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PHASE I MARINE ARCHEOLOGICAL REMOTE SENSING SURVEY OF THE PROPOSED MISSISSIPPI RIVER SAND BORROW SITES FOR THE LOUISIANA COASTAL AREA BARRIER SHORELINE RESTORATION PROJECT, PLAQUEMINES PARISH, LOUISIANA

FINAL REPORT
SEPTEMBER 2008

PREPARED FOR:

U.S. ARMY CORPS OF ENGINEERS
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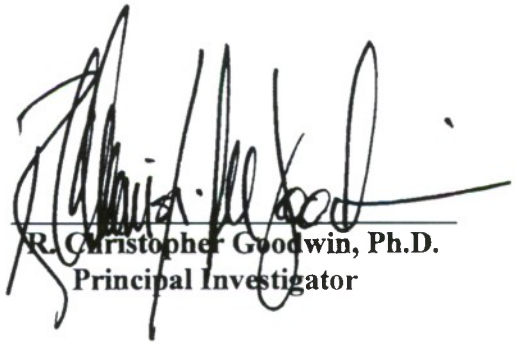
Final Report



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ABSTRACT

This report presents results of Phase 1 marine archeological remote sensing survey of the proposed Mississippi River sand borrow sites for the Louisiana Coastal Area Barrier Shoreline Restoration Project, Plaquemines Parish, Louisiana. R. Christopher Goodwin & Associates, Inc. performed this work on behalf of the U.S. Army Corps of Engineers, New Orleans District (USACE-NOD). This study was carried out prior to the planned commencement of dredging at this location to assist the USACE-NOD in compliance with Section 106 of the National Historic Preservation Act of 1966, as amended. All aspects of these investigations were completed in accordance with the Secretary of the Interior's *Standards and Guidelines for Archeology and Historic Preservation* (48 FR 44716), and in consultation with the Louisiana Department of Culture, Recreation and Tourism, Division of Archeology.

The study area comprised two survey blocks designated Blocks A and B. These areas measure a total of 2,065 ac (835.6 ha), and are located between Mile Markers 25.0 and 35.0 above Head of Passes along the Mississippi River.

Marine remote sensing survey was conducted utilizing a marine magnetometer, an echo sounder, a sub-bottom profiler, and a side-scan sonar. A total of forty (40) individual magnetic anomalies, and nine (9) individual acoustic anomalies were registered in Block A, and 332 individual magnetic anomalies, and 28 individual acoustic anomalies were registered in Block B. The application of pattern recognition protocols and examination of remote sensing data permitted the discrimination of five (5) targets in Block A, designated Targets 1-5, and 27 targets in Block B, designated Targets 6-32, that merited more detailed scrutiny. None of the targets identified in Block A, and only four of the targets identified in Block B exhibit characteristics that suggest they may represent significant submerged cultural resources. Targets 13, 30, 31 and 32 require either complete avoidance or further investigation in consultation with Louisiana SHPO.

TABLE OF CONTENTS

LIST OF FIGURES - (APPENDIX I)

LIST OF TABLES - (APPENDIX II)

CHAPTER I

INTRODUCTION

This report presents results of Phase I marine archeological remote sensing survey of the proposed Mississippi River sand borrow sites for the Louisiana Coastal Area Barrier Shoreline Restoration Project, Plaquemines Parish, Louisiana (Figure 1). R. Christopher Goodwin & Associates, Inc. performed this work on behalf of the U.S. Army Corps of Engineers, New Orleans District (USACE-NOD). This study was carried out prior to the planned commencement of dredging at this location to assist the USACE-NOD in compliance with Section 106 of the National Historic Preservation Act of 1966, as amended. All aspects of these investigations were completed in accordance with the Secretary of the Interior's *Standards and Guidelines for Archeology and Historic Preservation* (48 FR 44716), and in consultation with the Louisiana Department of Culture, Recreation and Tourism, Division of Archeology.

The present study area comprised two survey blocks located between Mile Markers 25.0 and 35.0 above Head of Passes (Figure 2). These survey blocks cover approximately 58 per cent of this reach of the Mississippi River. The upper block, Block A, measures approximately 458.0 acres (185.3 hectares), the lower block, Block B, measures approximately 1607.0 acres (650.3 hectares). A total of 86 transects of varying lengths were spaced at 50.0 ft (15.2 m) intervals and surveyed between 24 June and 16 July (Figure 2). Fifty (50) were surveyed in Block A for a total of 1422879.0 linear ft (433693.5 linear m), and 36 were surveyed in Block B for a total of 404528.0 linear ft (123300.1 linear m). Survey was conducted applying Louisiana State Plane (South 1702), North American Datum 1983 (NAD 83), survey feet.

Research Objectives and Design

Objectives of this study were to identify targets that have potential to represent significant submerged cultural resources, and, whenever possible, to assess the significance of identified resources applying the National Register of Historic Places (NRHP) Criteria for Evaluation (36 CFR 60.4 [a-d]). These objectives were met through the application of a research design that included both archival investigations and marine archeological remote sensing survey and analysis. The history of the project area was researched through examination of State of Louisiana archeological site files, local historical records, reports of previous cultural resources investigations, historic maps, and relevant secondary sources.

Archival investigations indicated a moderate potential for encountering submerged historic cultural resources within the project area. This is due to the identification of eleven shipwrecks that reportedly occurred within the study areas, and 54 others that occurred within 5.0 mi (8.0 km) of these locations (Figure 2). Table 1 lists these vessels and their reported locations. This list includes ironclad and cottonclad gunboats, freighters, barges, and charter vessels that were lost as a result of running aground, collision and foul weather, and provides a useful cross-section of shipping losses in the vicinity of the study area. Review of the geomorphology of the study area indicated a low potential for encountering submerged terrestrial archeological sites in these areas.

State of Louisiana archeological site files and relevant research reports document that twenty (20) cultural resources surveys have been conducted, twenty-two (22) previously recorded archeological sites have been identified, and two (2) previously recorded standing structures have been identified within 5.0 mi (8.0 km) of the present study area.

Marine remote sensing survey was conducted from the crew boat *Dahli Brooke*, operated by Jambon Boat Rentals, LLC. The equipment used during survey included a *Trimble AG132* differential global position system (DGPS), a *Geometrics G-881A* cesium vapor marine magnetometer, an *Imagenex 1030F* digital sub-bottom profiler, a *Marine Sonic* 600 kHz digital side scan sonar, and a *Cetrek* digital echosounder. Data were collected and correlated via laptop computer using *Hypack Max ver. 4.3b* hydrographic survey software, and inventoried, post-processed, and analyzed to identify specific targets that potentially represent significant submerged cultural resources.

Marine remote sensing survey registered a total of forty (40) individual magnetic anomalies, and nine (9) individual acoustic anomalies in Block A, and 332 individual magnetic anomalies, and 28 individual acoustic anomalies were recorded in Block B (Tables 3-4). The application of pattern recognition protocols and examination of remote sensing data permitted the discrimination of five (5) targets in Block A, designated Targets 1-5, and 27 targets in Block B, designated Targets 6-32, that merited more detailed scrutiny (Table 4).

R. Christopher Goodwin, Ph.D. served as the Principal Investigator for this project, and Jean B. Pelletier, M.A. directed data collection and analyses. Nautical Archeologist Franklin H. Price, M.A. assisted with remote sensing data collection. Katy Coyle, M.A., assisted with site file research, Brian Cleven, M.A. assisted with historical research, and Kirsten G. Peeler, M.A., served as the Project Historian. Kathryn A. Ryberg, M.Sc., assisted with editing and Troy J. Nowak, M.A. assisted with all aspects of this project.

Organization of the Report

This report develops the natural and historical contexts of the study area as the basis for analysis and interpretation. The natural settings of the study area are discussed in Chapter II, and Chapters III and IV discuss the prehistoric and historic context of the study areas. Chapter V reviews previously conducted cultural resources investigations within 5.0 mi (8.0 km) of the study area. Chapter VI reviews the sources consulted during archival investigations, as well as the instruments and methods employed during remote sensing data collection. Chapter VII examines results of archival investigations, and presents analyses of the remote sensing data. A summary of this study and management recommendations are provided in Chapter VIII.

CHAPTER II

NATURAL SETTINGS

This chapter reviews the geologic setting and geomorphic processes of the Mississippi River relevant to the present study areas. It provides insights into aspects of the physiography, sedimentation, and stratigraphy of these areas helpful to our understanding of the potential to discover significant cultural resources within the proposed project areas.

Geomorphology

Physiographically, the project area is situated in the Mississippi River deltaic plain subsection of the Lower Mississippi Valley section of the Gulf and Atlantic Coastal Plain Province of North America (Murray 1961). The deltaic plain consists of a near-sea-level, flat alluvial plain measuring approximately 39,960 km^2 (15,430 mi^2). This plain is dominated by long, low and narrow distributary ridges that are separated by broad interdistributary wetlands, intratidal swamps and marshes. It is part of the Mississippi Alluvial Plain Section of the Coastal Plains Province (Saucier 1994). The Mississippi deltaic plain is further divided into a composite geomorphic surface that consists of a series of coalesced deltaic plains called "delta complexes." The surface of each of these plains exhibits an extensive network of distributaries that radiate toward the Gulf of Mexico from either an abandoned or an active Mississippi River course. Each delta complex consists of individual delta lobes, and each delta lobe is comprised of smaller deltaic plains built by one of a number of major distributaries branching from the single Mississippi River course that fed the delta complex. Like the delta complexes, the amount of water and sediment that a delta lobe received from the Mississippi River varied greatly throughout the life of the complex. Thus, within the life of a delta complex, the times at which the different delta lobes comprising it were active varied considerably (Frazier 1967). The present study areas are located in the Plaquemines delta complex which dates from the last 1,350 years (R. Christopher Goodwin & Associates, Inc. 2006a).

The distal edges of the natural levees now lie below sea level and remain subaerially exposed only where protected by artificial levees. Natural levee deposits vary in thickness from 10.0 ft (3.0 m) to less than 5.0 ft (1.5 m) and typically overlie marsh deposits measuring approximately 3.3 ft (1.0 m) thick. The natural levees on the left descending bank tend to be thinner and narrower than the natural levees along the right descending bank. Away from the banks of the Mississippi River, the natural levee deposits quickly thin and grade laterally into marsh deposits approximately 16.0 to 23.0 ft (4.8 to 7.0 m) thick (R. Christopher Goodwin & Associates, Inc. 2006a).

Natural levee deposits typically consist of well-bedded, unfossiliferous, clayey silts and silty clays that have been deposited by seasonal floods, whose marsh deposits are composed of massive, organically-rich, clayey silts and silty clays that contain ostracods, the remains of fiddler crabs and crayfish, and gastropods such as *Littorina* sp. and *Neritina* sp. (Fisk et al. 1954; Kolb 1962). The marshes and distal natural levees in turn cover historic subdeltas. In the study areas, the marshes cover the Bayou du Mardi Gras Subdelta which formed during the early 1700s and the Liard Bayou Subdelta, which formed during the middle 1700s,

underlies the marshes that adjoin the natural levee and the point bar deposits (Morgan 1977; R. Christopher Goodwin & Associates, Inc. 2006a).

Soils in the project area are mapped as the Sharkey-Commerce, Frequently Flooded Association. This association consists of somewhat poorly drained to poorly drained soils that are subject to frequent flooding and typically are semi-permanently inundated or saturated for a major portion of the growing season. Because of their poor development and low height, the crests of these immature natural levees are characterized by the Commerce series, which normally occurs only on the low distal edges of mature natural levees. The Commerce series is a nonacid entisol that typically has a 1.7 to 3.3 ft (0.5 to 1.0 m) thick sola with an A-Bw-Ab-C horizon sequence. The buried A horizon, designated as an "Ab" horizon, results from high sedimentation rates within an aggrading natural levee system. Sharkey soils are poorly drained, nonacid inceptisols developed within the distal edge of the natural levees. Typically, its sola consist of a 3.0 to 4.9 ft (0.9 to 1.5 m) thick, A-Bg-BCg-Cg horizon sequence with a clay surface layer and either a silt loam, silty clay loam, or silty clay subsurface layer. Sharkey soils have a high shrink-swell potential (Schumbacher et al. 1988; U.S. Fish and Wildlife Service 1981).

Flora and Fauna

The flora and fauna in the vicinity of the project areas vary greatly between the natural levees and the adjacent freshwater swamps. The differences in flora and fauna result from the distinct differences in the drainage of each area (Penfound and Hathaway 1938).

The natural levees within the project area originally were covered by a natural levee oak forest. Principal overstory within the oak forest would have been water oak (*Quercus nigra*), overcup oak (*Quercus lyrata*), cottonwood (*Populus deltoides*), sweetgum (*Liquidambar styraciflua*), sycamore (*Platanus occidentalis*), black willow (*Salix nigra*), hackberry (*Celtis laevigata*), swamp privet (*Forestiera acuminata*), water locust (*Gleditsia aquatica*), and honey locust (*Gleditsia triacanthos*). The understory of these forests typically includes shrubs such as buttonbush (*Cephalanthus occidentalis*), wax myrtle (*Myrica cerifera*), dwarf palmetto (*Sabal minor*), marsh elder, elderberry (*Sambucus canadensis*), and yaupon (*Ilex vomitoria*), and vines such as trumpet creeper (*Campis radicans*), poison ivy (*Rhus radicans*), and ratten vine (*Berchmis scandens*). The ground cover of the natural levee consists of various grasses (*Gramineae*) and sedges (*Cyperaceae*). The transition zone between the natural levee oak forest and adjacent marsh is covered by dense shrubs and cane (Penfound and Hathaway 1938; R. Christopher Goodwin & Associates, Inc. 2006a).

Vegetation within the batture area consists of those pioneer species that first appear upon newly formed land along the margins of a point bar. The batture occupies an area that receives some sand and silt with each new flood. The flora commonly is dominated by black willow (*Salix nigra*) and associated cottonwood (*Populus deltoides*). The black willow is a temporary, short-lived pioneer species that rapidly colonizes newly deposited fluvial sediments. Cottonwood ultimately outgrows the black willow and becomes the dominant tree, except where frequent and extended flooding during the growing season covers the trees and limits its growth. Depending on the degree that batture aggradation has limited flooding, other plants such as riverbirch (*Betula nigra*), green ash (*Fraxinus pennsylvanica*), hackberry (*Celtis laevigata*), swamp privet (*Forestiera acuminata*), water elm (*Planera aquatica*), bald cypress (*Taxodium distichum*), box elder (*Acer negundo*), and red mulberry (*Morus ruba*) also can become significant components of the batture community (R. Christopher Goodwin & Associates, Inc. 2006a).

The natural levee oak forests and adjacent batture community support a large and varied fauna. The fauna includes large mammals like white-tailed deer (*Odocoileus virginianus*), and smaller species like gray squirrel (*Sciurus carolinensis*), fox squirrel (*Sciurus niger*), eastern cottontail (*Sylvilagus floridanus*), and swamp rabbit (*Sylvilagus aquaticus*). The fauna of both communities also include predator mammals such as red fox (*Vulpes fulva*), gray

fox (*Urcyon cinereoargenteus*), raccoon (*Procyon lotor*), long-tailed weasel (*Mustela frenata*), and mink (*Mustela vison*). These species, together with raptors, are important in limiting the size of the rabbit, mouse, squirrel, and bird populations. The mink and raccoon also are important along with nutria (*Mycocaster coypus*) and opossum (*Didelphis marsupialis*) as fur bearers. Some of the avian species commonly found within these forests include painted bunting (*Passerina cirris*), red-winged blackbird (*Agelaius phoeniceus*), common crow (*Corvus brachyrhynchos*), common night hawk (*Chordeiles minor*), screech owl (*Otus asio*), black vulture (*Coragyps atratus*), and turkey vulture (*Cathartes aura*). The oak forests are home for numerous amphibians such as various species of salamanders, toads, tree frogs, and true frogs. The numerous reptiles found within the oak forests include a variety of iguanids, skinks, lizards, snakes, pit vipers, and turtles (Lowery 1974a, 1974b; Penfound and Hathaway 1938; R. Christopher Goodwin & Associates, Inc. 2006a).

Climate

The overall natural setting of the proposed borrow project is consistent with the general climatic pattern for Plaquemines Parish. The parish is characterized by a humid subtropical climate with long, hot, and rainy summers, average temperatures peaking in July at 36° C (97° F) and an average maximum temperature of 89° F (32° C) (Trahan 1988). Winters generally are mild and pleasant with temperatures averaging about 50° F (10° C); freezing temperatures 32° F (0° C) may occur from November through mid-March, but usually only after nightfall. Measurable amounts of snowfall occur about once every 20 years; however, when snowfall does occur, it can exceed 2.0 in (5.0 cm) (Trahan 1988).

CHAPTER III

PREHISTORIC PERSPECTIVE

Introduction

Plaquemines Parish is located in southeastern Louisiana. It is comprised of alluvial deposits that date entirely from the Holocene and are associated with the development of the Mississippi River delta. The prehistory of this reach of Louisiana dates from 12000 B.P. to European contact, but the near surface landforms and deposits within the present study area date from no earlier than 5000 B.P. The prehistoric cultural sequence of this region ranges from the Paleo-Indian to the Mississippian Stages, but only sites dating from the Archaic Stage or later are anticipated within the study area. Nevertheless, this chapter includes a summary of the entire prehistoric cultural sequence in order to provide a comprehensive overview of Louisiana prehistory.

Louisiana prehistory can be divided into four general stages: Paleo-Indian, Archaic, Woodland, and Mississippian. These are developmental segments characterized by dominant patterns of subsistence and technology (Kreiger 1953; Willey and Phillips 1958). Each stage consists of a sequence of chronologically defined periods, which may be sub-divided into phases based on analyses of material culture and other characteristics particular to specific cultures and geographic regions (Jenkins 1979; Walthall 1980). While different systems have been used to organize and describe the prehistory of this region, the stage-period-phase system described by Willey and Phillips (1958) will be utilized in the discussion below.

Paleo-Indian Stage (ca. 12000 to 10000 B.P.)

Paleo-Indian occupation of the southeastern United States generally is believed to have occurred sometime between 10,000 and 12,000 years ago. Paleo-Indian sites are characterized by a distinctive assemblage of lithic tools that includes fluted and unfluted lanceolate projectile points/knives, unifacial end and side scrapers, gravers, and spokeshaves. Chipped stone artifacts of this stage exhibit a high level of workmanship including fine flaking, edge grinding, retouching, and basal thinning (Neuman 1984; Smith et al. 1983).

Paleo-Indian peoples are thought to have been highly mobile hunter-gatherers, organized in small bands or extended family groups. The notion that Paleo-Indian populations were represented by specialized big game hunters seems less tenable as information becomes available from a more inclusive set of Paleo-Indian sites. Although sufficient evidence exists for the exploitation of mega-fauna including mammoth, mastodon, bison, caribou, and elk at sites in the western and northern United States, no conclusive evidence exists that attests to a prevalence of similar practices in the southeast. The occurrence of fluted projectile points/knives in the southeastern United States is thought to reflect contemporaneity with a culture similar to that represented by Clovis sites recorded in the western and northern United States. Whether or not this suggests that big game hunting was a dominant adaptive strategy in the southeast is less certain because of the regional

environmental differences associated with the availability of the big game species.

Although there is little data upon which to base a dietary reconstruction, Paleo-Indian subsistence throughout the Southeast is believed to have encompassed a broad spectrum of resources, including fish, fowl, deer, small mammals, nuts, and gathered plants (Smith 1986:9-10; Steponaitis 1986:369; Walthall 1980:36).

Most of the archeological evidence associated with the Paleo-Indian occupation of the southeastern region is limited to surface finds of diagnostic projectile points/knives (Mason 1962). In the Lower Mississippi Valley, Paleo-Indian projectile points/knives have been recovered along valley margins, rarely in the alluvial valley or along the coastal plain, and site distribution studies indicate that Paleo-Indian sites in the eastern United States tend to be located on eroded terraces plateaus (Walthall 1980). Paleo-Indian and Early Archaic presence in the Lower Mississippi Valley is best documented at Maçon Ridge. Maçon Ridge is a relict Pleistocene braid plain in Northeastern Louisiana that until recently was not known to contain sites older than the Late Archaic Period (Saucier 1981). Hillman (1990) collected information concerning 121 sites on the Maçon Ridge from which over a thousand Paleo-Indian and "epipaleoindian" projectile points/knives have been collected, including 272 Dalton-Meserve, 39 Hardin, and over 400 San Patrice types. He concluded that the Early and Middle Paleo-Indian occupation of Maçon Ridge apparently was sporadic or seasonal, possibly reflecting the somewhat inhospitable conditions caused by the excessive accumulation of wind-blown dust across open grasslands during the formation of the loess hills.

The distribution of recorded sites suggests that Maçon Ridge was occupied more intensely during the Late Paleo-Indian and Early Archaic Periods. However, during the Late Paleo-Indian Period, hunting camps and base camps normally were located very close to streams, ponds, or sloughs, on landforms generally no more than 3.3 ft (1.0 m) above the water source, even when higher elevations or ridges were located in the immediate vicinity. This preferential use of areas adjacent to waterways may reflect the intensive use of the wooded fringes situated along the waterways rather than the exploration of open grasslands. By the early Archaic Stage, settlement shifted to the higher elevations, possibly reflecting an environmental transformation of Maçon Ridge from open grasslands to open woodlands (Hillman 1990).

Brain (1983) states that Paleo-Indian projectile points/knives have been found along relict channels of the Mississippi River and remnant Pleistocene surfaces in the floodplain that pre-date 9000 BP. In Louisiana, Paleo-Indian sites have been found along tertiary upland ridges and uplands/floodplain bluffs (Guy and Gunn 1983). Projectile points/knives such as Clovis, Folsom, Scottsbluff, Plainview, and Meserve have been found on the surface of these sites. The majority of these projectile points/knives have been found in northern Louisiana, very few have been found on late Pleistocene Prairie Terrace deposits in the southern part of the state.

Given the erratic nature of the Mississippi River and its meanderings, Paleo-Indian sites that once may have been abundant in southern Louisiana have been submerged by rising sea levels, destroyed by river scouring, or buried by alluvial deposition. All modern surface and near-surface landforms in the vicinity of the study area are believed to post-date the Paleo-Indian stage. If older landforms such as relict beach ridges do exist in the study area, they are deeply buried and beyond the scope of the present study. As a result, the probability of identifying cultural resources that provide evidence of Paleo-Indian occupation within the confines of the present study area is very low.

Archaic Stage (ca. 10000 to 3200 B.P.)

The term "Archaic" first was coined during the second quarter of the twentieth century as a descriptor for the pre-ceramic cultures that followed the Paleo-Indian Stage. Environmental changes at the end of the Pleistocene resulted in a range of technological and social developments (Willey and Phillips 1958). Although evidence suggests that a degree of continuity existed between the adaptations of prehistoric peoples living in

northern forests and those who lived in forests along the initial coastal plain of the Gulf of Mexico, these groups probably practiced varied resource and food procurement strategies that were based on the availability of local resources (Haag 1971). Caldwell (1958) termed hunting and gathering specialization as "maximum forest efficiency," and Brain (1971) modified this phrase to "maximum riverine efficiency" in reference to southeastern riverine and coastal communities. Archaic peoples often moved seasonally based on the availability of nuts, fruits, fish, game, shell fish, and other natural resources (Muller 1978).

