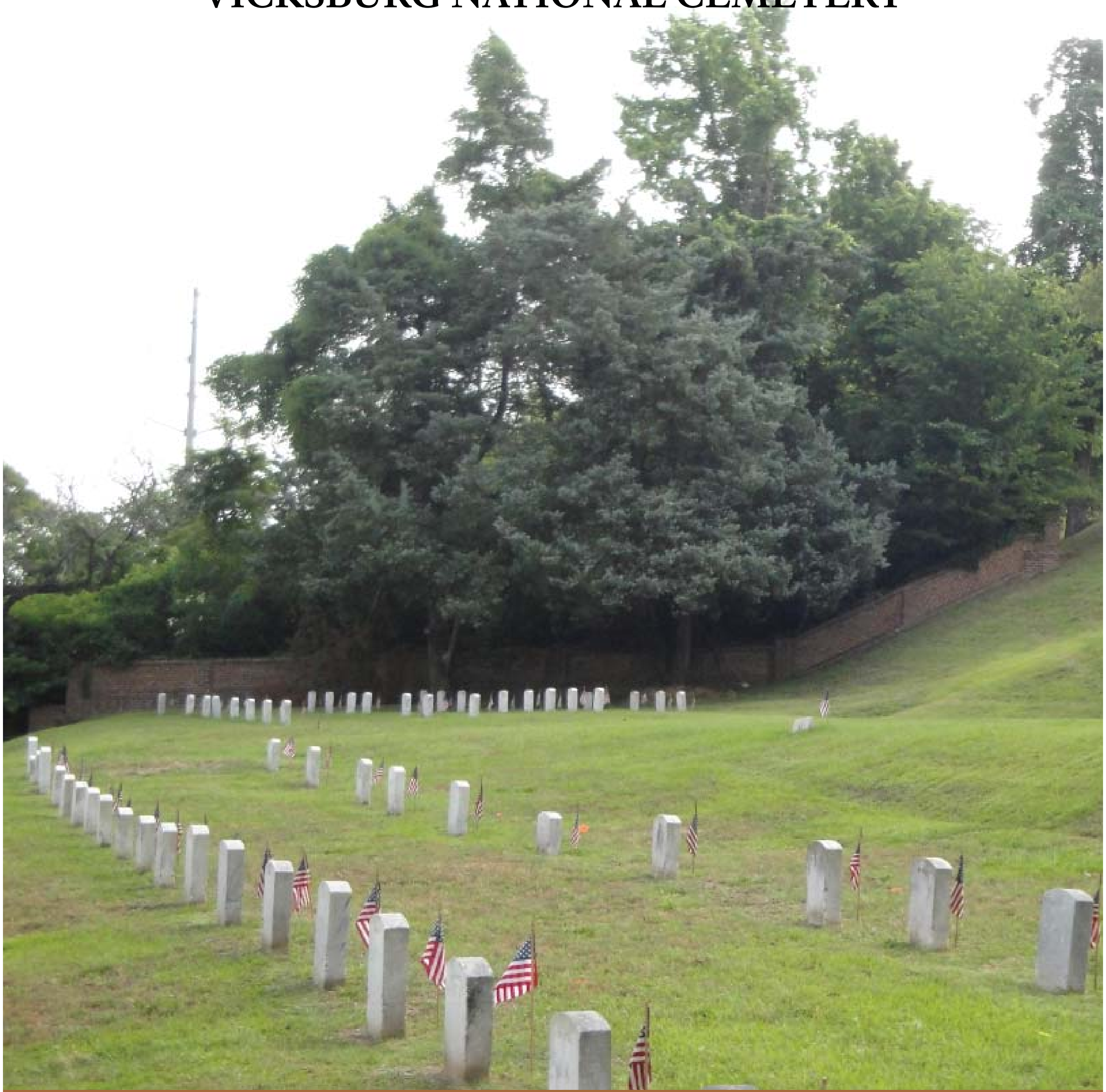
NATIONAL PARK SERVICE
U.S. DEPARTMENT OF THE INTERIOR

SOUTHEAST ARCHEOLOGICAL CENTER
TALLAHASSEE, FLORIDA

ARCHEOLOGICAL INVESTIGATIONS

AT

VICKSBURG NATIONAL CEMETERY



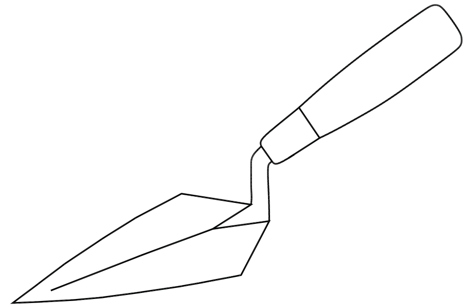
SOUTHEAST ARCHEOLOGICAL CENTER

The Southeast Archeological Center (SEAC) is a support operation of the National Park Service's Southeast Region. In assisting parks with their cultural resource management needs, SEAC facilitates long-term protection of archeological resources and compiles and utilizes the archeological information obtained from these resources. In addition to annually generating numerous archeological reports, as mandated by federal law and park operations, SEAC is the repository for over eight million artifacts that make up the Southeast Region's research collections and contribute to its cultural database. SEAC is staffed by professional NPS archeologists and regularly employs archeology students from Florida State University and other anthropology programs throughout the Southeast.

For more information contact:

Southeast Archeological Center
2035 East Paul Dirac Drive
Johnson Building, Suite 120
Tallahassee, Florida 32310
Telephone: 850-580-3011
Fax: 850-580-2884

http://www.nps.gov/seac/



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Jessica McNeil, M.A., RPA

with Contributions By

Meredith D. Hardy, Ph.D., RPA

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Southeast Archeological Center
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MANAGEMENT SUMMARY

The Vicksburg National Cemetery was established in 1866 and administered by the War Department until 1933 when it was transferred to the National Park Service (NPS). From the time it was established the cemetery was segregated according to race, with Section M reserved for black soldiers. In March of 1961 the NPS officially closed the cemetery for new interments, although the cemetery was not completely full. Room was left to honor existing reservations. Sixty-one reservations are still considered "active" although the park believes that many of those individuals have died and are buried elsewhere.

In late August of 2010 Vicksburg National Military Park (VICK) inadvertently discovered two unidentified individuals interred in unmarked plots within Section W of the national cemetery. In an effort to determine the full extent of the problem, the park requested assistance from the U.S. Army Corps of Engineers Environmental Research and Development Center (ERDC). Janet Simms conducted a ground penetrating radar (GPR) survey of a portion of Section M and all of Section W of the national cemetery using a Sensors & Software Noggin Plus with a 250 megahertz (MHz) antenna and an attached global positioning system (GPS). Simms walked individual survey lines to the east of, and parallel to, the rows of headstones. From the GPR data, Simms identified 49 possible unmarked burials in the 20th century addition to Section M, and another 13 in Section W. Note that the area of Section M surveyed during this project and by Simms was the 20th century addition that generally parallels Washington Street and for the sake of clarity will herein after be referred to as Section M. Given the potential for large numbers of unmarked burials, the park contacted the Southeast Archeological Center (SEAC) in early December 2010 for help in determining the exact number of unknown individuals within this portion of the cemetery.

The following month a crew from SEAC conducted a geophysical investigation of Sections M, W, MUU, X, and V of the national cemetery in an effort to determine the presence of additional unmarked burials. The survey encompassed 0.7 hectares (ha) (1.7 acres) divided into a series of 18 grids of varying sizes and orientation to accommodate the extensive contouring of the property. A Geophysical Survey Systems (GSSI) GPR unit with a 400 MHz antenna was used to survey the entire project area. Five grids within Section M were also surveyed with a 270 MHz antenna in order to determine if it would provide better results than the 400 MHz antenna setup. In all, 89 anomalies were identified that could possibly be associated with unmarked burials. Although the GPR identified a large number of potential unmarked burials, it failed to recognize all of the marked burials; therefore it was determined that subsurface investigations would also be warranted.

In May of 2011, a crew of archeologists from SEAC returned to VICK to conduct systematic probe testing throughout the questionable sections of the cemetery. Building upon the results of the GPR survey, using a 6 foot (1.8 meter) long ceramic tile probe, a single probe test was excavated at locations where an anomaly was identified. When there was a gap between the ordered headstones, a series of three probe tests were undertaken: one at the center of the potential internment and one on either side paralleling the headstone row at a 30 centimeter (cm) interval. Five-hundred and twenty six locations were subjected to probe testing, 46 percent of which encountered some form of resistance. Due to the variability of the results it was determined that mechanical scraping was warranted to clarify some of the more questionable areas, such as Sections M and W, where the probe testing tended to be unreliable.

The following month SEAC again returned to VICK to conclude the cemetery investigations. This final segment of the project entailed mechanical scraping of 62 cm wide shallow trenches throughout Sections M and W. Eighty-three trenches were excavated revealing the presence of 10 unmarked grave shafts. Initial speculation that as many as 89 graves were unmarked seems to have been high, likely due to the soil conditions.

In all, 13 probable unmarked burials have been identified at the Vicksburg National Cemetery (nine in Section M and four in Section W). Two of these were initially identified by the park and were confirmed visually; an additional 10 were encountered during the mechanical scraping and were identified by the presence of a grave shaft; and finally the last one is represented by a small, square cement marker that has identifying numbers on it. Although this last one has not been confirmed, either by the presence of a grave shaft, or through visual inspection of a coffin, it is recommended that the park treat this as an unidentified burial.

CONTENTS

FIGURES

TABLES

ACKNOWLEDGMENTS

No project of this magnitude would have been possible without the assistance of dedicated individuals. I would like to thank my field crew members: Stephen Andrew Wise, Michael Seibert, Hayley Singleton, Bethany Dykstra, Jeffrey Shanks, David W. Morgan and volunteer Morgan Smith. My sincerest thanks go out to Steven DeVore, Archeologist with the Midwest Archeological Center, who was able to fly to Vicksburg on such short notice in order to assist us with the ground penetrating radar operation, and for the loan of their 270 MHz antenna. I would also like to thank former SEAC Archeologist Charles Lawson, currently of Biscayne National Park, who flew to Tallahassee on a days notice in order to assist with data processing prior to the press conference.

I would also like to extend my thanks to all of the staff at VICK, particularly Superintendent Michael Madell and Chief Historian Terrence Winschel, for their assistance and expertise throughout this project. Finally, I would like to thank John E. Cornelison, Jr., Section 106 Compliance Manager, and Director David W. Morgan, both of SEAC, for allowing me to conduct this project.

CHAPTER 1

INTRODUCTION

Vicksburg National Cemetery sits on 47 ha (117 acres) of land overlooking the Yazoo River Diversion Canal along the western edge of Mississippi (Figure 1). It was established in 1866 and administered by the War Department until 1933 when it was transferred to the NPS. In March of 1961 the NPS officially closed the cemetery, although interments have continued since that time for individuals with existing reservations. The park believes that there are there are 61 reservations still outstanding.

In August of 2010, during a routine burial, VICK inadvertently discovered two unidentified individuals in unmarked plots within Section W of the national cemetery. Concerned about this discovery, the park promptly contacted the ERDC. In an effort to determine the presence of any additional unmarked burials, the Army Corps conducted a GPR survey of Sections M and W within the cemetery. The survey identified the presence of 62 possible unmarked burials. Based upon these results park staff conducted probe testing (using a 1.8 m tile probe) of a sample of the unmarked plots in Sections M and W. In the majority of the cases the probe encountered resistance at approximately 1.5 m (5 feet) below the ground surface. Park personnel also found approximately 20 small, unlabeled square, stone blocks (or markers), in line with headstones and buried approximately 7 to 15 cm (3 to 6 inches) below the ground surface.

In December 2010, VICK contacted SEAC requesting that we assist them in their search for unmarked burials. The following month a crew of archeologists from SEAC, under the direction of Archeologist Jessica McNeil, conducted an intensive GPR survey of Sections M, W, MUU, V, and X using a 400 MHz antenna, and a portion of Section M using a 270 MHz antenna. After all of the GPR grids had been combined into a cohesive whole, 89 anomalies were identified. These were classified into three separate categories of confident, possible, and probable unmarked burials.

In May of 2011, once the myriad of GPR data had been processed, a small crew of SEAC archeologists returned to VICK in order to conduct systematic probe testing throughout the project area. The probe testing entailed placing a single probe at the location of "unmarked" anomalies, and three probes across unmarked "plots." Forty-six percent of the probes encountered some sort of resistance and were recorded as positive hits. Unfortunately, the results from the probe testing were too variable in Sections M and W as to be used as reliable predictors of unmarked graves. The results from Sections MUU, V, and X were more consistent overall, and were deemed to be reliable.

The lack of conclusive results from the probe testing in Sections M and W necessitated a return to VICK in June of 2011 to conduct subsurface investigations within the questionable areas of the cemetery. Eighty-three trenches were mechanically excavated within Sections M and W. This proved to be the most effective method for determining the presence or absence of unmarked burials. In Section M, grave shafts could be clearly distinguished from the surrounding, darker soil matrix. The soil matrix in Section W was significantly different from that of M; however, once cleaned, the grave shafts were visible. All told 10 new distinct unmarked grave shafts were identified: nine in Section M and one in Section W.

Overall, 13 unmarked burials were found in five sections of the national cemetery. Two of these were identified by the park in August 2010. Another 10 were identified through mechanical scraping, and one is represented by a numbered marker in Section W.

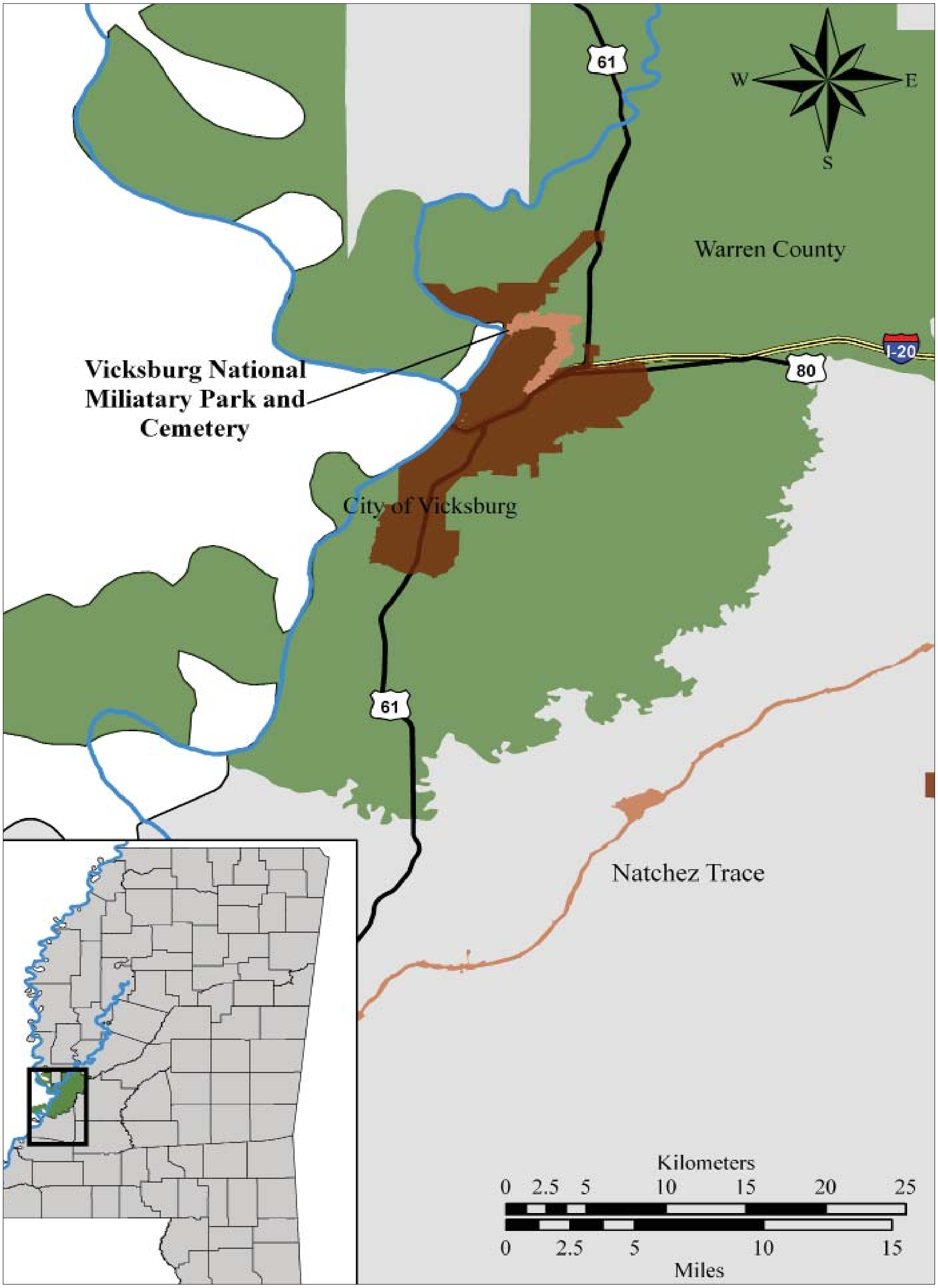

Figure 1. Location of Vicksburg National Cemetery.

CHAPTER 2

ENVIRONMENT

Warren County is located on the western edge of Mississippi, bordered on the west by the Mississippi River, with Madison Parish, Louisiana, immediately across the river. It covers an area of approximately 146,593 ha (362,240 acres) or 1,466 square kilometers (km^2) (566 square miles [mi^2]). The principal water body associated with VICK is the Yazoo River Diversion Canal, which flows in a former riverbed of the Mississippi River and is a major tributary of the Mississippi River in the Vicksburg area. The Yazoo River Diversion Canal was completed in 1903, and runs along nearly 0.8 km (0.5 mi) of the northwestern corner of the park, closest to the national cemetery. There are three major stream drainages or corridors in the park: Mint Spring Bayou, Glass Bayou, and Durden Creek, and their tributaries (NPS 2009a, 2010). Mint Spring Bayou is the only watercourse that exists completely within the park's boundary and is the primary waterbody in the park, which empties into the Yazoo River Diversion Canal. There are several smaller perennial and intermittent streams within the park boundary. There are no permanent standing bodies of water on park lands. Mint Spring Bayou was also a significant feature of the Siege of Vicksburg, providing water for both Union and Confederate troops and their animals.

Between 9,500 and 9,000 years ago, the volume of glacial outwash carried by the Mississippi River decreased, causing the river to change from a braided system to a meandering system. Pleistocene and recent alluvium comprise the upper 24 to 61 m (80 to 200 feet [ft]) of the Mississippi valley, covering Eocene, Cretaceous, and folded Paleozoic sediments; igneous Mesozoic rocks comprise the lowest strata. River flood plain features include natural levees, backswamp areas, point bars, and oxbow lakes. Natural levees form adjacent to the river during flood episodes and represent the highest naturally occurring elevations in the flood plain.

Warren County is dominated by two broad physiographic features – the Mississippi River alluvial plain and the Loess Hills (USDA 1964). The Mississippi River alluvial plain occupies a small portion of the county to the west of the city and the Loess Hills covers the bulk of the county to the east (Mississippi Geological Survey 1976).

The county, and the park itself, is located in what is referred to as the Bluff Hills or Mississippi Valley Loess Plain ecoregion; an ecoregion is defined as an area within which ecosystems are generally similar, with similar patterns of geology, physiography, vegetation, climate, soils, land use, wildlife, and hydrology (Bailey et al. 1994; Bryce et al. 1999; CEC 1997; Omnerik 1987, 1995; US EPA 2003). This ecoregion stretches from the Ohio River in western Kentucky to Louisiana, and is comprised of irregular plains and rolling hills, with oak-hickory and oak-hickory-pine natural vegetation. Near the Mississippi River the rolling hills are replaced by bluffs composed of thick loess, which comprises the parent material of upland areas. Loess is a wind-born and deposited fine-grained soil comprised of silt-sized particles mixed with small amounts of clays and very fine sand. During the Pleistocene, summer glacial meltwater created rivers and streams that carried glacially-ground bedrock downstream; during the winter, dry winds would blow these silts across the landscape, eventually blanketing the landscape in deposits ranging from 1 to 60 m (3 to 200 ft) thick that demonstrate little stratification (Morse 1935; Waters 1996:202). It is a yellowish-buff colored soil, and because it is the result of mechanical disintegration and not chemical decomposition most of its nutrients have not been leached (i.e., it is very fertile).

The hills themselves are comprised of clays, silts, sands, and lignite; they are capped by loess deposits that are sometimes over 15 m (50 ft) thick. There are many microenvironments, such as dry slopes and ridges, moist slopes, ravines, bottomlands, and cypress swamps. In general, the Bluff Hills are

> ...a line of steep hills and bluffs rising abruptly from the Mississippi alluvial plain and ranging from 75 to 125 feet in height. The general height of the bluffs does not change from Vicksburg northward. The elevation decreases and the slope is more gentle southward from Vicksburg. Eastward, the uplands slope gradually to the Big Black River and end in minor bluffs and escarpments [USDA 1964:67].

Adjacent to the Bluff Hills is the Mississippi Alluvial Plain ecoregion, a riverine system that extends from the confluence of the Ohio and Mississippi Rivers in southern Illinois south to the Gulf of Mexico. The Mississippi River watershed drains all or parts of thirty-one states, two Canadian provinces, and 124 ha (1,243,000 mi^2) before finally reaching the Gulf. The Mississippi Alluvial Plain is mostly a broad, flat alluvial plain with river terraces, swales, and levees providing the main elements of relief. Soils are typically finer-textured and more poorly drained than the upland soils of the adjacent Bluff Hills. This ecoregion is comprised of the Northern Holocene Meander Belt and Northern Backswamp. The meander belt is an alluvial ridge that is often at a higher elevation than the more distant floodplain or backswamp areas, and consists of point bars, oxbows, natural levees, and abandoned channels. The natural levees are the most conspicuous landform of the meander belt, and their distribution has influenced human settlement, transportation routes, and agricultural and industrial activities over millenia.

The Northern Backswamps consist of flat, poorly-drained, floodplain depressions where water often collects into small, low-gradient stream channels, lakes, swamps, and low-lying areas. These are areas generally not affected by migrations of the river channel. They often develop in locations of fine-grained overbank or slack-water deposits with low sedimentation rates. The soils are clayey, and mostly gray to black, with organic matter being present in the form of woody fragments, small particles, and peaty surface layers. Water levels are seasonally variable, and the clayey soils will shrink and swell during dry and wet periods.

Soils

The soils that formed on the alluvial plain of the Mississippi River differ widely because the river transported sediments containing many kinds of minerals, sediments that range from coarse sand to clays. The alluvial deposits found in the tributaries of the Mississippi River are fairly uniform in texture and dominated by silty loams. Soils of this region tend to be silt loams and clay loams derived from alluvium, and are often well drained to somewhat poorly drained.

The soils of Warren County are comprised of three separate but related associations: 1) Commerce-Robinsonville-Crevasse; 2) Sharkey-Tunica-Dowling; and 3) Memphis-Natchez-Adler (USDA 1964). Soils of the Commerce-Robinsonville-Crevasse association consist of poorly drained to excessively drained, medium- and coarse-textured alluvium, on recent natural levees in the western part of the county (along the eastern side of the Mississippi River). These soils lend themselves to some of the best farming in in the county. The soils of the Sharkey-Tunica-Dowling association consist of poorly drained, fine-textured slack-water alluvium, that occurs in wide, level areas and areas with scattered slopes along narrow depressions. These soils are typically found in forests associated with bald cypress (*Taxodium distichum*), eastern cottonwood (*Populus deltoids*), sweetgum (*Liquidambar styraciflua*), water tupelo (*Nyssa aquatic*), and various oaks (*Quercus* sp.). Soils of the Memphis-Natchez-Adler association consist of well-drained and moderately well-drained soils derived from hilly upland loess, occurring on long, narrow ridges on hilly steep uplands, that are dissected by steep drainages. These soils are most often found in forests associated with white ash (*Fraxinus americana*), black cherry (*Prunus serotina*), southern magnolia (*Magnolia grandiflora*), sweetgum, shortleaf pine (*Pinus echinata*), loblolly pine (*Pinus taeda*), and various oaks.

The soils of much of Vicksburg National Cemetery are classified as either silty land (SsF), Wakeland silt loam (Wa), or Gullied land (Gu) (US DA 1964). Silty lands are generally Memphis and Natchez silt loams that have been greatly altered by human activity. Wakeland silt loams are poorly drained, mildly alkaline, and friable, and they are found on bottomlands likely to be flooded. Gullied lands are loessal areas that have gullies so deep that they cannot actually be classified as soils; the gullies have cut into unweathered loess parent material.

Climate

The humid, warm, temperate climate of Warren County is characteristic of the southeastern part of the United States. Summers are hot and humid, and winters are often mild, with average daily minimum temperatures ranging from 40° Farenheit (F) in January to 71.6° F in July, and average daily maximum temperatures ranging from 61° F in January to 92.7° F in August. The prevailing winds are from the south, bringing moisture from the warm waters of the Gulf of Mexico to the county. As a result, the relative humidity is around 60 percent for three quarters of the year and higher during the summer. The average yearly precipitation is about 55 inches.

Flora

The floral communities of the Deep South on the Gulf Coastal Plain, even during its peak at ca. 20,000 B.C., remained relatively unaffected by the climatic changes of the Wisconsinan Continental Glaciation, with upland species of oaks, hickories (*Carya* sp.), and southern pines (*Pinus* sp.) remaining dominant. A mesic deciduous forest was supported in ravine and slope habitats next to major river valleys (Delcourt and Delcourt 1981:153). It is speculated that from roughly 40,000 B.C. to 25,000 B.C., cypress-gum forest covered the swampy poorly-drained bottomlands of the Mississippi alluvial valley and the Gulf Coast. During the peak of glaciation an unusual ecotype of white spruce extended south from the Lower Mississippi alluvial valley down to the Gulf of Mexico. After 14,500 B.C., the glaciers retreated to north and the region returned to cypress-gum forest (Delcourt and Delcourt 1981:147).

Today, the vegetation of the Mississippi Valley Loess Plains typically consists of oak-hickory, oak-hickory-pine, and some mixed mesophytic forests (US EPA 2003; Walker 1997). It is a combination of northern and southern flora and fauna, creating a diverse assemblage of species. While oak-hickory forest is the general natural vegetation type, some of the undisturbed bluff vegetation is rich in mesophytes, such as beech (*Fagus grandifolia*) and maples (*Acer* spp.) The upland Loess Hills are dominated by southern red oak (*Quercus falcata*), white oak (*Quercus alba*), cherrybark oak (*Quercus pagoda*), hickory, sweetgum, yellow poplar (*Liriodendron tulipifera*), and loblolly pine (*Pinus taeda*). Woodlands consist primarily of black gum (*Nyssa sylvatica*), tupelo gum (*Nyssa aquatic*), overcup oak (*Quercus lyrata*), American elm (*Ulmus americana*), sycamore (*Platanus occidentelis*), cypress, black willow (*Salix nigra*), ash (*Fraxinus* sp.), bitter pecan (*Carya aquatica*), hickory, cottonwood, and birch (*Betula* sp.) Forests in the southern part of the region contain greater numbers of southern magnolia (*Magnolia grandiflora*), water oak (*Quercus nigra*), and Spanish moss (*Tillandsia usneoides*).

Bottomlands are characterized by cottonwood, cherrybark oak, Nuttall oak (*Quercus nuttallii)*, overcup oak, water oak (*Quercus nigra*), white oak, willow oak (*Quercus phellos*), sweetgum, blackgum, and yellow poplar. In the frequently flooded bottomland or backwater areas, pure or nearly pure cypress forests are often found.

Nearby, the Mississippi Alluvial Plain ecoregion was once covered in bottomland deciduous forest vegetation prior to clearance for cultivation. It contained one of the largest continuous wetland systems in North America, and today remains a major bird migration corridor. Levees have been constructed that keep the river from overflowing, which has opened large areas for extensive agriculture.

The vegetation of VICK today consists of a mix of forested and open grassy areas. A natural resource survey of VICK conducted in 1997 identified a total of 299 plant species from 95 families (Cooper et al. 2004; Walker 1997). The dominant vegetation within VICK is generally mixed mesophytic oak/hickory forest interspersed with patches of perennial grasses that stand between one and three feet high. Principle hardwood trees are southern red oak and white oak, and other common over-story trees include southern sugar maple (*Acer barbatum*), black oak (*Quercus velutina*), bitternut hickory (*Carya cordiformis*), and northern red oak (*Quercus rubra*). This differs somewhat from the typical beech (*Fagus grandifolia*) and cucumber (*Magnolia acuminata*) trees that are typically found in this habitat. The under-story and shrub is comprised of dogwood (*Cornus florida*), redbud (*Cercis canadensis*), pawpaw (*Asimina triloba*), sassafras (*Sassafras albidum*), and oak-leaved hydrangea (*Hydrangea quercifolia*), among others. The common herbaceous species are green trillium (*Trillium viride*), rattlesnake fern (*Botrychium virginianum*), Christmas fern (*Polystichum acrostichoides*), and bedstraw (*Galium aparine*).

