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The Positive Developments and Applications of Geospatial Technologies in Archaeology on Fort Benning, Georgia

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THE POSITIVE DEVELOPMENTS AND APPLICATIONS OF GEOSPATIAL TECHNOLOGIES IN ARCHAEOLOGY ON FORT BENNING, GEORGIA

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COLUMBUS STATE UNIVERSITY

THE POSITIVE DEVELOPMENTS AND APPLICATIONS OF GEOSPATIAL TECHNOLOGIES IN ARCHAEOLOGY ON FORT BENNING, GEORGIA

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JANE MADER

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THE POSITIVE DEVELOPMENTS AND APPLICATIONS OF

GEOSPATIAL TECHNOLOGIES IN ARCHAEOLOGY ON

FORT BENNING, GEORGIA

By

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ABSTRACT

This thesis explores the advantages of using geospatial technologies in the field of archaeology. The purpose of this study, conducted on Site 9CE16 on Fort Benning, Georgia, was to examine the ways in which Geographic Information Systems (GIS) can be used to more accurately depict artifacts and features present on archaeological sites. With the research I gathered, I constructed an updated site map which can be viewed in Figures 1.1, 1.2, and 1.3. The map produced includes more features than were initially mapped at Site 9CE16 and help paint a clearer picture of the structures which existed at the original site. Also, included is a review of literature regarding the use of GIS in the field of archaeology. Overall, this paper argues that the benefit of using geospatial tools and analysis within archaeological field studies far outweighs the costs.

ACKNOWLEDGEMENTS

I would personally like to thank my thesis director, Dr. Brad Huff, for his immeasurable encouragement throughout my undergraduate degree and GIS research, Mrs. Danielle Cook, for her unwavering dedication to serving as my professor and mentor throughout the pursuit of my anthropology minor, and Dr. Cindy Ticknor, for the endless support she has provided throughout my Honors College journey. In addition, I would like to thank Ms. Jess Parks and Mr. Mike Ecks with Fort Benning Curations for their help in securing Site 9CE16 on three occasions for survey, helping to flag features, and for making this research experience unique. It is rare for students to have the chance to conduct research on military installations, and I am more than blessed to have had this opportunity.

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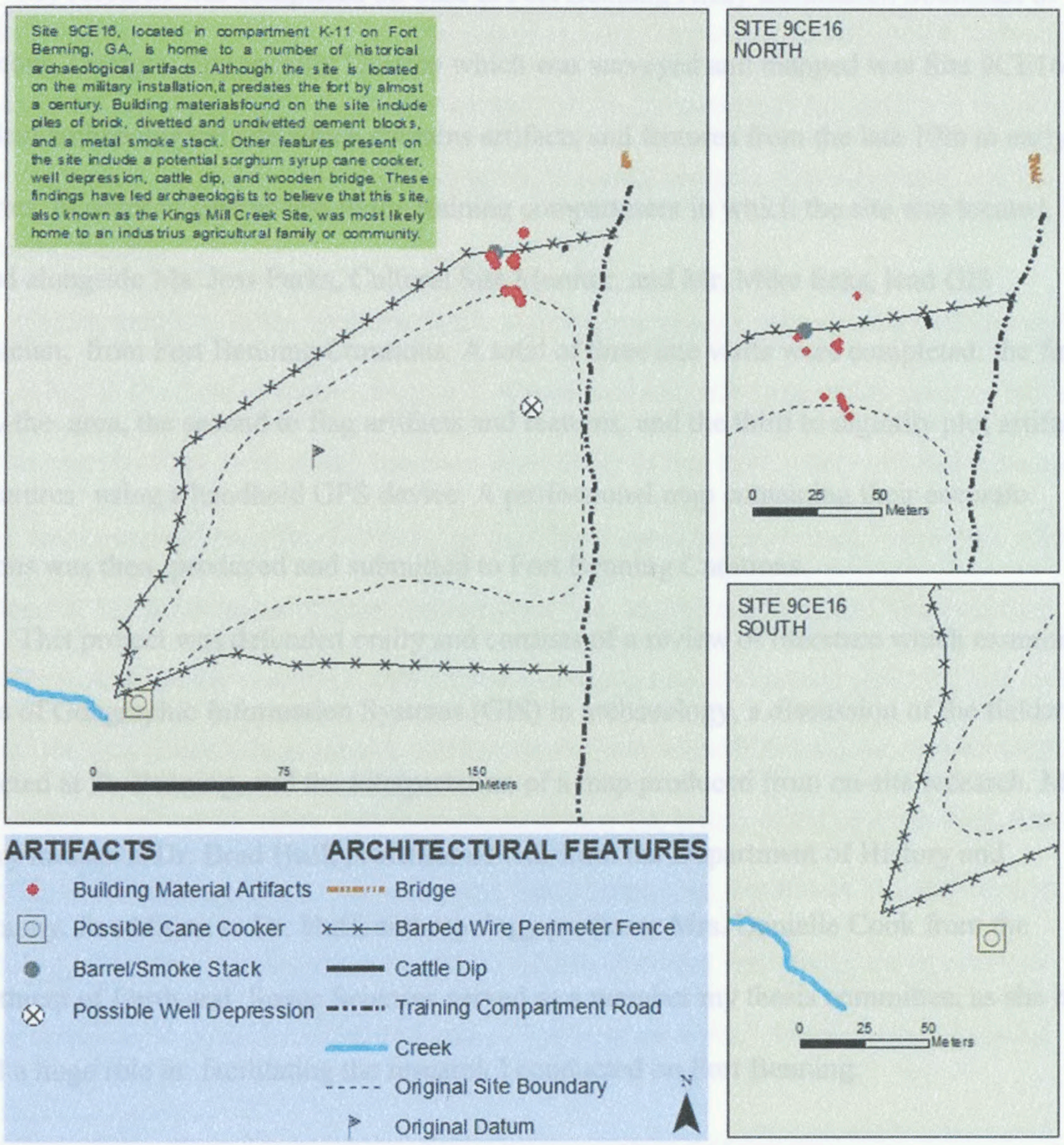

SOURCES: FORT BENNING CURATIONS, COLUMBUS STATE UNIVERSITY GIS DEPARTMENT

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Overview

The goal of this project was twofold: to examine the literature and explore the technological advancements which have recently developed in the field of Geographic Information Systems (GIS), and to apply geospatial methods in field archaeology to produce a map which will aid in future studies on the archaeological sites present on Fort Benning, Georgia.