Archaic societies typically formed macrobands formed during spring and summer, and microbands during the fall and winter (Muller 1978). Archaic populations apparently consumed a greater variety of terrestrial and marine species than their Paleo-Indian predecessors. Many populations with successful strategies during the Archaic Stage developed the first quasi-permanent settlements (Neitzel and Perry 1977).

The Paleo-Indian to Archaic Stage transition was accompanied by a change in stone tool morphology. These changes included the emergence of a wide variety of notched and stemmed projectile point/knife forms, and the disappearance of earlier fluted types. Archaic projectile point/knife sequences follow a general trend in haft morphology that progresses from side notched to corner notched to stemmed basal forms. These forms are not mutually exclusive. Other Archaic Stage flaked artifact types included adzes, scrapers, and choppers. During the latter half of the Archaic Stage granitic rock, chert, jasper, sandstone, slate, steatite, and scoria were ground and polished into a variety of stone ornaments and tools, which included beads, gorgets, bowls, and celts/axes. Archaic Stage burials also have been found at numerous sites, suggesting the existence of some form of religion or belief system (Neuman 1984; Walthall 1980). The Archaic Stage can be divided into three subdivisions or periods: Early Archaic, Middle Archaic, and Late Archaic.

Early Archaic Period

In the Southeast, the Early Archaic Period generally begins between 10000 and 8000 B.P., but because of regional variation and temporal overlapping of Stages, the dating of objects can be difficult. Some of the earliest Late Paleo-Indian/Early Archaic projectile point/knife types identified in Louisiana are the San Patrice, the Keithville, and the Pelican forms (Webb et al. 1971). Previously ascribed only to an area encompassing northwest Louisiana, northeast Texas, and southwest Arkansas, recent investigations have extended the geographic range of San Patrice from central Texas to southwest Alabama, and from southern Louisiana to central Arkansas (Brain 1983:32; Cantley et al. 1984).

Throughout the Early Archaic Period, subsistence patterns probably resembled the preceding Paleo-Indian Stage. Early Archaic peoples traveled seasonally in small groups between a series of base camps and extractive sites, hunted deer and collected acorns and nuts (Chapman and Shea 1981; Lentz 1986; Parmalee 1962; Parmalee et al. 1976).

The earliest extant tools associated with food processing, including manos, milling stones, and nutting stones, were recovered from Early Archaic sites. Commonly utilized plant foods, such as walnuts, hickory nuts, and white oak acorns could be hulled and eaten without cooking or additional processing (Larson 1980). Herbaceous seeds, which became an important food source later in the Archaic Stage, generally are absent from the Early Archaic Period assemblages (Chapman 1977; Lentz 1986). Living floors associated with hearths, shallow pit features, and milling tools are known from the Early and Middle Archaic Periods, but little evidence exists to suggest the practice of below-ground food storage or the construction of substantial structures (Steponaitis 1986:371).

Much of our knowledge regarding Paleo-Indian and Archaic lifeways is limited by preservation. Lithic tools often are the only artifacts that survive, but they provide only limited information about a narrow range of activities including the manufacture and maintenance of tools, the processing of meat and hides, and the working of wood and bone.

Although they rarely are preserved in the archeological record, clothing, baskets, and other artifacts made of perishable materials such as bone, wood, antler, shell, hair, hide, plant fiber, and feathers were undoubtedly important elements of the Archaic cultural tradition.

Middle Archaic Period

Three interrelated events shaped Middle Archaic cultures. First, the effects of continental glaciation subsided, resulting in a warmer and drier climate. Sometime prior to 3000 B.P., modern climatic and environmental conditions prevailed. Second, sociopolitical organization changed in some areas, and the development of ranked societies resulted in increased territorialism and regional diversification. Finally, further technological improvements occurred, particularly with respect to groundstone, bone, and antler implements.

This period is typified by the Morrow Mountain Horizon. Small to medium-sized, triangular projectile points/knives with short tapered stems characterize this Horizon. Morrow Mountain forms are distributed widely, and have been discovered from the eastern seaboard to as far west as Nevada, and from near the Gulf of Mexico to as far north as New England (Walthall 1980). In Louisiana, the Middle Archaic Period is represented by projectile points/knives that include Morrow Mountain, Johnson, Edgewood, and possibly Calcasieu types (Campbell et al. 1990:96; Perino 1985:195).

Late Archaic Period

For most of eastern North America, the Late Archaic Period represents the first cultural adaptation to an essentially modern environment. By 4,000 years ago, the current bay tree-bald cypress, southern pine, southern pine-bald cypress, and oak-southern pine forests were established along both the Gulf of Mexico and the Atlantic Coastal plain (Delcourt and Delcourt 1981). The population structure and boundaries of these forest communities may have varied as a result of subsequent climatic changes, but they were similar to their modern counterparts.

Evidence shows that the shorelines along the Atlantic Ocean and the Gulf of Mexico still were stabilizing from 5000 to 3000 B.P., based on the distribution of Late Archaic sites in those areas. Sea levels generally were 3.3 to 6.6 ft (1.0 to 2.0 m) lower during this period (DePratter and Howard 1980; Griffin and Smith 1954). Oyster beds, fish, and other related marine resources, were significant factors in the structure of Late Archaic settlement along the Atlantic and eastern Gulf coasts. Many Late Archaic sites were associated with lower estuaries and upper bays, reflecting a subsistence regime that focused on the use of fish and shellfish.

The Late Archaic Period represents a time of population growth, evidenced by an increasing number of sites found throughout the United States. Stone vessels made from steatite, fiber-tempered pottery, and groundstone artifacts characterize this period. Late Archaic Period projectile point/knife types discovered throughout Louisiana include corner notched and stemmed forms.

Sites associated with this period typically are found along the boundary of Quaternary and Tertiary areas with relatively flat or undulating bluff tops that overlook floodplains. Within the region, Late Archaic sites appear on prairie terraces and relict levees (Gagliano 1963). Archaic style projectile points/knives commonly are found throughout Louisiana; however, few discrete, intact archeological deposits that date from the Archaic Period have been systematically excavated, analyzed, and comprehensively reported in Louisiana (Neuman 1984).

A total of three Late Archaic cultural phases, the generally contemporaneous Pearl River, Copell, and Bayou Blue phases, have been identified for coastal Louisiana. The Pearl River phase is found in eastern Louisiana and frequently is associated with either fresh or brackish water shell middens. The Copell phase has been identified in the Petit Anse region, i.e., in south central Louisiana. In southwest Louisiana the Bayou Blue Site (16AL1), the Late Archaic Period type-site for the Bayou Blue phase, is an earthen midden situated on a natural levee that overlooks a relict channel of Bayou Blue in Allen Parish.

Artifacts recovered from this site include projectile points/knives and lithic debitage discovered beneath a later, Marksville Period, occupation.

Poverty Point Culture (ca. 3500 to 2500 B.P.). Poverty Point represents a transitional culture that originated ca. 4000 B.P., but did not realize its full potential until much later. As a result, the Poverty Point sphere of influence did not arrive in south central Louisiana, southwest Louisiana, or east Texas until ca. 3500 B.P. (Gibson 1994, 1979; Neuman 1984; Pertula and Bruseth 1994). This culture is best represented by its type site (16WC5) located in northeast Louisiana. It is situated adjacent to Bayou Maçon and near several major rivers, including the Mississippi, Tensas, Ouachita, and Boeuf. This riverine location was ideal for exploiting the flow of trade goods from other regions and for cultural diffusion (Jeter and Jackson 1990:142; Muller 1978; Neitzel and Perry 1977). Evidence of long distance trade at Poverty Point includes ceramics from the St. Johns River region of Florida and lithic materials from deposits in Arkansas, Illinois, Indiana, Missouri, Ohio, Oklahoma, and Tennessee (Connaway et al. 1977:106-119; Gibson 1974:26, 1979, 1994; Jeter and Jackson 1990; Lehmann 1982:11-18; Webb 1982:13-14). By convention, the Poverty Point culture has been thought to represent the first chiefdom-level society to develop in the eastern United States; however, Jackson (1991) no longer follows this supposition and believes that the nature of this culture is still unknown (Gibson 1985b; Muller 1978).

The Poverty Point site (16WC5) is distinguished primarily by its large earthworks and its complex microlithic industry. The earthworks at the Poverty Point site include six segmented ridges measuring 50.0 to 150.0 ft (15.2 to 45.7 m) wide that form five sides of an octagon, as well as several other Poverty Point mounds scattered throughout the area. The largest mound, designated Mound A, may be a large bird effigy (Webb 1982). At the time of its construction, Poverty Point was the largest earthwork in the Americas.

Materials identified at Site 16WC5 associated with Poverty Point culture include atlatls, plummets, beads and pendants, thin micro flints/blades, clay cooking balls and plastic objects such as figurines and fetishes, as well as both food storage and preparation containers. Evidence for the use of steatite vessels, baskets and basketry, and tempered and untempered ceramics was uncovered. The majority of ceramics discovered at this site were tempered with sand, grit, clay, or fiber. Webb (1982) also reported discoveries of seed processing implements, polished stone hoe blades, nutting stones, and milling stones and evidence for the use of earthen ovens.

Little is known about the daily lives of the Poverty Point people, and subsistence information is limited to the knowledge that Archaic hunting and gathering activities still were practiced by Poverty Point people. Despite the recovery of seed remains and processing instruments, no evidence of maize or any other cultigens exists to indicate that agriculture was practiced by these peoples (Connaway et al. 1977; Thomas and Campbell 1978; Webb 1982).

Brain (1971) perceives Poverty Point as a bottomland occurrence, while Webb (1982) suggests that Poverty Point sites typically are found in four locations. These areas include the Quaternary terraces or older land masses that overlook major stream courses, major river levees along active or relict river channels, river-lake junctions, and coastal estuaries or older land surfaces located within a coastal marsh area. Poverty Point sites appear to be located in areas ideal for exploiting forest-edge resources and for transporting exotic materials. Sites range in size from large ceremonial centers to more frequently identified hamlets or foraging stations.

In southeastern Louisiana, small shell middens located along the shores of Lake Pontchartrain exhibit Poverty Point traits and suggest seasonal and specialized adaptations to marsh environments. These sites represent two phases of Poverty Point culture: the Bayou Jasmine phase and the Garcia phase. Bayou Jasmine phase sites are located on the western shore of the lake as well as along the natural levee ridges of Mississippi River distributaries. Garcia phase sites are located along the eastern

shore of Lake Pontchartrain. The Garcia Site (16OR34), the type site for the Garcia phase, was found to contain a beach deposit of *Rangia* shells and midden debris. Radiocarbon dates from Bayou Jasmine phase components cluster around 3450 B.P., while Garcia phase sites date about 1000 years later (Gagliano 1963; Gagliano and Saucier 1963). Bayou Jasmine phase sites, such as the type site located along the western shore of the lake exclusively exhibit Poverty Point traits (Duhe 1976). In contrast, Garcia phase sites, located along the eastern shore, contain evidence of bone, tool, and microlithic industries (Gagliano and Saucier 1963).

Phillips (1970) identified a Poverty Point phase that he labeled Rabbit Island. Sites associated with the Rabbit Island phase are situated in the Teche-Mississippi region of coastal Louisiana, and artifacts recovered from this type site include non-local lithic materials, microlithics, and baked clay objects (Gagliano 1963). Subsequently, the name Beau Rivage was applied by Gibson (1975) to four Poverty Period sites (16LY5, 16LY6, 16LY13, and 16SL2) that he investigated along the Vermilion River, and that apparently represent a distinct phase. Beau Rivage, is taken from the type site (16LY5) within the Lafayette corporate limits, and sites of this phase are established in a different geographic setting than sites of the Rabbit Island phase; they are found to the northwest of the previously recorded Rabbit Island sites and they occupy the edge of the prairie terrace that overlooks the alluvial plain (Gibson 1980). A typical Beau Rivage artifact assemblage includes Poverty Point lithic materials and ceramic objects such as clay balls and figurines, as well as decorative rectangular or circular ceramic objects that have not yet been recovered at Poverty Point culture sites located further inland. Diagnostic projectile points/knives have included examples of Gary, Wells, Evans, Elam, Sinner, Ellis, Delhi, Marshall, and Palmillas points. These lithic projectile points/knives are characteristically shorter and narrower than those found at other Poverty Point sites.

Bayou Rivage and Rabbit Island phase sites apparently represent geographically distinct examples of Poverty Point culture in south central Louisiana. While Gibson (1975) dates the Bayou Rivage phase from ca. 3500 to 2650 B.P., no dates have been suggested for the Rabbit Island phase. Additional research is required to refine the chronology of these two phases.

Woodland Stage (ca. 2500 to 2000 B.P.)

Despite the many innovations introduced during the Poverty Point Period, it is frequently portrayed as either a Late Archaic Period culture or as a pre-Woodland transitional manifestation. The Woodland Stage in Louisiana is a formative one that is characterized by a combination of itinerant and possibly sedentary agriculture, the introduction of the bow and arrow, and the widespread use of ceramics. The Woodland Stage includes three periods: Early Woodland, Middle Woodland, and Late Woodland. The Early Woodland (ca. 2500 to 2000 B.P.) is represented by the Tchefuncte culture, the Middle Woodland (ca. 1600 to 800 B.P.) is associated with the Marksville culture and to a lesser extent the Troyville culture, and the Late Woodland (ca. A.D. 400 to 1200) originated with the Troyville culture but is dominated by the Coles Creek culture. In most parts of the region, the Woodland Stage was eclipsed by the Plaquemine culture, the florescence of the Mississippian Stage.

Early Woodland Period (ca. 2500 to 2000 B.P.)

Tchefuncte Culture (ca. 2500 to 2000 B.P.) Tchefuncte culture is characterized by the first widespread use of pottery within the context of a Late Archaic-like hunting and gathering tradition that maintained a Late Archaic-like tool inventory (Byrd 1994; Neuman 1984; Shenkel 1981:23). This culture first was identified at its type site (16ST1) located on the north shore of Lake Pontchartrain in southeast Louisiana (Ford and Quimby 1945; Weinstein and Rivet 1978). Later, the Tchefuncte culture was defined by Ford and Quimby (1945) based on Works Progress Administration excavations at Big Oak Island (16OR6) and Little Woods Midden

(16OR1-5), situated on the southeastern edge of the Lake Pontchartrain in Orleans Parish.

Originally, Tchefuncte culture was thought to be a local adaptation by an indigenous populace to the southwest Louisiana coast and to the central portion of the Vermilion River in south-central Louisiana. Tchefuncte or Tchefuncte-like ceramics now have been found in southeast Missouri, northwest Mississippi, the Yazoo Basin, coastal Alabama, and east Texas (Brookes and Taylor 1986:23-27; Mainfort 1986:54; Neuman 1984; Webb et al. 1969:32-35; Weinstein 1986:102). In coastal Louisiana, five phases have been designated for the Tchefuncte culture. From west to east, these are the Sabine Lake phase bordering Sabine Lake in southeast Texas and southwest Louisiana; the Grand Lake phase in the Grand Lake and Vermilion Bay area; the Lafayette phase on the west side of the Atchafalaya basin and west of the Vermilion River; the Beau Mire phase below Baton Rouge in the Ascension Parish area; and the Pontchartrain phase encompassing Lakes Maurepas and Pontchartrain in the Pontchartrain Basin (Weinstein 1986:108). Within the coastal region, only a total of three phases, designated Sabine Lake, Grand Lake, and Lafayette, have been documented.

For the purpose of this review, a date range extending from ca. 2500 to 2000 B.P. for the Tchefuncte culture will be used; however, research suggests that dates for the Tchefuncte both differ from region to region and occasionally within the same region (Webb et al. 1969:96; Weinstein 1986). Most scholars agree that Tchefuncte culture dates from as early as 2700 B.P. in the south and that it diffuses to the north, where it is known as Tchula, and terminates sometime around 1900 B.P. (Gibson and Shenkel 1988:14; Perrault and Weinstein 1994:48-49; Shenkel 1974:47; Toth 1988:19). However, there is evidence to support the existence of coastal Tchefuncte sites as late as 1700 B.P. (Byrd 1994:23; Neuman 1984:135). If these dates are correct, the last remaining coastal Tchefuncte communities were coeval with the Marksville culture (Toth 1988:27-28).

Tchefuncte ceramics usually are characterized by a soft, chalky paste, and a laminated appearance. They were fired at low temperatures and tempered with either sand or clay (Phillips 1970). Common Tchefuncte vessel forms include bowls, cylindrical and shouldered jars, and globular pots that sometime exhibit podal supports. Many of these were plain, but some were decorated with punctations, incisions, simple stamping, drag and jab, and rocker stamping. Punctated types appear more numerous than stamped types, but parallel and zoned banding, stippled triangles, chevrons, and nested diamonds also represent popular motifs. During the later portion of the Tchefuncte Period, red filming also was used to decorate some vessels (Perrault and Weinstein 1994:46-47; Phillips 1970).

The majority the stone and bone tool sub assemblages remained nearly unchanged from the preceding Poverty Point culture. Stone tools included boat stones, grooved plummets, chipped celts, and sandstone saws; bone tools included awls, fish hooks, socketed antler points, and ornaments. In addition, some tools such as chisels, containers, punches, and ornamental artifacts were manufactured from shell. Projectile points/knives characteristic of Tchefuncte culture include Gary, Ellis, Delhi, Motley, Pontchartrain, Maçon, and Epps (Ford and Quimby 1945; Smith et al. 1983:163). Bone and antler artifacts, such as points, hooks, awls, and handles, also became increasingly common during this period.

Tchefuncte sites generally are classified either as coastal middens, or as inland villages or hamlets. Settlement usually occurred along the slack water environments of slow, secondary streams that drained bottomlands, floodplain lakes, and littoral zones (Neuman 1984; Toth 1988:21-23). From southwest and south central Louisiana Tchefuncte burials and artifacts suggest an egalitarian social organization. Populations probably operated at the band level, with as many as 25 to 50 individuals per band. The widespread distribution of similar ceramic types and motifs implies a patrilocal residence with exogamous band marriage. Social organization probably remained focused within macrobands, and hunting, gathering, and fishing remained central to the Tchefuncte

lifestyle. Shell midden sites and their associated faunal remains are well known for Tchefuncte culture and document the wide variety of food resources utilized during this period. Recovered faunal remains include deer, opossum, muskrat, raccoon, otter, bear, fox, dog, ocelot, wildcat, alligator, bird, fish, freshwater and marine shellfish, and aquatic and terrestrial turtle. Recovered plant remains, all non-domesticated, include squash, gourds, plums, nuts, grapes, and persimmons (Neuman 1984; Smith et al. 1983). Neuman (1984) notes that the remains of crustaceans such as crab, shrimp, and crawfish do not appear within Tchefuncte middens. The absence of such readily available food sources probably reflects their relatively low caloric value.

Examination of faunal and floral remains from Morton Shell Mound (16IB3), a coastal Tchefuncte shell midden in Iberian Parish, suggests that some coastal sites were occupied on a seasonal basis, usually during summer and autumn, and possibly during spring (Byrd 1994:103). The preponderance of freshwater fish remains at coastal southeastern Louisiana sites such as Big Oak Island (16OR6) and Little Oak Island (16OR7) indicates a reliance on aquatic resources (Shenkel and Gibson 1974).

Marksville Culture (ca. 2000 to 1600 B.P.). Marksville culture, named for the Marksville site (16AV1) in Avoyelles Parish, often is viewed as a localized version of the elaborate mid western Hopewell culture which filtered down the Mississippi River from Illinois (Toth 1988:29-73). A more highly organized social structure than the Tchefuncte culture is implied by their complex geometric earthworks, their conical burial mounds, and their unique mortuary ritual systems. These elements characterize Marksville culture. Some items, such as elaborately decorated ceramics, were manufactured as grave goods. Items such as pearl beads, carved stone effigy pipes, copper ear spools, copper tubes, galena beads, and carved coal objects have been discovered in Marksville culture burials. Toward the end of the Marksville Period, Hopewellian influence declined, and mortuary practices became less complex (Smith et al. 1983).

Ceramic decorative motifs such as cross-hatching, U-shaped incised lines, zoned dentate rocker stamping, cord-wrapped stick impressions, stylized birds, and bisected circles were shared by Marksville and Hopewell cultures (Toth 1988:45-50). Additional Marksville traits include chipped stone assemblages of knives, scrapers, celts, drills, ground stone atlatl weights and plummets, bone awls and fishhooks, baked clay balls, and medium to large stemmed projectile points dominated by the Gary type.

The variety of exotic artifacts commonly found at Marksville sites suggests extensive trade networks and possibly a ranked, non-egalitarian society. Some commonly recovered exotic items include imported copper ear spools, panpipes, platform pipes, figurines, and beads (Toth 1988:50-73; Neuman 1984). Utilitarian material culture remained essentially unchanged, reflecting an overall continuity in subsistence systems (Toth 1988:211).

Marksville peoples probably used hunting, fishing, and gathering subsistence strategies much like those associated with earlier periods. Gagliano (1979) suggests that food procurement activities were cyclical/seasonal and involved two or more shifting camps. In the southeastern part of the state, shellfish collecting stations on natural levees and lower terraces around Lake Pontchartrain and Lake Maurepas were occupied and utilized during the summer months. During the winter months, semi-permanent hunting and gathering camps on the prairie terrace were occupied. This subsistence technique reflects a strategy that probably originated during the Archaic Stage.

A phase distribution of the Marksville culture has largely been made through a combination of diagnostic ceramic traits and geographic distribution. The Jefferson Island and the Veazey phases have been identified in the south central or Petite Anse region of Louisiana, and representative sites typically are situated along the Teche-Mississippi River channel in areas such as the Jefferson salt dome. Jefferson Island phase sites date from ca. 2000 to 1800 B.P. (Toth 1977). Decorated ceramics from this early phase are

characterized by curvilinear motifs, rocker stamping, and fabric impressions that predate the Veazey phase that dates from ca. 1800 to 1600 B.P. This second phase, named for the Veazey site (16VM7) in Vermillion Parish, frequently is associated with a scant presence of Late Marksville/Issaquena ceramic sherds that overlay Tchefuncte Period sites of the Grand Lake phase (Jeter et al. 1989; Phillips 1970). In addition, two southwest Louisiana phases, Lacassine and Lake Arthur, apparently are contemporaries of the Jefferson Island and the Veazey phases. While the Lacassine phase has been well documented by Bonnin and Weinstein (1975 and 1978) following excavations at the multi-component Strohe Site (16JD10), the Lake Arthur phase has been poorly defined (Bonnin and Weinstein 1978). According to Phillips (1970), coastal sites from the latter part of the Marksville Period may contain Marksville Stamped, Yokena Incised, and Churupa Punctated ceramic sherds (Jeter et al. 1989).