When present, plant understory includes cattail (*Typha* sp.), arrowhead (*Sagittaria* sp.), palmetto (*Sabal minor*), maypop or purple passionflower (*Passiflora incarnata*), switchcane (*Arundinaria tecta*), pokeweed (*Phytolacca americana*), muscadine (*Vitis rotundifolia*), blackberry (*Rubus* sp.), dayflower (*Commelina communis*), field groundcherry (*Physalis mollis*), and evening primrose (*Oenothera biennis*). Ground cover consists of various grasses, sedges, and rushes (USDA 1964).

A total of 83 invasive plant species have also been identified, 12 of which did not exist in the area during the battle (NPS 2009a). The dominant species of concern in the park are kudzu (*Pueraria lobata*), Johnsongrass (*Sorghum halepense*), Chinaberry (*Melia azedarach*), Chinese privet (*Ligustrum sinense*), Japanese privet (*Ligustrum japonicum*), English ivy (*Hedera helix*), Japanese honeysuckle (*Lonicera japonica*), Chinese parasol tree (*Firmiana simplex*), nandina (*Nandina domestica*), and trifoliate orange (*Poncirus trifoliatata*) (Cooper et al. 2004). Additionally, non-native Bermuda grass (*Cynadon datcylon*) has been planted on roughly 30 percent of the park.

Fauna

An inventory of mammalian species within VICK was conducted in 2005, which identified 38 native and seven non-native species (Linehan et al. 2008). According to lists that have been generated based upon sightings and range maps there are possibly 39 species of mammals within the park, with 36 being listed as residents. This list includes predator mammals such as raccoon (*Procyon lotor*), opossums (*Didelphis virginiana*), red fox (*Vulpes vulpes*), coyotes (*Canis latrans*), striped skunks (*Mephitis mephitis*), and an occasional bobcat (*Felis rufus*). Several species of bat have also been identified, including the Seminole bat (*Lasiurus seminolus*), the red bat (*Lasiurus borealis*), and the hoary bat (*Lasiurus cinereus*). Other mammals identified in the park include the eastern cottontail (*Sylvilagus floridanus*), white-tailed deer (*Odocoileus virginianus*), gray squirrel (*Sciurus carolinensis*), fox squirrel (*Sciuris niger*), southern flying squirrel (*Glaucomys volans*), and the eastern wood rat (*Neotoma floridana*).

Regarding avian species, 189 native and two non-native species were have been identified to date in the park (NPS 2010). Species include water birds such as common teal (*Anas crecca*), wood duck (*Aix sponsa*), mallard (*Anas platyrhynchos*), common merganser (*Mergus merganser*), and great blue heron (*Ardea gerodias*), barred owls (*Strix varia*), northern cardinal (*Cardinalis

cardinalis), indigo bunting (*Passerina cyanea*), wild turkey (*Meleagris gallopavo*), red-tailed hawk (*Buteo jamaicensis*), bobwhite (*Coloinuss viginianus*), mockingbird (*Mimus polyglottos*), pileated woodpecker (*Dryocopus pileatus*), red-winged blackbird (*Agelaius phoenicews*), black vulture (*Coragyps atratus*), and turkey vulture (*Cathartes aura*). Several species of conservation or high conservation priority, as identified by the National Audubon Society, including the white-eyed vireo (*Vireo griseus*), worm-eating warbler (*Helmitheros vermivorus*), hooded warbler (*Wilsonia citrina*), orchard oriole (*Icterus spurius*), swainson's warbler (*Limnothlypis swainsonii*), and Kentucky warbler (*Oporornis formosus*).

Herpetofauna (amphibians and reptiles) identified in the park, especially in wetland areas, include Ouachita map turtle (*Graptemys ouachitensis*), bull frog (*Rana catesbeiand*), leopard frog (*Rana sphenocephala*), gray treefrog (*Hyla versicolor*), alligator snapping turtle (*Macroclemys temmincki*), common snapping turtle (*Chelydra serpentina*), stinkpot (*Sternothaerus carinatus*), painted turtle (*Chrysemys picta*), cottonmouth (*Agkistrodon piscivorus*), green water snake (*Natrix cyclopion*), and banded water snake (*Natrix fasciata*) (Keiser 2002; NPS 2010). Species found in drier areas include copperhead (*Agkistrodon contortrix*), gray ratsnake (*Elaphe spiloides*), timber rattlesnake (*Crotalus horridus*), corn snake (*Elaphe guttata*), spotted dusky salamander (*Desmognathus fuscus conanti*), five-lined skink (*Eumeces fasciatus*), and slender glass lizard (*Ophisaurus attenuatus*). Alligators are known to inhabit the floodplain along the Mississippi and Yazoo Rivers, and some may occasionally pass through the bottomland forest where Mint Spring Bayou empties into the Yazoo River Diversion Canal.

Non-native animals that have been identified in the park include red imported fire ants (*Solenopsis invicta*), the fathead minnow (*Pimephales promelas*), domestic dogs (*Canis familiaris*), and cats (*Felis catus*).

Threatened and Endangered Species

No threatened or endangered plant species have been known to exist in the Vicksburg area or in the park, though a state species of special concern, prairie nymph (*Herbertia lahue*) has been detected.

Regarding animals, state species of concern include the oldfield mouse (*Peromyscus polionotus*), the alligator snapping turtle (*Macrochelys temminckii*), and the Mississippi map turtle (*Graptemys pseudogeographica*). There are no known federally listed threatened or endangered wildlife species that reside within the park, though the delisted but monitored bald eagle (*Haliaeetus leucocephalus*) and federally endangered interior least tern (*Sternaantillarum athalassos*) may occasionally utilize the park (Cooper et al. 2004; NPS 2009a).

CHAPTER 3

HISTORY OF THE NATIONAL CEMETERY

Unless indicated otherwise, this chapter is summarized from Cliff and Buysse 1999, Meyers 1968, and NPS 2009a.

The Vicksburg National Cemetery is one of many created as an on-the-spot, practical necessity for disposing of battlefield victims during the Civil War. During the War, soldiers who died from their wounds or disease were typically buried nearby. If their name was known, their grave was often marked in a makeshift fashion using whatever materials were at hand. It was most common to etch the name into a wooden board (headboards). Following the 1863 siege of Vicksburg, only a few primary burial places existed. These few large burial locales, spread across the hills of Vicksburg, consisted of long trenches into which hundreds of bodies had been placed. Mass graves such as these were created using the limited resources that were available as a means of rapidly burying the dead before disease could flourish. No attempt had been made to mark each grave so that the dead could later be identified. Furthermore, many other individuals were scattered in shallow graves over wide circuits of country, in fields and river levees both in Mississippi and across the river in Louisiana and were in danger of disappearing.

Following an inspection of the Vicksburg battlefield in 1866, Colonel James F. Rushing of the U.S. Army estimated that there were at least 8,000 Union dead on the Vicksburg side of the river and another 2,000 dead on the Louisiana side. Those on the Louisiana shore were primarily buried in the river levee from Milliken's Bend to Disharoon's plantation. High water on the river was constantly washing away the levee. Consequently, many graves were disappearing and bodies were washing away daily. Rushing felt that there could be an additional 5,000 dead who fell at the Yazoo River, Chickasaw Bayou, Big Black, and Grand Gulf around Vicksburg. The dead had been lying unattended and scattered around Vicksburg and Louisiana for over three years.

The attempt to compile a record of the dead in 1866 was slow because the roughly 15,000 graves were scattered across the entire area where the army had been stationed during the siege. It was believed that identification would proceed more quickly if all the remains were moved to a single place, and it was recommended that 75 to 100 acres be bought near the surrender monument, built on the spot where the historic oak tree once stood. Unfortunately, the cost of the desired locale proved to be too prohibitive. A suitable property was finally identified: a 40-acre tract located roughly one mile north of the city, which, on August 26, 1866, was purchased by the U.S. Government from Alney H. Jaynes and his wife for $9,000, thus establishing the Vicksburg National Cemetery.

The actual transfer of the dead to the new cemetery was anything but easy. In many places the graves were in bad condition, with no markers or indicators of a grave except for sunken soil. Few headboards were standing, and those that were standing were in bad shape. Orders were finally given in October 1866 to take possession of the lands purchased for the cemetery and to prepare the grounds for interment.

By 1867 an average of 16 interments were made a day. The majority of laborers (260 total) were being used, however, to prepare the grounds – grading, sodding slopes, and dressing the graves. The labor team was comprised of a commissioned officer, three superintendents, two clerks, four white foremen, 70 white laborers, 170 African American laborers, and 10 African American teamsters.

The irregularly-shaped cemetery measured roughly 580 m (1,900 ft) long (north-south) and 425 m (1,400 ft) wide (east-west), and was divided by a carriage road that went along its greatest length from north to south. To the west of the road little work was conducted on the grounds, but to the east a series of terraces were constructed that were 15 to 30 m (50 to 100 ft) wide, with banks 1.5 to 2.5 m (5 to 8 ft) high.

By August 1868, 15,595 interments had been made: 3,193 white and 130 black known soldiers; 6,589 white and 5,458 black unknown soldiers. From its beginning the cemetery was segregated according to race. The white soldiers were reinterred in sections A, B, C, D, E, F, G, H, and O, while all the initial reinterments of the black soldiers were confined to section M.

By 1870, the cemetery was still not complete. It was estimated that 200 bodies had to be exhumed and reburied in another part of the cemetery, and many thousands of linear feet of drainage and gutters remained to be laid, roads graded, retaining walls built, and the brick sewer completed. Also, many of the wooden headboards were highly decayed, so much so that the information on them was difficult to read, at best. Because the wooden headboards obstructed maintenance (lawn mowers and scythes could not pass between them), because of their rapid deterioration, and because the majority of the dead were unknown, it was proposed:

> …To place at each end of the two longest outer lines on a terrace a small marble obelisk shaped monument about 18 inches high and 8 inches at the base, and having simply the letter of the section, the number of the grave at the head of which it is placed, inscribed upon it… (Meyers 1968:53).

It was believed that since the graves were in straight lines, with distance between each one recorded, that all graves would be able to be relocated with a map. However, it was determined that markers for each of the known grave were necessary, and that designations of the graves of the unknown should also be made.

Work in the cemetery was suspended in December 1872, and an inspection in March 1873 found that the roads and terraces were in good condition, the drainage systems were working as designed, and maintenance costs were minimal.

By 1875, nearly all the remains of the Civil War dead had been removed to the cemetery — there were 16,588 graves. Marble headstones had been erected at all the graves of the known dead, and marble blocks were being placed at the graves of the unknown.

In 1899, VICK was established. Both it and the national cemetery were under the administration of the War Department.

By 1912, space available for new burials in the cemetery was rapidly diminishing. In 1911 the cemetery superintendent laid out a section in the northwest corner of the cemetery to accommodate 128 new burials and in 1912 authorization was granted to begin preparing this new section.

By 1930, there were only 410 grave sites that remained unfilled, and it was estimated that the cemetery would be full by 1944. This estimate did not account for deaths of World War I veterans whose wish was to be interred in the cemetery, the possibility of which made the need for space even more acute. It thus was recommended that the cemetery acquire additional lands. In 1933, only 18 grave sites remained available for African American veterans, and it was recommended that a plot of land be transferred from VICK, located just to the southeast of the cemetery.

On August 10, 1933, responsibility for the administration of 11 national cemeteries, including the one at Vicksburg, was transferred from the War Department to the Department of the Interior, National Park Service. At the time, the Secretary of War who was aware of the lack of space for recently deceased veterans communicated the need for the expansion of the cemetery to the Secretary of the Interior. In 1934, the Superintendent of Vicksburg National Military Park hired an engineer to create maps of the lands surrounding the cemetery and to determine their utility for use as burial ground. In 1935, an appropriation was made to extend the national cemetery, and by 1939 a total of 80 acres had been acquired. However, these lands remained unused.

In 1942, two of the rules of interment for national cemeteries were changed. The old regulations stated that 1) the wife of an officer could be buried in the cemetery before the death of her officer-husband, but that the wife of an enlisted man could be buried only after his death or after he was 70 years old; and 2) the wife of an enlisted man had to be buried in the same grave with her husband. The new regulations stated that the wife of an officer or enlisted man could be buried prior to her husband, provided that the veteran assured that he would be buried in the national cemetery, and that the wife of an enlisted man could be buried in an adjacent grave reserved for that purpose. These new regulations placed an additional burden on the already diminished land space within the cemetery.

Because of the rule change, by 1943 only 57 burial plots were open. The superintendent was able to gain additional space within the cemetery by moving several thousand brickbats to the west. In 1947, the superintendent of the national cemetery retired, and the position was transferred to VICK. The lands that had been acquired in 1939 had never been prepared for burial. In 1957, a parcel of land in the park was partially graded with the intention of exchanging it for some of these unused lands, but this exchange did not occur. By 1960, there were reportedly only 100 unreserved and available grave sites remaining and the park began to prepare the cemetery for closure.

The 47 ha (117 acre) cemetery closed for future burials in 1961, with the only exception being grave sites for veterans and widows who had reserved space prior to the closing. Today the cemetery includes over 18,000 interments, including 17,077 Civil War dead of which 12,909 are of unknown soldiers. Rounded, upright headstones mark the graves of the known soldiers, while small, square blocks, etched with a grave number only, designate the burials of the unknowns. A few graves are marked by non-government-issued headstones.

The names of the soldiers interred in Vicksburg National Cemetery have been compiled from the original cemetery ledgers. The three-volume set contains only basic information about each known veteran, recorded at the time of re-interment. Although the handwritten pencil entries are in remarkable condition, many do contain inaccuracies and/or only partial information about the soldiers.

CHAPTER 4

PREVIOUS ARCHEOLOGY

VICK is listed on the National Register of Historic Places. However, the park has not had a formal comprehensive archeological survey conducted in order to determine whether individual historic properties are eligible for inclusion in the National Register. The NPS is obligated by the National Historic Preservation Act (NHPA), Executive Order 11593, and Section 14 of the Archeological Resources Protection Act to identify, evaluate, preserve, and protect historic properties, including archeological sites. Specifically, Section 110 of the NHPA requires all federal agencies and departments to fully inventory and identify any potential historic properties that could be eligible for the Register. Without such an inventory, NPS personnel cannot make informed decisions regarding the management of irreplaceable cultural resources and historic properties.

Many times, documentary records and oral traditions fairly accurately record the actions and decisions of the past. However, many of these records are only partial and even biased to tell only part of the story. Archeology recovers, records, and interprets an independent data set that can be used to compare, corroborate, or test the documentary and traditional testimonial views of a past event. Archeological evidence gained from artifact analysis can yield details regarding individual behavior that are not typically available in the historical written record. Archeological surveys on battlefields have routinely answered numerous questions and solved controversies regarding the movement of troops across the field, and dispelled myths about the actual activities surrounding battles (Scott 2004; Scott et al. 1998; Scott et al. 2008). Additionally, remote sensing surveys, followed by ground-truthing with subsurface testing, have expanded the boundaries of a wide variety of historic resources, such as cemeteries, homesteads, slave villages, and agricultural fields. Historical sources are often compromised and biased towards the worldviews and prejudices of those writing such history. Only archeology, in association with historical research, can answer questions about past behaviors and actions in a systematic, scientific manner, such as with the Sand Creek Massacre (Scott 2004).

It is widely believed that the archeological resources left from the Civil War do not shed much light on the understanding of the siege and defense of Vicksburg (NPS 2009a). Vast quantities of bullets, shell fragments, artillery projectiles, and an array of accouterments and other items were deposited on the battlefield during the Battle of Vicksburg. Union occupation forces policed the field and recovered usable items in the aftermath of the siege, leaving behind mostly fired or dropped bullets, shell fragments of various sizes, and broken or damaged weapons such as rifles, swords, and bayonets. It is commonly believed that farmers plowed the area for the next 30 years and carted off wagonloads of items uncovered in the fields. However, there is no documentation available to support these claims.

Many of the archeological resources that existed in the park were disturbed by the Civilian Conservation Corps (CCC) during its tenure in the park from 1933 to 1941. For approximately eight years, the CCC used heavy equipment and hand tools to reshape slopes and ridges in the park to remove eroded features and prevent future erosion. It has often been assumed that, truckloads of items left from the siege were carted off by the CCC and that many of the artifacts that remain buried have been greatly disturbed by these activities, but these suppositions can only be verified via archeological survey.

Previous archeological studies within Vicksburg NMP have been generally limited to areas of proposed park construction activities, including proposed roadways, a walking trail, and other amenities. The findings made during even these compliance-driven, small-scale projects belie the mistaken notion that little intact archeological materials remain at VICK. A total of 14 archeological sites have been recorded within VICK which are summarized briefly below.

In 1968, Lee Hanson surveyed the right-of-way for four roads in the park (Hanson 1968). A pedestrian survey and metal detector survey were conducted, which identified a Confederate encampment.

In 1975, archeologists from Mississippi State University conducted an archeological pedestrian survey of a proposed walking trail that would parallel Confederate Avenue for roughly 3.5 miles within the park (Blakeman and Collins 1975). A total of 10 archeological sites were identified – one historic and nine prehistoric. All but two of the prehistoric sites were located on the bluffs, the others being on the south side of Mint Spring Bayou.

In 1975, Wayne Prokopetz of SEAC excavated a portion of a potential aboriginal “temple mound” (Vicksburg Cemetery Mound, Site 22Wr503) located in the National Cemetery, prior to the relocation of a visitor access road that was located close to the mound’s base (Prokopetz 1975). Although Prokopetz was unable to identify any construction episodes, his conclusions remain suspect as the project documentation is sparse.

In 1977, George Fischer of SEAC conducted archeological investigations along the proposed extension of the Mission 66 road and on the U.S.S. Cairo (Fischer 1977). A few late nineteenth century artifacts were located along the route, evidence of razed buildings. Fischer also visited other areas within the park for potential future archeological investigations, including the Shirley House, the Cemetery Mound, several areas of the battlefield, and Civil War features. Finally, the collections and structural remains of the U.S.S. Cairo were also examined.

In 1978, Christopher Hamilton of SEAC conducted a pedestrian survey of the final segment of the Mission 66 road extension (Hamilton 1978). A few historic artifacts were located along the route, but no further archeological work was recommended.

In 1979, Carlos Martinez of SEAC surveyed two areas within the park proposed for development, (Martinez 1979). The U.S.S. Cairo Shop Building area was completely disturbed, and the picnic area contained a course of bricks of undetermined origin, which were avoided during final construction.

In 1992, SEAC archeologists conducted a short shovel testing survey of several construction areas along Union Avenue prior to the excavation of a French drain system (Cornelison 1992). Modern artifacts were identified in only four of the shovel tests that were excavated. Four of the proposed areas for construction were cleared by the survey, while two of the proposed areas were not cleared because the construction plans had not yet been finalized.

Two additional sites, one near the Memorial Arch and the other north of the Minnesota Monument inside a sharp bend of Union Avenue, were identified in 1997 by an archeologist working for VICK on a volunteer basis (NPS 1998). A fourteenth site was located in the vicinity of Pemberton’s Headquarters.

The majority of the sites at VICK – 11 – are the result of inventory work done in advance of construction at Mint Spring Bayou which was completed in 2011 for a stabilization project adjacent to Vicksburg National Cemetery (Cliff and Buysse 1999). The purpose of the project was to stabilize the steep bluff north of Mint Spring Bayou, in order to stop the erosion that threatens the National cemetery road and burials. The project encompassed approximately six acres of land within the NPS boundary. Two archeological sites with late 19th to mid-20th century artifacts were identified, but neither site was recommended as eligible for listing on the NRHP.

A metal-detecting survey of 10 acres in the Railroad Redoubt area was conducted in 2004 prior to clearing activity. Numerous Civil War-era artifacts, consisting mostly of three-ring minié balls, were recovered during this survey. No new sites were identified. The report recommended that an archeologist be on-site during clearing activities to oversee any potential discoveries during the removal (Kidd 2004; NPS 2004). SEAC did not monitor any clearing activity.

In 2005, SEAC archeologists conducted a GPR survey followed by subsurface testing of anomalies and potential buried historic features at the Willis-Cowan House (Lawson 2005). The testing was conducted prior to the development of a handicap accessible lift and walkway, the rehabilitation of a retaining wall, and the construction of a small parking lot. Resources known to exist included the remains of a brick kitchen foundation, a privy pit, and a frame carriage house. The GPR survey identified the kitchen foundations, a brick patio, buried brick debris, episodes of filling, and a concrete walkway. It also vaguely identified the location of a deeply buried privy vault. A total of 10 test units were excavated in order to test anomalies identified in the GPR survey. At the kitchen foundation, the excavations revealed a builder's trench, a barrel cistern, ceramic drainage pipes, brick foundations, and a herringbone patio. Archeological testing in the southwest quadrant of the GPR grid revealed the privy vault. No remains for the carriage house were identified during either the GPR survey or the excavations.

Additional archeological investigations at the park have largely been comprised of damage assessments following numerous violations of the Archeological Resources Protection Act (ARPA 1979, PL 96-95) (Cornelison 1996, 2010; Des Jean 1990; Halchin 2007; Keel 1993, 2003).

CHAPTER 5

GEOPHYSICAL SURVEY

Traditional archeological spade and earth excavation is a time consuming, expensive, and destructive process, and unlike the early years of the science, today's standards of cultural resource management lean toward preservation of archeological patrimony in place rather than removal via excavation. This evolution of thinking, along with annual advances in computer processing power, have led an ever increasing number of archeologists toward geophysical survey techniques for conducting research at known archeological sites, and, more recently, for general site identification (Johnson 2006). The first use of archeological geophysics dates to the early 1950s when English archeologists began utilizing magnetometers to identify Roman pottery kilns (Aitken 1961). Magnetometer use increased in Europe upon the discovery that the thermoremanent magnetism of burnt structures and naturally filled in ditches could be easily detected by the instruments (Clark 1990). Resistance meters, which can be used to map underground features with varying moisture contents, were also utilized early in the history of archeological geophysics. Resistance meters are particularly well suited to the mapping of underground walls, tombs, and cavities, which made them of great use when searching for buried Roman settlements (Aitken 1961). Magnetic and resistivity surveys continued to gain popularity in northern Europe throughout the 1960s and 70s, and their success inspired experimentation with other geophysical prospecting techniques for archeology, such as magnetic susceptibility (Tite 1972; Tite and Mullins 1971), thermal imaging (Scollar 1990), and ground penetrating radar (Bevan 1998).

Although the birth of archeological geophysics coincided perfectly with the early careers of the American "New Archeologists," who were interested in hardening the science behind archeological investigation, the popularity of geophysical survey in Europe did not immediately translate to North American archeologists. In Europe, the successes of geophysical prospecting were associated with monumental architecture, such as buried Roman villas, and comparable archeological features in North America are infrequent. As a result, many American archeologists experimented with geophysics and received little useful results, leading them to abandon the science decades ago. However, the practice grew in Europe and additional instruments and computer software packages were developed for dealing with the large amounts of data generated during geophysical surveys. These further developments have spurred a resurgence in archeological geophysics in the United States over the past 30 years. This has been particularly true in the case of GPR, especially since several North American companies have begun to market GPR systems and software specifically to the needs of archeologists and forensic anthropologists.

For all of the successes and advancements in archeological geophysics over the past half century, imaging of buried features can still be a difficult task. In order for archeological features (or anomalies) to be detected, and be recognizable as archeological features and not natural disturbances, they must contrast in some way with the surrounding soil matrix. Unfortunately, geophysical instruments respond to both archeological and natural anomalies and, therefore, interpretation of geophysical survey results depends greatly on the recognition of patterns in the data that correspond to the expected form of an archeological feature. Often, if there is significant "noise" in the form of chemical or physical variations in the surrounding soil matrix, archeological features can be lost (Nickel 2003). In the case of magnetometers, this noise is usually associated with modern metal refuse scattered about the surface of a site. Such materials can cause such a large disruption of the earth's magnetic field that they easily mask more subtle archeological features. Magnetometers can also be negatively affected by overhead power lines and even passing traffic. In the case of GPR, ground conditions that are most conducive (though not necessarily required) for successful anomaly recognition include dry, homogeneous, non-electrically conductive soils (Conyers and Goodman 1997). Dry homogeneous sand is the base material in which GPR units are tested and designed to function, and it is the best medium for propagation of the microwave. However, in terms of archeology, homogenous sand is not particularly well suited in the maintenance of feature integrity, and though a GPR may function perfectly in it, there may be few preserved archeological features within it to be found. At VICK, the soil present in the project area is generally classified by the U.S. Department of Agriculture as silty land. Although, the properties of this soil type are not ideal for good GPR results, it was decided that this non-invasive technique should be attempted prior to any of the more invasive subsurface methods.

Ground Penetrating Radar

GPR is a non-invasive survey technique utilized by archeologists to identify buried anomalies that could be associated with archeological features (Conyers and Goodman 1997). These anomalies are represented by discrepancies in both the magnetic and electrical properties of the soil below the ground surface, and are conveyed in a subsurface profile produced by the reflecting radar pulses from respective antennae. GPR systems are capable of producing reliable three-dimensional images of the subsurface by evaluating depth based on the elapsed time (in nanoseconds) of the radar pulse from the subsurface anomaly to the surface (Conyers and Goodman 1997). GPR allows the evaluation of subsurface anomalies as deeply buried as 50 m; however, in archaeological contexts it is used most often to examine depths of no more than 5 m.

The resolution of the buried anomaly's signature is influenced by many factors, including radar frequency, the condition of the ground surface, and subsurface soil composition. GPR antennae operate on a variety of frequencies between 10 and 1600 MHz, although frequencies in the range of 250 to 400 MHz are most commonly utilized in archeological prospecting. Generally, the lower the antenna frequency, the greater the depth into the soil that features can be resolved. However, lower frequency antennas can only resolve very large objects and there is therefore a trade-off between depth of penetration and detail of anomaly resolution. GPR is most effective in dry, sandy soils. Clayey soils tend to cause the quick attenuation of the radar energy, and therefore inhibit the data resolution and evaluation of depth (Conyers and Goodman 1997).

GPR surveys are conducted by moving the paired antennas along the ground surface in a series of linear transects making up a larger grid. Two dimensional profiles that display radar reflections from the ground surface to the lowest level of radar penetration are recorded for each of the linear transects (see Appendix B, Figure 57). After all of the adjacent transect profiles within a grid are collected, computerized software can be used to combine the profiles and correlate the features, allowing for the production of a three-dimensional cube displaying images of buried features and soil stratigraphy under the grid (Conyers 2006). That block can then be horizontally sliced at different depths (or times in nanoseconds) to produce "time slice" maps displaying subsurface anomalies present at any depth below the ground surface. SEAC's analysis relies on a combination of inspection of both three-dimensional cube and horizontally sliced data.

Army Corps of Engineers Survey

In October of 2010 Janet Simms of the Army Corps of Engineers ERDC, conducted a GPR survey of Sections M and W of the national cemetery in order to assist the park with determining the number of unmarked burials present within the cemetery. Using a Sensors

& Software Noggin Plus with a 250 megahertz (MHz) antenna and an attached GPS, Simms walked individual survey lines to the east of, and parallel to, the rows of headstones, placing a marker within the data at the physical location of each headstone. Simms walked 14 survey lines (10 in Section M and four in Section W) placing a pin flag at each suspected unmarked burial. From the GPR survey, Simms identified 49 possible unmarked burials in Section M, and another 13 in Section W (Simms 2010). Given the potential for large numbers of unmarked burials, the park contacted SEAC in early December 2010 for help in determining the exact number of unknown individuals within this portion of the cemetery.

SEAC Survey

SEAC's survey utilized a 400 MHz antenna over the entire project area, supplemented by a 270 MHz antenna over a portion of the grids in Section M. A 400 MHz antenna is capable of resolving features measuring a minimum of 50 cm in diameter to a depth of 4 m in ideal situations. However, in practice, depth of penetration with a 400 MHz antenna is usually limited to about 2 m because of varying physical and electrical properties of the natural soil deposits, and because of a desire to focus the unit's resources on providing detail in nearer-surface deposits rather than attempting to boost signal reflection from great depth. During the VICK survey the reliable depth of penetration was limited to approximately 1.75 m with the 400 MHz antenna, and 2 m with the 270 MHz antenna. This means the radar data is likely to reflect off soil differences between grave shafts and the surrounding undisturbed matrix, except for the rarer cases in which burials were extremely shallow or contained multiple, stacked burials within the same shaft.

