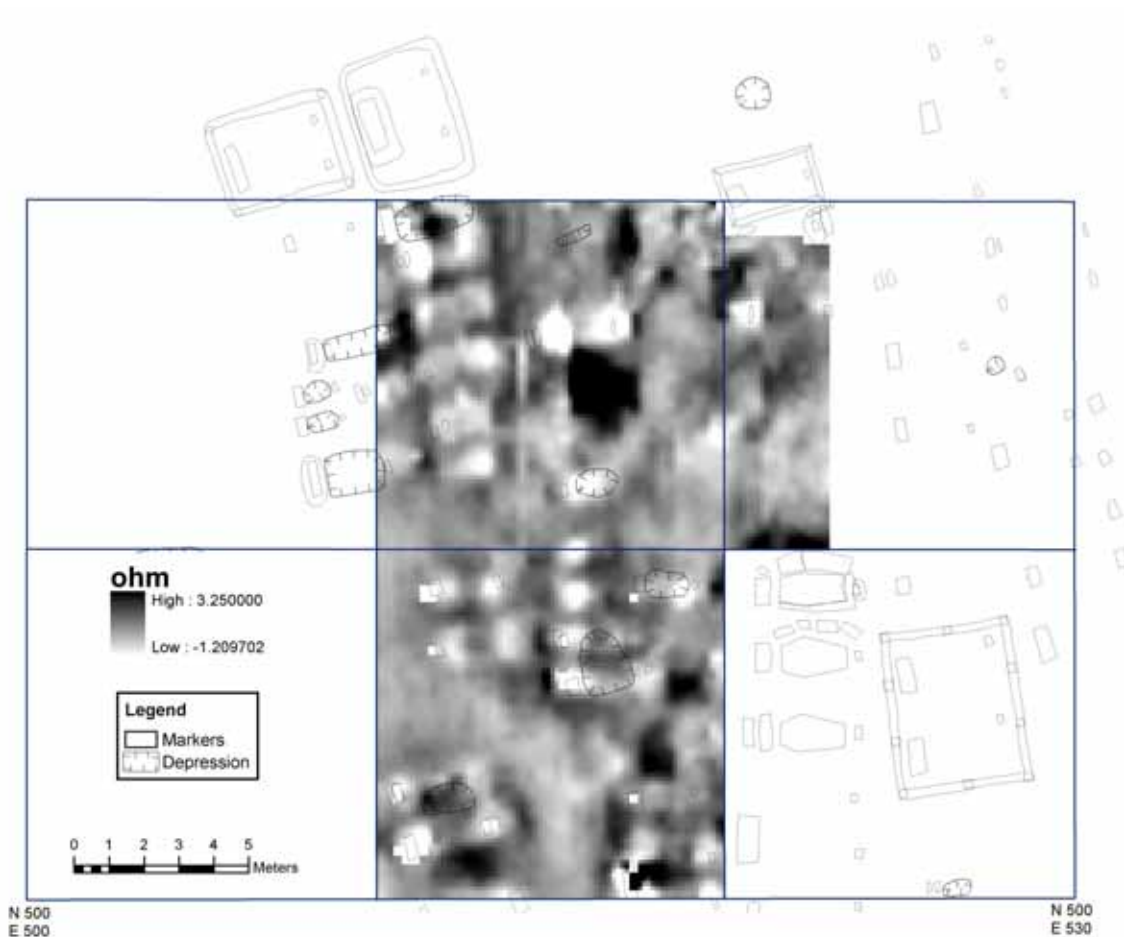


Figure 5.64. Electrical resistance survey at a 1.0 m probe spacing, focused on the central void area of 41CV1150 (Walker Cemetery).

The clarity of the 1.0 m deep resistance survey provided the best data set on which to determine the sample of graves to be tested in the subsequent archaeological investigations (**Figure 5.65**). It identified a row of six graves that ran approximately along the E512 line with greater clarity than the 0.50 m and magnetometer data sets. It also provided better clarity for the majority of graves located to the east of the E512 line of graves, with the exception of the high resistant grave located along the E516-517 lines. The deeper survey calls into question the nature of the anomaly, given the change in size and orientation. This potential grave locale is anomalous from the other grave signatures and required some subsequent testing in order to understand the differences.

A series of four investigative cores were placed down the long axis of the high resistance anomaly, labeled Grave 3 (**Figure 5.65**). The surface of the area around the anomaly contained

no visible depressions. The only observable difference in the area versus the surrounding void area was a single vertically oriented brick extending only slightly from the ground surface. At a depth of 0.40 m bs, a consistent obstruction was discovered across the anomaly. Inspections of the cores indicated that the obstruction was the placement of a brick cap within a burial shaft. Similar brick capped burials were recently identified by the authors in geophysical investigations in a cemetery dating from the early to mid-nineteenth century in Portsmouth, Virginia (Simpson and Peterson 2004). Given that the grave signature is anomalous to all others within the survey, it is believed that this grave may represent a very early burial at the cemetery, if not the oldest. If the dates from the Virginia cemetery are used as a guide, the grave could conservatively date to the mid-nineteenth century, predating the oldest marked grave by approximately 20 years.

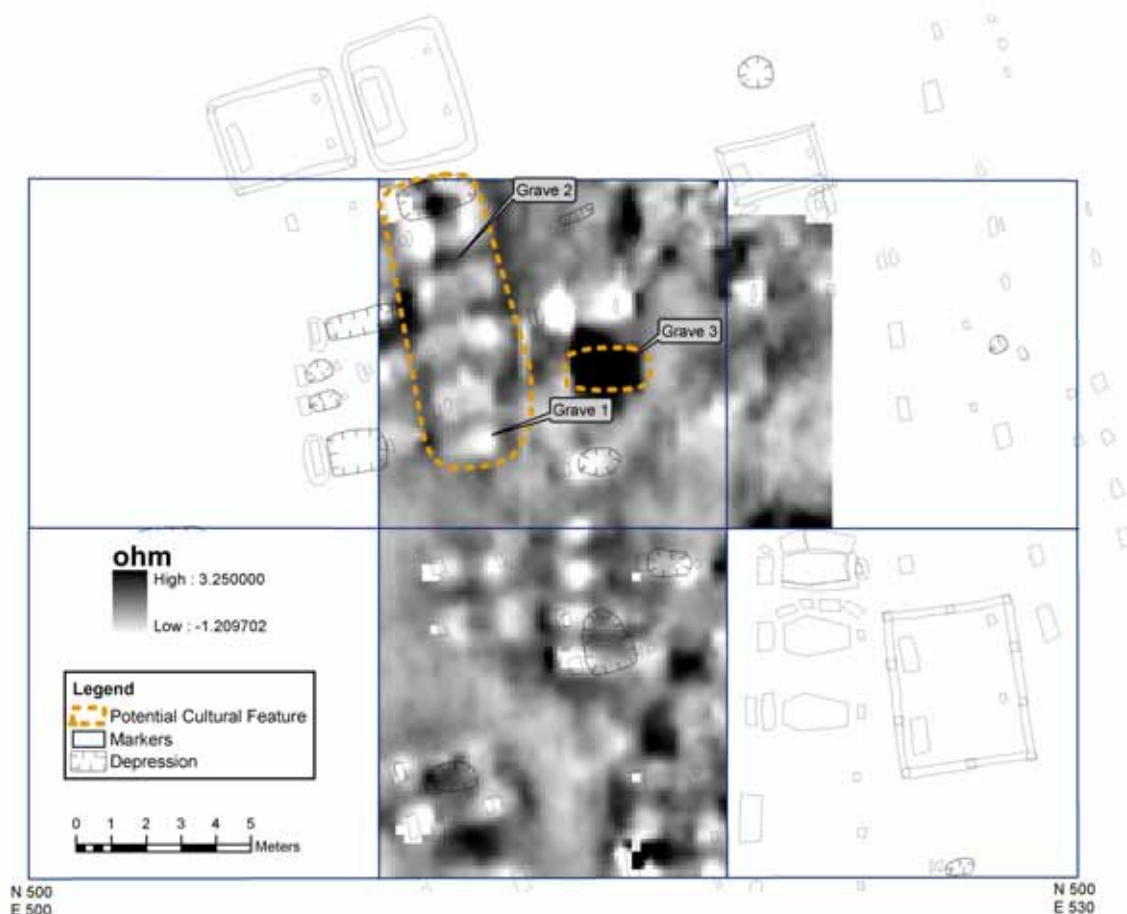


Figure 5.65. Interpretation of potential cultural features from 41CV1150, overlaid on the 1.0 m spaced resistance data set.

Given the sensitivity of testing within a marked cemetery, it was determined that only unmarked potential grave locations would be chosen for testing. Of the line of six graves noted in the 1.0 m deep resistance survey two were chosen for sampling (**Figure 5.65**). These two graves, Grave 1 and 2, both possessed excellent signatures, shallow depressions and no markers of any kind on the surface. These characteristics not only satisfied the sensitivity issues of testing but also possessed at least some limited surface indications that a probable grave shaft was located in the area of the anomaly.

41CV1150 Archaeological Investigations

The archaeological investigations at Walker Cemetery were focused on the two potential grave anomalies lying along the E512 line that corresponded to slight depressions on the surface (**Figure 5.65**). Two cores were used to sample both potential grave locations. In addition to the four feature cores, an additional eight background

cores were placed to characterize the unaltered portions of the cemetery (**Figure 5.66**). These cores were placed in areas that appeared unaltered based on the 1.0 m deep resistance data (**Figure 5.67**).



Figure 5.66. Core sampling at 41CV1150.

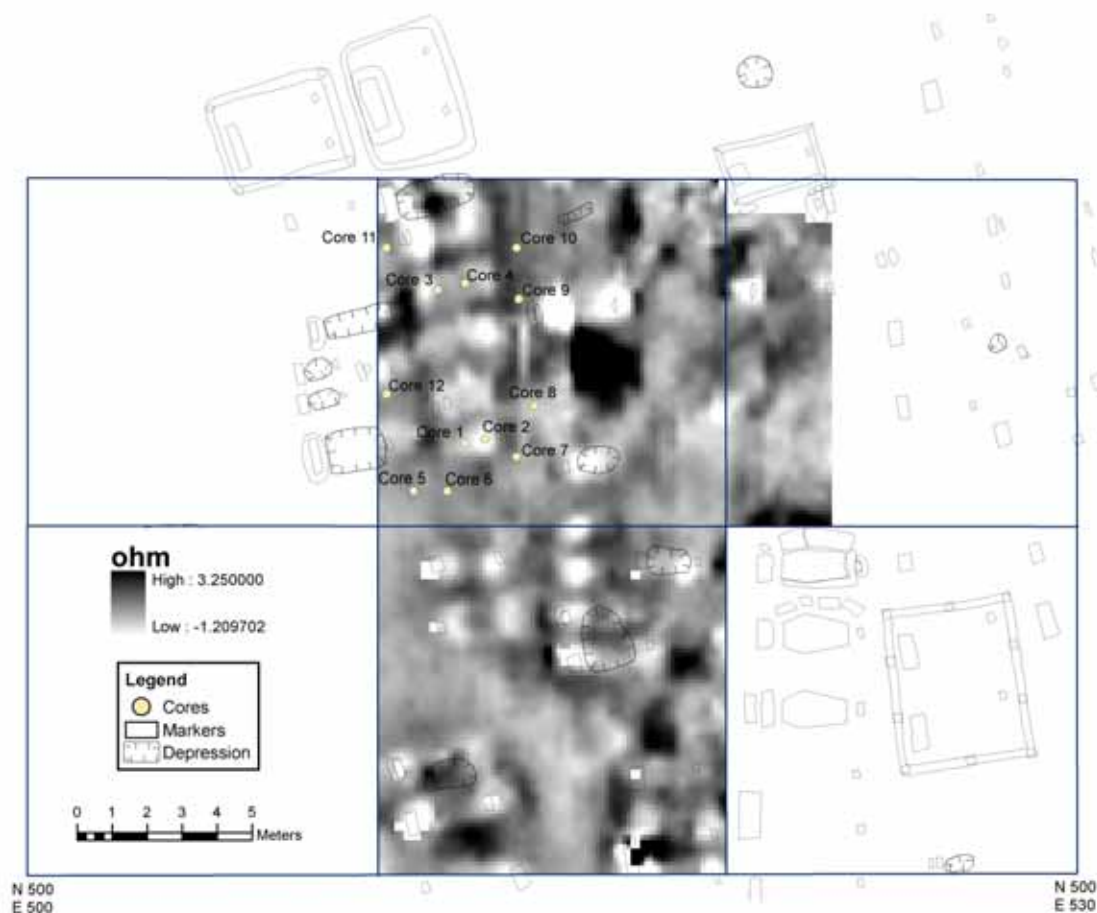


Figure 5.67. Placement of cores at 41CV1150, overlaid on the 1.0 m spaced resistance data.

The eight background cores are discussed first, in order to provide a context of soils across the site to compare the potential grave anomalies against. **Appendix A** (pages 175-177) offers detailed descriptions of all twelve core samples collected. The following discussion will summarize the basic strata that appear to exist at the site and the differences between the background and the grave locations.

The eight background cores expressed a great degree of homogeneity (**Appendix A:6-7**). All eight background cores possessed basically two strata. The surface stratum is a 10YR4/3 to 10YR4/6 brown to yellowish brown A-horizon (**Figure 5.68**). The A-horizon is a dense granular silty clay with from 2-5 percent degrading limestone intermixed throughout the matrix. This surface horizon was underlain by a thick 10YR6/6 yellowish brown Btk-horizon. The Btk-horizon contained well-developed clay-skins and fluctuating amounts of Ca concretions, ranging

from 15-20 percent. A few cores had slightly different color ranges and inclusion percentages, but in general the Btk horizon constitutes the majority of the lower soil horizon along the landform. Cores were taken to depths ranging from 1.25 to 1.75 m bs into the Btk prior to being terminated (**Appendix A:176-177**). Based on depths observed in the two potential grave locales, these depths were enough to properly characterize the soil strata present at the cemetery.

Cores 1 and 2 taken within the Grave 1 anomaly had very similar core profiles (**Appendix A:175**). Unlike the background cores there was no 0.28 m thick A-horizon on the surface; instead both cores began with a 10YR5/4 yellowish brown mottled with 10YR6/3 pale brown and 10YR4/4 dark yellowish brown massive clayey silt (**Figure 5.68**). This disturbed soil matrix extended from the surface to a depth of 1.20 m. This portion of the core was extremely soft. Based on these

characteristics, this 1.20 m thick section was interpreted as grave shaft fill. The shaft fill terminated at a thin 10YR4/3 brown massive clay loam stratum, with small wood fragment inclusions, that extended to a depth of 1.30 m bs (Figure 5.68).

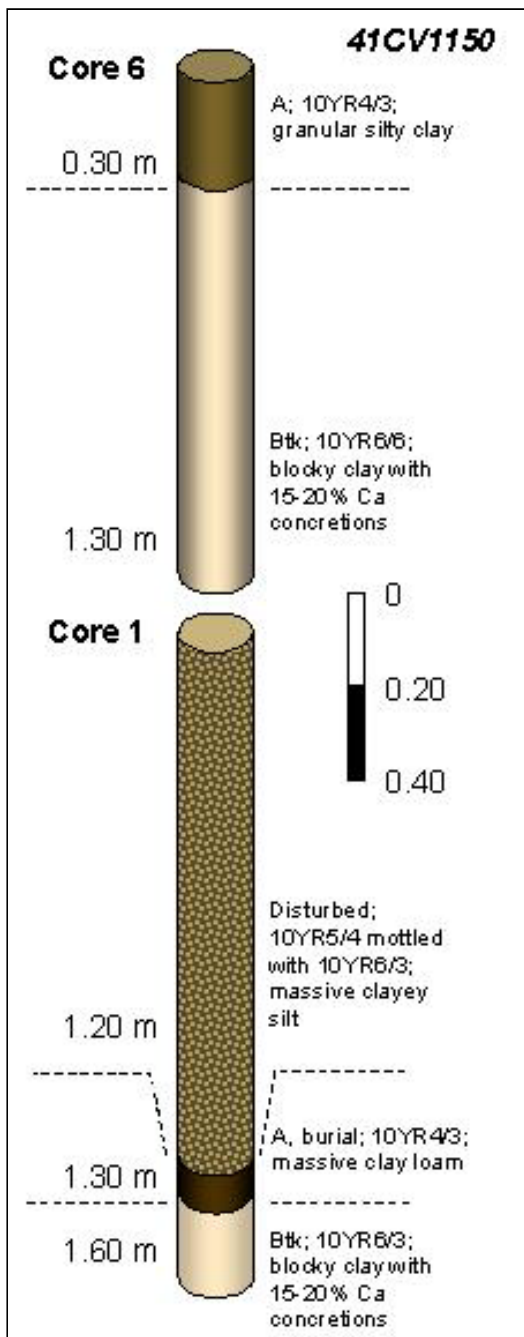


Figure 5.68. Representative soil core profiles from 41CV1150.

The stratum had an abrupt smooth boundary with the underlying 10YR6/3 pale brown Btk-horizon. The Btk-horizon was sampled to a depth of 1.60

m bs, and appears to be identical to the Btk-horizon identified within the background cores. The 10YR4/3 stratum was interpreted as the remnants of an historic grave, and that the wood fragment inclusions were deteriorated pieces of a coffin.

Core 3 and 4 taken within the Grave 2 anomaly possessed very similar profiles compared to each other and to those taken in Grave 1. Both Cores 3 and 4 possessed a disturbed section that extended from the surface to 1.48 m bs (Figure 5.68). The disturbed fill matrix was slightly moister than that sampled within Grave 1, and as such soil chroma was slightly higher (Appendix A:176), but generally the two are as similar as fill deposits can be. At 1.48 m bs in both cores, a thin 10YR4/3 brown stratum was identified that extended to a depth of 1.55 m bs. As with Grave 1, the base of this stratum possessed an abrupt and smooth boundary with the underlying Btk-horizon. The 10YR6/6 brownish yellow Btk-horizon extended to the core's termination at 1.90 m bs (Figure 5.68). The 10YR4/3 stratum did not include any wood fragments as did the cores in Grave 1, but Core 3 did contain fragments of bone. The bone fragments recovered from Core 3 were too small for identification, but given their context they were treated as if they were human and immediately placed back into the core location. Based on the recovery of the bone and the general characteristics of the two cores, the sampled area was interpreted as another historic grave.

Samples collected within both graves were taken directly above the grave within the shaft fill, within the burial matrix and directly below the burial in the unaltered Btk-horizon (Appendix A:175-177). Samples from the background cores were taken from within the Btk horizon only, at a depth above and either at or below the depths of the burials (Appendix A:175-177). These depths were believed to be adequate to characterize the background soil stratums at the depth of the burials. Samples were not taken from the surficial A-horizon given that it was believed to play little if any role in determining the chemical environment in which the burials resided. Results of the chemical samples are addressed in Chapter 7.

SITE 41CV1235**Open Site 41CV1235:****Cultural affiliation: Middle to Late Archaic****Site dimensions (LxW): m x m****Presence of known burials (depth): No****Presence of known non-burial features (depth): Yes (0.0-1.25 m)****Extent of site disturbance: spotty across the site, approximately 10%****Investigation techniques:** Resistance, Magnetometry

The site is situated on a series of terraces west of House Creek and north of an unnamed tributary in the western portion of the base (Kleinbach et al. 1999). The site has experienced a high degree of disturbance from military tank maneuvers that have eroded or obliterated portions of the site. The eroded areas of the site have exposed substantial archaeological deposits. These deposits have attracted the attention of looters, leading to extensive non-scientific excavation within the western section of the site to the present.

Dense riparian hardwoods including pecan, burr oak, live oak and juniper secondary forest cover approximately half of the site; the rest being covered with dense tall grass (**Figures 5.69** and **5.70**). The forest exists as dense patches within the north and eastern sections of the site, but becomes a dense contiguous unit south and west of the central road cut that transects the site. The density of growth in these areas made geophysical exploration impossible, with survey being focused on the grassy areas only.

**A**

A series of archaeological investigations have occurred at the site previously. These investigations have included shovel testing, trenching and unit excavation. These previous investigations have identified two extensive surface middens (Kleinbach et al. 1999). The middens consist of dense patches of burned rock, the majority of which is limestone, and pieces of debitage. The middens were identified within the road that transects the site from east to west. The exact dimensions of these middens are approximate due to dense surface vegetation in some portions of the site that has hindered investigations. The midden is estimated to be 150 m long, 30 m wide and 0.5 m thick (Kleinbach et al. 1999:176). The two middens are separated by an intermittent drainage that runs approximately north to south through the east central portion of the site. This drainage was used to separate the site into western and eastern sections within the current investigations.

Shovel testing completed across the middens in 1992 (Trierweiler 1994) indicated that the eastern portion (Labeled as Feature 2 by Kleinbach et al. 1999:178) contained cultural materials concentrated within 0.20 m of the surface, with the western midden (Labeled as Feature 1 by Kleinbach et al. 1999:178) having deposits extending to a depth of 0.50 m bs. Formal National Register testing occurred in 1996 (Kleinbach et al. 1999), with the investigations centered around the excavation of six trenches, ranging from 12 to 18 m in length, that were placed either in or around the two surface midden areas. In addition to these six trenches, five 1-x-1-m excavation units were placed along three of the trench walls to provide a more detailed vertical sample of cultural material.

**B****Figure 5.69 Western portion of the site, looking across Grids 1 (A) and Grids 2-4 (B).**



Eastern Section of 41CV1235, looking southwest. 20-x-20-m grid located in the farground beyond the road bed.



Site Location:
Fort Hood

Figure 5.70. Site map of 41CV1235.

The trench and unit excavations indicated at least two different occupations at the site. Analysis Unit 1 was identified across both sections of the site. This unit corresponds to Late Archaic period occupations that created the thick midden deposits that exist at the surface. The maximum depth of these deposits extends to 0.76 m bs along the western sections of the site and appears to be approximately 0.40 m bs within the eastern sections. Radiocarbon dates taken from the western portion of the midden place the occupations from 3900 to 3000 BP. A deeper Analysis Unit 2 relates to a Middle Archaic occupation that extended from a depth of 0.70 to approximately 1.40 m bs along the western section of the site, dating from 4700 to 4000 BP. This deeper midden deposit was not noted on the eastern portion of the site, but at a depth of approximately 1.75 and 2.2 m bs rock concentrations were noted in two of the trenches located along the western portion of the base. The exact nature and period of these occupations was not determined during the 1996 investigation.

41CV1235 Geophysical Survey

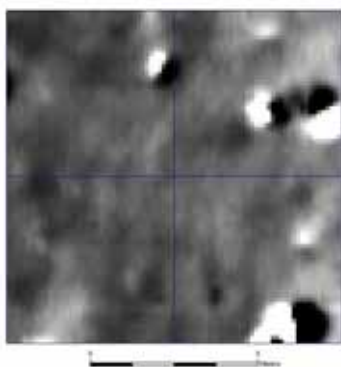
Initially geophysical survey was focused on two areas within the western section of the site (**Figure 5.70**). A 10-x-10-m grid (Grid 1) was established south of the east to west oriented road that transects the site, and a 10 m wide by 30 m long grid (Grids 2-4) was established north of the road. These were focused on areas just outside of the mapped extent of the surficial burned rock midden. Both collection areas were surveyed using a magnetometer and a single 0.50 m depth resistance survey, collecting individual

10-x-10-m grid within the broader grid area (**Figure 5.71** and **5.72**).

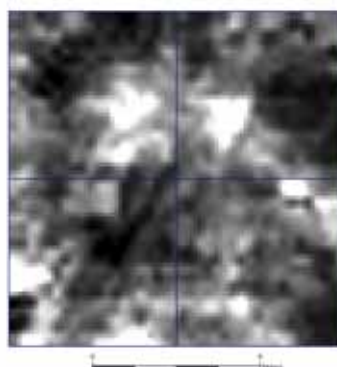
The 10-x-10-m grid located south of the road contained no obvious anomalies that appeared to be cultural in context in either of the geophysical data sets.

An assessment of the northern 10-x-30-m grid indicated a high degree of disturbance had occurred in this area. The resistance data set shows a plethora of linear anomalies that crisscross the collection grid (**Figure 5.71**). These anomalies are tracks from large motorized vehicles that have severely disturbed the upper portion of the soil profile by creating a series of ruts across the area.

The results from the western portion of the survey were less than promising for directing highly focused archaeological investigations. Due to the marginal nature of the western data sets, a third collection grid was established on the extreme eastern end of the site. A 20-x-20-m grid was established just south of the east-west oriented road that transects the site (**Figure 5.70**). The grid was placed as close to the disturbance related to the road as possible, given the fact that the surficial burned rock midden was mapped directly around the road in this portion of the site. As with the other collection grids, a magnetometer and 0.50 m deep resistance survey was completed within the eastern grid. The northern two 10-x-10-m grids were located on a slight rise above the southern two grids, probably related to gradual terrace scarp. The rock midden as mapped previously is isolated to this higher portion of the grid.

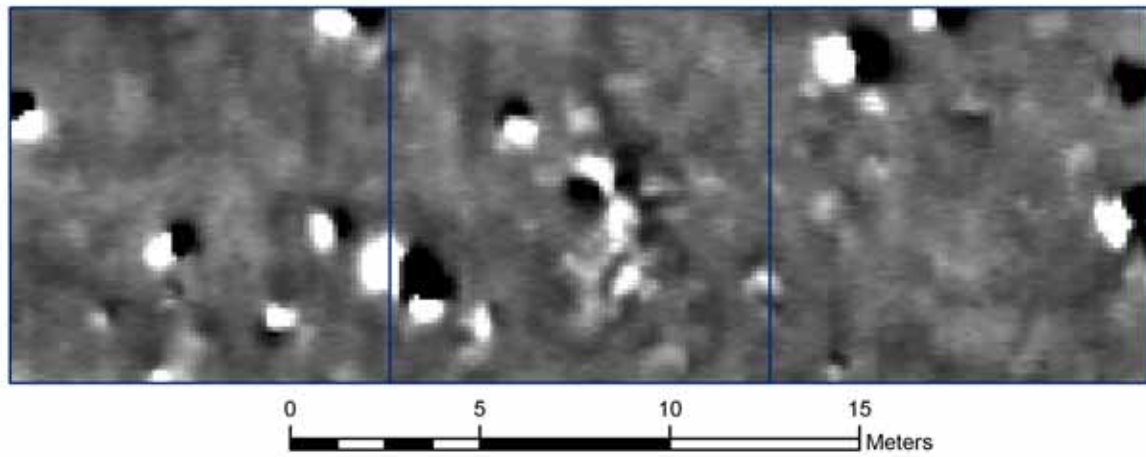


Magnetometer results

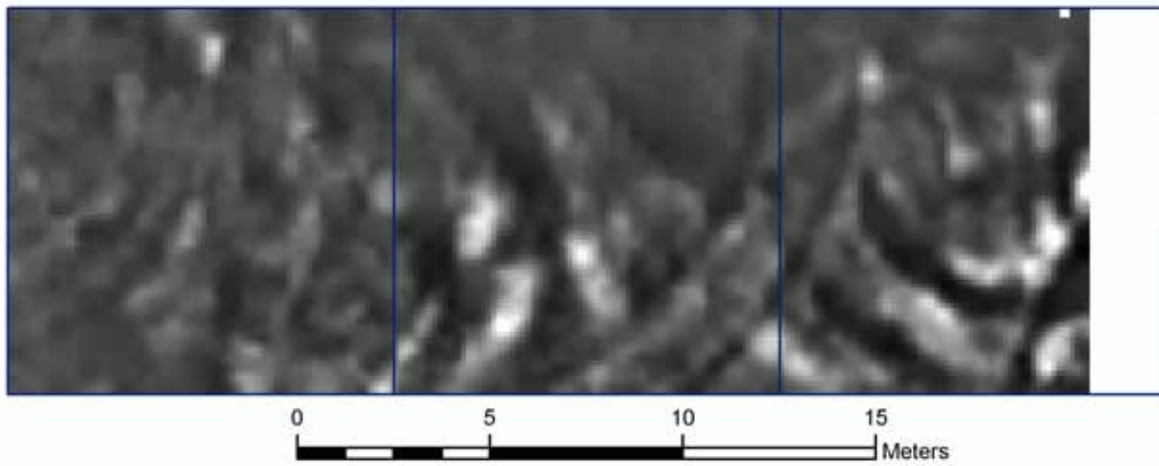


Resistance meter results, 0.50 m.

Figure 5.71. Magnetometer and resistance meter results from Grid 1 in western section of 41CV1235.



Magnetometer results



Resistance meter results, 0.50 m spacing

Figure 5.72. Magnetometer and resistance meter results from Grids 2-4 in western section of 41CV1235.

Both geophysical surveys of the eastern grid identified a number of anomalies that had potential to be cultural in nature. The resistance data identified a number of isolated high resistance anomalies (**Figure 5.73**). In addition to these smaller isolated anomalies, the resistance data identified a large amorphous anomaly within the northwestern quadrant of the grid (**Figure 5.73**). This high resistance anomaly was interpreted to be a portion of the burned rock midden. The location of the amorphous anomaly corresponds to the general area of the midden as mapped by previous archaeological investigations. Inspection of the ground surface within this area also noted pieces of burned limestone and debitage. Assessment of the magnetometer data shows a number of circular

anomalies occurring across the site, with a number lying either within or in proximity to the proposed burned rock midden (**Figure 5.74**).

Archaeologically, these burned rock middens are known to contain small isolated features, both within the midden deposits and also underneath them within the underlying strata. Assessment of the resistance data indicated a broad amorphous anomaly corresponding to the midden area. This anomaly, while valuable as a means of identifying the midden deposits, was of little use in defining isolated features within the midden. Based on this, the magnetometer was utilized as a means of identifying isolated circular anomalies within the midden deposits.

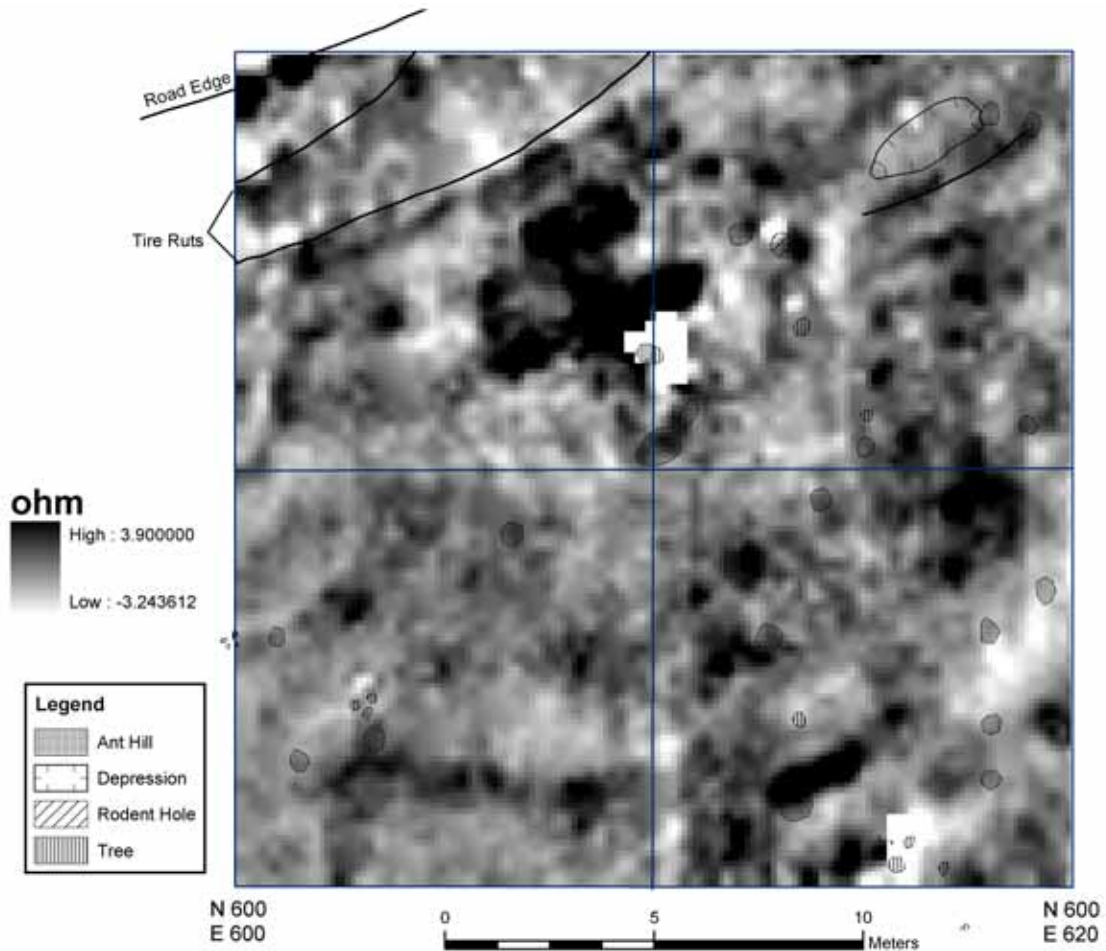


Figure 5.73. Resistance survey results from 41CV1235.

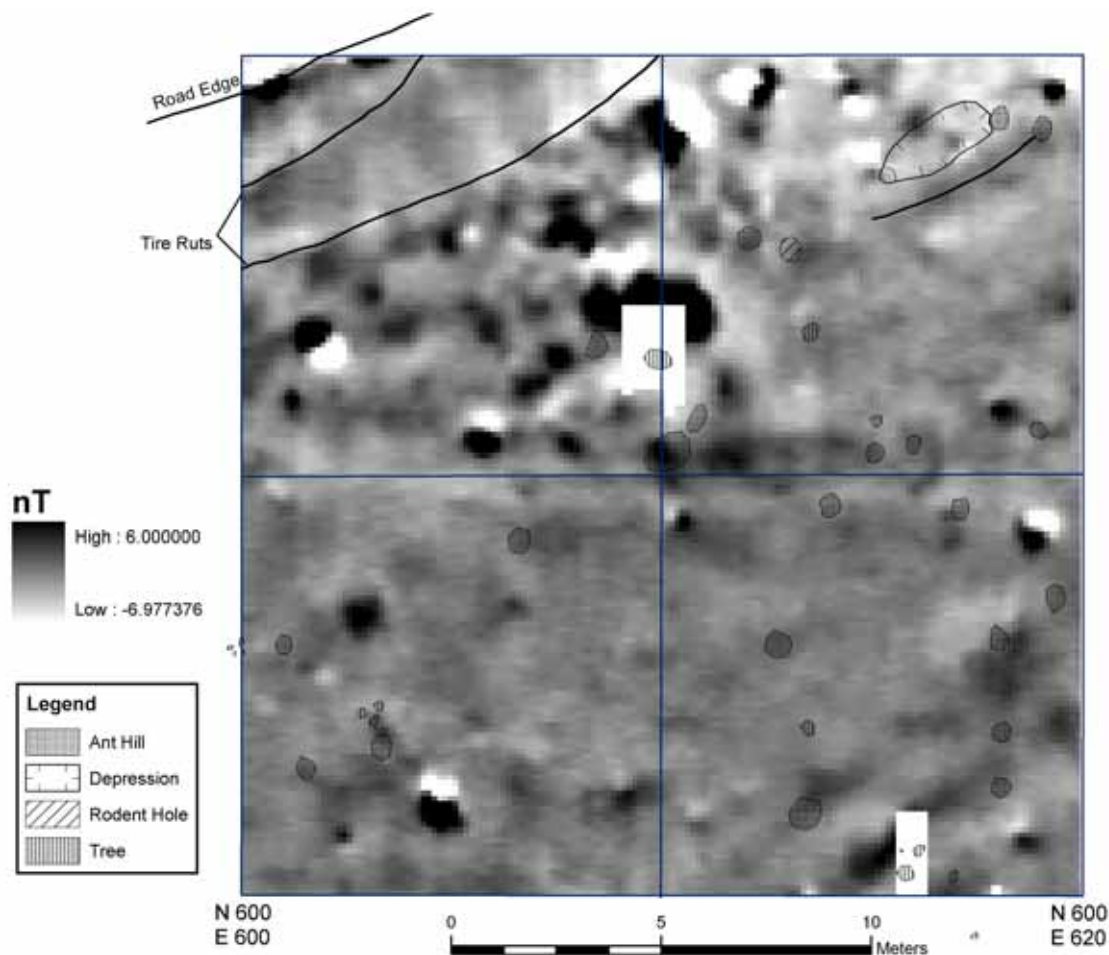


Figure 5.74. Magnetometer survey results from 41CV1235.

A total of seven circular anomalies were identified in proximity of the resistance defined midden area (**Figure 5.75**). Anomalies 1 through 4 were located within the midden area and Anomalies 5-7 were located in direct proximity to the midden. These anomalies ranged from 0.75 to 3.5 nT, a range indicative of cultural features identified in other magnetometer surveys. Anomaly 1 was chosen for testing because its signature was highly focused, ranging from 2.0 to 3.5 nT, and it was very similar to another anomaly, Anomaly 8, lying outside of the midden area.

Anomaly 8 was identified along the western edge of the grid and south of the midden (**Figure 5.75**).

The anomaly was identified within both of the geophysical data sets and did not have any surface disturbances associated with it (**Figure 5.73** and **5.74**). The anomaly was both highly resistant and magnetic, ranging from 2.0 to 2.9 nT within the magnetometer data set. This range was consistent with the other potential anomalies, as well as being even more focused than those identified within the midden. The anomaly was believed to represent a rock filled hearth, based on the high magnetic and resistance data measurements, and was therefore chosen for additional testing.

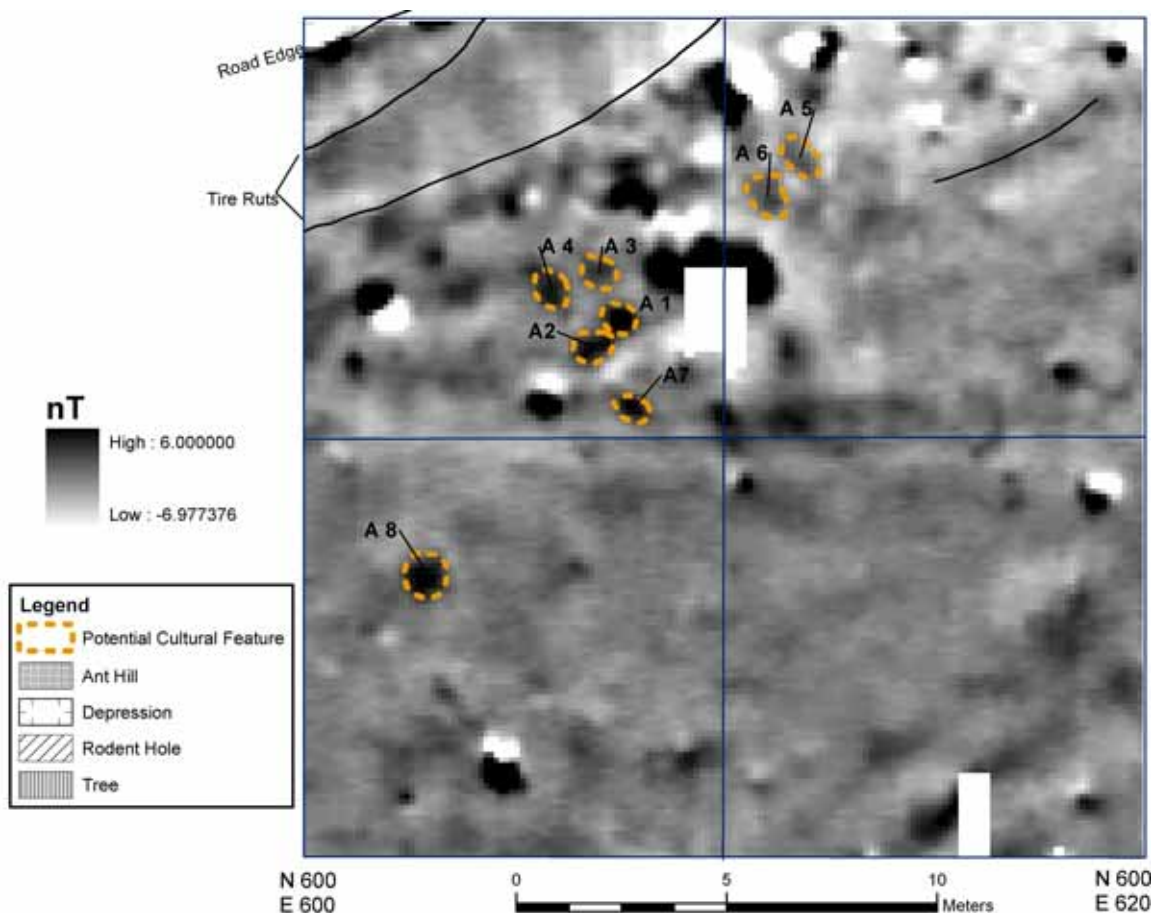


Figure 5.75. Interpretation of potential cultural features from 41CV1235, overlaid on the magnetometer data set.

Test Unit 1 was placed within the southern portion of Anomaly 8, with the hopes that an edge could be defined within the 0.50-x-0.50-m excavation unit (**Figure 5.76**). Test Unit 2 was placed within the southern section of Anomaly 1, also with the hope of defining a feature edge within the small excavation unit (**Figure 5.76**).

41CV1235 Archaeological Investigations

The archaeological investigations at 41CV1235 were focused on the two excavation units determined through the geophysical survey. In addition to these excavation units, a series of eight core samples were completed across the site to provide background soil characterization for soil samples collected from each excavation unit (**Figure 5.76**). The results of the background coring are discussed prior to the archaeological

excavations in order to offer an understanding of the soils at the site.

Core Samples

A total of eight cores were placed across the site (**Figure 5.76**). The majority of the cores were placed in areas that appeared culturally sterile based on the assessment of the geophysical results with the exception of Cores 17 and 20. These cores were placed into what was believed to be a rock midden that stretches across the northern portion of the collection grid, based on previous archaeological investigations and the resistance data (**Figure 5.73**). A complete list of all of the core logs and samples recovered from these background cores can be found in **Appendix A** on pages 177 and 178.