Troyville-Coles Creek Cultures (ca. 1600 to 800 B.P.). Troyville culture, called Baytown elsewhere, was named after the mostly destroyed Troyville mound group (16CT7) in Jonesville, Louisiana. Troyville represents a transition from the Middle to Late Woodland Period that culminated in Coles Creek culture (Gibson 1984). Though distinct, these two cultures are sufficiently similar that many researchers group them as a single prehistoric cultural unit. Neuman (1984) places the beginning of Troyville culture at 1612 B.P. (A.D 395), and Kidder (1988:57) places the beginning of the Coles Creek ca. 1600 B.P. The continuing developments of agriculture and the refinement of the bow and arrow during this time, reflected by Alba, Catahoula, Friley, Hayes, and Livermore projectile point types, radically altered subsequent prehistoric lifeways. During the Troyville Period, bean and squash agriculture may have became widespread based on the appearance of large ceramic vessels. This shift in subsistence practices probably fostered the development of more complex settlement patterns and social organization.

Only two Troyville phases, the Whitehall and the Roanoke, have been described in the coastal region of Louisiana, and these coexistent phases are separated only by their physical locations (Jeter et al. 1989). According to Phillips (1970), the Whitehall phase is used to describe the eastern portion of state. The Roanoke phase of west Louisiana was more recently defined by Bonnin and Weinstein (1978) based on information gathered during excavations at the Strohe site (16JD10).

The Late Woodland Coles Creek culture emerged from Troyville ca. 1200 B.P. and encompassed an era of considerable economic and social change in the Lower Mississippi Valley. By the end of the Coles Creek culture, communities became larger and more socially and politically complex, large-scale mound construction occurred, and there is evidence for resumption of long-distance trade on a scale not seen since the era of the Poverty Point culture. This implies the reemergence of a chiefdom-like society in the Southeast (Muller 1978). Coles Creek ceramics have been recovered from early Cahokia contexts dating ca. 1100 B.P. in southeastern Missouri (Kelly 1990:136). Material and sociopolitical concepts may have migrated into the Lower Mississippi Valley, along with trade items. These changes probably initiated the transformation of Coles Creek cultural traits into what is now recognized as Plaquemine culture from ca. 800 B.P.

Ceramics of this period are distinguished by their grog and grog/sand tempers, as opposed to the chalky, sand tempered paste of previous ceramic types. Decorative motifs include cord marking, red filming, and simplified zoned rocker-stamping, as well as decorations with incised and curvilinear lines. The Coles Creek peoples continued to use Troyville-type wares, with some elaboration (McIntire 1958). For example, the Churupa Punctated and the Mazique Incised designs, both of which are characteristic of the Troyville culture, were used by both Coles Creek and later Plaquemine pottery makers (McIntire 1958). Similarly, French Fork Incised, which formed the basis for many Troyville classifications, continued to be used well into the Coles Creek Period (Phillips 1970).

Coles Creek peoples developed a new ceramic complex that included larger vessels and a wider range of decorative motifs, usually positioned on the upper half of the vessel (Neuman 1984). Coles Creek Incised, Beldeau Incised, and Pontchartrain Check Stamped decorations characterize this period (Phillips 1970; Gibson 1976a-b; Weinstein et al. 1979). A distinctive decorative type, Coles Creek Incised, contains a series of parallel incised lines placed perpendicular to the rim of the vessel that is often accompanied by a lower row of triangular impressions (Gibson 1976a-b; Phillips 1970:70; Phillips et al. 1951:96-97). Several of these ceramic motifs suggest outside cultural influences. French Fork Incised motifs and decorative techniques, for example, mimic almost exactly Weeden Island Incised and Weeden Island Punctated decorations from the Northwest Florida Gulf Coast (Phillips 1970:84; Phillips et al. 1951:101; Willey 1949:411-422). Pontchartrain Check Stamped ceramics also appear at the same time as a resurgence of the check stamped ceramic tradition during Weeden Island III in Northwest Florida (Brown 1981:31).

Sites from the Coles Creek Period primarily were situated along stream systems where soil composition and fertility were favorable for agriculture. Natural levees, particularly those situated along old cutoffs and inactive channels, appear to have been the most desirable locations (Neuman 1984).

Most large Coles Creek sites, usually located inland, contain one or more mounds. Coles Creek mounds typically are larger, and exhibit more building episodes than earlier Marksville burial mounds. Burials occasionally are recovered from Coles Creek mounds; however, the primary function of these mounds appears to have been ceremonial. At some Coles Creek sites, mounds are connected by low, narrow causeways, and plazas occasionally are associated with these multiple mound sites (Gibson 1985a).

The complexity of Coles Creek mound systems suggests a more complex social structure. A centralized authority and a sizable labor force must have existed to build, maintain, and utilize these mounds. The centralized authority probably comprised a special religious class, while the general population occupied the regions surrounding large ceremonial centers (Gibson 1985a; Neuman 1984; Smith et al. 1983).

Small Coles Creek sites consist mostly of hamlets and shell middens, and they normally do not contain mounds. Coles Creek shell middens commonly occur in the coastal region on higher portions of natural levees (Springer 1974).

The theory that subsistence based on intensive maize agriculture was a hallmark of Coles Creek culture, can no longer be supported (Kidder 1992). Although Coles Creek populations exhibit tooth decay rates consistent with a diet based on starchy foods such as maize, the limited archeobotanical evidence for maize in Coles Creek midden deposits suggests that this may be related to the consumption of some other starchy foods (Kidder 1992; Steponaitis 1986). At present, the range of available evidence indicates that cultivation and consumption of maize was not widespread in the Lower Mississippi Valley until after the Coles Creek Period, ca. 800 B.P. (Kidder 1992:26; Kidder and Fritz 1993). Even though the existence of maize is attested in the archeological record during the Coles Creek Period, it was not the economic basis of this society.

Some sites in the Petit Anse region including the Morgan Site (16VM9) have produced limited amounts of wild plant species; however, subsistence in the coastal region of Louisiana apparently was based on the exploitation of available aquatic and/or terrestrial animal resources (Fuller and Fuller 1987). Excavations by R. Christopher Goodwin & Associates, Inc. (1986a) at Site 16CM61, a *Rangia* shell midden in western Louisiana, indicated patterns of seasonal exploitation of both marine mollusks and fish. In addition, Springer (1979) documented a variety of faunal material including mammals, avian, reptiles, and fish that originated from a Coles Creek component at the Pierre Clement site (16CM47) in Cameron Parish.

Earlier assumptions about the nature and extent of social and political differentiation of

the Coles Creek culture also must be reexamined. Square-sided, flat-topped mounds believed to serve as platforms for elite structures appear first during the Coles Creek culture; however, evidence for the elite residential or mortuary structures often considered to be associated with Coles Creek mounds remains elusive prior to 1000 B.P. (Kidder and Fritz 1993; Smith 1986; Steponaitis 1986). Nevertheless, both their form and their arrangement around plazas possibly indicate Meso-American influence (Willey and Phillips 1958; Williams and Brain 1983).

In the central and western areas of coastal Louisiana, early, middle, and late or transitional phases have been defined for the Coles Creek and transitional Coles Creek Periods (Brown 1984; Weinstein 1986:108; Weinstein et al. 1979; Ryan et al. 1996; Jeter et al. 1989). In the Petite Anse region these include the White Lake phase (ca. 1300 to 1100 B.P.); the Morgan phase (ca. 1100 to 1000 B.P.); and the Three Bayou phase (ca. 1000 to 800 B.P.). The Coles Creek phases of southwest Louisiana are nearly contemporaneous, and consist of the Welsh (ca. 1300 to 1250 B.P.), the Jeff Davis (ca. 1200 to 1000 B.P.), and the Holly Beach phases (ca. 1000 to 800 B.P.).

Mississippian Stage (ca. 800 to 300 B.P.)

The Mississippian Stage represents a cultural climax in population growth and social and political organization for the aboriginal peoples of the southeastern United States (Phillips 1970; Williams and Brain 1983). In the Lower Mississippi Valley, the advent of the Mississippian Stage is signaled at sites along the lower Mississippi River and along the northern Gulf of Mexico by the arrival of traits such as shell tempered ceramics, triangular arrow points, copper-sheathed wooden ear spools, and maize, beans and squash agriculture from the Cahokia area (Williams and Brain 1983). Formalized site plans consisting of large sub-structure "temple mounds" and plazas have been noted across the southeast at such places as Winterville, Transylvania, Natchez, Moundville, Bottle Creek, Etowah, and Kolomoki (Williams and Brain 1983; Hudson 1978; Walthall 1980; Knight 1984). In the coastal region of Louisiana, the Mississippian culture stage is characterized by both the Plaquemine culture or the Emergent Mississippian Period (ca. 800 to 550 B.P.), and the Late Mississippian Period (ca. 550 to 300 B.P.). However, it is likely that in some parts of the region either Plaquemine culture or a hybrid of that culture was in existence until European contact (Jeter et al. 1989).

Emergent Mississippian Period (ca. 800 to 550 B.P.)

The Emergent Mississippian Period Plaquemine culture appears to represent a transitional phase from the Coles Creek culture to a pure Mississippian culture (Kidder 1988). As stated in the discussion of Troyville-Coles Creek culture, interaction with the emerging Mississippian cultures of the Middle Mississippi Valley probably exerted enough influence during the latter part of the Coles Creek Period to initiate the cultural change that eventually became the Plaquemine culture. The Medora Site (16WBR1) is the Plaquemine culture type-site (Quimby 1951). Plaquemine peoples continued the settlement patterns, economic organization, and religious practices established during the Coles Creek Period; however, agriculture, sociopolitical structure, and religious ceremonialism intensified suggesting a complex social hierarchy. Plaquemine subsistence probably was based mainly on agriculture and supplemented by native plants and animals. Sites typically are characterized either as ceremonial sites, with multiple mounds surrounding a central plaza, or as dispersed villages and hamlets (Neuman 1984; Smith et al. 1983).

Plaquemine lithic assemblages are quite similar to those of the preceding Troyville-Coles Creek cultural complex and are dominated by the same small projectile point styles (Smith et al. 1983). In addition, Plaquemine ceramics are derived from Coles Creek types, however, they display distinctive features that mark the emergence of a new cultural tradition. In addition to incising and punctuating their ceramics, Plaquemine craftsmen also brushed and engraved

decorations onto their vessels (Phillips 1970). Plaquemine Brushed appears to have been the most widespread ceramic type. Plaquemine ceramic types included Leland Incised, Hardy Incised, L'Eau Noire Incised, Anna Burnished Plain, and Addis Plain. Kidder (1988) contends that the Plaquemine culture had evolved into a true Mississippian culture by ca. 550 B.P.

Gregory (1969) indicates that the location of Plaquemine culture sites demonstrate that Plaquemine peoples favored lowland areas including swamps and marshes; however, Plaquemine culture sites in the upper Tensas basin were located most frequently on well-drained natural levees characterized by sandy soils (Neuman 1984). In general, coastal sites tend to be smaller and less elaborate, and coastal shell middens are considered products of early Plaquemine activities (Davis et al. 1979; Brown and Lambert-Brown 1978). The presence of these sites may indicate the persistence of seasonal food procurement strategies.

Brown (1985) contends that coastal Plaquemine populations descended from incipient Coles Creek peoples in the Petit Anse region of southern Louisiana (Phillips 1970, Hally 1972, Jeter et al. 1989). Under this scheme, the transitional Coles Creek Three Bayou phase (ca. 1000 to 800 B.P.) is followed by the Burk Hill phase (ca. 800 to 400 B.P.). This phase includes sites along Vermillion Bay, and around the Salt Dome Islands (Brown 1985). In southwest Louisiana, the Bayou Chene phase (ca. 800 to 300 B.P.) has been explained by Weinstein (1985) as a localized expression of Plaquemine/Mississippian development. The Bayou Chene phase is based on the interaction of Transitional Coles Creek/Plaquemine peoples with those of a more localized tradition that likely originated as a result of migrations or diffusion from southeast Texas.

Late Mississippian Period (550 to 300 B.P.)

During this period, several traits that define the Mississippian Period were wide-spread across most of the Southeast. These diagnostic traits include well-designed mound groups, wide distributions of sites and trade networks, shell tempered ceramics, and a revival in ceremonial burial (Griffin 1990:7-9). In coastal Louisiana, Late Mississippian culture probably is related to the Pensacola variant. Knight (1984) contends that displaced Mississippian populations from the central Gulf Coast, specifically in the vicinity of the Mobile Bay and the Alabama/Tombigbee river systems, resettled in coastal Louisiana (Knight 1984). In addition, Brown and Lambert-Brown (1978) have recovered Yazoo River basin-like pottery from Avery Island in the Petit Anse region.

Mississippian subsistence was based on the cultivation of maize, beans, squash, and pumpkins, the collection of local plants, nuts, and seeds, and the fishing and hunting of local species. Major Mississippian sites were located on the fertile bottomlands of major river valleys, typically comprised of sandy and light loam soils. A typical Mississippian settlement consisted of an orderly arrangement of village houses, surrounding a truncated pyramidal mound. These mounds served as platforms for temples or houses of the elite. A highly organized and complex social system undoubtedly existed to plan these intricate communities.

Mississippian ceramics frequently are characterized by shell tempering, an innovation that enabled potters to create larger vessels (Brain 1971; Steponaitis 1983). Globular jars, plates, bottles, pots, and salt pans are examples common Mississippian vessel forms. The loop handle appears on many Mississippian vessels. Although utilitarian plainware was common, decorated wares were often produced utilizing techniques such as engraving, negative painting, and incising. Plastic elements such as animal heads and anthropomorphic images were also used to decorate clay vessels. Other Mississippian artifacts include chipped and groundstone tools; shell hairpins, beads, and gorgets; and mica and copper objects. Chipped and ground stone tools and Alba and Bassett style projectile points also were common.

Mississippian culture enjoyed a weak presence in south central and southwestern

Louisiana, and only two Mississippian or Mississippian-like phases have been recognized. The first, the Petite Anse (ca. 400 to 300 B.P.), has been used to describe Mississippian peoples from the lower Yazoo river basin who traveled to the Petit Anse region, specifically Avery Island, to procure salt (Brown and Lambert-Brown 1978). The second, the Little Pecan (ca. 350/300 to 250 B.P.), is located in southwestern Louisiana and is associated with the historic Attakapa. This phase is represented by a synthesis of ceramic types that originate from the Lower Mississippi Valley, Louisiana, and Texas (Jeter et al. 1989).

Historic Period Aboriginal Cultures (ca. 500 to 200 B.P.)

At present our understanding of historic Native American cultures of the southeastern United States is limited by our frequent inability to recognize the ancestral cultures from which these groups derived. This is due partially to the waning influence of Mississippian culture, but primarily results from the social disruption initiated by the legacy of Spanish and French exploration and colonization throughout the Southeast. These social interactions necessitated major social reorganization. Native American populations declined as a result of upheaval wrought by European contact. Warfare, forced migrations, and foreign disease decimated Native American populations (Smith 1987; Davis 1987). Information on historic aboriginal populations, gleaned only in part from the archeological record, relies on early European sources, and later ethnographic accounts of this tumultuous era.

Only two Native American groups, the Attakapa and the Opelousa occupied southwestern Louisiana at the time of European contact. Little is known of the Opelousa who were decimated by European disease between A.D. 1715 and 1804; however, Swanton (1946) believes that they probably were members of the Attakapan linguistic family. The second group was the Attakapa, a Choctaw and Mobilian phrase for "man eater" or "eaters of human flesh". While no acts of their reported cannibalism have ever been documented, this information may have been taken from a French officer, Simars de Delle-Isle, who was stranded on the Louisiana coast in A.D. 1719 (Post 1962). The Attakapa are known to have consisted of three or more groups that lived on the Calcasieu, Mermentau, and Vermilion Rivers in Louisiana but their influence extended as far west as the Trinity River in Texas (Swanton 1946; Aten 1983).

Convention holds that as the influence of Mississippian culture declined throughout the Southeast, and populations along the northern Gulf Coast reverted to egalitarian societies and readopted the regional hunting and gathering subsistence strategies that had been successful throughout the Archaic and Woodland stages (Peebles and Kus 1977; Peebles and Mann 1983). These strategies were frequently augmented by either itinerant horticulture or small-scale agriculture that produced corn, beans, and squash. Both archeological and ethnographic evidence indicates that the historic Attakapa lived an Archaic Period-like existence of fishing, hunting, and gathering.

Historical records indicate that the Attakapa interacted both with the French and the Spanish. Swanton (1946) reports that they allied against the British and supplied both men and supplies to Galvez for the purpose of attacking forts on the Mississippi River during A.D. 1779. Disease and disruptive migrations due to colonial expansion and European rule, accounted for the disintegration of aboriginal populations in the area. By A.D. 1805, approximately 80 Attakapa warriors inhabited South Louisiana (Swanton 1946).

CHAPTER IV

HISTORIC PERSPECTIVE

Introduction

The historical period in Louisiana begins with the early European exploration of the Mississippi River during the sixteenth century and continues to present. The history of Louisiana can be divided into four general periods: Early Exploration, The Rule of France, The Rule of Spain, The Rule of the United States of America. This chapter traces the historical development of Louisiana and focuses on the use of the Mississippi River in the vicinity of the present study area, located between the towns of Nairn and Empire in Plaquemines Parish, Louisiana.

Early Exploration

The Spanish were the first Europeans to claim the Louisiana region, but sources disagree regarding the identification of the first European explorer of the mouth of the Mississippi River: Alonso Álvarez de Pineda in 1519, or survivors of the Pánfilo de Narváez expedition in 1528. One of the survivors of the Narváez expedition, Alvar Núñez Cabeza de Vaca, described the mouth of the Mississippi River and the southern Louisiana coastline in his account of this ill-fated journey. However, historians agree that the first European to explore the Louisiana interior was Hernando de Soto. De Soto led his expedition across the southeastern United States, and crossed the Mississippi River near the present Tennessee/Mississippi state border during the spring of 1541. From there, he traveled westward, possibly as far as Oklahoma, before returning to the Mississippi. De Soto died somewhere along the river between Memphis and Baton Rouge in May 1542.

Following de Soto's death, survivors his expedition unsuccessfully attempted an overland trek to Texas in order to reach Spanish settlements in Mexico. During July 1543, remnants of Hernando de Soto's expedition returned to the Mississippi River and traveled south in seven *caravels* and a series of dug-out canoes that they had built. This fleet was attacked and pursued by a large flotilla of dug-out canoes for several days. The aboriginal watercraft that composed this flotilla were large and varied in size, carrying between 28 and 50 paddlers and up to 30 warriors each (Coastal Environments, Inc., 1989:70). De Soto's fleet passed through the present study area and eventually reached a location that may have been in the vicinity of Head of Passes (Coastal Environments, Inc., 1989:70). This location is described as an area where the Mississippi River is "divided into two arms, each of which may be a league and a half broad" (Smith 1968:182). More than sixty small canoes were seen by de Soto's forces near this area. These explorers continued south to the mouth of the Mississippi (Varner and Varner 1962:564-565; Smith 1968:174; Coastal Environments, Inc., 1989:76). Miraculously, they reached the Gulf of Mexico and arrived at Vera Cruz during September 1543. Following these disastrous expeditions, Spain took no further action to strengthen its claim to the Lower Mississippi Valley; the Spanish left this region undisturbed for nearly 140 years (Davis 1971:27-28; McLemore 1973:91-100).

The aboriginal watercraft seen by Spanish explorers in Louisiana primarily were dug-out canoes. The majority of the extant examples of these watercraft from Louisiana were fashioned from single cypress logs and range in size from roughly 12.5 to 31.0 ft (3.8 to 9.4 m) (Coastal Environments, Inc., 1989:72-75). Such small aboriginal and European vessels passed through the vicinity of the project area, but larger ocean-going vessels did not as the entrance to the Mississippi River delta was blocked by shoals.

A French expedition under the leadership of Réné Robert Cavalier, Sieur de La Salle, was next to explore the lower Mississippi. La Salle's expedition traveled down the Mississippi River beginning at its confluence with the Illinois River, and ending at the Gulf of Mexico during early April 1682. He and his men camped approximately three leagues (9.0 mi, 14.5 km) from the mouth of the river, and briefly explored its various outlets. With assurances from Native American tribes, they were "the first Europeans who have descended or ascended the River Colbert [the Mississippi River]." La Salle claimed all lands drained by the Mississippi River for Louis XIV, King of France, on 9 April 1682 (Davis 1971:28-29; French 1875:17-27).

The Rule of France, 1682-1766

The French began colonization efforts in Louisiana during the late seventeenth century with a failed attempt by La Salle to establish a military colony on the Mississippi River (Foster and Warren 1998:4). La Salle left France in 1684 with four ships carrying nearly three hundred settlers. His expedition never their destination, as they mistook Matagorda Bay, Texas, for a western branch of the Mississippi River.

Fifteen years later, four ships and approximately two hundred settlers under the guidance of Pierre le Moyne, Sieur d'Iberville departed France and found the mouth of the Mississippi. Upon entering the passes, he observed what appeared to be rocks and petrified trees in the waterway, but closer inspection revealed that these objects were mud lumps (McWilliams 1981:137-138). The French intended to fortify and colonize the mouth of the river, but the marshy, inhospitable lands of the Mississippi River delta discouraged them. Iberville did not establish his headquarters in Louisiana, but instead situated his fort, Fort Maurepas, northeast of the Mississippi River delta at Biloxi Bay (Davis 1971:39-41). That same year d'Iberville returned to France for additional supplies and colonists. His brother, Jean Baptiste le Moyne Sieur de Bienville, was left in charge of Mississippi River exploration. During September 1699, Bienville encountered a British ship on the Mississippi River. Captain Lewis Banks was sent by the British Crown to explore the lower Mississippi River in order to identify a suitable location for British settlement. Banks sailed 25 leagues up river, approximately 12 mi (19.3 km) below present-day New Orleans, before being challenged by Bienville who convinced him that he lead an advance party for a French fleet heading down river. The site of this encounter has since been known as *Detour de Anglais*, or English Turn. When Iberville learned of this incident he ordered the immediate construction of forts to protect French territories in Louisiana. Fortifications were constructed approximately 54.0 mi (86.9 km) upriver on the east bank of the Mississippi River near the present location of Phoenix in Plaquemines Parish, Louisiana. Construction was completed during 1700, making this fort, known as *Fort de la Boulaye*, the first European settlement in the lower Mississippi Valley. *Fort de la Boulaye* was manned officially until 1707, although it was not abandoned until 1715. Seven years later *Fort de la Boulaye* was destroyed by a hurricane (Davis 1970:39-42, 55-56; Meyer 1981:32-35, 94-95; R. Christopher Goodwin and Associates, Inc., 2006:12). Until the founding of New Orleans in 1718, French colonists concentrated most of their settlement efforts west of the Mississippi River delta (Wilds et al. 1996:8-11).