My research was completed on-base at Fort Benning Army Installation Southeast of Columbus, Georgia. The specific location which was surveyed and mapped was Site 9CE16, a historical archaeological site which contains artifacts and features from the late 19th to early 20th centuries. In order to gain access to the training compartment in which the site was located, I worked alongside Ms. Jess Parks, Cultural Site Monitor, and Mr. Mike Ecks, lead GIS Technician, from Fort Benning Curations. A total of three site visits were completed: the first to survey the area, the second to flag artifacts and features, and the third to digitally plot artifacts and features using a handheld GPS device. A professional map containing their accurate locations was then produced and submitted to Fort Benning Curations.

This project was defended orally and consists of a review of literature which examines the use of Geographic Information Systems (GIS) in archaeology, a discussion of the fieldwork conducted at Ft. Benning, and the interpretation of a map produced from on-site research. My primary mentor is Dr. Brad Huff, professor of GIS from the Department of History and Geography. In addition to Dr. Huff, anthropology professor Mrs. Danielle Cook from the Department of Earth and Space Sciences served as a member my thesis committee, as she has played a huge role in facilitating the research I conducted on Fort Benning.

Applications of GIS in Archaeology

There is currently a growing body of literature pertaining to the application of Geographic Information Systems (GIS), a mapping technology system used to gather and store locational data in order to analyze and interpret areas and patterns, in the humanities and sciences. One such developing field is archaeology in which geospatial technologies have increasingly been used to create more accurate representations of past environments. A number of archaeologists have written on this topic based on sites they surveyed using GIS methods. The majority of these professionals argue that because of the cross-disciplinary nature of the science, archaeology has reaped positive benefits in terms of spatial analysis, site surveying, and the pre-excavation process.

Spatial analysis, or the ability to study a given area using a map to view patterns and trends, is key in the field of archaeology as it allows professionals to remotely analyze entire sites. Despite all of the work which has been done lately in this field, many professionals agree that the most potential benefits of GIS in the field have yet to be uncovered.[1] However, what has been done at this point includes point data analysis (i.e. density mapping and interpolation), or the ability to statistically analyze points plotted in a given area to discover patterns, and areal data analysis (i.e. predictive modeling, catchment analysis, viewshed analysis, and simulation), or the ability to survey an entire area to understand how the layout of the environment, from vegetation to elevation, plays a role in the past and present. One significant development in archaeology from this perspective is the use of GIS to construct knowledge about previous environments based on artifacts and features still present on a site.[2] Another type of spatial

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[1] David Ebert, "Applications of Archaeological GIS," *Canadian Journal of Archaeology* 28, no. 2 (2004): 319.

[2] Ebert, "Applications of Archaeological GIS," 321-332.

analysis includes the study of global migrations, which is an invaluable tool in archaeology for studying the cultures and habits of peoples in the past.[3] Overall, many researchers predict a strong future for GIS spatial analysis in archaeology as the practice of GIS matures.

Site surveying, or the physical ground-truthing and exploration of a site, has also reaped the benefits of GIS. The most promising uses include advancements in exploration and delimitation (knowing where to dig) and architectural analysis using technologies such as high frequency ground penetrating radar (GPR), an archaeological tool which involves sending radio frequencies into the ground to determine if and where buried artifacts or structures are located within a given area. These methods are also known as geophysical surveys, or "extensive explorations made with instruments that create maps of properties of subsoil to obtain information of archaeological remains."[4] A number of technological advances that have been made in archaeology in recent years, including magnetometry, resistivity and other techniques such as Electromagnetic Induction Methods (EMI), have been used alongside new GIS technologies such as Light Detection and Ranging (LIDAR), to gain complete pictures of underground or covered sites. These technologies are key instruments for locating, excavating and analyzing archaeological sites. Overall, certain professionals argue that the most positive benefits of GIS are that it is non-destructive, inexpensive, and allows for an enhanced and increased study area.[5]

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[3] Mark D. McCoy and Thegn N. Ladefoged, "New Developments in the Use of Spatial Technology in Archaeology," *Journal of Archaeological Research* 17, no. 3 (2009272-273.

[4] R. Sala, E. Garcia and R.Tamba, "Archaeological Geophysics – From Basics to New Perspectives," In: *Archaeology: New Approaches in Theory and Techniques*, Imma Olich-Castanyer, ed. Rijeka (Croatia: InTech, 2012), 134.

[5] Sala et. al, "Archaeological Geophysics," 134.

On the same spectrum of site surveying is site prediction, which includes the use of "Geographic Information Systems (GIS) and Bayesian statistical modeling to predict the probable spatial distribution and number of settlements from the subset of known sites."[6] Using a "weights-of-evidence" model, one group of researchers were able to determine the probability of the location of Maya sites in the Yucatan Peninsula based on the "topographic slope, soil fertility, soil drainage," and watercourse proximity of an area.[7] The results predicted, within 82% accuracy, the location of these sites.[8] Overall, site prediction modeling using GIS will prove instrumental in archaeological surveying, as it both saves time in the site locating process and increases knowledge of trends among archaeological sites.