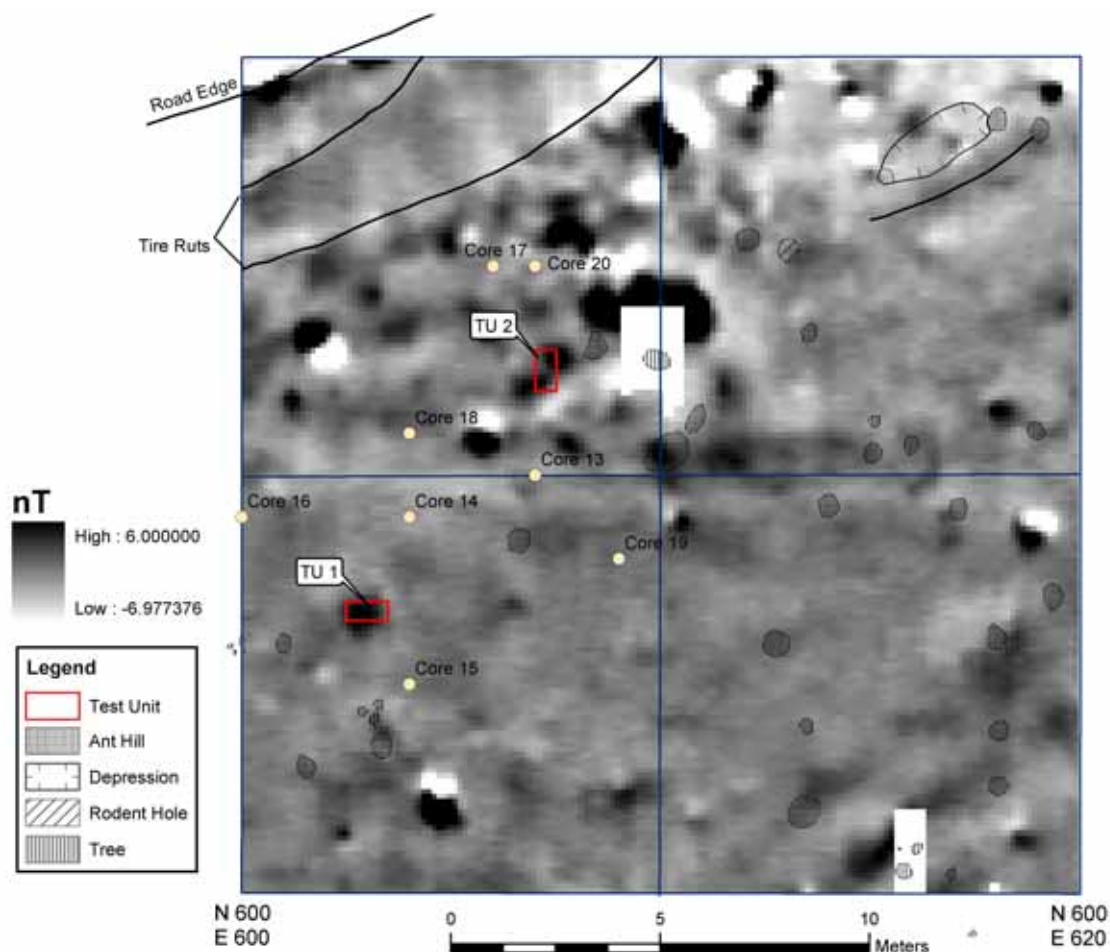


Figure 5.76. Placement of cores and test units at 41CV1235, overlaid on the magnetometer data set.

The background cores placed outside of the probable midden, Cores 13, 14, 15, 16, 18 and 19, possessed an A/AB stratigraphic sequence extending 0.40 m bs. The cores placed inside the probable midden, Cores 17 and 20, possessed an A/A2/AB stratigraphic sequence extending 0.54 m bs.

The six cores positioned outside of the probable midden possessed a surficial A-horizon that extended to average depth of 0.20 m bs (**Appendix A:177-178**). All of the A-horizon was characterized as a 10YR3/2 very dark grayish brown subangular blocky silty clay loam (**Figure 5.77**). This surface stratum was underlain by an

AB-horizon consistently across the site. The AB-horizon was characterized as a 10YR3/3 dark brown to 10YR4/4 dark yellowish brown subangular blocky silty clay loam. Average depth of sampling for the AB-horizon extended to 0.39 m bs.

The two cores positioned inside the probable midden possessed a surficial A-horizon that extended to a depth of 0.14 m bs in both cores (**Appendix A:177-178**). This surface horizon was characterized as a 10YR3/2 very dark grayish brown subangular blocky silty clay loam. This surface A-horizon was underlain by a second A-horizon that contained from 5-10 percent burned

limestone (**Figure 5.77**). The second A-horizon was characterized as a 10YR2/2 very dark brown to a 10YR4/2 dark grayish brown subangular blocky silty clay loam with 5-10 percent burned limestone inclusions. The second A-horizon extended to an average depth of 0.38 m bs. The second A-horizon was underlain by an AB-horizon that was characterized as a 10YR4/4 dark yellowish brown subangular blocky silty clay loam. Sampling into the AB-horizon extended to a depth of 0.54 m bs in both cores.

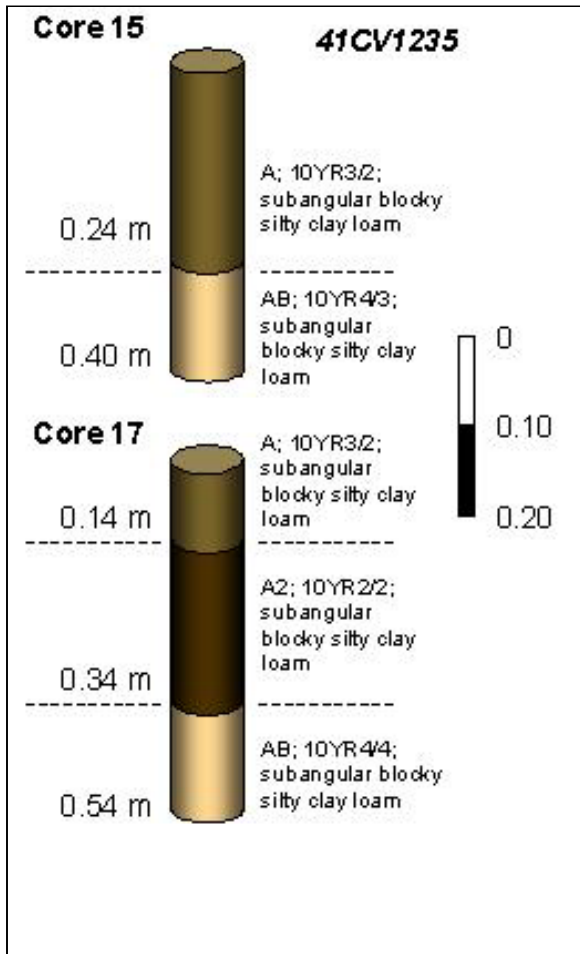


Figure 5.77. Representative core samples from 41CV1235.

The presence of the burned rock within both Cores 17 and 20 corroborated the interpretation that the broad resistance anomaly identified along the northern section of the grid is a burned rock midden (**Figure 5.73**). A number of cores were attempted for each of the two successful cores due to the density of rock along this section of the collection grid.

Soil samples from the background cores were taken from each of the identified strata (**Appendix A:177-178**). These samples were believed to be adequate to characterize the soils across the site. Results of the chemical samples are addressed in **Chapter 7**.

Test Unit Investigations

A total of two anomalies were identified for testing at 41CV1235 (**Figure 5.78**). The first anomaly was defined within the magnetometer and resistance data set as a high resistant and magnetic anomaly (**Figure 5.75**). Based on these characteristics, the anomaly was believed to be a rock hearth. Test Unit 1 was placed so as to lie within the southern portion of the anomaly (**Figure 5.76**). The second unit focused on an anomaly that possessed both a high resistance and magnetic signature within a portion of the extensive burned rock midden that runs along the northern portion of the collection grid. Test Unit 2 was placed across the center of this anomaly (**Figure 5.76**).



Figure 5.78. Excavation of units, Test Unit 1 on right and Test Unit 2 on left, at 41CV1235.

Test Unit 1 was placed within the southern portion of Anomaly 8. The 0.50-x-0.50-m unit was excavated in arbitrary 0.10 m levels within greater natural strata. The southwest corner was placed within the collection grid at N606.50 E602.50. Level 1 was excavated to a depth of 0.10 m bs, consisting of a 10YR3/2 very dark grayish brown subangular blocky silty clay loam. The level produced a total of 82 pieces of FCR as well as 36 pieces of debitage. At least 10 additional pieces of burned and cracked limestone were noted at the base of level 1. It appeared that the unit had been placed into a cultural feature, with little chance to define an edge. In an effort to identify an edge to the feature, the unit was

Non-Invasive Burial Determination

expanded to a 0.50-x-1.0-m unit oriented grid east-west (**Figure 5.79**). The expansion of the unit toward the east recovered an additional 36 pieces of FCR and 56 pieces of debitage. The eastern expansion also defined an edge to the feature at the base of the level (**Figure 5.79**). The feature matrix lightened to a 10YR4/2 dark grayish brown to a 10YR4/3 brown, with the soil outside being characterized as a 10YR4/4 dark yellowish brown AB-horizon. This soil was consistently represented as a basal stratum to the cultural deposits within the background cores.

The excavation of Level 2 within the unit was conducted within the eastern half only, allowing the majority of the feature to remain intact and undisturbed (**Figure 5.79**). The small portion of the feature lying in the eastern half was the only portion investigated. The feature continued to define itself within the northwestern corner of the eastern half of the unit. The feature matrix continued to be a consistent 10YR4/2 to 10YR4/3 dark grayish brown to brown subangular blocky

silty clay loam, but rock concentration increased until it covered the entire extent of the feature matrix at the base of Level 2. A total of 36 pieces of FCR were removed from the feature matrix along with an additional 34 pieces of debitage, and a number of the ubiquitous *rabdotus* snail shells. The AB-horizon matrix outside of the feature recovered little cultural material.

The excavation of Level 3 was almost completely contained within the AB-horizon. The base of the feature slowly pinched out into the northern wall from 0.23 to 0.30 m bs. The remainder of the level was contained within the AB-horizon. A total of 6 pieces of debitage were recovered. A final 0.10 m level was excavated into the underlying AB-horizon so as to fully expose the base of the feature. Level 4 produced no cultural material and was interpreted as being completely below the surficial cultural component of the site. Excavation within Test Unit 1 was terminated at the base of Level 4, 0.40 m bs.



Feature 1 photographed in planview, trowel indicates grid north.



Feature 1 profile and partial planview, looking grid northwest.

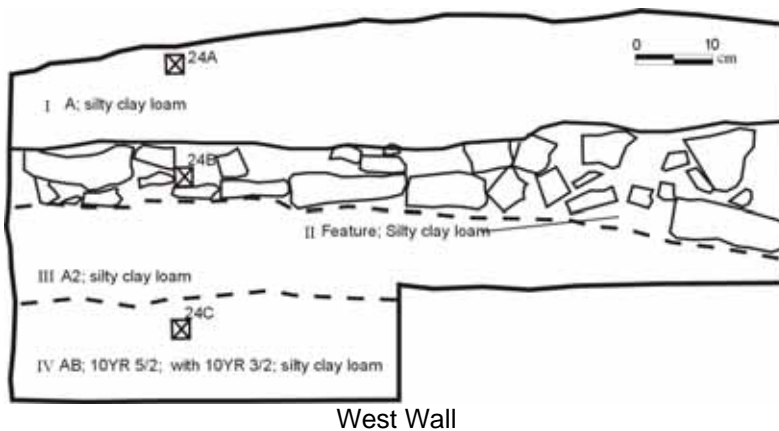
Figure 5.79. Photograph of plan and wall profiles of Test Unit 1 (Feature 1) at 41CV1235.

Test Unit 2 was placed within the southern portion of Anomaly 1 (**Figure 5.76**). The unit began as a 0.50-x-0.50-m being excavated in arbitrary 0.10 m levels within greater natural strata. The southwest corner was placed within the collection grid at N612.50 E607.00. Level 1 consisted of a 10YR3/3 dark brown silty clay loam with increasing amounts of burned limestone at the base of the level. A total of 51 pieces of burned rock, ranging from 0.03-0.07 m in diameter, were recovered from the level, the majority at the base. This rock was mixed throughout the bottom 0.05 m of the level with no specific concentrations. In addition to the burned limestone, 31 pieces of debitage were recovered from the level.

Level 2 consisted of a three-fold increase in burned rock content and darkening in soil color. The color gradually changed to a 10YR3/1 very dark gray by 0.15 m bs, and rock content increased till it constituted approximately 50 percent of the soil matrix. The level was excavated to a depth of 0.25 m bs, or 0.10 m below where the midden appeared to begin the profile (**Figure 5.80**). The unit produced over 150

pieces of burned limestone ranging in size from 0.05 to 0.15 m in diameter. In addition, 54 pieces of chert debitage was recovered.

Level 3 was excavated to a depth of 0.36 m bs, exposing the remaining basal portions of the midden and extending into the underlying AB-horizon. The midden deposits along the southern portion of the unit terminated at a depth of approximately 0.25 m bs but extended to 0.32 m bs along the northern wall. The midden was consistently characterized as a 10YR3/1 very dark gray silty clay loam, averaging approximately 150 pieces of burned limestone per level. Level 3 produced only 7 pieces of debitage from the midden portion of the level. At the base of the level, the underlying 10YR3/2 very dark grayish brown silty clay loam AB-horizon was exposed. This color is slightly darker than the usual AB-horizon identified in the background cores but this was attributed to organic leaching downward from the midden stratum. It was determined to open up a third unit along the southern wall of Test Unit 2 to improve interpretations.



Photograph of Test Unit 2 in plan at a depth of 0.30 m bs, looking grid north.

Figure 5.80. Photograph and wall profiles of Test Unit 2 and 3 (Feature 2) at 41CV1235.

Test Unit 3 was laid in contiguously with Test Unit 2 forming a 0.50-x-1.0-m unit oriented north-south within the grid (**Figure 5.80**). Level 1 within Test Unit 3 was identical as Level 1 in Test Unit 2. A total of 31 pieces of debitage were recovered from the upper 0.10 m of the soil profile. As with Test Unit 2, Level 2 within Test Unit 3 saw the beginning of the rock midden at a depth of approximately 0.15 m bs. Given this depth, Level 2 was excavated to a depth of 0.25 m bs, wherein the base of the midden was identified. The level produced a total of 28 pieces of debitage. Rock content within this portion of the midden was slightly reduced, with approximately 100-150 pieces of burnt limestone being recovered from the level, constituting approximately 35-40 percent of the level's matrix. The base of Level 2 fully exposed the 10YR3/2 very dark grayish AB-horizon.

A total of two 0.10 m thick levels were excavated into the AB-horizon in order to obtain an increased wall profile below the midden deposits (**Figure 5.80**). These two levels indicated that the organic leaching gradually reduced by a depth of 0.35 m bs. The soil color had changed to a 10YR5/2 grayish brown within the basal portions of the level from 0.40-0.45 m bs. This color was more consistent with those obtained for the AB-horizon within the background cores. The upper 0.10 cm of the level produced a total of 18 pieces of debitage. The AB-horizon contained <2 percent stone, all of which was rounded river pebbles, consistent with the alluvial terrace landform on which the site resides.

The characteristics of Feature 1, located in Test Unit 1, corroborated the original interpretation that

the anomaly was a rock hearth (**Figure 5.79**). The orientation of the feature within the unit corresponds exactly with the dimensions defined within the magnetometer data. Given this correspondence, it is postulated that the hearth is circular in planview and would measure 1.0 m in diameter. The hearth produced a total of 40 pieces of debitage, along with approximately 39 pieces of FCR. *Rabdotus* snail shells were present in quantity within the feature matrix but no exact count or collection was made.

Feature 2 appears to correspond to a denser and deeper portion of the burned rock midden contained within northern section of the unit (**Figure 5.80**). The midden extends approximately 0.10 m deeper along the northern wall of the unit in comparison to the extent of the midden noted in the east and west walls (**Figure 5.80**). The nature of the feature was not determined; it may represent just a deeper portion of the surficial rock midden or an isolated shallow basin that was infilled with the overlying midden. Based on the west wall profile, it appears that a shallow basin begins at about 0.30 m south of the north wall. Artifact content within the midden is greater within the northern portion of the unit, especially within this deeper section. Test Unit 2 produced 61 pieces of debitage within the northern portion of the unit in comparison to the 28 pieces of debitage recovered within the southern portion, as well as approximately 50 more pieces of burned rock. In total, the unit produced 62 pieces of debitage from the surficial A-horizon, 89 pieces of debitage from within the midden and 18 pieces of debitage from directly below the midden.

SURVEY AND TESTING OF SITES: CAMP LEJEUNE

Duane Simpson

6

INTRODUCTION

This chapter discusses the results of geophysical and archaeological investigations conducted at Camp Lejeune. As discussed in the **Chapter 5** introduction, this chapter is similarly subdivided into sections dealing with each of the individual site locales.

SITE 31ON71

Open Site 31ON71 (Freeman's Creek Tower)

Cultural affiliation: Multi-component, Prehistoric and Historic

Site dimensions: 657,645 m² (162 ac)

Presence of known burials (depth): Yes (historic cemetery)

Presence of known non-burial features (depth): Yes (shell pits exposed on surface)

Extent of site disturbance: Minimal, feed lot planting

Investigation techniques: Resistance, Magnetometry

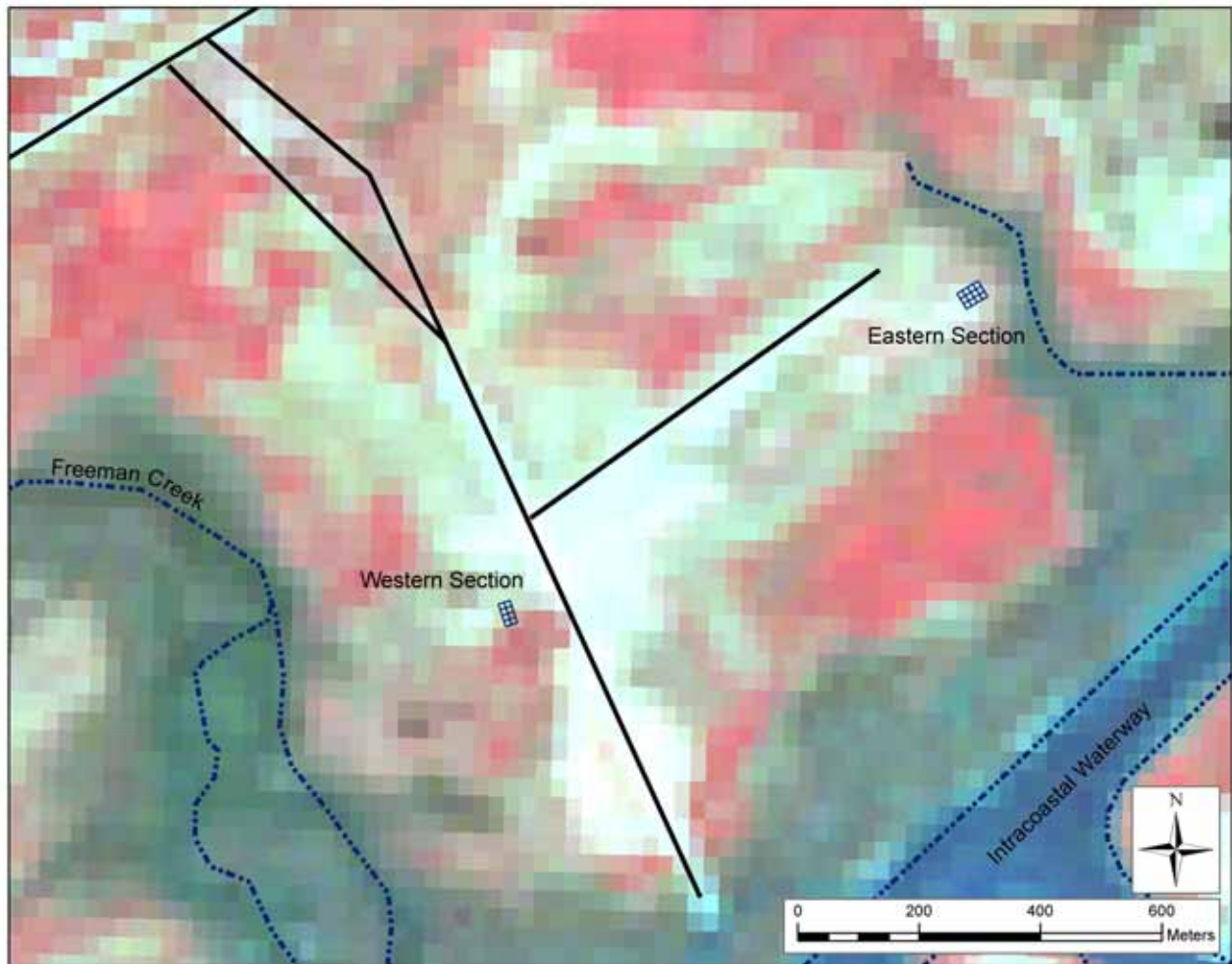
The Freeman Creek site (31ON71) extends across a broad terrace and ridgenose that is bounded by Freeman Creek on the east, the Atlantic Intercostals Waterway on the south and a small unnamed tributary to the west. The terrace and small ridgenose is surrounded by wetlands associated with the bounding drainages on the east, west and south. The portions of the site investigated lie along excessively drained Wando fine sand and moderately well drained Pactolus fine sand (Barnhill 1992).

Site 31ON71 extends over a vast area, containing a number of different prehistoric and historic loci. Artifacts recovered indicate occupations from the Early through Late Woodland (3000 to 400 B.P.). The majority of the diagnostic artifacts recovered from the prehistoric component are ceramics. A

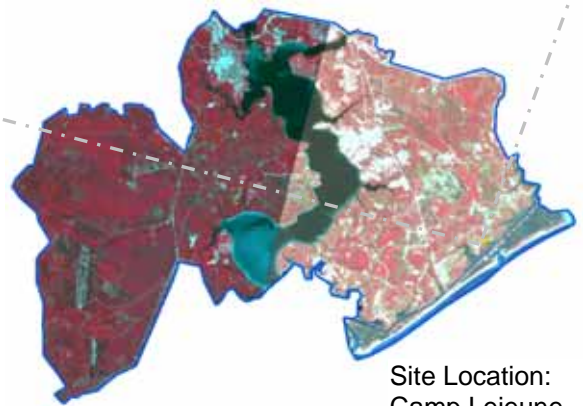
wide variety of ceramic types have been recovered at the site including: Deptford Punctate, Thoms Creek Plain and Simple Stamped, New River Cordmarked and Simple Stamped, Onslow Fabric Impressed, Hamp Landing Cordmarked and Simple Stamped, Cape Fear Cordmarked, White Oak Fabric Impressed and a variety of Hanover ceramic types (Millis 2003:39-46). A total of 2048 ceramic sherds were recovered from the site, the majority of which (n=1474) were identified as White Oak series. The White Oak series dates to the Late Woodland period.

Additional archival information indicated that an early plantation owned by the Ward Family covered the entire site area (Millis 2003). The plantation contained a house, associated barns and outbuildings and a small cemetery. All of the structures have been demolished and the cemetery is purported to have been removed in the 1940s. Initially, two areas within the larger site boundary were chosen for geophysical investigations. The two areas were placed to investigate a portion of the prehistoric component and the possible placement of the historic Ward family cemetery.

The prehistoric area was located on the far eastern end of the site (**Figure 6.1**). This area of the site had produced substantial amounts of prehistoric artifacts from surface collection and therefore was believed to represent the portion of the site with the greatest potential to contain subsurface features. The majority of the White Oak ceramics recovered from the site came from this eastern section of the site, as well as most of the smaller lithic component recovered. It was probable, based on surface collection data that a Late Woodland occupation could be expected within the area surveyed.



Eastern section of 31ON71, looking grid southwest.



Site Location:
Camp Lejeune

Figure 6.1. Site map of 31ON71.



Eastern section of 31ON71, looking grid north.



Shell concentrations on surface of Eastern section of 31ON71.

Figure 6.2. Photographs of site conditions of the eastern section of 31ON71.

Small row planted pines, high grasses and short undergrowth characterized the surface conditions in the eastern portion of the site (**Figure 6.2**). The grass and short undergrowth was cut prior to the survey in order to facilitate data collection. The small row planted pines were not cut, and offered some obstacles to data collection, but these were marginal. The cutting of the area led to some surficial disturbance due to the fact that a large tracked vehicle was used for clearing. This vehicle caused some rutting of the area, making it necessary to complete some additional processing steps for the geophysics data. The vehicle disturbance was substantial enough along the far eastern edge of the cleared area to restrict data collection, due to the fact that soils were heavily saturated in this area leading to increased degrees of rutting disturbance.

The historic cemetery located along the western portion of the site, was the second area of focus. The cemetery was purported to have been removed during the 1940s, but different local informants indicated that additional unmarked graves existed at the cemetery that were not removed. In addition, the Ward family owned a number of slaves. The slave graves were not marked and as of yet, have not been identified.

The area in which the core cemetery was recorded was covered in dense secondary growth, and was extremely wet (**Figure 6.3**). The stand of trees in which the cemetery was believed to reside covers a swampy backwater area that increases in saturation from the edge toward the interior. Disturbances to this area appeared minimal, given that it was a demarcated cemetery

up to the 1940s, and lies in an area of marginal use to agricultural or residential development.



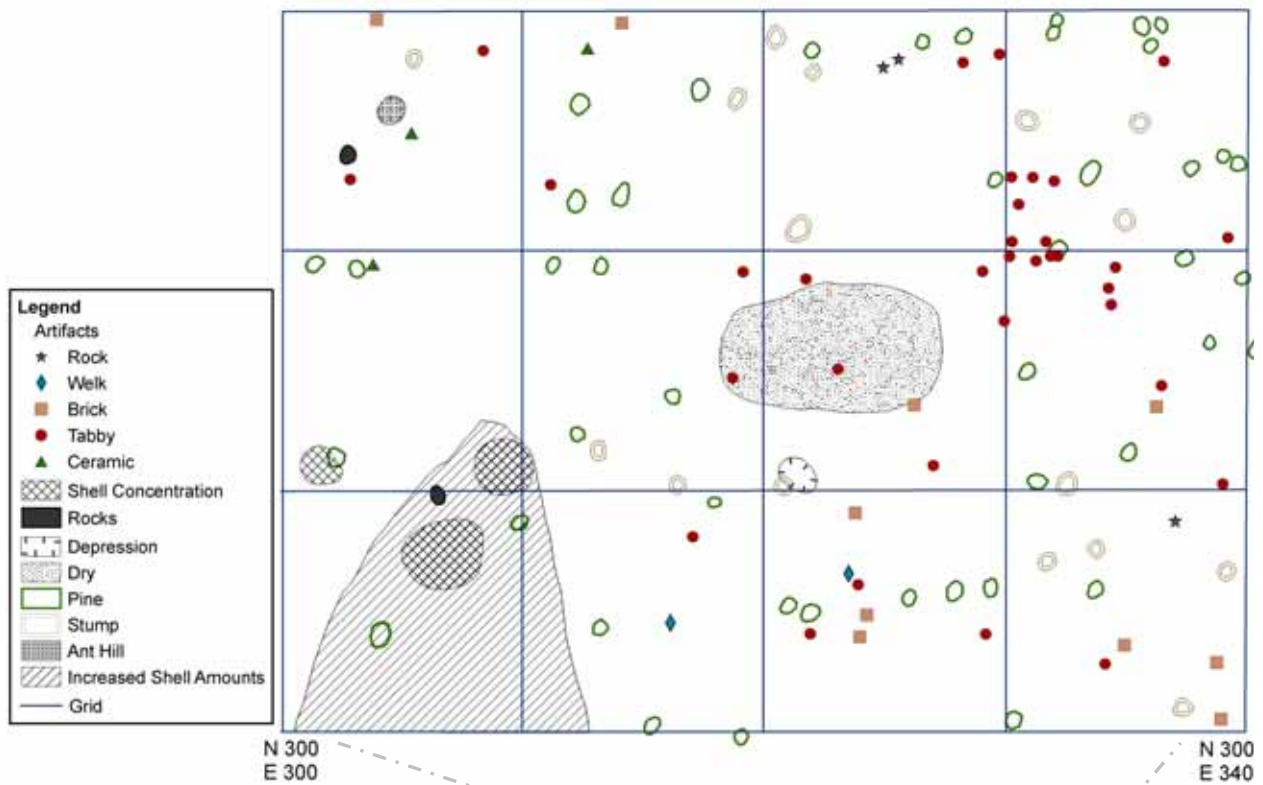
Figure 6.3. Photograph of possible Ward Cemetery location, on western section of 31ON71.

31ON71 Geophysical Survey

Geophysical investigations commenced on the western end of the site in the proposed area of the historic cemetery. An area approximately 20 m wide was cleared by hand into the dense secondary growth forest in which the cemetery was believed to lie (**Figure 6.3**). Data collection was started at the forest edge and extended into the forest 30 m. This exploratory geophysical survey discovered an older fence inside the treeline by approximately 12-15 m. The descriptions from the Millis (2003:33) report indicated that the cemetery was placed directly beside a field edge, with no obvious boundaries. It is believed that this fence demarcated the edge of the field. Additional investigations were completed beyond the fence but surface conditions became

increasingly wet and forest coverage became denser. No obvious grave shafts were observed within the data. Additional area was cleared around the exploratory 20 m swath using a large wheeled bush-hog type machine. The clearing machine created large ruts on all sides of the previously cleared area. These ruts made additional survey impossible. Given the lack of any identifiable grave shaft signatures and the deteriorated field conditions surrounding the area, survey at this portion of the site was terminated.

The focus of the geophysical survey moved to the prehistoric portion of the site (**Figure 6.4**). A 30 wide by 40 m long grid was established at the far eastern end of the site and within the area investigated by Millis (2003). This area was cleared using the same large wheeled bush-hog used at the cemetery area. This portion of the site though was not as saturated as the cemetery area, and as such, ruts were minimized, making data collection possible over the majority of the area cleared.



View of 31ON71, looking grid east.

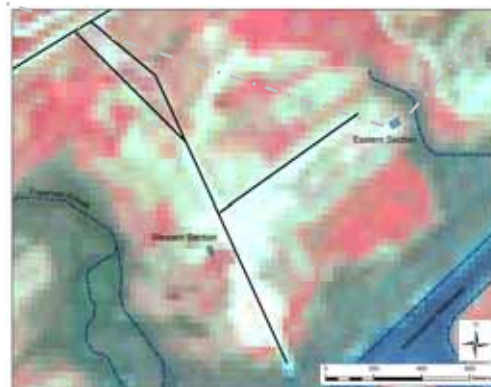


Figure 6.4. Site map of eastern section of 31ON71.

A magnetometer and 0.50 m deep resistance meter survey was completed across the collection area (**Figures 6.5** and **6.6**). Surface mapping of the area identified a number of broad surface shell middens in the area, as well as historic Tabby deposits (**Figure 6.4**). Based on the surface collection performed by Millis (2003) and surface inspections, it was believed that features would be present at the base of the plowzone, and as such a single 0.50 m deep resistance survey would be the only spacing needed to investigate the potential subsurface archaeological deposits. Both surveys utilized the methodology described for open-air survey detailed previously in **Chapter 3**.

The magnetometer data contained a substantial amount of dipoles that had a deleterious affect upon the interpretation of the data (**Figure 6.5**). The majority of this metal was probably

attributable to spent rounds and other associated military debris. The area was not screened with a metal detector prior to survey, due to the fact that little military training had apparently taken place in the area. A number of large caliber casings were noted during survey; these would be more consistent with helicopter rounds than infantry. Given this, it is probable that the metallic debris relates to casing rain falling on the site from passing helicopters. In addition to the preponderance of metallic debris, the sandy soils possessed a reduced magnetic range. The reduced magnetic range of the data, as well as the metallic debris, severely diminished the potential of the magnetometer data to identify subtle prehistoric features. Even with these hindrances a number of potential cultural anomalies were identified (**Figure 6.5**).

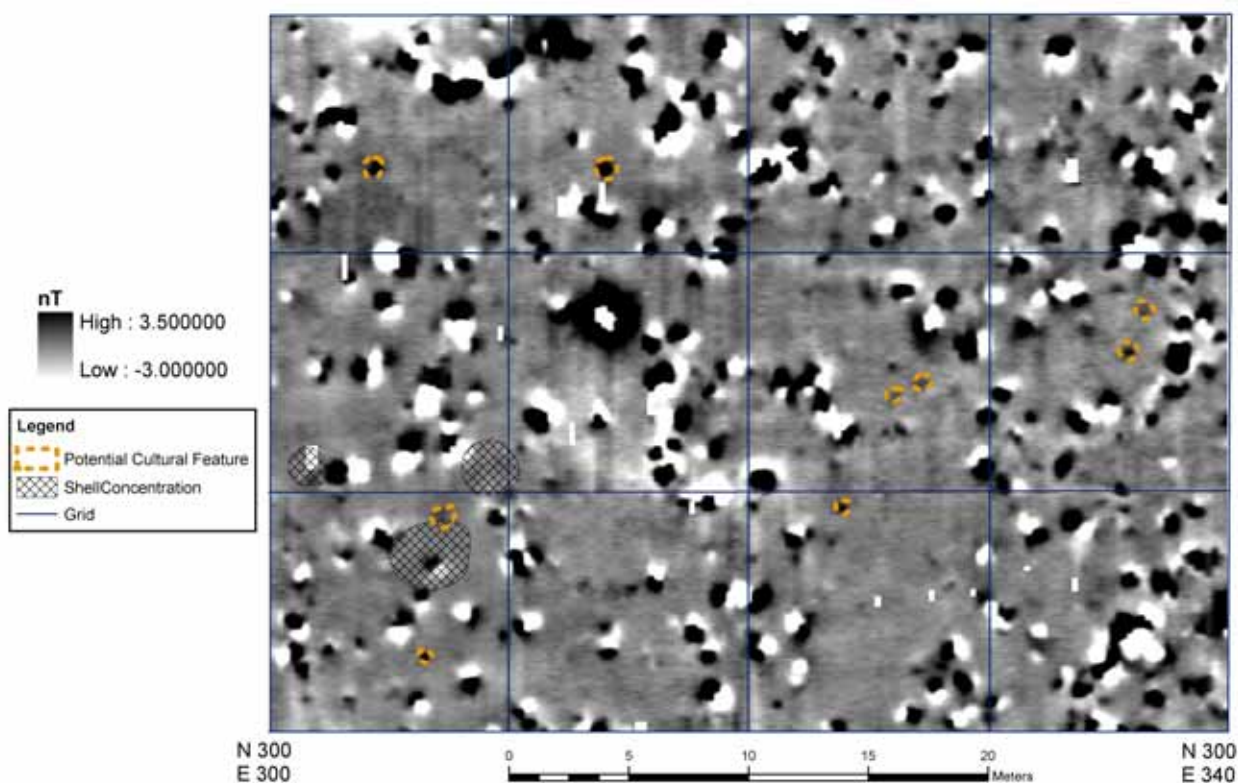
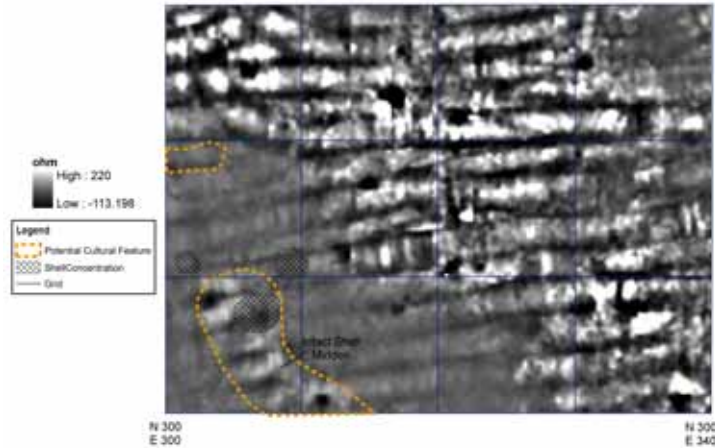


Figure 6.5. Magnetometer survey results from 31ON71.



Original resistance results, prior to Fourier transformation.

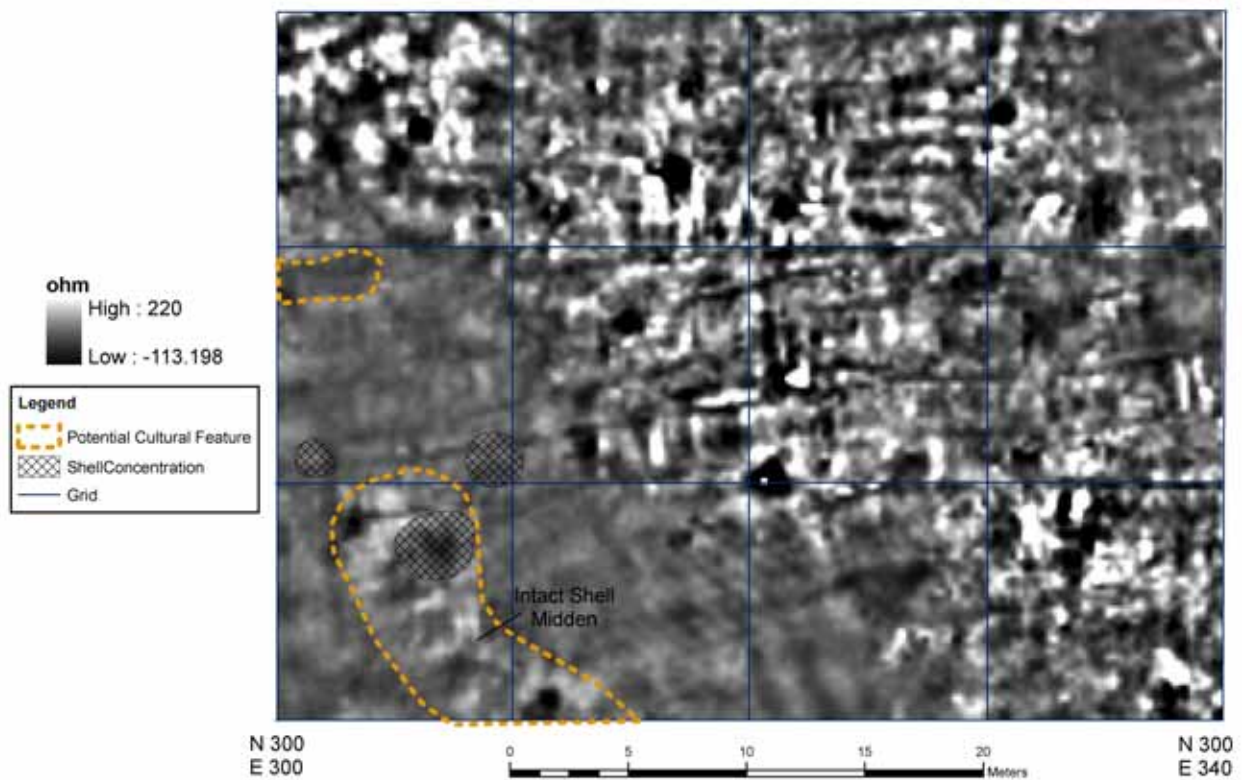


Figure 6.6. Electrical resistance survey results (Fourier Transformed) from 31ON71.

The clearing of the area produced a number of ruts that were recorded initially within the resistance data (**Figure 6.7**). These ruts had a distracting effect on the interpretation of the data. Fourier transformation was used as a data processing technique for eliminating plowcars within geophysics data, and was applied to the data to reduce and eliminate the ruts (**Figure 6.6**).

The resistance data contained a number of isolated and broad high resistant anomalies. The broad anomalies appear to correspond with the surficial shell middens mapped during the initial steps at the site (refer to methodology **Chapter 3**). Given the correlation of the surface mapping and the resistance data and a general assumption that prehistoric features would lie in proximity to these

middens, interpretations were focused on these areas of the data.



Figure 6.7. Resistance data collection at 31ON71, looking grid east. Note the ruts running diagonally across photograph.

A number of magnetic monopole anomalies were identified within the data. These anomalies ranged from 2.53 to 7.51 nT. Given that no information existed on the potential range for prehistoric features within the area, a series of investigative cores were used to determine the potential of some of these anomalies. These investigative cores revealed no cultural features, and were interpreted to represent probably historic material, such as brick fragments, mapped within the plowzone. Based on this exploratory information, the range of prehistoric features was believed to lie between 0.50 to 2.00 nT. Anomalies within this range became the focus of potential excavations.

A subtle magnetic anomaly was identified in the vicinity of N309 E307, placing it within the proposed shell midden deposits identified within the resistance data (Figure 6.5 and 6.6). The

magnetic anomaly ranged from 1.01 to 1.26 nT, placing well within the proposed range for prehistoric features at the site. Given the magnetic range of the feature and its correlation to the resistance mapped shell middens, this anomaly was chosen for further investigation.

The second anomaly chosen was based on coring results. During the collection of background core samples, a feature was identified along the western side of the grid. Assessment of the geophysical data in this area indicated a large resistance anomaly (Figure 6.6), and only a limited dipole anomaly within the magnetometer data (Figure 6.5). A prehistoric feature located within these sandy soils would not be able to produce a dipole anomaly. It is possible that metal within the plowzone obscured the subtler deeper feature. Given the identification of the anomaly within the core, a unit was placed along the southern edge of the resistance anomaly.

31ON71 Archaeological Investigations

The archaeological investigations at 31ON71 were focused on the two excavation units determined through the geophysical survey. In addition to these excavation units, a series of eight core samples were completed across the site to provide background soil characterization for soil samples collected from each excavation unit. The results of the background coring will be discussed prior to the archaeological excavations in order to offer an understanding of the soils at the site.

Core Samples

A total of eight cores were placed across the site (Figure 6.8). These cores, like the previous sites, were placed in areas that appeared culturally sterile based on the assessment of the geophysical results. A complete list of all of the core logs and samples recovered from these background cores can be found in **Appendix A** on pages 179 and 180. The background cores had some degree of variability but in general contained three strata.