Early attempts to navigate the passes of the Mississippi River were fraught with difficulty. River flow is relatively slow at the passes, and this low velocity results in the deposition of sediments at the river's mouth, "creating a shoal which reduces the depth of navigable water at

the most crucial point of the whole river system" (Clay 1983:22; U.S. Congress 1858:31).

Southeast Pass served as the principal point of entry into this reach of the Mississippi during the entire colonial period. In an attempt to guard the mouth of the pass, Pierre Blond de la Tour, the Chief Engineer of French Louisiana, established a fort on a small coastal island near its mouth. This fort was known as *Fort de la Balise* and served as a military installation and a lighthouse (Lincoln 1983). Unfortunately, this fortification slowly sank into the soft delta sediments. By the 1760s, French governors reduced this stronghold to a small coastal defense battery (Lincoln 1983:338). Even though the importance of this fort diminished, it served as the site where France officially transferred the colony of Louisiana to Spain in 1766.

The French never solved the problem of shoaling at the river's mouth or its passes. Initially, they found the average depth of the passes to range from approximately 6.0 to 8.0 ft (1.8 to 2.4 m), which provided sufficient depth for shallow draft vessels. French engineers initiated a process known as harrowing in 1726 to deepen the passes and facilitate the passage of deeper draft vessels. Harrowing involved the dragging of iron harrows along outlet bottoms to level sand bars. This method only temporarily deepened the passes, as sand bars and shoals quickly reformed. By 1728, the condition of the passes had deteriorated and harrowing efforts were abandoned (Clay 1983:22; Corthell 1881:2; Dent 1921:13,15).

Seventeenth century French explorers and eighteenth century French colonists utilized similar watercraft on Louisiana's inland waterways. Seventeenth century French explorers used birch bark canoes on the Mississippi River (Coastal Environments, Inc., 1989:77-79). These vessels were not native to the Lower Mississippi Valley. Similar in use and form, dug-out canoes were preferred over birch bark canoes for general transportation and shipping because of the local abundance of raw materials needed for their construction, and the simplicity of their manufacture. Ships and boats of European design and/or origin also were used by French explorers and colonists in Louisiana. These included the *bateau, radeau, felucca, biscayenne, chaloupe, traversier* and *frégate* (Coastal Environments, Inc., 1989:80-85). *Bateaux* of various sizes commonly were used on inland waterways for both general transportation and commerce. Other shallow draft vessels such as the *felucca, biscayenne,* and later the *radeau* also were used on these waterways. Deep draft vessels such as the *traversier* and the *frégate* were typically confined to the Gulf of Mexico and to deep water routes into the interior.

During the eighteenth century the majority of maritime traffic took place on the Gulf of Mexico, in the vicinity of New Orleans, and in areas along the Mississippi River north of the present study area. Shoals and shifting sandbars prevented the easy passage of deep draft vessels. Vessels such as the *chaloupe* were used both as coastal traders and to tow larger, deeper draft vessels through the passes and up the Mississippi River.

The Rule of Spain, 1766-1803

Under Spanish rule the Mississippi River continued to be used as a gateway into Louisiana. Following a failed attempt to establish a fort and station a pilot at Northeast Pass, Spain stationed a pilot at Southeast Pass to control the passage of ships bound for New Orleans and other points along the Mississippi River. Pilots were stationed at a series of forts that were sequentially built and abandoned due to flooding. These efforts did not enable safe navigation of the Mississippi River, as a lack of maintenance left portions of the passes shallow and dangerous to passing ships.

The ships and boats used on the Mississippi River included the Spanish *bercha*, flat boats, and keel boats of Anglo-Saxon design (Coastal Environments, Inc., 1989:93-99). Ocean-going ships used on the lower Mississippi River and on the Gulf of Mexico included the *paquet, brigantine, fluit, cournier, navire, gabare,* and *baldandre* (Coastal Environments, Inc., 1989:101). The routes used by these vessels were similar to those traveled by mariners under French rule, as little improvement and maintenance was conducted at the various passes of the Mississippi River.

The Rule of the United States of America, 1803 to Present

Spain ceded Louisiana to France in the secret Third Treaty of San Ildefonso on 10 October 1800, but Madrid provided a *de facto* government for the colony until 1803, when the territory was purchased by the United States. Under American rule, trade on the Mississippi River increased rapidly, particularly after the widespread use of the steam engine made shipping on inland waterways more efficient, affordable, and profitable. By the 1830s it was cheaper to ship cargo from the lower Ohio Valley and the East Coast via New Orleans than overland. The increased use of steamboats resulted in the decline of keelboats and flatboats, which often were operated by independent traders whose cargo commonly included corn, pork, and whiskey (Cable 1980:24).

New Orleans subsequently was transformed into a major port. Foreign cargoes arrived at New Orleans for shipment into the interior. Trade with cities of the Mississippi River basin, such as St. Louis, Cincinnati, and Cairo, helped to increase the stature of New Orleans as a commercial powerhouse (Cable 1980:22). Goods brought to New Orleans from the interior were loaded onto ocean-going vessels for export.

By the end of the nineteenth century, the population of Plaquemines Parish was concentrated along the northernmost 60.0 mi (96.5 km) of the Mississippi River (R. Christopher Goodwin & Associates, Inc., 1986b:139). Ninety-nine per cent of this population lived on 0.5 to 1.0 mi (0.8 to 1.6 km) of arable land that stretched outward from both banks of the river, with the east bank more populous than the west bank (R. Christopher Goodwin & Associates, Inc., 1986b:139). A lack of levees and the consequent threat of overflow rendered the southernmost 40.0 mi (64.4 km) of the Mississippi River unfit for cultivation or habitation (R. Christopher Goodwin & Associates, Inc., 1986b:139). This area includes the present study area.

During the nineteenth century, the number of ports along the Gulf Coast increased to handle growing commercial activity from local sugar plantations, truck farmers, and privateers. Export of lumber, grain, and cotton resulted in increased vessel traffic throughout the Gulf of Mexico as use of raw materials grew along the eastern seaboard of North America and in Europe. A "golden age" of shipping evolved in the Gulf of Mexico, as a commercial triangle developed connecting ports along the Gulf Coast to New York and major European cities (Coggins 1962).

The first steamboat on the Mississippi River was *New Orleans* in 1812. Steam power made shipping more affordable, and by the 1830s it was cheaper to ship cargo from the lower Ohio Valley and the East Coast via New Orleans than over land. Growth in the use of steamboats resulted in a decline in the use of keelboats and flatboats. Thousands of boats and ships sailed down the Mississippi River or across the Mississippi Sound from Mobile, Pensacola, or Galveston to bring cotton to New Orleans. After the construction of the Erie Canal in 1825, trade along the Mississippi River and New Orleans declined as shippers found it more efficient and profitable to ship goods by canal rather than by river (Cable 1980:27).

The nineteenth century witnessed the development of major design changes and distinctive vernacular vessel forms. The rigs and hull forms of sailing vessels ships were refined to improve their speed. The impetus to improve the speed of ships resulted from an environment of instability that surrounded American shores. At that time, there was no Navy to protect domestic shipping; international economic conditions were unstable; and smuggling was a profitable trade. Consequently, small, fast vessels often were employed to run dangerous waters. The "West Indies" sloop was developed in the previous centuries, and it later was modified with a schooner rig and raked masts to improve speed. Two additional vessels, also were developed for use in the coastal trade. By 1820, a larger schooner class known as the *Baltimore Clipper* was developed, and by the mid-1850s, shipyards in Philadelphia, New York, and New England began building large clipper ships. The production of these vessels peaked between 1853 and 1854. At the same time, vessels larger than schooners were being built with composite hulls. A number of

factors contributed to a decline in the production of large sailing vessels including the depression of 1857, the Civil War, and the competition of railroads (Wilson 1983; R. Christopher Goodwin & Associates, Inc., 2006).

The American Civil War

Plaquemines Parish suffered more economic than physical devastation from the Civil War. By denying the Confederate states use of the Mississippi River and establishing a blockade of their ports, the Union hoped to strangle the Confederacy. One of the most devastating blows to the Confederate war effort was the loss of the port of New Orleans in April 1862. The key to the Mississippi River was New Orleans, and its primary defense from the Union Navy lay in two forts, Fort St. Philip and Fort Jackson. These forts were located on opposing banks of the Mississippi River below New Orleans. They were armed heavily and surrounded by swamps that made them unassailable by land (R. Christopher Goodwin & Associates, Inc., 1993:31).

Confederate command at New Orleans recognized that unless the river was obstructed in some way to hold ships passing between the forts under fire, steam-powered vessels could pass confederate defenses before gunners could fire their weapons (Dufour 1960:90). Confederate efforts to install channel obstructions both were hindered by water depths of more than 100.0 ft (30.5 m) and by the strength of the river's flow. A series of hulks were chained together and sunk across the river below Fort Jackson, but this obstruction was damaged by storms and flooding and not repaired adequately before the Union fleet launched its attack (R. Christopher Goodwin & Associates, Inc., 1993:33).

Twenty-one Confederate vessels were stationed at Fort. St. Philip when Union forces under the command of Admiral Farragut attacked the forts on the morning of 24 April 1862. The confederate fleet included two ironclads, *Louisiana* and *Manassas*, two deep-draft steamers, *McRae* and *Jackson*, two launches, converted fishing boats designated *Launch Nos. 3 and 6*, and two lightly built side-wheelers, *Governor Moore* and *General Quitman*.

Three unarmed steamers, *Phoenix*, *W. Burton*, and *Landis*, served as tenders for *Louisiana* and *Manassas*, four chartered steamers, *Mosher, Belle Algerine, Star, and Music*, were under Confederate naval command (R. Christopher Goodwin & Associates Inc., 1993:48).

Six towboats, *Warrior*, *Stonewall Jackson*, *Resolute*, *Defiance*, *General Lovell*, and *R.J. Breckenridge* that had been converted to gunboats for the River Defense Fleet, also were present. The captains of these gunboats refused to place themselves under Confederate naval command.

The Union fleet was divided into three divisions. The first division was led by Captain Bailey and *Cayuga*, *Pensacola*, *Mississippi*, *Oneida*, *Varuna*, *Katahdin*, *Kineo*, and *Wissahickon*. The center division under the command of Flag-Officer David Farragut was comprised of *Hartford*, *Brooklyn*, and *Richmond*. The third division was led by Captain H.H. Bell and included *Sciota*, *Iroquois*, *Kennebec*, *Pinola*, *Itasa*, and *Winona* (R. Christopher Goodwin & Associates Inc., 1993:50). In addition, this fleet included twenty mortar boats lead by Commander David Porter (Winters 1991:84-85).

The battle resulted in the safe passage of the majority of the Union ships and the loss of almost the entire Confederate fleet. During the battle, four converted Confederate gun boats were set on fire or abandoned by their own crews. *Resolute* ran aground, abandoned, and later burned, *Defiance* sailed in circles at the command of a reportedly intoxicated captain, and *Belle Algerine* was sunk by *Governor Moore* after repeatedly running afoul of the larger vessel while it was trying to join the battle. After the battle only *Defiance*, *McRae*, *Launch No. 6*, and *Louisiana* with its tenders *Landis* and *W. Burton* were still afloat (R. Christopher Goodwin & Associates Inc., 1993:63). *Louisiana* and *Launch No. 6* were later burned, and *Defiance* was later scuttled, all near Fort St. Philip (R. Christopher Goodwin & Associates Inc., 1993:70). *Stonewall Jackson* escaped the battle, but was reportedly scuttled 13.0 mi (20.1 km) up river (Scharf 1887). Thus,

Stonewall Jackson may have been scuttled within 1.0 mi (1.6 km) of the Mississippi River sand borrow sites. Many of the other Confederate vessels that were destroyed during the battle appear to have drifted down river, as several Union commanders noted seeing burning hulks of several side wheel steamers drifting down river (U.S. Department of the Navy, 1.18:385, 401, 404, 416, 421; R. Christopher Goodwin & Associates Inc., 1993:70).

Throughout the Civil War, normal commerce stopped in the Gulf of Mexico because of the Union naval blockade imposed on Confederate ports. Because larger profits were possible, illicit traders were willing to run the blockade. These events spurred the development of new ship types. Older coastal shipping vessels disappeared, and new, swift, low-silhouetted sailing schooners and steam vessels appeared. These ships were designed to make quick runs from Havana, Bermuda, and Nassau to Brownsville, Galveston, New Orleans, Tampa and Mobile. Illicit commerce came to an abrupt close when the war ended (Coggins 1962). Traffic in the project area would have consisted of many steam-powered military vessels or passenger and freight ships.

The riverfront plantations were particularly affected by wartime conditions. Plantations belonging to Confederate sympathizers were confiscated, and many plantations were looted by both sides. Slaves escaped their bondage for protection with the Union army, leaving plantations to lay fallow with no one to tend the fields. In 1862, the editor of the New Orleans *Daily True Delta* stated that "(t)hc difficulty of the Louisiana sugar planter will not be found in the imposition of a tax upon his product, but in depriving him of his labor . . ." (Roland 1957:68-73, 101).

Reconstruction and the Late Nineteenth Century

The South experienced a serious financial crisis after the Civil War. Cash was unavailable to invest in the sugar industry. As a result, farmers switched to cultivating other products such as cotton and rice. Before the Civil War, Plaquemines Parish produced two-thirds of Louisiana's rice crop (R. Christopher Goodwin & Associates, Inc., 1986b:145). By 1881, Plaquemines Parish produced one-third of the state's total crop. Despite the proportional decrease, the actual production of rice increased fivefold (R. Christopher Goodwin & Associates, Inc., 1986b:145).

After reconstruction, commercial shipping re-appeared along the Gulf Coast. Post-war traffic moved along coastal and direct routes to South American, European, Caribbean, and eastern U.S. markets (Laing 1974). Although coastal maritime transportation was restricted by law to U.S. vessels during the latter part of the nineteenth century, the American merchant marine never recovered its pre-Civil War status due to Confederate privateers, lost markets, and increased costs. A share of the Gulf trade was captured by foreign merchants from Norway, Britain, Denmark, Holland, Germany, Italy, and even Colombia. These merchant empires established routes to Gulf ports. During the 1870s, railroads surpassed river transportation as the chief mode of transport in and out of the central United States. Transportation via the Mississippi increased again during the early twentieth century because of the use of barges for specialized bulk cargoes.

After the Civil War, shipyards in New England took the lead in developing and perfecting the "down-eastern" ship form. These vessels were over 190.0 ft (58.0 m) long, carried less sail than clipper ships, and were less elaborately decorated. By 1900, those vessels were replaced by merchant steamers and small coastal schooners (Wilson 1983).

In the Gulf, small coastal vessels rigged as sloops, schooners, brigantines, and brigs conducted trade with other ports of the United States. Foreign vessels were prohibited from entering United States waters after March 1, 1817. After this date, both the use of small coastal vessels and the size of the United States merchant fleet increased (Wilson 1983).

Until the efficiency of railroads destroyed many passenger lines, ships were considered more comfortable, faster, safer, and cleaner than overland travel. Passenger vessels remained popular until the last quarter of the nineteenth century (Wilson 1983).

The Twentieth Century

The communities of Buras and Ostrica were founded as agricultural settlements and as commercial fishing and oyster farming operations. Both Buras and Empire began as oyster camps populated by immigrants from the Balkan states. Even today, descendants of these Balkan immigrants dominate the populations of Buras and Ostrica, as well as the oyster industry of Plaquemines Parish (Vujnovich 1974; R. Christopher Goodwin & Associates, Inc., 1988).

Originally named Burat after the French settlers who first settled the area, the first area known as Buras extended well above and below the current confines of the town. The area included several riverside plantations, all owned by members of the Burat (Buras) family. The region on both sides of the river had been well known for the production of sugar during the antebellum era.

After the collapse of the plantations following the Civil War and emancipation, sugar production no longer was profitable, and many local residents began to cultivate other crops. As early as 1870, immigrants from the Dalmatia region of Croatia began to move into the region, where they engaged in fishing, specifically the oyster industry. Most Balkan immigrants settled in the fishing villages, remote camps, and canning communities below Bohemia on the east bank, and in the vicinity of Empire on the west bank. By the 1890s, Balkan immigrant communities underwent unprecedented growth. Canals at Ostrica and Empire provided easy access to the oyster beds, and canneries were constructed throughout the parish (R. Christopher Goodwin & Associates, Inc., 1986b:160). Balkan immigrants also pioneered a new industry in southern Louisiana, the production of oranges (R. Christopher Goodwin & Associates, Inc., 1988). As early as 1885, oranges were cultivated just south of Buras, in the vicinity of Triumph, Louisiana (Vujnovich 1974:61). In 1930, John Lulich and George Pivach began an orange wine industry, selling their product throughout the United States.

Terrible hurricanes swept through the Ostrica/Buras region in 1893 and 1915. According to one source (Armstrong 2000), the town of Buras was completely destroyed on 1 October 1893. Over 300 people who lived in Buras and Ostrica, most of them Slovakian or Croatian descendants, died in the storm and its aftermath. Another deadly storm in 1915 prompted an increase in hurricane protection. Consequently, the levees along both sides of the Mississippi River were dramatically raised by 1920. The Ostrica Locks were completed in the early decades of the twentieth century, both to aid in navigation and to ease flood conditions when the river rises. The Ostrica and Empire locks also increased oyster production between 1900 and 1910 (R. Christopher Goodwin & Associates, Inc., 1988.). Unfortunately, the hurricanes that swept through the area during the twentieth century wiped out almost all of the orange groves. As a result, the orange wine industry was abandoned. The severe storms also wrought havoc with the oyster industry, destroying the fragile oyster beds for several years at a time.

The region experienced an economic boost with the rise of sulfur and oil and gas industries during the 1930s and 1940s (Stringfield 2001). Sulfur was discovered in quantities large enough to warrant mining as early as 1920, and two mines just off the mouth of the river were in operation by World War II. Oil was discovered in Plaquemines Parish in 1928. Offshore oil and gas industries developed immediately after World War ended. These new ventures resulted in the construction of a large variety of industrial structures located along the riverbank.

CHAPTER V

PREVIOUS INVESTIGATIONS

Introduction

Chapter five reviews previous archeological and architectural investigations completed in the vicinity of the study area. This information was sought in order to ensure that any previously recorded cultural resources within the study area were identified prior to the commencement of fieldwork.

This chapter is divided into two sections. The first contains a review of previous cultural resource investigations completed within 5.0 mi (8.0 km) of the study area. The second presents a review of previously recorded archeological sites and standing structures located within 5.0 mi (8.0 km) of the study area. This review is based on a search of data on file at the Louisiana Department of Culture, Recreation and Tourism, Office of Cultural Development, Divisions of Archaeology and Historic Preservation, located in Baton Rouge, Louisiana.

Previously Conducted Cultural Resources Investigations within 5.0 mi (8.0 km) of the Study Area

Twenty-five (25) previously completed cultural resources investigations have been conducted within 5.0 mi (8.0 km) of the study area. Each of these investigations is discussed below.

A cultural resources investigation was undertaken in the vicinity of Block B prior to the commencement of a pipeline construction project during 1975. This study identified no significant cultural resources (Gulf South Research Institute 1975:31).

During 1976, J. Richard Shenkel conducted cultural resources survey of four areas proposed for levee improvements on the right descending bank of the Mississippi River between levee stations 2731+00 and 2875+06. No cultural resources were identified as a result of this study (Shenkel 1976). The following year Shenkel conducted another cultural resources survey prior to the proposed commencement of Homeplace levee enlargement and slope pavement, south of Port Sulphur, Louisiana. No cultural resources were identified as a result of this study (Shenkel 1977).

During 1978, George Castille of the Louisiana Department of Culture, Recreation, and Tourism conducted cultural resources survey of an area proposed for levee construction around Fort Jackson, on the right descending bank of the Mississippi River near Mile Marker 20.0. Castille recommended confining levee expansion to the batture side of the existing levee, to minimize the impact of construction on scenic integrity and to minimize the likelihood of impacting unidentified cultural resources that may exist near and be associated with Fort Jackson (Castille 1978:7-8).

That same year, Tulane University studied two areas associated with the planned construction of a proposed Hurricane Levee spanning from New Orleans to Venice Louisiana. No cultural resources were discovered and no adverse affects were expected to known cultural resources located in the vicinity of the study areas (Davis et al. 1978:i).

The East Bank Barrier Levee Plan, which covers an area located along the lower Mississippi River, was studied during 1979. Measures were recommended to protect and manage cultural resources at Fort St. Philip, a site listed on the National Register of Historic

Places (NRHP) that would be impacted by the East Bank Barrier Levee Plan. Adverse impacts were expected at twenty-three (23) other sites, but only two were recommended for further study to assess their eligibility for listing on the NRHP: Ostrica (16PL66), an oyster processing factory and an associated residential area for factory employees; and Dunn's Camp (16PL82), the remains of a late nineteenth-century home. This study recommended that any cultural resources identified during construction activities should be reported to the Louisiana State Historic Preservation Office (Davis et al. 1979:i, 227-232).

Coastal Environments, Inc., conducted a cultural resources survey of an area that spans from Empire to the Gulf of Mexico Waterway prior to the commencement of dredging activities. Three historic hunting-fishing campsites were identified during survey, but these sites were not eligible for listing on the NRHP. Nevertheless, Coastal Environments recommended avoidance of two of these sites (Gagliano et al. 1979:i).

During 1981, the Iroquois Research Institute studied four proposed revetment locations, one in Bayou Lamoque and one near Tropical Bend, and in the Port Sulphur area as part of a large cultural resources survey that included a total of fourteen individual study areas. No cultural resources were identified in any of the study areas located within 5.0 mi (8.0 km) of the present Nairn and Tropical Bend study areas (Iroquois Research Institute 1982:1, 2, 85). The proposed Bayou Lamoque revetment was studied again during 1983, but no significant cultural resources were identified during this survey (Stuart and Greene 1983:1).

R. Christopher Goodwin & Associates, Inc., surveyed the Port Sulphur revetment right of way during a 1985 study of five areas in Louisiana. No significant cultural resources were identified as a result of this study (R. Christopher Goodwin & Associates, Inc. 1985:1-2).

The Agency for Conservation Archeology at Eastern New Mexico University provided a summary of cultural resources investigations related to the New Orleans to Venice Hurricane Protection Project. According to their 1988 report, 31 cultural resource surveys were completed and 80 archeological sites were identified. Forty of these sites would be directly or indirectly affected by project activities. Three of these are National Historic Landmarks: Fort Jackson (16PL38), Fort St. Philip (16PL39), and Fort de la Boulaye (16PL27). Another four were considered eligible for listing on the NRHP: Olga (16PL61), Ostrica (16PL66), Adolph's Camp (16PL80), and Dunn's Camp (16PL82). This report also recommended that field survey be conducted in four areas north of Fort Jackson and that further investigations would be necessary if any National Historic Landmarks or sites considered eligible for listing on the NRHP could not be avoided (Montgomery et al. 1988).