The survey of the Vicksburg National Cemetery encompassed 0.7 ha. Prior to beginning the GPR survey a series of 18 grids was established. In each case, grid north was established to correspond, as closely as possible, to true north. Due to the extensive terracing and contouring, as well as the orientation of the headstone rows, which tended to follow the contours of the terraces, the size and orientation of each grid was variable (Figure 2). All grids were numbered sequentially according to the order in which they were collected. In five grids (2/3 and 5/6 in Section M; 2/3 in Section W; and 2 in Sections V and MUU) the GPR battery died part of the way through data collection. In Sections M and W, it was possible to stitch two grids together to form a cohesive whole, but in Sections V and MUU, the entire grid was re-collected using the next grid number in the sequence.

Transect spacing during the data collection was at 50 cm and when possible all transects were collected in a north/south direction (Table 1). Although it is more efficient during the data processing stage to have collected all transects in the same direction, it is not strictly necessary as the GPR software can compensate for these types of variations. The orientation of transects in the individual grids is a function of the orientation of the headstones in each section, or area. In each grid the GPR was run perpendicular to the grave shaft (parallel to the headstone rows). It was felt that orienting transects in this manner would provide the best possible data resolution, as well as being the most efficient method of running the system. A GSSI TerraSIRch SIR System-3000 in the Utility-Scan Cart Configuration was utilized to collect the radar data.

Following data collection, each grid was subjected to a series of post processing steps using the software package Radan®. These processing steps are intended to improve feature resolution, remove background noise, and accurately identify feature depth and size. The data was then exported to the contour mapping software program Surfer®, in which additional refinement could be made to further resolve some features and produce quality graphics. Finally, the graphics were exported in a tagged image file format (TIFF) and georectified in ArcGIS® in order to provide real world coordinates for the anomalies. This also allowed the data results from both antennae to be overlaid, and viewed simultaneously

Figure 2. GPR grids as established within each section of the cemetery. The small rectangles within the grids show the placement of headstones.

Table 1. Size of Geophysical Grids Run at the National Cemetery.

Section	Grid #'s 400 MHz Antenna	270 MHz Antenna	Resistivity	Dimensions (m)	Area (sq m)	Transect Orientation
M	1	1	1	20x20	400	North/South
M	2/3	2	2	20x20	400	North/South
M	4	3	3	20x20	400	North/South
M	5/6	4		10x75	750	North/South
M	7	5	4	18x20	360	North/South
M	8			10x20	200	North/South
M	9			5x20	100	North/South
M	10			10x35	350	North/South
M	11			5x15	75	North/South
M	C-1			38x18	570	South only
M	R-1			5x10	50	East/West
W	1			10x120	1200	North/South
W	2/3			15x25	375	North/South
MUU	1			20x20	400	East/West
MUU	3			15x20	300	North/South
V	1			30x15	450	North/South
V	3			30x20	600	South only
X	4			20x30	600	North/South

so that the results could be interpreted as a whole. Results from the 18 individual survey grids were combined into a single project in order to view the entire survey area. The following is a brief overview of the results derived from the GPR survey (see Appendices A and B for more detailed GPR results).

400 MHz Antenna

All 18 grids of the project area were surveyed with the 400 MHz antenna configuration (Figure 3). Figure 4 shows the combined GPR results throughout all of the sections surveyed. The bright orange and red areas represent high amplitude reflection anomalies. Neither Grids C-1 nor R-1 produced any interpretable GPR results. In the case of Grid C-1 this may have been due to an equipment malfunction or operator error. This can be evidenced by the relative lack of variation in the reflected data. The mechanical scraping that was conducted in June of 2011, however, determined that there were no unmarked graves in this portion of Section M. The lack of interpretable GPR data in this section was therefore not critical. The lack of interpretable data in Grid R-1 was a different issue altogether. Large areas of data are necessary in order to differentiate interpretable anomalies from the surrounding soil matrix. Unfortunately, the configuration of this area was simply too small and awkward to establish a larger grid, as this double row of headstones was at the end of a raised, remnant road. Due to the lack of results, Grids C-1 and R-1 will not be included in any further discussion of Sections M and W.

Figure 5 shows the shallowest time-slice in each grid where potentially interpretable GPR results were visible in the data. With the exception of Section W Grid 2, which shows a time-slice at approximately 32 centimeters below the surface (cmbs), all of the grids in Figure 5 represent

Figure 3. Location of 400 MHz antenna grids as run throughout the national cemetery.

near-surface reflections. In Section M, several highly reflective linear anomalies are particularly evident in the southern half. These anomalies are all between approximately 1.5 and 2.5 m in length, and are oriented roughly east/west. Where visible, the anomalous signatures are represented in groups of three, which is probably indicative of "ringing" in the dataset. This type of data noise can often be removed during the processing. In this case however, it was determined that, although the ringing was still visible in the processed data, it visually produced the most interpretable data. In Grid 1 of Section W two anomalies are visible at this depth. The first is the remnant road along the western half of the grid. It is visible as light blue and pale yellow reflections in the data. The second is the roughly rectangular yellow signature in the approximate center of this grid. This anomaly corresponds with the 2010 inadvertent discovery by the park.

In Figure 6 the remnant road in Section W is clearly visible at approximately 44 cmbs. The recent ground disturbance that was clearly visible in the approximate 12 cmbs time-slice is more diffuse and less obvious at this depth. Unfortunately, the GPR was still unsuccessful in clearly differentiating marked burials. In Figure 7 the remnant road is still visible, as is the 2010 ground disturbance in Section W. In the northern portion of the study area is the faint signature of what appears to be the foundation walls of a structure. It is rectangular in shape and measures approximately 12x15 m. In the southern half of Section M is a series of high-amplitude reflection anomalies. The anomaly that is primarily in Grids 1 and 7 is approximately 7 m in diameter and is roughly circular in shape. It is unclear at this time what these anomalies represent.

Figure 8 shows the combined GPR results for Sections MUU, V, X and M Grid R-1 at depths between approximately 28 and 34 cmbs. A small number of faint burial signatures are visible at this depth in Section MUU. Also visible in Section MUU are a drain opening and the remains of a cistern. In Section V, a fairly amorphous high-amplitude reflection anomaly is visible in the center of Grid 3. The anomaly is roughly 4 m in diameter, and probably represents the root system of a tree at that location. This anomaly is not visible at approximately 56 cmbs. The high amplitude reflections along the southern edge of Grid 3 in Section V are probably a function of signal loss, due to the severe slope at this location. In Figure 9, which shows the combined GPR results at approximately 80 cmbs, the drain in Section MUU is still clearly visible but the signature from the cistern is much more diffuse. There are no clear burial signatures at this depth.

270 MHz Antenna

Although the 400 MHz antenna was able to distinguish the possible remains of a rectangular structure and a small number of burials, the data was unable to produce the desired results. It was therefore decided that five grids of Section M should be resurveyed using a 270 MHz (Figure 10) in an attempt to determine whether the lower frequency antenna would be able to achieve better results. When the ERDC initially surveyed Sections M and W, they utilized a Noggin GPR with a 250 MHz antenna, which appeared to achieve better results. It should be noted however that the ERDC was also unable to detect anomalies at all of the headstones and suggested that it was "possible that these headstones represent burials where no remains were recovered" (Simms 2010:2).

Unfortunately, this antenna configuration was unable to produce better results than the 400 MHz antenna. Figure 11 illustrates the combined GPR results using the 270 MHz antenna configuration. Along the southern portion of Grid 3 is a linear anomaly that spans the width of the grid and is approximately 3 m north to south. In Figure 12 the linear anomaly is still slightly visible, but has become somewhat diffuse. There is no further differentiation of anomalies associated with headstones.

Ground Penetrating Radar Summary

Once all of the data had been processed and compiled, they were scrutinized for the presence of anomalies that could potentially be associated with unmarked burials. In all, 89 such anomalies were identified (Figure 13), 12 of which were identified using the lower frequency antenna. Seventy-five of the anomalies were located in Section M; 13 were located in Section W; and one was located in Section V. Although 89 potential unmarked burials were identified, this number was suspect as both antenna configurations failed to identify many of the known burials. Having gained insight as to the most likely of places to expect unmarked graves, we then set out to ground-truth the anomalies and investigate areas where GPR results were ambiguous or negative. The subsurface investigations will be discussed in detail in the following chapter.

Figure 4. Combined processed GPR results using the 400 MHz antenna configuration from between approximately 7 and 41 cmbs.
The bright orange represent high amplitude reflections. The dark teal areas in Sections M, V, and X represent areas of no-data collection.

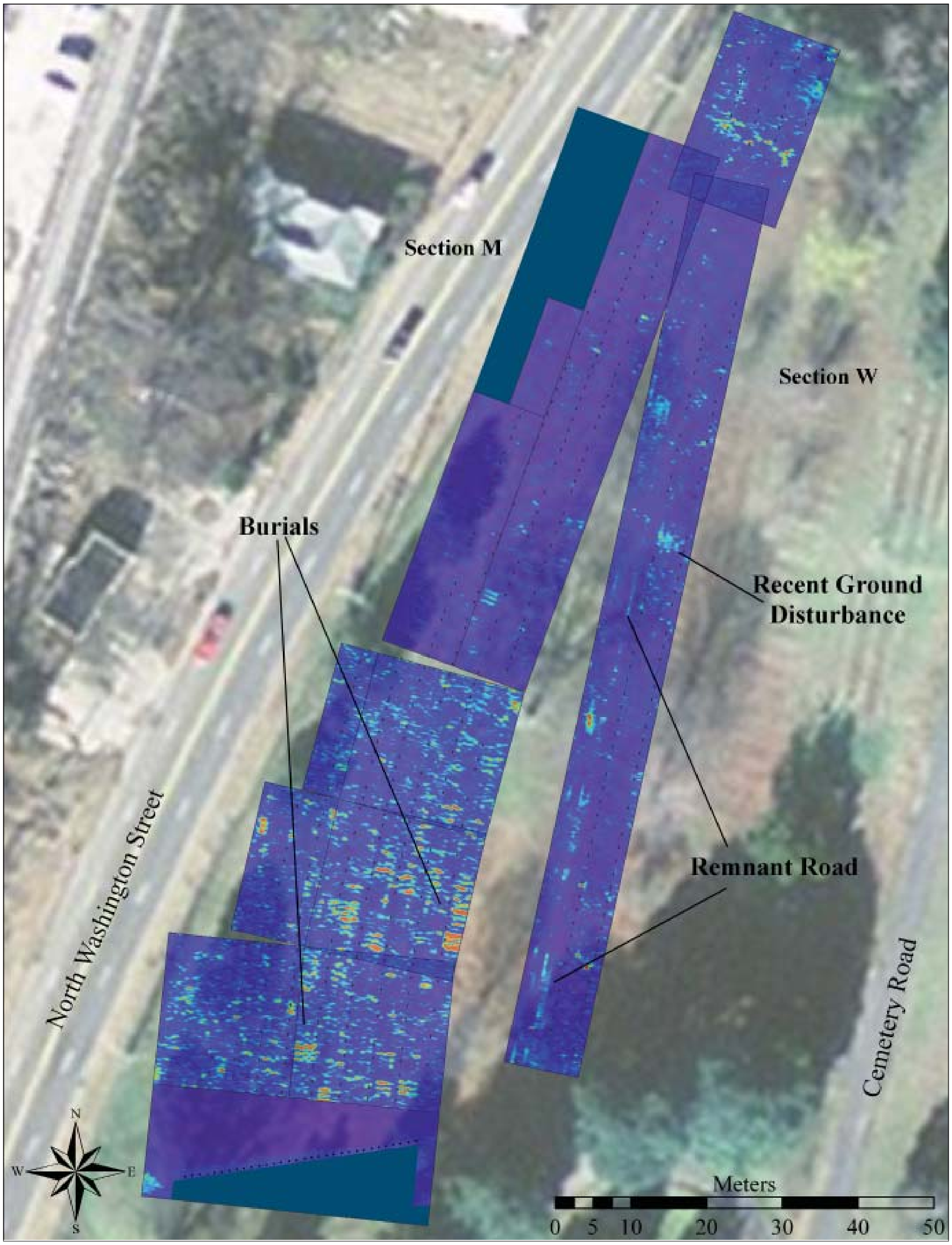

Figure 5. Close-up of combined processed GPR results using the 400 MHz antenna configuration from between approximately 7 and 41 cmbs in Sections M and W.
The dark teal areas in Section M represent areas of no-data collection. The lighter striping along the western half of Section W represents a slightly higher amplitude reflection from the remnant road that is visible on the ground surface. In Section M Grids 1, 2/3, 7, and 8 are at approximately 14 cmbs; 4 and 9 are at approximately 15 cmbs; and 5, 10, and 11 are at approximately 7 cmbs. In Section W Grid 1 is illustrated at approximately 12 cmbs, while Grid 2 is illustrated at approximately 32 cmbs.

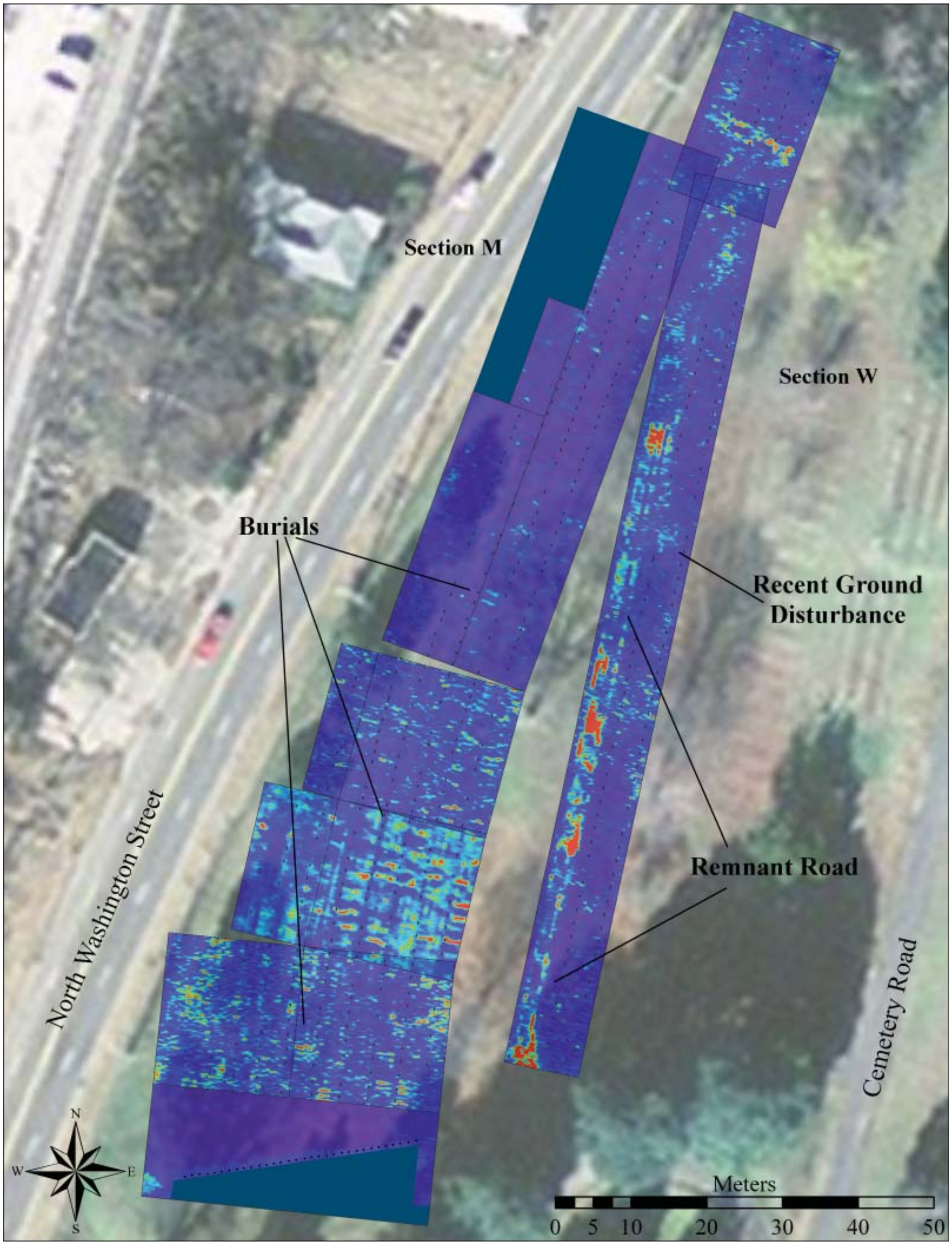

Figure 6. Close-up of combined processed GPR results using the 400 MHz antenna configuration from between approximately 19 and 49 cmbs in Sections M and W.
The dark teal areas in Section M represent areas of no-data collection. In Section M Grids 1 and 7 are at approximately 25 cmbs; 2/3 and 8 are at approximately 19 cmbs; 4 and 9 are at approximately 24 cmbs; and 5, 10, and 11 are at approximately 33 cmbs. In Section W Grid 1 is illustrated at approximately 44 cmbs, while Grid 2 is illustrated at approximately 49 cmbs.

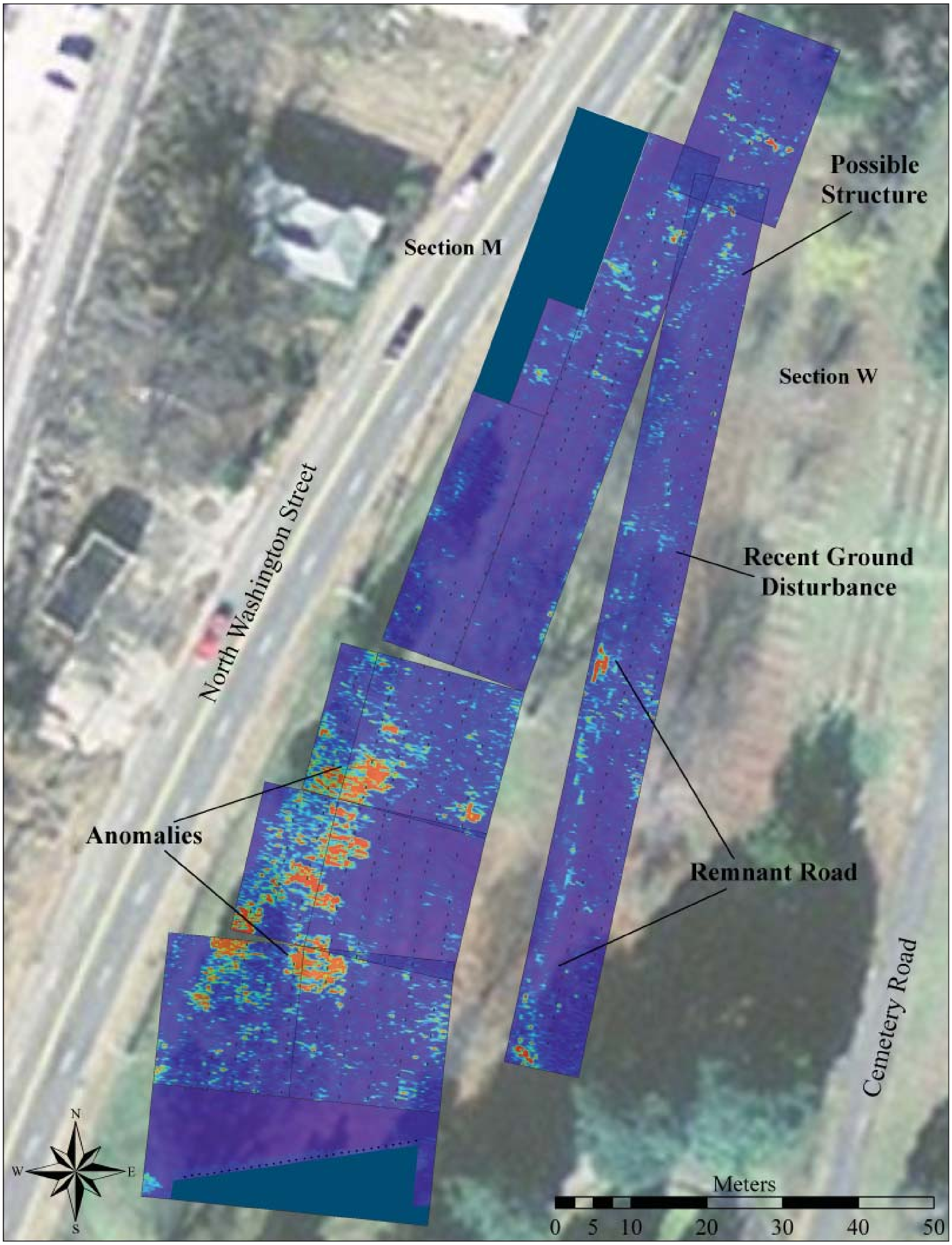

Figure 7. Combined processed GPR results using the 400 MHz antenna configuration from between 54 and 80 cmbs in Sections M and W.
The dark teal areas in Section M represent areas of no-data collection. In Section M Grids 1, 2/3, 7, and 8 are at approximately 54 cmbs; 4 and 9 are at approximately 78 cmbs; and 5, 10, and 11 are at approximately 80 cmbs. In Section W Grid 1 is illustrated at approximately 54 cmbs, while Grid 2 is illustrated at approximately 71 cmbs.

Figure 8. Combined processed GPR results using the 400 MHz antenna configuration from between 28 and 34 cmbs in Sections MUU, V, X, and M Grid R-1.
The dark teal areas in Sections V and X represent areas of no-data collection. Section M Grid R-1 is illustrated at approximately 34 cmbs; Section MUU is illustrated at approximately 28 cmbs; and Sections V and X are illustrated at approximately 32 cmbs.

Figure 9. Combined processed GPR results using the 400 MHz antenna configuration at approximately 80 cmbs in Sections MUU, V, X, and M Grid R-1.
The dark teal areas in Sections V and X represent areas of no-data collection. Section M Grid R-1 is illustrated at approximately 80 cmbs; and Sections MUU, V and X are illustrated at approximately 80 cmbs.

Figure 10. Location of 270 MHz antenna grids as run within Section M of the national cemetery.

Figure 11. Combined processed GPR results using the 270 MHz antenna configuration at between 53 and 103 cmbs. Grids 1 and 5 are illustrated at 88 cmbs; Grid 2 is at 58 cmbs; Grid 3 is at 103 cmbs; and Grid 4 is shown at 84 cmbs.

Figure 12. Combined processed GPR results using the 270 MHz antenna configuration at between 106 and 133 cmbs. Grids 1,2, and 5 are illustrated at 122 cmbs; Grid 3 is at 133 cmbs; and Grid 4 is at 106 cmbs.

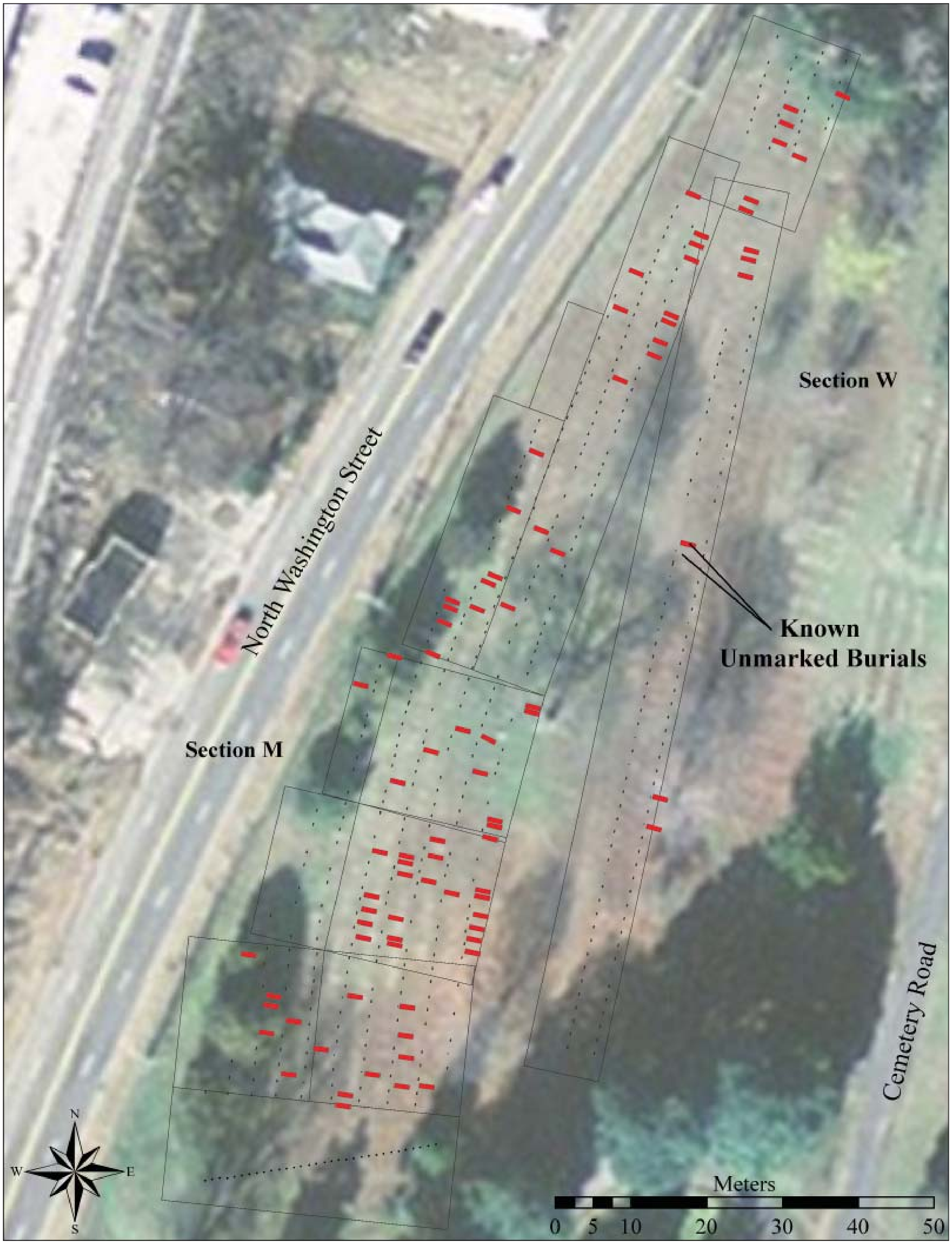

Figure 13. Location of GPR anomalies in Sections M and W potentially associated with unmarked burials.

CHAPTER 6

SUBSURFACE INVESTIGATIONS

After reviewing the results of all of the GPR data it was determined that subsurface investigations would be necessary in order to obtain a clearer picture of the number of unmarked burials within the questionable sections of the cemetery. The additional investigations were conducted over the course of two separate trips. The first entailed systematic probe testing throughout the questionable areas of the cemetery; while the second trip entailed systematic trenching and identification of grave shafts.

Probe Testing

The systematic probe testing was conducted in May of 2011. Using a 2.48 m (8.1 ft) long probe, 526 locations within Sections M, MUU, V, W, and X of the cemetery were tested, 46 percent of which (n=244) were positive for some type of obstruction. Building upon the results of the GPR survey, a single probe test was excavated at locations where an anomaly was identified. When there was a gap between the ordered headstones, a series of three probe tests were excavated: one at the center of the potential interment and one on either side paralleling the headstone row at a 30 cm interval (Figure 14). The probe tests were numbered sequentially and each test was marked with a wire flag labeled with the corresponding number. Finally, the location of each test was recorded with both a laser transit and a GPS. The depth at which some form of obstruction was encountered varied from 20 to 224 cmbs. Table 2 shows a summary of the results derived from the probe testing. The majority of the testing was conducted in Section M, with the majority of those being positive. Unfortunately, the results from the probe testing proved to be so variable as to be unreliable (at least in Sections M and W). It was therefore determined that mechanical scraping was warranted to clarify some of the more questionable areas, such as Sections M and W, where the probe testing tended to be unreliable. Note that in Grid R-1 of Section M, the probe testing results were more consistent with Section MUU and it was determined that no additional investigations would be required. In

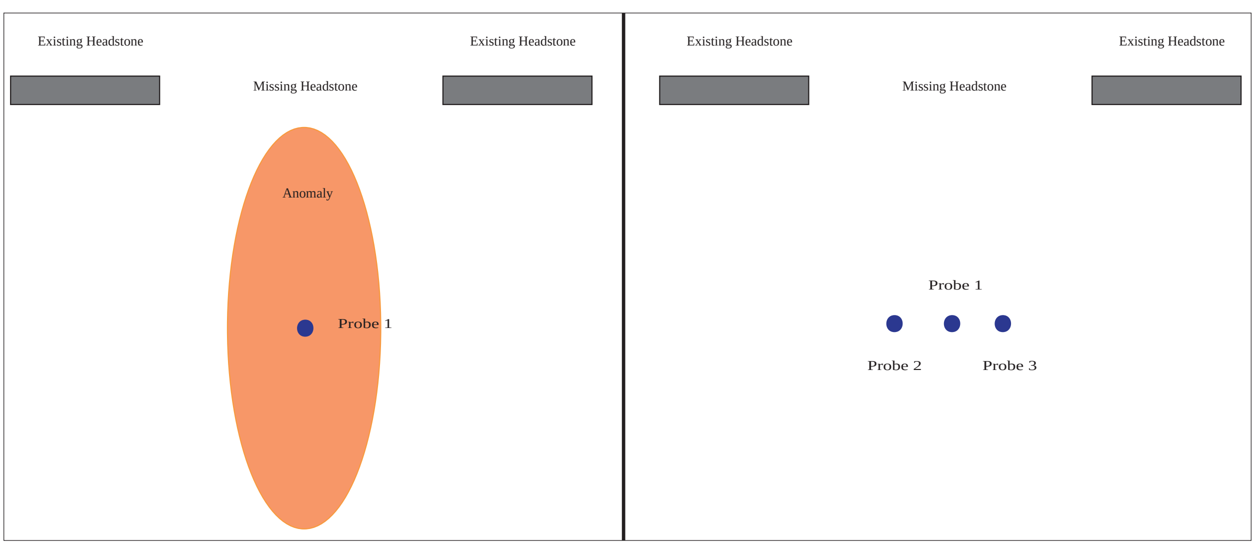

Figure 14. Example of idealized probe test placement. On the left is an example of the single probe test placement when a GPR anomaly was present. On the right is an example of the placement of the probe tests when no GPR anomaly was identified.