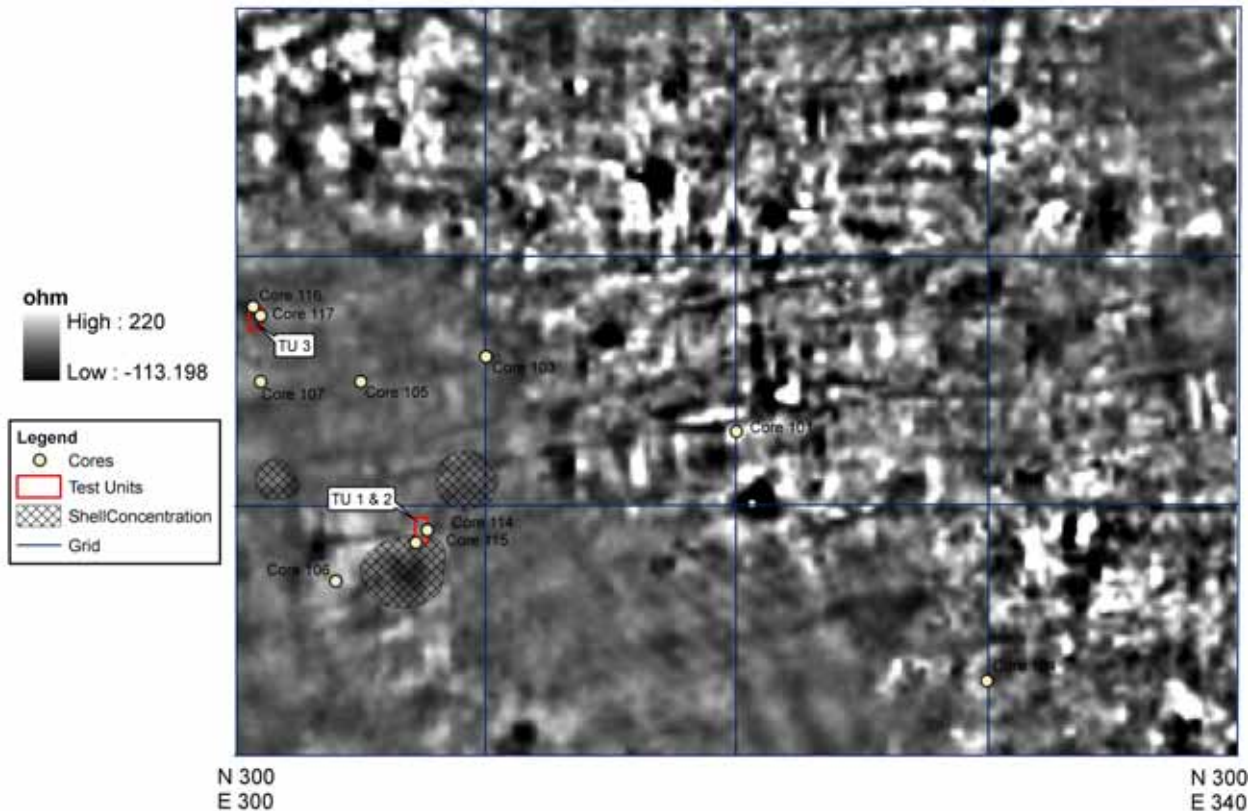


Figure 6.8. Core and test unit placement at 31ON71.

All of the cores contained a consistent Ap stratum that extended to an average depth of 0.22 m bs (Figure 6.9). The Ap stratum ranged from a 10YR3/2 very dark brown to a 10YR4/3 brown fine sand (Appendix A:179-180). Fragmented mussel shell content fluctuated within the Ap stratum across the site, based on the position of the core in relation to the high-resistance surface shell middens.

The majority of the cores contained an AB-horizon directly under the Ap stratum, with the exception of Core 102. A fine sandy 10YR5/6 yellowish brown Bw-horizon stratum underlies Core 102's Ap stratum (Appendix A:179). The lack of an AB horizon may relate to deflation, given the fact that Core 102 was placed along the highest portion of the site. The AB in this area may have been incorporated into the Ap stratum. The depth of the AB-horizon ranged from 0.26 to 0.53 m bs, and was characterized as a dark brown 10YR3/3 to very dark grayish brown 10YR3/2 fine sand mottled with 10YR5/4-10YR5/6 yellowish brown sand (Figure 6.9). The AB contained varying amounts of mussel shell depending on the

placement of the core in relation to the surface shell middens (Figure 6.8). The reason for the fluctuating depth of the horizon is unknown.

The AB-horizon was underlain in three of the cores by a yellowish brown 10YR5/6 sand Bw-horizon (Appendix A:179). This Bw-horizon extended to an average depth of 0.50 m bs and had a very gradual boundary with the underlying BC-horizon. All of the background cores terminated into a wet massive medium to fine sand BC-horizon that underlies the entire site (Figure 6.9). The BC-horizon ranged in color from 10YR6/4 light yellowish brown to a 10YR6/6 brownish yellow. Cores were terminated in this horizon at depths ranging from 0.64 to 0.80 m bs (Appendix A:179-180). Soil samples from the background cores were taken from depths approximating the depths of the two features investigated in the excavation units (Appendix A:179-180). These samples were taken from above, at and below the average depth of the features. These depths were believed to be adequate to characterize the soils across the site.

Results of the chemical samples are addressed in the following **Chapter 7**.

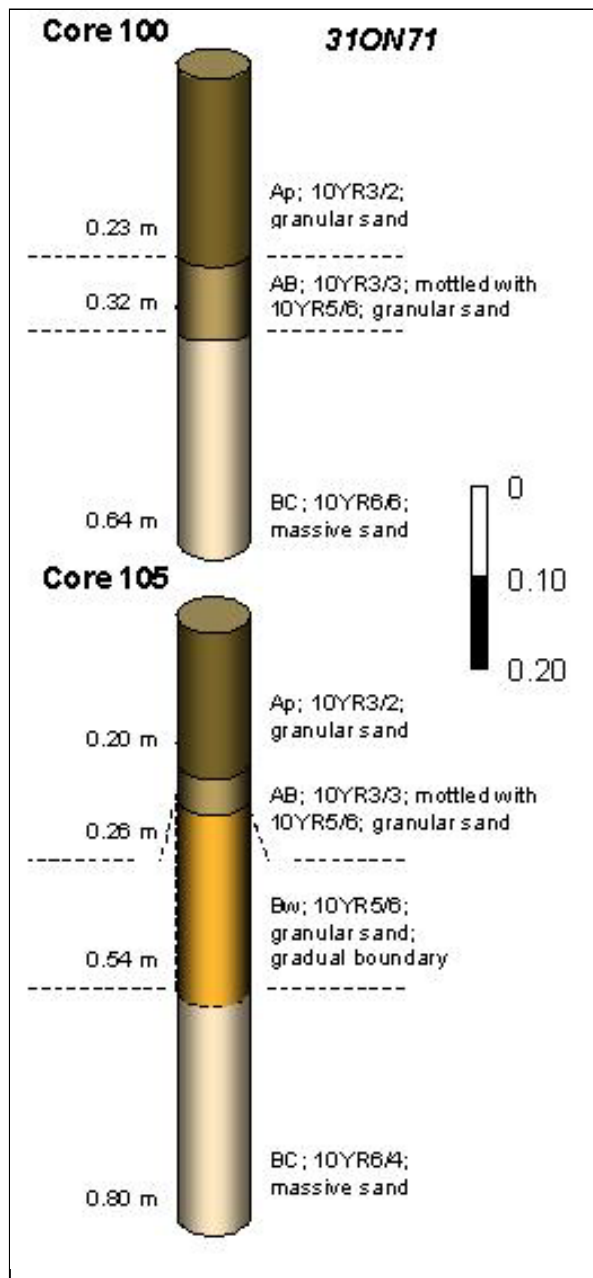


Figure 6.9. Representative core samples from 31ON71.

Test Unit Investigations

Test Unit 1 was placed to investigate the subtle magnetic anomaly that was identified within the dense shell midden that ran along the southwest corner of the collection grid (**Figure 6.8**). This unit measured 0.50-x-0.50-m with its southwest corner

located at N309.05 E307.15. The edge of the unit was placed approximately along the northern edge of the subtle magnetic anomaly.

Excavation of Test Unit 1 was completed in 0.10 m arbitrary levels within greater natural strata. Levels 1 and 2 were excavated through the Ap. The Ap consisted of a granular 10YR3/2 very dark grayish brown sandy loam with prodigious amounts of broken mussel shell mixed throughout the matrix. At a depth of 0.16 m bs, the shell content of the soil became more dense and appeared to be not as fragmented. Assessment of the unit profile at the base of Level 2 indicated that from 0.16 to 0.20 m bs the shell was completely intact and did not appear to have been disturbed by plowing. In addition to the prodigious amounts of broken and intact mussel shell, the unit produced 2 prehistoric ceramic sherds and 2 pieces of FCR.

Level 3 consisted of a 10YR4/4 dark yellowish brown loamy sand with only a few pieces of mussel shell present. Level 3 produced 1 prehistoric ceramic sherd, 1 piece of lithic debitage and a small burned mussel shell fragment. This stratum gradually graded within Level 4 to a 10YR5/6 yellowish brown sand. Level 4 produced 2 sherds from the upper 4 cm of the level. Level 5 was excavated to a depth of 0.50 m bs into the 10YR5/6 yellowish brown sand. This level produced no cultural material, and excavation was terminated.

Table 6.1 provides a summary by level of the ceramic artifacts recovered from Test Unit 1. White Oak variety ceramics, typical of Late Woodland populations, were confined to the plowzone deposits (**Levels 1-2**). Hanover Cord Marked ceramics were recovered from the intact deposits and indicates a Middle Woodland occupation. The cultural deposits in this unit appear to be distinctly separated from one another, with the Middle Woodland component extending from 16 cm bs to the base of Test Unit 1.

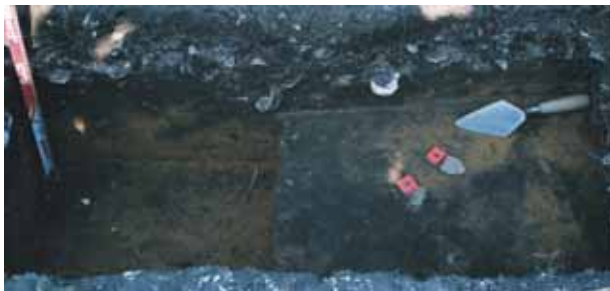
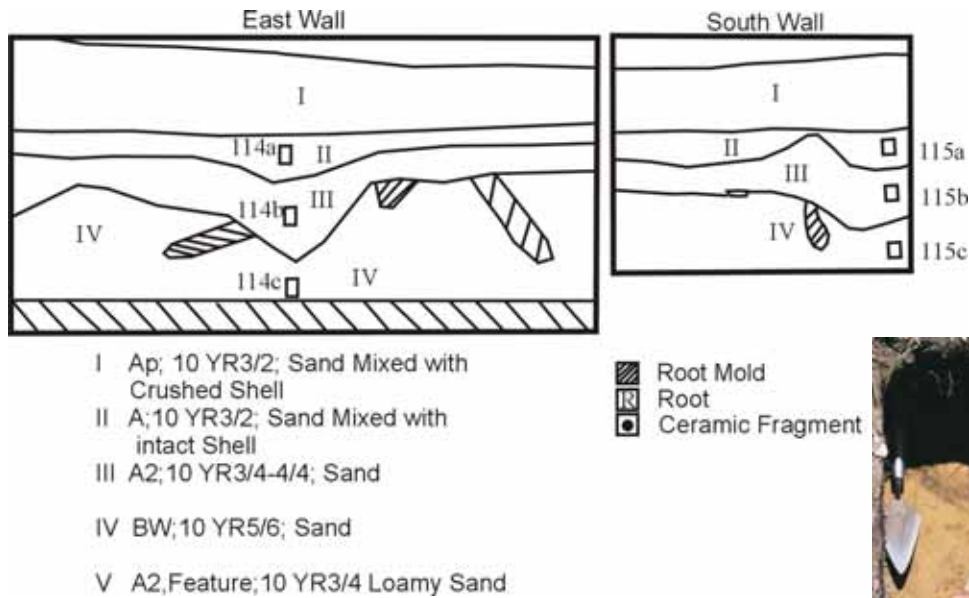
Table 6.1. Ceramics from Test Unit 1.

Lvl	N	Ceramic Type
1	1	White Oak, unclassified surface treatment
2	1	White Oak fabric impressed, var.2
3	1	Hanover Cord Marked, var. 1
4	2	Hanover Cord Marked, var. 1

Assessment of the unit indicated that the 10YR4/4 dark yellowish brown stratum was deeper along the southern wall of the unit, potentially indicating that this stratum was in fact the matrix of a feature. Based on this potential, the unit was expanded to the south, creating a 0.50-x-1.0-m long excavation unit. This 0.50-x-0.50-m extension of Test Unit 1 was labeled as Test Unit 2. This expansion placed the new southwest corner of the unit at N308.55 E307.15 within the collection grid.

Levels 1 and 2 within Test Unit 2 were identical to those within Test Unit 1. The Ap extended to a depth of 0.16 m bs, producing a total of 8 prehistoric sherds. The basal portion of Level 2 again indicated a layer of dense unplowed shell,

but no cultural material was recovered from this portion of the unit. Level 3 was identical to that observed in Test Unit 1, producing a total of 10 sherds and 1 unknown organic. At the base of Level 3, the 10YR4/4 dark yellowish brown stratum began to define itself to an amorphous linear shape (**Figure 6.10**). At the top of Level 4, two large prehistoric sherds were noted lying in situ within the linear stain. These two sherds were piece plotted and bagged separately from the remaining cultural material (**Figure 6.11**). The linear feature was excavated separately from the underlying 10YR5/6 yellowish brown sand. It extended a depth of 0.33 m bs. The remainder of Level 4 and Level 5 consisted of the 10YR5/6 yellowish brown sand that contained no additional artifacts



Photograph of Test Unit 1 and 2 east wall profile, showing intact portion of shell midden, piece plotted sherds and basal stain of Feature 1.



Photograph of Feature 1 planview, looking grid south.

Figure 6.10. Photographs, planviews and wall profiles of Test Unit 1 (Feature 1) at 31ON71.

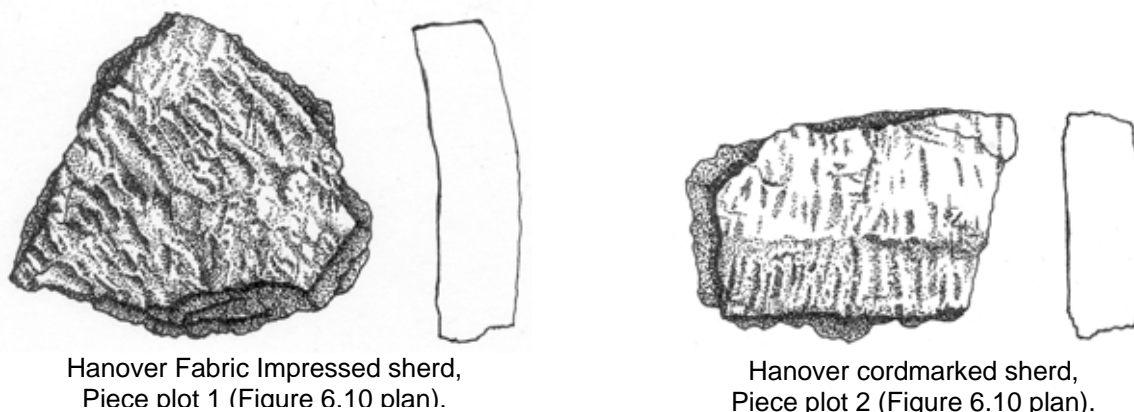


Figure 6.11. Illustrations of ceramics recovered from Test Unit 1 (Feature 1) at 31ON71, shown in planview photograph. (illustrations scale of 1:1).

Analysis of the ceramics recovered (**Table 6.2**) revealed a greater mixing of cultural components than was detected in the adjacent Test Unit 1. Hanover Cord Marked varieties, associated with the Middle Woodland period were recovered from the plowzone deposits in conjunction with Late Woodland White Oak ceramics. In addition a single White Oak ceramic was identified in Level 3, though this level was dominated by Hanover and unclassified ceramic sherds. Level 4 produced Hanover sherds exclusively making it consistent with the Middle Woodland component observed at this level in the adjacent Test Unit 1.

Table 6.2. Ceramics from Test Unit 2.

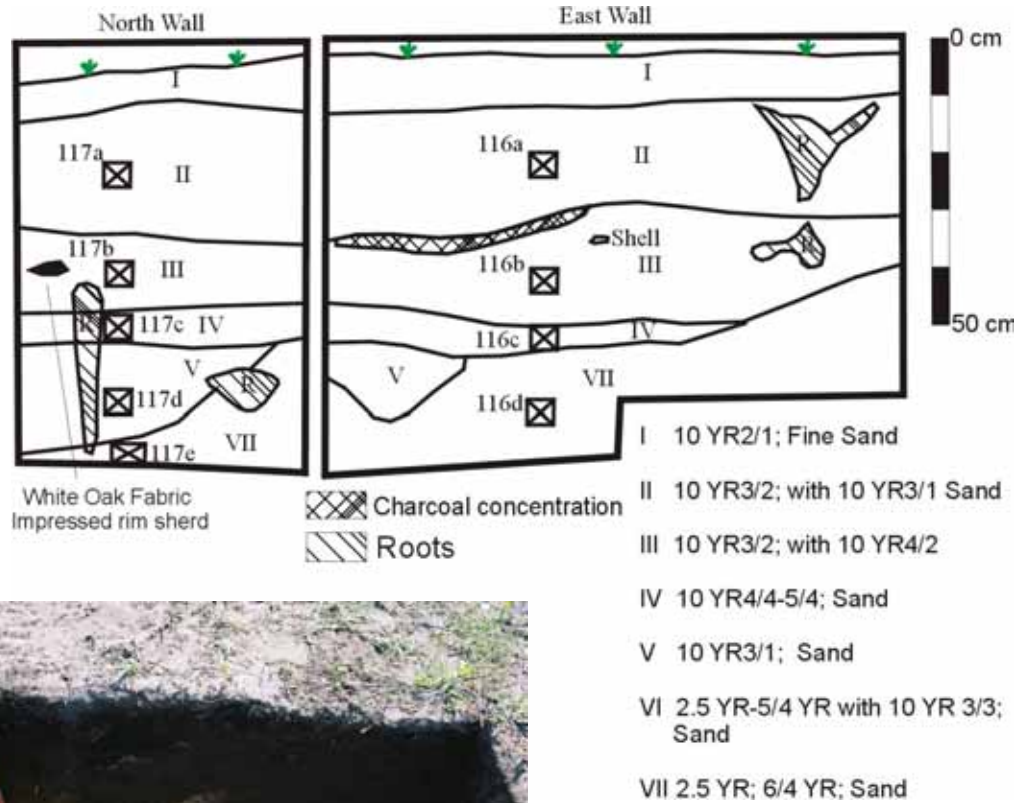
Lvl	N	Ceramic Type
1	4	White Oak Fabric Impressed, var. 2
	1	White Oak, unclassified surface treatment
	1	Hanover Cord Marked, var. 2
2	1	White Oak Fabric Impressed, var. 3
	1	Hanover Cord Marked, var. 1
3	4	Hanover Cord Marked, var. 1
	1	White Oak Fabric Impressed, var. 2
	5	Unclassified residual sherds
4	1	Hanover Fabric Impressed, var. 2
	1	Hanover Cord Marked, var. 1

The profile of the unit indicated a broad feature extending from the base of the dense shell midden running diagonally through the unit (**Figure 6.10**). Cores placed around and in the shell midden did not contain a similar stratum at

the base of the plowzone. The exact purpose of the feature is unknown. Total artifact count for the feature matrix from both units includes: 17 prehistoric sherds, 1 piece of debitage, 1 burnt shell fragment and 1 unknown organic. A total of six soil samples were collected from the intact portions of the upper strata, the feature matrix and the underlying subsoil stratum (**Appendix A:180**). Core 114 was placed at N309.05 E307.65 and Core 115 was placed at N308.55 E307.20 (**Figure 6.10**).

Test Unit 3 was placed to investigate the probable feature that was identified during the background coring within a broad high resistance anomaly along the western portion of the grid (**Figure 6.8**). This unit measured 0.50-x-1.0-m with its southwest corner located at N318.00 E300.50. This placed the unit approximately along the southern edge of the high resistance anomaly.

Excavation of Test Unit 3 was completed in 0.10 m natural levels within greater natural strata. Levels 1, 2, and 3 were excavated through the Ap. The Ap consisted of a granular 10YR2/1 black massive sandy loam surface layer that graded into a 10YR3/2 very dark grayish brown sand. The upper two strata that constituted the Ap contained a total of 11 prehistoric sherds, 1 bone and 1 unknown organic fragment. At approximately the base of Level 3, the 10YR3/2 very dark grayish brown granular sand began to lighten with the inclusion of 10YR4/2 dark grayish brown sand (**Figure 6.12**).



Photograph of west wall profile of Test Unit 3.

Figure 6.12. Photographs, planviews and wall profiles of Test Unit 2 (Feature 2) at 31ON71.

In Level 4, the mottling of the 10YR4/2 dark grayish brown increased within the overall 10YR3/2 very dark grayish brown matrix, with isolated charcoal flecking in portions of the level. This stratum constituted the upper portions of the feature. The level produced 6 total prehistoric sherds (Figure 6.13). One of these six sherds was a large rim that was found lying horizontally along the northern wall of the unit, and piece plotted at a depth of 0.34 m bs (Figure 6.14). It was identified as a White Oak Fabric Impressed rim sherd (Figure 6.13). The White Oak ceramic series has been dated to the Late Woodland period.

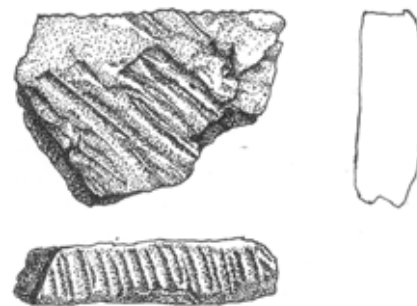


Figure 6.13. A possible Deptford Simple Stamped sherd recovered from the general level 4 collection within Test Unit 3 at 31ON71, shown in plan and profile. (illustration scale of 1:1).

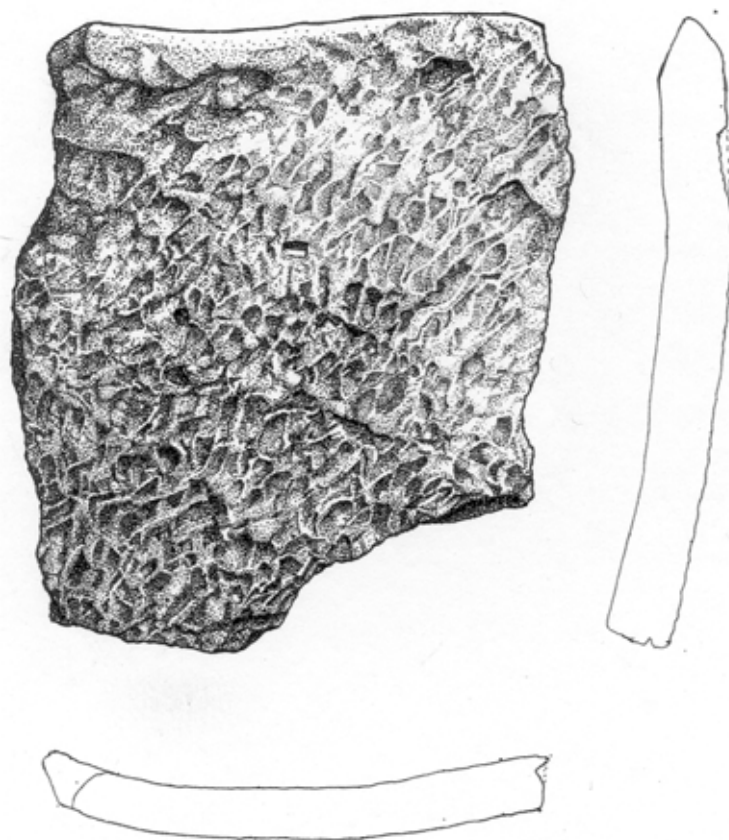


Figure 6.14. An illustration of a White Oak Fabric Impressed rimsherd recovered from the Level 4 within Test Unit 3 at 31ON71, shown in plan and profile. (illustration scale of 1:1).

The excavation of Level 5 revealed the earliest definition of the feature within the southern portion of the unit. At the base of Level 5, the feature matrix was contained within approximately the northern half of the unit only (Figure 6.12). The color of the feature was found to lighten to a 10YR5/4 yellowish brown and turn darker again to a 10YR4/4 dark yellowish brown along the northern edge of the unit. Assessment of the profile indicates that this lighter 10YR5/4 yellowish brown portion of the feature appears to be a different zone within the feature. This lower zone contained 3 sherds, 1 piece of debitage and 2 bone fragments (neither of which were large enough for analysis).

The darker 10YR4/4 remaining portion of the feature darkened to a 10YR3/1 very dark gray along the northern edge of the unit within Level 6.

This had increased amounts of charcoal flecking. This small section of the feature contained 1 sherd and 1 piece of debitage. The feature continued to dip toward the northern portion of the unit (Figure 6.12). A small stain still persisted in the northern 0.20 m of the unit only. Based on the reduction in the feature's extent, Level 7 was excavated only in the northern half of the unit, given the fact that the southern half of the unit had been completely contained within the underlying 2.5Y6/4 light yellowish brown massive sand C-horizon since the beginning of Level 6.

Level 7 was excavated to a depth of 0.70 m bs. The remaining feature stain ended from 0.63 to 0.67 m bs. This small section of the feature produced no cultural material. The underlying C-horizon portions of the unit did not produced any cultural material from any level. The excavation

was terminated due to the fact that the base of the feature had been defined and the general lack of artifacts recovered from the underlying C-horizon.

Analysis of the ceramic artifacts recovered from Test Unit 3 revealed Middle and Late Woodland diagnostics (**Table 6.3**). The Middle Woodland ceramics, which included Hanover varieties, were recovered from Levels 3-6 The Late Woodland ceramics, represented by White Oak varieties, were recovered from Levels 1-5. The predominance of Middle Woodland ceramics logically increases with depth, but only Level 6 contained exclusively Middle Woodland ceramics.

Table 6.3. Ceramics from Test Unit 3.

Lvl	N	Ceramic Type
1	1	White Oak, unclassified surface treatment
	1	Unclassified residual sherd
2	1	Unclassified sand temper, simple stamped surface treatment
	1	White Oak Fabric Impressed, var. 2
3	2	Unclassified sand temper, simple stamped surface treatment
	3	White Oak Fabric Impressed, var. 2
	1	Hanover Fabric Impressed, var. 2
	1	Hanover, unclassified surface treatment
4	1	Unclassified sand temper, simple stamped surface treatment
	1	Unclassified residual sherd
	2	White Oak Fabric Impressed, var. 2
	1	Hanover, unclassified surface treatment
	1	White Oak Fabric Impressed, var. 2
5	1	White Oak Fabric Impressed, var. 2
	1	Unclassified sand temper, simple stamped surface treatment
	1	Unclassified residual sherd
6	1	Hanover, unclassified surface treatment

The profile of the unit indicated a deep basin that extended from the Ap to a depth of 0.67 m bs. The feature contained little in the way of shell, faunal or botanical material, with only slightly greater amounts of prehistoric lithics and ceramics. The White Oak Fabric Impressed sherd recovered from the top of the feature places it in the Late Woodland occupation of the site. A total of nine soil samples were collected from the Ap,

the various zones represented within the feature and the underlying subsoil stratum (**Appendix A:180-181**). Core 116 was placed at N317.65 E301.00 and Core 117 was placed at N318.00 E300.70 (**Figure 6.12**).

SITE 31ON1019

Open Site 31ON1019 (Golf Course)

Cultural affiliation: Middle to Late Woodland

Site dimensions: 15,137 m² (3.74 ac)

Presence of known burials (depth): Yes (75 cm bs)

Presence of known non-burial features (depth): No, but high potential

Extent of site disturbance: Minimal

Investigation techniques: Resistance, Magnetometry

The site is located along an elevated terrace of Northeast Creek, part of the New River drainage. The site is characterized as a Marvyn loamy fine sand (Barnhill 1992). The site is contained within one of the active golf courses at Camp Lejeune.

The area was archaeologically tested in 2001 by TRC-Garrow. Shovel testing identified a range of artifacts including: White Oak Fabric Impressed, Onslow Fabric Impressed and Hanover Fabric Impressed ceramic sherds. These ceramic types range in age from the Middle to Late Woodland periods (2000 to 600 BP). Based on initial shovel testing, a 1-x-1-m test unit was excavated. This unit partially exposed a single human burial at a depth of approximately 0.75 m bs. The lower portion of the burial extended into the northern wall of the test unit. Excavation was terminated upon identification of a human burial. This burial is believed to be a portion of the Middle to Late Woodland occupation. Following fieldwork a plastic fence was constructed around the burial location, and a plaque erected explaining the significance of the fenced-off area (**Figure 6.15**). This fence measures approximately 12-x-12-m. Disturbance related to golf course construction was kept to a minimum across the core area of the site (**Figure 6.16**).



Figure 6.15. View of fenced area of 31ON1019, looking grid north.

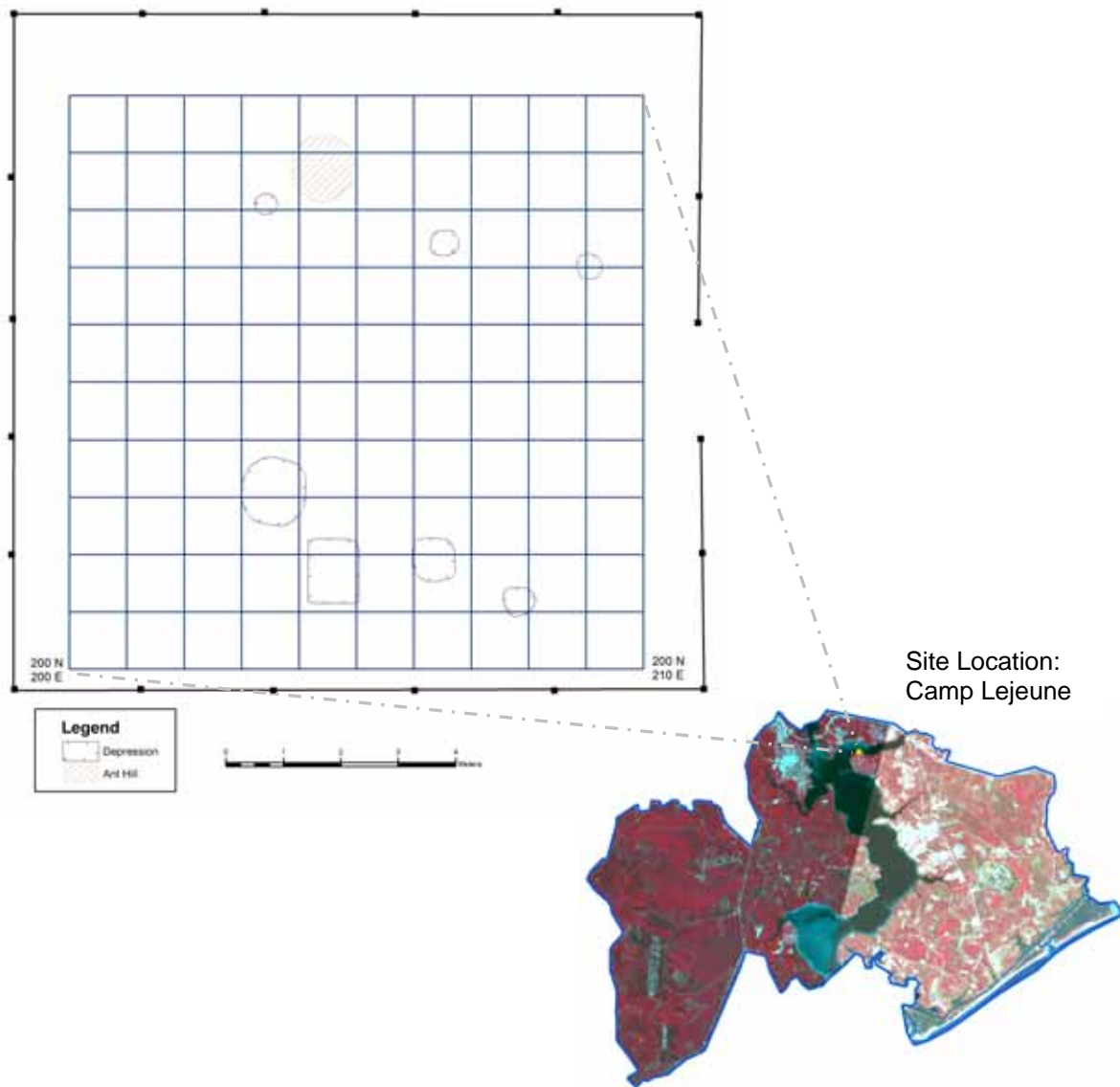


Figure 6.16. Site map of 31ON1019.

31ON1019 Geophysical Survey

A single 10-x-10-m grid was established within the fenced area (**Figure 6.16**). The previous test unit was identified along the southern end of the grid as a shallow squarish depression. This unit and the burial identified within was the central focus of the geophysical survey.

A total of two geophysical data collections, magnetometry and a 0.75 m deep resistance survey, were completed at the site. The proximity of the fence to the grid had a deleterious effect on the magnetometer data collection (**Figure 6.17**), by obscuring the more subtle details due to the amount of metal contained within the fence. Given the placement of the burial in relation to the fence it was not possible to reduce this effect during data collection, nor during post-processing.

The magnetometer data set was of little interpretative use for determining the placement of the sample tests, due to the high incidence of metal surrounding the area, as well as the much reduced magnetic range of the loamy sand soils

(**Figure 6.18**). Assessment of the test locale did not indicate any signature above background values. A dipole does appear within the general area of the test unit, and was attributed to metal left within the unit by the previous excavators. Thus interpretations and placement of tests was driven by the resistance data set (**Figure 6.19**).



Figure 6.17. Magnetometer survey at 31ON1019, looking grid east.

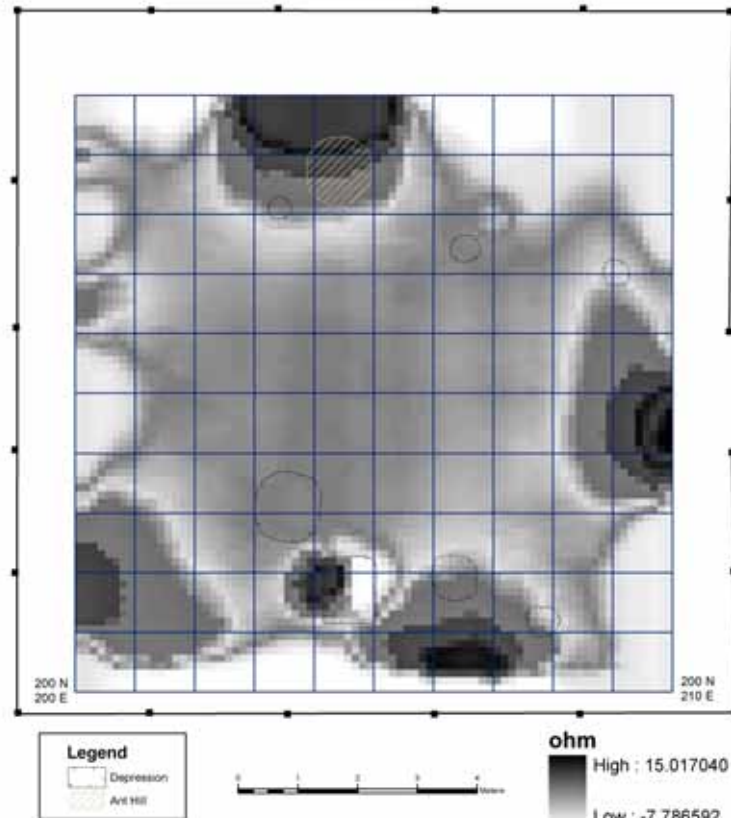


Figure 6.18. Magnetometer survey results from 31ON1019.

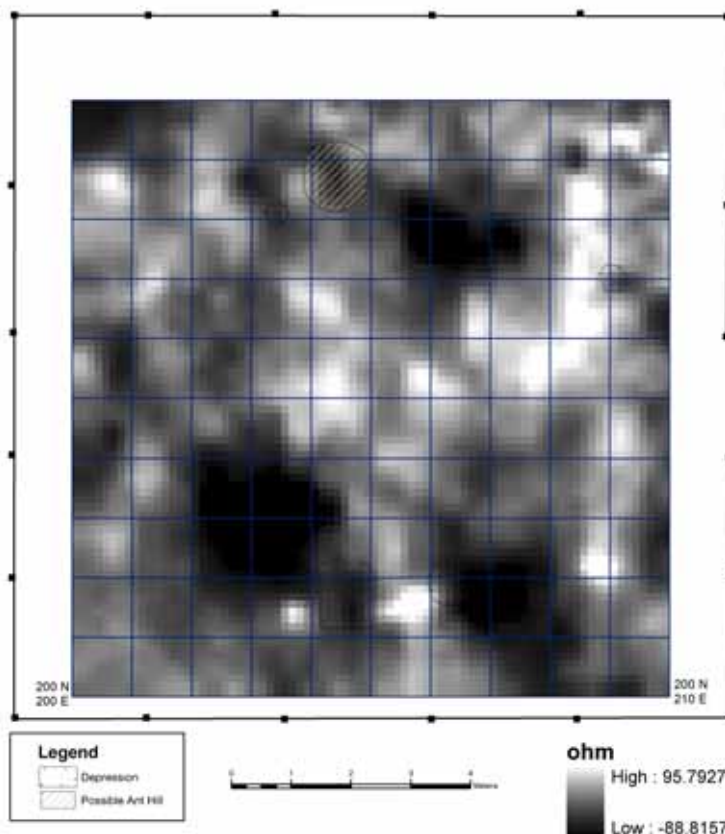


Figure 6.19. Electrical resistance survey results from 31ON1019.

The resistance data set indicated a squarish anomaly extending north from the previous test unit locale (**Figure 6.20**). This anomaly was interpreted as the unexcavated portion of the burial identified previously in 2001. This location became the focus of later archaeological coring. Based on the prior knowledge of the burial and its probable identification within the resistance data, no test excavation units were deemed necessary. Soil testing was limited to core sampling only.

31ON1019 Archaeological Investigations

The archaeological investigations at 31ON1019 were focused solely on the burial identified during

previous survey and within the resistance data set (**Figure 6.20**). The investigation was limited to a series of core samples taken from both the burial locale and a selection of background areas that characterize the chemical signatures of the site (**Figure 6.21**). The placement of the core samples was determined based on the geophysical results.

A total of six cores were placed at the site (**Figure 6.21**). Two of these cores were placed into the proposed burial anomaly, and four background cores (**Appendix A:181-182**). The background cores had some degree of variability but in general contained three strata.

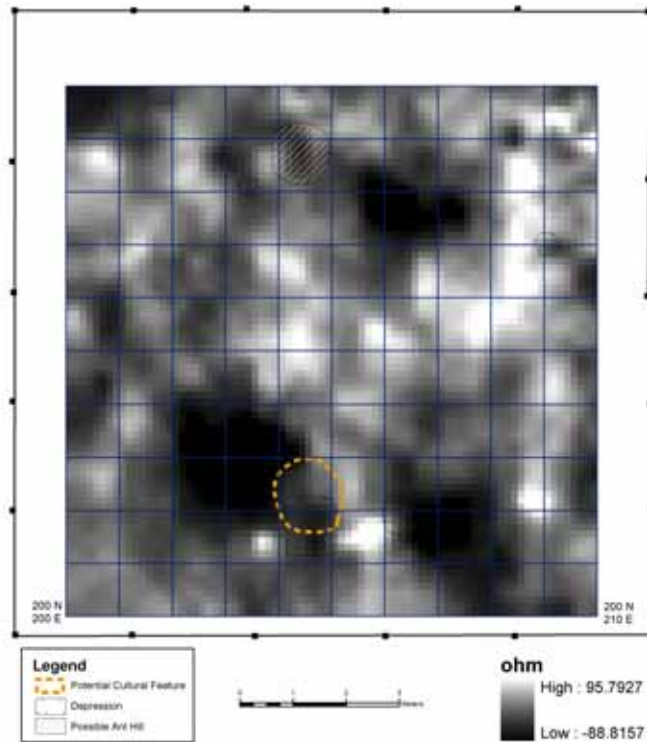


Figure 6.20. Interpretation of potential cultural feature from 31ON1019, overlaid on the resistance data set.

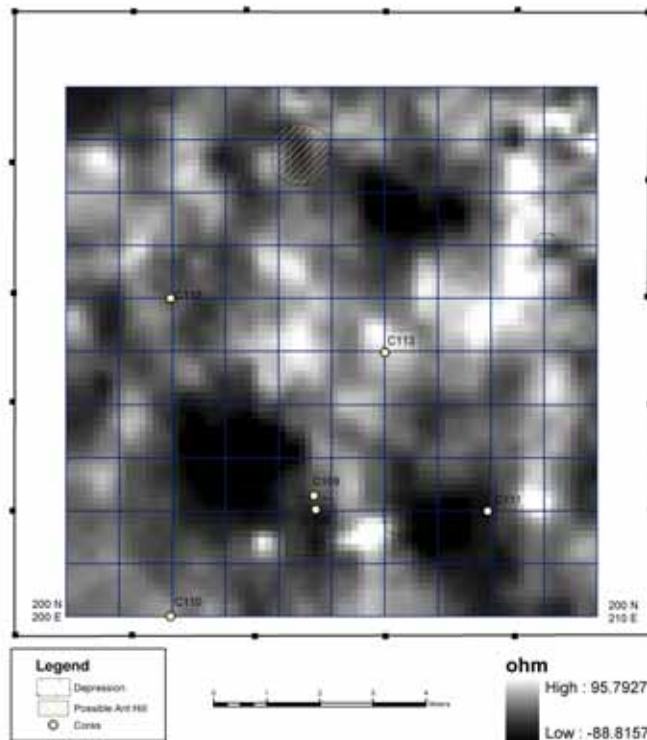


Figure 6.21. Placement of cores at 31ON1019, overlaid on the resistance data set.

All of the cores contained a consistent A-horizon stratum that extended to an average depth of 0.15 m bs (**Figure 6.22**). The A-horizon ranged from a 10YR2/2 to a 10YR4/3 very dark brown to brown fine sand. The A horizon was underlain by a fine sandy stratum that ranged in color from a 10YR4/3 brown to a 10YR5/6 yellowish brown to a 10YR6/4 light yellowish brown. This second horizon extended to an average depth of 0.25 m bs. The degree of variability is probably attributable to isolated disturbances, possibly related to bioturbation or historic disturbance. The second stratum was consistently underlain by a fine sand 10YR7/4 very pale brown C-horizon. This stratum consistently extended to at least 0.93 m bs. In most of the cores, this stratum usually became more mottled with a 10YR5/6 yellowish brown to 10YR8/6 yellowish sand (**Appendix A:181-182**).