During 1989, the U.S. Army Corps of Engineers (USACE) undertook a study of the aesthetic impacts of the Hurricane Protection Project on Fort Jackson. Using its Visual Impact Assessment procedure, various positions were selected for viewshed analysis. This study determined that the levee enlargement portion of the project would have no significant visual impact on Fort Jackson, because the increased levee height would be barely detectable from the fort and an insignificant number of trees would be lost. However, other portions of the project, including excavation of several borrow areas and the relocation of a marina facility, would have an adverse impact on the fort because planned deforestation in the vicinity of these areas would adversely affect the character of the landscape visible from Fort Jackson. To mitigate these effects, the establishment of three 200-foot non-clearance buffer zones along the levee corridor that surrounds Fort Jackson was recommended, along with the designation of these zones as fish and wildlife mitigation areas and the purchasing of long-term easements in the vicinity of these areas (U.S. Army Corps of Engineers, Cultural Recreation Section, Planning Division 1989:4-6, 27).

Several additional cultural resources surveys were undertaken for the New Orleans to Venice Hurricane Protection Project from

1988 to 1990. Three studies were conducted during 1988. Coastal Environments, Inc., studied two proposed construction areas, the Homeplace and Tropical Bend borrows located north of Empire. No significant cultural resources were identified within these areas (Coastal Environments, Inc., 1990b). The third study focused on a 267-acre proposed borrow area located south of Fort Jackson. This study also failed to identify any significant cultural resources (Coastal Environments, Inc., 1990a). The Museum of Geoscience at Louisiana State University conducted a study of the proposed Solari borrow site in Empire. No significant cultural resources were discovered as a result of this study (Museum of Geoscience, Louisiana State University 1989).

During 1989, R. Christopher Goodwin & Associates, Inc., studied three proposed borrow sites areas near Port Sulphur. No significant cultural resources were discovered as a result of this study (R. Christopher Goodwin & Associates, Inc. 1989).

Between October 1989 and April 1990, Coastal Environments, Inc., studied four additional areas of the New Orleans to Venice Hurricane Protection Project near Fort Jackson. This work was completed in accordance with a research design that accompanied their 1990 report (Coastal Environments, Inc., 1990a). Although Civil War-era artillery shell fragments were recovered from two of these areas, this study concluded that no significant cultural resources existed in any of the four study areas because previous construction activities and other disturbances have negatively impacted site integrity (Coastal Environments, Inc., 1992).

During 1991, Richard C. Beavers, an archeological consultant, conducted a Level II archeological investigation at the proposed Freeport Sulphur borrow site. No significant cultural resources were identified as a result of this study (Beavers and Lamb 1991:iv).

Two investigations were conducted to determine the locations of ships lost during an April 1862 naval battle between Union and Confederate forces on the Mississippi River in the vicinity of Fort St. Philip and Fort Jackson.

One of these investigations, an undated study by the Louisiana Division of Archeology, examined the Mississippi River bottom from Statute River Mile (SRM) 27.5 near Buras to SRM 14.0 above Venice. Remote sensing survey identified thirteen magnetic anomalies that appeared to represent shipwrecks. Under water investigation by diving archeologists was not conducted for five of these anomalies because of adverse environmental conditions. Two anomalies were thought to contain steamboats and were located near the recorded losses of the *C.S.S. Star* and the *C.S.S. General Quitman.* However, these anomalies were located in areas where water depth exceeded the 60.0 ft (18.3 m) depth limit set for diving archeologists during this study. Three other areas were too obscured by other materials to be identifiable. Of the eight magnetic anomalies investigated by diving archeologists, only one area yielded artifacts that indicated the site of a shipwreck. This site was identified as the remains of *C.S.S. Warrior.* A "comprehensive and well-documented data collection effort to identify all sites within the area of study" as well as formal management plans for these resources were recommended (Louisiana Division of Archeology n.d.:1, 47-51).

Another investigation, completed by R. Christopher Goodwin & Associates, Inc., during 1994, identified two historic shipwrecks, the ironclad *C.S.S. Louisiana* and the River Defense fleet vessel *Defiance* in the vicinity of Fort St. Philip and Fort Jackson (R. Christopher Goodwin & Associates, Inc., 1994:ii).

Previously Recorded Archeological Sites

Twenty-two previously recorded archeological sites are located within a 5.0 mi (8.0 km) of the present study areas. One site, 16PL13, contains only a prehistoric component. This site, known as Buras Mounds, is comprised of four earthen mounds arranged around a rectangular plaza. It has yielded prehistoric ceramics and scattered debitage from the Plaquemines period.

Two sites other contain prehistoric and historic components. Adams Bay (16PL8)

consists of three earthen mounds. The prehistoric components of this site include plain clay and incised pottery from the Plaquemines period, and the historic components of this site include undated examples of purple, green, and clear glass. The Arbula Site (16PL76) contains undated prehistoric ceramics, as well as ceramics, glass, and metal dated to the mid to late nineteenth century.

The other nineteen sites contain only historic components. Three of these are military sites: Fort Bourbon (16PL29), Fort Jackson (16PL38), and Fort St. Philip (16PL39). These forts are located along the Mississippi River southeast of the present study area. Fort Bourbon was first constructed during 1794 as a mud and timber redoubt. This site was destroyed by a hurricane during August 1795, and rebuilt immediately. This fort was in use until 1803 when it was likely destroyed by another storm. No remains of this fort are believed to survive.

Fort St. Philip (16PL38) and Fort Jackson (16PL39), face each other across the Mississippi River. These forts served as the main Confederate defense of New Orleans during the Civil War. Both of these forts are National Historic Landmarks. The French originally constructed Fort St. Philip during 1746. It was rebuilt by the Spanish during 1791 and repaired by Andrew Jackson during 1814. Other repairs and construction projects were undertaken at Fort St. Philip during the Spanish-American War and during World War I. This fort was abandoned during the early twentieth century. The site record form on file at the Louisiana Division of Archeology, dated 1978, notes that cultural features including remnants of the original fort as well as World War I era buildings, bunkers, and emplacements survive. Materials collected at Fort St. Philip include U.S. Navy projectiles that date from the period between 1857 and 1862. Fort Jackson was constructed in 1822 and remained in operation until 1920. The Fort Jackson site record form includes the remains of a bastioned brick pentagon.

Three sites are believed to be shipwrecks. Light 22 (16PL97) includes articulated timbers buried in mud. Other materials present at this site include coal, melted metal, spikes, iron bars that may have served as gun carriage hardware, a long iron rod, bolts, and an eyebolt. Varuna (16PL93) and Governor Moore (16PL90) have been identified as possible Civil War shipwrecks.

Six other sites reflect historic domestic use. The Tree Site (16PL96) represents a dock and house that date from between 1830 to 1880. The Point Pleasant Camp Site (16PL64) includes a one-story Creole-style wood frame cottage with a corrugated metal roof, rusted machinery, brick, glass, ceramics, and metal. This site dates from the late nineteenth and early twentieth centuries. The Empire Oil Field 1 Site (16PL71) contains a wooden shotgun-style house raised on pilings, an associated cattle pen and chute, the remains of a walkway to the river, and assorted ceramic, glass, and metal objects. This site dates from the late nineteenth and early twentieth centuries. Site 22A (16PL95) is a house site that contains glass, ceramics, iron, and coal. It dates from between 1830 to 1900. The Quarantine Lodge Site (16PL100) was a lodge that housed immigrants with communicable diseases from 1870 to 1919. This site no longer contains any standing structures. The Home Place/Port Sulphur historic surface scatter (16PL131) contains brick fragments, glass, asphalt, shells, and wire nails. This site has been disturbed.

Three additional sites reflected various uses. The Ostrica Site (16PL66) contained an oyster factory and associated structures, dating from the late nineteenth and early twentieth centuries. Materials identified during investigations at this site include a brick kiln, a brick floor, cement and brick foundation pilings, glass, metal, ceramics, and the remains of a chimney. Old St. Patrick's Cemetery (16PL132) contains a surface scatter of brick, slate, and cement. This site was abandoned during 1952. The Point Bolivar Site (16PL68) contains a cement block near the river bank that might have served as a foundation for a light during the nineteenth and twentieth centuries. Materials from this site include ceramics, glass, metal, and a French gunflint. Brancovich (16PL74) contains oyster shells, brick, glass, ceramics, and bone dating from

the eighteenth to early twentieth centuries. This may have been the site of a store or other special activity area.

Three sites contain historic scatters. The Jeanfreau Site (16PL67) contains glass, ceramics, metal, and brick dating from the mid-nineteenth to early twentieth centuries. Nestor Canal I (16PL75) contains oyster shells, glass, bricks, and ceramics from the seventeenth through nineteenth centuries. The Barrow and Slatter Site (16PL77) contains glass fragments from the late nineteenth and twentieth centuries.

Previously Recorded Historic Structures

Two previously recorded historic structures are located within 5.0 mi (8.0 km) of the present study areas: Fort St. Philip and Fort Jackson. These sites contain both archeological sites and standing structures.

CHAPTER VI

METHODS

Archival Methods

Archival research conducted for Phase I marine archeological remote sensing survey of the proposed Mississippi River sand borrow sites for the Louisiana Coastal Area Barrier Shoreline Restoration Project, Plaquemines Parish, Louisiana focused on identifying previously recorded archeological sites, shipwrecks and other obstructions in the vicinity of the study areas (Table 1). This involved reviewing various sources of information including archeological reports, site records, nautical charts, maps, shipwreck databases, and relevant secondary sources.

Primary Sources

Maps and Charts. Federally produced charts are available at the National Archives and the Library of Congress. They disseminate information gathered during hydrographic surveys undertaken from the 1860s to present. These charts are intended to guide vessels through waterways by providing bathymetric data and buoy positions. The listing of wrecks and other obstructions began during the 1930s. National Oceanic and Atmospheric Administration (NOAA) charts detail features that may prove hazardous to ships and boats. NOAA Navigation Chart No. 11364 *Mississippi River* includes locations of wrecks and obstructions in the vicinity of the study area.

Shipwreck Reports and Databases. The vertical files and newspaper indices of the City Archives of New Orleans both were examined to help identify shipwrecks in the vicinity of the study areas. A Database of Louisiana Shipwrecks on file at the Louisiana Department of Culture, Recreation and Tourism, Division of Archaeology in Baton Rouge, Louisiana, also was examined. This list contains summaries of reported shipwrecks in Louisiana waters (Clune and Wheeler 1991). In addition, The National Oceanic and Atmospheric Administration (NOAA) Automated Wreck and Obstruction Information System (AWOIS) database contains information on shipwrecks and obstructions in the coastal waters of the United States. Even though this resource provides little information regarding shipwrecks and obstructions located on inland waterways, such as the Mississippi River, a search of this database was conducted to ensure that no shipwrecks or obstructions are listed within the vicinity of the present study area.

Secondary Sources

The following volumes with lists of reported shipwrecks also were examined as corroborative evidence for other sources examined for this report:

- *Encyclopedia of American Shipwrecks* (Berman 1972);

- *Beneath the Waters: A Guide to Civil War Shipwrecks* (Hemphill 1998);

- *Survey of Federal Archives in Louisiana, 1937-38: A Record of Casualties to Persons and Vessels on the Mississippi River, Its Tributaries, on Lakes and Other Waterways of the U.S. Customs District Port of New Orleans, 1837-1924. (WPA 1938);*

- *A Guide to Sunken Ships in American Waters* (Lonsdale and Kaplan 1964);

- *Merchant Steam Vessels of the United States, 1790-1868* (Lytle and Holdcamper 1975);

- *Way's Packet Directory, 1848-1994* (Way, Jr., 1983);

- *Way's Steam Towboat Directory* (Way, Jr., and Rutter 1990)

Archeological Remote Sensing Methods and Investigations

Phase I marine archeological remote sensing survey of the proposed Mississippi River sand borrow sites for the Louisiana Coastal Area Barrier Shoreline Restoration Project, Plaquemines Parish, Louisiana was conducted from the crew boat *Dahli Brooke*, operated by Jambon & Associates, LLC. The remote sensing survey was designed to identify specific magnetic or acoustic anomalies and/or clusters of anomalies that might represent potentially significant submerged cultural resources, such as shipwrecks or remnants of structures associated with late nineteenth and early twentieth century navigational improvements at Head of Passes. The natural and anthropogenic forces that form such sites typically deposit or scatter ferrous and non-ferrous objects, including fasteners, anchors, engine parts, ballast, weaponry, cargo, tools, and miscellaneous related debris across the bottom. These objects normally can be detected with a remote sensing array that includes a marine magnetometer, a side scan sonar, a sub-bottom profiler, and an echosounder. This array records anomalous signatures that stand out against the ambient magnetic and visual fields. Two critical elements in the interpretation of such anomalies are their spatial distribution or patterning, and in the case of magnetic anomalies, their amplitude and duration. Because of the importance of anomaly patterning, accurate recording and positioning of anomaly locations is essential.

The equipment array used during survey included a *Trimble AG132* DGPS, a *Geometrics G-881A* digital cesium vapor marine magnetometer, a *Marine Sonic* 600 kHz side scan sonar, an *Imagenex* digital sub-bottom profiler, and a *Cetrek* echosounder. Data were collected and correlated via a laptop computer using hydrographic survey software.

Positioning

Two Differential Global Positioning Systems (DGPS) were used to direct navigation and to provide accurate positions of magnetic and acoustic anomalies. The primary DGPS unit consisted of a *Trimble AG 132*, with a *Northstar 941XD* internal DGPS as a secondary system. The *Trimble AG 132* and the *Northstar 941XD* are considered to be accurate to within 3.3 ft (1.0 m) and 9.9 ft (3.0 m) respectively. These systems transmitted position information in NMEA 0183 code to the computer navigation system: Coastal Oceanographics *Hypack Max* vers. 4.3b (*Hypack*).

Hypack translates the NMEA message and displays vessel position on a computer screen relative to pre-plotted transects. During post-processing, position files can be used to plot transects and to derive the X, Y, and Z values used to produce magnetic and bathymetric contour plots. For this project, control points were obtained at one-second intervals, and strong differential signals were acquired with a minimum noise to signal ratio.

Magnetometry

The digital cesium vapor marine magnetometer is a state-of-the-art electronic instrument used to record the strength of the earth's magnetic field in increments of nanoTeslas (nT). Magnetometers have proven useful in marine research as detectors of anomalous distortions in the earth's ambient magnetic field, particularly distortions that are caused by concentrations of natural and anthropogenic ferrous materials. Distortions or changes as small as 0.01 nT are detectable when operating the magnetometer at a sampling rate 0.1 seconds. Magnetic distortions caused by submerged cultural resources may range in intensity from several nanoTeslas to several thousand nanoTeslas, depending on such factors as the mass of

ferrous materials present, the distance of the ferrous mass from the sensor, and the orientation of the mass relative to the sensor. The uses of magnetometers in marine archeology and the theoretical aspects of the physical principles behind their operation have been summarized and discussed in detail by Green (1990), Weymouth (1986), Breiner (1973), Titc (1972), Hall (1970, 1966), Aitken (1961).

Individual anomalies produce distinctive magnetic signatures. An individual signature may be categorized as: a positive monopole, a negative monopole, a dipole; or a multi-component. Monopoles usually indicate a single source. They are registered as positive or negative deflections from the ambient magnetic field, depending on how the object that they reprcsent is oriented relative to the magnetometer sensor. Dipolar signatures comprise a rise and a fall above and below the ambient magnetic field. They also are commonly associated with single source anomalies, with the dipolc usually aligned along the axis of the magnetic field and the negative peak of the anomaly falling nearest the North Pole. Multi-component, or complex signature anomalies, consist of both dipolar and monopolar magnetic perturbations associated with a large overall deflection that can be indicative of ferrous materials comprising debris patterns similar to those typically associated with shipwrecks and other submerged cultural resources. The complexity of the signature is affected partially by the distancc of the scnsor from the fcrrous mass and the quantity of dcbris present. If the sensor is close to a cluster of ferrous materials, the signaturc of thesc objects will register as a multi-component; if far enough away, these objects will register as a monopole or a dipole.

A *Geometrics G881-A* cesium vapor marine magnetometer with an integrated altimetcr was employcd during this survey. This instrument is a 0.01 nT sensitivity magnetometer that uploads magnetic data as digital numeric data files to *Hypack*. As magnetic data are being collected, *Hypack* attaches precise real-time DGPS coordinates to each magnetic reading. The magnetometer was towed far enough behind the survey vessel to minimize the associated noise, which generally measured less than 2.0 nT.

Acoustic Imaging

Over the past 25 years, the combined use of acoustic and magnetic remotc scnsing equipment has proven to bc the most effective method of identifying submerged cultural resources and of assessing thcir potential for further research (Grcen 1990, Hall 1970). When combined with magnetic data, the near photographic-quality of acoustic rccords produced by sidc scan sonar systems has left little doubt regarding the identification of some intact shipwrecks. For targets lacking structural integrity or those partially buried beneath bottom sediments, identification can be extremely difficult. Because intact and exposed shipwrecks are less common than those that are broken and buried, rcmote sensing surveys gcncrally produce acoustic targets that require ground-truthing by diving archeologists to determine their identity and significance.

A *Marine Sonic* 600 kHz digital side scan sonar system was used continuously during survey to produce images of the river bottom within the study area. This system consisted of a tow fish operating at a frcquency of 600 kHz linked to a computer proccssing system that integrated DGPS signals with the tow fish every 2.0 seconds. The sonar was set at a range of 164.0 ft (50.0 m) per channel, to yield overlapping coverage of the study areas. Sonar data were recorded in a digital format with streams of time-tags and positions to assist in thc correlation of the acoustic and magnetic data sets. During survey, images were displayed on a computer monitor real-time, and an observation log was maintained by thc sonar technician to rccord the descriptions and locations of anomalies. Potential targets were inventoried both during survey and post-processing.

An *Imagenex 1030* digital sub-bottom profiler also was employed during survey to delineate buried shipwrecks. This unit uses a scanning FM continuous transmission pulse of 10 to 30 kHz to create high-resolution images of subsurface anomalies at a resolution of 2.0

cm (0.8 in). Data were collected digitally and viewed real-time during survey.

All positioning and remote sensing equipment performed reliably throughout survey, and regular coverage of the entire survey area was achieved.

Survey Control and Correlation of Data Sets

Hypack provided the primary method of control during survey. Transects were planned, geodetic parameters were established, and instruments were interfaced and recorded through this software package. During survey, planned transects displayed on a computer screen, and the survey vessel's track was monitored. In addition to providing steering direction for the helmsman, *Hypack* allowed surveyors to simultaneously monitor position, instrument performance and incoming data.

Positions for all data then were corrected using *Hypack* for instrument layback and offsets. Positions were recorded applying Louisiana State Plane (South 1702), North American Datum 1983 (NAD 83) and using survey feet as units of measure.

Remote Sensing Data Analysis

During the analysis of magnetometer data, individual anomalies were identified and examined carefully. An inventory of magnetic anomalies then was compiled, and the profile of each anomaly was characterized in terms of signature, amplitude, and duration. Particular attention was paid to anomalies that indicated areas of high density, to anomalies exhibiting complex magnetic signatures, to clusters of anomalies, and to anomalies of unusually high amplitude and duration with adjacency on multiple transects. The signatures of these anomalies then were plotted using Golden Software *Surfer 7.0* to provide a visual aid for interpretation. Magnetic data were correlated with field notes, so that deflections from modern sources, such as aids to navigation, could be identified.

Analysis of side scan sonar data was conducted to identify acoustic anomalies that potentially represent significant submerged cultural resources. Acoustic anomaly locations then were correlated using GIS software with magnetic targets to establish possible relationships between these two datasets. Acoustic data were analyzed in digital format, and images were captured of potential targets for inclusion as illustrations in the report.

The discrimination of potentially significant cultural resources from magnetometer, side scan sonar and sub-bottom profiler data extends beyond the review of individual characteristics. The identification of potentially significant cultural resources involves pattern recognition from a suite of attributes. The first step in this process involves the elimination of simple point source anomalies. This requires correlation of remote sensing data, and/or the analytical combination of individual signatures into multi-component targets when the characteristics of anomalies indicate relationships between components. This pattern recognition protocol is related to standard terrestrial archeological procedures for site definition, or the recognition of multiple components of a single terrestrial archeological site. The difference between the definition of terrestrial and under water archeological sites is that underwater site definition often relies almost entirely on a combination of remote sensing proficiency and historical research.

Review of raw magnetometer, side scan sonar, and sub-bottom profiler data resulted in the identification of forty (40) individual magnetic anomalies and nine (9) individual acoustic anomalies in Block A, and 332 individual magnetic anomalies, and 28 individual acoustic anomalies in Block B. No sub-bottom anomalies were identified during the post-processing of remote sensing data. The application of pattern recognition protocols and examination of remote sensing data permitted the discrimination of five (5) targets in Block A, designated Targets 1-5, and 27 targets in Block B, designated Targets 6-32, that merited more detailed scrutiny.

CHAPTER VII

RESULTS

Site Description

Phase I marine remote sensing cultural resources investigation of the proposed Mississippi River sand borrow sites for the Louisiana Coastal Area Barrier Shoreline Restoration Project covered two survey blocks located between Mile Markers 25.0 and 35.0 above Head of Passes (Figures 1 and 2). These survey blocks cover approximately 58 per cent of this reach of the Mississippi River. The upper block, Block A, measures approximately 458.0 acres (185.3 hectares), the lower block, Block B, measures approximately 1607 acres (650.3 hectares).

Archival Results

Several sources provide data on ships lost on the Mississippi River. The Automated Wreck and Obstruction Information System (AWOIS) maintained by the National Oceanic and Atmospheric Administration (NOAA) and *A Database of Louisiana Shipwrecks* (Clune and Wheeler 1991), on file at the State of Louisiana Department of Culture, Recreation and Tourism, Office of Cultural Development, Division of Archaeology in Baton Rouge, Louisiana, were examined to ascertain known shipping losses within 5.0 mi (8.0 km) of the present study area. These data were compared to relevant primary and secondary sources in an attempt to understand the history of these vessels and the circumstances of their loss.

Automated Wreck and Obstruction Information System

The National Oceanic and Atmospheric Administration (NOAA) Automated Wreck and Obstruction Information System (AWOIS) database contains information on shipwrecks and obstructions in the coastal waters of the United States. Even though this resource provides little information regarding shipwrecks and obstructions located on inland waterways, such as the Mississippi River, a search of this database was conducted to ensure that no shipwrecks or obstructions are listed within the vicinity of the present study area. This search resulted in a determination that no previously reported shipwrecks are listed in the Automated Wreck and Obstruction Information System Database within 5.0 mi (8.0 km) of the present study area.

A Database of Louisiana Shipwrecks

Review of *A Database of Louisiana Shipwrecks* resulted in the identification of 56 shipwrecks recorded within 5.0 mi (8.0 km) of the present study area. Information presented in this database was gathered from archival documents and secondary sources. Positions recorded as latitudes/longitudes, and/or River Miles are included in this resource; however, many of the shipwreck locations that appear in this database have not been verified.