GIS has even proved to be useful in the pre-excavation phases of archaeological sites, in which below-ground surveying is used to determine whether or not a site exists in an area. The fact that there are time constraints on archaeological excavations has called for faster forms of data collection and entry, i.e. using mobile GPS units, which uses orbiting satellites above the Earth, as well as base station towers located on the ground, to accurately plot the exact locations of objects or features. Many archaeologists have employed GIS data collection models using with programs that can be used to establish geodatabases, overlay grid systems, and set up data entry defaults to speed up the data collection process.[9] However, the downsides of using technology in archaeological data collection include unreliable backups, lack of data security,

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6 Anabel Ford, Keith Clarke and Gary Raines, "Modeling Settlement Patterns of the Late Classic Maya Civilization with Bayesian Methods and Geographic Information Systems," *Annals of the Association of American Geographers* 99, no. 3 (2009): 496-497.

7 Ford et al, "Modeling Settlement Patterns of the Late Classic Maya Civilization with Bayesian Methods and Geographic Information Systems," 500.

8 Ibid, 508.

9 Nicholas Tripcevich, and Steven A. Wernke, "On-Site Recording of Excavation Data Using Mobile GIS," *Journal of Field Archaeology* 35, no. 4 (2010): 381-386.

and the fragility of equipment. Thus, the best archaeological analysis can be completed with the combination of digital technology and paper note-taking.[10]

Perhaps the most far-reaching pre-excavation survey technology invented is light imaging, detection, and ranging, commonly known as LiDar. “There are times when advances in technology are so far-reaching that they serve as catalysts in transforming our understanding of both the past and archaeological research, thus triggering a scientific revolution…”[11] LiDar is a form of mapping which involves rebounding laser light onto a large area of land in order to better view differences in elevation and analyze buried archaeological features such as buildings Overall, LiDar will continue to develop technologically and prove invaluable in archaeological site analysis.

Finally, GIS is a cross-disciplinary science as it can be used alongside not only archaeology, but in other fields such as environmental studies. One such study also occurred on Fort Benning, Georgia in which GIS was used to analyze the history of pine forest destruction for the use of training compartments. Their study was composed of archaeological data which was gathered using ArcGIS software with remote sensing. The researchers in this case also utilized historical documents alongside a raster-based grid to study land on Fort Benning and better understand landscape and vegetation.[12] Overall, the disciplines of archaeology, history, and geography are often combined in order to reconstruct past environments; such studies have

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[10] Tripcevich and Wernke, "On-Site Recording of Excavation Data Using Mobile GIS," 394-395.

[11] Arlen Chase, Diane Chase, Christopher Fisher et al, “Geospatial Revolution and Remote Sensing LiDar in Mesoamerican Archaeology,” *Proceedings of the National Academy of Sciences in the United States of America* 109, no. 32 (2012): 12916.

[12] Thomas Foster et. al, “Studying the Past for the Future: Managing Modern Biodiversity from Historic and Prehistoric Data,” *Human Organization* 69, no. 2 (2010): 152.

proven extremely valuable on Fort Benning, Georgia and will help experts better understand how GIS can benefit our region.

The majority of archaeologists who employ GIS within their research methods generally vouch for the positive implications which result from combining the two fields. Many also recognize that there are downsides to GIS, such as compromised data security and fragile equipment. Some point out that these shortcomings are being mitigated through improved data collection devices. Though it is a discipline which is not yet as widely available in institutions of higher education, the job market for GIS specialists is expanding exponentially and academia will soon be forced to keep up. As far as archaeology, landscape reconstruction, the process which, after combining geographic data gathered with 3D modeling technologies, archaeologists are able to reconstruct what an original environment or site would have looked like prior to its destruction or degradation, will continue to prove valuable and will become much more advanced with the introduction of more developed 3D modeling programs. In the near future, archaeologists may be able to accurately reconstruct entire cities and civilizations. It can easily be argued that the list of benefits regarding the use of GIS in the field of archaeology will continue to increase ten-fold.

History of Fort Benning, Georgia and Site 9CE16

"Fort Benning: The Land and the People" by Sharyn Kane and Richard Keeton, historians and authors of multiple archaeological history sources for the Southeastern United States, and "A Cultural Resources Survey of Compartment K-11 Fort Benning Military Reservation, Chattahoochee County, Georgia" by Daniel Elliott, professional archaeologist, are two secondary sources that provide the archaeological history of Fort Benning, Georgia. I chose these specifically for two reasons. First, both chronologically discussed the development of Fort Benning from the prehistoric environment of the region to becoming one of the largest military installations in the southeastern United States, which provided valuable insight into the area as a whole. Second, each explores separately the archaeological work which has been completed on base, with Kane and Keeton's from a strictly historical perspective and Elliott's from a strictly archaeological perspective. When studied together, one gets a unique, cross-disciplinary understanding of Fort Benning and its many sites, including Site 9CE16.

One of the earliest historic peoples to inhabit the Fort Benning region was the Creek Native American population.[13] In addition to the Creeks was the Yuchi population, whose town was "a thriving Native American Community in the 1700s on land now occupied by Fort Benning."[14] Though there is evidence of thousands of older, prehistoric Native American sites present on base, many have been either partially or fully destroyed by the construction of tank roads and other structures for modern military use.

With the increase of industrialization and the desire for white farmers to settle in the area, thousands of Creek Indians were forcibly removed from their homes and migrated westward in the 1830s. Following their exodus, the land on which they had made their homes for generations was consolidated by Muscogee County and portioned out in a "land lottery." According to the rules, "any [white] male citizen of Georgia, age 21 or older, could participate and gain one chance to win property… Women could participate only if they were widows."[15] The result of this process

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[13] Sharyn Kane and Richard Keeton, *Fort Benning: The Land and the People* (Fort Benning: Defense Logistics Agency, 2015), 62.

[14] Kane and Keeton, *Fort Benning: The Land and the People*, 81.