Table 2. Summary of the Probe Testing Results.

Section	Result	Count
M	Positive	151
M	Negative	147
MUU	Positive	17
MUU	Negative	56
V	Positive	13
V	Negative	26
W	Positive	61
W	Negative	22
X	Positive	2
X	Negative	31

Sections MUU, V, and X the results of the probe testing were more consistent and along the lines of what one would expect. Only 34 of the 142 locations tested (24 percent) were positive for some type of obstruction. The positive probe tests typically did not encounter resistance at the same depths. In Section MUU the positive probe tests were primarily clustered along the cemetery wall. This, combined with the variability of the depth at which some form of resistance was encountered indicates that the positive probe tests were likely the result of remnant debris from the construction of the wall rather than burials. The cluster of positive probe tests along the eastern edge of Section V (Figure 15) is more indicative of changes in soil (i.e. highly compact or concreted soils) than it is of burials, as the depth at which an obstruction was encountered was inconsistent across each potential plot. Figure 15 shows the locations of all probe testing conducted by SEAC within the National Cemetery. See Appendix B for a listing of the probe testing results.

Mechanical Scraping

The mechanical scraping was conducted over the course of a week in June 2011. It was accomplished through the use of a back-hoe with a 62 cm (24 inch), flat bladed bucket (Figure 16). The trenches were excavated parallel to the headstone rows across areas where regularly placed headstones were missing. The trenches ranged in length from approximately 2 to 27 meters. They varied in depth, but were always excavated to below the humic layer, and were typically no more than 30 cm. Eighty-three trenches were excavated in Sections M and W (Figure 17).

It quickly became apparent that the trenching was the most effective method for identifying grave shafts in Section M. The soil matrix of Section M was primarily comprised of a yellowish brown (10 YR 5/6) or dark yellowish brown (10 YR 4/6) silty soil containing numerous artifacts. None of the artifacts were collected but they included items such as glass, nails, metal fragments, and ceramic fragments that would indicate the presence of at least one, but possibly multiple, structures in this area. The artifacts in the soil would likely account for much of the variability in the soil probing results. The probe would have encountered a hard object such as a brick or metal fragment, leading to a positive result. In contrast to the surrounding soil matrix, the soils in the grave shafts were typically comprised of a yellowish (10 YR 7/6) silt, making the identification of grave shafts particularly easy (Figure 18). Nine apparent unmarked shafts were recorded in Section M.

In Section W, the situation that presented itself was significantly different. In this section the soil was comprised of highly mottled, light colored (typically pale yellow [2.5 Y 7/4]) silt; while the grave shafts themselves were often a yellowish brown (10 YR 5/6) silt. The primary soil matrix of Section W was typically highly rocky, which would account for the number of false positives during the soil probing in this section. One apparent unmarked grave shaft was identified during the scraping in Section W.

Summary of Subsurface Investigations

The subsurface investigations of the Vicksburg National Cemetery involved a two-pronged approach. The first entailed systematic probe testing throughout the five sections. In Sections MUU, V, and X the probe testing results were fairly consistent, and did not produce any

Figure 15. Location of probe testing within the national cemetery. Red indicates a positive probe test result and blue indicates a negative result.

potential unmarked burials. However, the results of the probe testing in Sections M and W proved to be so inconsistent as to warrant additional subsurface testing. The additional testing in these sections took the form of mechanical trenching with the assistance of a backhoe. In all, 83 trenches were excavated resulting in the identification of 10 probable unmarked burials: nine in Section M and one in Section W (Figure 19).

Figure 16. Backhoe mechanically excavating a trench in Section M.

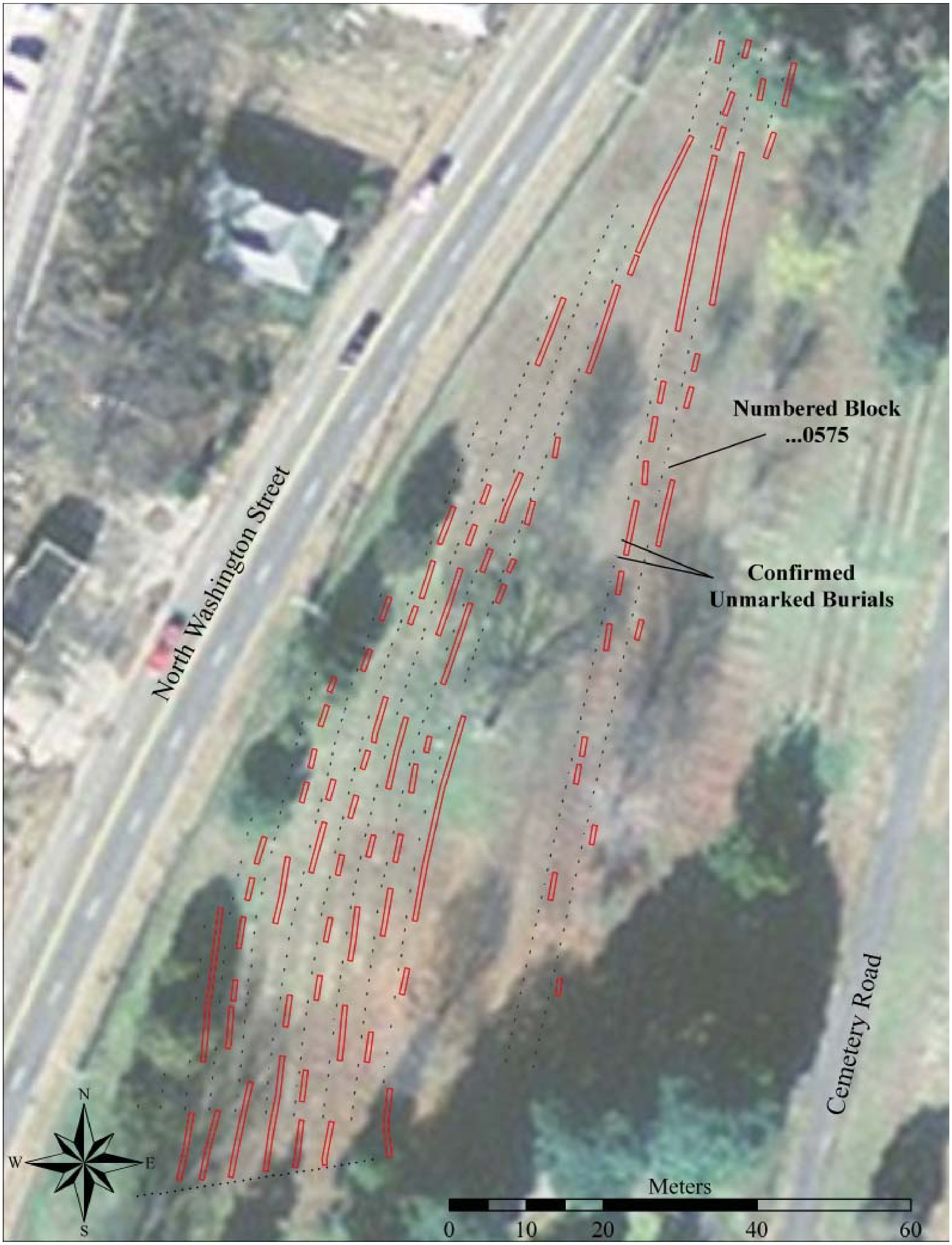

Figure 17. Trenching locations in Sections M and W.

Figure 18. Trench 32 in Section M. Note the clearly defined grave shafts, indicated by the lighter colored soils.

Figure 19. Location of apparent unmarked graves in Sections M and W. Red indicates the locations of unmarked grave shafts identified during trenching. The unmarked burials that were visually identified by VICK and the numbered block are also indicated.

CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

In August of 2010, while preparing a reserved burial plot for an impending interment, VICK encountered two unmarked burials within Section W of the national cemetery. Concerned that there may be additional heretofore unknown individuals buried within the cemetery, the park contacted the Army Corps of Engineers ERDC to assist with determining the extent of the problem. The ERDC conducted a preliminary GPR survey of two Sections within the cemetery and identified 62 possible unmarked burials within Sections M and W.

The following December, VICK requested SEAC's assistance in determining the extent of the unmarked burials within Sections M, MUU, V, W, and X. In January of 2011, SEAC began a multi-pronged approach to solving the problem. The project began with a systematic GPR survey of all five sections using a 400 MHz antenna, supplemented by a partial survey of Section M utilizing a 270 MHz antenna. Unfortunately the results of the GPR survey were less than satisfactory given the ultimate goals of the project, and it was determined that subsurface investigations would be warranted.

Building upon the results of the GPR survey, SEAC conducted a systematic probe testing survey in an attempt to refine the findings. More than 500 probe tests were conducted, 46 percent of which were positive for some sort of obstruction. The probe testing appeared to work well in Sections MUU, V, and X, but produced problematic results in Sections M and W due to soil conditions. It was therefore determined that as a final step, mechanical scraping would be conducted in Sections M and W.

SEAC returned to VICK in June of 2011 to conduct the final part of the investigations. The mechanical scraping proved to be the most definitive means for identifying the unmarked burials (barring excavating down to the top of the coffin). Eighty-three trenches were excavated in Sections M and W, uncovering 10 previously unidentified burials: one in Section W and nine in Section M.

In all, 13 unmarked burials have been identified at the Vicksburg National Cemetery (nine in Section M and four in Section W). Two of these were initially identified by the park and were confirmed visually; 10 were encountered during the mechanical scraping and were identified by the presence of a grave shaft; and finally the last one is represented by a small, square cement marker that has identifying numbers on it. The last four digits on the block are 0575; the first portion of this identifying marker has been obliterated. Although this last one has not been confirmed, either by the presence of a grave shaft, or through visual inspection of a coffin, it is recommended that the park treat this as an unidentified burial.

APPENDICES

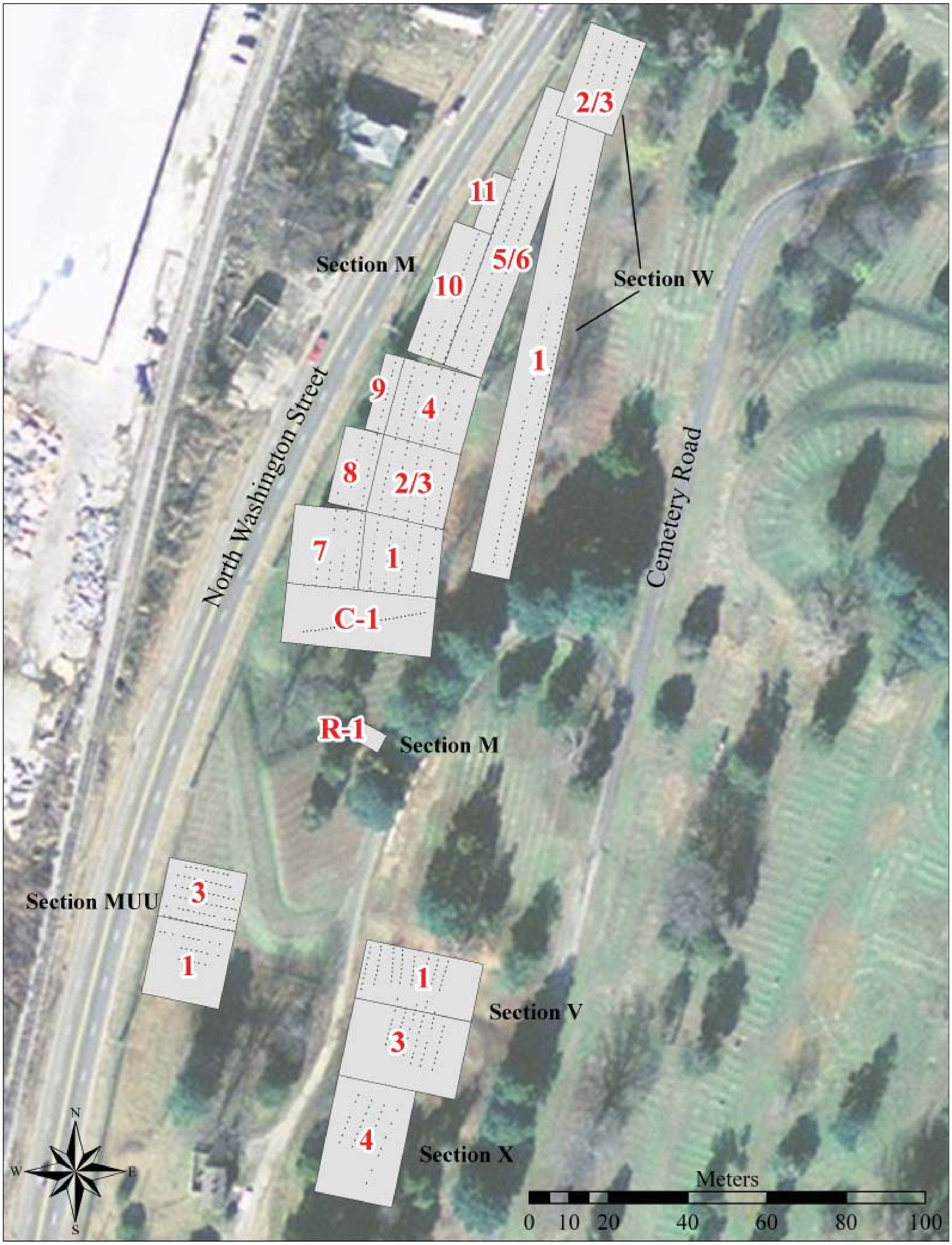

Figure 20. Location of Grids using 400 MHz antenna configuration.

Figure 21. Combined processed GPR results using the 400 MHz antenna configuration from between approximately 7 and 41 cmbs.
The bright orange represent high amplitude reflections. The dark teal areas in Sections M, V, and X represent areas of no data-collection. (Note that Grid C-1 in Section M will remain pictured at a depth of 41 cmbs throughout this appendix due to an error in data collection).

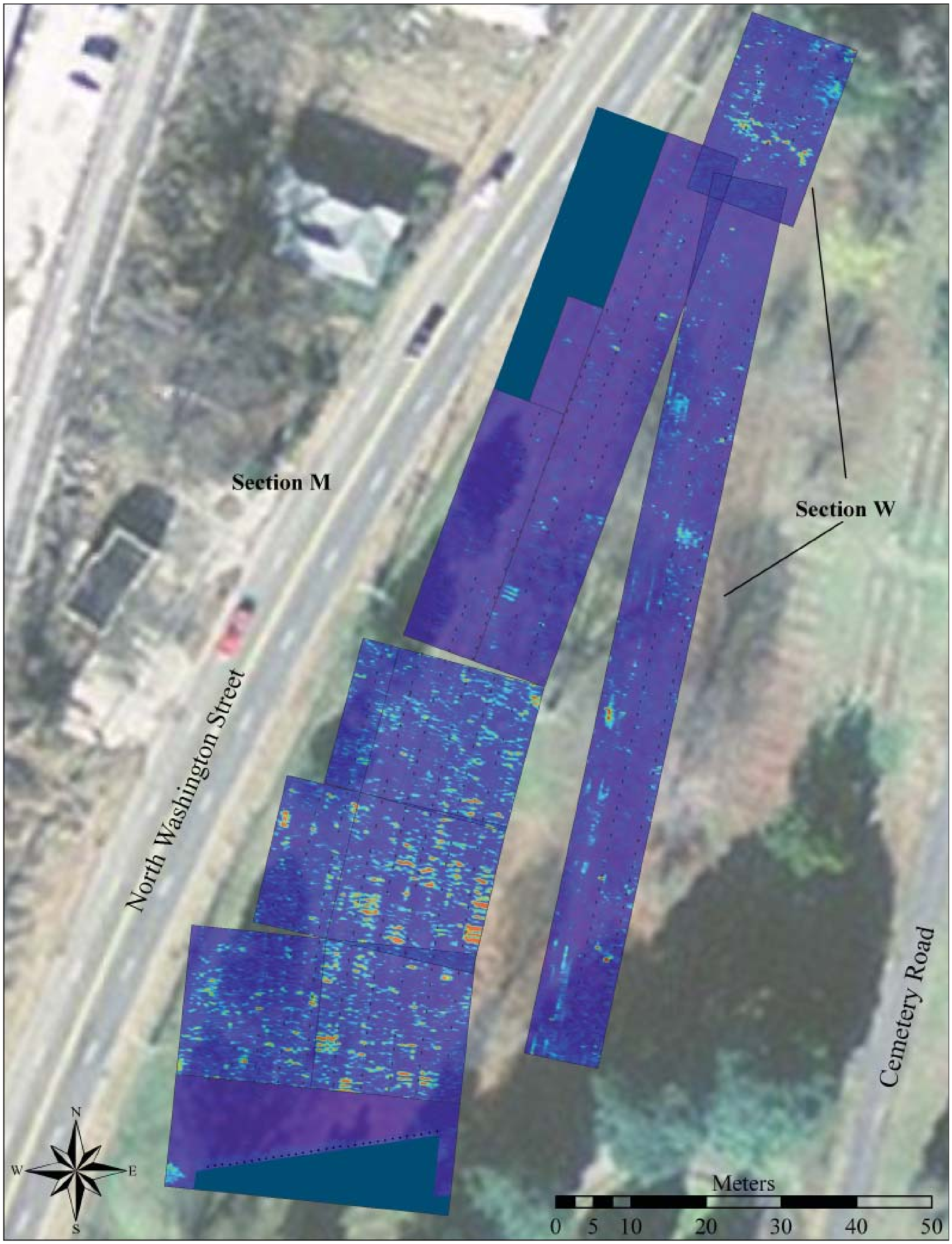

Figure 22. Combined processed GPR results of Sections M & W using the 400 MHz antenna configuration from between approximately 7 and 41 cmbs.
The dark teal areas in Section M represent areas of no-data collection. In Section M Grids 1, 2/3, 7, and 8 are at approximately 14 cmbs; 4 and 9 are at approximately 15 cmbs; 5, 10, and 11 are at approximately 7 cmbs; and C-1 is at approximately 41 cmbs. In Section W Grid 1 is illustrated at approximately 12 cmbs, while Grid 2 is illustrated at approximately 32 cmbs.

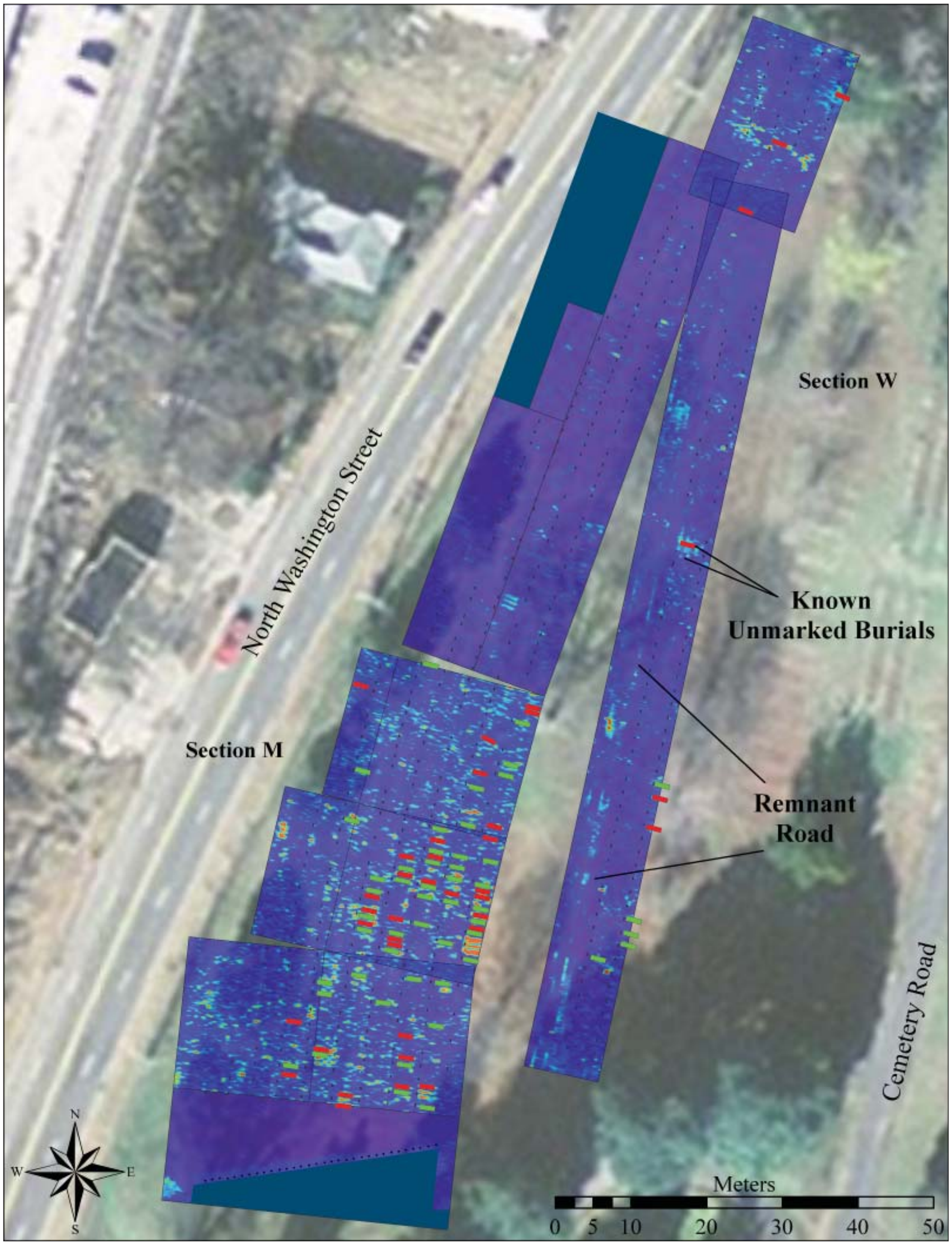

Figure 23. Anomalies identified as potential burials that are observable at a depth of no greater than 32 cmbs overlaid on the Figure 22 graphic.
Green represents anomalies at marked graves and red represents anomalies at unmarked locations. The dark teal areas in Section M represent areas of no-data collection. In Section M Grids 1, 2/3, 7, and 8 are at approximately 14 cmbs; 4 and 9 are at approximately 15 cmbs; 5, 10, and 11 are at approximately 7 cmbs; and C-1 is at approximately 41 cmbs. In Section W Grid 1 is illustrated at approximately 12 cmbs, while Grid 2 is illustrated at approximately 32 cmbs.

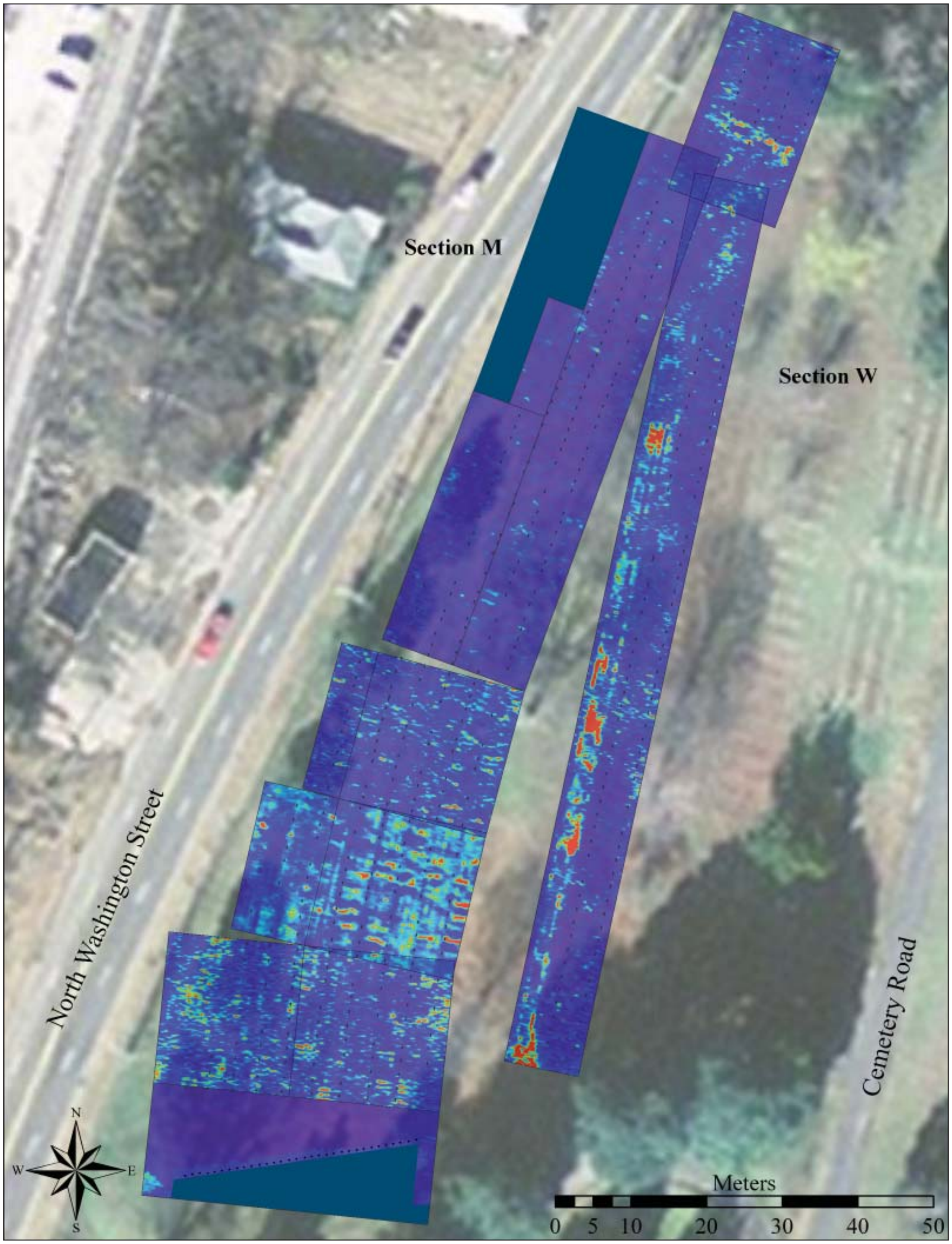

Figure 24. Close-up of combined processed GPR results using the 400 MHz antenna configuration from between approximately 19 and 44 cmbs in Sections M and W.
The dark teal areas in Section M represent areas of no-data collection. In Section M Grids 1 and 7 are at approximately 25 cmbs; 2/3 and 8 are at approximately 19 cmbs; 4 and 9 are at approximately 24 cmbs; and 5, 10, and 11 are at approximately 33 cmbs; C-1 is at approximately 41 cmbs. In Section W Grid 1 is illustrated at approximately 44 cmbs, while Grid 2 is illustrated at approximately 49 cmbs.