The two cores placed in the probable burial locale produced almost identical core samples (**Appendix A:181-182**). These cores, like the background, consistently possessed a 0.10 to 0.15 thick surficial A-horizon (**Figure 6.22**). This surface stratum was underlain by a 0.55 to 0.60 m thick BC-horizon characterized as a 10YR6/4 light yellowish brown fine sand. At a depth of 0.65 to 0.70 m bs, a black 10YR2/1 stain was discovered that extended approximately 0.10 m within both cores. This stain also contained small fragments of bone within Core 108 (**Appendix A:181**). The same very pale brown 10YR7/4 massive fine sand C-horizon observed within the background cores extended from the black feature stain to the end of both core samples.

Based on the recovery of small bone fragments within Core 108 and the very dark 0.10 m thick stain, the interpretation that the anomaly was in fact a burial locale was confirmed. The bone observed within Core 108 was immediately removed from the sample and returned to the core location. Samples were recovered from the feature context, as well as from both above and below the feature stratum (**Appendix A:181**). Samples from the background cores were taken from depths close to the feature's depth (**Appendix A:181-182**). These samples were taken from above, at and below the average depth of the burial. These depths were believed to be adequate to characterize the soil stratum at the depth of the burial. Results of the chemical samples are addressed in the following **Chapter 7**.

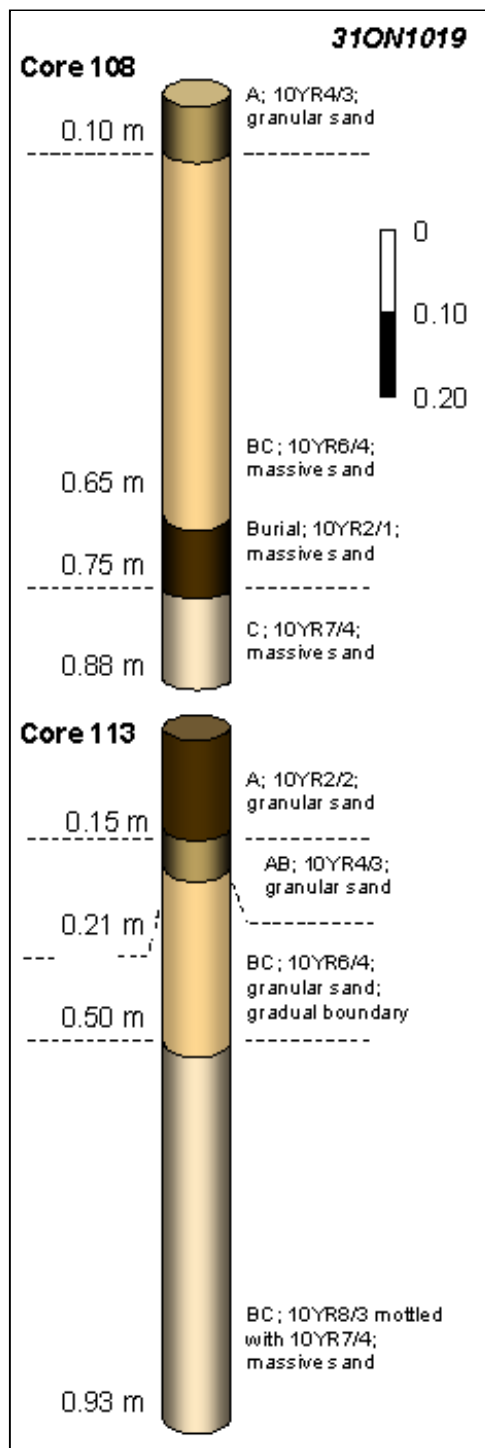


Figure 6.22. Representative soil core profiles from 31ON1019.

SITE 31ON1236**Open Site 31ON1236 (Mile Hammock Bay)****Cultural affiliation:** Early to Late Woodland**Site dimensions:** 506,710 m² (125.21 ac)**Presence of known burials (depth):** Yes (0.75 m bs)**Presence of known non-burial features (depth):** Unknown**Extent of site disturbance:** Unknown**Investigation techniques:** Resistance, Magnetometry

Site 31ON1236 has been interpreted as a short to long-term prehistoric habitation containing an extensive surface shell midden. The site is located along broad elevated terraces of the New River, and drained by a series of small tertiary drainages. The drainages flow into Traps Bay, a saltwater embayment that is a portion of the New River estuary, approximately 200 m west of the site. The site is characterized by a wide variety of different soil types including: Marvyn loamy fine sand, Pactus fine sand, Wando fine sand, Kureb fine sand, Bohicket silty clay loam and Muckalee loam (Barnhill 1992). The variety of different soil types is due to the large size of the site, 125.21 acres. The area of central interest to the current investigations is typified by the loamy to fine sand soil types.

The area was archaeologically tested in 2002 by TRC-Garrow. Shovel testing and test units excavated at the site identified a range of prehistoric artifacts including: shell, faunal material, FCR, a limited collection of lithic material and a wide variety of ceramics. Ceramic types include varieties from the Cape Fear series, White Oak series, Onslow series, Hanover series, Hamps Landing series and Thoms Creek plain sherds. These ceramic types range in age from the Early to Late Woodland periods (3000 to 600 BP). Based on initial shovel testing, a small set of 1-x-1-m test unit were excavated at different locations across the site. One of these test units discovered a flexed burial at a depth of approximately 0.70 m bs. The unit was expanded to a 1-x-2-m so as to fully expose the burial. Excavation was terminated upon identification of a human burial. Disturbance to the burial location area appears to be minimal. The area surrounding the burial location is covered with patchy dense secondary growth.

31ON1236 Geophysical Survey

A small 5-x-5-m area was cleared by hand around the location of the burial (**Figure 6.23**). The dense secondary growth that typifies the area made the creation of a larger grid almost impossible without the assistance of large mechanized clearing devices (**Figure 6.24**), thus the investigations at the Mile Hammock Bay site were limited to a 5-x-5-m survey just around the previously identified burial location. Surface inspection of the grid identified the previous excavation unit as a depression measuring approximately 1-x-2-m (**Figure 6.23**).



Figure 6.23. View of the small 5-x-5-m area, looking grid south, that was cleared for data collection at 31ON1236.

A magnetometer and a 0.75 m deep resistance survey were completed at the site (**Figure 6.25** and **6.26**). The depth of the resistance survey was predicated on the depth of the flexed burial based on previous archaeological work at the site. Given that the burial was completely uncovered by a test excavation unit, it was expected that the geophysics would record the unit and, to a reduced degree, the actual burial. Assessment of both data sets corroborated this theory.

The magnetometer data contains two dipoles in the approximate location of the previous test unit (**Figure 6.25**). The distance between the two dipoles approximates the dimension of the test excavation unit. The dipoles probably relate to metallic material included in the back-filling of the unit. The excavation of the unit and the associated metal debris has obscured the more subtle details that would be associated with the prehistoric burial.

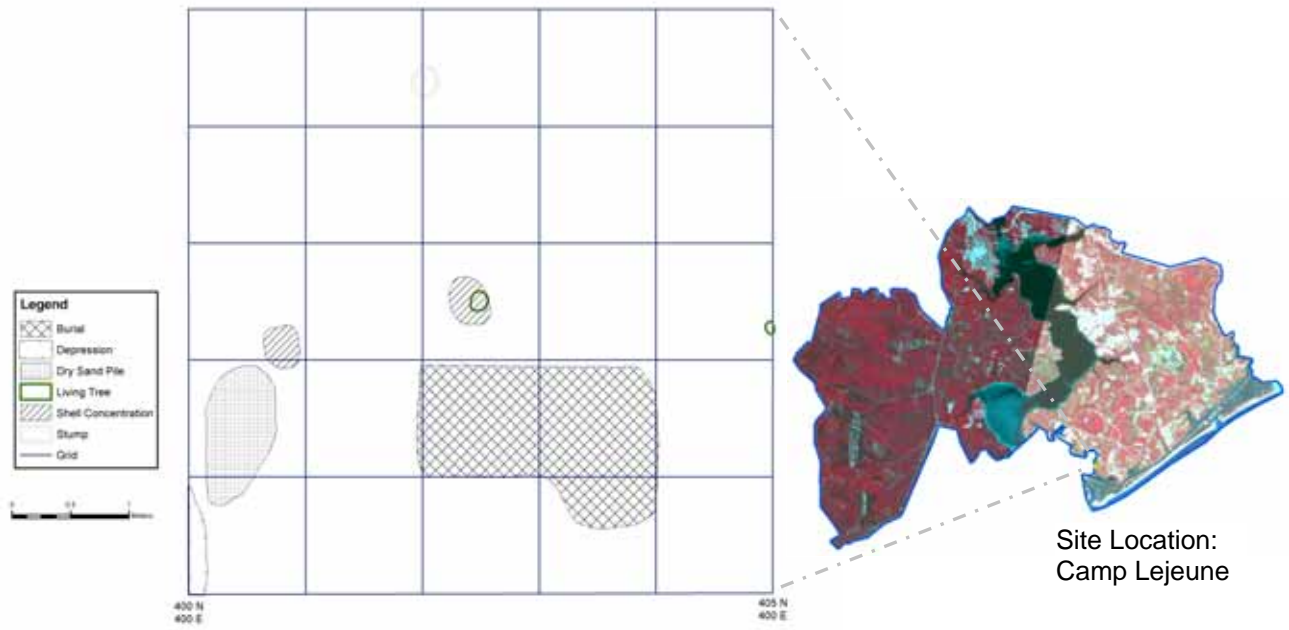


Figure 6.24. Site map of 31ON1236.

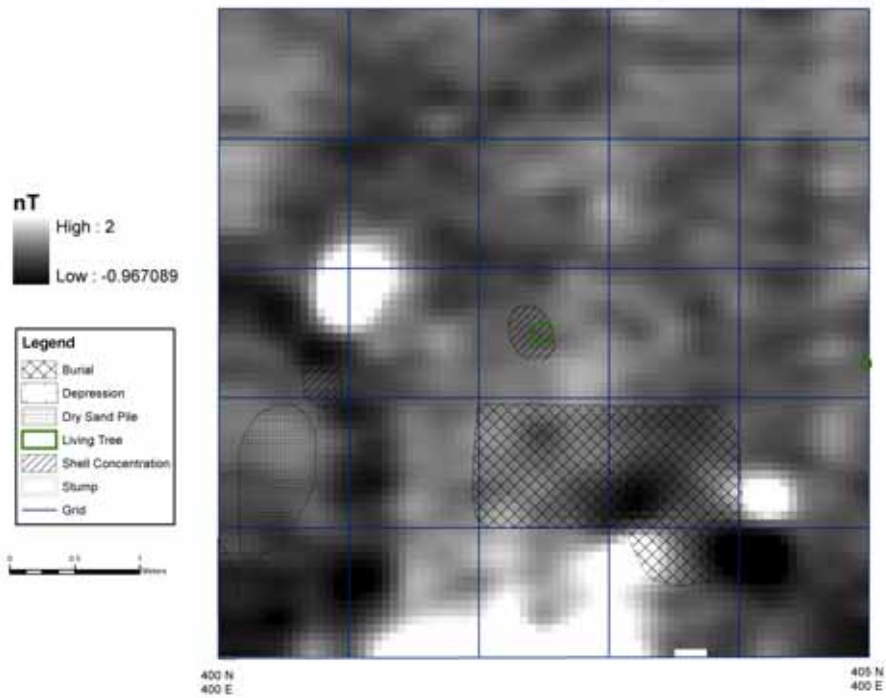


Figure 6.25. Magnetometer survey results from 31ON1236.

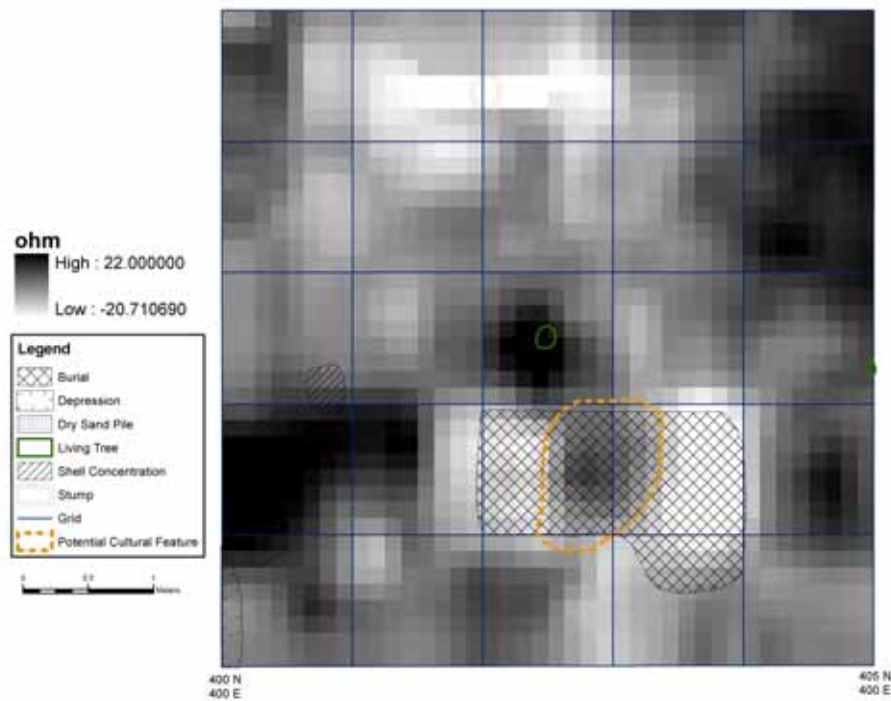


Figure 6.26. Electrical resistance survey results from 31ON1236.

Assessment of the resistance data also identifies the previous excavation unit as a very conductive anomaly measuring approximately 1.0-x-2.3-m (**Figure 6.26**). Internal to the conductive anomaly a more resistance anomaly exists. This anomaly was believed to relate to the burial. Given that the unit and potential burial were identified within the geophysical data, it was deemed unnecessary to excavate a test unit. Testing at the site was limited to core sampling only, since this should provide ample data for positively identifying the prehistoric burial.

31ON1236 Archaeological Investigations

The archaeological investigations at 31ON1236 were focused solely on the burial identified during previous survey and within the resistance data set

(**Figure 6.27**). These investigations were limited to a series of core samples taken from both the burial locale and a selection of background areas that characterize the chemical signatures of the site. The cores were placed both into the probable test unit locale and in areas of the resistance data that appeared for the most part to characterize the general site soil conditions.

A total of six cores were placed at the site (**Figure 6.27**). Two of these cores were placed into the signature of the test unit and therefore into the proposed burial, and four background cores (**Appendix A:182-183**). The background cores had some degree of variability but in general contained three strata.

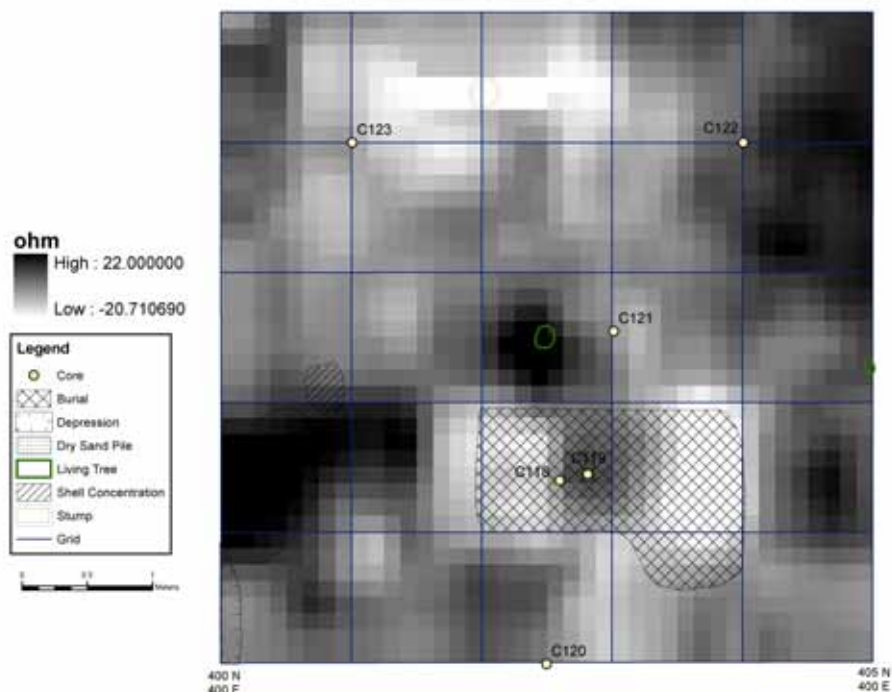


Figure 6.27. Placement of cores at 31ON1236, overlaid on the resistance data set.

All of the cores contained a consistent O-horizon or Ap stratum that extended to an average depth of 0.20 m bs (Figure 6.28). This stratum was a consistent 10YR2/2 very dark brown fine sand. A black 10YR2/1 fine sandy stratum that contained different percentages of fragmented mussel shell underlay the surface horizon. This stratum represents the prehistoric shell midden that covers the majority of the extent of 31ON1236. This second horizon extended to different depths across the small grid, ranging from 0.25 to 0.50 m bs (Appendix A:182-183). The variability in the depth of the stratum would be consistent with an anthropogenically-derived stratum. The midden was consistently underlain by a fine sand 2.5Y7/4 pale yellow C-horizon. This stratum consistently extended to at least 0.75 m bs. Cores taken from within the excavation unit indicated that this basal C-horizon stratum extended to at least 0.90 m bs.

The two cores placed into the test unit and the probable burial locale produced similar core samples (Appendix A:182-183). The upper section of each core was heavily mottled and disturbed by the previous archaeological excavation. These mottled disturbed soils were consistent until they abruptly stopped at a black

10YR2/1 stain (Figure 6.28). The depth of this abrupt stain was not the same, ranging from 0.60 to 0.68 m bs, between the two cores, but this was considered consistent with the uneven floor of an excavation unit that had been cleaned to expose the burial prior to backfilling. This stain also contained small fragments of bone within Core 118 (Appendix A:182). The feature matrix averaged approximately 0.10 m in thickness in both cores. The same pale yellow 2.5Y7/4 massive fine sand C-horizon that was observed within the background cores extended from the black feature stain to the end of both core samples at a depth of 0.90 m bs

Based on the recovery of small bone fragments within Core 118 and the very dark approximately 0.10 m thick stain, the sampling of the burial identified within excavation unit was corroborated. As with all of the bone recovered from the testing phase of the project, the bone recovered from Core 118 was immediately removed from the sample and returned to the burial context. Samples were recovered from the feature context and below the feature stratum (Appendix A:182). No samples were taken from above the feature due to the disturbed nature of the soils within the

excavation unit. Samples from the background cores were taken from depths close to the feature's depth (**Appendix A:182-183**). These samples were taken from above and either at or below the average depth of the burial. A sample from the midden deposit and the underlying C-horizon were considered sufficient to adequately characterize the site background. Results of the chemical samples are addressed in **Chapter 7**.

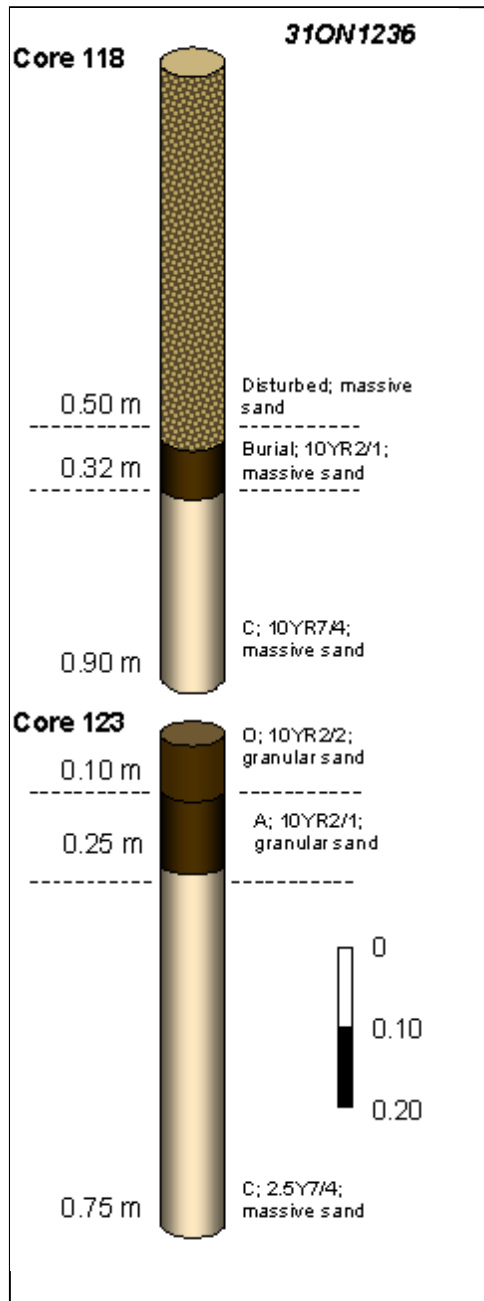


Figure 6.28. Representative core samples from 31ON1236.

WARDS-WILL CEMETERY

Open Site Wards Will Cemetery

Cultural affiliation: Historic Cemetery; late eighteenth to late nineteenth century

Site dimensions (LxW): 22.50 m x 24.50 m

Presence of known burials (depth): Yes

Presence of known non-burial features (depth): No

Extent of site disturbance: Localized disturbance from previous grave removal

Investigation techniques: Resistance

The cemetery is located approximately 300 m east of the New River, and on an interfluvial terrace between Goose and Duck creeks. This landform probably formed as a terrace of the New River, prior to its embayment. Sandy soils characterize the majority of the soils at the site. The cemetery has been neglected since the removal of the graves in 1941. Based on pictures taken at the time of grave removal, it appears the cemetery has been neglected or in decline for probably the majority of the twentieth century (Littleton 1981). A dense secondary forest canopy has developed within and around the cemetery lot, including American holly, Loblolly pine, wild cherry and an assortment of other deciduous tree species. This forest canopy was overgrown with vines and smaller secondary ground coverage within the cemetery lot (**Figure 6.29**).



Figure 6.29. Site conditions at Wards-Will cemetery prior to clearance.

The cemetery is bounded by the basal remnants of a three-course brick wall (**Figure 6.30**). The wall probably was originally 5 ft high by about 1.3 ft thick (OCOCS 1997:44). This wall completely encloses the cemetery area and attaches to a small building on the southeast corner of the cemetery. The upper portions of the building are no longer extant.

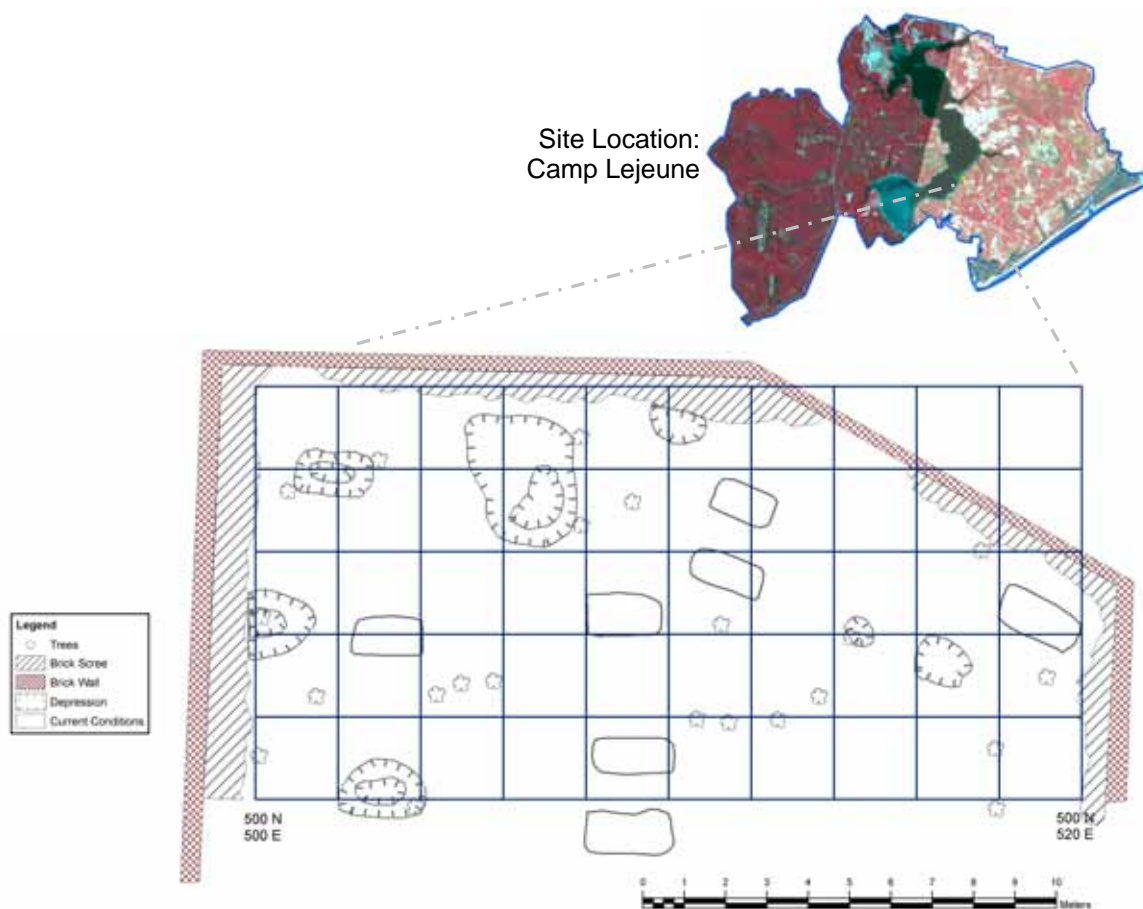


Figure 6.30. Site map of Wards-Will cemetery.

The building is now characterized by its basement portion, which extends to a depth of approximately 4 ft from the existing ground surface (OCOCS 1997:44). The brick wall that encloses the area is formed in an irregular shape. The northeastern corner of the wall extends diagonally from the north and east walls. This diagonal orientation of the wall is believed to have been built to run beside an older roadbed that appears to cross the area just northeast of the cemetery (**Figure 6.30**).

The cemetery contained a total of 24 marked graves. Of these 24 marked graves, 19 possessed names and death dates. Death dates for the marked graves indicate a use period from 1785 to 1870, but the majority were interred from 1834 to 1856 (OCOCS 1997). Three main families appear to constitute the majority of those interred, the Wards, Fonvielles and Montforts. The markers were made of a variety of stones, as well as wood. The wood markers were found to be in deteriorated conditions, and the majority possessed no writing to indicate the name of the

deceased or date of death. The 24 marked graves were moved to a base-wide cemetery in late 1941 (Littleton 1981). These marked graves were located in only a portion of the cemetery boundary. Additional depressions were noted during the removal, but only marked graves were investigated and moved. Based on these observations, it is probable that older unmarked graves still exist in the cemetery.

Wards-Will Geophysical Survey

A 1.0 m deep resistance survey was the only geophysical method attempted at the Wards-Will cemetery (**Figure 6.31**). A depth of 1.0 m was chosen based on the excellent results obtained from the Walker Cemetery survey. It was also noted that a high degree of surficial disturbance from forest cover and removal of the graves during the 1940s probably have led to a number of natural anomalies at the surface that would obscure the deeper subtle grave shafts

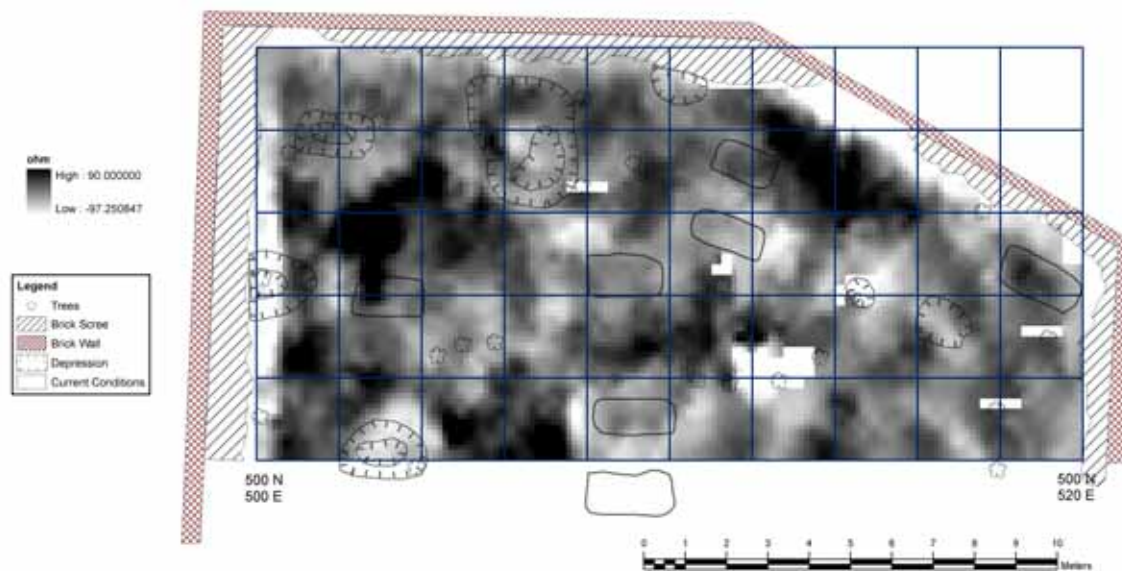


Figure 6.31. Electrical resistance survey results from Wards-Will cemetery.

Magnetometry work completed at Walker Cemetery, and additional research performed by the author at other cemeteries, has shown that excessive amounts of metallic material typical of cemeteries makes the magnetometer marginal to identify historic graves. In addition, magnetic survey at the other Camp Lejeune prehistoric sites indicated that background magnetic ranges are severely restricted due to the sandy conditions that typify the base, making it difficult to obtain acceptable results. Due to these reasons, it was determined that magnetometry would not provide data that could be effectively used to direct later testing and sampling.

As with all of the sites at Camp Lejeune, Wards-Will Cemetery is characterized as a loamy sand to fine sand. This type of soil will not typically maintain vertical excavations, such as a grave shaft, for any length of time. Given this knowledge, it was expected that grave shaft signatures would be ephemeral and need to possess some degree of pattern or correlation with surface mapping to be able to be correctly interpreted. These two interpretive tools were heavily relied upon to identify and choose anomalies within the data that could be unmarked graves.

Initially the data was assessed against surface mapping completed prior to survey. A number of depressions were noted during the mapping (**Figure 6.30**). These depressions were assessed against the resistance data as well as a georeferenced map of the 1941 removal of the marked graves. As one can see, a number of the mapped depressions and geophysical anomalies relate directly to the map of graves removed in the 1940s (**Figure 6.32**). A few depressions exist at the cemetery that do not correlate to the removed grave locations. A few of these depressions appear to correlate to ephemeral high and low resistant anomalies.

The two diagonal depression identified between the E511 to E513 grid lines appear to have excellent potential (**Figure 6.33**). One of the depressions correlates to a grave removed in 1941, but the other does not appear to correspond. A number of linear diagonal anomalies crisscross this area. The depression corresponds to one of these linear anomalies. Based on the correlation of the resistance anomaly with a surficial depression, and the similar orientation of both to a known removed grave, this anomaly was chosen for testing.

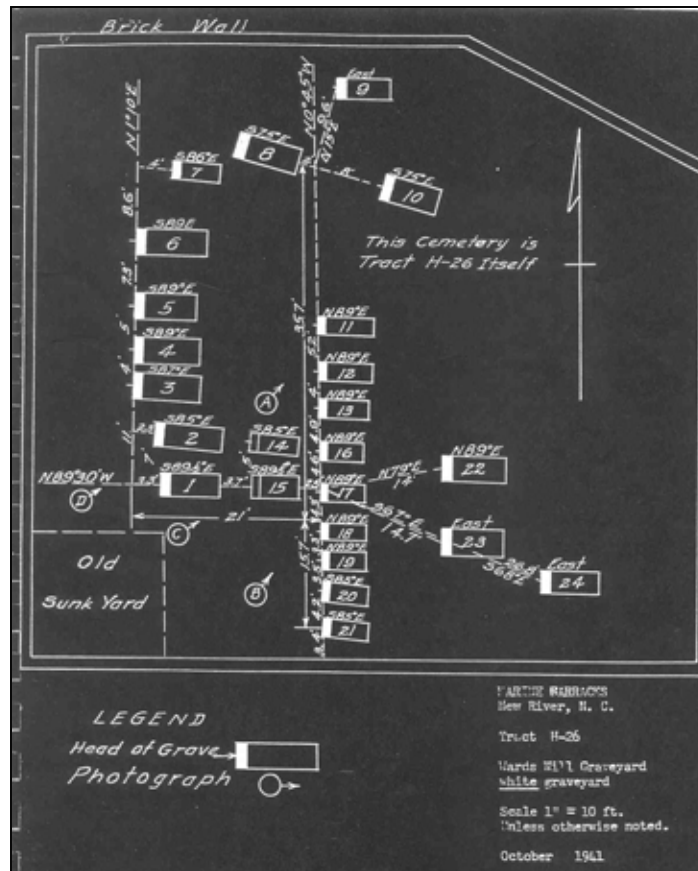


Figure 6.32. 1941 map of grave removal at Wards-Will cemetery.

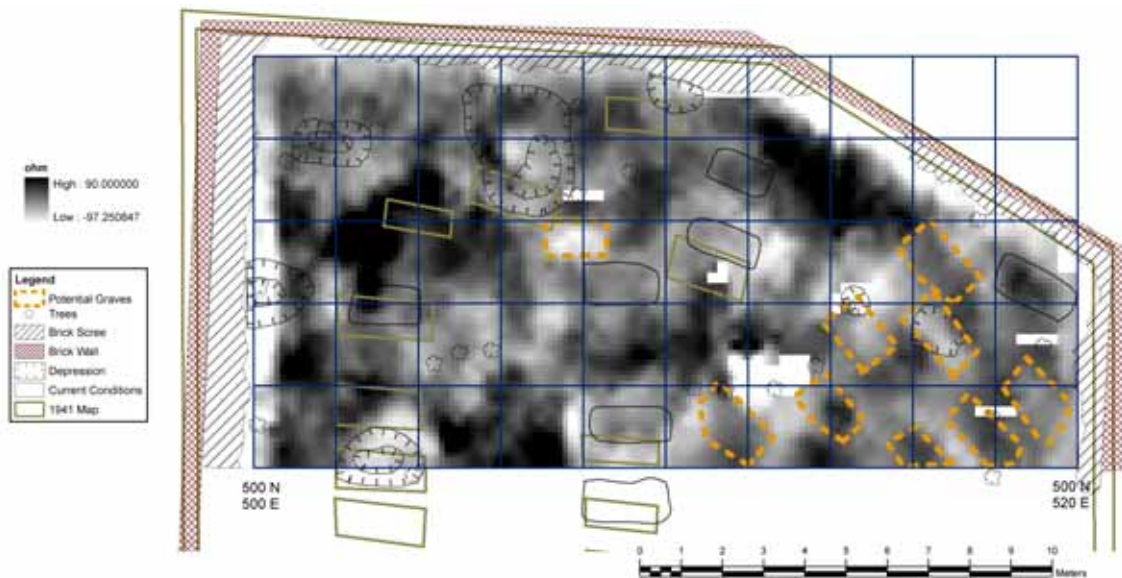


Figure 6.33. Interpretation of potential graves from Wards-Will cemetery, overlaid on the resistance data set.

A pattern of high and low resistance anomalies was identified along the eastern edge of the resistance survey (**Figure 6.33**). These anomalies run diagonal to the grid and to the general orientation of the graves previously removed. These anomalies also run approximately perpendicular to the diagonal wall along the northeast corner of the cemetery lot (**Figure 6.34**). These anomalies were interpreted to be possible historic graves, but were not slated for testing, unless the anomaly chosen above produced no grave context.



Figure 6.34. Wards-Will cemetery lot, looking grid east. Diagonal cemetery wall shown on the left-side of photograph.

Wards-Will Archaeological Investigations

The archaeological investigations at Wards-Will Cemetery were focused on the depression and linear anomaly identified within the resistance data at N507 E512 (**Figure 6.35**). Given the correlation of the resistance anomaly and the depression it was believed that this anomaly was actually an unmarked historic grave. A series of core samples were believed to provide the best non-invasive technique to investigating the anomaly and characterizing the background soils at the site.

A total of six cores were placed at the site (**Figure 6.35**). Two of these cores were placed into the proposed grave, and the remaining four cores were placed throughout the cemetery in order to offer a representative generalized soil profile for the site and background chemical sample (**Appendix A:183-184**). The majority of the background cores were placed within the bounds of the cemetery, but Core 128 was placed outside of the brick wall. This core was placed outside of the walls in order to determine the degree of disturbance that had occurred to the cemetery lot by offering a relatively undisturbed soil profile as a comparison to those taken inside. **Appendix A** offers detailed descriptions of all six core samples collected. The following discussion summarizes the basic strata that appear to exist at the site and the differences between the background and the potential grave location.

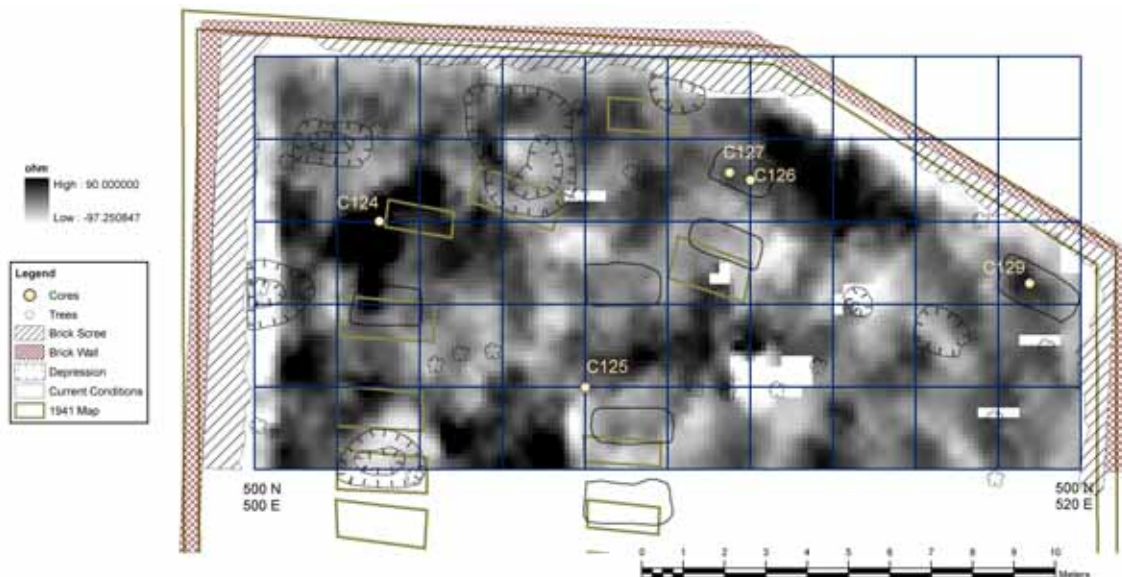


Figure 6.35. Placement of cores at Wards-Will cemetery, overlaid on the resistance data set.

The background cores had a wide degree of variability within the cemetery lot. All of the cores contained a consistent O-horizon that extended to an average depth of 0.15 m bs within the cemetery lot (**Figure 6.36**). This stratum was a consistent 10YR2/1 black fine sand. Core 128, placed outside of the cemetery, contained a dark brown 10YR3/3 sand surface horizon that extended to 0.20 m bs.

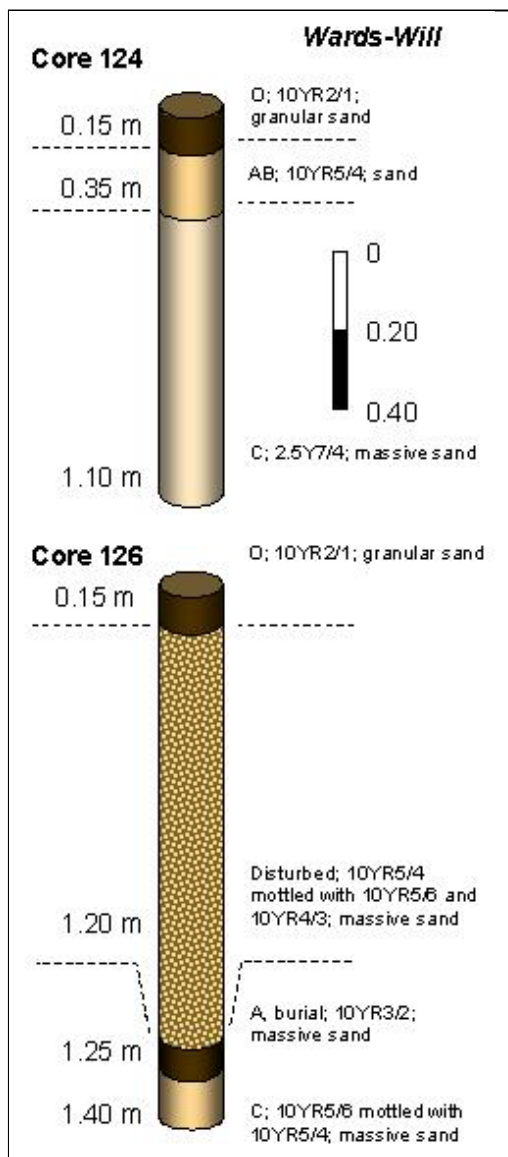


Figure 6.36. Representative core samples from Wards-Will cemetery.

The difference in organic content between the cemetery lot and the outside core sample probably is attributable to the lack of erosion and possibly historic augmentations to the surface within the cemetery lot. The surface horizon was

underlain by a fine sand consistently across the site, but the organic content and degree of soil development appears to differ between nearly all of the cores.

The second stratum ranged from a 10YR4/3 brown A-horizon in Core 125 to an AB-horizon or weakly developed B-horizon within the other background cores contained within the cemetery lot. These horizons extended consistently to an average depth of 0.40 m bs. The core placed outside the lot did not contain this second stratum, but instead possessed a very pale brown 10YR7/4 BC-horizon directly under the surface horizon. Given the degree of variability within this second stratum within the cemetery lot and the lack of a similar stratum within the core placed outside of the lot, it is probable that these strata may represent isolated disturbances relating to bioturbation or modern historic construction. This stratum is consistently underlain across the site by basal BC to C-horizon strata.

The BC to C-horizon is consistently represented across the site as a pale brown to pale yellow fine sand (**Figure 6.36**). Some of the cores have substantial amounts of yellowish brown 10YR5/6 loamy sand lenses within these pale sand strata. These lenses are probably lamella bands that ribbon through the soil at different depths, relating to fluctuating water tables. These basal C-horizon deposits extend from an average of 0.35 m bs to as great a depth as 1.65 m bs (**Appendix A:183-184**).