NOAA Navigation Chart No. 11364 *Mississippi River*

National Oceanic and Atmospheric Administration (NOAA) charts detail features that may prove hazardous to ships and boats. NOAA Navigation Chart No. 11364 *Mississippi River* includes locations of wrecks and obstructions in the vicinity of the study area. Study of this chart revealed that nine unidentified shipwrecks are located within 5.0 mi (8.0 km) of the study areas, but none are located within Blocks A or B. It was not possible to ascertain whether or not these

vessels are included in *A Database of Louisiana Shipwrecks*, as only the positions of these obstructions are provided on Chart No. 11364.

Results of Archival Investigations

Study of the above-mentioned sources revealed that only eleven of the up to sixty-five possible shipwrecks have a moderate probability of being located within the study areas. The remaining 54 shipwrecks are reportedly located between 365.0 and 26400.0 ft outside the study areas. All of these vessels are listed in Table 1. This list includes one vessel lost between 1800 and 1850, sixteen vessels lost between 1851 and 1900, seven vessels lost between 1901 and 1950, and 32 vessels lost between 1951 and 1984. No vessels lost after 1984 are listed within 5.0 mi (8.0 km) of the present study areas in *A Database of Louisiana Shipwrecks* (Clune and Wheeler 1991). As NOAA Navigation Chart No. 11364 *Mississippi River* provides little data on the nine shipwrecks it contains within 5.0 mi (8.0 km) of the study areas, information such as dates of loss and vessel names could not be ascertained for these vessels. None of these shipwrecks are plotted on Chart No. 11364 within Blocks A and B.

The single vessel lost between 1800 and 1850 is reportedly located in Block A and is discussed below. The large number of vessels lost between 1851 and 1900 is related to the April 1862 naval battle between Union and Confederate forces in the vicinity of Forts Jackson and St. Philip. None of these shipwrecks are believed to be located within Blocks A or B. The progressive increase in vessel losses during the periods ranging from 1901 and 1950 and 1951 to 1984 reflects the general growth of both commercial and leisure traffic along the Mississippi River.

Coordinates provided in *A Database of Louisiana Shipwrecks* plot only one shipwreck within Block A: *Athenian* (Record no. 202). This vessel is a barge that reportedly burned on 15 July 1841. This resource records eight shipwrecks within Block B, these are discussed below.

The oldest ship reportedly located in Block B is *Empire* (Record no. 325). *Empire* was owned by F.M. Stockfleth, and Frank Buntelich was her master. On the morning of 7 March 1905, *Empire* caught fire and partially burned. This accident was attributed to "neglect of engine as to gasoline tank," and caused $1000 worth of damage to a vessel valued at over $3000. That night, Captain Larko fell overboard while trying to put out the fire, and was never found (*New Orleans Daily Picayune* 3/20/1905). The Coast Guard declared this vessel a total loss (WPA Wreck Reports 1939, n.p.).

On 22 December 1920, *Sampson* (Record no. 574), owned and captained by Peter Rosich, caught fire at Empire landing. The engine apparently caused the fire, which caused $2000 worth of damage, resulting in the total loss of the vessel. *Sampson* may have sunk in Block B near Empire Landing. Approximately seven years later, on 1 November 1927, an oil screw named *Victoria* (Record no. 646) reportedly burned in Block B.

Star of Honduras (Record no. 1481) was a 160.0 ft (48.8 m) cargo vessel that was transporting lumber from New Orleans to Cuba during November 1952. It was traveling downstream along the west bank of the Mississippi River when it was struck on its port bow by the Esso Standard tanker *Queenston Heights* which presumably had just left dock. *Star of Honduras* was hit below the waterline and ran aground on the bank approximately 1000.0 ft (304.8 m) upriver of the Gulf Refining Company dock in Ostrica, and capsized (*New Orleans Times-Picayune*, 11/22/1952). Even though *Star of Honduras* is listed in *A Database of Louisiana Shipwrecks* and the coordinates provided in this resource plot this vessel within Block B, other sources suggest that this vessel may not have sunk. Therefore, it is unlikely that *Star of Honduras* is located in within the study areas.

Five years later, a steel barge known as *G.R. CO. 4* (Record no. 1406), reportedly foundered on 17 July 1957 within Block B and later, on 2 December 1965, the 77 ton oil screw *Twilight* (Record no. 1488) is reported to have collided with the tug *Miss Geraldine* in this same area.

Four unnamed shipwrecks also are listed as located within Block B. These vessels include Record no. 1495, an unnamed 285 hp gas powered charter vessel lost on 19 January 1963, Record no. 1680, an unnamed gas powered steel crewboat lost as a result of a collision on 17 September 1968, Record no. 1501, an unnamed vessel lost on 23 May 1979, and Record no. 1571, an unnamed vessel lost on an unrecorded date during 1979.

Archeological Remote Sensing Survey Results

Forty (40) magnetic anomalies and nine (9) acoustic anomalies were recorded during remote sensing survey of Block A, and 332 magnetic anomalies and 28 acoustic anomalies were recorded during remote sensing survey of Block B (Tables 2 and 3). The application of pattern recognition protocols and examination of remote sensing data permitted the discrimination of anomaly clusters meriting more detailed scrutiny. Similarly, insignificant point source anomalies and acoustic anomalies clearly not representative of cultural resources were eliminated from further consideration. As a result, five (5) targets were identified for further analysis in Block A, and 27 targets were identified for further analysis in Block B (Table 4). Only Targets 13, 30, 31, and 32 exhibit characteristics that suggest that they may represent significant submerged cultural resources. All of these are located in Block B.

Discussions of magnetic, acoustic, sub-bottom, and bathymetric anomalies appear below, followed by individual descriptions and evaluations of targets.

Magnetic Anomalies

Forty magnetic anomalies were recorded during marine remote sensing cultural resources investigation of Block A (Table 2). Twenty-one magnetic anomalies were recorded with low amplitudes, eight were recorded with medium amplitudes and eleven were recorded with high amplitudes. Only M1 and M19 were recorded with short and medium durations, respectively. The remaining 38 magnetic anomalies exhibited long durations. Thirty-two magnetic anomalies exhibited simple, monopolar or dipolar, signatures, and only eight were recorded with complex, multi-component signatures. Seven of these complex anomalies were identified for further scrutiny and are discussed below. Even though M1 exhibits a complex, multi-component, signature it did not receive further study as its amplitude and spatial isolation clearly indicated that it does not represent a significant submerged cultural resource.

Twenty-three magnetic anomalies recorded in Block A were identified for further scrutiny and are discussed in Targets 1-5 below. These represent anthropogenic structures related to modern ATONs (Aids to Navigation), docks, barge moorings, pipelines and casually discarded or lost debris. None of these appear to represent significant submerged cultural resources. The remaining seventeen magnetic anomalies that were not grouped into target clusters probably represent casually discarded or lost debris from passing boat and ship traffic, and debris transported into the study area as a result of Hurricane Katrina.

Three hundred thirty-two magnetic anomalies were recorded during marine remote sensing cultural resources investigation of Block B (Table 2). One hundred seventy-two magnetic anomalies were recorded with low amplitudes, eighty were recorded with medium amplitudes and eighty were recorded with high amplitudes. Fifty (50) magnetic anomalies were recorded with medium durations and 282 were recorded with long durations. Two hundred ninety-two (292) magnetic anomalies exhibited simple, monopolar or dipolar, signatures, and forty (40) were recorded with complex, multi-component signatures. Even though M47, M137, M144, M161, M163, and M365 exhibit complex, multi-component signatures, they did not receive further study because their spatial isolation indicated that they do not represent significant submerged cultural resources.

One hundred eighty-six of these were identified for further scrutiny and are discussed in Targets 6-32 below. The majority of these probably represent anthropogenic structures related to modern docks, barge moorings,

pipelines and casually discarded or lost debris. Only ten magnetic anomalies were recorded that potentially represent significant submerged cultural resources, ie. shipwrecks. The remaining 146 magnetic anomalies that were not grouped into target clusters probably represent casually discarded or lost debris from passing boat and ship traffic, and debris transported into the study area as a result of Hurricane Katrina.

Acoustic Anomalies

Nine acoustic anomalies, designated A1-A9, were recorded by the side scan sonar in Block A (Table 3). A1-A4 are images of scouring and sand waves and A5-A8 record the presence of modern anthropogenic structures and objects such as docks, ATON and barge moorings, and modern debris. A9 shows a failure along the right descending bank of the Mississippi River. None of the acoustic anomalies recorded in Block A represent significant submerged cultural resources.

Twenty-eight acoustic anomalies, designated A10-A37, were recorded by the side scan sonar in Block B (Table 3). The majority of these anomalies fail to exhibit characteristics indicative of significant submerged cultural resources. These represent bottom scouring, bank failure, pipeline matting, moorings, docks, and debris. Six acoustic anomalies, designated A31, A32, A33, A34, A35, and A37, were identified that may represent significant submerged cultural resources. These are discussed in the target descriptions below.

Sub-bottom Anomalies

No sub-bottom anomalies were recorded that indicate the presence of significant submerged cultural resources in Blocks A or B.

Bathymetric Anomalies

No bathymetric anomalies were recorded that indicate the presence of significant submerged cultural resources in Blocks A or B.

Evaluation of Reported Shipwreck Locations

No magnetic or acoustic anomalies were recorded at the reported locations of the eleven shipwrecks that were determined to have a high probability of being located within the study areas. Analyses of remote sensing data revealed it is unlikely that any of these vessels are located at the locations reported in *A Database of Louisiana Shipwrecks* (Clune and Wheeler, 1991).

Description and Evaluation of Targets

Target 1

Target 1 (Figure 2, Map 1) is comprised of one acoustic anomaly, designated A9, and is located in Block A at 349736.19 N, 3828743.69 E approximately 417.0 ft (127.1 m) from the right descendant bank of the Mississippi River at a depth of approximately 10.0 to 15.0 ft (3.0 to 4.6 m). A9 measures approximately 112.0 x 30.0 ft (34.1 x 9.1 m) with 7.5 ft (2.3 m) relief. Preliminary analysis of this anomaly suggested that it may be an anthropogenic structure. This assertion was based primarily on its geometry, but further study indicated that it probably represents an area of bank failure. A marine magnetometer was towed along a transect located within 100.0 ft (30.0 m) of this area, but no magnetic anomalies were identified during post-processing that could be associated with A9. Nevertheless, a magnetic contour plot of the area surrounding A9 was produced and reviewed to further ensure that no significant deviations from the ambient magnetic field were recorded in this area. This target fails to possess characteristics indicative of submerged cultural resources. No further work is recommended for Target 1.

Target 2

Target 2 (Figure 2, Map 1) is comprised of eight magnetic anomalies, designated M24, M25a, M28, M29, M33, M34, M36, and M39, and two acoustic anomalies, designated A7 and A8. This target is located in Block A at 350428.81 N, 3827453.40 E approximately 290.0 ft (88.4 m) from the right descendant bank of the Mississippi River at a depth that

ranged from approximately 5.0 to 60.0 ft (1.5 to 18.2 m). M24 exhibits a high amplitude (385.4 nT), a long duration (353.8 s), and a simple, dipolar, signature. M25a exhibits a low amplitude (27.3 nT), a long duration (224.7 s), and a simple, dipolar, signature. M28 exhibits a low amplitude (37.0 nT), a long duration (300.0 s), and a complex, multi-component, signature. M29 exhibits a medium amplitude (66.2 nT), a long duration (412.7 s), and a complex, multi-component, signature. M33 exhibits a high amplitude (202.4 nT), a long duration (229.5 s), and a complex, multi-component, signature. M34 exhibits a high amplitude (622.4 nT), a long duration (304.8 s), and a complex, multi-component, signature. M36 exhibits a high amplitude (869.9 nT), a long duration (401.0 s), and a complex, multi-component, signature. M39 exhibits a high amplitude (674.0 nT), a long duration (289.7 s), and a complex, multi-component, signature. A7 represents a dock that measures approximately 87.0 x 38.0 ft (26.5 x 11.6 m). This dock was visible during data collection. A8 represents a barge mooring. The mooring measures approximately 45.0 x 6.0 ft (13.7 x 1.8 m). A barge was moored at this location during data collection.

Spatial and magnetic contour analyses indicate that M33, M34, M36, and M39 are associated and represent the dock captured in A7, and M24, M25a, M28, and M29 are associated and represent the barge mooring captured in A8. Study of this target reveals that it fails to possess characteristics indicative of submerged cultural resources. Target 2 represents both a dock and a barge mooring. This target is not indicative of a submerged cultural resource. No further work is recommended for Target 2.

Target 3

Target 3 (Figure 2, Map 1) is comprised of two magnetic anomalies, designated M16 and M20. No acoustic anomalies were recorded that can be associated with this target. Target 3 is located in Block A at 350277.69 N, 3829139.73 E near the center of the Mississippi River at a depth of approximately 86.0 ft (26.2 m). M16 exhibits a low amplitude (30.3 nT), a long duration (35.6 s), and a simple, dipolar, signature. M20 exhibits a low amplitude (29.3 nT), a long duration (33.0 s), and a simple, monopolar, signature. Spatial and magnetic contour analyses indicate that these signatures represent a small cluster of ferrous objects recorded on multiple transects. Target 3 is a simple magnetic disturbance that does not possess the complexity associated with submerged cultural resources and probably represents casually discarded or lost ferrous debris. This target is not indicative of a submerged cultural resource. No further work is recommended for Target 3.

Target 4

Target 4 (Figure 2, Map 1) is comprised of two acoustic anomalies, designated A5 and A6, and two magnetic anomalies, designated M19 and M21. This target is located in Block A at 347959.96 N, 3831744.77 E in the vicinity of an ATON plotted on NOAA Chart 11364 *Mississippi River* at a depth of approximately 43.0 ft (13.1 m). A5 represents a small segment of pipe that measures approximately 3.2 x 0.7 ft (1.0 x 0.2 m). A6 represents an ATON mooring and measures approximately 8.0 x 11.0 ft (2.4 x 3.3 m). M19 exhibits a low amplitude (22.2 nT), a medium duration (18.4 s), and a simple, monopolar, signature. M21 exhibits a medium amplitude (69.3 nT), a long duration (46.2 s), and a simple, monopolar, signature. Spatial analysis indicates that M19 and M21 exhibit adjacency. Magnetic contour analysis indicates that these signatures represent a cluster of ferrous objects recorded on multiple transects. Target 4 does not possess the complexity associated with submerged cultural resources and probably represents the ATON plotted on NOAA Chart 11364, and a small unassociated ferrous object. This target is not indicative of a submerged cultural resource. No further work is recommended for Target 4.

Target 5

Target 5 (Figure 2, Map 2) is comprised of eleven magnetic anomalies, designated M8, M10, M12, M14, M18, M22, M23, M25, M26, M30 and M31. No acoustic anomalies were recorded that can be associated with this target.

Target 5 is located in Block A, and spans an area measuring approximately 580.0 ft (176.8 m) in length on the east side of the navigation channel at a depth of approximately 139.0 ft (42.4 m). This area is located between 343157.12 N, 3832366.65 E, and 3433265.80 N, 3831775.63 E. M8 exhibits a medium amplitude (53.3 nT), a long duration (138.9 s), and a simple, dipolar, signature. M10 exhibits a medium amplitude (79.8 nT), a long duration (167.7 s), and a complex, multi-component, signature. M12 exhibits a high amplitude (127.1 nT), a long duration (154.1 s), and a simple, dipolar, signature. M14 exhibits a high amplitude (121.1 nT), a long duration (138.6 s) and a simple, dipolar, signature. M18 exhibits a high amplitude (124.7 nT), a long duration (95.4 s), and a simple, dipolar, signature. M22 exhibits a high amplitude (107.5 nT), a long duration (103.0 s), and a simple dipolar, signature. M23 exhibits a medium amplitude (89.1 nT), a long duration (129.8 s), and a simple, dipolar, signature. M25 exhibits a low amplitude (35.0 nT), a long duration (214.3 s), and a simple, dipolar, signature. M26 exhibits a low amplitude (24.2 nT), a long duration (255.4 s), and a simple, dipolar, signature. M30 exhibits a low amplitude (16.2 nT), a long duration (181.7 s), and a simple, dipolar, signature. M31 exhibits a low amplitude (48.8 nT), a long duration (239.8 s), and a simple, dipolar, signature. Preliminary analysis based on the spatial associations between these anomalies, and their magnetic characteristics suggested that they may represent a pipeline even though their distribution is not strictly linear. As a result, these anomalies were grouped into a single target for more detailed scrutiny. Further analysis suggests that the non-linear distribution of these anomalies results from variations in instrument layback due to strong river currents. This conclusion, coupled with magnetic contour analysis, indicates the presence of a linear feature with spatial and magnetic characteristics that suggest the presence of an uncharted pipeline. The complex magnetic signature M10 may represent a pipeline coupling, matting, associated hardware or unrelated modern debris. Target 5 does not possess the complexity associated with submerged cultural resources and probably represents an uncharted pipeline. This target is not indicative of a submerged cultural resource. No further work is recommended for Target 5.

Target 6

Target 6 (Figure 2, Map 3) is comprised of one acoustic anomaly, designated A10, and is located in Block B at 338623.02 N, 3831237.18 E approximately 775.0 ft (236.2 m) from left descendant bank of the Mississippi River at a depth of approximately 69.0 ft (21.0 m). A10 measures approximately 222.0 x 4.0 ft (67.6 x 1.2 m) with little relief. Preliminary analysis of this anomaly suggested that it may be an anthropogenic structure and associated debris. This assertion was based primarily on its geometry, but further study indicated that it probably represents a natural mound on the riverbed surrounded by scattered tree limbs or other non-ferrous debris. A marine magnetometer was towed along a transect located within 15.0 ft (4.5 m) of this area, but no magnetic anomalies were identified during post-processing that could be associated with A10. This target fails to possess characteristics indicative of submerged cultural resources. No further work is recommended for Target 6.

Target 7

Target 7 (Figure 2, Map 3) is comprised of thirteen magnetic anomalies, designated M40, M41, M44, M72, M73, M87, M88, M105, M106, M117, M118, M136 and M141. No acoustic anomalies were recorded that can be associated with this target. Target 8 is located in Block B and spans the study area on the east side of the navigation channel at a depth of approximately 69.0 ft (21.0 m). This area is located between 337841.94 N, 3831589.29 E and 337954.56 N, 3830807.81 E, and is designated as a "Pipeline Area" on NOAA Chart 11364 *Mississippi River.* All of the magnetic anomalies that compose this target have medium amplitudes, ranging from 59.3 to 86.4 nT, long durations, ranging from 45.9 to 177.3 s, and simple, dipolar signatures. Preliminary analysis based on the spatial associations between these anomalies, and their magnetic characteristics suggested that

they may represent a pipeline even though their distribution is not strictly linear. As a result, these anomalies were grouped into a single target for more detailed scrutiny. Further analysis suggests that the non-linear distribution of these anomalies results from variations in instrument layback due to strong river currents. This conclusion, coupled with magnetic contour analysis, indicates the presence of a linear feature with spatial and magnetic characteristics that suggest the presence of a pipeline. Target 7 does not possess the complexity associated with submerged cultural resources and probably represents a pipeline. This target is not indicative of a submerged cultural resource. No further work is recommended for Target 7.

Target 8

Target 8 (Figure 2, Map 3) is comprised of two magnetic anomalies, designated M168 and M177 (Tables 2 and 4). No acoustic anomalies were recorded that can be associated with this target. Target 8 is located in Block B at 336656.39 N, 3830857.70 E near the center of the Mississippi River at a depth of approximately 89.0 ft (27.1 m). M168 exhibits a low amplitude (44.8 nT), a long duration (57.5 s), and a simple, dipolar, signature. M177 exhibits a low amplitude (41.3 nT), a long duration (58.7 s), and a simple, dipolar, signature. Spatial and magnetic contour analyses indicate that these signatures represent a single isolated ferrous object that was recorded on multiple transects. Target 8 is a simple magnetic disturbance that does not possess the complexity associated with submerged cultural resources and probably represents casually discarded or lost ferrous debris. This target is not indicative of a submerged cultural resource. No further work is recommended for Target 8.

Target 9

Target 9 (Figure 2, Map 3) is comprised of one acoustic anomaly, designated A24, and is located in Block B at 331417.78 N, 3832885.71 E near the center of the Mississippi River at a depth of approximately 80.0 ft (24.4 m). A24 measures approximately 24.0 x 14.0 ft (7.3 x 4.3 m) with little relief. Preliminary analysis of this anomaly suggested that it may be anthropogenic in nature. This assertion was based primarily on its geometry, but further study indicated that it probably represents casually discarded or lost non-ferrous debris and an associated drag. A marine magnetometer was towed along a transect located within 15.0 ft (4.5 m) of this area, but no magnetic anomalies were identified during post-processing that could be associated with A24. This target fails to possess characteristics indicative of submerged cultural resources. No further work is recommended for Target 9.

Target 10

Target 10 (Figure 2, Map 3) is comprised of one acoustic anomaly, designated A30, and is located in Block B at 330791.69 N, 3832208.33 E approximately 530.0 ft (161.5 m) from the right descendant bank of the Mississippi River at a depth of approximately 109.5 ft (33.4 m). A30 measures approximately 163.0 x 70.0 ft (49.7 x 21.3 m) with 3.0 ft (0.9 m) relief. Preliminary analysis of this anomaly suggested that it may represent a sunken barge. This assertion was based primarily on its geometry, but further study indicated that it probably represents an area of bank failure. A marine magnetometer was towed along a transect located within 15.0 ft (4.6 m) of this area, but no magnetic anomalies were identified during post-processing that could be associated with A30. This target fails to possess characteristics indicative of submerged cultural resources. No further work is recommended for Target 10.

Target 11

Target 11 (Figure 2, Map 3) is comprised of four magnetic anomalies, designated M70, M75, M85 and M89. No acoustic anomalies were recorded that can be associated with this target. Target 11 is located in Block B at 330522.07 N, 3834144.37 E approximately 480.0 ft (146.3 m) from the left descendant bank of the Mississippi River at a depth of approximately 44.0 ft (13.4 m). M70 exhibits a medium amplitude (85.5 nT), a long duration (30.0 s), and a simple, dipolar, signature. M75 exhibits a low amplitude (48.9 nT), a medium

duration (20.4 s), and a simple, monopolar, signature. M85 exhibits a medium amplitude (81.6 nT), a medium duration (23.4 s), and a simple, dipolar, signature. M89 exhibits a medium amplitude (61.4 nT), a medium duration (27.1 s), and a simple, dipolar, signature. Spatial and magnetic contour analyses indicate that these signatures represent a cluster of ferrous objects that was recorded on multiple transects. Target 11 is a relatively simple magnetic disturbance that does not possess the complexity associated with submerged cultural resources. This target probably represents casually discarded or lost ferrous debris. This target is not indicative of a submerged cultural resource. No further work is recommended for Target 11.