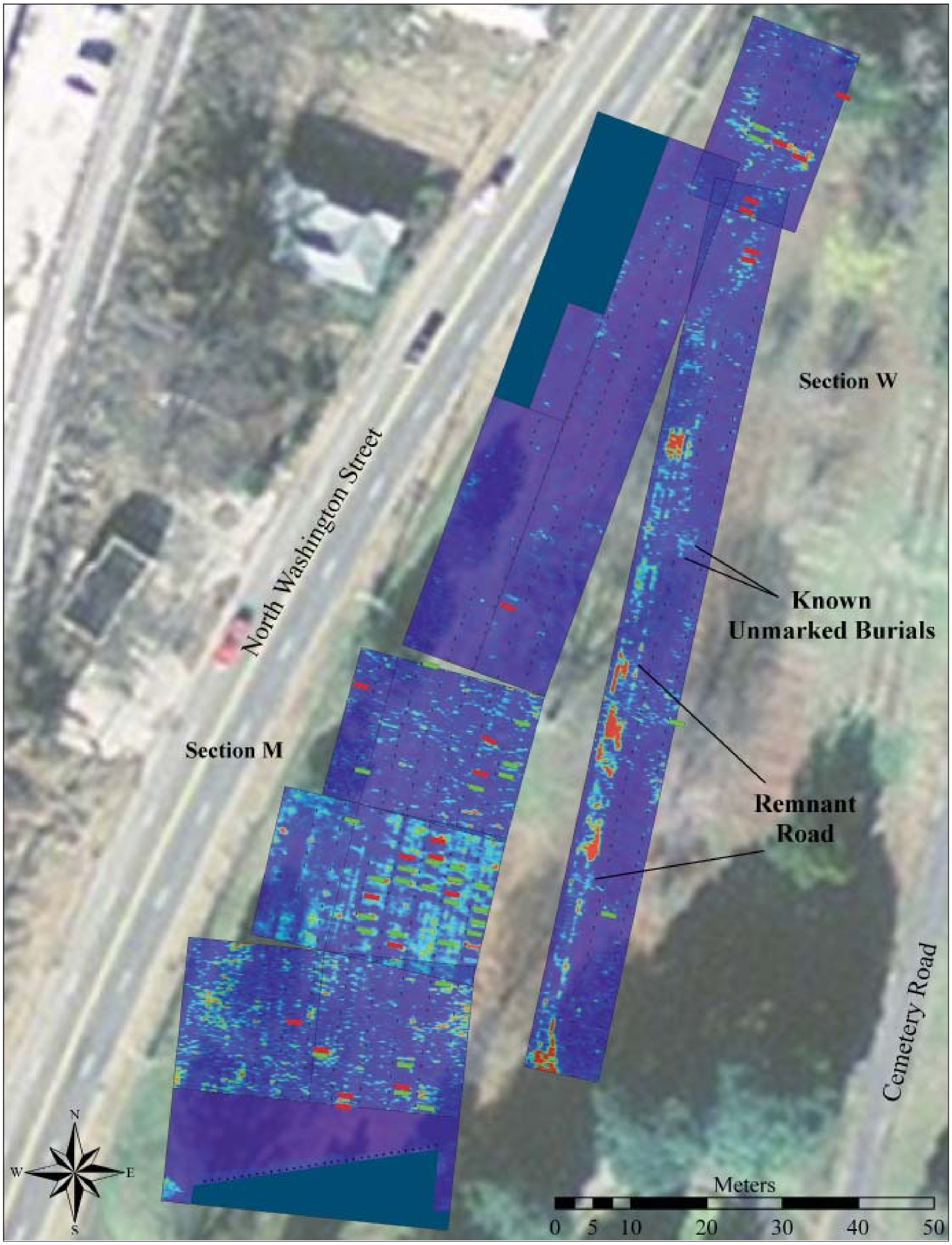

Figure 25. Anomalies identified as potential burials that are observable at a maximum depth of between 19 and 49 cmbs, overlaid on the Figure 24 graphic
Green represents anomalies at marked graves and red represents anomalies at unmarked locations. The dark teal areas in Section M represent areas of no-data collection. In Section M Grids 1 and 7 are at approximately 25 cmbs; 2/3 and 8 are at approximately 19 cmbs; 4 and 9 are at approximately 24 cmbs; and 5, 10, and 11 are at approximately 33 cmbs; C-1 is at approximately 41 cmbs. In Section W Grid 1 is illustrated at approximately 44 cmbs, while Grid 2 is illustrated at approximately 49 cmbs.

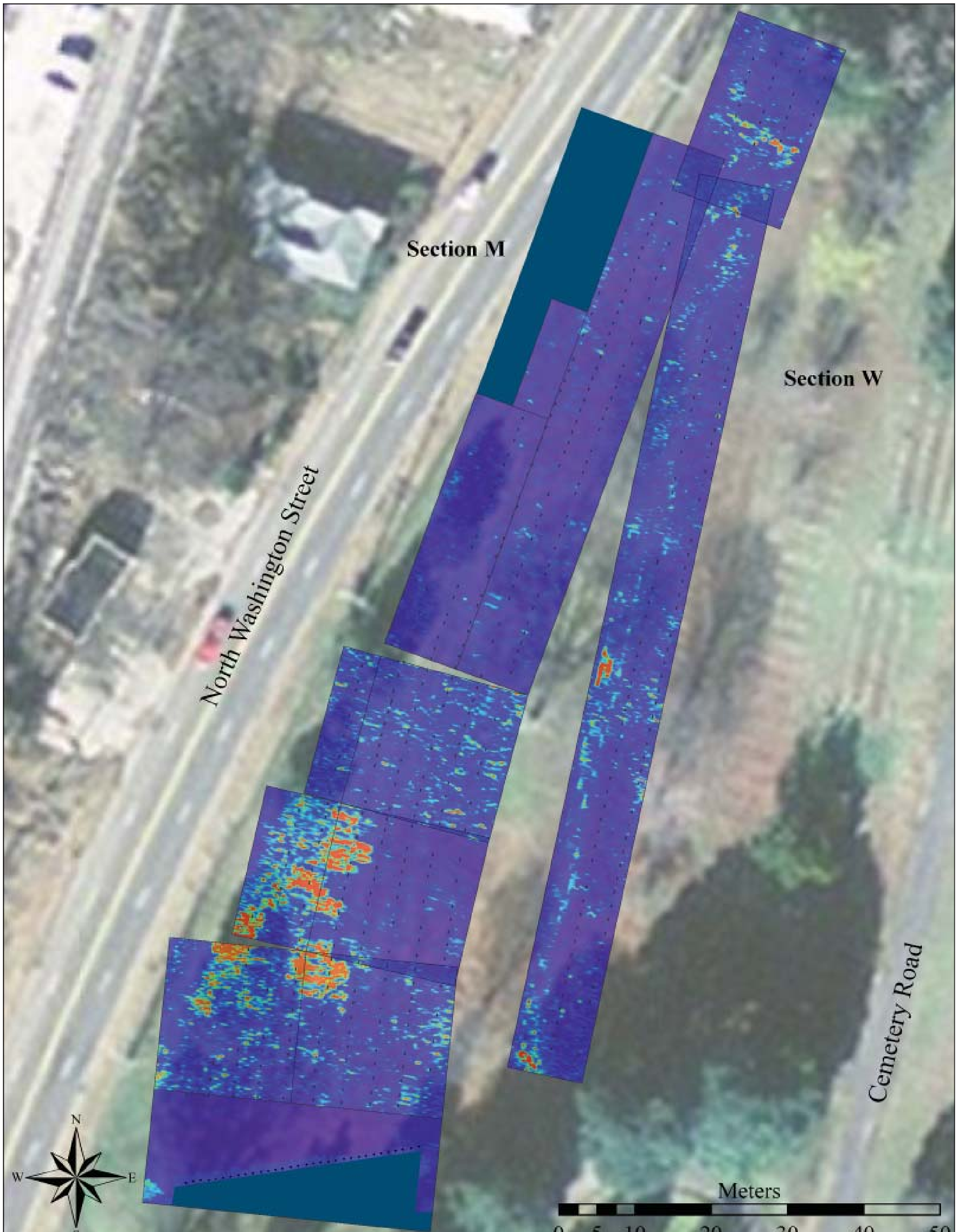

Figure 26. Combined processed GPR results using the 400 MHz antenna configuration from between 24 and 58 cmbs in Sections M and W.
The dark teal areas in Section M represent areas of no-data collection. In Section M Grids 1, 2/3, 7, and 8 are at approximately 54 cmbs; 4 and 9 are at approximately 24 cmbs; 5, 10, and 11 are illustrated at approximately 33 cmbs; and C-1 is at approximately 41 cmbs. In Section W Grid 1 is illustrated at approximately 54 cmbs, and Grid 2 is at approximately 58 cmbs.

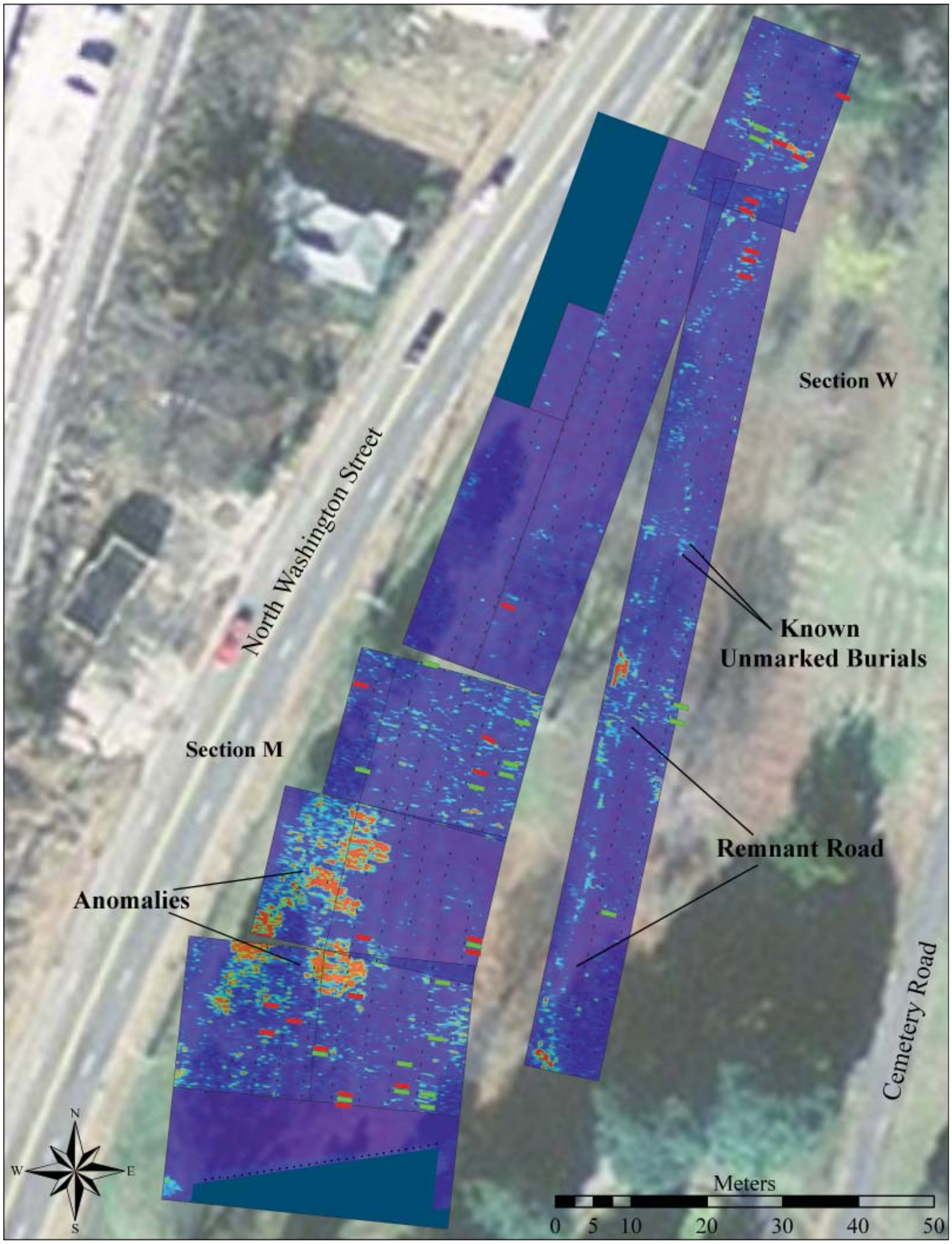

Figure 27. Anomalies identified as potential burials that are observable at a maximum depth of between 24 and 58 cmbs, overlaid on the Figure 26 graphic.
Green represents anomalies at marked graves and red represents anomalies at unmarked locations. The dark teal areas in Section M represent areas of no-data collection. In Section M Grids 1, 2/3, 7, and 8 are at approximately 54 cmbs; 4 and 9 are at approximately 24 cmbs; 5, 10, and 11 are illustrated at approximately 33 cmbs; and C-1 is at approximately 41 cmbs. In Section W Grid 1 is illustrated at approximately 54 cmbs, and Grid 2 is at approximately 58 cmbs.

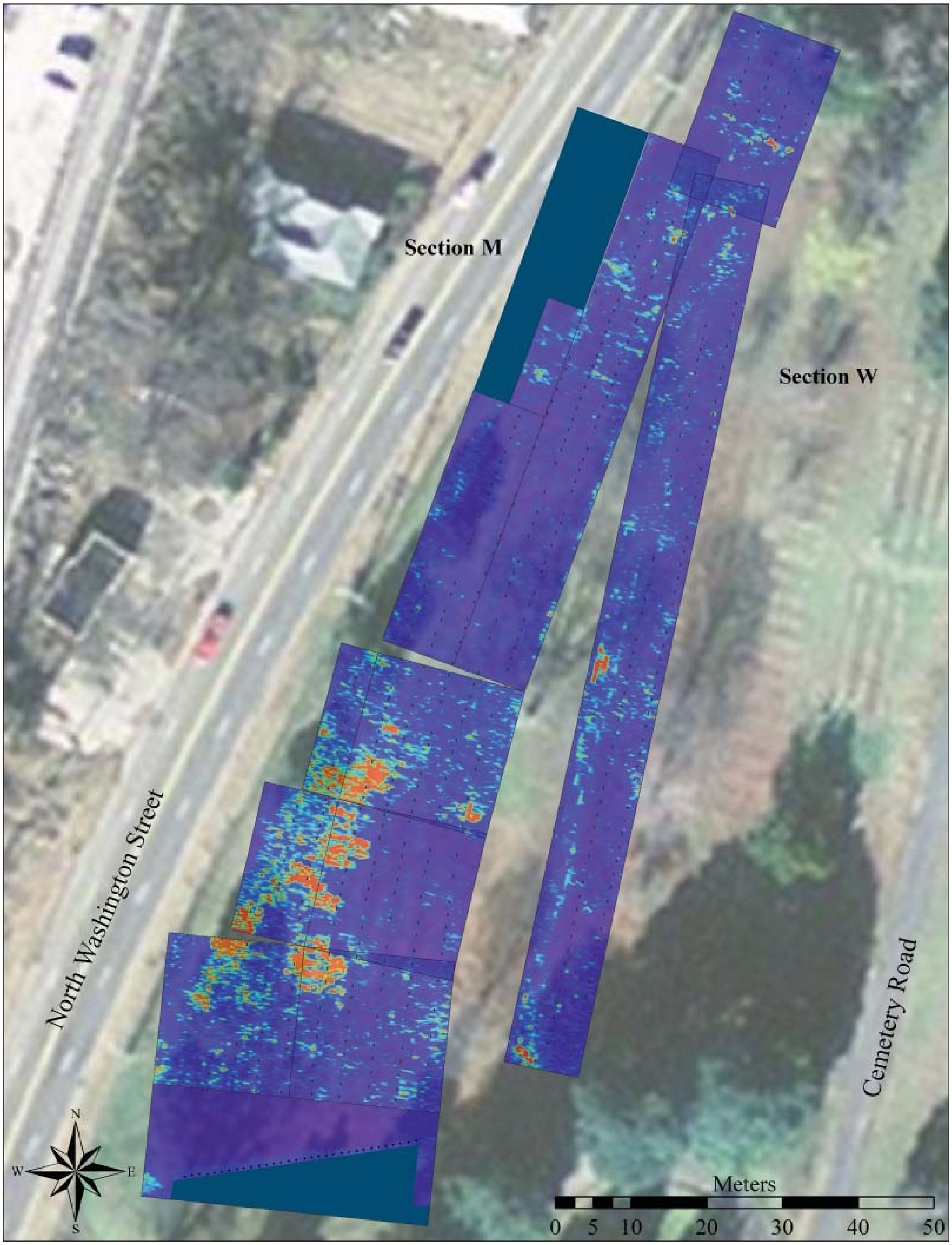

Figure 28. Combined processed GPR results using the 400 MHz antenna configuration from between 54 and 80 cmbs in Sections M and W.

The dark teal areas in Section M represent areas of no-data collection. In Section M Grids 1, 2/3, 7, and 8 are at approximately 54 cmbs; 4 and 9 are at approximately 78 cmbs; 5, 10, and 11 are at approximately 80 cmbs; and C-1 is at approximately 41 cmbs. In Section W Grid 1 is illustrated at approximately 54 cmbs, while Grid 2 is illustrated at approximately 71 cmbs.

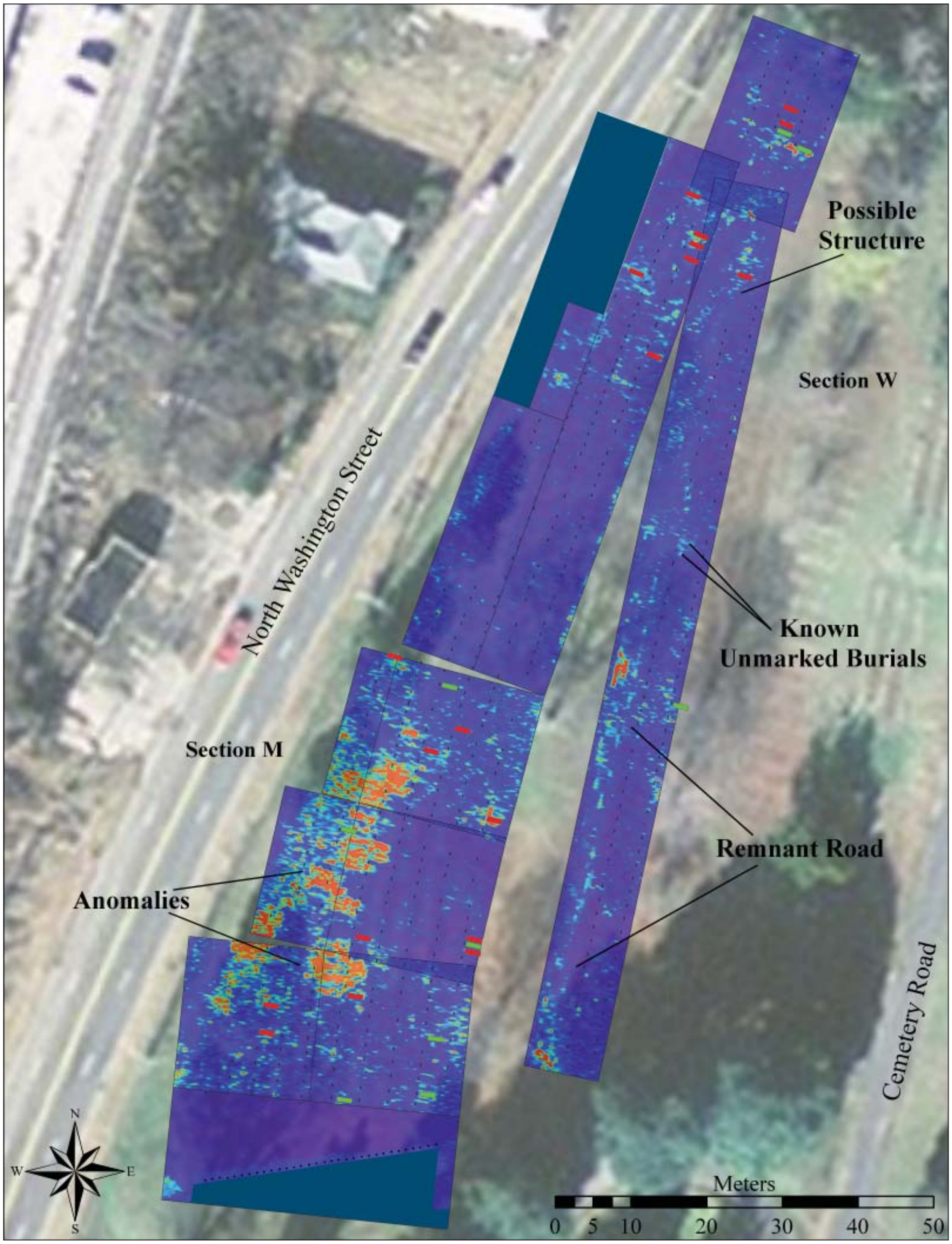

Figure 29. Anomalies identified as potential burials that are observable at a maximum depth of between 54 and 80 cmbs, overlaid on the Figure 28 graphic.

Green represents anomalies at marked graves and red represents anomalies at unmarked locations. The dark teal areas in Section M represent areas of no-data collection. In Section M Grids 1, 2/3, 7, and 8 are at approximately 54 cmbs; 4 and 9 are at approximately 78 cmbs; 5, 10, and 11 are at approximately 80 cmbs; and C-1 is at approximately 41 cmbs. In Section W Grid 1 is illustrated at approximately 54 cmbs, while Grid 2 is illustrated at approximately 71 cmbs.

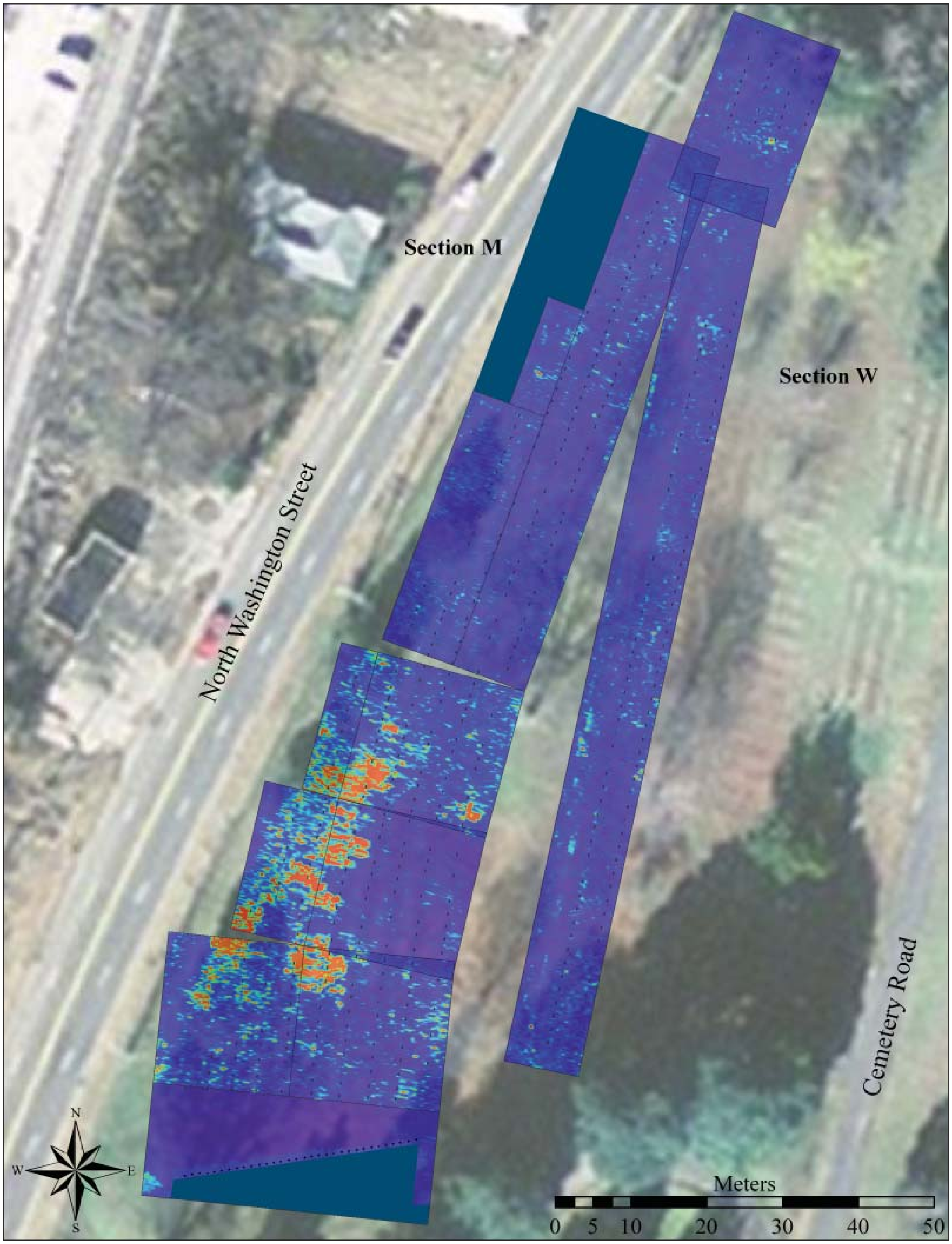

Figure 30. Combined processed GPR results using the 400 MHz antenna configuration from between 54 and 117 cmbs in Sections M and W.

The dark teal areas in Section M represent areas of no-data collection. In Section M Grids 1, 2/3, 7, and 8 are at approximately 54 cmbs; 4 and 9 are at approximately 78 cmbs; 5, 10, and 11 are at approximately 104 cmbs; and C-1 is at approximately 41 cmbs. In Section W Grid 1 is illustrated at approximately 117 cmbs, while Grid 2 is illustrated at approximately 110 cmbs.

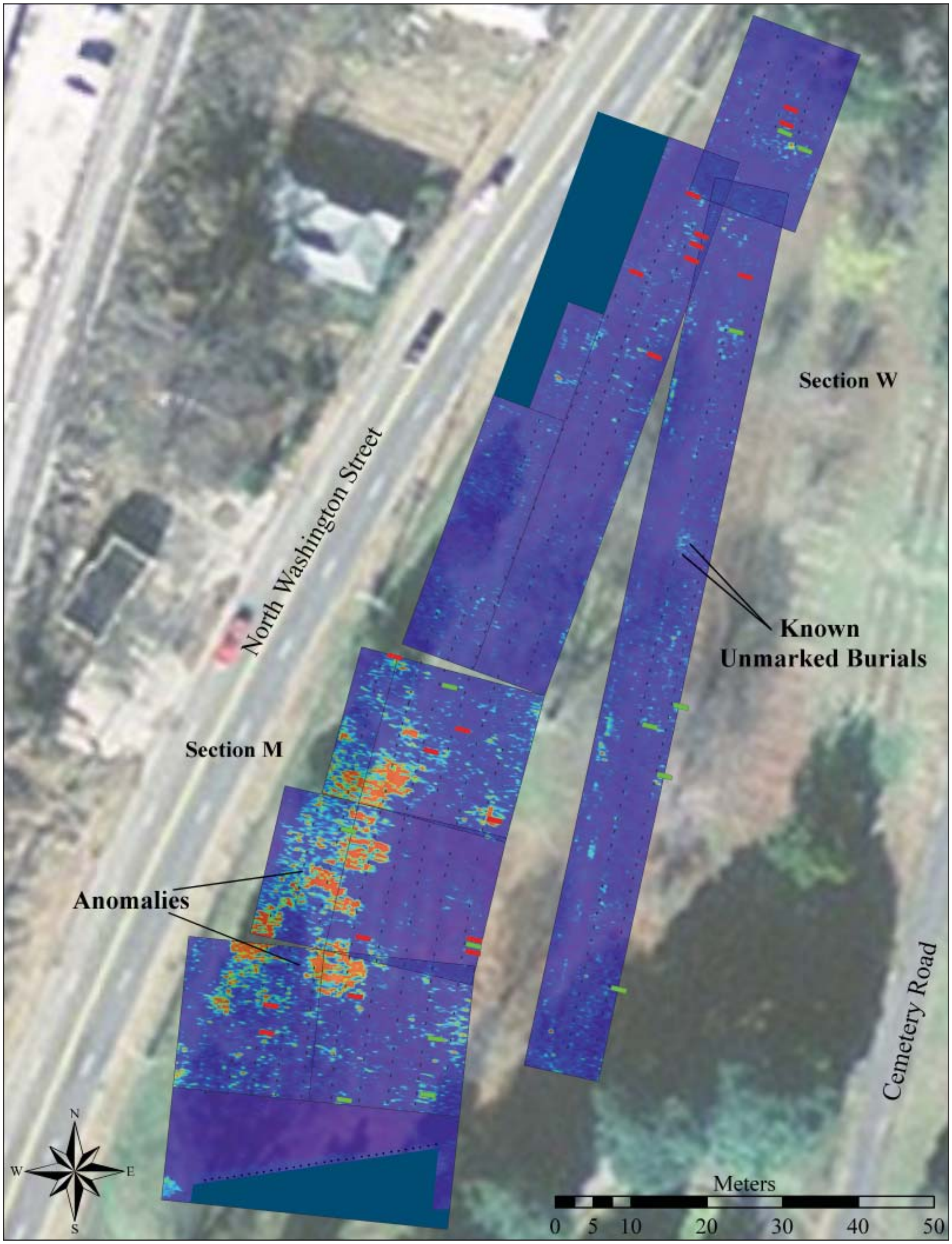

Figure 31. Anomalies identified as potential burials that are observable at a maximum depth of between 54 and 114 cmbs, overlaid on the Figure 30 graphic.