The two cores placed into the possible grave locale produced almost identical core samples (**Appendix A:183-184**). The surface of each core contained a thin 0.10 m thick O-horizon. This was similar to the other cores taken from within the cemetery lot. The surface horizon was underlain by a loose disturbed sand horizon. This horizon was typified by a mixing of 10YR5/4 yellowish brown sand mottled with equal parts of a 10YR5/6 yellowish brown loamy sand and a 10YR4/3 brown sand. This mixed disturbed stratum was interpreted as a historic grave shaft. Similar mixing was observed in grave shafts tested at Walker Cemetery. These mottled disturbed soils were consistent till they abruptly stopped at a very dark grayish brown 10YR3/2 stain (**Figure 6.36 and 6.37**). The stain extended approximately 0.05 m, where in the stain also abruptly stopped at a clear flat smooth boundary. The same yellowish brown 10YR5/6 to 10YR5/4 massive fine sand C-horizon that was observed within the background

cores extended from the feature stain to the end of both core samples at a depth of 1.40 m bs.

The stain observed in Cores 126 and 127, and the deep disturbance stratum, were inconsistent to the profiles obtained from the background core locations. The smooth and abrupt boundary that the stain possessed appeared consistently between the two samples and at the same depth (**Figure 6.37**). Based on the abrupt boundary and the inconsistencies between the probable grave locale and the background samples, it is believed that the stain recovered from 1.20 to 1.25 m bs in Cores 126 and 127 are the remnant of a historic grave. Samples were recovered from the feature context, as well as above and below the feature

stratum (**Appendix A:183**). Samples from the background cores were taken from depths close to the feature's depth (**Appendix A:183-184**). These samples were taken from above and either at or below the average depth of the burial. A sample from the upper section of the BC-horizon, or the AB-Bw stratums, and the underlying C-horizon were considered sufficient to adequately characterize the site background. Results of the chemical samples are addressed in **Chapter 7**.



Figure 6.37. Core 126 recovered from grave location at Wards-Will Cemetery, depth increases from right to left. Note 0.05 m thick dark grave stain in core on the left.

SOIL TESTING RESULTS

Duane Simpson

7

INTRODUCTION

This section summarizes the results of soil chemical testing completed at the eleven archaeological sites investigated within this report. A total of 234 soil samples were collected from 95 different core locations. Of these 234 samples, 233 were analyzed for total phosphorous and a suite of different trace metals. Sample 66c was lost in transit to the STL labs. This was a basal sample taken from a background core at 41CV1038 (**Appendix A:175**). While regrettable, the loss of the sample did not drastically affect the

analysis at 41CV1038, or the overall assessment of cultural features investigated in the project.

The number of cores and samples collected at each site was not consistent. Depending upon stratigraphy, previous archaeological work and the nature of current investigations, the total number of samples differed within each individual site. **Chapters 5** and **6** summarized the differences between the various sites, as well as the number and placement of sampling locations. The following table lists the total number of cores and samples collected at each site. Samples collected from test units were included as core locations within **Table 7.1**.

Table 7.1. Totals of Core and Sample Locations by Site.

Site	Installation	No. Cores	No. Samples
41BL69	Ft. Hood	8	16
41BL744	Ft. Hood	8	17
41BL780	Ft. Hood	10	23
41BL844	Ft. Hood	12	30
41CV1038	Ft. Hood	3	7*
41CV1150, Walker Cem.	Ft. Hood	12	28
41CV1235	Ft. Hood	12	29
31ON71	Camp Lejeune	12	39
31ON1019	Camp Lejeune	6	18
31ON1236	Camp Lejeune	6	12
Wards-Will Cem.	Camp Lejeune	6	14
Totals		95	233

*total number of samples that were analyzed.

There are a wide variety of different trace metals that have been used in the past for characterizing human burial locations. As discussed in **Chapter 4**, these various studies have resulted in differing interpretations pertaining to the effectiveness of certain metals in characterizing burials. In fact, many of these studies have produced contradictory results, making it difficult to determine the best suite of trace metals to investigate as a component of the current project. The background research indicated that one of the confounding problems in many of the studies was that the chemical background of each site had variable effects on the concentrations of trace metals that could be detected. The background chemical signatures of many sites effectively masked some trace metals. Given these issues, it was determined that a single site would be tested for a wide array prior to analysis of the bulk of the archaeological sites investigated to aid in the choice of the most useful metals.

One confounding problem with the identification of a representative site was that the sites investigated included an array of different environmental settings and cultural site types, ranging from prehistoric occupations within rockshelters, to prehistoric open-air occupations within terrace deposits and historic cemeteries. Thus a total of three different site types and two environmental types were represented within the sample of eleven different archaeological sites. Based on the diversity within the site sample, it was determined that no representative site could be chosen from the eleven sites investigated, and that the final determination would need to be determined by the research goals of the project.

The research goals of the chemical signature portion of the project revolved around the comparison of a human burial versus the background environment of a site, and versus other cultural features or culturally enhanced horizons. The site would therefore need to contain a human burial in which to compare to the background environment. Secondly, the site would also need to have another cultural feature or an obvious anthropogenically enhanced horizon at the site for comparison with the burial locale. While the burials may appear chemically different than the overall environment, it was also necessary that the final chemical signature be different than other cultural features or horizons that may have elevated amounts of culturally derived material, such as bone or charcoal. Lastly, it was preferable that the analyzed site contain a

larger comparable number of samples as were collected at the other ten sites.

Four of the sites: 41BL780, 41CV1038, 41CV1235 and 31ON71 did not contain any burials, and therefore were excluded from the selection process. Walker (41CV1150) and Wards-Will cemeteries were excluded also from the selection process given their very specific site type, and the fact that they were believed not to be comparable to the other prehistoric sites within the project. While sites 41BL69, 31ON1019 and 31ON1236 all contained burials, none of these possessed additional cultural features or a well-defined cultural horizon in which the burials could be directly compared. This left only two sites, 41BL744 and 41BL844, as potential exploratory investigative locations. 41BL844 appeared to be the best choice given that it contained a burial, an additional cultural feature and an associated culturally augmented horizon in which samples were collected. In addition, 30 samples were collected from 41BL844, making it one of the most heavily sampled of the eleven sites investigated.

EXPLORATORY INVESTIGATION

Background investigations identified total phosphorus (total P) and trace metals analysis as two chemical processes that had produced acceptable results in the past for either identifying or characterizing burial locations. It was determined that total P would be determined for all 30 samples collected from 41BL844. Background research identified as many as 14 trace metals that had produced varying results in past studies. A set of eight metals was chosen for testing based upon an assessment of this background information, the various site conditions and the reporting limits for different metals. The trace metals chosen included, aluminum (Al), copper (Cu), iron (Fe), magnesium (Mg), manganese (Mn), sodium (Na), lead (Pb) and zinc (Zn). Seven of these metals had shown good to excellent results within various studies of prehistoric burials. Lead has produced excellent results in historic period burials due to the high amount of lead in a number of materials, such as pewter and paint, used during the period. Pb in detectable levels does not naturally occur in the human body; it must be absorbed throughout the life of an individual. Exposure of prehistoric populations to Pb is not likely. Its inclusion within the assessment of the prehistoric rockshelters was influenced by the subsequent investigation of historic graves within the project, as well as

providing necessary information about any potential problems that may occur due to interference from high levels of other background chemicals.

The results from the exploratory chemical investigations for 41BL844 are summarized on page 186 in **Appendix B**. The lab results indicated that sodium and to a lesser degree copper, were consistently found below standard reporting limit values, but still within the detection limits of the instrumentation. This did not have an affect on the quality of the data, given that the sampling completed for this project was not being assessed within the structure of the EPA guidelines for environmental analysis. Not surprisingly, the exploratory results did indicate that a problem existed for the lead samples. Of the 30 lead samples processed, only 10 produced any detectable amounts, with the remainder having to be extrapolated. The lead results were therefore speculative at best. The low lead readings were attributable to high amounts of calcium within the soil at 41BL844. The rockshelter, like all those at Fort Hood, are formed from limestone solution cavities, and therefore the majority of the sediments contained within the rockshelter, or any upland site, will contain naturally high amounts of calcium within the soil. It was based on this knowledge of the sites' environments that calcium was not chosen as a potential trace metal for study, given the belief that small changes between the burial and the general environment would be masked by the elevated levels. Based on these issues, the results from the lead samples were not assessed, and lead was dropped as a potential trace metal for additional testing within the project.

Assessment of the results was constructed to answer two main questions. First, are the cultural features different from the environment? Secondly, is the burial different than the environment, including the total background, as well as the culturally enhanced A-horizon and cultural feature? An assessment of these questions could lead to an understanding of which elements were different from the environment as well as which may have predictive powers for identifying burials in relation to other cultural features.

The sample size and variance between the burial and the background samples were substantially different in all elements analyzed. The burial sample included only two samples in comparison

to the 28 collected from the other features and the surrounding background cores. This disparity could not be helped, due to the necessity to minimize disturbance to the burial locales. The disparity between sample groups also led to differences between group variances. These two aspects were addressed within the assessment process. In addition, neither the burial samples nor the background samples could be modeled on a normal distribution, making the application of parametric tests difficult. Based on these problems, a number of modifications and assumptions were necessary in order to compare the samples.

The background samples were separated into three different groups. Group 1 included those samples recovered from the A-horizon or other cultural feature. This group was designed to address the question of whether any of the chemical signatures collected could distinguish a burial from another cultural feature or anthropogenically enhanced A-horizon deposit. Group 2 included those samples collected from the C-horizon deposits, or from strata that did not contain significant concentrations of organics. The group was designed to differentiate the burial from any possible baseline background chemical signatures that would be present in the environment at 41BL844. The final group, Group 3 represented a combination of all of the samples, including the cultural feature.

A number of nonparametric and parametric tests were reviewed to distinguish statistically significant differences between the burials versus the various background sample groups. A parametric test was selected due to the fact that nonparametric tests are difficult to make broader population wide statements given the lack of a common distribution. The issues stated above made the majority of the parametric tests problematic due to one or more assumptions under which the tests function. Based on some modifications, natural log transformation and a 10 percent trimming of the mean, a parametric two-sided t-test was chosen to assess differences between the means of the burial sample and the various groups listed above. While modifications were necessary to work within the t-test parameters, basing the hypothesis testing within the normal distribution provides a potential wealth of inferences that can be used to explore relationships between samples. Inferences can also be made about the broader population of chemical samples that can be recovered from any

specific site. Modeling the results over the normal distribution would also provide a basic framework to construct confidence or prediction limits for the burial samples against the background. The two-sided t-test assumes two equal aspects between compared samples: first that the distribution of the data is normal, and secondly that the measurements are independent.

The individual groups, Burial sample and Background Groups 1, 2 and 3, were all natural log transformed. This transformation smoothed the data, creating normal distributions. The t-test is also severely affected by outlier measurements, especially when dealing with small sample sizes. The mean of the background groups were trimmed at a 10 percent level, or the outliers on either end of each distribution were removed. This step reduced the effect of outlying data as well as creating even more normal distributions. Lastly, the t-test statistics were constructed without assuming equal variances. This modification corrects for the degrees of freedom for each test, creating an approximate value for the number of samples used in calculating the statistic. This last modification reduces the power of the test but helps to correct any problems that might arise from unequal variances that still might occur even after log transformation. Even with these modifications the power of the test was reduced due to the small sample size. While a problem

with this exploratory data set, it was believed that this problem would diffuse as additional sites and samples were processed, leading to greater sample size and increasing normality within the sample data sets.

A series of hypothesis tests were created that compared the mean of the burial sample against the mean of the various background groups. A two-sided t-test with a 95 percent confidence level was selected that assumed unequal variances between samples. **Table 7.2** summarizes the results for the various hypothesis tests comparing the burial sample (n=2) to the various background groups: Group 1 (n=10), Group 2 (n=14) and Group 3 (n=26). The degrees of freedom differences also listed in **Table 7.2** differ from the original values due to the utilization of the Welch modification for testing unequal variance samples. The t-score listed below relates the t-test statistic against the T distribution, a slight modification of the normal distribution. The p-values summarized in the table relate to the probability that a similar t-score could be produced by chance alone, or the percentage chance of being wrong in choosing the alternative hypothesis that the two groups' means are not statistically the same. For example, within **Table 7.2**, there are 2 chances in 10,000 that the difference between the aluminum concentrations noted between the burial and Group 3 were created by chance alone

Table 7.2. Site 41BL844 Results from Exploratory Hypothesis Testing.

	Burial μ to Group 1 μ			Burial μ to Group 2 μ			Burial μ to Group 3 μ		
	t-score	df	p-value	t-score	df	p-value	t-score	df	p-value
Al	0.6473	9.805	0.5323	5.9907	13.342	*0.0000	4.4687	22.679	*0.0002
Cu	0.8513	9.506	0.4155	9.1251	13.911	*0.0000	5.1986	24.000	*0.0000
Fe	0.0933	9.987	0.9275	6.5844	13.490	*0.0000	3.2263	23.675	*0.0036
Mg	0.1045	4.317	0.9214	-2.3419	3.074	*0.0989	-0.7884	4.832	0.4674
Mn	0.5582	6.846	0.5945	12.9729	10.363	*0.0000	5.2117	22.180	*0.0000
Na	-1.5927	9.461	*0.1440	1.9362	1.264	0.2609	-0.1897	7.187	0.8548
Tot.P	1.0076	1.862	0.4264	3.2687	1.374	*0.1322	2.4974	1.395	0.1816
Zn	-0.5635	5.530	0.5952	11.4689	13.917	*0.0000	4.9823	23.964	*0.0000

t-score: score based on normal or t-distribution.

df: degrees of freedom (not whole values due to Welch modification for assuming unequal variances).

p-value: percent chance of error in choosing alternative hypothesis: sample means not equal to zero.

*p-values that were determined significant or having potential to produce significant results.

The total phosphorus measurements were not significant at the 95 percent confidence level, but background research indicated numerous studies in which total phosphorus had been used to identify grave locations. Even though the samples were not significant they were found to be suggestive of differences within the overall environment and with the C-horizon deposits. Given the small sample size, levels of significance were looked at speculatively within the assessment of all chemical signatures. In general, if metals appeared to be trending toward differences between the burial sample and the environment they were assessed as having some degree of potential. Based on these suggestive results, it was believed that additional samples from other locales might prove effective in defining phosphorous as predictive for burial locations, and was retained as one of the chemical tests to run against the broader collection samples.

An evaluation of the other seven trace metals against the overall background (Group 3) at 41BL844 indicated that five were found significant at the 95 percent confidence level (**Table 7.2**). An assessment of the burial in relation to the C-horizon samples (Group 2) indicated that five were significant at the 95 percent confidence level with the other two being suggestive of significant differences. The difference between the burial context and the underlying C-horizon was obvious

in both soil types as well chemical signature. By reviewing the results of these two groups it was obvious that Al, Cu, Fe, Mn and Zn indicated differences between the burial and the overall environment, and especially the C-horizon samples. An assessment of the burial against the Group 1 background samples indicated that none of the trace metals were found to be significant at the 95 percent confidence level, with Na being the only element that indicated any level of significant difference. Based on this assessment, Na was the only potential trace metal to show differences between the A-horizon and the burial locale, making it the only element with a potential to define a burial within a host of other cultural features. Based on this potential, Na was selected as one of the trace metals to be run against the broader collection samples.

A review of the results for the other six metals indicated that magnesium (Mg) was not significantly different within the burial versus the surrounding environment and was therefore dropped from further investigations. The remaining five metals, Al, Cu, Fe, Mn and Zn, were all significantly different within Groups 2 and 3, and none were different within Group 1. Copper (Cu) retained the second best p-value within the Group 1 assessment, and as such, was believed to at least have some degree of predictive potential between burials and other cultural

features. Based on this potential, copper was selected as a trace metal to be analyzed against the broader collection samples. Fe was the inverse of Cu, in that it performed the worst within the Group 1 assessment and was therefore dropped from any additional testing. In addition to its poor predictive power within the Group 1 sample, background research into rockshelter soil chemistry indicated that Fe and Al could have the potential to be affected by differing levels of calcium within the environment. This interference did not appear consistent between rockshelters or various environmental site types, making it difficult to quantify without additional chemical and soil analysis. Based on this potential interference problem, Al was also dropped from consideration. Measurements for both Mn and Zn were extremely similar to those produced by Al. Based on these results, Mn and Zn were both retained for additional chemical tests against the broader collection samples.

Based on the hypothesis testing, a total of five elements were retained for testing on the remaining samples collected. Total phosphorus testing and trace metals analysis of Cu, Mn, Na and Zn were determined to provide the best predictive potential. The chemical signatures for these various elements contained a high degree of variability (**Appendix B:186**). The degree of variability within all of the various elements was believed to be normal, based on the levels of variability and contradiction observed within previous studies. In addition, the heterogeneous nature of the rockshelter deposits probably exacerbated this variability within the 41BL844 samples.

STATISTICAL ANALYSIS METHODOLOGY

A cursory review of the chemical results obtained from the various sites indicated that certain chemical signatures from burials and non-burial contexts were different than the environment, but that these appeared to differ at each individual site. While expected to some degree, it appeared necessary that some level of evaluation be completed at each individual site to understand the predictive quality of these various elements prior to making any sort of greater predictive statements.

Based on the cursory inspection of the data, it also appeared that the creation of a broad predictive limit for burials irrelevant of different site-specific conditions would be difficult to create.

Thus a staged process was developed that would allow for an evaluation of the chemical data at various levels, providing a systematic approach that would at least produce results if the broader overall research goal was not achievable. The staged approach for analysis was devised, based upon comparisons of means between the various sample groups that would lead to confidence intervals and prediction limits.

The initial stage was to create a series of hypothesis tests based on a comparison of means between various groups at each site. This was completed in order to understand what chemical signatures were significantly different than the background samples. The results from each individual site assessment would then be compared in order to identify any sort of trend within the chemical data. The comparative results would be used to determine if consistent trends in the chemical signatures were predictive, as well as the possibility that certain environmental types or site types may contain specific trends. If these comparisons determined that significant trends were noted within the data, a broader evaluation would be completed between various groups.

The secondary broader evaluations would look at significant trends across various environmental site types. These would entail the comparison of means between the various groups, the selection of the most predictive chemical signatures, and, if possible, the creation of prediction limits for identifying a burial within these various environmental or site-specific groups. If broad significant trends could be identified in a number of site and environmental types then an even broader evaluation could be completed.

The final broadest evaluation would be the creation of prediction limits for the identification of human interments versus the environment. These prediction limits would also need to be able to identify a specific range or limits in which burials could be expected in comparison to other cultural features. The end result would be a prediction or confidence limit in which burials would fall that was specific to them in relation to other cultural features.

Results from Fort Hood Sites

This section relates the results of chemical testing of the sites in Fort Hood. The sites tested at Fort Hood consist of a number of different environments, site types and time periods. This

variability complicates the comparison of each site, but given the end goal of the project: to define a potential predictive chemical signature for burials at any location, variability between sites was an expected complication within the broader research goal.

41BL69 Chemical Results

This site was the first of four rockshelters investigated. The site contained a previously identified burial that was the central point of investigation. A total of 16 samples were collected from 8 cores at 41BL69. Six of these cores were collected to characterize the background environment and two were collected from the burial location. Stratigraphically the samples were collected from two distinct horizons, one from an A-horizon that covered the surface of the shelter deposits and one from the basal C-horizon deposits (**Appendix A:170**). Soil pH levels were collected from 14 of the samples ranging from 6.80 to 8.65, with a mean (μ) of 7.81, a median of 7.72 and a variance of 0.342. The burial locale was too dry to obtain reliable pH levels. The pH levels indicated a neutral to slightly basic environment, appropriate for a protected limestone rockshelter in a subtropical subhumid environment like Fort Hood.

Soil pH can affect the concentrations of certain chemicals. Given the possibility that pH may play a role in chemical concentrations a series of correlations were completed between pH and the overall concentrations for each trace metal or chemical concentration. **Table 7.3** summarizes the results of these correlations.

Table 7.3. Correlation of pH Values with Chemical Concentration at 41BL69.

	Correlation: (r: value range 1.0 to -1.0)
Cu	-0.402159
Mn	-0.539572
Na	-0.360516
Tot.P	-0.124354
Zn	-0.506049

Correlation values indicate that all of the various samples have a slight to moderate negative correlation with increasing pH values. Total phosphorous is the only chemical signature that does not appear to be correlated to pH values. An assessment of pH values indicated that they became more basic with depth, whereas in general the various chemicals decreased in concentration with depth. It is probable that the moderate correlations noted between pH and the chemical concentrations are also related to depth below surface.

The initial assessment of the data collected from 41BL69 was formulated identically as that described previously within the Exploratory Investigation section. The soil stratigraphy at the site dictated that samples be run and analyzed from a surficial A-horizon and underlying C-horizon. Based on these characteristics, a series of three groups were created for comparison to the burial location. These groups were the same as those defined within the exploratory work at 41BL844, including Group 1, Group 2 and Group 3. Group 1 consisted of samples recovered from the A-horizon, Group 2 included those samples collected from the C-horizon deposits and Group 3 represented a combination of all of the background samples. As explained in the previous exploratory section these various groups were designed to address a series of questions pertaining to eventual research goals.

The following table (**Table 7.4**) summarizes the results for the various hypothesis tests comparing the burial sample (n=2) to the various background groups: Group 1 (n=6), Group 2 (n=4) and Group 3 (n=12). The t-tests were Welch modified allowing for data of different variances to be modeled on the t-distribution. This testing was based on the log-transformed data, produced in the same fashion as that created for 41BL844.

Table 7.4. Analysis results of Chemical Sampling at 41BL69.

	Burial μ to Group 1 μ			Burial μ to Group 2 μ			Burial μ to Group 3 μ		
	t-score	df	p-value	t-score	df	p-value	t-score	df	p-value
Cu	0.3893	7.837	0.7074	0.6730	5.189	0.5297	0.7895	13.997	0.4430
Mn	-0.3148	6.464	0.7628	1.0487	5.951	0.3350	0.5116	7.082	0.6245
Na	-0.4270	2.142	0.7085	0.5738	2.911	0.6074	0.0294	1.719	0.9796
Tot.P	0.7702	1.068	0.5755	1.0490	1.032	0.4805	0.8941	1.029	0.5322
Zn	0.8357	7.190	0.4302	1.2911	5.639	0.2471	1.4682	10.041	0.1727

t-score: score based on modified normal distribution.

df: degrees of freedom.

p-value: percent chance of error in choosing alternative hypothesis: sample means not equal to zero.

The degrees of freedom for a number of the tests were severely reduced from the original comparison groups. Assessment of these groups indicated that log transformation was not able to sufficiently model the data to a normal distribution and subsequently variance between groups was still significantly different. As a means of assessing the degree to which the t-test results could be adequately trusted, a second non-parametric test was run. A Wilcoxon rank-sum test was completed for those comparisons that had severely reduced degrees of freedom. This test allows comparison of data distributed in any fashion possessing fewer assumptions than a t-test, while still maintaining a 95 percent power efficiency in comparison (Blalock 1972:261). This hypothesis test was constructed with the same assumptions as used in the t-test methodology: 95 percent level of confidence and an alternative hypothesis that the true mean is not equal to 0 for the two samples. Given the fact that this test is non-parametric there was no need for log transformation, so the rank-sum tests were run against the original concentrations.

The Wilcoxon rank-sum test provides a p-value for a means of establishing a probability that the alternative hypothesis is true. As with the t-test, this value indicates the potential to incorrectly accept the alternative hypothesis, in this case that the two groups means are not equal. **Table 7.5** summarizes the results of those comparisons that had reduced degrees of freedom.

Table 7.5. Comparisons of Groups 1,2,3 at 41BL69 Using a Wilcoxon Test.

	Burial. μ to G1 μ	Burial. μ to G2 μ	Burial. μ to G3 μ
Na	0.8889	0.6429	0.9333
Tot.P	0.7111	0.1313	0.3017

Sodium and total phosphorous were the only two chemical signatures that had a severe reduction in their degrees of freedom within the 41BL69 sampling. A comparison of the results for sodium within the rank sum test corresponded well with the results obtained from the t-test. The results of the assessment did not correspond as well as sodium. Group 1 assessment indicates a reduced p-value, but this does not affect final interpretations, given that both are far below the 95 percent confidence level. The Group 2 and 3 assessment indicates an increased p-value for both, probably indicating that variance and normality issues are more pronounced within these comparisons. Again neither is significant at the 95 percent level, but it is probable that differences between the burial and the underlying C-horizon (Group 2) are potentially significant, more so than is represented within the t-test results and confirmed within the Wilcoxon test.

The chemical results recovered from 41BL69 indicated that the burial does not appear different from the environment in general. This lack of differentiation may be related to the semi-disturbed nature of the burial context. All of the raw sample results lie squarely within the overall distribution. A number of the chemicals sampled: total phosphorous and sodium, possesses a high degree of internal variance between samples,

while others, such as copper and zinc, contain little variance between samples (**Appendix B:187**). This general trend of differing degrees of variance between internal samples was found commonly within the other sites. In the case of the investigations at 41BL69, the burial would not be identified in any of the metals tested as unique against any of the various background groups.

41BL744 Chemical Results

41BL744 was the second of four rockshelters investigated. The site contained a previously identified burial that was the central point of investigation. The burial was sampled from a single core location as well as a profile cut into the talus. A total of 17 samples were collected from 8 cores at 41BL744. Six of these cores were collected to characterize the background environment and two were collected from the burial location. Stratigraphically the samples were collected from two distinct horizons, one from an A-horizon that covered the surface of the shelter deposits and one from the basal C-horizon deposits (**Appendix A:171-172**). Determinations of pH levels were collected for the various samples and ranged from 7.41 to 8.50, with a mean (μ) of 8.00, a median of 7.97 and a variance of 0.103. The pH levels indicated a neutral to slightly basic environment, appropriate for a protected limestone rockshelter in a subtropical subhumid environment like Fort Hood.

The soil pH was similarly assessed for 41BL744 as those samples from 41BL69. Given the possibility that pH may play a role in chemical concentrations within the rockshelter a series of correlations were completed between pH and the overall concentrations for each trace metal or chemical concentration. **Table 7.6** summarizes these results of these correlations. The pH levels had slight to no correlation to the chemical samples. Given these correlations there does not appear to be a connection between pH levels and preservation issues for any of the various chemical samples at 41BL744.

Table 7.6. Correlation of pH Values with Chemical Concentration at 41BL744.

	Correlation: (r: value range 1.0 to -1.0)
Cu	-0.230521
Mn	-0.330302
Na	0.199098
Tot.P	-0.373631
Zn	-0.398372

The initial assessment of the data collected from 41BL744 was formulated identically as that described previously. The soil stratigraphy at the site was extremely similar to the other rockshelters investigated, dictating samples to be run and analyzed from a surficial A-horizon and underlying C-horizon. Based on these characteristics, a series of three groups were created to compare to the burial location. Group 1 consisted of samples recovered from the A-horizon, Group 2 included those samples collected from the C-horizon deposits and Group 3 represented a combination of all of the background samples.

Table 7.7 summarizes the results for the various hypothesis tests comparing the burial sample (n=2) to the various background groups: Group 1 (n=6), Group 2 (n=5) and Group 3 (n=12). The structure of the hypothesis testing was the same as outlined above.

Table 7.7. Analysis Results of Chemical Sampling at 41BL744.

	Burial μ to Group 1 μ			Burial μ to Group 2 μ			Burial μ to Group 3 μ		
	t-score	df	p-value	t-score	df	p-value	t-score	df	p-value
Cu	-0.0535	2.622	0.9611	4.5754	1.994	0.0449	2.3155	3.208	0.0978
Mn	1.8506	5.997	0.1137	8.4749	4.666	0.0005	4.4034	12.97	0.0007
Na	-1.8941	5.394	0.1125	-1.8104	2.946	0.1696	-2.2937	2.882	0.1092
Tot.P	1.0031	5.763	0.3560	6.7757	4.717	0.0013	3.7781	12.886	0.0023
Zn	-0.1328	5.520	0.8991	7.6019	4.315	0.0012	3.1934	12.581	0.0073

t-score: score based on modified normal distribution.

df: degrees of freedom.

p-value: percent chance of error in choosing alternative hypothesis: sample means not equal to zero.

Review of the results obtained from the t-test comparison indicated that copper and sodium were the only two that had severe reductions in their degrees of freedom. As with 41BL69, a non-parametric Wilcoxon rank-sum test was run to evaluate the data. **Table 7.8** summarizes the p-value results obtained from the various group comparisons.

Table 7.8. Comparisons of Groups 1,2,3 at 41BL744 Using a Wilcoxon Test.

	Burial. μ to G1 μ	Burial. μ to G2 μ	Burial. μ to G3 μ
Cu	0.8889	0.0556	0.3017
Na		0.2222	0.2353

An assessment of the results from the rank sum test indicated a general agreement with the t-test results for both copper and sodium for the Group 1 and 2 results, but the Group 3 comparison indicated that reduction in significance for the rank sum results for both chemicals. Neither of the results within Group 3 were significant at the 95 percent confidence level under the t-test results but appeared suggestive that difference may exist if larger samples were collected. The p-values obtained from the rank sum test though indicate a substantial reduction for the Group 3 comparison, indicating that the t-test results need to be assessed more speculatively.

A final assessment of the results recovered from 41BL744 indicated that in general the burial is significantly different than the C-horizon deposits, and in some aspects is suggestive of potential differences against the Group 3 sample, or a

composite of all the samples. The Group 1 comparison of the burial to the A-horizon deposits indicated that sodium and manganese were the only two samples that possessed potential differences. The level of significance of sodium in comparison with the A-horizon correlates well with the results obtained from the original exploratory data analysis at 41BL844, but manganese is surprising, given the fact that in neither 41BL844 nor 41BL69 assessments indicated any sort of significant differences. Given differences in variance and the small comparative sample sizes, results from these hypothesis tests were looked upon as only estimations of potentially important differences between certain chemicals and the background. Secondary assessment of a combined burial sample against approximately equal numbers of background samples is necessary to offer true significant values and probabilities.

41BL780 Chemical Results

41BL780 was the third of four rockshelters investigated. This site did not contain any previously known cultural features, and was used as a test case for the geophysical interpretations of the rockshelter data sets. Limited excavations discovered two non-burial prehistoric features. Both features were sampled from excavation unit wall profiles. A total of 23 samples were collected from 10 cores at 41BL780. Eight of these cores were collected to characterize the background environment and two were collected from the features. Stratigraphically the samples were collected from two distinct horizons, one from an A-horizon that covered the surface of the shelter deposits and one from the basal C-horizon

deposits (**Appendix A:172-173**). Soil pH levels were collected from all of the samples, ranging from 7.38 to 8.85, with a mean (μ) of 8.03, a median of 7.94 and a variance of 0.178. The pH levels indicated a slightly basic environment, appropriate for a protected limestone rockshelter in a subtropical subhumid environment like Fort Hood.

The soil pH was similarly assessed at 41BL780 as the previous sites. Given the possibility that pH may play a role in concentrations within the rockshelter a series of correlations were completed between pH and the overall concentrations for each trace metal or chemical concentration. **Table 7.9** summarizes the results of these correlations.

Table 7.9. Correlation of pH Values with Chemical Concentration at 41BL780.

	Correlation: (r: value range 1.0 to -1.0
Cu	0.441701
Mn	0.087155
Na	0.516914
Tot.P	0.383797
Zn	0.154467

Sodium and copper indicate moderate correlations of pH values with soil chemical samples. The remaining groups have slight to no correlation between pH values and chemical concentrations. As with the moderate correlations noted within 41BL69, raw concentration values reduce in value with depth, relating to differences in organic concentration.

The initial assessment of the data collected from 41BL780 was formulated identically as that described previously. The soil stratigraphy at the site was extremely similar to the other rockshelters investigated, dictating samples to be run and analyzed from a surficial A-horizon and underlying C-horizon. Based on these characteristics, a series of three groups were created to compare to the burial location. Group 1 consisted of samples recovered from the A-horizon, Group 2 included those samples collected from the C-horizon deposits and Group 3 represented a combination of all of the background samples.

The following table (**Table 7.10**) summarizes the results for the various hypothesis tests comparing the feature sample (n=2) to the various background groups: Group 1 (n=12), Group 2 (n=5) and Group 3 (n=19). The structure of the hypothesis testing was the same as outlined previously.

Table 7.10. Analysis Results of Chemical Sampling at 41BL780.

	Features μ to Group 1 μ			Features μ to Group 2 μ			Features μ to Group 3 μ		
	t-score	df	p-value	t-score	df	p-value	t-score	df	p-value
Cu	1.1327	1.750	0.3888	4.7635	4.978	0.0051	2.5922	6.110	0.0404
Mn	0.5442	1.153	0.6727	2.0808	2.158	0.1635	1.0561	1.223	0.4560
Na	-0.1720	1.149	0.8887	0.7544	1.045	0.5841	0.1743	1.091	0.8883
Tot.P	1.5593	1.169	0.3363	3.3926	1.100	0.1642	2.1948	1.179	0.2410
Zn	0.8885	11.349	0.3927	5.0992	4.120	0.0065	3.0110	18.900	0.0072

t-score: score based on modified normal distribution.

df: degrees of freedom.

p-value: percent chance of error in choosing alternative hypothesis: sample means not equal to zero.

Review of the results obtained from the t-test comparison indicated that a large portion of the chemical samples had severe reductions in their degrees of freedom, with the exception of zinc. As with previous rockshelter sites, a non-parametric Wilcoxon rank-sum test was run to evaluate the data collected at 41BL780 with reduced degrees of freedom. **Table 7.11** summarizes the p-value results obtained from the various group comparisons.

Table 7.11. Comparisons of Groups 1,2,3 at 41BL780 Using a Wilcoxon Test.

	Burial.μ to G1μ	Burial.μ to G2μ	Burial.μ to G3μ
Cu	0.4256		
Mn	0.7000	0.2222	0.4427
Na	0.9333	0.6667	0.9565
Tot.P	0.1500	0.0556	0.0711

The majority of the p-values correspond well between the two tests, with the exception of those for total phosphorous. The rank sum test indicates an increase in significant probability within all of the total phosphorous results. This increase is probably an artifact of not clipping some of the larger values obtained for the features within the raw concentration data, as compared to the clipped and log-transformed results obtained within the t-test. Given this, it is probable that total phosphorous possessed some degree of potential difference between the features and the background samples at 41BL780.

In general, the chemical signatures of the two cultural features at the site are not significantly different than the background values. Copper, zinc and to a lesser degree total phosphorus have significant differences within Group 2 and 3, as is common with the majority of the sites. None of the chemical results indicate any significant difference as compared to the A-horizon, or Group 1 mean. It is interesting that sodium and manganese are poor indicators within the 41BL780 comparison with Group 1, but were significant within the same comparison of the burial in 41BL744.

41BL844 Chemical Results

41BL844 was the fourth of four rockshelters investigated. This site contained two prehistoric

features, one of which was a previously undocumented burial. Both features were sampled from excavation unit wall profiles. A total of 30 samples were collected from 12 cores at 41BL844. Eight of these cores were collected to characterize the background environment and four were collected from the two features. Stratigraphically the samples were collected from three distinct horizons, one from an A-horizon that covered the surface of the shelter deposits, one from an AB-horizon that typified the deposits along the dripline portion of the shelter and one from the basal C-horizon deposits (**Appendix A:173-175**). Soil pH levels were collected from 30 of the samples ranging from 7.04 to 8.84, with a mean (μ) of 8.04, a median of 8.09 and a variance of 0.231. The pH levels indicated a slightly basic environment, appropriate for a protected limestone rockshelter in a subtropical subhumid environment like Fort Hood.

The soil pH at 41BL844 was assessed in the same fashion as the previous sites. Given the possibility that pH may play a role in concentrations within the rockshelter, a series of correlations were completed between pH and the overall concentrations for each trace metal or chemical concentration. **Table 7.12** summarizes the results of these correlations.

Table 7.12. Correlation of pH Values with Chemical Concentration at 41BL844.

	Correlation: (r: value range 1.0 to -1.0)
Cu	-0.074256
Mn	-0.440341
Na	-0.460977
Tot.P	-0.218746
Zn	-0.557046

Sodium, manganese and zinc have moderate correlations of pH values with soil chemical samples. The remaining groups have slight to no correlation between pH values and chemical concentrations. As with the moderate correlations noted within 41BL69, raw concentration values reduce in value with depth, relating to differences in organic concentration. Thus depth of the sample location may have as much to do with the correlation as does the pH levels.

Table 7.13. Analysis Results of Chemical Sampling at 41BL844.

	Burial μ to Group 1 μ			Burial μ to Group 2 μ			Burial μ to Group 3 μ		
	t-score	df	p-value	t-score	df	p-value	t-score	df	p-value
Cu	0.8513	9.506	0.4155	9.1251	13.911	0.0000	5.1986	24.000	0.0000
Mn	0.5582	6.846	0.5945	12.9729	10.363	0.0000	5.2117	22.180	0.0000
Na	-1.5927	9.461	0.1440	1.9362	1.264	0.2609	-0.1897	7.187	0.8548
Tot.P	1.0076	1.862	0.4264	3.2687	1.374	0.1322	2.4974	1.395	0.1816
Zn	-0.5635	5.530	0.5952	11.4689	13.917	0.0000	4.9823	23.964	0.0000

t-score: score based on modified normal distribution.

df: degrees of freedom.

p-value: percent chance of error in choosing alternative hypothesis: sample means not equal to zero.

As indicated in the previous section, the background samples were separated into three different groups: Group 1, 2 and 3. Group 1 consisted of samples recovered from the A-horizon or cultural feature. Group 2 included those samples collected from the C-horizon deposits. Group 3 represented a combination of all of the samples, including the cultural feature. As explained in the previous exploratory section these various groups were designed to address a series of questions pertaining to eventual research goals.

The initial analysis provided below is a summarization of the information provided previously for the five target elements, Cu, Mn, Na, P and Zn, which were tested within the broader study. **Table 7.13** offers a summarization of the t-test results for just these five elements. Review of the results obtained from the t-test comparison indicated that sodium and total phosphorous had severe reductions in their degrees of freedom. As with previous rockshelter sites, a non-parametric Wilcoxon rank sum test was run to evaluate those samples with reduced degrees of freedom. **Table 7.14** summarizes the p-value results obtained the affected group comparison.

Table 7.14. Comparisons of Groups 1,2,3 at 41BL844 Using a Wilcoxon Test.

	Burial. μ to G1 μ	Burial. μ to G2 μ	Burial. μ to G3 μ
Na		0.1221	0.4220
Tot.P	0.4396	0.0789	0.1185

The rank sum results tended to increase the potential differences between the burial and the background groups. Although raised, they are not significant at the 95 percent confidence level.

The burial possesses significant differences with the majority of Group 2 and Group 3 assessments, but only sodium possessed any potential difference within the Group 1 comparison. The results are similar to those obtained from 41BL744, but a separate assessment will be necessary to adequately investigate the possibility that the burials are significantly different than the environment due to the small sample size and disparities between the number of feature samples and background samples.

41CV1038 Chemical Results

This site is located on a series of terraces of Cowhouse Creek. Recent excavations by the Fort Hood archaeological staff had identified a rock cluster within a buried A-horizon, during ground-truthing of a collection of geophysical results from the site. Samples of the rock cluster feature were taken from the wall of an excavation unit. A total of 7 samples were collected from 3 cores at 41CV1038. Two of these cores were collected to characterize the background environment and one was collected from the rock cluster. Stratigraphically the samples were collected from three distinct horizons, one from a buried A-horizon that contained the rock cluster feature and two from a series of AB-horizon that represented horizons bracketing the buried Ab-horizon (**Appendix A:175**). Soil pH levels were collected from all of the samples, ranging from 7.09 to 8.03, with a mean (μ) of 7.72, a median of 7.84 and a

variance of 0.112. The pH levels indicated a neutral to slightly basic environment, appropriate for terraces constructed from limestone parent material in an exposed subtropical subhumid environment. Stable pH levels were recorded, even with high fluctuating amounts of organics within the various horizons sampled.

The soil pH was similarly assessed at 41CV1038 as the previous sites. **Table 7.15** summarizes these results of correlations completed against the overall sample concentrations with soil pH.

Table 7.15. Correlation of pH Values with Chemical Concentration at 41CV1038.

	Correlation: (r: value range 1.0 to -1.0)
Cu	-0.0826
Mn	-0.3169
Na	0.7059
Tot.P	0.1769
Zn	-0.1392

None of the chemical results appear to be correlated to pH values with the exception of sodium. A correlation value of .7059 indicates a good linear positive relationship between pH value and sodium increasing with depth at the site. It is not known if this relationship is reducing or augmenting the chemical results, but given the fact that the sodium values are not significant within the t-test it is possible that increasing pH has lead to a masking of sodium values. A cursory comparison between the other sites and 41CV1038 does show a general reduction in the sodium values, but this reduction appears consistent to all values recorded at the site, and not specifically affecting a certain sample depth. Based on this, it was not believed that the correlation was having an effect on the comparability of the sodium levels internally within the site between the feature and the background.

The assessment of the data collected from 41CV1038 was formulated identically as that described previously. The soil stratigraphy at the site consisted of alternating A and AB-horizons that possessed differing thicknesses and characteristics. Given this variability in the stratigraphy a single composite sample was compared to the feature location, basically

creating a sample that was the same as Group 3 used within the majority of the sites investigated, and was referred to as such within this section.

The following table (**Table 7.16**) summarizes the results for the various hypothesis tests comparing the feature sample (n=2) to the background group: Group 3 (n=6). The structure of the hypothesis testing was the same as outlined above.

Table 7.16. Analysis Results of Chemical Sampling at 41CV1038.

	Features μ to Group 3 μ		
	t-score	df	p-value
Cu	1.9196	5.009	0.1129
Mn	-1.6847	5.015	0.1527
Na	-0.3219	5.010	0.7605
Tot.P	7.3244	5.000	0.0007
Zn	4.9498	5.035	0.0042

Unlike the other previous sites, the degrees of freedom used to calculate the t-scores and p-values appeared to be consistent at the site. Thus it was not necessary to complete a rank sum test. total phosphorus and zinc were significant at a 95 percent confidence level, with copper and manganese indicating potential differences.