[15] Ibid, 104-105.

was the creation of a number of family-owned farms which were scattered around the soon-to-be Fort Benning area.[16]

With the onset of World War I, Army officials began to devote their attention to establishing a specific training location for the U.S. Infantry in the Southeast. Camp Benning, named after Army Colonel Henry Benning from the Columbus, Georgia area, had already begun to house soldiers and was strategically chosen to be the new home of the Infantry.[17] Individual farms created in the land lottery nearly a hundred years prior were consolidated into hundreds of training compartments and comprise what is now known as Fort Benning. The areas where these communities were once located are still recognized by the installation by their original names and certain features are accessible today, including cemeteries and churches. One such farm can be found on Site 9CE16, in which this project was based.

Site 9CE16 is located in Fort Benning training compartment K-11. The site was originally surveyed by Southern Research in 1996, a cultural resource management (CRM) archaeological firm based in the Southeast. Included are site maps for both the eastern portion of the site (Figure 1.4) and the western portion (Figure 1.5), surveyed by CRM firm Panamerican Consultants, who worked alongside Southern Research to complete an incredibly in-depth cultural, geophysical, and environmental survey of this region in the mid-90s. According to this report, Site 9CE16 is known as the Kings Mill Creek Site and was purchased by Fort Benning in the 1940s.[18]

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[16] Ibid, 105.

[17] Ibid, 160.

[18] Daniel Elliott, Brant Loflin, Debra Wells, Robbie Ethridge, and David Leigh, "A Cultural Resources Survey of Compartment K-11 Fort Benning Military Reservation, Chattahoochee County, Georgia," *Directorate of Public Works Environmental Mgt Division CRM Report* no. 85 (1999): 54.

Research Process

During Fall 2017 under the guidance of Dr. Brad Huff and Mrs. Danielle Cook, as well as Ms. Jess Parks and Mr. Mike Ecks of Fort Benning Curations, I was responsible for remapping an existing historical archaeological site 9CE16 on Fort Benning, Georgia. After conducting a total of three site visits, I mapped a number of visible artifacts from the site, including building materials, architectural features, and a barbed wire site perimeter. A map, shown in Figure 1.1, was then produced to showcase the final product of my research.

When discussing Site 9CE16 and archaeological site names, the initial number represents the U.S. state in which the site is located, the two-letter abbreviation represents the county or area in that state, and the final numbers represent the order in which the site was excavated in said area. The site is split into East and West portions by one of Fort Benning's many tank training compartment access roads. Both Prehistoric Native American artifacts and historic artifacts are found on the East side of the site. The West side, where I completed my research, has no known evidence of prehistoric artifacts and instead contains a number of historic features such as building materials and industrial equipment which date to the late 19th and early 20th centuries.[19] However, this does not suggest that there are not both prehistoric artifacts on both sides of the site. Further research is necessary in order to prove or disprove said claim.

We conducted a total of three site visits throughout the research process. The objective of the first was to gain insight into the general layout of the site and to compare and contrast the locations of artifacts based on the original site map produced by PanAmerican Consultants nearly two decades ago. During this survey, we visited the bridge and viewed local water features, walked the barbed wire fence line to better gauge site perimeter, explored differences in

[19] Elliott et al, "A Cultural Resources Survey of Compartment K-11," 54.

elevation inside the site, and confirmed the locations of artifacts and features based on existing cartography. The objective of the second site visit was to flag artifacts and features which would later be remapped. Many of these artifacts were ones which were present on the original site map, with the exception of the wooden bridge and the sorghum syrup cane cooker. The entire perimeter fence was flagged and mapped to show how the site is not contained based on the compartment parameters established by Fort Benning. This process proved to be difficult, as much of the fencing was covered by foliage and had to be carefully distinguished. On the third and final site visit, we returned to flagged artifacts and features and plotted their locations within the closest possible accuracy. The original site boundary and datum point established by PanAmerican Consultants was also included for comparison.

The locations of visible artifacts and features present on the site were mapped using a Trimble Juno 3B handheld GPS data collector. The locations for these artifacts were recorded within 4-meter accuracy. The shapefiles with the locations of artifacts and architectural features was then uploaded to ArcMap 10.5 ArcGIS software in order to produce an overall site map which can be seen in Figure 1.1. When initially setting up the database, artifacts and architectural features were separated into individual shapefiles in order to differentiate between line and point features. Artifacts were classified as point features and architectural features were classified as line features. Artifacts mapped included building materials such as concrete blocks and bricks, a possible cane cooker, smoke stack, and possible well depression. Architectural features included a bridge, contemporary barbed wire perimeter fence, cattle dip, training compartment road, and a natural creek.

In order to better analyze the individual components present on the eastern side of Site 9CE16, I included three data frames into the final map which can be viewed in Figure 1.1. One includes only the North side of the side, the other the South side, and the last is the entire area which was surveyed for this research project. After the site map was produced, however, it became apparent that it was difficult to differentiate between map symbology because of the size of the survey area. This larger map was then separated into North and South, which can be viewed in Figures 1.2 and 1.3, in order to better analyze the contexts of artifacts and features on the site.

The north side of Site 9CE16, which can be viewed in Figure 1.2, includes the majority of artifacts and architectural features. Here, we located a conglomeration of numerous building material artifacts including large cement foundation blocks, both divetted and undivetted, and brick piles (Figures 2.1, 2.2, and 2.3). Remnants of a wooden bridge (Figure 2.4) are located just north of these artifacts and connect the training compartment road to marshland, marking the northernmost point of research on the north end of Site 9CE16. Approximately 10 meters north of the building materials is a metal smoke stack. (Figure 2.5). An arsenic cattle dip (Figure 2.6), used by farmers to de-tick their cattle, is located approximately 25 meters east of the building materials and smoke stack. Though it is not visible in Figure 1.2, a possible well depression (Figure 2.7) is present on the site approximately 50 meters south of the building materials, although the existence of a well may have been unlikely due to the creek which would have run through the area.