Target 12

Target 12 (Figure 2, Map 4) is comprised of three magnetic anomalies, designated M227, M242 and M243. No acoustic anomalies were recorded that can be associated with this target Target 12 is located in Block B at 328815.64 N, 3833907.67 E approximately 520.0 ft (158.5 m) from the right descendant bank of the Mississippi River at a depth of approximately 113.5 ft (34.6 m). This area is designated as "Piling" on NOAA Chart 11364 *Mississippi River* and is approximately 1200.0 ft (365.8 m) north of the charted "Empire Lock". M227 exhibits a low amplitude (48.1 nT), a long duration (79.6 s), and a complex, multi-component, signature. M242 exhibits a low amplitude (23.9 nT), a medium duration (71.8 s), and a complex, multi-component, signature. M243 exhibits a low amplitude (21.4 nT), a medium duration (76.7 s), and a complex, multi-component, signature. Spatial and magnetic contour analyses indicate that these signatures represent a cluster of ferrous objects that was recorded on multiple transects. Target 12 is a relatively simple low amplitude magnetic disturbance that does not possess the complexity associated with submerged cultural resources. This target probably represents casually discarded or lost ferrous debris. This target is not indicative of a submerged cultural resource. No further work is recommended for Target 12.

Target 13

Target 13 (Figure 2, Map 4) is comprised of one magnetic anomaly, designated M332 and one acoustic anomaly, designated A33. This target is located approximately 40.0 ft (12.2 m) outside Block B at 326209.16 N, 3835844.46 E approximately 280.0 ft (85.3 m) from the right descendant bank of the Mississippi River at a depth of approximately 93.0 ft (28.3 m). This area is approximately 2100.0 ft (640.0 m) south of "Empire Lock" on NOAA Chart 11364 *Mississippi River*, and within 2000.0 ft (609.6 m) of the reported locations of *Empire* (Record no. 325) and *Sampson* (Record no. 574). Analysis of A33 suggests that it may represent a shipwreck measuring approximately 30.0 x 14.0 ft (9.1 x 4.3 m) with 5.0 ft (1.5 m) relief. M332 exhibits a low amplitude (31.3 nT), a long duration (47.7 s), and a simple, monopolar, signature. Full magnetometer coverage of the area surrounding A33 was not conducted, as this anomaly is located outside of the study area. As a result of its position, no magnetic data was recorded south or west of A33. This may explain the apparent absence of ferrous materials at precise location. Nevertheless, a magnetic contour plot of the area surrounding A33 was produced and reviewed. This plot shows a small cluster of ferrous objects, including the object represented by M332, located between 30.0 and 100.0 ft (9.1 and 30.5 m) northeast of Target 14. These objects may be related to A33. Furthermore, bank disturbances evident on the acoustic record suggest that A33 is sliding down the bank. Target 13 may represent a significant submerged cultural resource. The area surrounding Target 13 requires either complete avoidance or further investigation in consultation with Louisiana SHPO.

Target 14

Target 14 (Figure 2, Map 4) is comprised of one acoustic anomaly, designated A20, and is located in Block B at 325534.34 N, 3839408.41 E approximately 1050.0 ft (320.0 m) from the left descendant bank of the Mississippi River at a depth of approximately 40.5 ft (12.3 m). A20 measures approximately

7.0 x 8.0 ft (2.1 x 2.4 m) with no relief. Preliminary analysis of this anomaly suggested the presence of a partially buried cylindrical object that may represent a tank. A marine magnetometer was towed along a transect located within 26.0 ft (7.9 m) of this object, but no magnetic anomalies were identified during post-processing that could be associated with A20. Considering the magnetic characteristics and the area surrounding A20, this target probably represents an area of bottom disturbance. Target 14 fails to possess characteristics indicative of submerged cultural resources. No further work is recommended for Target 14.

Target 15

Target 15 (Figure 2, Map 4) is comprised of one acoustic anomaly, designated A23, and is located in Block B at 325251.01 N, 3839866.12 E approximately 975.0 ft (297.2 m) from the left descendant bank of the Mississippi River at a depth of approximately 42.0 ft (12.8 m). A23 measures approximately 6.0 x 2.0 ft (1.8 x 0.6 m) with 1.0 ft (0.3 m) relief. Preliminary analysis of anomaly suggests that it may represent a small debris scatter. A marine magnetometer was towed along a transect located within 23.0 ft (0.3 m) of this area, but no magnetic anomalies were identified during post-processing that could be associated with A23. This target probably represents a scatter of non-ferrous debris and fails to possess characteristics indicative of submerged cultural resources. No further work is recommended for Target 15.

Target 16

Target 16 (Figure 2, Map 4) is comprised of a single magnetic anomaly, designated M370. No acoustic anomalies were recorded that can be associated with this target. Target 16 is located in Block B at 323437.30 N, 3839405.40 E approximately 510.0 ft (155.4 m) from the right descending bank of the Mississippi River at a depth of approximately 85.0 ft (25.9 m). M370 exhibits a high amplitude (1370.2 nT), a long duration (49.5 s), and a simple, monopolar, signature. Magnetic contour analysis indicates an isolated area of magnetic disturbance that does not possess the complexity associated with submerged cultural resources and probably represents casually discarded or lost ferrous debris. No further work is recommended for Target 16.

Target 17

Target 17 (Figure 2, Map 5) is comprised of twenty-seven magnetic anomalies, designated M55, M68, M99, M100, M133, M151, M165, M173, M183, M189, M200, M209, M214, M219, M226, M229, M240, M245, M255, M258, M269, M276, M292, M295, M330, M343, and M369. No acoustic anomalies were recorded that can be associated with this target. Target 18 is located in Block B and spans the entire study area from 323540.02 N, 3843121.93 E to 321799.90 N, 3841785.38 E at a depth that ranges from approximately 30.0 to 90.0 ft (9.1 to 27.4 m). This area is within a region designated as "Pipeline Area" on NOAA Chart 11364 *Mississippi River*. The magnetic anomalies that compose this target all have low amplitudes, except M100, M133, and M151 that have amplitudes ranging from 51.4 to 62.5 nT, medium to long durations, ranging from 21.9 to 60.0 s, and simple, monopolar or dipolar signatures. Preliminary analysis based on the spatial associations between these anomalies, and their magnetic characteristics suggested that they may represent a pipeline even though their distribution is not strictly linear. As a result, these anomalies were grouped into a single target for more detailed scrutiny. Further analysis suggests that the non-linear distribution of these anomalies results from variations in instrument layback due to strong river currents. This conclusion, coupled with magnetic contour analysis, indicates the presence of a linear feature with spatial and magnetic characteristics that suggest the presence of a pipeline. Target 17 does not possess the complexity associated with submerged cultural resources and probably represents a buried pipeline. This target is not indicative of a submerged cultural resource. No further work is recommended for Target 17.

Target 18

Target 18 (Figure 2, Map 5) is comprised of three magnetic anomalies, designated M56, M83 and M91. No acoustic anomalies were recorded that can be associated with this target Target 18 is located in Block B at 323197.78 N, 3843488.21 E approximately 700.0 ft (213.4 m) from the left descendant bank of the Mississippi River at a depth of approximately 39.0 ft (11.9 m). This area is within a region designated as "Pipeline Area" on NOAA Chart 11364 *Mississippi River.* M56 exhibits a high amplitude (177.2 nT), a medium duration (20.7 s), and a simple, monopolar, signature. M83 exhibits a high amplitude (111.1 nT), a medium duration (21.0 s), and a simple, monopolar, signature. M91 exhibits a high amplitude (149.7 nT), a long duration (150.0 s), and a complex, multi-component, signature. Spatial and magnetic contour analyses indicate that these signatures represent a cluster of ferrous objects that was recorded on multiple transects. Target 18 is a relatively simple magnetic disturbance that does not possess the complexity associated with submerged cultural resources. This target probably represents casually discarded or lost ferrous debris that may be related to pipeline construction. This target is not indicative of a submerged cultural resource. No further work is recommended for Target 18.

Target 19

Target 19 (Figure 2, Map 5) is comprised of thirty-five magnetic anomalies, designated M57, M67, M77, M82, M98, M113, M132, M140, M150, M158, M164, M172, M188, M199, M201, M208, M215, M218, M225, M230, M246, M254, M259, M268, M277, M286, M291, M296, M308, M312, M329, M344, M353, M356, and M366, and one acoustic anomaly, designated A26. Target 19 is located in Block B and spans the entire study area from 323142.40 N, 3843803.41 E to 321283.03 N, 3842751.33 E at a depth that ranges from approximately 39.0 to 95.0 ft (11.9 to 29.0 m). This area is within a region designated as "Pipeline Area" on NOAA Chart 11364 *Mississippi River.* The magnetic anomalies that compose this target exhibit amplitudes ranging from 13.5 to 201.4 nT, durations ranging from 28.3 to 107.5 s, and simple, monopolar or dipolar, signatures. Preliminary analysis based on the spatial associations between these anomalies, and their magnetic characteristics suggested that they may represent a pipeline even though their distribution is not strictly linear. As a result, these anomalies were grouped into a single target for more detailed scrutiny. Further analysis suggests that the non-linear distribution of these anomalies results from variations in instrument layback due to strong river currents. This conclusion, coupled with magnetic contour analysis, indicates the presence of a linear feature with spatial and magnetic characteristics that suggest the presence of a pipeline. A26 measures approximately 78.0 x 40.0 ft (23.8 x 12.2 m) with 4.0 ft (1.2 m) relief, and probably represents pipeline matting or guards. Target 19 does not possess the complexity associated with submerged cultural resources and probably represents a pipeline. This target is not indicative of a submerged cultural resource. No further work is recommended for Target 19.

Target 20

Target 20 (Figure 2, Map 5) is comprised of twenty-one magnetic anomalies, designated M60, M112, M171, M198, M202, M217, M223, M234, M239, M247, M253, M260, M267, M278, M285, M313, M328, M339, M352, M361, and M368, and one acoustic anomaly, designated A36. Target 20 is located in Block B and spans the entire study area from 322153.72 N, 3845792.89 E to 320300.25 N, 3844785.36 E at a depth that ranges from approximately 40.0 to 94.0 ft (12.2 to 28.7 m). This area is within a region designated as "Pipeline Area" on NOAA Chart 11364 *Mississippi River.* The magnetic anomalies that compose this target, have varied amplitudes, ranging from 11.7 to 356.6 nT, medium to long durations, ranging from 24.6 to 71.1 s, and simple, monopolar or dipolar signatures. Preliminary analysis based on the spatial associations between these anomalies, and their magnetic characteristics suggested that they may represent a pipeline even though their distribution is not strictly linear. As a

result, these anomalies were grouped into a single target for more detailed scrutiny. Further analysis suggests that the non-linear distribution of these anomalies results from variations in instrument layback due to strong river currents. This conclusion, coupled with magnetic contour analysis, indicates the presence of a linear feature with spatial and magnetic characteristics that suggest the presence of a pipeline. A36 measures approximately 124.0 x 30.0 ft (37.8 x 9.1 m) with no relief. Preliminary analysis of this anomaly suggested that it may represent a partially buried shipwreck. This assertion was based primarily on its geometry, but further study indicated that it probably represents an area of bank failure. Target 20 does not possess the complexity associated with submerged cultural resources and probably represents a pipeline. This target is not indicative of a submerged cultural resource. No further work is recommended for Target 20.

Target 21

Target 21 (Figure 2, Map 5) is comprised of nineteen magnetic anomalies, designated M61, M66, M78, M81, M92, M97, M107, M111, M124, M131, M145, M149, M159, M170, M184, M187, M197, M203, and M207, and one acoustic anomaly, designated A14. Target 21 is located in Block B at 321139.50 N, 3847118.05 E at a depth of approximately 45.0 ft (13.7 m). This area is designated "Tanker Loading Dock" and marked with five ATONs on NOAA Chart 11364 *Mississippi River*. It was necessary to adjust the run of transects during data collection to avoid vessels docked at this facility. All of the magnetic anomalies that compose this target are associated with the tanker loading dock. The majority have high amplitudes, long durations, and complex multi-component signatures. M203 and M207 exhibit medium amplitudes, long durations and monopolar and multi-component signatures, respectively. This is a result of their distance from the tanker loading dock: approximately 590.0 ft (179.8 m). A14 clearly represents a submerged structure associated with this facility. Target 21 clearly represents the tanker loading dock. No further work is recommended for Target 21.

Target 22

Target 22 (Figure 2, Map 5) is comprised of eighteen magnetic anomalies, designated M216, M233, M237, M249, M252, M261, M266, M279, M290, M298, M306, M315, M326, M337, M346, M351, M357, and M360. No acoustic anomalies were identified that can be associated with this target. Target 22 is located in Block B, and spans an area measuring approximately 1020.0 ft (310.9 m) in length on the west side of the navigation channel at a depth of approximately 98.0 ft (29.9 m). This area is located between 319862.43 N, 384825.08 E, and 318898.88 N, 3848203.89 E. This area is within a region designated as "Pipeline Area" on NOAA Chart 11364 *Mississippi River*. The magnetic anomalies that compose this target, have varied amplitudes, ranging from 35.4 to 585.3 nT, medium to long durations, ranging from 29.8 to 157.4 s, and primarily simple, monopolar or dipolar signatures. Preliminary analysis based on the spatial associations between these anomalies, and their magnetic characteristics suggested that they may represent a pipeline even though their distribution is not strictly linear. As a result, these anomalies were grouped into a single target for more detailed scrutiny. Further analysis suggests that the non-linear distribution of a number of these anomalies results from variations in instrument layback due to strong river currents. Preliminary analysis conducted during post-processing also indicated that M252 exhibits a complex, multi-component signature, but magnetic contour analysis revealed that this anomaly is a simple magnetic disturbance indicative of an isolated area of ferrous debris. These conclusions indicate the presence of both a linear feature with spatial and magnetic characteristics that suggest the presence of a pipeline and debris that may or may not be associated with pipeline construction. Target 22 does not possess the complexity associated with submerged cultural resources and probably represents a pipeline and discarded or lost debris. This target is not indicative of a

submerged cultural resource. No further work is recommended for Target 22.

Target 23

Target 23 (Figure 2, Map 5) is comprised of two magnetic anomalies, designated M96 and M110. No acoustic anomalies were recorded that can be associated with this target. Target 23 is located in Block B at 320374.81 N, 3849515.80 E approximately 750.0 ft (228.6 m) from the left descendant bank of the Mississippi River at a depth of approximately 52.0 ft (15.8 m). M96 exhibits a high amplitude (112.6 nT), a medium duration (25.9 s), and a simple, monopolar, signature. M110 exhibits a high amplitude (102.8 nT), a medium duration (27.7 s), and a simple, monopolar, signature. Spatial and magnetic contour analyses indicate that these signatures represent a small scatter of ferrous debris. Target 23 is a simple magnetic disturbance that does not possess the complexity associated with submerged cultural resources and probably represents casually discarded or lost ferrous debris. This target is not indicative of a submerged cultural resource. No further work is recommended for Target 23.

Target 24

Target 24 (Figure 2, Map 6) is comprised of two magnetic anomalies, designated M62 and M65. No acoustic anomalies were recorded that can be associated with this target. Target 24 is located in Block B at 320232.34 N, 3850835.78 E approximately 550.0 ft (167.6 m) from the left descendant bank of the Mississippi River at a depth of approximately 34.0 ft (10.4 m). M62 exhibits a high amplitude (231.9 nT), a medium duration (23.2 s), and a simple, dipolar, signature. M65 exhibits a high amplitude (162.8 nT), a long duration (34.2 s), and a simple, dipolar, signature. Spatial and magnetic contour analyses indicate that these signatures represent a small scatter of ferrous debris. Target 24 is a simple magnetic disturbance that does not possess the complexity associated with submerged cultural resources and probably represents casually discarded or lost ferrous debris. This target is not indicative of a submerged cultural resource. No further work is recommended for Target 24.

Target 25

Target 25 (Figure 2, Map 6) is comprised of two magnetic anomalies, designated M251 and M262, and one acoustic anomaly, designated A29. Target 25 is located in Block B at 318367.71 N, 3852333.84 E approximately 790.0 ft (240.8 m) from the right descendant bank of the Mississippi River at a depth of approximately 80.0 ft (24.4 m). A29 measures approximately 220.0 x 70.0 ft (67.0 x 21.3 m) with no relief. Preliminary analysis of this anomaly suggests that it may represent a sunken barge. This assertion was based primarily on its geometry, but further study indicated that it probably represents an area of bank failure. M251 exhibits a medium amplitude (52.1 nT), a long duration (66.1 s), and a complex, multi-component, signature. M262 exhibits a low amplitude (23.5 nT), a long duration (40.1 s), and a simple, dipolar, signature. Spatial and magnetic contour analyses indicate that these signatures represent a small isolated scatter of ferrous objects that was recorded on multiple transects. Target 25 is a simple magnetic disturbance that does not possess the complexity associated with submerged cultural resources and probably represents casually discarded or lost ferrous debris. This target is not indicative of a submerged cultural resource. No further work is recommended for Target 25.

Target 26

Target 26 (Figure 2, Map 6) is comprised of one magnetic anomaly, designated M64. No acoustic anomalies were recorded that can be associated with this target. Target 28 is located in Block B at 319517.50 N, 3853299.50 E approximately 535.0 ft (163.0 m) from the left descendant bank of the Mississippi River near the dock that appears on NOAA Chart 11364 *Mississippi River* at a depth of approximately 56.5 ft (17.2 m). M64 exhibits a high amplitude (3372.3 nT), a long duration (262.3 s), and a complex, multi-component, signature. It was necessary to adjust the run of transects during data collection to avoid vessels docked at this

location. Spatial and magnetic contour analyses indicate that these signatures probably represent a barge mooring. Target 26 is a complex magnetic disturbance that probably represents a barge mooring. This target is not indicative of a submerged cultural resource. No further work is recommended for Target 26.

Target 27

Target 27 (Figure 2, Map 6) is comprised of five magnetic anomalies, designated M63, M79, M80, M93 and M94. No acoustic anomalies were recorded that can be associated with this target. Target 29 is located in Block B at 319302.86 N, 3853915.82 E approximately 600.0 ft (182.9 m) from the left descendant bank of the Mississippi River near the dock that appears on NOAA Chart 11364 *Mississippi River* at a depth of approximately 53.0 ft (16.1 m). M63 exhibits a high amplitude (1210.9 nT), a long duration (323.4 s), and a complex, multi-component, signature. M79 exhibits a high amplitude (926.1 nT), a long duration (372.7 s), and a complex, multi-component, signature. M80 exhibits a high amplitude (1139.8 nT), a long duration (355.8 s), and a complex, multi-component, signature. M93 exhibits a high amplitude (563.4 nT), a long duration (325.4 s), and a complex, multi-component, signature. M94 exhibits a high amplitude (335.6 nT), a long duration (292.8 s), and a simple, monopolar, signature. It was necessary to adjust the run of transects during data collection to avoid vessels docked near M80. Spatial and magnetic contour analyses indicate that M80 probably represents a barge mooring, and M63, M79, M93, and M94 probably represent mixture of casually discarded or lost debris as well as debris from the destruction of portions of the nearby dock as a result of Hurricane Katrina. Target 27 does not possess the complexity associated with submerged cultural resources. This target probably represents a barge mooring, casually discarded or lost ferrous debris, and debris from the destruction of portions of the nearby dock. This target is not indicative of a submerged cultural resource. No further work is recommended for Target 27.

Target 28

Target 28 (Figure 2, Map 6) is comprised of sixteen magnetic anomalies, designated M108, M146, M169, M186, M205, M250, M263, M265, M280, M284, M289, M300, M305, M318, M323, and M336. No acoustic anomalies were recorded that can be associated with this target. Target 28 is located in Block B and spans the study area from 317615.52 N, 3853101.14 E along the right descendant bank of the Mississippi River to 319127.60 N, 3853838.50 E near the location of the dock and associated debris represented by Target 29 at depths that ranges from approximately 53.0 to 85.0 ft (16.1 to 25.9 m). This area is within a region designated as "Cable and Pipeline Area" on NOAA Chart 11364 *Mississippi River*. The magnetic anomalies that compose this target all have high amplitudes that range from 133.6 to 4211.1 nT, except M169, M186, M205, M250, M263, and M265 that have amplitudes ranging from 24.1 to 56.8 nT, all have long durations, ranging from 59.1 to 542.0 s, and dipolar or multi-component signatures. Preliminary analysis based on the spatial associations between these anomalies, and their magnetic characteristics suggested that they may represent a pipeline even though their distribution is not strictly linear. As a result, these anomalies were grouped into a single target for more detailed scrutiny. Further analysis suggests that the non-linear distribution of these anomalies results from variations in instrument layback due to strong river currents. This conclusion, coupled with magnetic contour analysis, indicates the presence of a linear feature with spatial and magnetic characteristics that suggest the presence of a pipeline. Target 28 does not possess the complexity associated with submerged cultural resources and probably represents a buried pipeline. This target is not indicative of a submerged cultural resource. No further work is recommended for Target 28.

Target 29

Target 29 (Figure 2, Map 6) is comprised of two magnetic anomalies, designated M335 and M347. No acoustic anomalies were recorded that can be associated with this target.

Target 29 is located within a region designated as "Cable and Pipeline Area" on NOAA Chart 11364 *Mississippi River* in Block B at 317531.40 N, 3853494.50 E approximately 181.0 (55.2 m) from the right descendant bank of the Mississippi River at a depth of approximately 85.0 ft (25.9 m). This area is along the southern margin of the study area; as a result, no data was collected south of M347. M335 exhibits a high amplitude (101.1 nT), a long duration (35.4 s), and a simple, monopolar, signature. M347 exhibits a high amplitude (302.9 nT), a medium duration (28.4 s), and a simple, dipolar, signature. Spatial and magnetic contour analyses indicate that these signatures represent a small scatter of ferrous debris that was recorded on multiple transects. Target 29 is a simple magnetic disturbance that does not possess the complexity associated with submerged cultural resources and probably represents casually discarded or lost ferrous debris. This target is not indicative of a submerged cultural resource. No further work is recommended for Target 29.

Target 30

Target 30 (Figure 2, Map 6) is comprised of four magnetic anomalies, designated M319, M322, M334 and M349 and one acoustic anomaly, designated A37. Target 30 is located within a region designated as "Cable and Pipeline Area" on NOAA Chart 11364 *Mississippi River* in Block B at 317333.34 N, 3854369.48 E approximately 230.0 ft (70.1 m) from the right descendant bank of the Mississippi River at a depth of approximately 82.5 ft (25.1 m). This location is within 2000.0 ft (609.6 m) of the reported locations of *Victoria* (Record no. 646), *G.R. CO. 4* (Record no. 1406), and *Star of Honduras* (Record no. 1481). This area is along the southern margin of the study area; as a result, no magnetic data was collected south of M349. M319 exhibits a medium amplitude (65.1 nT), a long duration (53.6 s), and a simple, monopolar, signature. M322 exhibits a high amplitude (366.6 nT), a long duration (56.1 s), and a simple, monopolar, signature. M334 exhibits a high amplitude (931.9 nT), a long duration (34.1 s), and a simple, monopolar, signature. M349 exhibits a high amplitude (5149.4 nT), a long duration (36.6 s), and a simple, dipolar, signature. Spatial and magnetic contour analyses indicate that these signatures represent a cluster of relatively large ferrous objects that was recorded on multiple transects. A37 measures approximately 90.0 x 30.0 ft (27.4 x 9.1 m) with 2.0 ft (0.6 m) relief. Preliminary analysis of this anomaly suggested that it may represent a sunken and partially buried barge. The high magnitudes of the anomalies that compose this target coupled with the acoustic record suggest that this target may represent a shipwreck that is considered a significant submerged cultural resource. Target 30 requires either complete avoidance or further investigation of this location in consultation with Louisiana SHPO.