**41CV1150 Walker Cemetery
Chemical Results**

Walker Cemetery is located on a broad upland slope that extends down to Shoal Creek in the far northwestern corner of Fort Hood. Geophysical results from the cemetery identified a number of unmarked grave locations. Two graves were sampled using coring instruments only. A total of 28 samples were collected from 12 cores at 41CV1150. Four cores were collected to characterize the two grave locations, with the remainder being collected for background site characterization. Stratigraphically the samples were collected from two distinct horizons, one from the grave shaft fill lying above the bodies and one from a Btk-horizon that typifies the lower portion of the soil profile across the landform (**Appendix A:175-177**). Soil pH levels were collected from 28 of the samples ranging from 6.71 to 7.89, with a mean (μ) of 7.39, a median of 7.42 and a variance of 0.059. The pH levels indicated a neutral environment. The low 6.71 pH

level recovered from one of the background cores is questionable. It is probable that pH levels at the site range from 7.00 to 8.00.

The soil pH at 41CV1150 was similarly assessed as at the previous sites. **Table 7.17** summarizes these results of correlations completed against the overall sample concentrations with soil pH.

Table 7.17. Correlation of pH Values with Chemical Concentration at 41CV1150.

	Correlation: (r: value range 1.0 to -1.0)
Cu	0.271072
Mn	-0.150798
Na	0.225876
Tot.P	0.333916
Zn	0.207870

The correlation results indicated that there were no significant correlations between pH and the various soil chemical samples. Total phosphorous is the only one that shows even a slight correlation to pH.

The initial assessment of the data collected from 41CV1150 was formulated identically as that described within the exploratory investigation of 41BL844. The burial depth at the site averaged 1.35-1.45 m bs. It was believed that the surficial A-horizon would play little if any role in characterizing the background of the burial locations given the distance between the locales. Thus a series of deep samples within the Btk-horizon, which underlies the A-horizon across the site, were collected. Given that these samples came from the same strata, a single composite background sample was compiled for comparison to the burial locations. Included within this were samples collected from the grave shaft locations. Although disturbed, the majority of the sediment within the shafts were the same Btk-horizon soils that constitute the majority of the upper 1.8 m of the soil profile. Given that this sample is a composite of all the various samples, it is the same as Group 3 used within the majority of the sites investigated, and was referred to as such within this section.

The following table (**Table 7.18**) summarizes the results for the hypothesis test comparing the

burial sample (n=2) to the background group: Group 3 (n=20). The structure of the hypothesis testing was the same as outlined above.

Table 7.18. Analysis Results of Chemical Sampling at 41CV1150.

	Burials μ to Group 3 μ		
	t-score	df	p-value
Cu	2.3848	3.676	0.0813
Mn	0.6638	7.425	0.5269
Na	1.3605	3.050	0.2655
Tot.P	1.0025	3.165	0.3865
Zn	2.7612	3.074	0.0682

Review of the results obtained from the t-test comparison indicated that all of the samples had substantial reductions in their degrees of freedom within the Welch modified format. As with previous sites, a non-parametric Wilcoxon rank sum test was run to evaluate the potential that the transformations were not sufficient to approximate a normal distribution. **Table 7.19** summarizes the p-value results obtained for all of the various groups.

Table 7.19. Comparisons of Groups 1,2,3 at 41CV1150 Using a Wilcoxon Test.

	Burial. μ to G3 μ
Cu	0.0396
Mn	0.6936
Na	0.0524
Tot.P	0.5328
Zn	0.0053

The rank sum results corroborated the significant results obtained within the copper and zinc samples. The manganese and total phosphorous were still found to be not significant, but sodium had a substantially different level of significance in comparison with the t-test results. This elevation is probably related to running the test against the non-transformed raw concentrations. The spike located in sample 3b is probably increasing the significance of the test between sample means (**Appendix B:190**). In general, the sodium results are not significantly different than the background outside of this loan sample.

The soil sampling at Walker cemetery indicated that copper and zinc were significantly elevated in relation to the background samples, with the exception of Core 4 (**Appendix B:191**). This core possessed higher concentrations of phosphorous from above and below the burial, possibly indicating some degree of disturbance to the burial in this location, or inadequate separation between samples. In general, the grave locations possessed different chemical signatures within the copper and zinc samples.

41CV1235 Chemical Results

The site is situated on a series of terraces west of House Creek and north of an unnamed tributary in the western portion of the base. Previous archaeological work identified a burned rock midden extending along a portion of the terrace. Geophysical results led to the investigation of two non-burial features both outside of and within the burned rock midden. Samples taken from the features were recovered from the excavation unit walls. A total of 29 samples were collected from 12 cores at 41CV1235. Eight of these cores were collected to characterize the background environment and four were collected from the two cultural features. Stratigraphically the samples were collected from three distinct horizons, one from an A-horizon, one from the rock midden and one from an AB-horizon that underlies the midden and cultural features (**Appendix A:177-178**). Soil pH levels were collected from all of the samples, ranging from 7.21 to 8.09, with a mean (μ) of 7.73, a median of 7.78 and a variance of 0.031. The pH levels indicated a neutral to slightly basic environment, appropriate for terraces constructed from limestone parent material in an exposed subtropical subhumid environment. Stable pH levels were recorded, even with high fluctuating amounts of organics within the various horizons sampled.

The soil pH was similarly assessed at 41CV1235 as the previous sites. **Table 7.20** summarizes these results of correlations completed against the overall sample concentrations with soil pH. The correlation results indicated that there were no significant correlations between pH and the various soil chemical samples.

Table 7.20. Correlation of pH Values with Chemical Concentration at 41CV1235.

	Correlation: (r: value range 1.0 to -1.0)
Cu	-0.166130
Mn	-0.074417
Na	-0.063520
Tot.P	0.066022
Zn	-0.011291

The initial assessment of the data collected from 41CV1235 was formulated identically as that described previously. The soil stratigraphy at the site included an A-horizon and an underlying AB-horizon in each of the tests. A portion of the midden was sampled within Core 20. This midden fill was included in the A-horizon samples for analysis. Based on these characteristics, a series of three groups were created to compare to the feature locations. Group 1 consisted of samples recovered from the A-horizon, Group 2 included those samples collected from the AB-horizon deposits and Group 3 represented a combination of all of the background samples.

Table 7.21 summarizes the results for the various hypothesis tests comparing the feature sample (n=2) to the various background groups: Group 1 (n=13), Group 2 (n=12) and Group 3 (n=25). The structure of the hypothesis testing was the same as outlined above.

Table 7.21. Analysis Results of Chemical Sampling at 41CV1235.

	Features μ to Group 1 μ			Features μ to Group 2 μ			Features μ to Group 3 μ		
	t-score	df	p-value	t-score	df	p-value	t-score	df	p-value
Cu	-0.5086	4.416	0.6354	-0.0141	4.062	0.9895	-0.2859	3.609	0.7906
Mn	-2.7853	7.245	0.0262	2.1945	4.904	0.0807	-0.5130	7.422	0.6229
Na	-2.6006	14.135	0.0208	-4.1789	13.158	0.0011	-4.4755	25.428	0.0001
Tot.P	0.8725	15.000	0.3967	1.8585	4.854	0.1240	1.3975	11.474	0.1887
Zn	0.4591	4.898	0.6658	3.7151	11.461	0.0032	2.3593	8.068	0.0458

t-score: score based on modified normal distribution.

df: degrees of freedom.

p-value: percent chance of error in choosing alternative hypothesis: sample means not equal to zero.

Review of the results obtained from the t-test comparison indicated that copper, manganese, zinc and to a lesser degree total phosphorous had substantial reductions in their degrees of freedom within the Welch modified format. As with previous sites, a non-parametric Wilcoxon rank sum test was run to evaluate the potential that the transformations were not sufficient to approximate a normal distribution. **Table 7.22** summarizes the p-value results obtained for all of the various groups.

Table 7.22. Comparisons of Groups 1,2,3 at 41CV1235 Using a Wilcoxon Test.

	Feature. μ to G1 μ	Feature. μ to G2 μ	Feature. μ to G3 μ
Cu	0.6504	0.8081	0.6809
Mn	0.0445	0.1006	0.8247
Tot.P		0.1146	
Zn	0.4953		0.1133

In general, the majority of the assessments correspond well, a few, such as the Group 3 comparison for zinc are not significant as compared to the t-test results. Given that the power of each test is reduced due to the small sample size, this aberration was interpreted as an indicator that the difference between the features and the background within the zinc signature are indicative of potentially important differences, enough so that the t-test results were believed relatively accurate for initial assessment.

As with the assessment of 41BL744, the cultural features at the site contained significant

differences within the manganese and sodium signatures in comparison to A-horizon (Group 1). Sodium was found to possess significant difference across all comparisons. The contents of the features at 41CV1235 contained little bone, but did have substantial amounts of shell, burnt limestone and charcoal. The commonality of these features with the burial at 41BL744 is not fully understood. It is possible that the general constituent parts of the feature matrix fill are similar to those contained within the fill matrix of the burial pit at 41BL744. The sampling of the burial was confined to the fill included in the pit only at 41BL744 and did not contain any human bone fragments. It is possible that elevated levels of sodium and manganese may be common to certain combinations of midden fill and not to bone. A secondary assessment of the burial locations and the cultural features was completed as a means of addressing the differences; it follows later in this chapter.

Zinc was also found to have significant differences with Groups 2 and 3. In general, the features do appear different than the underlying AB-horizon and the composite sample. This significant difference was common throughout the assessment of most sites investigated.

Results from Camp Lejeune Sites

This section relates that results of chemical testing of the sites in Camp Lejeune. Unlike the sites at Fort Hood, the sites investigated at Camp Lejeune all have very similar environmental locations: broad older terraces of the flooded coastal rivers that drain the coastal plain. In addition, all of the sites, with the exception of Wards-Will cemetery, contain archaeological deposits associated with occupations extending from the Early to Late Woodland periods.

31ON71 Chemical Results

The Freeman Creek site extends across a broad terrace and ridgenose that is bounded by Freeman Creek on the east, the Atlantic Intracoastal Waterway on the south and a small unnamed tributary to the west. The terrace and small ridgenose is surrounded by wetlands associated with the bounding drainages on the east, west and south. Previous archaeological work identified materials associated with prehistoric occupations from the Early to Late Woodland periods. The portion of the site investigated contained a dense shell midden that covers approximately half of the area surveyed. Geophysical results guided the investigation of two non-burial features, both outside and within the shell midden. Samples from the features were taken from the excavation unit walls. A total of 39 samples were collected from 12 cores at 31ON71. Eight of these cores were collected to characterize the background environment and four were collected from the two cultural features. Stratigraphically the samples were collected from three distinct horizons, one from an Ap-horizon, one from an AB to a Bw-horizon that underlies the majority of the Ap across the site and one from the basal C-horizon deposits (**Appendix A:179-181**). Soil pH levels were collected from all of the samples, ranging from 6.51 to 8.05, with a mean (μ) of 7.33, a median of 7.33 and a variance of 0.187. The pH levels are elevated due to the presence of the extensive shell midden deposits. The portion of the site surveyed is slightly acidic to slightly basic. In general, it is believed that other portions of the site would be more normally characterized as slightly acidic to neutral. While the shell midden deposits are not consistently represented across the site, it would appear that in general the pH levels only range about 1.0 from the lowest to the highest reading at any one location.

A correlation assessment was completed between the pH levels and the various soil chemical concentrations taken at the site. **Table 7.23** summarizes these results of correlations completed against the overall sample concentrations with soil pH. The correlation results indicated that there were no significant correlations between pH and the various soil chemical samples. Manganese was the only trace metal to show even a slight positive correlation with pH levels.

Table 7.23. Correlation of pH Values with Chemical Concentration at 31ON71.

	Correlation: (r: value range 1.0 to -1.0)
Cu	-0.105132
Mn	0.365976
Na	0.047113
Tot.P	0.143823
Zn	0.119560

Stratigraphically the site contained a total of four strata within the upper 1.0 m of the soil profile. The site was covered by an Ap-horizon. The Ap was underlain generally with either an AB or a Bw-horizon, depending on the amount of shell midden contained within that portion of the site. Both of these horizons gradually graded into a C-horizon that underlay the entire site locale. Although the second horizon fluctuated in structure, inclusions and color it was consistently represented as a stratum between the A and C-horizons. Given these characteristics, samples were collected from all three strata. Based on the previous strategy, these three different strata were assessed against the two features separately, along with a composite sample of all the various background samples collected at the site. As a means of making the nomenclature consistent with that used at the other sites, Groups 1, 2 and 3 represent the same collection of samples. Group 1 consisted of samples recovered from the Ap-horizon, Group 2 included those samples collected from the C-horizon deposits and Group 3 represented a combination of all of the background samples. Group 4 (n=8) represents the collection of samples taken from the second fluctuating strata contained at 31ON71. **Table 7.24** summarizes the results from the Group 4 comparison.

Table 7.24. Analysis Results of Chemical Sampling at 31ON71.

	Features μ to Group 4 μ		
	t-score	df	p-value
Cu	-1.0271	8.953	0.3337
Mn	3.0538	9.956	0.0122
Na	1.7678	10.917	0.1050
Tot.P	-2.3873	13.000	0.0329
Zn	0.1329	7.524	0.8978

The results of the Group 4 comparison indicated significant differences between the features and the background values for manganese and total phosphorous, as well as a significant trend difference for sodium at approximately the 90 percent confidence level. Degrees of freedom for the Welch modified t-test were good for the Group 4 comparison requiring no need to utilize a secondary rank sum assessment.

Table 7.25 summarizes the results for the various hypothesis tests comparing the feature samples (n=7) to the various background groups: Group 1 (n=12), Group 2 (n=12) and Group 3 (n=32). The structure of the hypothesis testing was the same as outlined above.

Table 7.25. Analysis Results of Chemical Sampling at 31ON71.

	Features μ to Group 1 μ			Features μ to Group 2 μ			Features μ to Group 3 μ		
	t-score	df	p-value	t-score	df	p-value	t-score	df	p-value
Cu	-1.0217	8.953	0.3337	-0.3705	14.470	0.7164	-0.9542	8.714	0.3657
Mn	-2.7487	16.273	0.0141	6.8867	15.868	0.0000	2.8447	34.922	0.0074
Na	-0.5075	12.833	0.6204	0.5817	13.176	0.5706	0.4591	35.291	0.6490
Tot.P	-1.4960	15.929	0.1542	5.0653	16.438	0.0001	0.5031	26.952	0.6190
Zn	-2.3752	16.974	0.0296	3.3082	13.849	0.0052	1.0205	36.367	0.3142

t-score: score based on modified normal distribution.

df: degrees of freedom.

p-value: percent chance of error in choosing alternative hypothesis: sample means not equal to zero.

The results obtained from the traditional three groups indicated only severely reduced degrees of freedom values from copper. **Table 7.26** relates the rank sum results from a Wilcoxon test completed for the various copper comparisons.

Table 7.26. Comparisons of Groups 1,2,3 at 31ON71 Using a Wilcoxon Test.

	Feature. μ to G1 μ	Feature. μ to G2 μ	Feature. μ to G3 μ
Cu	0.0687	0.6419	0.2131

Group 2 and 3 assessments under the rank sum test were similar to those obtained by the t-test, but the result for the Group 1 assessment is clearly different. Raw, untransformed, concentration measurements were used for the assessment of the rank sum test, given that the log-transformed results were not necessary. A review of the raw measurements indicated one large sample recovered from Core 117c (**Appendix B:193-194**). This large sample is significantly different than the average background values of the site. It is this lone measurement that is creating the significance change between the two tests. The t-test results were retained as the baseline assessment for copper.

An assessment of the Groups 1, 2 and 3 results indicated that manganese and zinc were the only two chemical signatures that indicated significant differences between the background and the features. The Group 1 results are both significantly different within the manganese and zinc measurements, indicating that disturbance related to the surficial Ap does not appear to be having any degree of affect on the feature contexts. Copper and sodium indicated poor results between the Ap and the features, but both also retained poor results against the lower C-horizon stratum samples as well, indicating that the lack of significant difference is probably not related to any alterations imposed by the disturbed Ap. Group 3 comparisons were marginal with the exception of manganese.

31ON1019 Chemical Results

The site is located along an elevated terrace of Northeast Creek, part of the New River drainage. The site contained a previously identified burial that was the central point of investigation. A total of 18 samples were collected from 6 cores at 31ON1019. Four of these cores were collected to characterize the background environment and two were collected from the burial location. Stratigraphically the samples were collected from three general horizons, one from a consistently represented A-horizon, one from a second horizon that ranged in characteristics from an AB to a BC-horizon and one from the basal C-horizon deposits (**Appendix A:181-182**). Soil pH levels were collected from all of the samples ranging from 5.10 to 7.75, with a mean (μ) of 6.95, a median of 7.20 and a variance of 0.628. There is a fair amount of variability within the pH levels obtained from the various strata.

A review of the stratigraphy indicated that, in general, two different stratigraphic sequences were noted at the site, with these two sequences having different trends within the pH measurements. These different sequences cluster in two areas of the grid, probably indicating that some stratigraphic change is occurring within the grid from north to south. This change is believed to relate to the distance of the cores from the river, potentially that a scarp edge was once present north of the burial location. This sort of position for the burial in relation to a higher drier portion of the terrace would appear appropriate. The pH levels indicated a neutral to slightly acidic environment, appropriate for an older weathered surface consisting of sand-based parent material.

Given some of the stratigraphic issues identified during coring, a correlation assessment was completed between the pH levels and the various soil chemical concentrations taken at the site. **Table 7.27** summarizes these results of correlations completed against the overall sample concentrations with soil pH. The correlation results indicated that there were no significant correlations between pH and the various soil chemical samples. Chemical results do not appear to be correlated to stratigraphic differences at the site.

Table 7.27. Correlation of pH Values with Chemical Concentration at 31ON1019.

	Correlation: (r: value range 1.0 to -1.0)
Cu	0.130444
Mn	0.202500
Na	0.212860
Tot.P	0.211493
Zn	0.134063

Like 31ON71, 31ON1019 contained a total of four strata within the upper 1.0 m of the soil profile. A surficial A-horizon that slightly undulates in depth covers the collection area. The A-horizon was underlain generally with either an AB or a BC-horizon. This second stratum at the site contains a great deal of variability and may relate to the position of the grid along a terrace scarp or disturbance related to golf course construction. These second horizons gradually graded into a C-horizon that underlay the entire site locale. Although the second horizon fluctuated in structure, inclusions and color, it was consistently represented between the surficial A-horizon and the basal C-horizon deposits. These characteristics led to samples being collected from all three different strata. Based on the previous strategy, these three different strata were assessed against the burial separately, along with a composite sample of all the various background samples collected at the site. As a means of making the nomenclature consistent with that used at the other sites, Groups 1, 2 and 3 represent the same collection of samples. Group 1 consisted of samples recovered from the A-horizon, Group 2 included those samples collected from the C-horizon deposits and Group 3 represented a combination of all of the

background samples. Group 4 (n=4) represents the collection of samples taken from the second fluctuating strata contained at 31ON1019. **Table 7.28** summarizes the results from the Group 4 comparison.

Table 7.28. Analysis Results of Chemical Sampling at 31ON1019.

	Burial μ to Group 4 μ		
	t-score	df	p-value
Cu	3.5191	3.987	0.0246
Mn	0.1290	3.942	0.9037
Na	2.4747	1.147	0.2180
Tot.P	4.9387	1.011	0.1252
Zn	2.2968	1.013	0.2589

The majority of the t-test results for the Group 4 comparisons indicated reduced degrees of freedom. A secondary rank sum test was completed as a comparison. This rank sum test was completed against the untransformed raw concentrations. **Table 7.29** relates the results of this test as p-values.

Table 7.29. Comparisons of Groups 4 at 31ON1019 Using a Wilcoxon Test.

	Burial. μ to G4 μ
Cu	0.1333
Mn	0.5333
Na	0.1333
Tot.P	0.1333
Zn	0.1002

A comparison of the results from the two tests indicates a number of differences that relate directly to assessing the raw concentration results instead of the log-transformed and trimmed mean results. The increase in significance of sodium and zinc within the rank sum test is related to large concentration spikes within Cores 108b within both samples that had been eliminated in the transformed samples. The other results in general correspond between the two tests.

Table 7.30 summarizes the results of the traditional three groups, Group 1 (n=6), Group 2 (n=6) and Group 3 (n=16), contained within the majority of the other sites investigated. A number of these t-tests contain reduced degrees of freedom. As with the Group 4 comparison, a secondary rank sum test was completed against the untransformed concentration data. **Table 7.31** summarizes the results of the Wilcoxon rank sum test.

The t-test and Wilcoxon rank sum results do not possess a great deal of agreement. The rank sum results indicate that the majority of the results are either significant at the 90 percent confidence level or are indicating potential differences between the burial and background samples, with the exception of copper. The t-test in comparison indicates that almost all of the samples are not significant at the 90 percent confidence level. The disparity between the two tests is directly related to substantial outliers within the burial samples.

Table 7.30. Analysis Results of Chemical Sampling at 31ON1019.

	Burial μ to Group 1 μ			Burial μ to Group 2 μ			Burial μ to Group 3 μ		
	t-score	df	p-value	t-score	df	p-value	t-score	df	p-value
Cu	0.5878	5.371	0.5805	1.7938	5.855	0.1242	2.1421	12.845	0.0519
Mn	1.4969	1.425	0.3181	1.7954	1.320	0.2746	1.2794	1.413	0.3715
Na	2.3033	1.054	0.2505	2.5674	1.101	0.2175	2.4844	1.029	0.2380
Tot.P	4.1314	1.035	0.1447	4.1446	1.169	0.1227	4.3753	1.039	0.1360
Zn	1.7646	1.020	0.3245	2.0247	1.182	0.2607	2.0174	1.032	0.2870

t-score: score based on modified normal distribution.

df: degrees of freedom.

p-value: percent chance of error in choosing alternative hypothesis: sample means not equal to zero.

Table 7.31. Comparisons of Groups 1,2,3 at 31ON1019 Using a Wilcoxon Test.

	Burial. μ to G1 μ	Burial. μ to G2 μ	Burial. μ to G3 μ
Cu	0.2857	0.4286	0.1398
Mn	0.2405	0.0714	0.1058
Na	0.0714	0.0714	0.0131
Tot.P	0.0714	0.0714	0.0131
Zn	0.0714	0.0651	0.0292

Total phosphorous, sodium and zinc all have substantial spikes in at least one sample in comparison with the background, causing the burial sample to possess a vastly different variance. This difference led to a substantial reduction within the t-test's degrees of freedom, reducing the power of the test. Given that the Wilcoxon test makes no assumption about the distribution of the data, this problem does not affect its results. Based on this assessment, the rank sum results appear to offer a better estimate in the degree of difference between the burial and the background environment.

Sodium, zinc and the total phosphorous results indicated significant difference between the burial sample and the background. This difference was exacerbated due to the fact that bone fragments were recovered within Core 108b, leading to the substantial data spikes noted above (**Appendix B:194**). While the bone was removed from the sample and replaced into the core location, the

proximity of the sample to the bone indicates that it is possible to use these trace metals to identify the bone as anomalous to the environment. Samples taken from other parts of the burial, in which bone was not within proximity to the core location, were substantially reduced in chemical concentration. This proximity issue illustrated here appears common to all of the burial sample locations, in which bone was recovered within the core.

31ON1236 Chemical Results

31ON1236 is located along broad elevated terraces of the New River. The site contained a previously identified burial that was the central point of investigation. An extensive shell midden that occurs across the area defines the site. This midden was identified consistently within the coring. A total of 12 samples were collected from 6 cores at 31ON1236. Four of these cores were collected to characterize the background environment and two were collected from the burial location. Stratigraphically the samples were collected from two general horizons, one from a consistently represented anthropogenically enhanced A-horizon containing differing amount of shell midden deposits and one from the basal C-horizon deposits (**Appendix A:182-183**). Soil pH levels were collected from all of the samples ranging from 6.89 to 7.85, with a mean (μ) of 7.57, a median of 7.64 and a variance of 0.071. The pH levels indicated a neutral to slightly acidic environment, appropriate for an older weathered surface consisting of sand based parent material. The higher pH readings at 31ON1236 than those obtained at 31ON1019 is probably related to the

prodigious amounts of shell that were added to have added extensive amounts of CaCO₃ to the soil, increasing the amount of basic material within the soil profile and neutralizing the usually acidic type environments that typify the Coastal Plain.

A correlation assessment was completed between the overall concentrations of the five chemical signatures and pH levels. **Table 7.32** summarizes the results of this correlation assessment.

Table 7.32. Correlation of pH Values with Chemical Concentration at 31ON1236.

	Correlation: (r: value range 1.0 to -1.0)
Cu	0.243962
Mn	-0.680669
Na	-0.852738
Tot.P	-0.553112
Zn	-0.778246

Unlike all of the other sites investigated, 31ON1236 possessed a high degree of correlation between concentration amounts and pH. All of the chemicals, with the exception of copper, were negatively correlated, indicating that while concentrations were decreasing in size with depth pH levels were consistently increasing. The substantial correlation between concentrations and pH is not fully understood at the site. Particle

the surface horizon. This additional shell would size between the A-horizon and the C-horizon appeared relatively consistent. Shell content was consistent within all of the A-horizon samples. It is possible that the consistent nature of the shell midden deposits has substantially increased the preservation of chemicals within the upper 0.30 m of the soil profile, as compared to the levels lying below the A-horizon. If this is the case then the differences between the burial locale and the A-horizon have been reduced from their more normal environmental levels.

The initial assessment of the data collected from 31ON1236 was formulated identically as that described previously. The soil stratigraphy at the site included an anthropogenically enhanced A-horizon midden and an underlying C-horizon in each of the tests. The midden at the site contained dense fluctuating amounts of shell, altering pH levels across the survey grid. Based on these characteristics, a series of three groups were created to compare to the burial location. Group 1 consisted of samples recovered from the midden A-horizon, Group 2 included those samples collected from the C-horizon deposits and Group 3 represented a combination of all of the background samples.

Table 7.33 summarizes the results for the various hypothesis tests comparing the burial sample (n=2) to the various background groups: Group 1 (n=4), Group 2 (n=6) and Group 3 (n=10). The structure of the hypothesis testing was the same as outlined above.

Table 7.33. Analysis Results of Chemical Sampling at 31ON1236.

	Burial μ to Group 1 μ			Burial μ to Group 2 μ			Burial μ to Group 3 μ		
	t-score	df	p-value	t-score	df	p-value	t-score	df	p-value
Cu	-0.9242	3.658	0.4122	-0.0960	3.401	0.9289	-0.5361	2.483	0.6361
Mn	0.4632	1.313	0.7083	1.9695	1.050	0.2897	1.3374	1.183	0.3823
Na	1.5011	1.007	0.3728	2.1564	1.035	0.3034	1.8888	1.035	0.3034
Tot.P	3.1743	3.875	0.0353	11.6609	5.722	0.0000	5.6204	9.993	0.0002
Zn	0.8153	1.196	0.5456	2.5197	1.049	0.2311	1.7862	1.203	0.2917

t-score: score based on modified normal distribution.

df: degrees of freedom.

p-value: percent chance of error in choosing alternative hypothesis: sample means not equal to zero.

As with many of the previous site assessments using the t-distribution, the degrees of freedom were substantially reduced due to differences in variances between the burial and background samples. The assessment at 31ON1236 is no different, and as such a secondary Wilcoxon rank sum test was performed against all of the various group comparisons. **Table 7.34** summarizes the results from the rank sum tests.

Table 7.34. Comparisons of Groups 1,2,3 at 31ON1236 Using a Wilcoxon Test.

	Burial.μ to G1μ	Burial.μ to G2μ	Burial.μ to G3μ
Cu	0.5333	0.8668	0.9143
Mn	0.8000	0.0714	0.1818
Na	0.1333	0.0714	0.0303
Tot.P	0.1333	0.0714	0.0303
Zn	0.8000	0.0714	0.1818

A comparison of the p-value results between the two tests indicates general agreement between copper and total phosphorous, but the other trace metals have substantially different results. As with 31ON1019, these results appear tied to spikes within certain samples. The comparisons that have the greatest degrees of freedom reduction also have the greatest comparative change between the two tests. This is linked to substantial variance differences between burial and background samples, leading to reduced degrees of freedom and power within the t-test. Given this fact, the results of the Wilcoxon rank sum test appear to be more reliable than those obtained from the t-test.

Total phosphorous, sodium and zinc have significant differences at the 90 percent confidence level. These results appear to correspond well with the results obtained at the 31ON1019 burial, but at a reduced level of significance. This reduction may be related to the negative correlation discovered at the site between pH levels and concentrations, leading to an overall reduction in differences between the burial location and the A-horizon. If this is the case, then it is expected that the burial would contain significant differences at the higher 95 percent confidence level, as did the 31ON1019 burial.

Wards-Will Cemetery Chemical Results

The Wards-Will Cemetery is located approximately 300 m east of the New River, and on an interfluvium between Goose and Duck creeks. This landform probably formed as a terrace of the New River prior to its embayment. Sandy soils characterize the majority of the site. Geophysical results from the cemetery identified a number of potential unmarked grave locations. One of these graves was sampled using coring instruments only. A total of 14 samples were collected from 6 cores at the site. Two of these cores were collected to characterize the grave location, with the remainder being collected for background site characterization. Stratigraphically, cores placed within the cemetery lot indicated a substantial amount of variability in comparison to the lone core placed outside of the lot. The samples collected from the grave were recovered from three distinct horizons, including an upper disturbed stratum that was interpreted as a grave shaft, the grave itself and the underlying C-horizon. The background samples were collected from two general horizons, one from a AB or BC-horizon and an underlying C-horizon (**Appendix A:183-184**).

Soil pH levels were collected from all of the samples ranging from 5.36 to 7.80, with a mean (μ) of 6.47, a median of 6.35 and a variance of 0.646. The pH levels indicated a slightly acidic to neutral environment, appropriate for an older weathered surface consisting of sand based parent material. The high degree of fluctuations within the pH levels probably is related to disturbances that have occurred at the cemetery within the recent past.

A correlation assessment was completed between the overall concentrations of the five chemical signatures and pH levels. **Table 7.35** summarizes the results of this correlation assessment.

Table 7.35. Correlation of pH Values with Chemical Concentration at Wards-Will Cemetery.

	Correlation: (r: value range 1.0 to -1.0)
Cu	-0.100422
Mn	-0.506260
Na	-0.707356
Tot.P	-0.267649
Zn	-0.449253

Sodium, manganese and zinc all possessed from moderate to good negative correlations with soil pH. Sodium and zinc values increase with depth within four of the six cores, with pH values becoming more acidic with depth within five of the six, creating a negative correlation between the two measurements. Sodium and zinc levels appear to be increasing with depth due to leaching and possibly increasing acidic content of the soil at the site. This increase appears to occur at a depth below the burial position, indicating that leaching and acid levels may actually be lessening the difference between burial samples and the surrounding environment.

A review of the raw copper concentration data indicated that leaching from Core 127 had substantially increased the underlying C-horizon concentration. This increase lessened the degree of correlation between pH and the copper levels. This single measurement was removed to assess its importance within the correlation; the resultant correlation increased to -0.68662, indicating that copper may be similarly masked against the background as in the case of sodium and zinc. Assessment of total phosphorous and manganese did not indicate a similar trend in correlation values masking potential concentration values. These masking correlations were taken into consideration within the review of hypothesis testing results from the Wards-Will samples.

The initial assessment of the data collected from Wards-Will cemetery was formulated identically as that described within the exploratory investigation of 41BL844. The burial depth at the site averaged 1.20-1.25 m bs. Samples were collected within both an A-horizon that appeared consistently represented in both the cemetery lot and outside, as well as samples from the underlying C-horizon

that typified the soils at the depth of the burial. The soil profiles within the burial lot were highly disturbed, leading to fluctuating depths for certain strata. Given these disturbances a single composite background sample was created to characterize the background. The grave shaft samples were included into the background composite sample. Given that this sample is a composite of all the various samples it is the same as Group 3 used within the majority of the sites investigated, and was referred to as such within this section.

The following table (Table 7.36) summarizes the results for the hypothesis test comparing the burial sample (n=2) to the background group: Group 3 (n=8). The structure of the hypothesis testing was the same as outlined previously.

Table 7.36. Analysis Results of Chemical Sampling at Wards-Will Cemetery.

	Burial μ to Group 3 μ		
	t-score	df	p-value
Cu	1.0576	1.010	0.4807
Mn	-2.2066	6.697	0.0648
Na	1.8551	1.176	0.2850
Tot.P	4.8107	1.745	0.0527
Zn	1.5015	1.122	0.3545

The majority of the t-test results possessed a substantial reduction in the degrees of freedom, common of many of the sites investigated at Camp Lejeune. As with the other sites, a secondary Wilcoxon rank sum test was used as a comparison with the t-test results. Table 7.37 summarizes the results of rank sum test.

Table 7.37. Comparison of Group 3 at Wards-Will Cemetery Using a Wilcoxon Test.

	Burial. μ to Group 3 μ
Cu	0.2003
Mn	0.3603
Na	0.1978
Tot.P	0.0440
Zn	0.1685

A comparison of the p-value results between the two tests indicates general agreement between copper and total phosphorous, but the other trace metals have substantially different results. As with 31ON1019 these results appeared tied to spikes within certain samples. The comparisons that have the greatest degrees of freedom reduction also have the greatest comparative change between the two tests. This is linked to substantial variance difference between burial and background samples, leading to reduced degrees of freedom and power within the t-test. Given this fact the results of the Wilcoxon rank sum test appear to be more reliable than those obtained from the t-test.

The general rank sum results indicate that only total phosphorus was significant at the 95 percent confidence level. The remaining values were found to have potential differences between the grave and background samples, with the exception of manganese. Based on the pH correlation analysis, it would appear necessary to give increased credence to the potential significance of the copper, sodium and zinc values, given the fact that they appear to be masked somewhat in comparison to the background values. All three contain at least one concentration value that is substantially different from the environment (**Appendix B:195**). In both the copper and zinc samples, leaching has augmented the sample taken from the below the grave to above normal environmental levels. A reassessment of Wilcoxon rank sum test lest the Core 127c sample increased the significance of both tests: copper (0.1659) and zinc (0.1360). It appears that total phosphorous was significantly different, and trace elements, copper and zinc, were suggestive of differences between the grave location and the general normal background values at Wards-Will cemetery.

REVIEW OF INDIVIDUAL SITES & BROADER ASSESSMENT

The individual site assessments revealed general trends that were noted within the results. An assessment of the raw concentrations indicated a substantial range both internal to features as well as within the background. Chemical concentrations were not consistent in reference to sample variances across the investigated sites. Some sites contain very limited ranges for certain chemicals, while other sites may contain substantial variances for samples from the same chemical signature. As a means of addressing this

variability, a series of assessments were completed that were designed to compare the differences and predictive power of chemical signatures against a variety of different groups and environmental conditions.

Of the 40 potential samples run against A-horizons (Group 1 comparisons) from both installations; only 13, or 32.5 percent, were found to be significant at an 85 percent confidence level or higher. Of the 13 significant samples, five were collected at sites from Fort Hood, 25 percent of all samples, and eight, 53 percent of all samples, from Camp Lejeune. Sodium was found to be significant at five of the sites, three for both manganese and total phosphorous and two for zinc at an 85 percent confidence level. Zinc and total phosphorus were found to have significant difference at Camp Lejeune only. Manganese was found at 41BL744, 41CV1235 and 31ON71 to have significant levels of difference. Sodium was by far the best indicator, with differences noted at 41BL744, 41BL844, 41CV1235, 31ON1019 and 31ON1236, the majority of which compared burials to the background. The results for sodium against the background values corroborated the belief established from the initial exploratory investigations, that it was the only trace metal to have any predictive power against the A-horizon soils.

An overall assessment of the samples against the C-horizon or non-anthropogenically enhanced stratum (Group 2 or 3 comparisons) at the sites indicated a much greater degree of difference than the A-horizon samples. Of the 55 potential samples run against the C-horizon from both installations, 36, or 65.5 percent, were found to be significant at an 85 percent confidence level or higher. A total of 22 samples were recorded from Fort Hood sites, 63 percent of all samples, and 14, 70 percent of all samples, from Camp Lejeune. Copper was found to be significantly different within the Group 3 comparison within 5 out of 7 sites at Fort Hood, but was not found to be significant against any of the sites at Camp Lejeune. Manganese was found significant at 4 out of 7 sites at Fort Hood and 3 out of 4 at Camp Lejeune. Sodium was found to be significant at 41CV1235 only at Fort Hood and at 3 out of 4 sites at Camp Lejeune. Total phosphorous and zinc were found to have significant differences for 6 or the 7 sites at Fort Hood and at all 4 sites at Camp Lejeune. Based on these general results, it is probable that minimal testing would be able to obtain a significant difference between cultural

features and the underlying C-horizon samples at a high percentage of sites irrelevant of differing environmental conditions.

Given the difference between the features and the Group 2 or 3 comparisons, it did not appear necessary to perform any additional assessment to determine the potential predictive power of the various chemical signatures. The lack of significant difference between the A-horizon and the chemical signatures appears to be the controlling factor in the ability to predict burial locations. The final research goal was to identify a chemical signature process that could discern a burial from other potential cultural features. Based on this goal, it was necessary to identify a sample of features that contained both human remains and ones that did not, therefore providing a range of samples for comparison. A separate hypothesis test was created to assess the potential that burials located at the various sites were different than the cultural features. These hypothesis tests were run using the same assumptions as those performed in the individual site assessments. An equal amount of 16 samples was collected from burial locations and cultural features. These samples represented the basis for this initial comparison. **Table 7.38** summarizes the p-value results from comparisons made using both the t-test and Wilcoxon rank sum tests.

Table 7.38. Burials Compared to other Cultural Features at All Sites Investigated.

	Burial μ to Cultural Feature μ	
	p-value: T-test	p-value: Rank sum
Cu	0.3512	0.5971
Mn	0.2602	0.2273
Na	0.0029	0.0047
Tot.P	0.6621	0.7304
Zn	0.0417	0.0456

A comparison of the two tests indicates a general correspondence or results. Sodium and zinc were the only two chemical signatures that possessed significant results at a 95 percent confidence level. This result continued to indicate some degree of difference between burials and other organically rich environments when compared through sodium. But it was possible that although the sample size was equal between the two groups that the cultural features were not

representative enough of the overall breadth of the population. The majority of the features tested contained little bone, and thus might not be offering the most representative sample of organically enriched environments. As a means of improving the comparative background sample, a selection of chemical signatures were added from a number of sites in which bone or midden deposits were noted. A total of 34 appropriate A-horizon samples from 41BL744, 41BL780, 41BL844, 41CV1235 and 31ON1236 were added to the cultural feature signatures for sodium and zinc. Another hypothesis test was run against the burial locations and the augmented cultural feature/midden sample. **Table 7.39** summarizes the p-value results from comparisons made using both the t-test and Wilcoxon rank sum tests for both sodium and zinc.

Table 7.39. Burials compared to other Culturally Augmented samples at all Sites Investigated.

	Burial μ to Cultural Feature μ	
	p-value: T-test	p-value: Rank sum
Na	0.7558	0.4453
Zn	0.6495	0.8937

Although there is some degree of disparity between the two samples results, neither indicates a significant difference between the burials and the culturally augmented samples. The result of this hypothesis testing indicates that none of the five chemical signatures tested were found to provide significant differences between burial locations and broad sample of other culturally augmented features. The comparison of the burials to the more restrictive cultural feature sample indicated that differences do appear to exist within individual sites, but when applied to a broader context these differences are subsumed. This lack of differentiation between the burials and the broader environment points out another potential problem in the development of a broad testing scheme utilizing bulk concentration samples.

A series of descriptive statistics were run for the various chemical signatures collected from sites at Fort Hood and Camp Lejeune. These were created to illustrate the level of differences in concentrations between sites from the two installations. **Table 7.40** summarizes these descriptive statistics, illustrating the differences

between the Fort Hood sites and those investigated at Camp Lejeune.

A review of these results indicates that only copper contained relatively similar concentrations between the two installations (**Table 7.40**). While the ranges may overlap somewhat, in general the other four chemical signatures are vastly different. The Fort Hood samples indicate a consistently higher concentration than those samples obtained from Camp Lejeune. The reason for this disparity is probably linked to differences in particle size. It may be possible to create a formula to center the data to a consistent baseline of reference, based on certain soil constituents. Background research could not identify such a formula. If a formula could be created it would probably need to include more rigorous soil chemistry data, as well as more sites from a broader range of environmental types.

As indicated above, individual site assessments produced a range of elevated chemical signatures for cultural features in comparison to site backgrounds. Thus chemical signature development on a site-specific basis appears to provide some degree of differentiation and predictive power, but which chemical signature and to what degree of differentiation can be expected, appears to be fairly random. This random nature may be an artifact of small sample size, but is more than likely inherent within the myriad of different preservation issues that may affect each individual site. Even with these various problems, some broader evaluations and trends

were noted between sites within specific environmental or cultural contexts.

Evaluation of the chemical results against certain environmental or site types does appear to have produced some general trends. Sites 41BL744, 41BL844, 41CV1235, 31ON1019 and 31ON1236 all contained elevated levels of sodium versus a broad collection of other organically enriched samples. All of these feature samples, with the exception for those at 41CV1235, were comparing burials to the A-horizon. Sites 41BL744, 41BL844, 31ON1019 and 31ON1236 constitute all of the sites that contained prehistoric burials, with the exception of 41BL69. Sodium levels at both historic cemeteries also indicated potential differences between the graves and the background environment, but not to the degree as that noted within the prehistoric burials. This lack of differentiation may be related to differences in background samples used for comparison or be related to duration of interment. As indicated above, testing of these burial samples against a larger and broader proxy sample of potential cultural features showed a lack of significant difference. While exploratory, this evaluation has problems given the over-reliance on rockshelter midden deposits, which contained consistently the highest concentrations of sodium within the background samples. If a broader sample of A-horizon deposits had been obtainable it may be possible that the differences noted between the burials and the cultural features would have held for a larger broader sample.

Table 7.40. Descriptive Statistics for Fort Hood and Camp Lejeune Sites.

	Fort Hood				Camp Lejeune			
	min.	max.	μ	σ	min.	max.	μ	σ
Cu	1.0	29.2	10.8	6.2	0.3	53.4	3.8	6.7
Mn	13.8	860.0	199.0	146.4	4.2	183.0	24.6	27.7
Na	81.3	3930.0	399.9	451.4	21.5	316.0	87.9	42.2
P	24.4	2070.0	464.6	443.2	21.5	1060.0	297.8	237.7
Zn	2.4	119.0	24.6	19.9	0.7	24.6	3.3	3.0

Non-Invasive Burial Determination

An evaluation of the historic cemeteries also indicated that not only was sodium elevated, but so were copper and zinc. The differentiation for copper and zinc were more pronounced at Walker as compared to Wards-Will but this may relate to less leaching and the smaller particle size constituent at Walker as compared to Wards-Will. Elevated levels of copper and zinc may relate to actual differences within the chemical make-up of the historic interments versus the prehistoric burials, or may relate to burial hardware or some other inclusion not represented within prehistoric burial contexts. In general, there appears to be a correspondence between the historic cemetery

samples, irrelevant of significant environmental differences.