Green represents anomalies at marked graves and red represents anomalies at unmarked locations. The dark teal areas in Section M represent areas of no-data collection. In Section M Grids 1, 2/3, 7, and 8 are at approximately 54 cmbs; 4 and 9 are at approximately 78 cmbs; 5, 10, and 11 are at approximately 104 cmbs; and C-1 is at approximately 41 cmbs. In Section W Grid 1 is illustrated at approximately 117 cmbs, while Grid 2 is illustrated at approximately 110 cmbs.

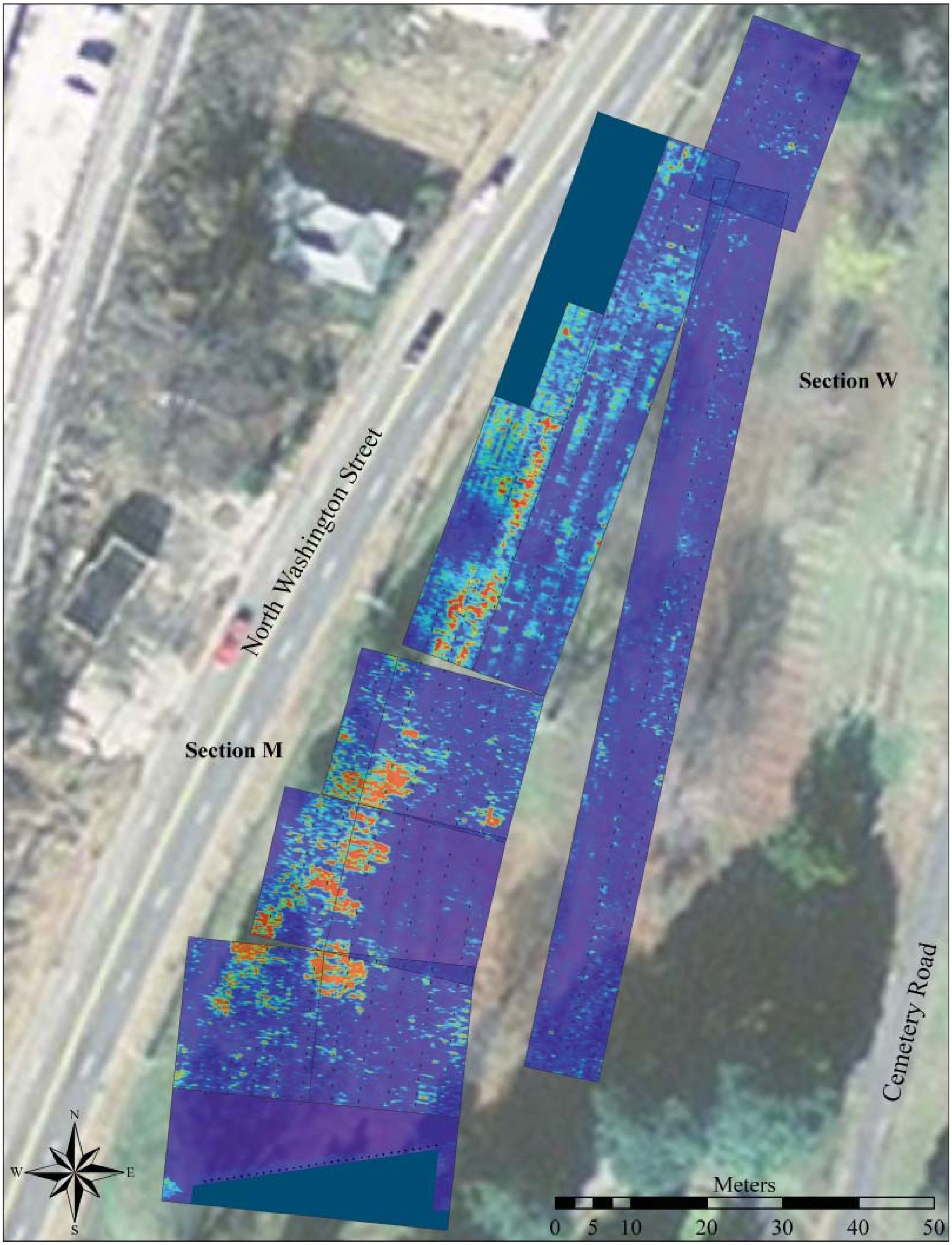

Figure 32. Combined processed GPR results using the 400 MHz antenna configuration from between 54 and 136 cmbs in Sections M and W.
The dark teal areas in Section M represent areas of no-data collection. In Section M Grids 1, 2/3, 7, and 8 are at approximately 54 cmbs; 4 and 9 are at approximately 78 cmbs; 5, 10, and 11 are at approximately 138 cmbs; and C-1 is at approximately 41 cmbs. In Section W Grid 1 is illustrated at approximately 136 cmbs, while Grid 2 is illustrated at approximately 125 cmbs.

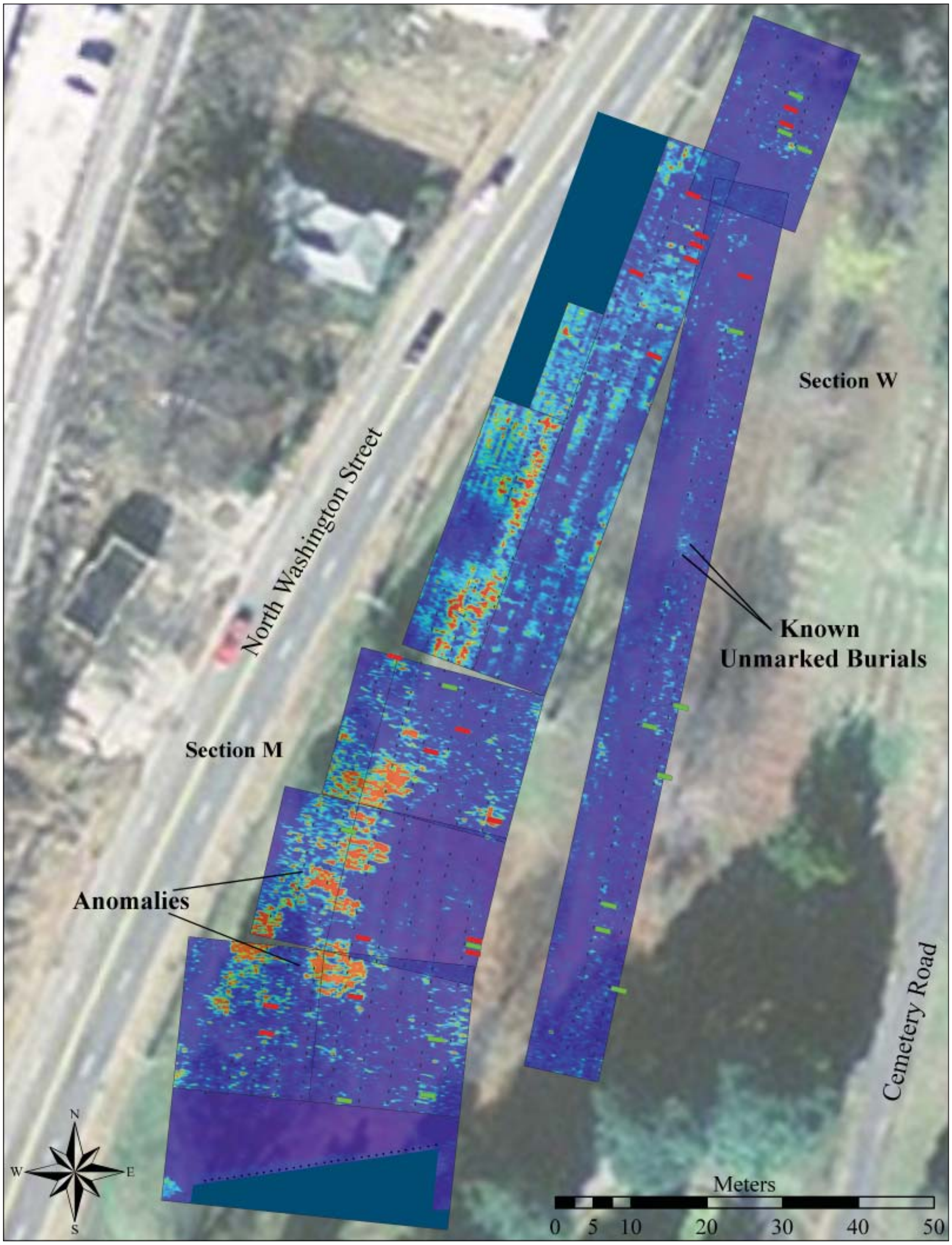

Figure 33. Anomalies identified as potential burials that are observable at a maximum depth of between 54 and 136 cmbs, overlaid on the Figure 32 graphic.
Green represents anomalies at marked graves and red represents anomalies at unmarked locations. The dark teal areas in Section M represent areas of no-data collection. In Section M Grids 1, 2/3, 7, and 8 are at approximately 54 cmbs; 4 and 9 are at approximately 78 cmbs; 5, 10, and 11 are at approximately 138 cmbs; and C-1 is at approximately 41 cmbs. In Section W Grid 1 is illustrated at approximately 136 cmbs, while Grid 2 is illustrated at approximately 125 cmbs.

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Figure 34. Location of GPR grids using the 270 MHz antenna configuration.

Figure 35. Combined processed GPR results using the 270 MHz antenna configuration from between 58 and 103 cmbs in Section M .
Grids 1 and 5 are illustrated at approximately 72 cmbs; Grid 2 is at approximately 58 cmbs; Grid 3 is at approximately 103 cmbs; and Grid 4 is at approximately 84 cmbs.

Figure 36. Anomalies identified as potential burials that are observable at a maximum depth of between 58 and 103 cmbs, overlaid on the Figure 35 graphic.
Green represents anomalies at marked graves and red represents anomalies at unmarked locations. Grids 1 and 5 are illustrated at approximately 72 cmbs; Grid 2 is at approximately 58 cmbs; Grid 3 is at approximately 103 cmbs; and Grid 4 is at approximately 84 cmbs.

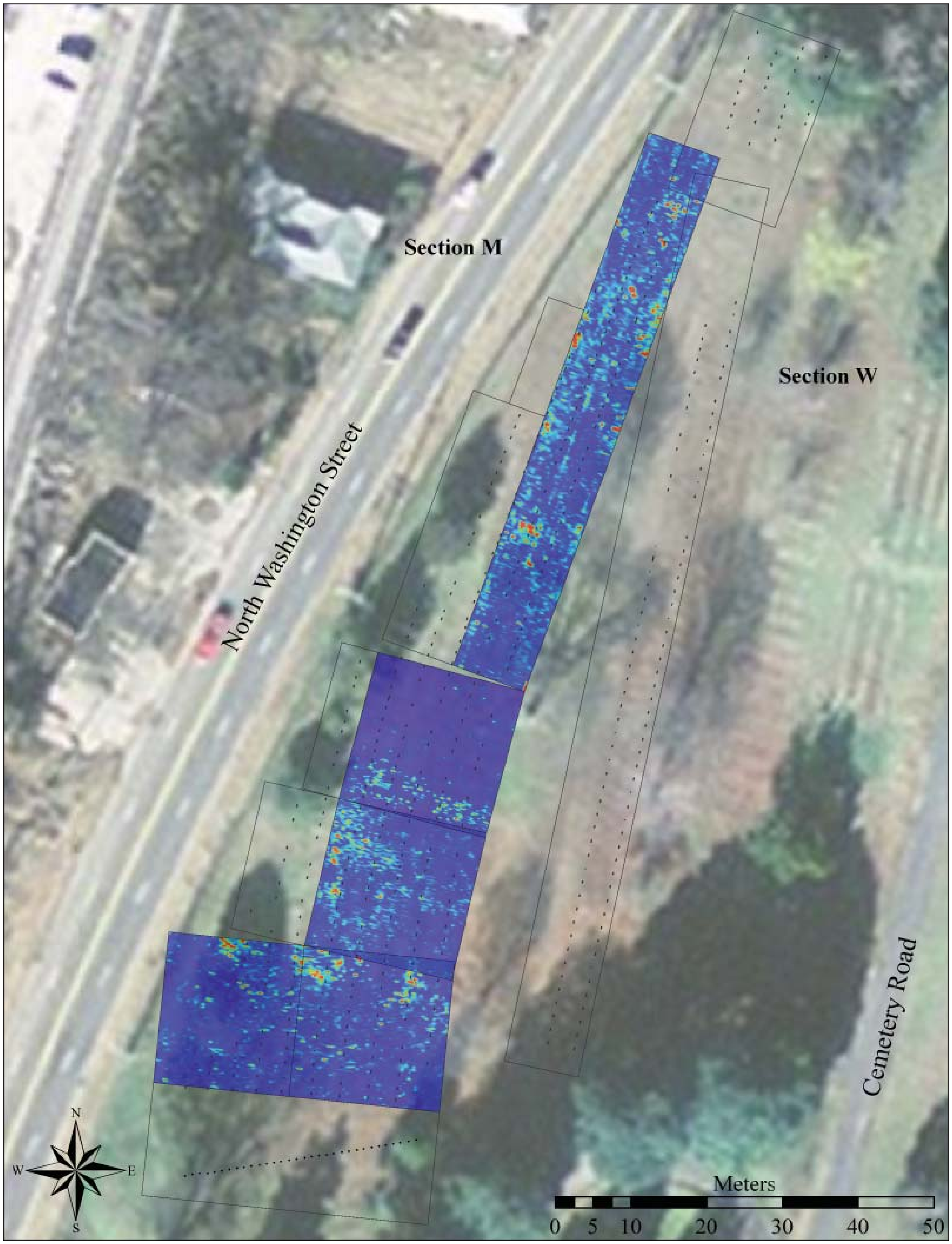

Figure 37. Combined processed GPR results using the 270 MHz antenna configuration from between 88 and 122 cmbs in Section M .
Grids 1 and 5 are illustrated at approximately 88 cmbs; Grid 2 is at approximately 122 cmbs; Grid 3 is at approximately 103 cmbs; and Grid 4 is at approximately 104 cmbs.

Figure 38. Anomalies identified as potential burials that are observable at a maximum depth of between 88 and 122 cmbs, overlaid on the Figure 37 graphic.

Green represents anomalies at marked graves and red represents anomalies at unmarked locations. Grids 1 and 5 are illustrated at approximately 88 cmbs; Grid 2 is at approximately 122 cmbs; Grid 3 is at approximately 103 cmbs; and Grid 4 is at approximately 104 cmbs.

Figure 39. Combined processed GPR results using the 270 MHz antenna configuration from between 106 and 133 cmbs in Section M .
Grids 1, 2, and 5 are illustrated at approximately 122 cmbs; Grid 3 is at approximately 133 cmbs; and Grid 4 is at approximately 106 cmbs.

Figure 40. Anomalies identified as potential burials that are observable at a maximum depth of between 106 and 133 cmbs, overlaid on the Figure 39 graphic.

Green represents anomalies at marked graves and red represents anomalies at unmarked locations. Grids 1, 2, and 5 are illustrated at approximately 122 cmbs; Grid 3 is at approximately 133 cmbs; and Grid 4 is at approximately 106 cmbs.

Figure 41. Combined processed GPR results using the 270 MHz antenna configuration from between 122 and 197 cmbs in Section M .
Grids 1 and 5 are illustrated at approximately 139 cmbs; Grid 2 is illustrated at approximately 122 cmbs; Grid 3 is at approximately 146 cmbs; and Grid 4 is at approximately 197 cmbs.

Figure 42. Anomalies identified as potential burials that are observable at a maximum depth of between 122 and 197 cmbs, overlaid on the Figure 41 graphic.
Green represents anomalies at marked graves and red represents anomalies at unmarked locations. Grids 1 and 5 are illustrated at approximately 139 cmbs; Grid 2 is illustrated at approximately 122 cmbs; Grid 3 is at approximately 146 cmbs; and Grid 4 is at approximately 197 cmbs.

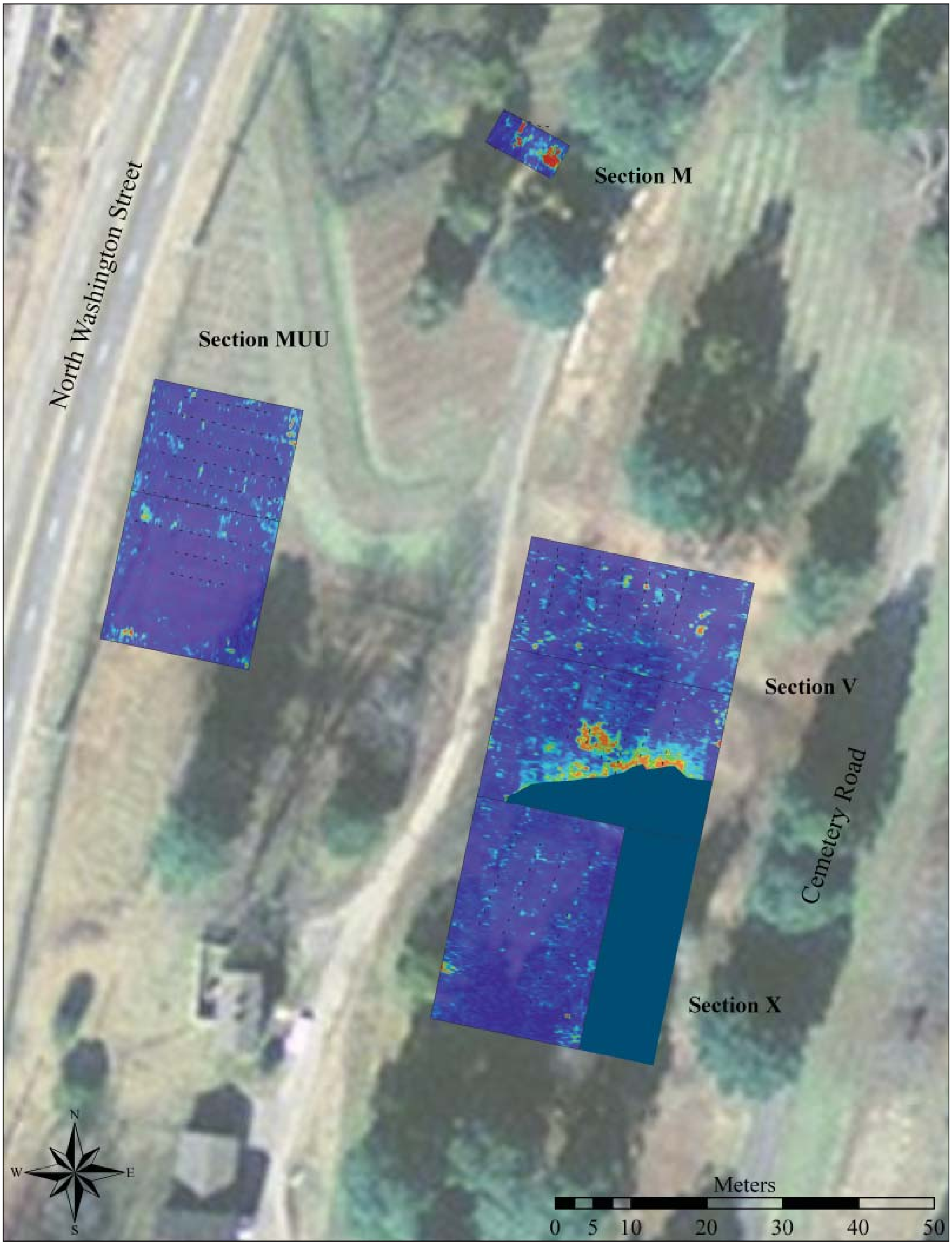

Figure 43. Combined processed GPR results using the 400 MHz antenna configuration from between 28 and 34 cmbs in Sections MUU, V, X, and M Grid R-1.
The dark teal areas in Sections V and X represent areas of no-data collection. Section M Grid R-1 is illustrated at approximately 34 cmbs; Section MUU is illustrated at approximately 28 cmbs; and Sections V and X are illustrated at approximately 32 cmbs.

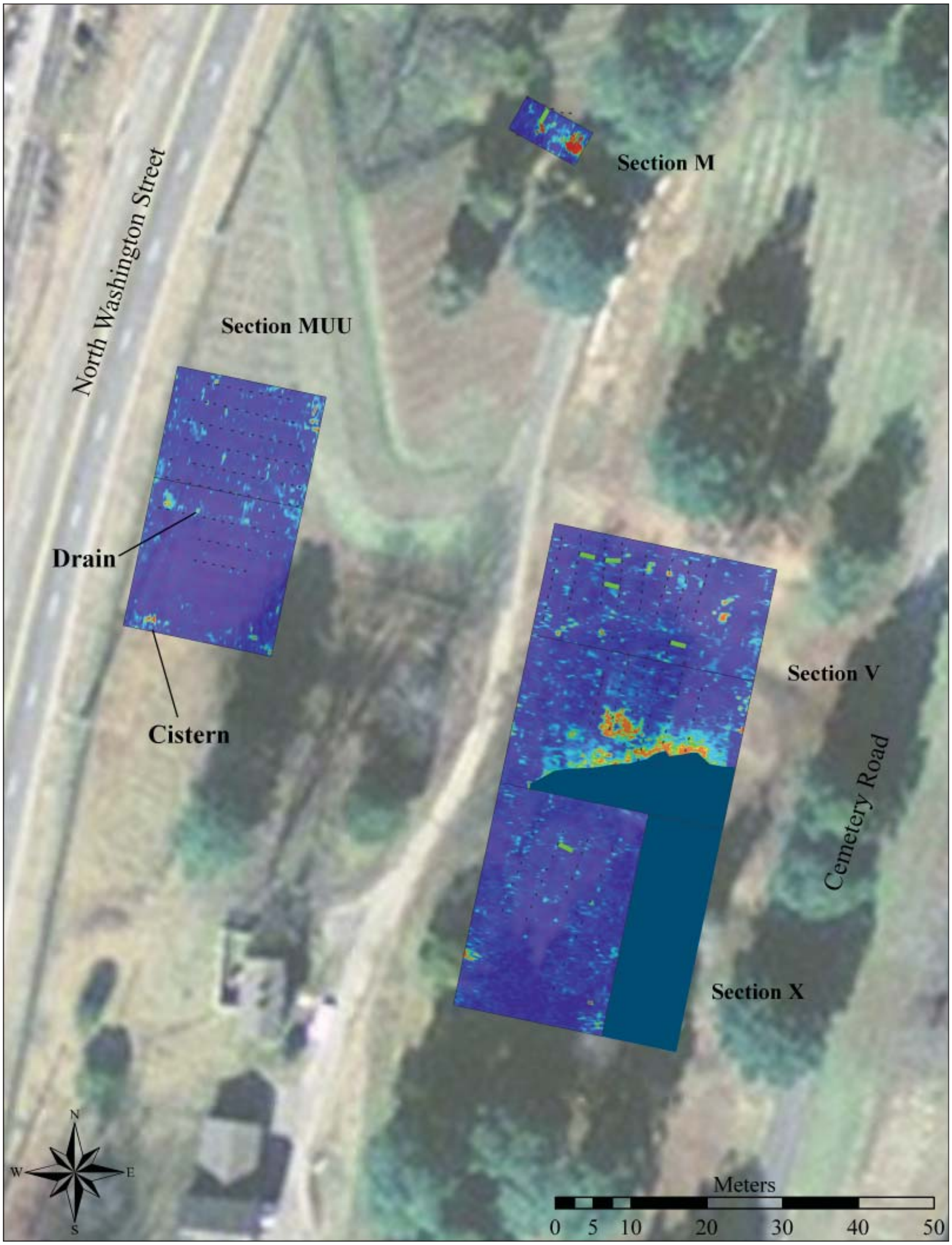

Figure 44. Anomalies identified as potential burials that are observable at a maximum depth of between 28 and 34 cmbs, overlaid on the Figure 43 graphic.

Green represents anomalies at marked graves and red represents anomalies at unmarked locations. The dark teal areas in Sections V and X represent areas of no-data collection. Section M Grid R-1 is illustrated at approximately 34 cmbs; Section MUU is illustrated at approximately 28 cmbs; and Sections V and X are illustrated at approximately 32 cmbs.

Figure 45. Combined processed GPR results using the 400 MHz antenna configuration from between 48 and 56 cmbs in Sections MUU, V, X, and M Grid R-1.
The dark teal areas in Sections V and X represent areas of no-data collection. Section M Grid R-1, and Sections V and X are illustrated at approximately 56 cmbs; and Section MUU is illustrated at approximately 48 cmbs.

Figure 46. Anomaly identified as a potential burial that is observable at a maximum depth of between 48 and 56 cmbs, overlaid on the Figure 45 graphic.
Red represents anomalies at unmarked locations. The dark teal areas in Sections V and X represent areas of no-data collection. Section M Grid R-1, and Sections V and X are illustrated at approximately 56 cmbs; and Section MUU is illustrated at approximately 48 cmbs.

Figure 47. Combined processed GPR results using the 400 MHz antenna configuration at approximately 80 cmbs in Sections MUU, V, X, and M Grid R-1.
The dark teal areas in Sections V and X represent areas of no-data collection. Section M Grid R-1 is illustrated at approximately 81 cmbs; and Sections MUU, V and X are illustrated at approximately 80 cmbs.

Figure 48. Anomalies identified as potential burials that are observable at a maximum depth of between 80 and 81 cmbs, overlaid on the Figure 47 graphic.
Green represents anomalies at marked graves. The dark teal areas in Sections V and X represent areas of no-data collection. Section M Grid R-1 is illustrated at approximately 81 cmbs; and Sections MUU, V and X are illustrated at approximately 80 cmbs.

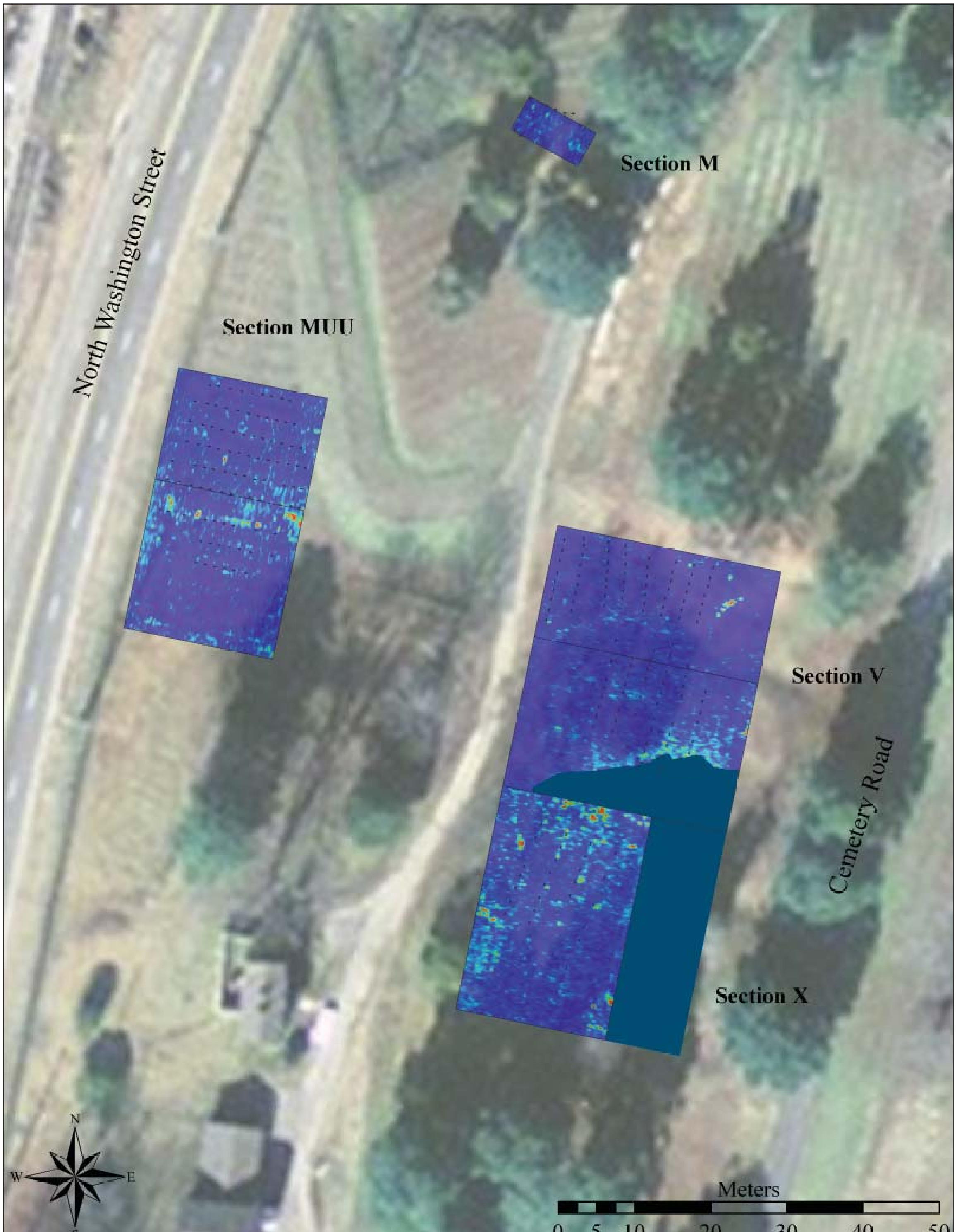

Figure 49. Combined processed GPR results using the 400 MHz antenna configuration from between 130 and 176 cmbs in Sections MUU, V, X, and M Grid R-1.
The dark teal areas in Sections V and X represent areas of no-data collection. Section M Grid R-1 is illustrated at approximately 164 cmbs; Section MUU is illustrated at approximately 176 cmbs; and Sections V and X are illustrated at approximately 130 cmbs.