Because the building material artifacts on the north side are located so close together, it can be inferred that the primary structure of the site was located there and was most likely a house with a smoke stack chimney. A cattle yard or pasture would have been located south of this structure near the cattle dip, and the well depression may have existed a bit further south for additional freshwater access. Because the bridge aligns almost perfectly with the compartment access road, archaeologists believe that the presence of a road in the same location may predate the one Fort Benning re-cut by at least a century.

The south side of Site 9CE63, which can be viewed in Figure 1.3, contains only two distinct features: the possible sorghum cane cooker (Figure 2.8) and the creek which runs approximately 10 meters south of the cooker. Though it seems too far away from the building materials on the north end of the site to be related, the cane cooker would have likely been kept at a safe distance from the house due to it being a fire hazard. Overall, with the number of agricultural components present on the site, archaeologists have concluded the site would have been home to a very industrious family who produced much of their own food, water, and sorghum syrup.

Though the map which was produced as a result of my research was similar to the original site map produced by PanAmerican Consultants, a few updates have been made. The inclusion of the remapped barbed wire site perimeter fence is one, as it is vital in grasping the size of the site in relativity to Fort Benning land parcels. The site predates the fencing, as it does not fully encompass the artifacts on the North side of the site and the possible cane cooker on the south side. Because the cane cooker is located so far away from the other centralized artifacts at Site 9CE16, it could have been missed by original shovel test pits, thus being why it was not included in the original site map. In addition, the wooden bridge was also not included in previous maps completed at this site, though it is vital in understanding both how the geography of the creek played a role at the site and for grasping the full scope of the site, which could very well extend across the marshland.

For any future endeavors at site 9CE16, I would recommend utilizing the LiDar of the region, as well as historical documents, to produce a 3D model to recreate Site 9CE16. This would allow researchers to visualize and interpret how the site may have looked over a century ago. Using such a model will give archaeologists a base from which to work when studying similar sites on Fort Benning.

Conclusion and Setbacks

Throughout the research process, I encountered a number of setbacks. The first was the difficulty in accessing Site 9CE16. Because the site is located approximately twenty miles inside of Fort Benning, the training compartment in which it is located is frequently used for tank drills. In order to get cleared to visit the site safely, days had to be chosen which worked around the Army's training schedules. The second was the limited amount of time we had to visit the site, which can be attributed to its difficulty to access. Had we had more chances to survey the site, it may have been possible to plot more scattered artifacts and do a more thorough sweep of the site to have a more developed push piles analysis of fallen building materials. The last was the lack of higher-tech survey equipment, such as a total station GPS, which can plot the locations of artifacts and features within centimeters of accuracy instead of meters. Though the Trimble Juno I utilized can typically predict within inches of accuracy, the dense tree cover over the site interfered with satellite communications to and from my unit. Despite these difficulties, it was still possible to conduct thorough research and produce a closely accurate site map.

Furthermore, without the use of GIS in the field, archaeologists would be forced to rely on hand-drawn maps in order to pinpoint the location of artifacts and architectural features. Though archaeologists relied solely on this practice for decades, it is no longer a sufficient stand-alone method for the analysis of sites. The introduction of GIS has been invaluable in that has made site and landscape reconstruction possible, which has revolutionized the way archaeologists study past environments and cultural groups. In addition, the ability to plot artifacts within centimeters of locational accuracy has significantly improved the validity of archaeological research and will aid in any future research. GIS has even made it possible to predict the potential location of undiscovered sites using statistical and mathematical variables. This new technology is changing the game across the board of the humanities and archaeology is no exception. I sincerely look forward to using GIS in my future research endeavors and anticipate the many developments which have yet to make their debut in the field.