Site-specific evaluation was able to identify a few broader trends within the data that indicated potential differences between burials and the environment. These trends were not consistent across differences in site type or environmental variables. Based on these results, it appears that no overarching predictive or confidence limits can be created for burials against the environment on a broad scale using the current research path.

INTERPRETATIONS & CONCLUSIONS

Duane Simpson and Ryan Peterson

8

INTRODUCTION

The original scope of work established a set of tasks or goals; focused on the creation of a methodology that would, through the use of non-invasive techniques, identify potential burial anomalies, sample these anomalies and return a chemical signature that would positively identify the anomaly as a burial. These goals had to be met one in succession for the development of a complete methodology. Given the importance that each succeeding step provide the following step with adequate results, an intense survey methodology was created to ensure that the final chemical signature development phase could potentially be developed.

The first step or task was to create a geophysical collection strategy that would ensure good to excellent results within any environmental or physical site type. The central focus of the research had initially been the rockshelters located at Fort Hood. Rockshelters have provided substantial difficulties regarding exploration and interpretation for previous researchers. Given this central focus, a more intense and improved combination of geophysical data sets were needed, offering the best chance to locate and sample a range of burial and cultural features. As explained in **Chapter 3**, this methodology increased sampling density to a minimum of 12.5 cm between measurements. This dense sampling provided the level of detail necessary to define very small anomalies, as well as clarify the edges of larger anomalies, vastly improving final interpretations. In addition to increased sampling, multiple geophysical techniques were used, including magnetometer, electrical resistance, laser field scanning and accurate mapping, with resistance data being collected within multiple narrow depth intervals. The layering of data provided a substantial amount of information for interpreting the rockshelter survey.

The intense methodology was slightly reduced for survey in the open-air sites, given differences in survey size, and the fact that some of the intense difficulties related to the rockshelter environments were not present within these sites. Data collection was reduced to a minimum of 25 cm intervals for magnetometer and electrical resistance survey, and laser field scanning was dropped as an investigative tool. Resistance survey was also limited to specific depths determined by environmental conditions or previous archaeological knowledge. While the open-air sites were not as complex, they contained different difficulties. Two historic cemeteries were among the open-air sites investigated. These site types are notorious for producing marginal if not questionable data, due to a multitude of problems. The intense open-air methodology produced usable to excellent results at both, providing the information necessary to complete the succeeding tasks. The inclusion of Camp Lejeune also complicated the geophysical survey task, due to the fact that the majority of the installation is underlain by sandy soils. These types of soils are difficult to obtain geophysical survey results, because the large particle size of the soils tends to mute differences between cultural features and the surrounding background. Again, the more intense survey methodology provided the information necessary to investigate the various sites.

The second step or task was to create a methodology to sample each of the potential anomalies with the least amount of disturbance. The importance of this step was to determine if sufficient quantities of soil could be collected from each of the various burial and cultural features to produce usable chemical results. In addition, the sampling methodology must provide minimal disturbance to the burials, in order to meet the goals of the research, as well as treat the grave with sensitivity and respect. The main collection methodology used was core sampling with a small, less than an inch in diameter, barrel soil

core. A series of small excavation units were also used in the process. These units were used to investigate geophysical anomalies consisting of unknown cultural deposits. No excavations were conducted in areas that contained known burials. These methodologies were used effectively to identify and sample a range of burial and non-burial features.

The third step or task was the creation of a chemical testing methodology. This step was by far the hardest, due to the fact that background research had identified few cases in which chemical sampling had been used solely to identify a burial location. In fact, background research indicated that no definitive technique could be found to positively identify a human grave from other potential cultural features. Complicating the creation of a methodology was also the fact that the chemical methodology would have to be relatively easy to sample and not cost-prohibitive. If collection methods were too difficult it may not be possible to apply the technique within field conditions, making the test relatively useless to archaeologists. If the sample processing itself were too expensive, then archaeologists and other cultural resources managers would be forced to use more invasive, but cheaper, techniques to investigate the potential burial locations. All of these various issues and complications were part of the chemical testing methodology. The utilization of trace element testing and total phosphorous meet all of these various issues. Both tests use limited samples, making them easily recoverable from a small barrel core. Background research produced an extensive and somewhat well researched history for both chemical processes, providing the basis on which to design a testing protocol. Given that they have been well used in the past within archaeology, as well as soil chemistry, biology and a vast number of other specialties, they were not cost-prohibitive for researchers to use or interpret.

The following sections address the effectiveness of the various methodologies created for the process, attempting to point out strengths and weaknesses for each step. In addition to an overall assessment of each step within the methodology, the results from certain sites are discussed to provide some new and interesting avenues for additional research within the overall methodology.

TASK 1: GEOPHYSICAL SURVEY

As discussed above, the geophysical survey had to create usable results to allow for later testing and analysis. Given the focus on burials, a number of sites were included from both installations that were known to contain human burials. This simplification ensured that a sufficient number of burials were recovered for sampling and comparative purposes. The geophysics at these sites, namely 41BL69, 31ON1019 and 31ON1236, were in some aspects secondary to the previous knowledge gained through archaeological excavations. At all three of these sites, previous excavations masked the location of a portion or all of the burial. While these sites provided marginal geophysical results, with sampling being directed primarily by previous archaeological knowledge, the majority of the site investigations were directed by the geophysical results.

The investigations at 41BL844, 41BL780, 41CV1150, 41CV1235, 31ON71 and Wards-Will cemetery produced usable to excellent geophysical results, providing data accurate to within less than 10 cm of actual feature placement. These sites were contained within rockshelter environments, open-air terrace sites and historic cemeteries, representing a variety of potential environmental and cultural site types investigated within the current study. The investigations at rockshelters 41BL844 and 41BL780 recovered a total of four previously unknown cultural features, one of which contained a human burial. This testing verified that the methodology and interpretation developed for the research could be used to direct archaeological investigations within the difficult rockshelter environments. Not only could the geophysical results direct investigations but could do so with a limited and non-invasive methodology, providing a means of achieving one of the central research goals of the project.

The results from the historic cemeteries illustrated another positive aspect of the intense methodology, in that, not only did the methodology allow for highly focused investigations but also worked in two different environmental contexts. The survey at Wards-Will cemetery illustrates some of the improvement in using the methodology developed for the research. While cemeteries have been historically a difficult site type to investigate using geophysics, Wards-Will cemetery was also

located in sandy soils and was somewhat disturbed by previous grave removal, both of which would further marginalize the geophysical results. The intense methodology was able to locate a number of potential grave locations, as well as direct highly focused investigations, confirming that at least one grave still remains within a cemetery that was reported to have been moved in the 1940s.

While the geophysical results from the testing were extremely positive, achieving nearly a 100 percent accuracy rate for identifying and testing 13 cultural features or burials, a few aspects could be improved upon within the methodology. It should be noted that a total of 16 cultural features were sampled, but geophysical results only marginally drove the investigations at 41BL69 and 31ON1236, and 41CV1038. The three features investigated at these sites were recovered using information outside of the current project methodology and therefore were dropped from the estimation of accuracy. The investigations at 41BL69 and 31ON1236 illustrated that even with the improved methodology, disturbance related to previous excavation was still difficult to interpret, making the direction of archaeological investigations precarious. In addition, the marginal results obtained at 41BL69 may be related to drier field conditions, given that it was the driest of any of the rockshelters investigated within the project. The drier field conditions certainly played a role in marginalizing the collection results, and will need to be addressed in future rockshelter geophysical research. While the investigations within the sandier sites at Camp Lejeune were vastly improved over previous investigations, the sandy nature of the soils still marginalized the effectiveness of the geophysical results and interpretations. Interpretations though can be improved by increasing usage of geophysics within this more marginal environmental type, providing a greater breadth of information for the development of better feature signatures.

The geophysical methodology provided the level of mapping necessary to direct archaeological investigations, irrelevant of challenges from environmental or cultural site types. In the case of the current project, the geophysical methodology was found to be highly accurate providing usable information to direct archaeological investigations at all of the sites investigated. Based on the reliability and accuracy of the method, future work within the rockshelters and sandy sites are recommended to be collected at this more intense

interval. While increasing collection time by about a third over traditional methodologies it reduced subsequent archeological investigations by at least half the time, providing better data with no increase in time over traditional methods.

TASK 2: ARCHAEOLOGICAL SAMPLING

One of the primary focuses of the archaeological sampling was the creation of a methodology that would be as non-invasive as possible, while still providing the information necessary to confirm a cultural features context. The intense geophysical survey methodology provided the basis on which to place highly accurate test units. These units were placed on the edges of potential cultural features. This placement allowed for the units to act as feature profiles, identifying the edge of features and therefore providing the minimal amount of information necessary to determine the context of the anomalies as cultural features.

The second component of the archaeological sampling involved the use of a small barrel (less than one inch diameter) Oakfield soil core. This technique was used to minimize the impact of collecting soil samples from burial contexts. The relatively small samples collected were of adequate size for the chemical testing required to determine trace element and total phosphorus levels.

The soil coring methods applied during this project also had negative aspects. The sample size obtained was large enough for trace element and total phosphorous testing, but there was not enough sample for other descriptive analyses such as particle size and bulk density. The coring process also proved to be difficult at times, particularly in the rockshelters, with two or even three attempts necessary to successfully obtain the desired core due to rocks and other inclusions in the soil. When cores were successfully obtained, compaction that occurred throughout the coring process had to be accounted for. Rates of compaction varied widely, from virtually absent to 50 percent or slightly greater.

Another component of the archaeological sampling worthy of discussion was the field determination of pH levels. The application of a specialized device that allows for a probe to be inserted directly into the soil sample was utilized and produced results accurate to a level appropriate for the present study. This process was also more economical than laboratory

analysis for the number of determinations required for the present study. One drawback to field determination of pH was the calibration of the instrument and the process of collecting the data. This process proved to be time consuming at various points throughout the fieldwork investigations.

TASK 3: CHEMICAL TESTING

The final and most challenging component of the project involved the development of a chemical signature that could distinguish human burials with minimal sampling of soil from the burial context. Completion of this task produced mixed results. The limited successes and shortcomings are summarized below.

As described in components of **Chapters 4, 5, 6, and 7**, testing of trace elements and total phosphorous levels were examined to determine whether or not a unique chemical composition of burials could be differentiated from background samples, and samples obtained from non-burial archaeological deposits. The analyses conducted required extremely small samples of soil to complete. As little as 15 g of soil was adequate to complete the determinations resulting in minimal disturbance of the burial context. In addition, the soil testing process was relatively inexpensive compared with more extensive traditional excavation techniques. The low cost is due to the use of common testing protocols that can be completed by a multitude of commercial and academic laboratories.

Successes in applying these techniques were limited, but noteworthy. This project did not succeed in creating an overarching chemical signature that could identify a burial in any archaeological context. Rather, site specific as well as general site type successes were realized. One of the greater difficulties encountered was differentiating burials from other features as well as A-horizon deposits. Determination of Na levels proved to be the best indicator tested, producing statistically significant results at five sites. Three sites tested significant for both manganese and total phosphorous and two sites for zinc at an 85 percent confidence level.

Evaluation of the chemical results against certain environmental or site types does appear to have produced some general trends. Sites 41BL744, 41BL844, 41CV1235, 31ON1019 and 31ON1236 all contained elevated levels of sodium versus a

broad collection of other organically enriched samples. All of these feature samples, with the exception of those at 41CV1235, were comparing burials to the A-horizon. Sites 41BL744, 41BL844, 31ON1019 and 31ON1236 constitute all of the sites that contained prehistoric burials, with the exception of 41BL69. Sodium levels at both historic cemeteries also indicated potential differences between the graves and the background environment, but not to the degree as that noted within the prehistoric burials. This lack of differentiation may be related to differences in background samples used for comparison or be related to duration of interment. As indicated above, testing of these burial samples against a larger and broader proxy sample of potential cultural features showed a lack of significant difference.

While exploratory, this evaluation has problems given the over-reliance on rockshelter midden deposits, which contained consistently the highest concentrations of sodium within the background samples. If a broader sample of A-horizon deposits had been obtainable it may be possible that the differences noted between the burials and the cultural features would have held for a larger broader sample.

An evaluation of the historic cemeteries also indicated that not only was sodium elevated, but so were copper and zinc. Elevated levels of copper and zinc may relate to actual differences within the chemical make-up of the historic interments versus the prehistoric burials, or may relate to burial hardware or some other inclusion not represented within prehistoric burial contexts. In general, there appears to be a correspondence between the historic cemetery samples, irrelevant of significant environmental differences.

Site-specific evaluation was able to identify a few broader trends within the data that indicated potential differences between burials and the environment. These trends were not consistent across differences in site types or environmental variables. Based on these results, it appears that no overarching predictive or confidence limits can be created for burials against the environment on a broad scale using the current research path.

Future Research Directions

While all of the research goals of the project were not met, many valuable contributions to the study of archaeology were made. Perhaps the greatest

single contribution of this project was the development and application of extremely dense geophysical sampling techniques. High-density data is routinely sacrificed by researchers in favor of less detailed data that covers a larger area. This project demonstrated the utility of this technique by obtaining quality data from site types usually referred to as marginal to poor for geophysical investigations. Future research on rockshelters, historic cemeteries, and sites with soil types that are less than favorable should apply the techniques described in this report. This technique can also provide greater detail to sites that were previously investigated at a more coarse resolution. Given the success displayed with the geophysics in rockshelters and historic cemeteries, geophysical investigation at these site types should be considered on a regular basis. Both of these site types are sensitive resources and can be more effectively and eloquently

investigated by incorporating a geophysical survey.

The trace element analysis and total phosphorous determination data will contribute to the ever growing body of knowledge in this type of investigation. The limited successes that were realized are not enough to support further pursuit of this technique to create a specific signature that can be applied across all site types. Rather, this technique should focus on specific site types that exhibited the most promise such as historic cemeteries. Historic cemeteries routinely do not have the same complications incurred at prehistoric sites, such as midden deposits, non-burial features, etc. Further development of this technique for historic cemeteries would be particularly useful in areas where significant burial decomposition has occurred.

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**APPENDIX A: Summary of Geologic Profiles and Soil Samples
collected from Soil Cores and Excavation Unit
Profiles**

41BL69

Core 25 N96.10 E100.60

0-0.19 m bs; A; 10YR4/2 Dark grayish brown; massive silt; 7.02 ph; 21.2°C (sample 25a: 0.44-0.13 m bs).

0.19-0.50 m bs; C; 10YR4/4 Dark yellowish brown; massive silty clay; 7.64 ph; 21.2°C (sample 25b: 0.25-0.35 m bs).

Core 26 N98.50 E100.15

0-0.12 m bs; A; 10YR5/4 Yellowish brown dry; massive silt; 8.20 ph; 21.2°C (sample 26a: 0.03-0.10 m bs).

0.12-0.17 m bs; A2; 10YR6/4 Light yellowish brown dry; massive silt; 8.54 ph; 23.5°C (sample 26b: 0.12-0.17 m bs).

0.17-0.30 m bs; C; 10YR7/4 Very pale brown dry; massive silty clay; 8.65 ph; 24.4 °C (sample 26c: 0.20-0.27 m bs).

Core 27 N98.65 E99.35

0-0.12 m bs; A; 10YR6/3 Pale brown dry; massive silt; 7.02 ph; 21.1°C (sample 27a: 0.02-0.10 m bs).

0.12-0.25 m bs; C; 10YR6/4 Light yellowish brown dry; massive silt; 7.64 ph; 21.2°C (sample 27b: 0.14-0.24 m bs).

Core 28 N96.80 E100.95

0-0.13 m bs; A; 10YR4/4 Dark yellowish brown dry; massive silt; 7.70 ph; 21.3°C (sample 28a: 0.04-0.12 m bs).

0.13-0.26 m bs; C; 10YR6/4 Light yellowish brown dry; massive silt; 8.07 ph; 22.6°C (sample 28b: 0.16-0.24 m bs).

Core 29 N96.80 E99.50

0-0.15 m bs; A; 10YR4/4 Dark yellowish brown dry; massive silt; 8.11 ph; 23.2°C (sample 29a: 0.04-0.12 m bs).

0.15-0.24 m bs; C; 10YR6/4 Light yellowish brown dry; massive silt; 8.55 ph; 22.6°C (sample 29b: 0.17-0.23 m bs).

Core 30 N98.30 E99.80

0-0.18 m bs; A; 10YR6/4 Light yellowish brown dry; massive silt; 6.80 ph; 24.5°C (sample 30a: 0.05-0.15 m bs).

0.18-0.29 m bs; A2; 10YR7/3 Very pale brown dry; massive silt; 7.70 ph; 24.0°C (sample 30b: 0.20-0.27 m bs).

0.29-0.35 m bs; C; 10YR6/3 Pale brown; massive silt; 7.75 ph; 24.0 °C (sample 30c: 0.30-0.35 m bs).

Core 62 N97.84 E100.48

0-0.12 m bs; A; 10YR6/2 Light brownish gray dry; loose massive silt.

0.12-0.25 m bs; feature matrix; 10YR5/3 Brown dry; massive silt with bone (sample 62a: 0.12-0.16 m bs).

Core 63 N97.82 E100.40

0-0.12 m bs; A; 10YR6/2 Light brownish gray dry; loose massive silt.

0.12-0.25 m bs; feature matrix; 10YR5/3 Brown dry; massive silt (sample 63a: 0.12-0.16 m bs).

41BL744

Core 54 N703.00 E707.31

0-0.33 m bs; A; 10YR3/2 to 10YR2/2 Very dark grayish brown to Very dark brown; granular silt clay; 7.45 ph; 20.5°C (sample 54a: 0.15-0.25 m bs).

0.33-0.48 m bs; feature matrix; 10YR2/1 Black; massive silt; 7.90 ph; 20.5°C (sample 54b: 0.35-0.45 m bs).

0.48-0.75 m bs; C; 10YR7/2 Light gray mottled with 10YR4/3 Brown; massive silt; 7.72 ph; 20.0°C (sample 54c: 0.49-0.58 m bs).

Core 55 N703.40 E707.25

0-0.10 m bs; A; 10YR2/2 Very dark brown; loose clay silt.

0.10-0.37 m bs; A; 10YR3/2 to 10YR2/2 Very dark grayish brown to Very dark brown; granular silt clay; 8.25 ph; 18.8°C (sample 55a: 0.27-0.32 m bs).

0.37-0.47 m bs; feature matrix; 10YR2/1 Black; massive silt; 8.04 ph; 18.3°C (sample 55b: 0.40-0.45 m bs).

0.47-0.69 m bs; C; 10YR7/2 Light gray mottled with 10YR4/3 Brown; massive silt; 8.00 ph; 17.8°C (sample 55c: 0.52-0.57 m bs).

Core 56 N702.10 E706.00

0-0.25 m bs; A; 10YR2/2 Very dark brown; loose massive silt.

0.25-0.35 m bs; A2; 10YR3/2 Very dark grayish brown; massive silt; 7.58 ph; 20.7°C (sample 56a: 0.27-0.34 m bs).

0.35-0.50 m bs; C; 10YR5/2 Grayish brown mottled with 10YR7/2 Light gray; massive silt; 7.95 ph; 21.4°C (sample 56b: 0.43-0.48 m bs).

Core 57 N700.00 E708.90

0-0.22 m bs; A; 10YR2/2 Very dark brown; loose massive silt.

0.22-0.33 m bs; C; 10YR7/2 Light gray; massive silt; 8.41 ph; 21.8°C (sample 57a: 0.23-0.33 m bs).

0.33-0.48 m bs; Cr; 10YR8/6 Yellow; massive silt with degrading limestone.

Core 58 N702.53 E708.39

0-0.25 m bs; A; 10YR2/2 Very dark brown; loose massive silt.

0.25-0.40 m bs; A2; 10YR3/2 Very dark grayish brown; massive silt; 8.26 ph; 20.2°C (sample 58a: 0.28-0.35 m bs).

0.40-0.45 m bs; C; 10YR6/2 Light brownish gray mottled with 10YR8/6 Yellow; massive silt; 7.55 ph; 20.6°C (sample 58b: 0.40-0.45 m bs).

Core 59 N701.27 E701.87

0-0.30 m bs; A; 10YR2/2 Very dark brown; massive silt; 7.82 ph; 21.8°C (sample 59a: 0.15-0.25 m bs).

0.30-0.50 m bs; Cr; 10YR6/2 Light brownish gray; massive silt with degrading limestone; 7.85 ph; 21.5°C (sample 59b: 0.35-0.45 m bs).

Core 60 N700.12 E707.85

0-0.28 m bs; A; 10YR3/2 Very dark grayish brown; massive silt; 7.97 ph; 20.3°C (sample 60a: 0.10-0.18 m bs).

0.28-0.50 m bs; Cr; 10YR6/2 Light brownish gray; massive silt with degrading limestone; 8.46 ph; 20.1°C (sample 60b: 0.30-0.40 m bs).

Appendix A - Summary of Geologic Profiles and Soil Samples collected

Core 61 N700.75 E703.32
0-0.25 m bs; A; 10YR3/2 Very dark grayish brown to 10YR4/2 Dark grayish brown; massive silt; 8.50 ph; 21.0°C (sample 61a: 0.15-0.24 m bs).
0.25-0.45 m bs; Cr; 10YR6/2 Light brownish gray mottled with 10YR8/6 Yellow; massive silt with degrading limestone; 8.25 ph; 20.0°C (sample 61b: 0.28-0.35 m bs).

41BL780

Core 44 N402.00 E408.25
0-0.14 m bs; A; 10YR3/2 Very dark grayish brown; granular silty clay; 7.74 ph; 20.8°C (sample 44a: 0.05-0.12 m bs).
0.14-0.24 m bs; A2; 10YR2/1 Black; granular silty clay; 7.72 ph; 20.8°C (sample 44b: 0.15-0.22 m bs).

Core 45 N402.00 E406.50
0-0.12 m bs; A; 10YR3/2 Very dark grayish brown; granular silty clay; 8.40 ph; 22.5°C (sample 45a: 0.04-0.10 m bs).
0.12-0.19 m bs; A2; 10YR2/1 Black; granular silty clay; 8.85 ph; 21.8°C (sample 45b: 0.12-0.18 m bs).

Core 46 N400.50 E409.00
0-0.14 m bs; A; 10YR2/1 Black; granular silty clay; 7.94 ph; 21.4°C (sample 46a: 0.09-0.14 m bs).
0.14-0.26 m bs; AC; 10YR6/2 Light brownish gray mottled with 10YR4/4 Dark yellowish brown; massive silty clay; 8.12 ph; 20.8°C (sample 46b: 0.20-0.26 m bs).

Core 47 N403.25 E409.60
0-0.14 m bs; A; 10YR2/1 Black; granular silty clay; 7.90 ph; 24.3°C (sample 47a: 0.04-0.12 m bs).
0.14-0.23 m bs; A2; 10YR3/1 Very dark gray; granular silty clay; 8.11 ph; 24.1°C (sample 47b: 0.14-0.22 m bs).

Core 48 N400.75 E405.25
0-0.13 m bs; A; 10YR3/2 Very dark grayish brown; granular silty clay; 8.07 ph; 24.7°C (sample 48a: 0.04-0.12 m bs).
0.13-0.22 m bs; A2; 10YR4/2 Dark grayish brown; granular silty clay; 7.87 ph; 24.4°C (sample 48b: 0.14-0.20 m bs).

Core 49 N401.00 E406.50
0-0.09 m bs; A; 10YR2/1 Black; granular silty clay; 7.67 ph; 20.0°C (sample 49a: 0.02-0.08 m bs).
0.09-0.28 m bs; AC; 10YR4/4 Dark yellowish brown; massive silty clay; 7.75 ph; 18.0°C (sample 49b: 0.15-0.22 m bs).

Core 50 N401.00 E410.00
0-0.20 m bs; A; 10YR3/3 Dark brown; granular silty clay; 7.45 ph; 24.1°C (sample 50a: 0.12-0.19 m bs).
0.20-0.33 m bs; C; 10YR6/6 Brownish yellow; massive silty clay; 7.38 ph; 22.7°C (sample 50b: 0.22-0.30 m bs).

Non-Invasive Burial Determination

Core 51 N402.00 E405.20

0-0.12 m bs; A; 10YR3/2 Very dark grayish brown; granular silty clay; 7.70 ph; 20.6°C (sample 51a: 0.04-0.12 m bs).

0.12-0.22 m bs; A2; 10YR2/1 Black; granular silty clay; 8.08 ph; 21.5°C (sample 51b: 0.13-0.20 m bs).

0.22-0.28 m bs; C; 10YR6/2 Light brownish gray; massive silty clay; 7.83 ph; 20.9°C (sample 51c: 0.22-0.28 m bs).

Core 52 N402.00 E409.15

0-0.05 m bs; A; 10YR2/2 Very dark brown; granular silty clay; 8.48 ph; 19.7°C (sample 52a: 0.01-0.05 m bs).

0.05-0.18 m bs; feature matrix; 10YR2/1 Black; massive silty clay; 8.20 ph; 18.4°C (sample 52b: 0.15-0.18 m bs).

0.18-0.30 m bs; AC; 10YR4/4 Dark yellowish brown; massive silty clay; 7.52 ph; 17.6°C (sample 52c: 0.18-0.25 m bs).

Core 53 N401.00 E407.10

0-0.07 m bs; A; 10YR2/2 Very dark brown; granular silty clay; 8.81 ph; 20.0°C (sample 53a: 0.02-0.05 m bs).

0.07-0.15 m bs; feature matrix; 10YR2/2 Very dark brown mottled with 10YR4/4 Dark yellowish brown; massive silty clay; 8.81 ph; 19.0°C (sample 53b: 0.07-0.12 m bs).

0.15-0.34 m bs; AC; 10YR4/4 dark yellowish brown; massive silty clay; 8.20 ph; 17.7°C (sample 53c: 0.18-0.22 m bs).

41BL844

Core 32 N302.00 E309.00

0-0.28 m bs; A; 10YR2/1 Black; granular silty clay; 7.55 ph; 22.0°C (sample 32a: 0.10-0.20 m bs).

0.28-0.58 m bs; AB; 10YR4/4 Dark yellowish brown; granular silty clay; 7.76 ph; 21.4°C (sample 32b: 0.50-0.58 m bs).

0.58-0.84 m bs; Cr; 10YR7/2 Light gray; massive silty clay with degrading limestone; 8.84 ph; 21.7°C (sample 32c: 0.65-0.75 m bs).

Core 33 N302.00 E304.00

0-0.18 m bs; A; 10YR2/2 Very dark brown; granular silty clay; 7.78 ph; 21.4°C (sample 33a: 0.05-0.15 m bs).

0.18-0.37 m bs; AB; 10YR4/4 Dark yellowish brown; granular silty clay; 7.83 ph; 21.1°C (sample 33b: 0.20-0.30 m bs).

0.37-0.71 m bs; C; 10YR7/2 Light gray; massive silty clay; 8.00 ph; 20.2°C (sample 33c: 0.40-0.50 m bs).

Core 34 N300.00 E310.00

0-0.25 m bs; A; 10YR4/3 Brown; granular silty clay; 7.04 ph; 22.5°C (sample 34a: 0.07-0.15 m bs).

0.25-0.40 m bs; C; 10YR7/2 Light gray; massive silty clay; 8.80 ph; 21.7°C (sample 34b: 0.28-0.35 m bs).

Core 35 N300.75 E308.55

0-0.18 m bs; A; 10YR4/2 Dark grayish brown; granular silty clay; 8.26 ph; 23.5°C (sample 35a: 0.02-0.08 m bs).

0.18-0.41 m bs; C; 10YR7/2 Light gray; massive silty clay; 8.28 ph; 21.3°C (sample 35b: 0.15-0.25 m bs).

Appendix A - Summary of Geologic Profiles and Soil Samples collected

- Core 36 N302.40 E308.50
0-0.21 m bs; A; 10YR3/2 Very dark grayish brown; granular silty clay; 7.55 ph; 22.8°C (sample 36a: 0.05-0.15 m bs).
0.21-0.35 m bs; A2; 10YR2/1 Black; granular silty clay; 7.24 ph; 23.0°C (sample 36b: 0.25-0.34 m bs).
0.35-0.72 m bs; AB; 10YR5/3 Brown; granular silty clay; 8.09 ph; 26.9°C (sample 36c: 0.40-0.50 m bs).
0.72-1.05 m bs; C; 10YR7/2 Light gray; massive silty clay; 8.45 ph; 25.2°C (sample 36d: 0.75-0.85 m bs).
- Core 37 N299.10 E307.50
0-0.14 m bs; A; 10YR4/4 Dark yellowish brown; granular silty clay; 7.09 ph; 22.6°C (sample 37a: 0.05-0.13 m bs).
0.14-0.22 m bs; C; 10YR7/2 Light gray; massive silty clay; 7.43 ph; 22.7°C (sample 37b: 0.14-0.21 m bs).
- Core 38 N302.50 E302.00
0-0.54 m bs; AB; 10YR5/3 Brown; granular silty clay; 8.33 ph; 27.3°C (sample 38a: 0.15-0.25 m bs).
0.54-0.65 m bs; C; 10YR7/2 Light gray; massive silty clay; 8.83 ph; 25.5°C (sample 38b: 0.56-0.64 m bs).
- Core 39 N300.50 E307.25
0-0.19 m bs; A; 10YR4/3 Brown; granular silty clay; 7.60 ph; 22.9°C (sample 39a: 0.05-0.14 m bs).
0.19-0.25 m bs; A; 10YR5/3 Brown dry; granular silty clay.
0.25-0.54 m bs; C; 10YR7/2 Light gray; massive silty clay; 8.10 ph; 21.6°C (sample 39b: 0.30-0.40 m bs).
- Core 40 N301.20 E309.18
0-0.12 m bs; feature matrix; 10YR3/2 Very dark grayish brown; massive clayey silt; 8.22 ph; 18.1°C (sample 40a: 0.04-0.07m bs).
0.12-0.14 m bs; AB; 10YR4/3 Brown; granular clayey silt.
0.14-0.22 m bs; C; 10YR6/2 Light brownish gray; massive silt; 8.36 ph; 16.5°C (sample 40b: 0.17-0.20 m bs).
0.22-0.25 m bs; Cr; 10YR6/6 Brownish yellow mottle with 10YR4/6 Dark yellowish brown; massive silt with 20% degrading limestone.
- Core 41 N300.70 E309.08
0-0.12 m bs; feature matrix; 10YR3/2 Very dark grayish brown; massive clayey silt; 8.02 ph; 17.5°C (sample 41a: 0.05-0.08m bs).
0.12-0.14 m bs; AB; 10YR4/3 Brown; granular clayey silt.
0.14-0.22 m bs; C; 10YR6/2 Light brownish gray; massive silt; 8.43 ph; 16.5°C (sample 41b: 0.17-0.20 m bs).
0.22-0.25 m bs; Cr; 10YR6/6 Brownish yellow mottle with 10YR4/6 Dark yellowish brown; massive silt with 20% degrading limestone.
- Core 42 N301.00 E307.60
0-0.10 m bs; A; 10YR2/2 Very dark brown; granular silt; 7.99 ph; 18.3°C (sample 42a: 0.07-0.10 m bs).
0.10-0.25 m bs; feature matrix; 10YR2/1 Black; massive clayey silt; 8.14 ph; 17.2°C (sample 42b: 0.20-0.25 m bs).
0.25-0.50 m bs; Cr; 10YR5/2 Grayish brown; massive silt with 10% degrading limestone; 8.52 ph; 25.0°C (sample 42c: 0.39-0.45 m bs).

Non-Invasive Burial Determination

Core 43 N301.00 E307.90

0-0.10 m bs; A; 10YR2/2 Very dark brown; granular silt; 8.38 ph; 18.0°C (sample 43a: 0.08-0.10 m bs).

0.10-0.29 m bs; feature matrix; 10YR2/1 Black; massive clayey silt; 8.26 ph; 16.7°C (sample 43b: 0.25-0.29 m bs).

0.29-0.50 m bs; Cr; 10YR5/2 Grayish brown; massive silt with 10% degrading limestone; 7.95 ph; 22.0°C (sample 43c: 0.39-0.46 m bs).

41CV1038

Core 64

0-0.16 m bs; A; 10YR3/3 Dark brown; subangular blocky silty clay loam.

0.16-0.40 m bs; AB; 10YR4/3 Brown; subangular clayey silt loam.

0.40-0.50 m bs; Ab; 10YR3/2 Very dark grayish brown; subangular blocky silt loam; 7.09 ph; 20.8°C (sample 64a: 0.40-0.45 m bs).

0.50-1.00 m bs; A2, feature matrix; 10YR2/2 Very dark brown; subangular blocky silty clay; 7.84 ph; 19.9°C (sample 64b: 0.70-0.75 m bs).

1.00-1.60 m bs; AB; 10YR3/3 to 10YR4/3 Dark brown to Brown; subangular blocky silty clay; 7.99 ph; 24.2°C (sample 64c: 1.25-1.30 m bs).

Core 65

0-0.75 m bs; A; 10YR3/2 Very dark grayish brown; subangular blocky silty clay; 7.57 ph; 29.2°C (sample 65a: 0.40-0.48 m bs).

0.75-1.24 m bs; AB; 10YR4/2 Dark grayish brown; subangular blocky silty clay; 8.03 ph; 28.2°C (sample 65b: 0.75-0.83 m bs).

Core 66

0-0.16 m bs; A; 10YR3/2; subangular silt.

0.16-0.34 m bs; AB; 10YR4/2 Dark grayish brown; subangular blocky silt; 7.94 ph; 27.2°C (sample 66a: 0.20-0.30 m bs).

0.34-0.85 m bs; Ab; 10YR3/1 Very dark gray; subangular blocky silty clay; 7.57 ph; 25.8°C (sample 66b: 0.60-0.70 m bs).

0.85-1.25 m bs; AB; 10YR4/2 Dark grayish brown; subangular blocky silty clay; 8.00 ph; 25.9°C (sample 66c: 1.10-1.20 m bs).

41CV1150 Walker Cemetery

Core 1 N512.35 E512.52

0-1.20 m bs; grave shaft; 10YR5/4 Yellowish brown mottled with 10YR6/3 Pale brown and 10YR4/4 Dark yellowish brown; massive clayey silt; 7.28 ph; 26.5°C (sample 1a: 1.10-1.20 m bs).

1.20-1.30 m bs; grave; 10YR4/3 Brown; massive clay loam with coffin wood inclusions; 7.26 ph; 28.2°C (sample 1b: 1.20-1.30 m bs).

1.30-1.60 m bs; Btk; 10YR6/3 Pale brown; blocky clay with Ca concretions; 7.28 ph; 28.6°C (sample 1c: 1.30-1.40 m bs).

Core 2 N512.50 E513.00

0-1.23 m bs; grave shaft; 10YR5/4 Yellowish brown mottled with 10YR6/3 Pale brown and 10YR4/4 Dark yellowish brown; massive clayey silt; 7.41 ph; 30.0°C (sample 2a: 1.15-1.23 m bs).

1.23-1.30 m bs; grave; 10YR4/3 Brown; massive clay loam with coffin wood inclusions; 7.32 ph; 28.2°C (sample 2b: 1.23-1.30 m bs).

1.30-1.60 m bs; Btk; 10YR6/3 Pale brown; blocky clay with Ca concretions; 7.72 ph; 28.2°C (sample 2c: 1.30-1.37 m bs).

Appendix A - Summary of Geologic Profiles and Soil Samples collected

- Core 3 N516.75 E511.75
0-1.48 m bs; grave shaft; 10YR5/6 Yellowish brown mottled with 10YR6/6 Brownish yellow and 10YR4/4 Dark yellowish brown; massive clayey silt; 7.31 ph; 30.2°C (sample 3a: 1.38-1.48 m bs).
1.48-1.55 m bs; grave; 10YR4/3 Brown; massive clay loam with bone; 7.78 ph; 30.0°C (sample 3b: 1.48-1.55 m bs).
1.55-1.90 m bs; Btk; 10YR6/6 Brownish yellow; blocky clay with Ca concretions; 7.57 ph; 31.1°C (sample 3c: 1.55-1.65 m bs).
- Core 4 N517.00 E512.50
0-1.50 m bs; grave shaft; 10YR5/6 Yellowish brown mottled with 10YR6/6 Brownish yellow and 10YR4/4 Dark yellowish brown; massive clayey silt; 7.47 ph; 28.8°C (sample 4a: 1.42-1.50 m bs).
1.50-1.55 m bs; grave; 10YR4/3 Brown; massive clay loam; 7.89 ph; 28.2°C (sample 4b: 1.50-1.57 m bs).
1.55-1.90 m bs; Btk; 10YR6/6 Brownish yellow; blocky clay with Ca concretions; 7.43 ph; 26.8°C (sample 4c: 1.58-1.65 m bs).
- Core 5 N511.00 E511.00
0-0.30 m bs; A; 10YR4/3 to 10YR4/6 Brown to Dark yellowish brown; granular silty clay with 2-5% degrading limestone.
0.30-1.30 m bs; Btk 10YR6/6 Brownish yellow; blocky clay with 15-20% Ca concretions; 6.71 to 7.20 ph; 26.9°C to 26.5°C (sample 5a: 85-95 m bs, sample 5b: 1.10-1.20 m bs).
- Core 6 N511.00 E512.00
0-0.30 m bs; A; 10YR4/3 to 10YR4/6 Brown to Dark yellowish brown; granular silty clay with 2-5% degrading limestone.
0.30-1.30 m bs; Btk 10YR6/6 Brownish yellow; blocky clay with 15-20% Ca concretions; 7.01 to 7.05 ph; 24.9°C to 26.2°C (sample 6a: 0.90-1.0 m bs, sample 6b: 1.10-1.20 m bs).
- Core 7 N512.00 E514.00
0-0.30 m bs; A; 10YR4/3 to 10YR4/6 Brown to Dark yellowish brown; granular silty clay with 2-5% degrading limestone.
0.30-1.30 m bs; Btk 10YR6/6 Brownish yellow; blocky clay with 15-20% Ca concretions; 7.57 to 7.38 ph; 25.2°C to 23.8°C (sample 7a: 0.95-1.05 m bs, sample 7b: 1.10-1.18 m bs).
- Core 8 N513.50 E514.50
0-0.20 m bs; A; 10YR4/3 to 10YR4/6 Brown to Yellowish brown; granular silty clay with 2-5% degrading limestone.
0.20-0.75 m bs; Btk 10YR7/4 Very pale brown; block clay with 20-30% degrading limestone and Ca concretions;
0.75-1.25 m bs; Btk 10YR6/3 Pale brown; blocky clay with 5% degrading limestone and Ca concretions; 7.40 to 7.60 ph; 22.2°C to 22.1°C (sample 8a: 0.88-0.95 m bs, sample 8b: 1.15-1.25 m bs).
- Core 9 N516.50 E514.00
0-0.30 m bs; A; 10YR4/3 Brown; granular silty clay with 2-5% degrading limestone.
0.30-1.75 m bs; Btk 10YR6/6 to 10YR8/6 Brownish yellow to Yellow; blocky clay with 15-20% Ca concretions; 7.53 to 7.56 ph; 23.0°C to 23.5°C (sample 9a: 1.05-1.15 m bs, sample 9b: 1.25-1.35 m bs).

Non-Invasive Burial Determination

Core 10 N518.00 E514.00

0-0.25m bs; A; 10YR4/3 Brown; granular silty clay with 2-5% degrading limestone.
0.25-1.50 m bs; Btk 10YR6/6 to 10YR8/6 Brownish yellow to Yellow; block clay with 15-20% Ca concretions; 7.18 to 7.42 ph; 23.4°C to 23.1°C (sample 10a: 1.05-1.15 m bs, sample 10b: 1.25-1.35 m bs).

Core 11 N518.00 E510.25

0-0.30 m bs; A; 10YR4/3 Brown; granular silty clay with 2-5% degrading limestone.
0.30-1.75 m bs; Btk 10YR6/6 to 10YR8/6 Brownish yellow to Yellow; blocky clay with 15-20% Ca concretions; 7.48 to 7.42 ph; 22.5°C to 21.7°C (sample 11a: 1.05-1.15 m bs, sample 11b: 1.25-1.35 m bs).

Core 12 N513.75 E510.25

0-0.28 m bs; A; 10YR4/3 Brown; granular silty clay with 2-5% degrading limestone.
0.28-1.65 m bs; Btk 10YR6/6 to 10YR8/6 Brownish yellow to Yellow; blocky clay with 15-20% Ca concretions; 7.47 to 7.20 ph; 22.5°C to 25.3°C (sample 12a: 1.05-1.15 m bs, sample 12b: 1.25-1.35 m bs).

41CV1235

Core 13 N610.00 E607.00

0-0.18 m bs; A; 10YR3/2 Very dark grayish brown; subangular blocky silty clay loam; 7.79 ph; 25.8°C (sample 13a: 0.08-0.15 m bs).
0.18-0.38 m bs; AB 10YR4/4 Dark yellowish brown; subangular blocky silty clay loam; 7.70 ph; 24.9°C (sample 13b: 0.28-0.35 m bs).

Core 14 N609.00 E604.00

0-0.22 m bs; A; 10YR3/2 Very dark grayish brown; subangular blocky silty clay loam; 7.78 ph; 25.7°C (sample 14a: 0.05-0.15 m bs).
0.22-0.35 m bs; AB 10YR3/3 Dark brown; subangular blocky silty clay loam; 7.84 ph; 23.9°C (sample 14b: 0.23-0.35 m bs).

Core 15 N605.00 E604.00

0-0.24 m bs; A; 10YR3/2 Very dark grayish brown; subangular blocky silty clay loam; 7.78 ph; 24.9°C (sample 15a: 0.05-0.15 m bs).
0.24-0.40 m bs; AB 10YR4/3 Brown; subangular blocky silty clay loam; 7.82 ph; 23.3°C (sample 15b: 0.25-0.35 m bs).

Core 16 N609.00 E600.00

0-0.23 m bs; A; 10YR2/2 Very dark brown; subangular blocky silty clay loam; 7.21 ph; 27.6°C (sample 16a: 0.05-0.15 m bs).
0.23-0.40 m bs; AB 10YR4/3 Brown; subangular blocky silty clay loam; 7.88 ph; 26.1°C (sample 16b: 0.25-0.35 m bs).