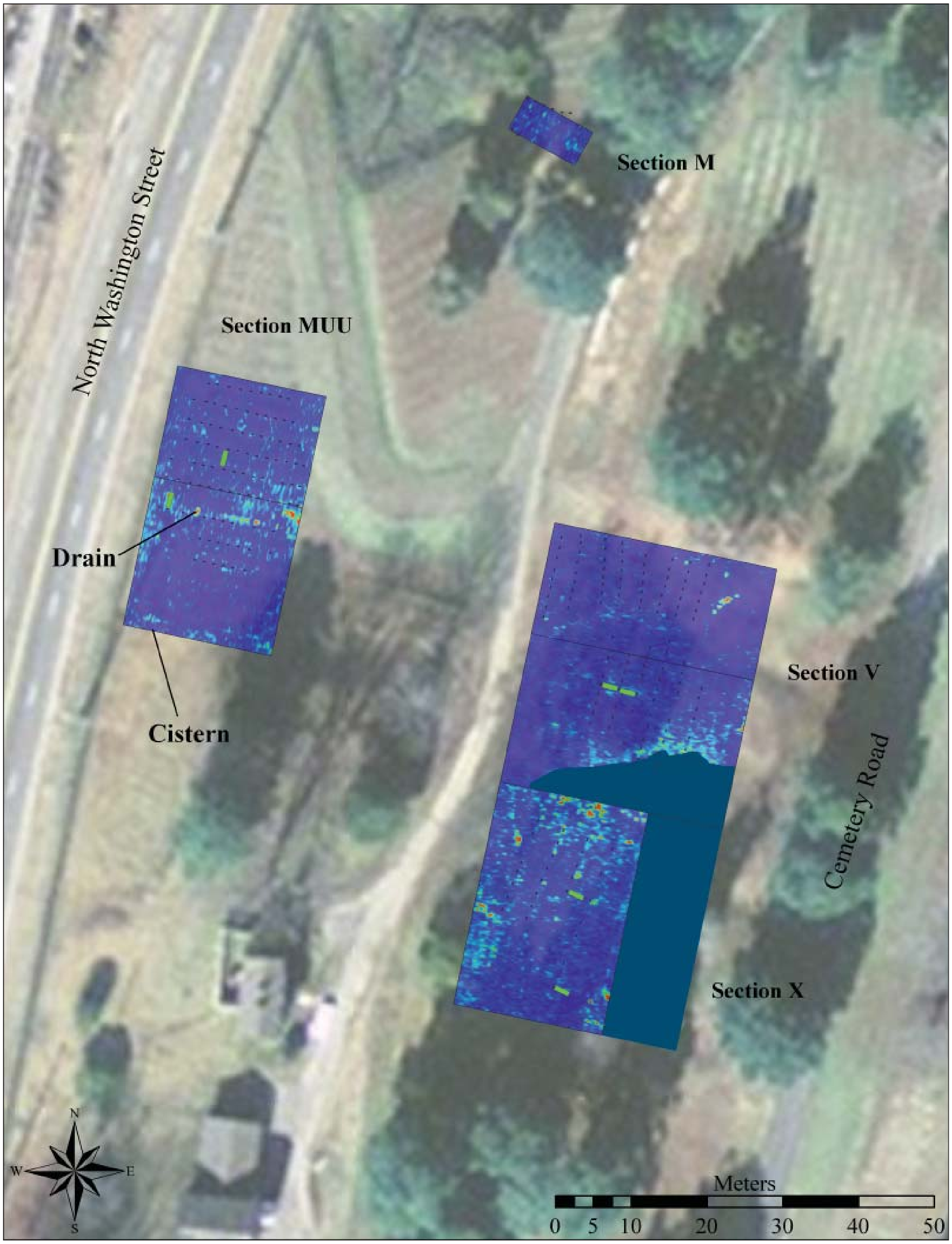

Figure 50. Anomalies identified as potential burials that are observable at a maximum depth of between 130 and 176 cmbs, overlaid on the Figure 49 graphic.
Green represents anomalies at marked graves. The dark teal areas in Sections V and X represent areas of no-data collection. Section M Grid R-1 is illustrated at approximately 164 cmbs; Section MUU is illustrated at approximately 176 cmbs; and Sections V and X are illustrated at approximately 130 cmbs.

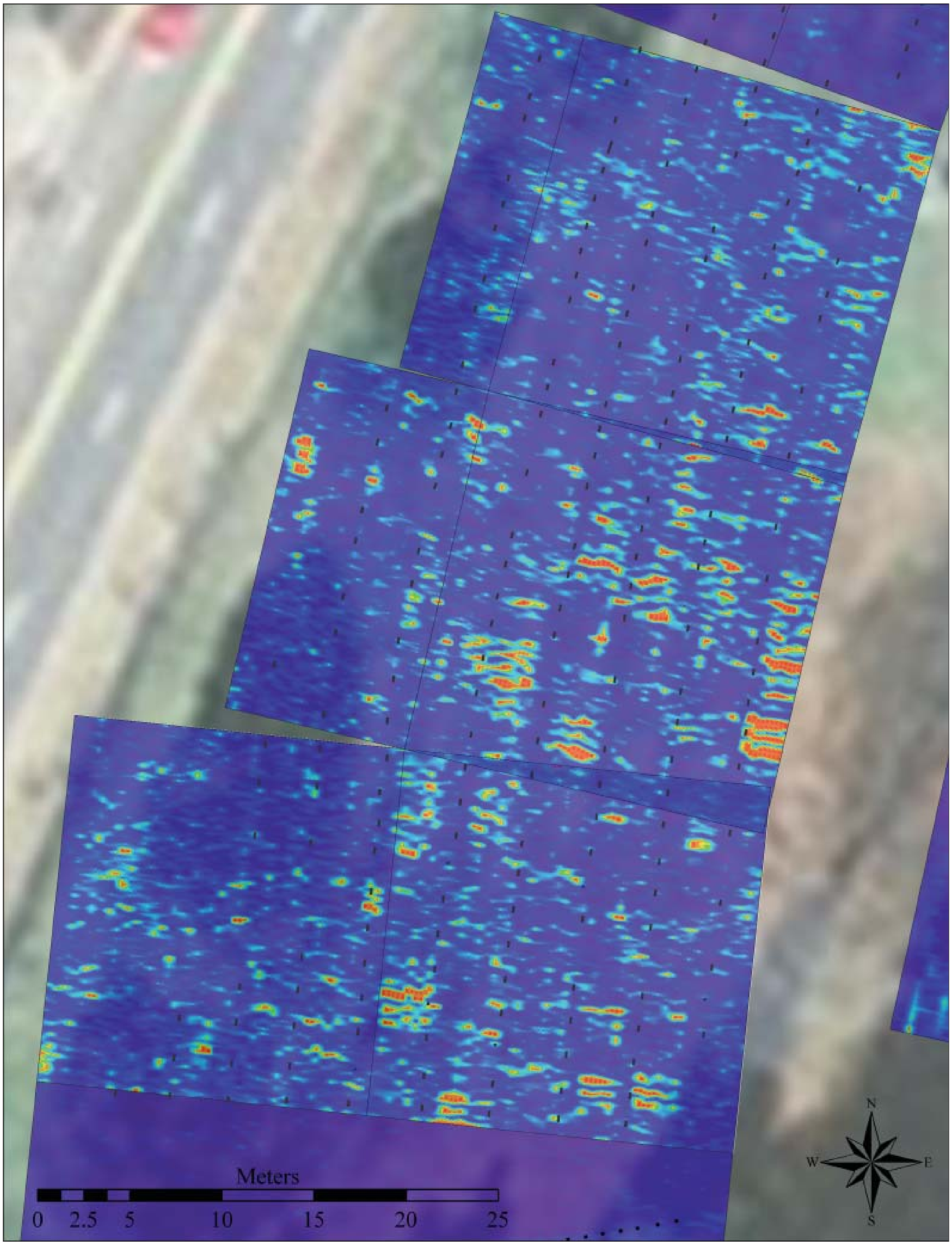

Figure 51. Closeup of near-surface GPR results from Grids 1, 2, 4, 7, 8, and 9 in Section M using the 400 MHz antenna.

The high amplitude orange linear reflections represent probable burial locations. Note the ringing multiples which are particularly evident in Grid 1, and along the eastern boundary of Grid 2. Grids 1, 2, 7, and 8 are illustrated at a depth of approximately 14 cmbs, and Grids 4 and 9 are illustrated at a depth of approximately 15 cmbs.

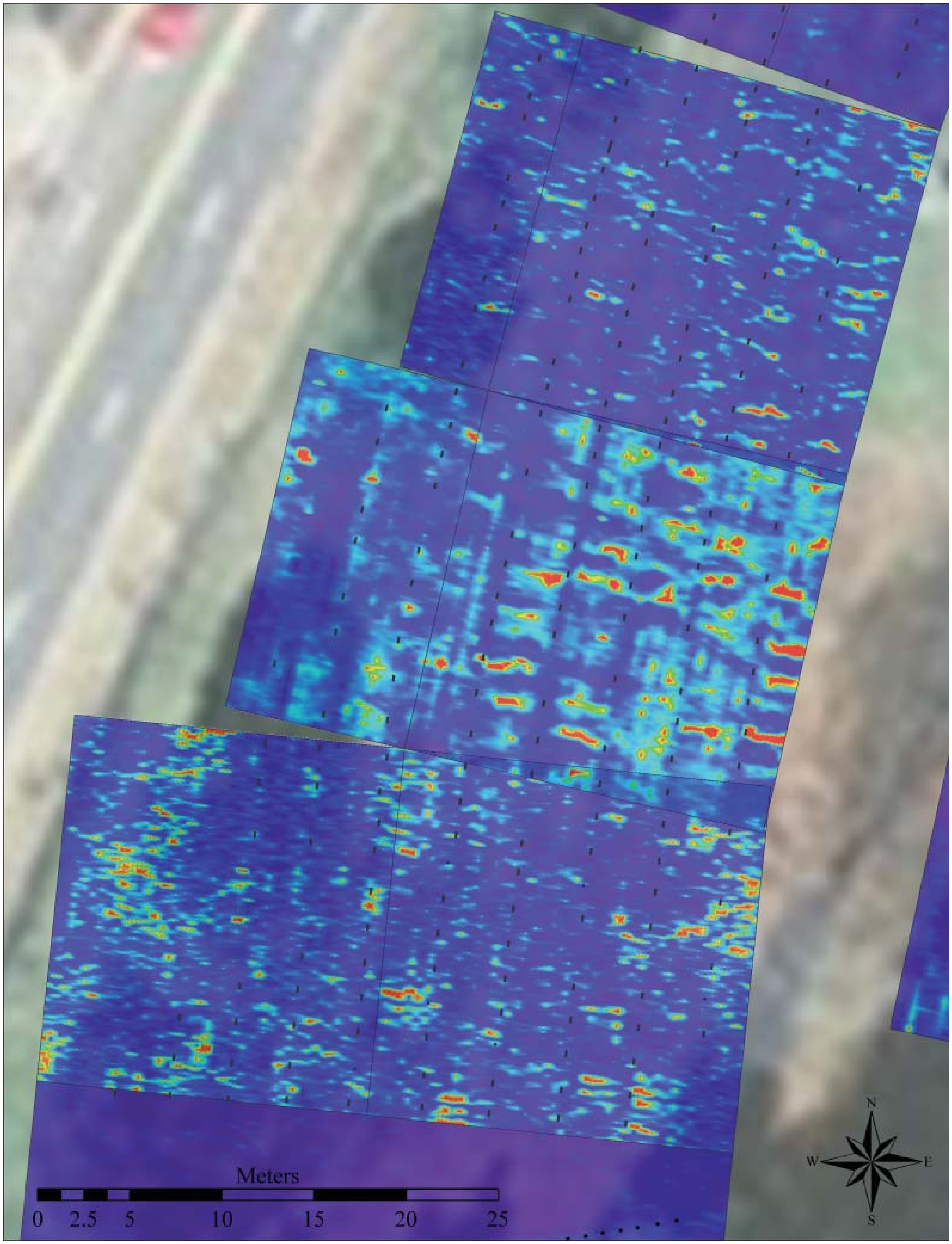

Figure 52. Closeup of GPR results from Grids 1, 2, 4, 7, 8, and 9 in Section M at between approximately 19 and 25 cmbs using the 400 MHz antenna.

The high amplitude orange linear reflections represent probable burial locations. Grids 1 and 7 are illustrated at a depth of approximately 25 cmbs, Grids 2 and 8 are illustrated at a depth of approximately 19 cmbs, and Grids 4 and 9 are illustrated at a depth of approximately 24 cmbs.

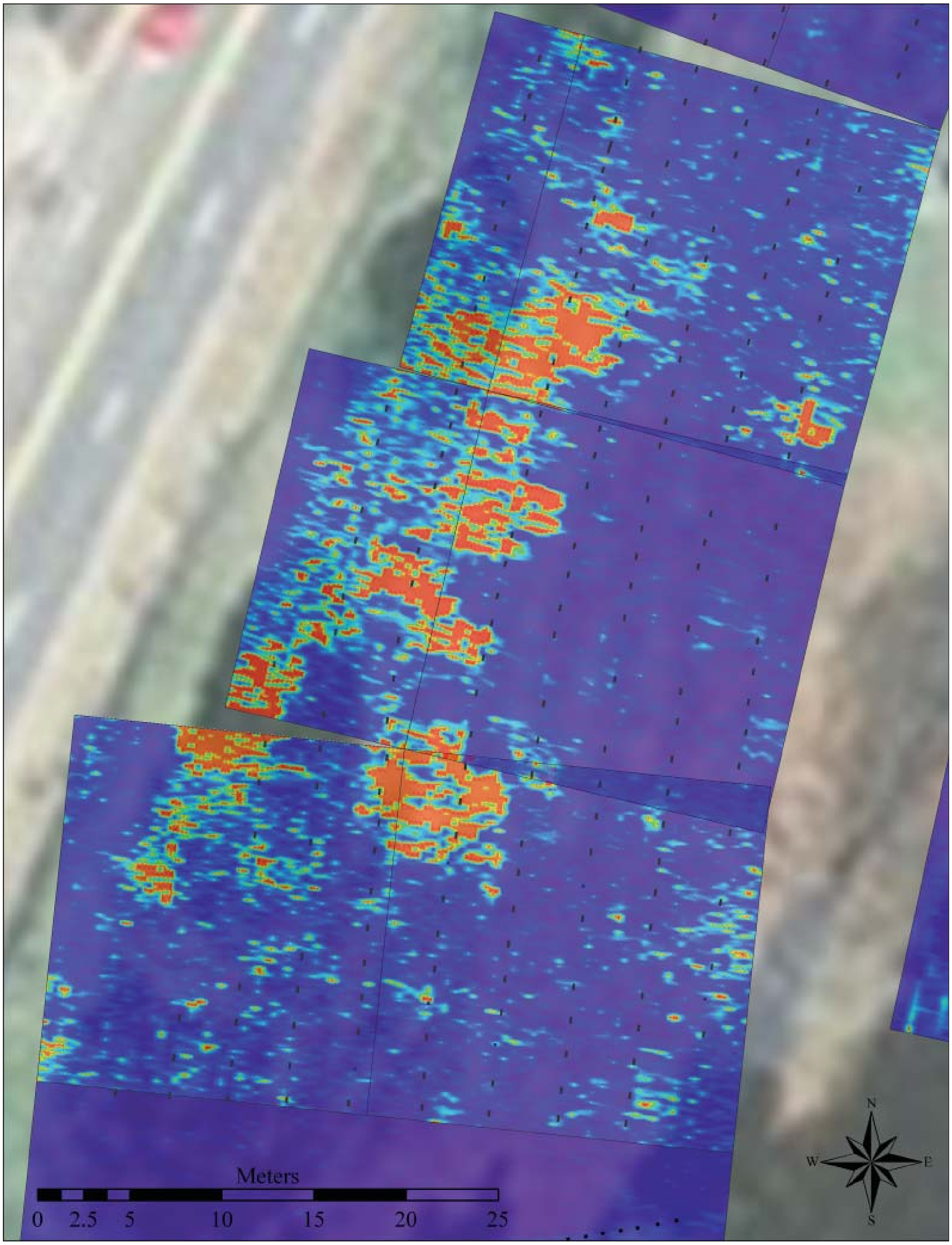

Figure 53. Closeup of GPR results from Grids 1, 2, 4, 7, 8, and 9 in Section M at between approximately 54 and 78 cmbs using the 400 MHz antenna.

The high amplitude orange linear reflections represent probable burial locations. Grids 1, 2, 7, and 8 are illustrated at a depth of approximately 54 cmbs, and Grids 4 and 9 are illustrated at a depth of approximately 78 cmbs.

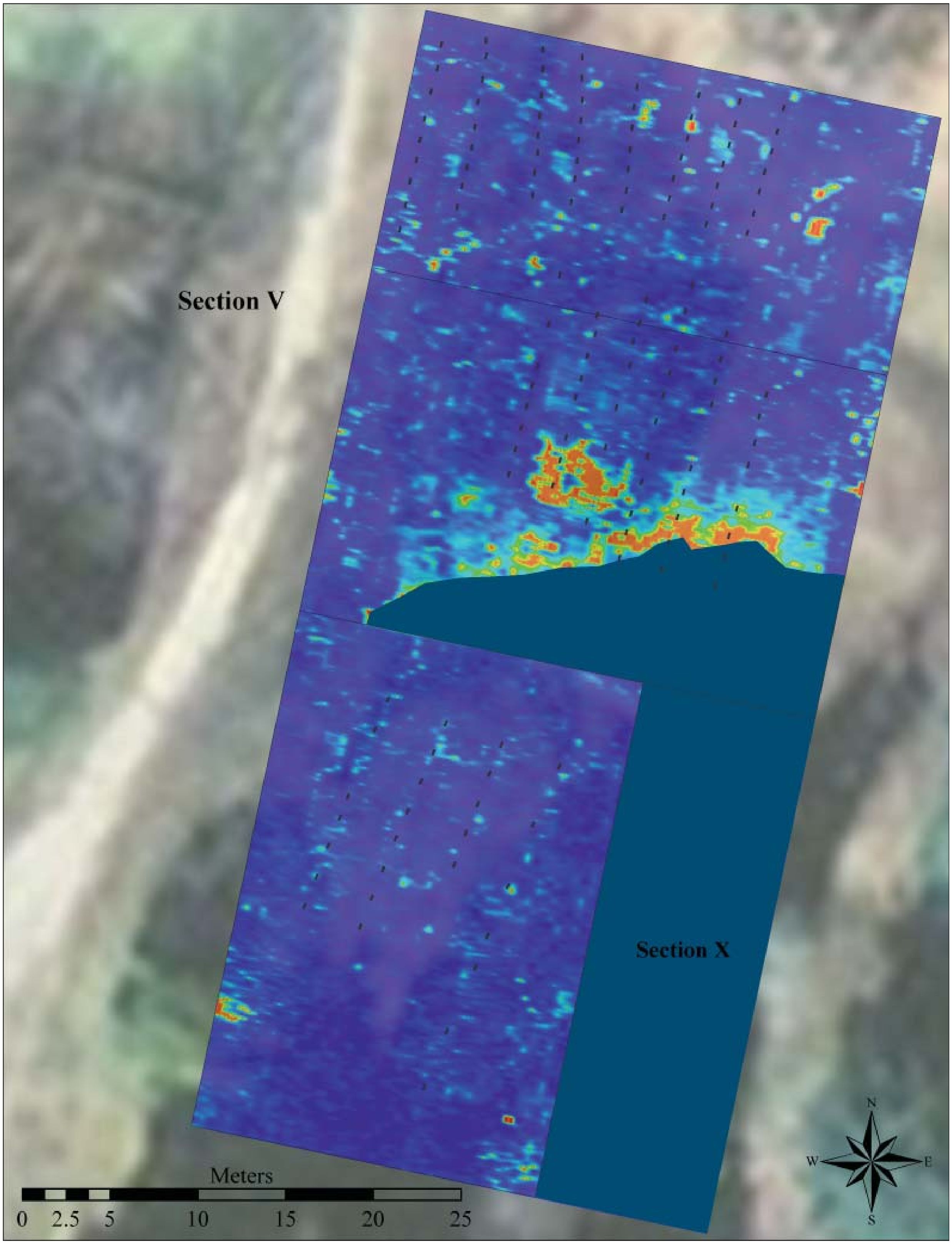

Figure 54. Closeup of GPR results from Sections V and X at approximately 32 cmbs using the 400 MHz antenna.

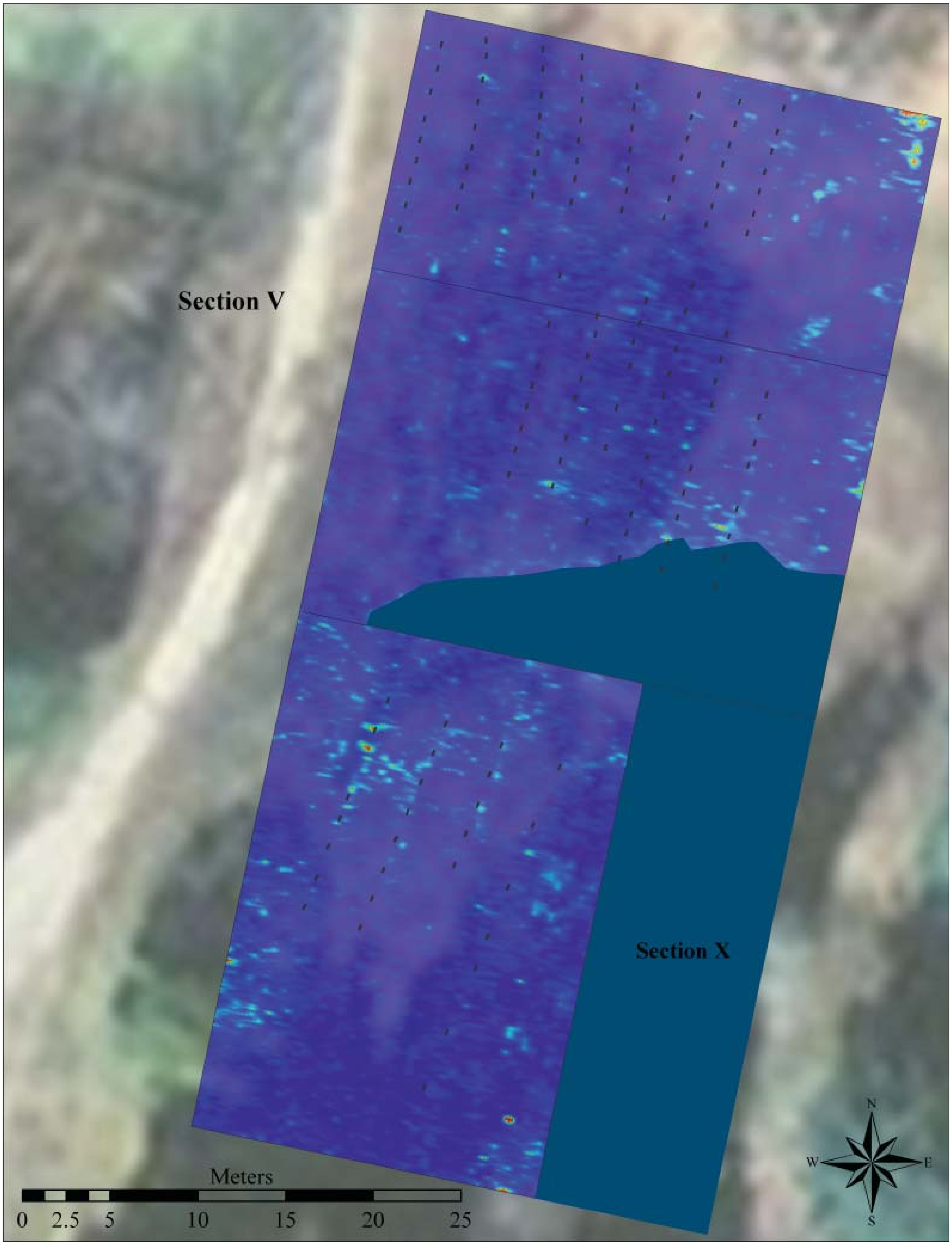

Figure 55. Closeup of GPR results from Sections V and X at approximately 62 cmbs using the 400 MHz antenna.

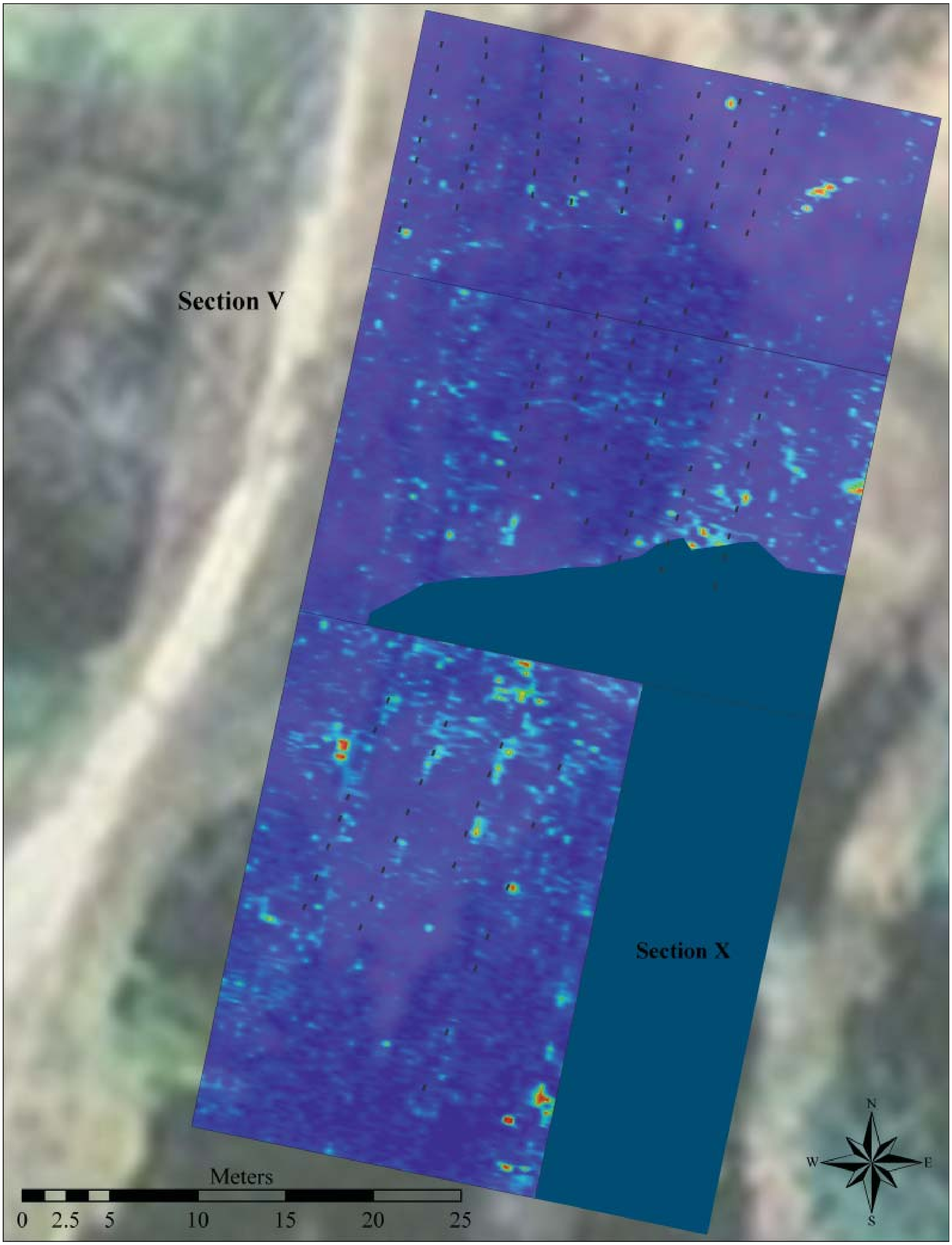

Figure 56. Closeup of GPR results from Sections V and X at approximately 102 cmbs using the 400 MHz antenna.