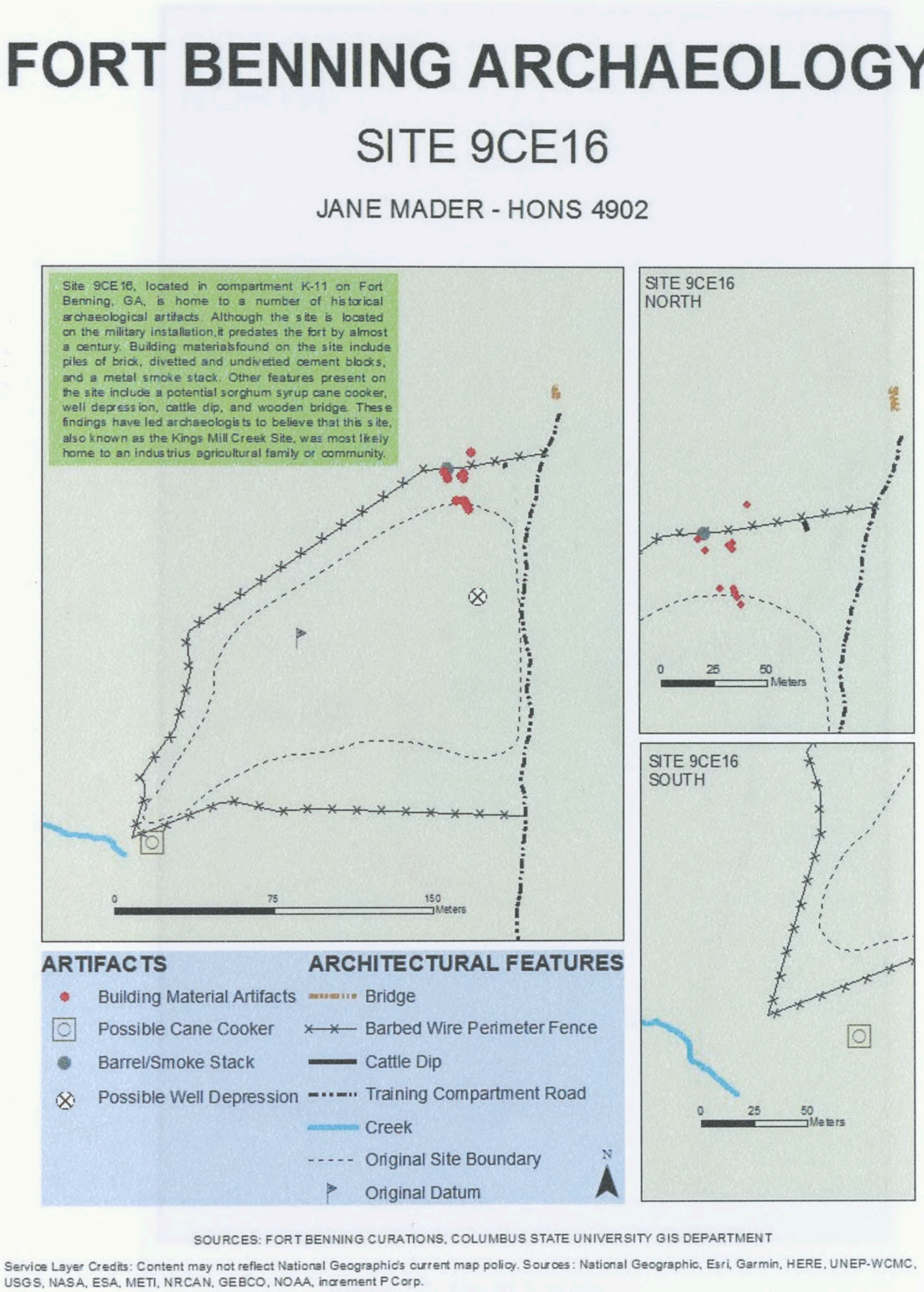

Figure 1.1: Fort Benning Archaeology: Site 9CE16

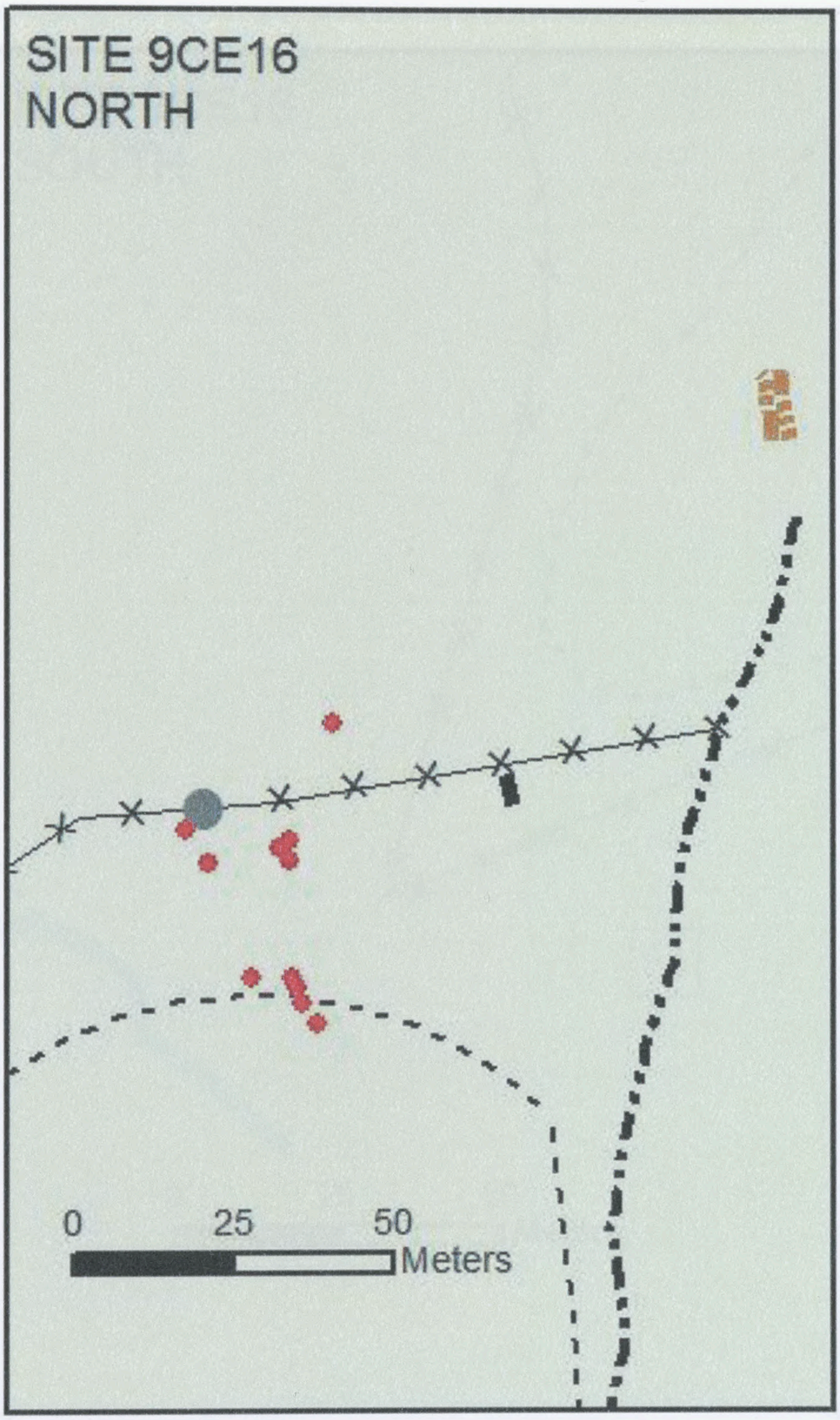

Figure 1.2: Site 9CE16 North

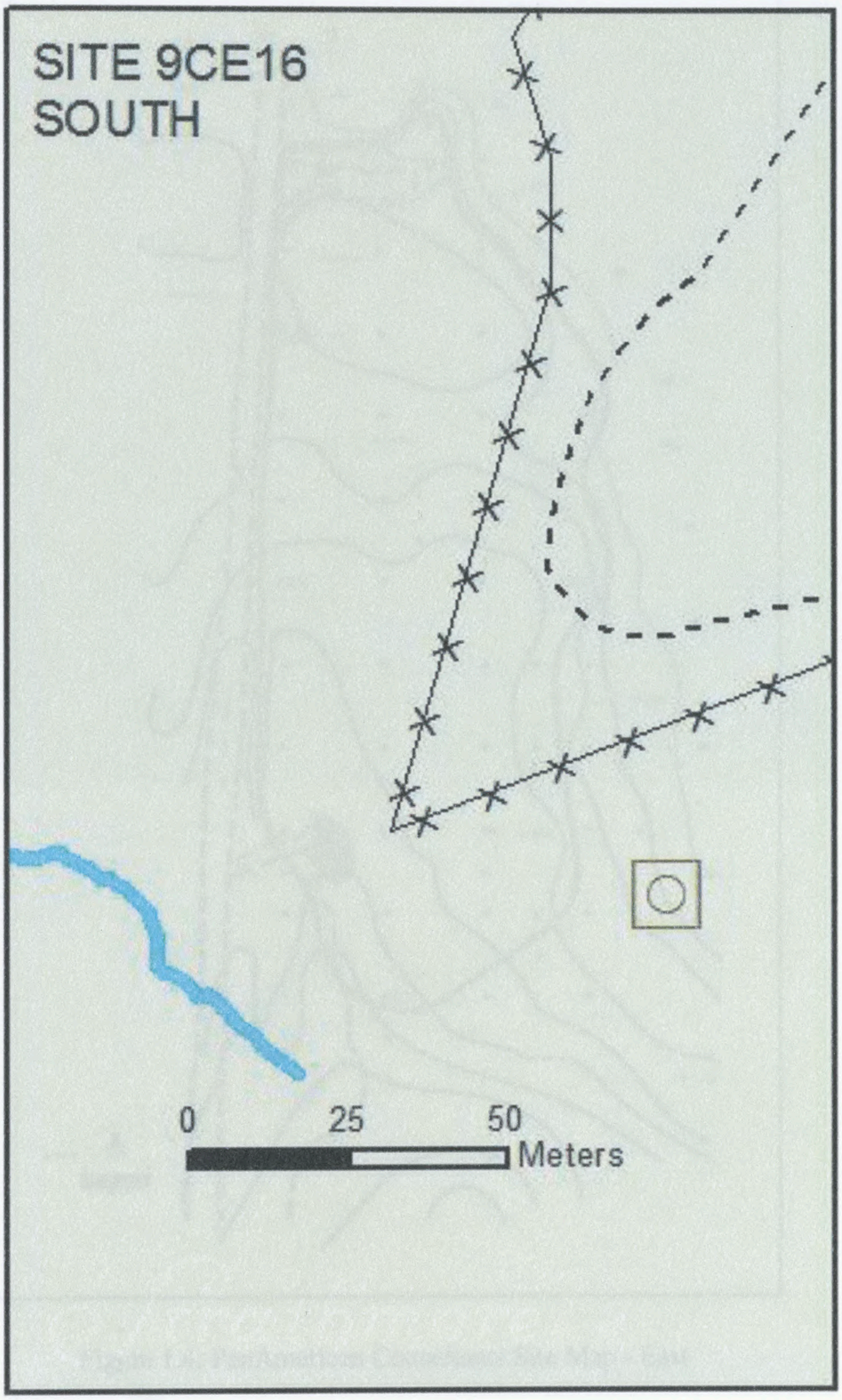

Figure 1.3: Site 9CE16 South