Core 17 N615.00 E606.00

0-0.14 m bs; A; 10YR3/2 Very dark grayish brown; subangular blocky silty clay loam; 7.83 ph; 28.3°C (sample 17a: 0.05-0.13 m bs).
0.14-0.37 m bs; midden; 10YR2/2 Very dark brown; subangular blocky silty clay loam with 5-10% burned limestone.
0.37-0.54 m bs; AB 10YR4/4 Dark yellowish brown; subangular blocky silty clay loam; 7.61 ph; 26.6°C (sample 17b: 0.38-0.50 m bs).

Appendix A - Summary of Geologic Profiles and Soil Samples collected

- Core 18 N611.00 E604.00
0-0.18 m bs; A; 10YR3/2 Very dark grayish brown; subangular blocky silty clay loam; 7.77 ph; 26.6°C (sample 18a: 0.04-0.12 m bs).
0.18-0.40 m bs; AB 10YR4/4 Dark yellowish brown; subangular blocky silty clay loam; 7.48 ph; 24.3°C (sample 18b: 0.25-0.35 m bs).
- Core 19 N608.00 E609.00
0-0.18 m bs; A; 10YR3/3 Dark brown; subangular blocky silty clay loam; 7.81 ph; 25.2°C (sample 19a: 0.05-0.15 m bs).
0.18-0.40 m bs; AB 10YR4/4 Dark yellowish brown; subangular blocky silty clay loam; 7.78 ph; 23.6°C (sample 19b: 0.25-0.35 m bs).
- Core 20 N615.00 E607.00
0-0.14 m bs; A; 10YR3/2 Very dark grayish brown; subangular blocky silty clay loam; 7.78 ph; 25.8°C (sample 20a: 0.03-0.10 m bs).
0.14-0.40 m bs; midden; 10YR4/2 Dark grayish brown; subangular blocky silty clay loam with 5-10% burned limestone; 7.45 ph; 24.2°C (sample 20b: 0.25-0.32 m bs).
0.40-0.54 m bs; AB 10YR4/4 Dark yellowish brown; subangular blocky silty clay loam; 7.55 ph; 23.9°C (sample 20c: 0.44-0.52 m bs).
- Core 21 N606.50 E602.75
0-0.10 m bs; A; 10YR3/2 Very dark grayish brown; subangular blocky silty clay loam; 8.00 ph; 23.3°C (sample 21a: 0.03-0.10 m bs).
0.10-0.23 m bs; feature matrix; 10YR4/2 Dark grayish brown; subangular blocky silty clay loam; 7.60 ph; 24.7°C (sample 21b: 0.12-0.20 m bs).
0.23-0.50 m bs; AB 10YR4/4 Dark yellowish brown; subangular blocky silty clay loam; 7.88 ph; 24.6°C (sample 21c: 0.28-0.35 m bs).
- Core 22 N606.50 E603.15
0-0.10 m bs; A; 10YR4/3 Brown; subangular blocky silty clay loam; 7.53 ph; 23.7°C (sample 22a: 0.03-0.10 m bs).
0.10-0.30 m bs; feature matrix; 10YR4/3 Brown; subangular blocky silty clay loam; 7.75 ph; 25.2°C (sample 22b: 0.20-0.30 m bs).
0.30-0.40 m bs; AB 10YR4/4 Dark yellowish brown; subangular blocky silty clay loam; 8.09 ph; 26.5°C (sample 22c: 0.30-0.40 m bs).
- Core 23 N613.00 E607.25
0-0.15 m bs; A; 10YR3/3 Dark brown; subangular blocky silty clay loam; 7.70 ph; 22.8°C (sample 23a: 0.10-0.15 m bs)
0.15-0.32 m bs; feature matrix; 10YR3/1 Very dark gray; subangular blocky silty clay loam; 7.66 ph; 20.6°C (sample 23b: 0.23-0.28 m bs).
0.32-0.45 m bs; AB 10YR3/2 Very dark grayish brown; subangular blocky silty clay loam; 7.59 ph; 19.5°C (sample 23c: 0.40-0.45 m bs).
- Core 24 N612.25 E607.00
0-0.15 m bs; A; 10YR3/3 Dark brown; subangular blocky silty clay loam; 7.86 ph; 22.8°C (sample 24a: 0.02-0.07 m bs)
0.15-0.25 m bs; feature matrix; 10YR3/1 Very dark gray; subangular blocky silty clay loam; 7.70 ph; 20.6°C (sample 24b: 0.20-0.25 m bs).
0.25-0.37 m bs; A2; 10YR3/1-10YR3/2 Very dark gray to Very dark grayish brown; subangular blocky silty clay loam.
0.37-0.50 m bs; AB 10YR3/2- 10YR5/2 Very dark grayish brown to Grayish brown; subangular blocky silty clay loam; 7.82 ph; 19.5°C (sample 24c: 0.41-0.46 m bs).

31ON71

Core 100 N330.00 E325.00

0-0.23 m bs; Ap; 10YR3/2 Very dark grayish brown; granular sand; 6.84 ph; 28.5°C (sample 100a: 0.10-0.15 m bs)
0.23-0.32 m bs; AB; 10YR3/3 Dark brown mottled with 10YR5/4 Yellowish brown; granular sand; 7.60 ph; 28.4°C (sample 100b: 0.25-0.30 m bs).
0.32-0.64 m bs; BC 10YR6/6 Brownish yellow; massive sand; 7.13 ph; 28.4°C (sample 100c: 0.50-0.55 m bs).

Core 101 N313.00 E320.00

0-0.23 m bs; Ap; 10YR3/2 Very dark grayish brown; granular sand; 7.15 ph; 23.1°C (sample 101a: 0.10-0.20 m bs)
0.23-0.43 m bs; AB; 10YR3/3 Dark brown mottled with 10YR5/4 Yellowish brown; granular sand; 7.22 ph; 20.3°C (sample 101b: 0.35-0.45 m bs).
0.43-0.57 m bs; Bw; 10YR5/6 Yellowish brown; granular sand.
0.57-0.64 m bs; BC 10YR6/4 Light yellowish brown; massive sand; 6.98 ph; 18.9°C (sample 101c: 0.60-0.70 m bs).

Core 102 N330.00 E300.00

0-0.09 m bs; O; 10YR3/1 Very dark gray; granular sand.
0.09-0.23 m bs; Ap; 10YR4/3 Brown; granular sand; 6.78 ph; 20.9°C (sample 102a: 0.10-0.20 m bs)
0.23-0.44 m bs; Bw; 10YR5/6 Yellowish brown; granular sand; 6.80 ph; 19.2°C (sample 102b: 0.25-0.35 m bs).
0.44-0.64 m bs; BC 10YR6/4 Light yellowish brown; massive sand; 6.54 ph; 19.1°C (sample 102c: 0.50-0.60 m bs).

Core 103 N316.00 E310.00

0-0.23 m bs; Ap; 10YR3/2 Very dark grayish brown; granular sand with 10% shell; 7.98 ph; 18.9°C (sample 103a: 0.10-0.20 m bs)
0.23-0.47 m bs; AB; 10YR3/2 Very dark grayish brown mottled with 10YR5/6 Yellowish brown; granular sand with 5-10% shell; 7.87 ph; 18.4°C (sample 103b: 0.30-0.40 m bs).
0.47-0.70 m bs; BC 10YR6/6 Brownish yellow; wet massive sand; 7.46 ph; 18.0°C (sample 103c: 0.50-0.60 m bs).

Core 104 N303.00 E330.00

0-0.23 m bs; Ap; 10YR3/2 Very dark grayish brown; granular sand with <2% shell; 7.89 ph; 19.7°C (sample 104a: 0.10-0.20 m bs)
0.23-0.45 m bs; AB; 10YR5/6 Yellowish brown mottled with 10YR3/2 Very dark grayish brown; granular sand with 5-10% shell; 7.25 ph; 17.4°C (sample 104b: 0.30-0.40 m bs).
0.45-0.70 m bs; BC 10YR6/4 Light yellowish brown; wet massive sand; 6.59 ph; 18.9°C (sample 104c: 0.50-0.60 m bs).

Core 105 N315.00 E305.00

0-0.20 m bs; Ap; 10YR3/2 Very dark grayish brown; granular sand with <2% shell; 7.45 ph; 22.0°C (sample 105a: 0.10-0.20 m bs)
0.20-0.26 m bs; AB; 10YR3/3 Dark brown mottled with 10YR5/6 Yellowish brown; granular sand.
0.26-0.50 m bs; Bw; 10YR5/6 Yellowish brown; granular sand; 7.80 ph; 20.1°C (sample 105b: 0.28-0.38 m bs).
0.50-0.80 m bs; C 10YR6/4 Light yellowish brown; wet massive sand; 6.51 ph; 20.1°C (sample 105c: 0.65-0.75 m bs).

Appendix A - Summary of Geologic Profiles and Soil Samples collected

Core 106 N307.00 E304.00

0-0.23 m bs; Ap; 10YR3/2 Very dark grayish brown; granular sand with 5-10% shell; 7.33 ph; 20.9°C (sample 106a: 0.13-0.23 m bs)

0.23-0.47 m bs; AB; 10YR5/6 Yellowish brown mottled with 10YR3/3 Dark brown; granular sand with 5-10% shell; 7.87 ph; 19.7°C (sample 106b: 0.30-0.40 m bs).

0.47-0.67 m bs; BC 10YR6/4 Light yellowish brown; wet massive sand; 7.29 ph; 19.6°C (sample 106c: 0.50-0.60 m bs).

Core 107 N315.00 E301.00

0-0.20 m bs; Ap; 10YR3/2 Very dark grayish brown; granular sand; 7.63 ph; 20.6°C (sample 107a: 0.10-0.20 m bs)

0.20-0.53 m bs; AB; 10YR3/3 Dark brown; granular sand; 7.42 ph; 19.9°C (sample 107b: 0.30-0.40 m bs).

0.53-0.65 m bs; BC 10YR6/4 Light yellowish brown; wet massive sand; 7.28 ph; 19.4°C (sample 107c: 0.50-0.60 m bs).

Core 114 N309.05 E307.65

0-0.14 m bs; Ap; 10YR3/2 Very dark grayish brown, massive sand with 50% shell fragments.

0.14-0.20 m bs; A; 10YR3/2 Very dark grayish brown; granular sand with 50% shell; 7.76 ph; 21.6°C (sample 114a: 0.19-0.23 m bs)

0.20-0.37 m bs; feature matrix; 10YR3/4-10YR4/4 Dark yellowish brown; massive sand with 5% shell; 7.73 ph; 21.2°C (sample 114b: 0.29-0.34 m bs).

0.37-0.46 m bs; Bw; 10YR5/6 Yellowish brown; granular sand; 7.82 ph; 20.3°C (sample 114c: 0.42-0.46 m bs).

Core 115 N308.55 E307.20

0-0.13 m bs; Ap; 10YR3/2 Very dark grayish brown, massive sand with 50% shell fragments.

0.13-0.20 m bs; A; 10YR3/2 Very dark grayish brown; granular sand with 50% shell; 7.80 ph; 21.3°C (sample 115a: 0.15-0.19 m bs)

0.20-0.28 m bs; feature matrix; 10YR3/4-10YR4/4 Dark yellowish brown; massive sand with 5% shell; 7.92 ph; 20.4°C (sample 115b: 0.23-0.28 m bs).

0.28-0.38 m bs; Bw; 10YR5/6 Yellowish brown; granular sand; 8.05 ph; 19.8°C (sample 115c: 0.33-0.38 m bs).

Core 116 N317.65 E301.00

0-0.10 m bs; Ap; 10YR2/1 Black; massive sand.

0.10-0.30 m bs; Ap; 10YR3/2 Very dark grayish brown; granular sand; 7.35 ph; 19.9°C (sample 116a: 0.20-0.25 m bs)

0.30-0.45 m bs; feature matrix; 10YR3/2 Very dark grayish brown mottled with 10YR4/2 Dark grayish brown; massive sand; 7.57 ph; 19.4°C (sample 116b: 0.35-0.40 m bs).

0.45-0.50 m bs; feature matrix2; 10YR4/4-10YR5/4 Dark yellowish brown to Yellowish brown; massive sand; 7.02 ph; 19.6°C (sample 116c: 0.45-0.50 m bs).

0.50-0.72 m bs; C 2.5Y6/4 Light yellowish brown; granular sand; 6.85 ph; 19.2°C (sample 116d: 0.58-0.62 m bs).

Non-Invasive Burial Determination

Core 117 NN318.00 E300.70

0-0.07 m bs; Ap; 10YR2/1 Black; massive sand.

0.07-0.28 m bs; Ap; 10YR3/2 Very dark grayish brown; granular sand; 7.34 ph; 25.8°C (sample 117a: 0.15-0.20 m bs)

0.28-0.42 m bs; feature matrix; 10YR3/2 Very dark grayish brown mottled with 10YR4/2 Dark grayish brown; massive sand; 7.33 ph; 23.6°C (sample 117b: 0.33-0.38 m bs).

0.42-0.47 m bs; feature matrix2; 10YR4/4-10YR5/4 Dark yellowish brown to Yellowish brown; massive sand; 7.05 ph; 23.3°C (sample 117c: 0.42-0.47 m bs).

0.47-0.65 m bs; feature matrix3; 10YR3/1 Very dark gray; granular sand with organics; 6.93 ph; 22.3°C (sample 117d: 0.55-0.60 m bs).

0.65-0.70 m bs; C 2.5Y6/4 Light yellowish brown; granular sand; 6.88 ph; 21.0°C (sample 117e: 0.65-0.70 m bs).

31ON1019

Core 108 N202.10 E204.60

0-0.10 m bs; A; 10YR4/3 Brown; granular sand.

0.10-0.65 m bs; BC; 10YR6/4 Light yellowish brown; massive sand; 7.75 ph; 22.4°C (sample 108a: 0.30-0.40 m bs).

0.65-0.75 m bs; feature matrix; 10YR2/1 Black; massive sand with bone; 7.66 ph; 24.0°C (sample 108b: 0.65-0.75 m bs).

0.75-0.88 m bs; C 10YR7/4 Very pale brown; massive sand; 7.20 ph; 21.9°C (sample 108c: 0.80-0.88 m bs).

Core 109 N202.30 E204.60

0-0.15 m bs; A; 10YR4/3 Brown; granular sand.

0.15-0.70 m bs; BC; 10YR6/4 Light yellowish brown; massive sand; 7.75 ph; 24.5°C (sample 109a: 0.30-0.40 m bs).

0.70-0.80 m bs; feature matrix; 10YR2/1 Black; massive sand; 6.80 ph; 23.0°C (sample 109b: 0.70-0.80 m bs).

0.80-1.10 m bs; C 10YR7/4 Very pale brown mottled with 10YR5/6 Yellowish brown; massive sand; 5.10 ph; 22.3°C (sample 109c: 0.85-0.95 m bs).

Core 110 N200.00 E202.00

0-0.12 m bs; A; 10YR4/3 Brown; granular sand.

0.12-0.32 m bs; BC; 10YR6/4 Light yellowish brown; massive sand; 7.34 ph; 23.3°C (sample 110a: 0.20-0.30 m bs).

0.32-0.90 m bs; C 10YR7/4 Very pale brown mottled with 10YR5/6 Yellowish brown below 0.80 m bs; massive sand; 7.50-7.15 ph; 26.1-25.6°C (sample 110b: 0.65-0.75 m bs and sample 110c: 0.80-0.88 m bs).

Core 111 N202.00 E208.00

0-0.15 m bs; A; 10YR3/2 Very dark grayish brown; granular sand.

0.15-0.23 m bs; Bw; 10YR5/6 Yellowish brown; granular sand; 5.40 ph; 24.4°C (sample 111a: 0.15-0.23 m bs).

0.23-0.75 m bs; C; 10YR7/4 Very pale brown; massive sand; 7.35 ph; 23.2°C (sample 111b: 0.30-0.40 m bs).

0.75-0.90 m bs; C 10YR7/4 Very pale brown mottled with 10YR5/6 Yellowish brown; massive sand; 7.20 ph; 22.4°C (sample 111c: 0.75-0.85 m bs).

Appendix A - Summary of Geologic Profiles and Soil Samples collected

Core 112 N206.00 E202.00
0-0.15 m bs; A; 10YR2/2 Very dark brown; granular sand.
0.15-0.21 m bs; AB; 10YR4/3 Brown; granular sand; 6.15 ph; 28.0°C (sample 112a: 0.15-0.21 m bs).
0.21-0.40 m bs; BC; 10YR6/4 Light yellowish brown; massive sand; 7.01 ph; 25.9°C (sample 112b: 0.30-0.40 m bs).
0.40-0.90 m bs; C 10YR7/4 Very pale brown; massive sand; 7.57 ph; 24.4°C (sample 112c: 0.80-0.90 m bs).

Core 113 N205.00 E206.00
0-0.15 m bs; A; 10YR2/2 Very dark brown; granular sand.
0.15-0.25 m bs; AB; 10YR4/4 Dark yellowish brown; granular sand; 5.90 ph; 26.3°C (sample 113a: 0.15-0.25 m bs).
0.25-0.50 m bs; BC; 10YR6/4 Light yellowish brown; massive sand; 7.02 ph; 25.9°C (sample 113b: 0.30-0.40 m bs).
0.50-0.93 m bs; C; 10YR8/3 mottled with 10YR7/4 Very pale brown; massive sand; 7.30 ph; 23.7°C (sample 113c: 0.80-0.90 m bs).

31ON1236

Core 118 N401.40 E 402.60
0-0.50 m bs; disturbed back fill of previous archaeological excavation.
0.50-0.60 m bs; feature matrix; 10YR2/1 Black; massive sand with bone; 6.89 ph; 25.5°C (sample 118a: 0.50-0.60 m bs).
0.60-0.90 m bs; C; 2.5Y7/4 Pale yellow; massive sand; 7.72 ph; 25.5°C (sample 118b: 0.60-0.70 m bs).

Core 119 N401.45 E402.80
0-0.68 m bs; disturbed back fill of previous archaeological excavation.
0.68-0.75 m bs; feature matrix; 10YR3/2 Very dark grayish brown; massive sand; 7.40 ph; 25.8°C (sample 119a: 0.68-0.75 m bs).
0.75-0.90 m bs; C 2.5Y7/4 Pale yellow; massive sand; 7.75 ph; 25.0°C (sample 119b: 0.80-0.90 m bs).

Core 120 N400.00 E402.50
0-0.20 m bs; O; 10YR2/2 Very dark brown; humus.
0.20-0.40 m bs; A; 10YR2/1 Black; granular sand; 7.41 ph; 23.8°C (sample 120a: 0.25-0.35 m bs).
0.40-0.50 m bs; BC; 2.5Y7/4 Pale yellow mottled with 10YR4/2 Dark grayish brown; massive sand.
0.50-0.76 m bs; C; 2.5Y7/4 Pale yellow; massive sand; 7.52 ph; 23.8°C (sample 120b: 0.60-0.70 m bs).

Core 121 N402.50 E403.00
0-0.25 m bs; O; 10YR2/2 Very dark brown; humus.
0.25-0.40 m bs; A; 10YR2/1 Black; granular sand; 7.47 ph; 24.3°C (sample 121a: 0.30-0.37 m bs).
0.40-0.70 m bs; C; 2.5Y7/4 Pale yellow; massive sand; 7.55 ph; 23.6°C (sample 121b: 0.60-0.70 m bs).

Non-Invasive Burial Determination

Core 122 N404.00 E404.00

0-0.20 m bs; O; 10YR2/2 Very dark brown; humus.

0.20-0.50 m bs; A; 10YR2/1 Black; granular sand with 20% shell; 7.76 ph; 25.1°C (sample 122a: 0.35-0.45 m bs).

0.50-0.70 m bs; C; 2.5Y7/4 Pale yellow; massive sand; 7.85 ph; 24.2°C (sample 122b: 0.60-0.70 m bs).

Core 123 N404.00 E401.00

0-0.10 m bs; O; 10YR2/2 Very dark brown; humus.

0.10-0.25 m bs; A; 10YR2/1 Black; granular sand; 7.75 ph; 25.9°C (sample 123a: 0.15-0.25 m bs).

0.25-0.75 m bs; C; 2.5Y7/4 Pale yellow; massive sand; 7.80 ph; 23.4°C (sample 123b: 0.60-0.70 m bs).

Wards-Will Cemetery

Core 124 N506.00 E503.00

0-0.15 m bs; O; 10YR2/1 Black; humus.

0.15-0.35 m bs; AB; 10YR5/4 Yellowish brown; granular sand; 6.10 ph; 21.7°C (sample 124a: 0.30-0.40 m bs).

0.35-1.10 m bs; C; 2.5Y7/4 Pale yellow; massive sand; 6.00 ph; 21.6°C (sample 124b: 0.90-1.00 m bs).

Core 125 N502.00 E508.00

0-0.15 m bs; O; 10YR2/1 Black; humus.

0.15-0.30 m bs; A; 10YR4/3 Brown; granular sand.

0.30-0.70 m bs; AB; 10YR5/4 Yellowish brown; granular sand; 7.30 ph; 21.2°C (sample 125a: 0.55-0.65 m bs).

0.70-1.10 m bs; C; 2.5Y7/4 Pale yellow; massive sand; 7.80 ph; 21.1°C (sample 125b: 0.90-1.00 m bs).

Core 126 N507.00 E512.00

0-0.10 m bs; O; 10YR2/1 Black; humus.

0.10-1.20 m bs; grave shaft; 10YR5/4 Yellowish brown mottled with 10YR5/6 Yellowish brown and 10YR4/3 Brown; massive sand; 6.92 ph; 32.4°C (sample 126a: 0.90-1.00 m bs).

1.20-1.25 m bs; grave; 10YR3/2 Very dark grayish brown; massive sand; 6.42 ph; 34.0°C (sample 126b: 1.20-1.25 m bs).

1.25-1.40 m bs; C; 10YR5/6 mottled with 10YR5/4 Yellowish brown; massive sand with lamella; 5.80 ph; 28.1°C (sample 126c: 1.30-1.40 m bs).

Core 127 N507.20 E511.50

0-0.10 m bs; O; 10YR2/1 Black; humus.

0.10-1.20 m bs; grave shaft; 10YR5/4 Yellowish brown mottled with 10YR5/6 Yellowish brown and 10YR4/3 Brown; massive sand; 6.95 ph; 29.3°C (sample 127a: 1.05-1.15 m bs).

1.20-1.25 m bs; grave; 10YR3/2 Very dark grayish brown; massive sand; 6.28 ph; 28.4°C (sample 127b: 1.20-1.25 m bs).

1.25-1.40 m bs; C; 10YR5/6 mottled with 10YR5/4 Yellowish brown; massive sand with lamella; 5.64 ph; 28.0°C (sample 127c: 1.25-1.30 m bs).

Core 128 N512.00 E513.00

0-0.20 m bs; A; 10YR3/3 Dark brown; granular sand.

0.20-1.50 m bs; BC; 10YR7/4 Very pale brown; granular sand; 7.34 ph; 24.0°C (sample 128a: 1.20-1.30 m bs).

1.50-1.65 m bs; BC; 7.5YR5/6 Strong brown mottled with 10YR6/4 Light yellowish brown; massive sand with lamella; 5.36 ph; 25.4°C (sample 128b: 1.52-1.62 m bs).

Appendix A - Summary of Geologic Profiles and Soil Samples collected

Core 129 N504.50 E518.75

0-0.20 m bs; A; 10YR2/1 Black; granular sand.

0.20-0.40 m bs; Bw; 10YR5/6 Yellowish brown; granular sand.

0.40-1.25 m bs; AB; 10YR6/4 Light yellowish brown; granular sand; 7.34 ph; 24.0°C (sample 129a: 1.10-1.20 m bs).

1.25-1.32 m bs; BC; 7.5YR5/6 Strong brown mottled with 10YR6/4 Light yellowish brown; massive sand with lamella; 5.36 ph; 25.4°C (sample 129b: 1.25-1.32 m bs).

**APPENDIX B: Summary of Soil Chemical Results collected
from Soil Cores and Excavation Unit Profiles**

41BL844

Core #	Sample Type	Total P	Trace Metals							
			Al	Cu	Fe	Mg	Mn	Na	Pb	Zn
32a	B	203.0	28600	22.3	17400	9110	742.0	*350	9.2	53.4
32b	B	55.4	6480	5.7	3740	31300	54.3	*384	**0.20	8.9
32c	B	62.9	4410	3.7	2290	47700	20.6	*456	**0.21	3.8
33a	B	90.3	8680	13.5	5270	28200	259.0	*410	**0.22	23.1
33b	B	1310.0	4640	5.4	2670	33300	38.3	*402	**0.21	5.1
33c	B	103.0	2790	*1.7	1450	30900	15.7	*324	**0.17	2.5
34a	B	988.0	6410	16.0	5990	47800	189.0	3930	0.97	31.1
34b	B	33.9	3040	7.3	3350	63700	19.7	608	**0.21	2.6
35a	B	835.0	5770	15.2	3790	47600	186.0	1610	**0.18	28.2
35b	B	57.0	2370	3.9	1770	48200	21.1	*501	**0.19	3.3
36a	B	140.0	11600	21.8	7120	22900	478.0	*337	1.70	38.2
36b	B	435.0	29300	29.2	19900	5320	860.0	*153	10.70	62.8
36c	B	95.9	13100	11.6	8460	32100	150.0	*357	1.20	19.4
36d	B	116.0	4060	9.0	2310	49600	20.6	*464	**0.20	3.1
37a	B	186.0	6230	17.7	4370	36200	211.0	2030	2.30	42.4
37b	B	160.0	1980	3.9	2090	50800	22.1	*515	**0.18	2.8
38a	B	85.7	6630	5.3	4450	27400	99.7	*342	**0.22	10.6
38b	B	103.0	3220	10.5	2010	25800	39.6	*423	**0.22	4.8
39a	B	333.0	7720	24.6	5150	36900	352.0	2040	1.40	47.5
39b	B	171.0	2670	6.0	1690	38700	13.8	*412	**0.20	3.0
40a	F	655.0	8370	24.2	5300	27300	458.0	*533	0.81	39.9
40b	B	118.0	3480	*2.2	2500	50100	30.0	*478	**0.21	5.8
41a	F	612.0	6560	14.9	4040	41800	224.0	941	**0.17	32.6
41b	B	132.0	1930	*0.95	2050	51300	28.5	*452	**0.19	2.4
42a	B	647.0	8620	25.6	5440	23700	479.0	788	1.20	38.1
42b	F	373.0	7880	19.8	5170	30100	307.0	*586	**0.21	31.6
42c	B	330.0	3830	6.8	2210	40200	57.6	*480	**0.18	10.4
43a	B	717.0	7350	28.9	5090	36100	463.0	631	**0.21	34.4
43b	F	850.0	8120	21.2	5340	34600	364.0	*480	0.77	35.0
43c	B	308.0	3580	4.3	2110	45900	37.6	*449	**0.19	6.1

Core Type: B = background, F = feature/burial

Trace Metals: Al (Aluminum), Cu (Copper), Fe (Iron), Mg (Magnesium), Mn (Manganese),
Na (Sodium), Pb (Lead), Zn (Zinc).

* below standard reporting limit but within tolerance of instrumentation.

** negative interference related to high concentrations of calcium, data suspect.

Non-Invasive Burial Determination

41BL69

Core #	Sample Type	Total P	Trace Metals			
			Cu	Mn	Na	Zn
25a	B	463	18.3	309.0	1050	90.1
25b	B	229	16.2	138.0	*262	53.4
26a	B	577	10.3	132.0	772	33.5
26b	B	157	9.5	93.2	*170	24.4
26c	B	172	*2.3	19.4	*178	3.5
27a	B	297	13.4	158.0	*317	46.5
27b	B	504	12.1	127.0	*195	40.8
28a	B	916	19.5	256.0	*385	80.6
28b	B	248	18.6	164.0	*250	64.5
29a	B	460	18.5	236.0	507	69.8
29b	B	254	9.3	74.2	*145	26.5
30a	B	180	12.2	164.0	*464	46.3
30b	B	287	5.2	48.7	*180	14.2
30c	B	254	18.0	184.0	1070	51.8
62a	F	2790	13.8	161.0	*472	60.9
63a	F	279	12.6	123.0	*247	47.5

Core Type: B = background, F = feature/burial
Trace Metals: Cu (Copper), Mn (Manganese), Na (Sodium), Zn (Zinc).
* below standard reporting limit but within tolerance of instrumentation.

41BL744

Core #	Sample Type	Total P	Trace Metals			
			Cu	Mn	Na	Zn
54a	B	1550.0	14.4	246.0	*341	40.6
54b	F	1290.0	13.8	219.0	*438	22.0
54c	B	269.0	7.1	43.5	*440	4.3
55a	B	1020.0	9.8	149.0	*365	20.1
55b	F	1110.0	10.4	248.0	*362	24.0
55c	B	395.0	4.3	45.3	*385	5.3
56a	B	1190.0	12.1	181.0	*422	34.1
56b	B	315.0	6.5	57.9	*418	5.9
57a	B	252.0	4.7	23.5	601	4.7
58a	B	1030.0	15.2	197.0	740	27.2
58b	B	341.0	4.7	58.6	*543	7.7
59a	B	1160.0	15.9	230	1020	20.5
59b	B	290.0	5.4	54.2	*475	6.5
60a	B	1450.0	19.2	267.0	946	38.4
60b	B	101.0	8.1	18.8	687	2.0
61a	B	557.0	7.6	94.3	*457	11.6
61b	B	81.8	2.7	19.6	719	*1.5

Core Type: B = background, F = feature/burial
Trace Metals: Cu (Copper), Mn (Manganese), Na (Sodium), Zn (Zinc).
* below standard reporting limit but within tolerance of instrumentation.

Non-Invasive Burial Determination

41BL780

Core #	Sample Type	Total P	Trace Metals			
			Cu	Mn	Na	Zn
44a	B	946	18.7	416.0	*328.0	42.6
44b	B	639	13.0	338.0	*209.0	29.7
45a	B	654	20.9	403.0	755.0	43.3
45b	B	971	28.6	406.0	*389.0	54.2
46a	B	1330	18.2	320.0	*322.0	48.7
46b	B	624	6.6	80.6	*217.0	18.8
47a	B	1300	14.6	478.0	*121.0	58.2
47b	B	1210	17.6	460.0	*138.0	51.2
48a	B	2070	17.6	203.0	*427.0	36.7
48b	B	1730	19.7	242.0	*242.0	48.4
49a	B	1770	18.6	321.0	*507.0	42.5
49b	B	880	6.2	146.0	*191.0	26.9
50a	B	1140	12.3	396.0	*216.0	46.8
50b	B	736	9.3	291.0	*139.0	41.2
51a	B	1010	22.7	310.0	*508.0	53.7
51b	B	488	16.3	207.0	*258.0	22.5
51c	B	495	15.1	145.0	*205.0	20.9
52a	B	1460	14.4	479.0	*186.0	46.2
52b	F	1500	18.3	544.0	*167.0	47.0
52c	B	1080	12.2	428.0	*81.3	38.9
53a	B	1930	17.6	318.0	1590.0	43.0
53b	F	2810	20.9	300.0	*493.0	48.3
53c	B	605	6.6	114.0	*270.0	22.5

Core Type: B = background, F = feature/burial
Trace Metals: Cu (Copper), Mn (Manganese), Na (Sodium), Zn (Zinc).
* below standard reporting limit but within tolerance of instrumentation.

41CV1038

Core #	Sample Type	Total P	Trace Metals			
			Cu	Mn	Na	Zn
64a	B	549	8.3	331	*90	24.2
64b	F	955	12.1	308	*121	31.1
64c	B	589	7.3	288	*185	19.5
65a	B	785	9.8	347	*121	26.1
65b	B	683	8.9	298	*118	21.1
66a	B	538	10.5	377	*146	27.5
66b	B	623	15.8	360	*108	25.1
66c*	B	----	----	----	----	----

Core Type: B = background, F = feature/burial
Trace Metals: Cu (Copper), Mn (Manganese), Na (Sodium), Zn (Zinc).
*Core 66c was broken in transit, no testing completed.
* below standard reporting limit but within tolerance of instrumentation.

Non-Invasive Burial Determination

41CV1150 Walker Cemetery

Core #	Sample Type	Total P	Trace Metals			
			Cu	Mn	Na	Zn
1a	B	61.7	3.6	76.4	*175	11.7
1b	F	109.0	9.9	96.4	*183	33.6
1c	B	80.4	4.9	82.1	*155	11.6
2a	B	46.5	4.0	81.1	*198	14.1
2b	F	64.8	16.7	126.0	*201	91.8
2c	B	36.4	6.6	123.0	*183	119.0
3a	B	49.3	9.7	126.0	*219	14.6
3b	F	1150.0	16.5	104.0	*393	22.2
3c	B	89.0	7.3	90.4	*174	14.3
4a	B	58.0	16.8	111.0	*166	13.4
4b	F	103.0	6.8	87.3	*191	19.5
4c	B	101.0	15.6	131.0	*202	15.9
5a	B	69.5	5.2	96.3	*211	17.1
5b	B	137.0	8.8	109.0	*174	10.4
6a	B	95.2	6.8	78.4	*183	10.7
6b	B	127.0	3.9	165.0	*178	12.4
7a	B	38.8	12.8	39.6	*165	7.8
7b	B	27.5	6.8	95.5	*174	11.9
8a	B	24.4	6.8	47.0	*200	7.3
8b	B	22.5	7.1	136.0	*156	11.7
9a	B	219.0	7.5	138.0	*176	12.3
9b	B	163.0	10.7	79.3	*163	15.1
10a	B	115.0	9.9	264.0	*173	12.0
10b	B	149.0	*2.8	44.2	*169	9.0
11a	B	137.0	7.4	88.8	*233	20.7
11b	B	154.0	5.6	134.0	*176	17.3
12a	B	124.0	5.3	89.7	*186	14.2
12b	B	112.0	4.9	72.4	*165	10.5

Core Type: B = background, F = feature/burial
Trace Metals: Cu (Copper), Mn (Manganese), Na (Sodium), Zn (Zinc).
* below standard reporting limit but within tolerance of instrumentation.

Appendix B - Summary of Soil Chemical Results

41CV1235

Core #	Sample Type	Total P	Trace Metals			
			Cu	Mn	Na	Zn
13a	B	72.2	14.3	267	*264	13.1
13b	B	279.0	8.3	209	*251	10.7
14a	B	256.0	13.0	302	*284	13.8
14b	B	376.0	8.0	226	*280	11.4
15a	B	208.0	8.5	263	*233	13.1
15b	B	261.0	14.4	235	*269	12.4
16a	B	155.0	10.1	309	*265	14.3
16b	B	299.0	8.8	262	*298	14.3
17a	B	386.0	7.7	306	*337	13.7
17b	B	300.0	5.7	233	*304	10.7
18a	B	690.0	9.9	295	*277	13.0
18b	B	408.0	5.7	238	*321	11.1
19a	B	416.0	6.7	239	*261	12.7
19b	B	325.0	6.7	222	*301	9.2
20a	B	500.0	12.7	312	*212	12.7
20b	B	349.0	16.6	245	*184	13.9
20c	B	403.0	10.2	219	*237	10.7
21a	B	430.0	5.4	278	*183	14.8
21b	F	403.0	14.8	252	*193	14.8
21c	B	315.0	11.7	216	*195	11.4
22a	B	449.0	6.2	256	*191	14.4
22b	F	303.0	7.7	227	*206	13.1
22c	B	343.0	6.1	238	*196	13.4
23a	B	547.0	4.6	289	*204	12.5
23b	F	450.0	5.6	258	*196	13.2
23c	B	347.0	4.7	238	*210	12.5
24a	B	398.0	5.0	270	*192	12.9
24b	F	400.0	4.8	260	*208	13.5
24c	B	256.0	4.8	230	*216	12.0

Core Type: B = background, F = feature/burial
Trace Metals: Cu (Copper), Mn (Manganese), Na (Sodium), Zn (Zinc).
* below standard reporting limit but within tolerance of instrumentation.

Non-Invasive Burial Determination

310N71

Core #	Sample Type	Total P	Trace Metals			
			Cu	Mn	Na	Zn
100a	B	582.0	3.6	47.5	*79.5	3.3
100b	B	838.0	7.1	30.2	*72.6	2.1
100c	B	158.0	*2.2	10.3	*67.9	*0.9
101a	B	527.0	5.9	44.5	*58.6	5.4
101b	B	467.0	12.7	20.2	*93.8	2.2
101c	B	230.0	3.3	5.5	*50.9	*1.2
102a	B	518.0	*0.7	30.9	*86.9	2.5
102b	B	571.0	*1.0	11.6	*74.4	1.9
102c	B	185.0	3.9	12.4	*36.5	*1.1
103a	B	612.0	5.0	57.9	*97.3	4.5
103b	B	494.0	7.5	26.5	*93.5	2.7
103c	B	181.0	4.5	19.2	*94.2	5.0
104a	B	461.0	2.7	38.8	*67.5	2.8
104b	B	379.0	*1.2	20.7	*68.2	24.6
104c	B	182.0	8.9	10.8	*85.0	3.9
105a	B	757.0	*1.7	59.5	*70.4	4.0
105b	B	385.0	*1.1	20.7	*72.7	2.0
105c	B	132.0	*1.7	27.5	*113.0	*1.2
106a	B	1060.0	4.5	89.4	*316.0	4.9
106b	B	352.0	*0.9	13.3	*75.7	*2.1
106c	B	55.2	*2.5	16.4	*87.9	2.3
107a	B	161.0	*1.9	55.1	*117.0	5.1
107b	B	347.0	6.1	54.0	*120.0	4.5
107c	B	143.0	6.9	15.0	*146.0	*2.0
114a	B	607.0	*1.9	77.2	*133.0	5.3
114b	F	287.0	*1.1	39.0	*83.9	3.4
114c	B	253.0	*0.7	15.6	*90.8	2.9
115a	B	317.0	*2.4	82.0	*151.0	5.9
115b	F	199.0	*1.4	54.6	*95.4	4.1
115c	B	127.0	*0.6	16.2	*86.1	2.9
116a	B	117.0	*1.4	50.3	*91.5	4.2
116b	F	364.0	*1.2	45.0	*89.3	3.6
116c	F	301.0	*0.7	28.1	*91.6	2.5
116d	B	151.0	*0.3	9.9	*139.0	*1.6
117a	B	423.0	*1.2	53.9	*93.3	4.2

Table continued on next page.

Appendix B - Summary of Soil Chemical Results

117b	F	351.0	*1.1	43.8	*88.5	3.6
117c	F	427.0	13.4	34.0	*112.0	3.4
117d	F	407.0	*0.9	36.5	*105.0	3.0
117e	B	153.0	*0.3	4.2	*136.0	*1.4

Core Type: B = background, F = feature/burial
 Trace Metals: Cu (Copper), Mn (Manganese), Na (Sodium), Zn (Zinc).
 * below standard reporting limit but within tolerance of instrumentation.

31ON1019

Core #	Sample Type	Total P	Trace Metals			
			Cu	Mn	Na	Zn
108a	B	205.0	*0.9	17.1	*47.0	3.0
108b	F	50700.0	4.2	16.9	1840.0	35.2
108c	B	368.0	*2.3	14.2	*63.8	*1.9
109a	B	349.0	3.0	30.2	*36.1	3.1
109b	F	6470.0	5.3	41.5	*224.0	6.5
109c	B	580.0	3.5	15.9	*25.4	6.4
110a	B	269.0	53.4	9.8	*51.5	5.1
110b	B	129.0	3.7	183.0	*35.0	2.5
110c	B	298.0	4.7	16.3	*22.1	4.8
111a	B	234.0	2.3	8.4	*37.6	3.2
111b	B	116.0	*1.4	11.5	*21.5	*1.8
111c	B	115.0	*0.7	7.0	*24.2	*1.6
112a	B	148.0	*1.8	9.8	*98.6	3.4
112b	B	112.0	*1.6	10.8	*72.2	2.2
112c	B	99.4	6.5	12.2	*71.5	*1.6
113a	B	352.0	*2.2	10.0	*85.4	2.9
113b	B	89.4	*1.9	14.2	*64.4	2.2
113c	B	133.0	*1.4	6.1	*68.5	*1.8

Core Type: B = background, F = feature/burial
 Trace Metals: Cu (Copper), Mn (Manganese), Na (Sodium), Zn (Zinc).
 * below standard reporting limit but within tolerance of instrumentation.

Non-Invasive Burial Determination

31ON1236

Core #	Sample Type	Total P	Trace Metals			
			Cu	Mn	Na	Zn
118a	F	1150	*2.4	83.6	*515.0	10.4
118b	B	274	*0.8	15.7	*76.3	*1.7
119a	F	1330	*1.2	23.9	*182.0	3.9
119b	B	240	*1.1	15.1	*106.0	2.1
120a	B	673	5.7	41.3	*138.0	5.3
120b	B	261	*1.1	12.8	*115.0	*2.0
121a	B	469	*0.8	16.6	*129.0	2.7
121b	B	181	*1.6	9.6	*102.0	*1.6
122a	B	803	4.3	33.1	*145.0	4.4
122b	B	136	8.3	9.5	*88.0	*1.4
123a	B	997	3.4	50.7	*149.0	4.9
123b	B	315	2.6	16.1	*112.0	2.3

Core Type: B = background, F = feature/burial
Trace Metals: Cu (Copper), Mn (Manganese), Na (Sodium), Zn (Zinc).
* below standard reporting limit but within tolerance of instrumentation.

Wards-Will Cemetery

Core #	Sample Type	Total P	Trace Metals			
			Cu	Mn	Na	Zn
124a	B	80.2	*0.8	7.0	*88.5	*1.9
124b	B	44.3	*1.3	5.0	*77.3	*1.1
125a	B	111.0	*0.7	6.0	*66.7	*1.8
125b	B	50.2	*1.2	6.4	*59.2	*1.1
126a	B	77.6	*2.3	7.9	*75.0	*2.1
126b	F	297.0	*2.0	5.6	*95.9	3.3
126c	B	262.0	*1.9	5.7	*115.0	3.9
127a	B	43.2	*1.9	6.0	*73.9	2.1
127b	F	186.0	250.0	5.9	*133.0	16.9
127c	B	107.0	15.6	7.1	*99.9	6.8
128a	B	21.5	*2.0	5.6	*77.6	*0.7
128b	B	99.2	7.1	8.8	*101.0	6.6
129a	B	45.1	*0.5	4.6	*71.8	*1.1
129b	B	31.2	4.0	8.6	*99.0	5.6

Core Type: B = background, F = feature/burial
Trace Metals: Cu (Copper), Mn (Manganese), Na (Sodium), Zn (Zinc).
* below standard reporting limit but within tolerance of instrumentation.