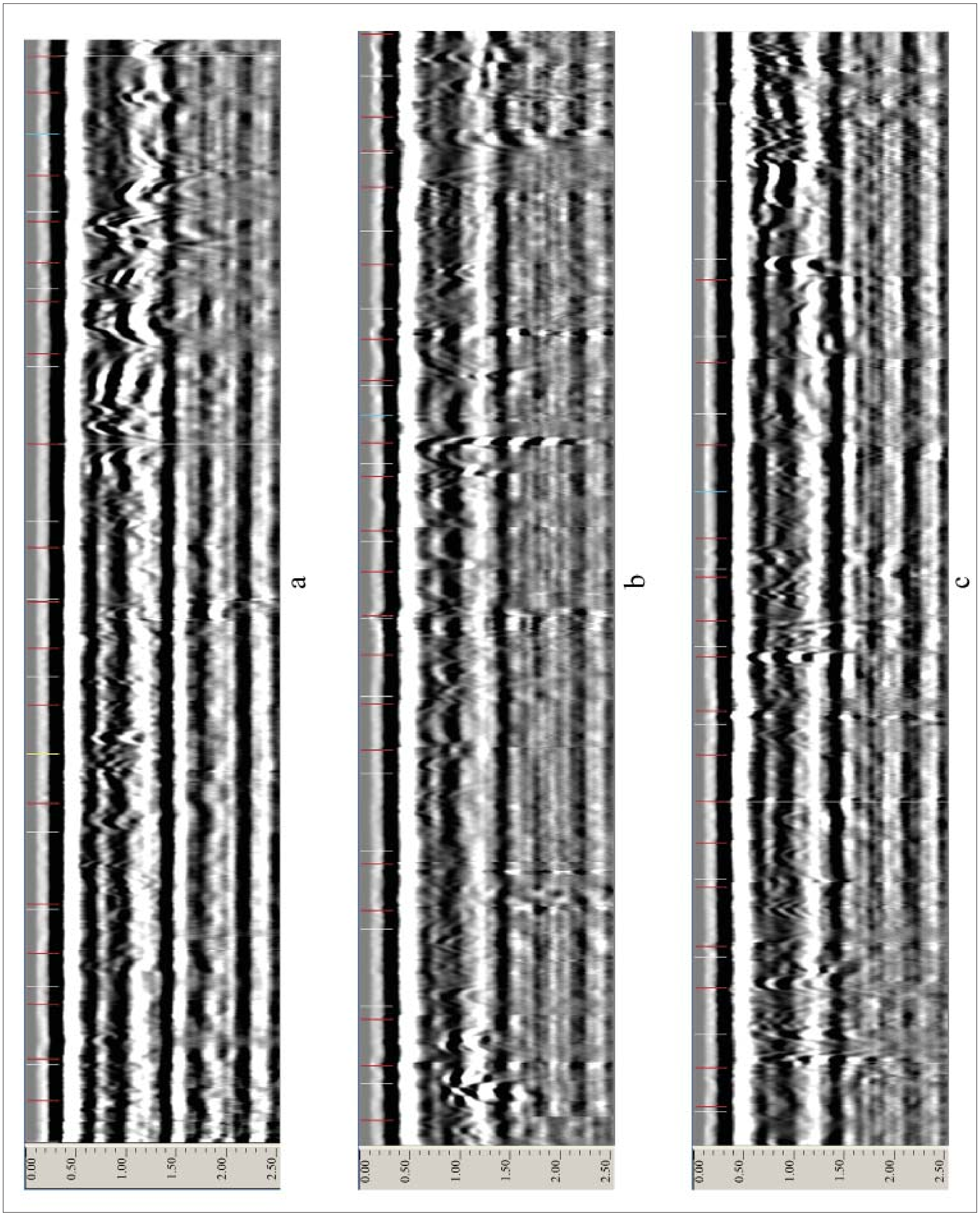

Figure 57. Example GPR profile data acquired with the 270 MHz antenna in Section M.
Red marks indicate location of headstones, yellow mark indicates the location of a block and the blue marks indicate the location of an unmarked burial as identified following the mechanical scraping. Each profile is 20 m in length. Approximate depths (cmbs) are shown at the left, and are calculated from radar return times measured in nanoseconds.

Figure 58. Location of transect shown in Figure 57 within Section M.
Transect was run South to North. Each headstone location was marked on the GPR while running the transect.

Table 3. Results from the Probe Testing in Sections M, MUU, V, and X at Vicksburg National Cemetery.

Probe Test #	Section	Result	Depth of Material (cmbs)	Material Encountered	Date
1	M	Positive	140		1/12/2011
2	M	Positive	137		1/12/2011
3	M	Negative			1/12/2011
4	M	Negative			1/12/2011
5	M	Negative			1/12/2011
6	M	Negative			1/12/2011
7	M	Positive	107		1/12/2011
8	M	Negative			1/12/2011
9	M	Negative			1/12/2011
10	M	Positive	58		1/12/2011
11	M	Positive	58		1/12/2011
12	M	Negative			1/12/2011
13	M	Negative			1/12/2011
14	M	Positive	97		1/12/2011
15	M	Positive	133		1/12/2011
16	M	Positive	77		1/12/2011
17	M	Negative			1/12/2011
18	W	Positive	140	Hard	5/24/2011
19	W	Negative			5/24/2011
20	W	Negative			5/24/2011
21	W	Positive	119	Hard	5/24/2011
22	W	Positive	126	Hard	5/24/2011
23	W	Positive	120	Hard	5/24/2011
24	W	Positive	115	Hard	5/24/2011
25	W	Positive	115	Hard	5/24/2011
26	W	Negative			5/24/2011
27	W	Negative			5/24/2011
28	W	Negative			5/24/2011
29	W	Positive	117	Hard	5/24/2011
30	W	Positive	113	Hard	5/24/2011
31	W	Positive	116	Hard	5/24/2011
32	W	Positive	107	Hard	5/24/2011
33	W	Positive	109	Hard	5/24/2011
34	W	Positive	111	Hard	5/24/2011
35	W	Positive	137	Soft	5/24/2011
36	W	Positive	159	Soft	5/24/2011

Probe Test #	Section	Result	Depth of Material (cmbs)	Material Encountered	Date
37	W	Positive	143	Soft	5/24/2011
38	W	Positive	103	Hard	5/24/2011
39	W	Positive	102	Hard	5/24/2011
40	W	Negative			5/24/2011
41	W	Positive	107	Hard	5/24/2011
42	W	Positive	113	Hard	5/24/2011
43	W	Negative			5/24/2011
44	W	Positive	114	Hard	5/24/2011
45	W	Positive	51	Hard	5/24/2011
46	W	Positive	51	Hard	5/24/2011
47	W	Positive	44	Hard	5/24/2011
48	W	Positive	45	Hard	5/24/2011
49	W	Positive	48	Hard	5/24/2011
50	W	Positive	43	Hard	5/24/2011
51	W	Positive	165	Hard	5/24/2011
52	W	Negative			5/24/2011
53	W	Negative			5/24/2011
54	W	Negative			5/24/2011
55	W	Positive	157	Soft	5/24/2011
56	W	Negative			5/24/2011
57	W	Positive	153	Soft	5/24/2011
58	W	Positive	169	Soft	5/24/2011
59	W	Negative			5/24/2011
60	W	Positive	48	Hard	5/24/2011
61	W	Positive	55	Hard	5/24/2011
62	W	Positive	55	Hard	5/24/2011
63	W	Positive	49	Hard	5/24/2011
64	W	Positive	50	Hard	5/24/2011
65	W	Positive	53	Hard	5/24/2011
66	W	Positive	115	Soft	5/24/2011
67	W	Positive	65	Hard	5/24/2011
68	W	Positive	110	Hard	5/24/2011
69	W	Positive	90	Hard	5/24/2011
70	W	Positive	95	Hard	5/24/2011
71	W	Positive	94	Hard	5/24/2011
72	W	Positive	156	Hard	5/24/2011
73	W	Positive	61	Hard	5/24/2011
74	W	Negative			5/24/2011

Probe Test #	Section	Result	Depth of Material (cmbs)	Material Encountered	Date
75	W	Positive	76	Soft	5/24/2011
76	W	Negative			5/24/2011
77	W	Positive	70	Soft	5/24/2011
78	W	Positive	101	Hard	5/24/2011
79	W	Positive	86	Hard	5/24/2011
80	W	Positive	70	Hard	5/24/2011
81	W	Positive	158	Hard	5/24/2011
82	W	Positive	154	Hard	5/24/2011
83	W	Positive	178	Hard	5/24/2011
84	W	Positive	174	Hard	5/24/2011
85	W	Positive	90	Hard	5/24/2011
86	W	Positive	200	Hard	5/24/2011
87	W	Positive	160	Hard	5/24/2011
88	W	Positive	172	Hard	5/24/2011
89	W	Negative			5/24/2011
90	W	Negative			5/24/2011
91	W	Negative			5/24/2011
92	W	Negative			5/25/2011
93	W	Negative			5/25/2011
94	W	Positive	56	Hard	5/25/2011
95	W	Negative			5/25/2011
96	W	Negative			5/25/2011
97	M	Positive	76	Hard	5/25/2011
98	M	Positive	79	Hard	5/25/2011
99	M	Positive	87	Soft	5/25/2011
100	M	Positive	57	Soft	5/25/2011
101	M	Positive	73	Hard	5/25/2011
102	M	Positive	55	Soft	5/25/2011
103	M	Positive	53	Soft	5/25/2011
104	M	Positive	70	Soft	5/25/2011
105	M	Positive	63	Soft	5/25/2011
106	M	Negative			5/25/2011
107	M	Positive	81	Hard	5/25/2011
108	M	Positive	80	Hard	5/25/2011
109	M	Negative			5/25/2011
110	M	Negative			5/25/2011
111	M	Positive	65	Soft	5/25/2011
112	M	Negative			5/25/2011

Probe Test #	Section	Result	Depth of Material (cmbs)	Material Encountered	Date
113	M	Negative			5/25/2011
114	M	Negative			5/25/2011
115	M	Negative			5/25/2011
116	M	Negative			5/25/2011
117	M	Negative			5/25/2011
118	M	Negative			5/25/2011
119	M	Negative			5/25/2011
120	M	Negative			5/25/2011
121	M	Negative			5/25/2011
122	M	Negative			5/25/2011
123	M	Negative			5/25/2011
124	M	Negative			5/25/2011
125	M	Negative			5/25/2011
126	M	Positive	64	Soft	5/25/2011
127	M	Negative			5/25/2011
128	M	Positive	52	Hard	5/25/2011
129	M	Negative			5/25/2011
130	M	Positive	46	Hard	5/25/2011
131	M	Negative			5/25/2011
132	M	Negative			5/25/2011
133	M	Negative			5/25/2011
134	M	Negative			5/25/2011
135	M	Negative			5/25/2011
136	M	Negative			5/25/2011
137	M	Negative			5/25/2011
138	M	Negative			5/25/2011
139	M	Negative			5/25/2011
140	M	Negative			5/25/2011
141	M	Negative			5/25/2011
142	M	Positive	82	Soft	5/25/2011
143	M	Positive	137	Soft	5/25/2011
144	M	Positive	182	Soft	5/25/2011
145	M	Positive	180	Soft	5/25/2011
146	M	Negative			5/25/2011
147	M	Negative			5/25/2011
148	M	Positive	100	Hard	5/25/2011
149	M	Negative			5/25/2011
150	M	Negative			5/25/2011

Probe Test #	Section	Result	Depth of Material (cmbs)	Material Encountered	Date
151	M	Negative			5/25/2011
152	M	Positive	164	Soft	5/25/2011
153	M	Positive	172	Hard	5/25/2011
154	M	Positive	135	Soft	5/25/2011
155	M	Positive	159	Soft	5/25/2011
156	M	Negative			5/25/2011
157	M	Negative			5/25/2011
158	M	Negative			5/25/2011
159	M	Positive	180	Soft	5/25/2011
160	M	Positive	175	Hard	5/25/2011
161	M	Positive	117	Hard	5/25/2011
162	M	Positive	136	Soft	5/25/2011
163	M	Positive	182	Soft	5/25/2011
164	M	Positive	184	Hard	5/25/2011
165	M	Positive	197	Hard	5/25/2011
166	M	Positive	224	Hard	5/25/2011
167	M	Positive	109	Soft	5/25/2011
168	M	Positive	170	Soft	5/25/2011
169	M	Positive	80	Soft	5/25/2011
170	M	Positive	145	Soft	5/25/2011
171	M	Positive	189	Soft	5/25/2011
172	M	Positive	66	Hard	5/25/2011
173	M	Positive	69	Hard	5/25/2011
174	M	Positive	59	Hard	5/25/2011
175	M	Positive	56	Hard	5/25/2011
176	M	Positive	54	Hard	5/25/2011
177	M	Positive	57	Hard	5/25/2011
178	M	Negative			5/25/2011
179	M	Positive	60	Hard	5/25/2011
180	M	Negative			5/25/2011
181	M	Positive	152	Soft	5/25/2011
182	M	Positive	115	Hard	5/25/2011
183	M	Negative			5/25/2011
184	M	Negative			5/25/2011
185	M	Positive	191	Hard	5/25/2011
186	M	Negative			5/25/2011
187	M	Negative			5/25/2011
188	M	Negative			5/25/2011

Probe Test #	Section	Result	Depth of Material (cmbs)	Material Encountered	Date
189	M	Positive	163	Hard	5/25/2011
190	M	Negative			5/25/2011
191	M	Negative			5/25/2011
192	M	Negative			5/25/2011
193	M	Negative			5/25/2011
194	M	Negative			5/25/2011
195	M	Positive	147	Hard	5/25/2011
196	M	Negative			5/25/2011
197	M	Negative			5/25/2011
198	M	Negative			5/25/2011
199	M	Negative			5/25/2011
200	M	Negative			5/25/2011
201	M	Negative			5/25/2011
202	M	Negative			5/25/2011
203	M	Negative			5/26/2011
204	M	Negative			5/26/2011
205	M	Positive	40	Soft	5/26/2011
206	M	Positive	62	Soft	5/26/2011
207	M	Negative			5/26/2011
208	M	Negative			5/26/2011
209	M	Positive	43	Soft	5/26/2011
210	M	Positive	25	Soft	5/26/2011
211	M	Positive	32	Soft	5/26/2011
212	M	Positive	57	Soft	5/26/2011
213	M	Positive	51	Hard	5/26/2011
214	M	Positive	91	Soft	5/26/2011
215	M	Positive	143	Soft	5/26/2011
216	M	Positive	156	Soft	5/26/2011
217	M	Positive	37	Soft	5/26/2011
218	M	Negative			5/26/2011
219	M	Positive	48	Soft	5/26/2011
220	M	Positive	174	Soft	5/26/2011
221	M	Positive	32	Soft	5/26/2011
222	M	Positive	41	Soft	5/26/2011
223	M	Positive	31	Hard	5/26/2011
224	M	Negative			5/26/2011
225	M	Negative			5/26/2011
226	M	Positive	54	Hard	5/26/2011

Probe Test #	Section	Result	Depth of Material (cmbs)	Material Encountered	Date
227	M	Positive	44	Soft	5/26/2011
228	M	Positive	157	Soft	5/26/2011
229	M	Negative			5/26/2011
230	M	Negative			5/26/2011
231	M	Positive	86	Soft	5/26/2011
232	M	Positive	75	Soft	5/26/2011
233	M	Positive	84	Hard	5/26/2011
234	M	Positive	68	Hard	5/26/2011
235	M	Positive	197	Soft	5/26/2011
236	M	Positive	77	Hard	5/26/2011
237	M	Positive	85	Hard	5/26/2011
238	M	Positive	100	Soft	5/26/2011
239	M	Positive	95	Hard	5/26/2011
240	M	Positive	96	Hard	5/26/2011
241	M	Negative			5/26/2011
242	M	Positive	215	Soft	5/26/2011
243	M	Positive	203	Hard	5/26/2011
244	M	Positive	85	Hard	5/26/2011
245	M	Positive	83	Hard	5/26/2011
246	M	Positive	74	Hard	5/26/2011
247	M	Positive	98	Hard	5/26/2011
248	M	Positive	57	Hard	5/26/2011
249	M	Positive	63	Hard	5/26/2011
250	M	Positive	89	Soft	5/26/2011
251	M	Positive	42	Hard	5/26/2011
252	M	Negative			5/26/2011
253	M	Positive	125	Soft	5/26/2011
254	M	Negative			5/26/2011
255	M	Positive	75	Soft	5/26/2011
256	M	Positive	41	Hard	5/26/2011
257	M	Positive	39	Hard	5/26/2011
258	M	Positive	49	Hard	5/26/2011
259	M	Positive	48	Hard	5/26/2011
260	M	Positive	47	Hard	5/26/2011
261	M	Positive	48	Hard	5/26/2011
262	M	Positive	42	Hard	5/26/2011
263	M	Positive	33	Hard	5/26/2011
264	M	Positive	30	Hard	5/26/2011

Probe Test #	Section	Result	Depth of Material (cmbs)	Material Encountered	Date
265	M	Positive	33	Hard	5/26/2011
266	M	Positive	34	Hard	5/26/2011
267	M	Positive	47	Hard	5/26/2011
268	M	Positive	50	Soft	5/26/2011
269	M	Positive	114	Hard	5/26/2011
270	M	Positive	61	Hard	5/26/2011
271	M	Positive	48	Hard	5/26/2011
272	M	Positive	74	Hard	5/26/2011
273	M	Negative			5/26/2011
274	M	Negative			5/26/2011
275	M	Positive	152	Soft	5/26/2011
276	M	Negative			5/26/2011
277	M	Negative			5/26/2011
278	M	Positive	29	Hard	5/26/2011
279	M	Positive	31	Hard	5/26/2011
280	M	Positive	29	Hard	5/26/2011
281	M	Positive	34	Hard	5/26/2011
282	M	Positive	52	Hard	5/26/2011
283	M	Positive	24	Hard	5/26/2011
284	M	Positive	52	Hard	5/26/2011
285	M	Positive	28	Hard	5/26/2011
286	M	Positive	40	Hard	5/26/2011
287	M	Positive	29	Hard	5/26/2011
288	M	Negative			5/26/2011
289	M	Negative			5/26/2011
290	M	Positive	89	Soft	5/26/2011
291	M	Positive	90	Soft	5/26/2011
292	M	Positive	88	Soft	5/26/2011
293	M	Positive	29	Hard	5/26/2011
294	M	Positive	35	Hard	5/26/2011
295	M	Positive	20	Hard	5/26/2011
296	M	Positive	20	Hard	5/26/2011
297	M	Positive	22	Hard	5/26/2011
298	M	Negative			5/26/2011
299	M	Negative			5/26/2011
300	M	Negative			5/26/2011
301	M	Negative			5/26/2011
302	M	Negative			5/26/2011

Probe Test #	Section	Result	Depth of Material (cmbs)	Material Encountered	Date
303	M	Negative			5/26/2011
304	M	Positive	75	Soft	5/26/2011
305	M	Positive	157	Soft	5/26/2011
306	M	Positive	85	Soft	5/26/2011
307	M	Negative			5/26/2011
308	M	Positive	34	Hard	5/26/2011
309	M	Positive	29	Hard	5/26/2011
310	M	Negative			5/26/2011
311	M	Negative			5/26/2011
312	M	Negative			5/26/2011
313	M	Negative			5/26/2011
314	M	Negative			5/26/2011
315	M	Negative			5/26/2011
316	M	Negative			5/26/2011
317	M	Positive	103	Soft	5/26/2011
318	M	Positive	96	Soft	5/26/2011
319	M	Negative			5/26/2011
320	M	Negative			5/26/2011
321	M	Negative			5/26/2011
322	M	Negative			5/26/2011
323	M	Negative			5/26/2011
324	M	Negative			5/26/2011
325	M	Negative			5/26/2011
326	M	Negative			5/26/2011
327	M	Negative			5/26/2011
328	M	Positive	206	Hard	5/26/2011
329	M	Negative			5/26/2011
330	M	Positive	203	Hard	5/26/2011
331	M	Positive	163	Hard	5/26/2011
332	M	Negative			5/26/2011
333	M	Negative			5/26/2011
334	M	Positive	20	Hard	5/26/2011
335	MUU	Negative			5/27/2011
336	MUU	Negative			5/27/2011
337	MUU	Negative			5/27/2011
338	MUU	Negative			5/27/2011
339	MUU	Positive	108	Soft	5/27/2011
340	MUU	Negative			5/27/2011

Probe Test #	Section	Result	Depth of Material (cmbs)	Material Encountered	Date
341	MUU	Negative			5/27/2011
342	MUU	Negative			5/27/2011
343	MUU	Negative			5/27/2011
344	MUU	Negative			5/27/2011
345	MUU	Negative			5/27/2011
346	MUU	Negative			5/27/2011
347	MUU	Negative			5/27/2011
348	MUU	Negative			5/27/2011
349	MUU	Negative			5/27/2011
350	MUU	Positive	63	Hard	5/27/2011
351	MUU	Positive	162	Soft	5/27/2011
352	MUU	Positive	94	Soft	5/27/2011
353	MUU	Negative			5/27/2011
354	MUU	Positive	173	Hard	5/27/2011
355	MUU	Negative			5/27/2011
356	MUU	Positive	103	Hard	5/27/2011
357	MUU	Negative			5/27/2011
358	MUU	Negative			5/27/2011
359	MUU	Negative			5/27/2011
360	MUU	Positive	42	Hard	5/27/2011
361	MUU	Negative			5/27/2011
362	MUU	Positive	158	Hard	5/27/2011
363	MUU	Positive	170	Hard	5/27/2011
364	MUU	Positive	108	Hard	5/27/2011
365	MUU	Positive	202	Hard	5/27/2011
366	MUU	Negative			5/27/2011
367	MUU	Negative			5/27/2011
368	MUU	Negative			5/27/2011
369	MUU	Positive	156	Hard	5/27/2011
370	MUU	Negative			5/27/2011
371	MUU	Positive	102	Hard	5/27/2011
372	MUU	Positive	99	Hard	5/27/2011
373	MUU	Negative			5/27/2011
374	MUU	Negative			5/27/2011
375	MUU	Positive	112	Hard	5/27/2011
376	MUU	Positive	99	Hard	5/27/2011
377	MUU	Negative			5/27/2011
378	MUU	Negative			5/27/2011

Probe Test #	Section	Result	Depth of Material (cmbs)	Material Encountered	Date
379	MUU	Positive	89	Hard	5/27/2011
380	MUU	Negative			5/27/2011
381	MUU	Negative			5/27/2011
382	MUU	Negative			5/27/2011
383	V	Negative			5/27/2011
384	V	Negative			5/27/2011
385	V	Negative			5/27/2011
386	V	Negative			5/27/2011
387	V	Negative			5/27/2011
388	V	Negative			5/27/2011
389	V	Negative			5/27/2011
390	V	Positive	173	Hard	5/27/2011
391	V	Negative			5/27/2011
392	V	Negative			5/27/2011
393	V	Negative			5/27/2011
394	V	Negative			5/27/2011
395	V	Negative			5/27/2011
396	V	Negative			5/27/2011
397	V	Negative			5/27/2011
398	V	Negative			5/27/2011
399	V	Negative			5/27/2011
400	V	Negative			5/27/2011
401	V	Negative			5/27/2011
402	V	Negative			5/27/2011
403	V	Negative			5/27/2011
404	V	Negative			5/27/2011
405	V	Negative			5/27/2011
406	V	Negative			5/27/2011
407	V	Positive	119	Hard	5/27/2011
408	V	Positive	118	Hard	5/27/2011
409	V	Positive	117	Hard	5/27/2011
410	V	Positive	171	Hard	5/27/2011
411	V	Positive	192	Hard	5/27/2011
412	V	Positive	193	Hard	5/27/2011
413	V	Positive	167	Hard	5/27/2011
414	V	Positive	160	Hard	5/27/2011
415	V	Positive	147	Hard	5/27/2011
416	V	Positive	137	Hard	5/27/2011

Probe Test #	Section	Result	Depth of Material (cmbs)	Material Encountered	Date
417	V	Positive	140	Hard	5/27/2011
418	V	Positive	142	Hard	5/27/2011
419	X	Negative			5/27/2011
420	X	Negative			5/27/2011
421	X	Negative			5/27/2011
422	X	Negative			5/27/2011
423	X	Negative			5/27/2011
424	X	Negative			5/27/2011
425	X	Negative			5/27/2011
426	X	Negative			5/27/2011
427	X	Negative			5/27/2011
428	X	Negative			5/27/2011
429	X	Negative			5/27/2011
430	X	Negative			5/27/2011
431	X	Negative			5/27/2011
432	X	Negative			5/27/2011
433	X	Negative			5/27/2011
434	X	Negative			5/27/2011
435	X	Negative			5/27/2011
436	X	Negative			5/27/2011
437	X	Negative			5/27/2011
438	X	Negative			5/27/2011
439	X	Negative			5/27/2011
440	X	Negative			5/27/2011
441	X	Negative			5/27/2011
442	X	Negative			5/27/2011
443	M	Negative			5/28/2011
444	M	Negative			5/28/2011
445	M	Negative			5/28/2011
446	M	Negative			5/28/2011
447	M	Negative			5/28/2011
448	M	Negative			5/28/2011
449	M	Negative			5/28/2011
450	M	Negative			5/28/2011
451	M	Negative			5/28/2011
452	M	Negative			5/28/2011
453	M	Negative			5/28/2011
454	M	Negative			5/28/2011

Probe Test #	Section	Result	Depth of Material (cmbs)	Material Encountered	Date
455	M	Negative			5/28/2011
456	M	Negative			5/28/2011
457	M	Negative			5/28/2011
458	M	Negative			5/28/2011
459	M	Negative			5/28/2011
460	M	Negative			5/28/2011
461	MUU	Negative			5/28/2011
462	MUU	Negative			5/28/2011
463	MUU	Negative			5/28/2011
464	MUU	Negative			5/28/2011
465	MUU	Negative			5/28/2011
466	MUU	Negative			5/28/2011
467	MUU	Negative			5/28/2011
468	MUU	Negative			5/28/2011
469	MUU	Negative			5/28/2011
470	MUU	Negative			5/28/2011
471	MUU	Negative			5/28/2011
472	MUU	Negative			5/28/2011
473	MUU	Negative			5/28/2011
474	MUU	Negative			5/28/2011
475	MUU	Negative			5/28/2011
476	MUU	Negative			5/28/2011
477	MUU	Negative			5/28/2011
478	MUU	Negative			5/28/2011
479	MUU	Negative			5/28/2011
480	MUU	Negative			5/28/2011
481	MUU	Negative			5/28/2011
482	MUU	Negative			5/28/2011
483	MUU	Negative			5/28/2011
484	MUU	Negative			5/28/2011
485	MUU	Negative			5/28/2011
486	V	Negative			5/28/2011
487	V	Negative			5/28/2011
488	V	Negative			5/28/2011
489	X	Positive	192	Hard	5/28/2011
490	X	Positive	198	Hard	5/28/2011
491	X	Negative			5/28/2011
492	X	Negative			5/28/2011

Probe Test #	Section	Result	Depth of Material (cmbs)	Material Encountered	Date
493	X	Negative			5/28/2011
494	X	Negative			5/28/2011
495	X	Negative			5/28/2011
496	X	Negative			5/28/2011
497	X	Negative			5/28/2011
498	M	Negative			5/29/2011
499	M	Negative			5/29/2011
500	M	Negative			5/29/2011
501	M	Positive	141	Hard	5/29/2011
502	M	Positive	139	Hard	5/29/2011
503	M	Negative			5/29/2011
504	M	Positive	145	Hard	5/29/2011
505	M	Positive	163	Hard	5/29/2011
506	M	Positive	146	Hard	5/29/2011
507	M	Positive	153	Hard	5/29/2011
508	W	Negative			5/29/2011
509	W	Positive	129	Hard	5/29/2011
510	W	Positive	172	Hard	5/29/2011
511	W	Positive	192	Hard	5/29/2011
512	M	Negative			5/29/2011
513	M	Negative			5/29/2011
514	M	Negative			5/29/2011
515	M	Negative			5/29/2011
516	M	Negative			5/29/2011
517	M	Negative			5/29/2011
518	M	Negative			5/29/2011
519	M	Negative			5/29/2011
520	M	Negative			5/29/2011
521	M	Negative			5/29/2011
522	M	Negative			5/29/2011
523	M	Negative			5/29/2011
524	M	Negative			5/29/2011
525	M	Negative			5/29/2011
526	M	Negative			5/29/2011

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NATIONAL PARK SERVICE
U.S. DEPARTMENT OF THE INTERIOR

SOUTHEAST ARCHEOLOGICAL CENTER
TALLAHASSEE, FLORIDA

Southeast Archeological Center
2035 East Paul Dirac Drive
Johnson Building, Suite 120
Tallahassee, Florida 32310

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