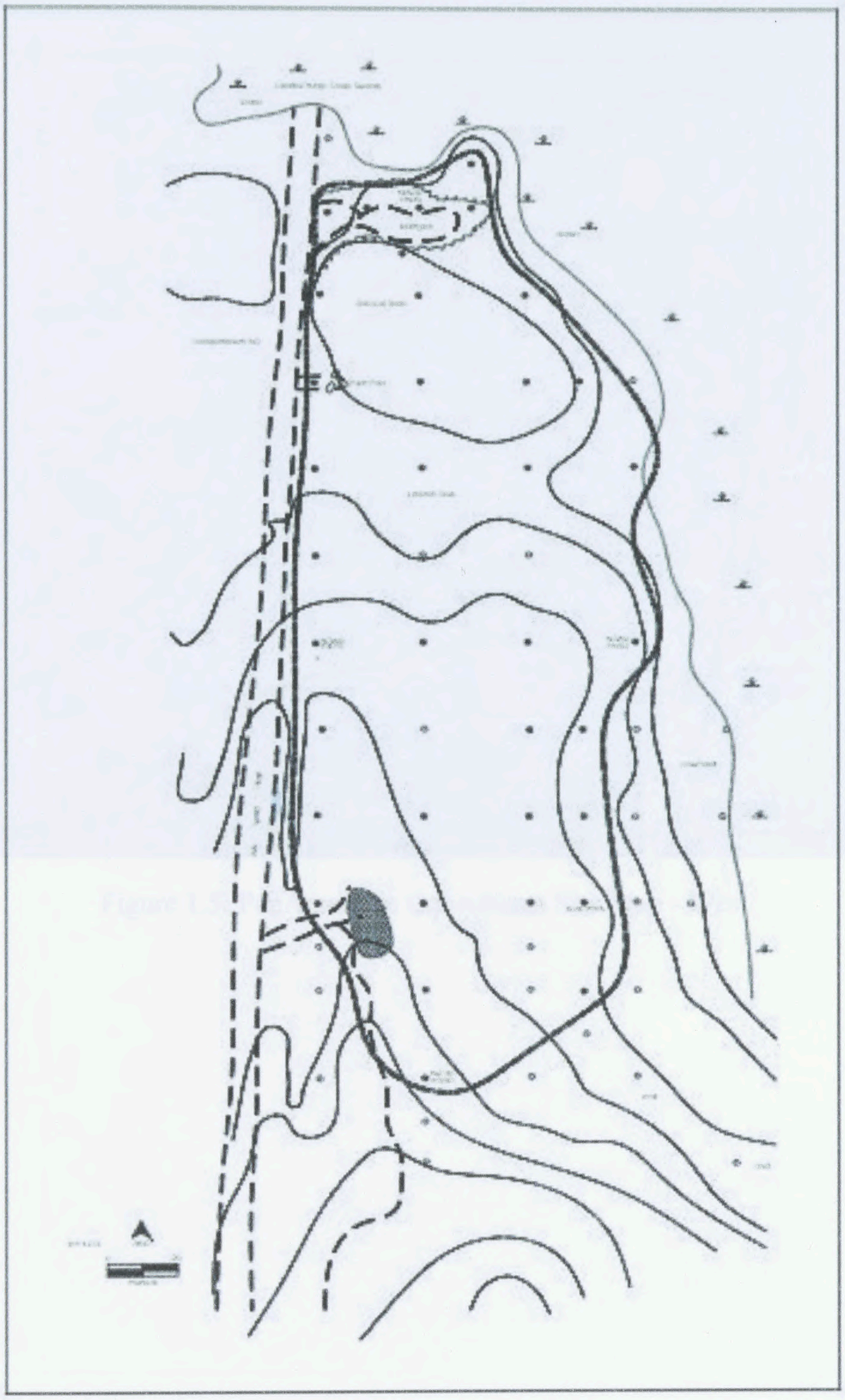

Figure 1.4: PanAmerican Consultants Site Map - East

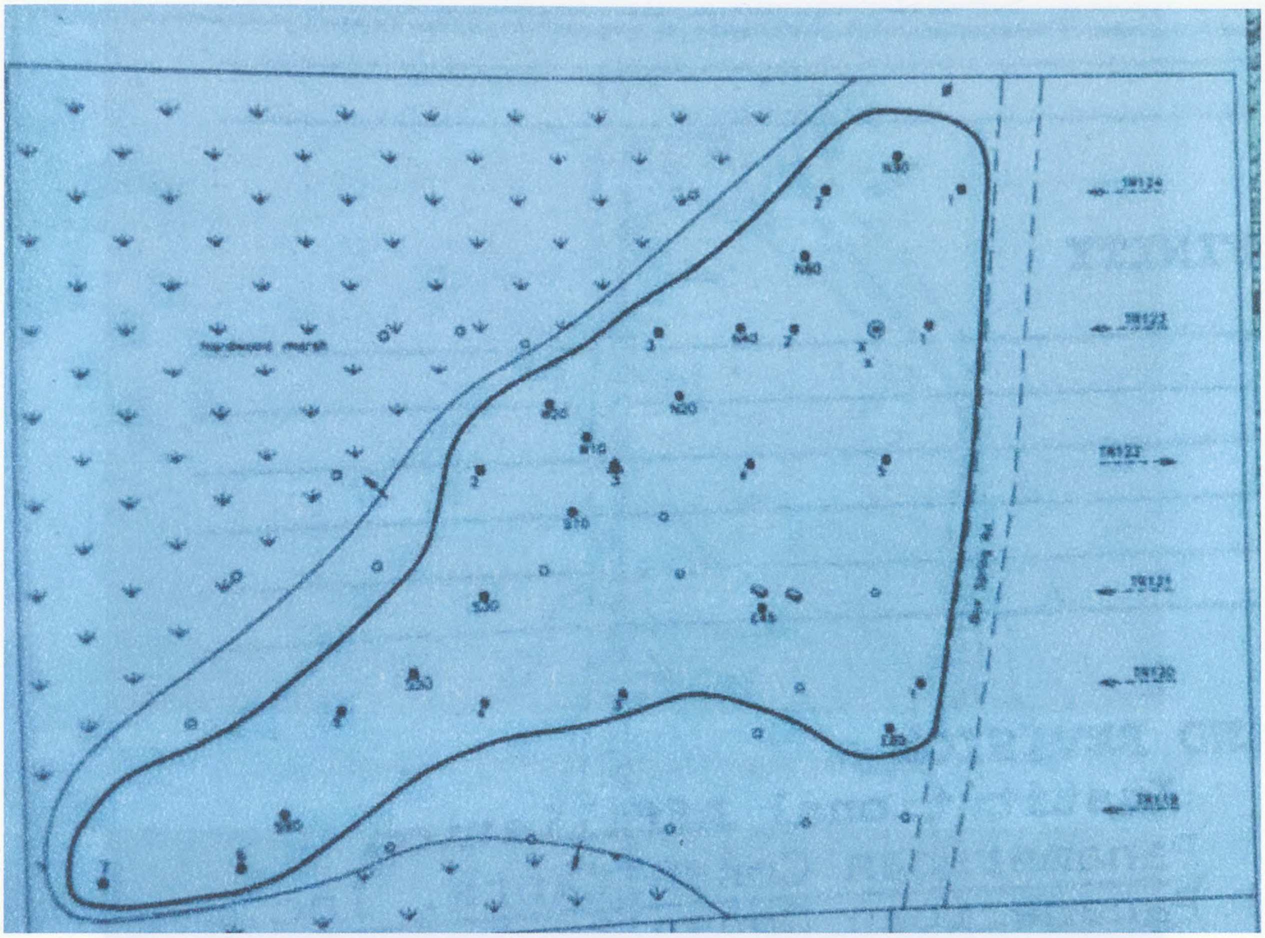

Figure 1.5: PanAmerican Consultants Site Map - West

Figure 2.1: Divetted Cement Foundation Block

Figure 2.2: Undivetted Cement Foundation Block

Figure 2.3: Large Brick Pile

Figure 2.4: Wooden Bridge

Figure 2.5: Smoke Stack

Figure 2.6: Cattle Dip

Figure 2.7: Possible Well Depression

Figure 2.8: Sorghum Syrup Cane Cooker

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