Target 31

Target 31 (Figure 2, Map 6) is comprised of two magnetic anomalies, designated M301 and M304 and two acoustic anomalies, designated A31 and A32. Target 33 is located within a region designated as "Cable and Pipeline Area" on NOAA Chart 11364 *Mississippi River* in Block B at 3177381.72 N, 3854960.64 E approximately 430.0 ft (131.0 m) from the right descendant bank of the Mississippi River at a depth of approximately 80.0 ft (24.4 m). This location is within 2000.0 ft (609.6 m) of the reported locations of *Tom II* (Record no. 1262), *G.R. CO. 4* (Record no. 1406), and *Star of Honduras* (Record no. 1481). M301 exhibits a low amplitude (48.5 nT), a long duration (80.4 s), and a simple, dipolar, signature. M304 exhibits a low amplitude (47.9 nT), a long duration (61.5 s), and a simple, monopolar, signature. A31 measures approximately 175.0 x 40.0 ft (53.3 x 12.2 m) with 11.0 ft (3.4 m) relief. A32 measures approximately 175.0 x 40.0 ft (53.3 x 12.2 m) with 10.0 ft (3.0 m) relief. Preliminary analysis of these acoustic anomalies determined that they probably represent a single sunken barge. Spatial and magnetic contour analyses indicate that M301 and M304 represent a relatively small scatter of ferrous material that was recorded on multiple transects. Even though the magnetic characteristics of anomalies M301 and M304

do not match those typically associated with submerged cultural resources, anomalies A31 and A32 do appear to record the presence of a large anthropogenic object that may represent a shipwreck that is considered a significant cultural resource. Target 31 requires either complete avoidance or further investigation of this location in consultation with Louisiana SHPO.

Target 32

Target 32 (Figure 2, Map 6) is comprised of three magnetic anomalies, designated M321, M333, and M350 and two acoustic anomalies, designated A34 and A35. Target 32 is located within a region designated as "Cable and Pipeline Area" on NOAA Chart 11364 *Mississippi River* in Block B at 317195.30 N, 3854863.60 E approximately 245.0 ft (74.7 m) from the right descendant bank of the Mississippi River at a depth of approximately 80.0 ft (24.4 m). This location is within 2000.0 ft (609.6 m) of the reported locations of *Tom II* (Record no. 1262), *G.R. CO. 4* (Record no. 1406), and *Star of Honduras* (Record no. 1481). M321 exhibits a high amplitude (457.8 nT), a long duration (70.3 s), and a simple, monopolar, signature. M333 exhibits a high amplitude (925.0 nT), a long duration (54.8 s), and a simple, monopolar, signature. M350 exhibits a high amplitude (3055.0 nT), a long duration (70.1 s), and a simple, dipolar, signature. A34 measures approximately 220.0 x 30.0 ft (67.1 x 9.1 m) with 10.0 ft (3.0 m) relief. A35 measures approximately 220.0 x 30.0 ft (67.1 x 9.1 m) with 10.0 ft (3.0 m) relief. Preliminary analysis of these acoustic anomalies determined that they probably represent a single sunken barge. Spatial and magnetic contour analyses indicate that this target represents an anthropogenic object with a large ferrous component that was recorded on multiple transects. This target may represent a shipwreck that is considered a significant submerged cultural resource. Target 32 requires either complete avoidance or further investigation of this location in consultation with Louisiana SHPO.

CHAPTER VIII

CONCLUSIONS

This report presents results of phase I marine remote sensing cultural resources investigation of the proposed Mississippi River sand borrow sites for the Louisiana Coastal Area Barrier Shoreline Restoration Project, Plaquemines Parish, Louisiana (Figures 1 and 2). R. Christopher Goodwin & Associates, Inc. performed this work on behalf of the U.S. Army Corps of Engineers, New Orleans District (USACE-NOD). This study was carried out prior to the planned commencement of dredging at this location to assist the USACE-NOD in compliance with Section 106 of the National Historic Preservation Act of 1966, as amended. All aspects of these investigations were completed in accordance with the Secretary of the Interior's *Standards and Guidelines for Archeology and Historic Preservation* (48 FR 44716), and in consultation with the Louisiana Department of Culture, Recreation and Tourism, Division of Archeology.

The present study area comprised two survey blocks located between Mile Markers 25.0 and 35.0 above Head of Passes (Figure 2). These survey blocks cover approximately 58 per cent of this reach of the Mississippi River. The upper block, Block A, measures approximately 458.0 acres (185.3 hectares), the lower block, Block B, measures approximately 1607 acres (650.3 hectares). A total of 86 transects of varying lengths were spaced at 50.0 ft (15.2 m) intervals and surveyed between 24 June and 16 July 2006. Fifty (50) were surveyed in Block A for a total of 1422879.0 linear ft (433693.5 linear m), and 36 were surveyed in Block B for a total of 404528.0 linear ft (123300.1 linear m). Survey was conducted applying Louisiana State Plane (South 1702), NAD 83, survey feet.

Objectives of this study were to identify targets that have potential to represent significant submerged cultural resources, and, whenever possible, to assess the significance of identified resources, applying the National Register of Historic Places (NRHP) Criteria for Evaluation (36 CFR 60.4 [a-d]). These objectives were met through the application of a research design that included both archival investigations and marine archeological remote sensing survey and analysis. The history of the project area was researched through examination of State of Louisiana archeological site files, local historical records, reports of previous cultural resources investigations, historic maps, and relevant secondary sources.

Marine remote sensing survey registered a total of forty (40) individual magnetic anomalies, and nine (9) individual acoustic anomalies in Block A, and 332 individual magnetic anomalies, and 28 individual acoustic anomalies were recorded in Block B (Tables 2-3). The application of pattern recognition protocols and examination of remote sensing data permitted the discrimination of five (5) targets in Block A, designated Targets 1-5, and 27 targets in Block B, designated Targets 6-32, that merited more detailed scrutiny (Table 4). Only four targets, designated Targets 13, 30, 31, and 32, exhibit characteristics that suggest they may represent significant submerged cultural resources. Targets 13, 30, 31 and 32 require either complete avoidance or further investigation in consultation with Louisiana SHPO.

No impacts to submerged cultural resources are expected as a result of dredging at the proposed borrow site locations resulting in a determination of "No historic properties affected," provided that Targets 13, 30, 31 and 32 are avoided (36 CFR 800.4). If avoidance is not possible, further evaluatory investigations should be undertaken in consultation with Louisiana SHPO.

Disturbance of the riverbed has the potential to encounter and cause significant long-term adverse impacts to unidentified submerged cultural resources. Although remote sensing surveys conducted in consultation with Louisiana SHPO are expected to be highly effective at identifying submerged cultural resources, the possibility of encountering an unidentified and unanticipated submerged cultural resource, however unlikely, is always present during construction and dredging activities. As a result, the implementation of an Unanticipated Discoveries Plan designed in consultation with Louisiana SHPO is recommended for all construction and dredging activities.

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APPENDIX I

FIGURES

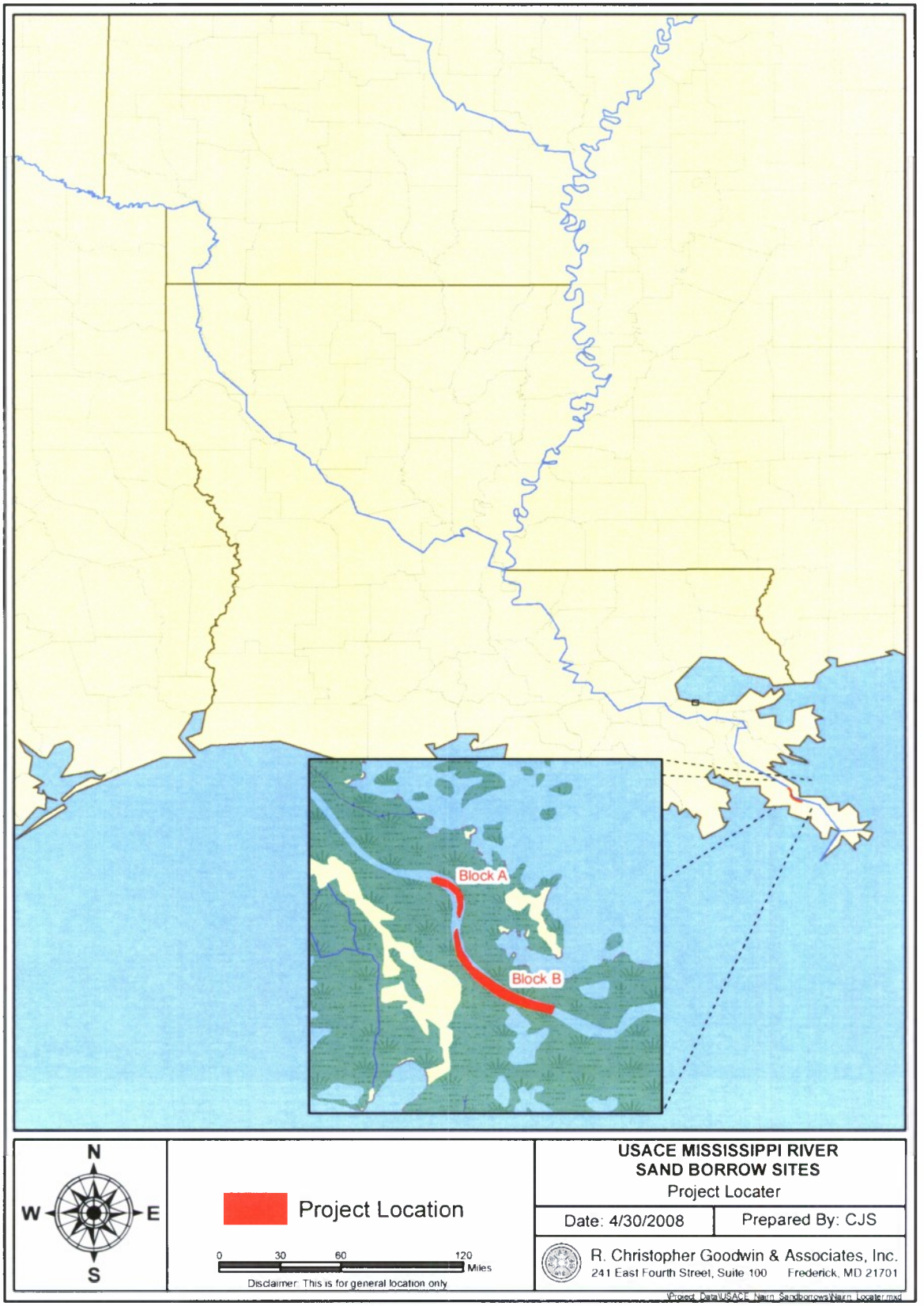

Figure 1. Map of Louisiana showing the study area

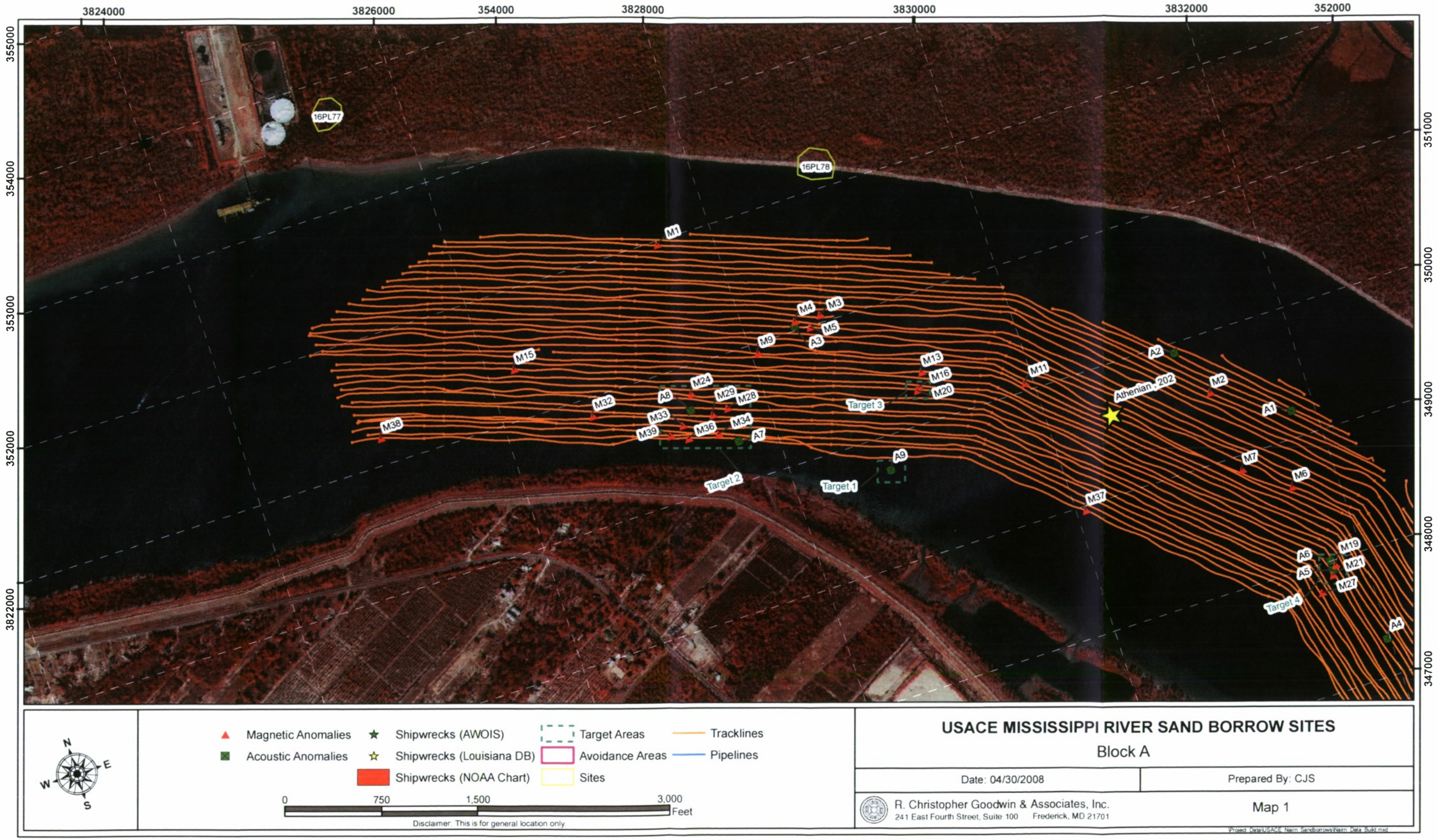

Figure 2. Map of the survey area showing transects, anomalies, and targets (Map 1 of 6)

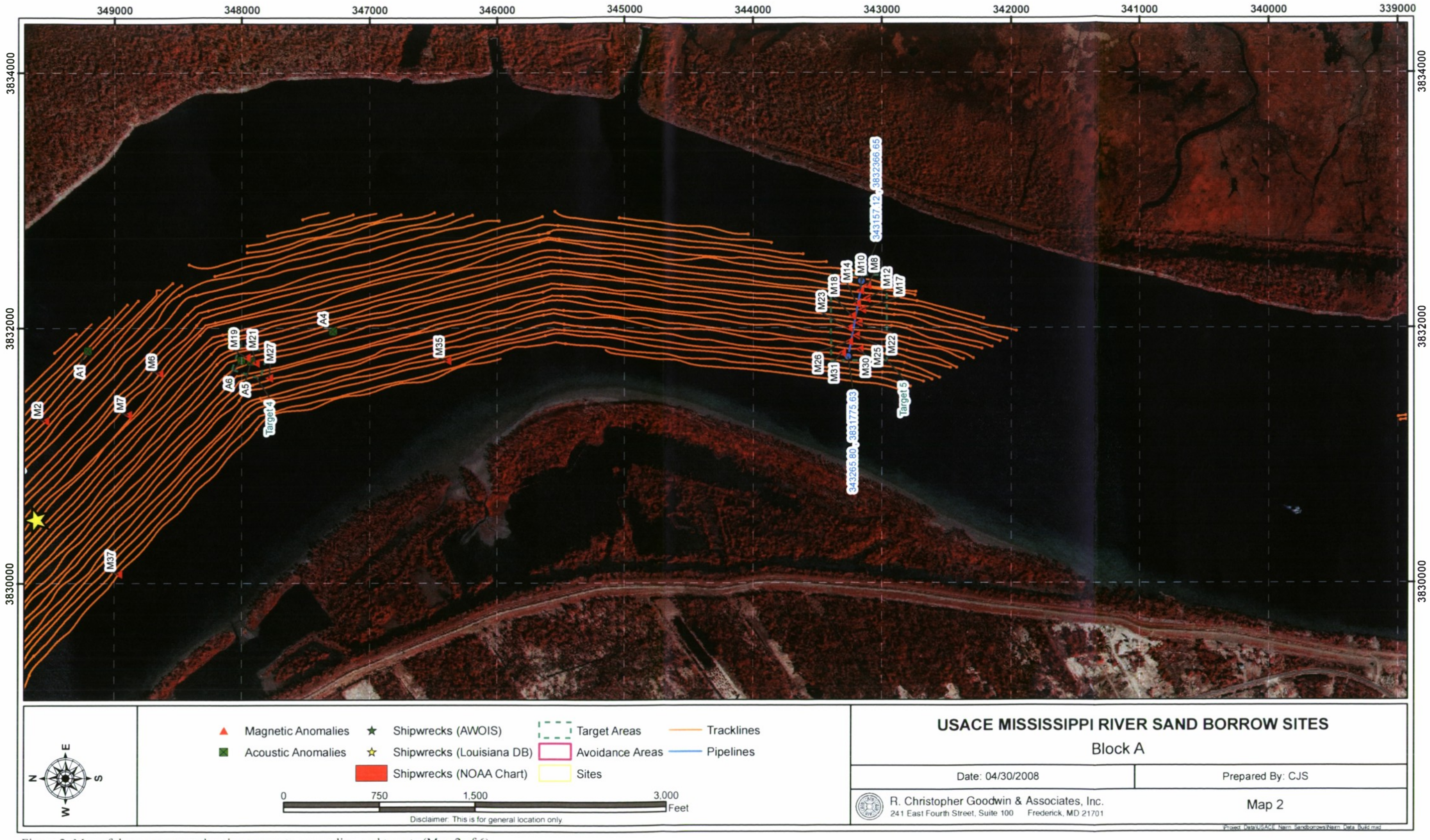

Figure 2. Map of the survey area showing transects, anomalies, and targets (Map 2 of 6)

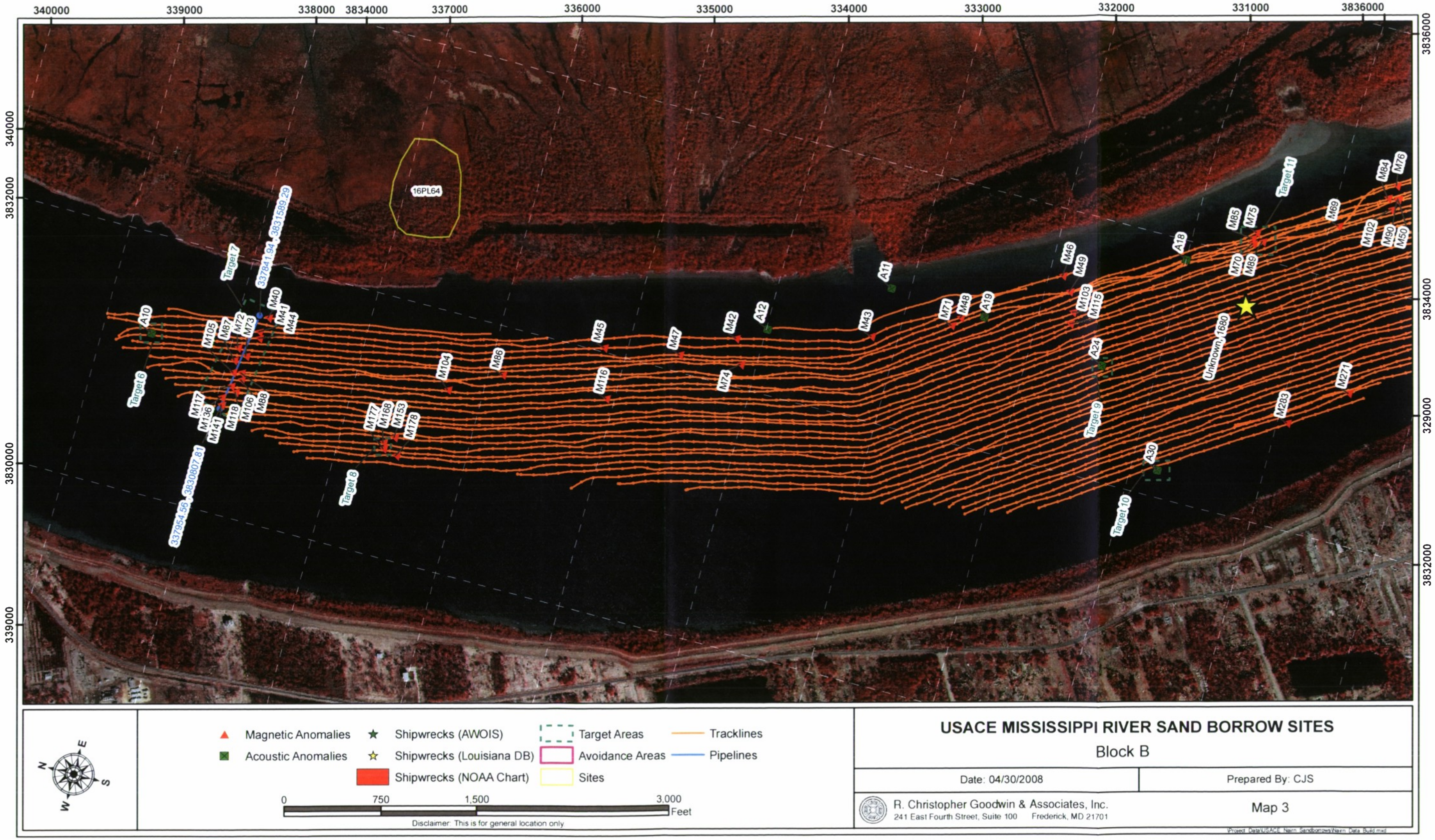

Figure 2. Map of the survey area showing transects, anomalies, and targets (Map 3 of 6)

Figure 2. Map of the survey area showing transects, anomalies, and targets (Map 4 of 6)

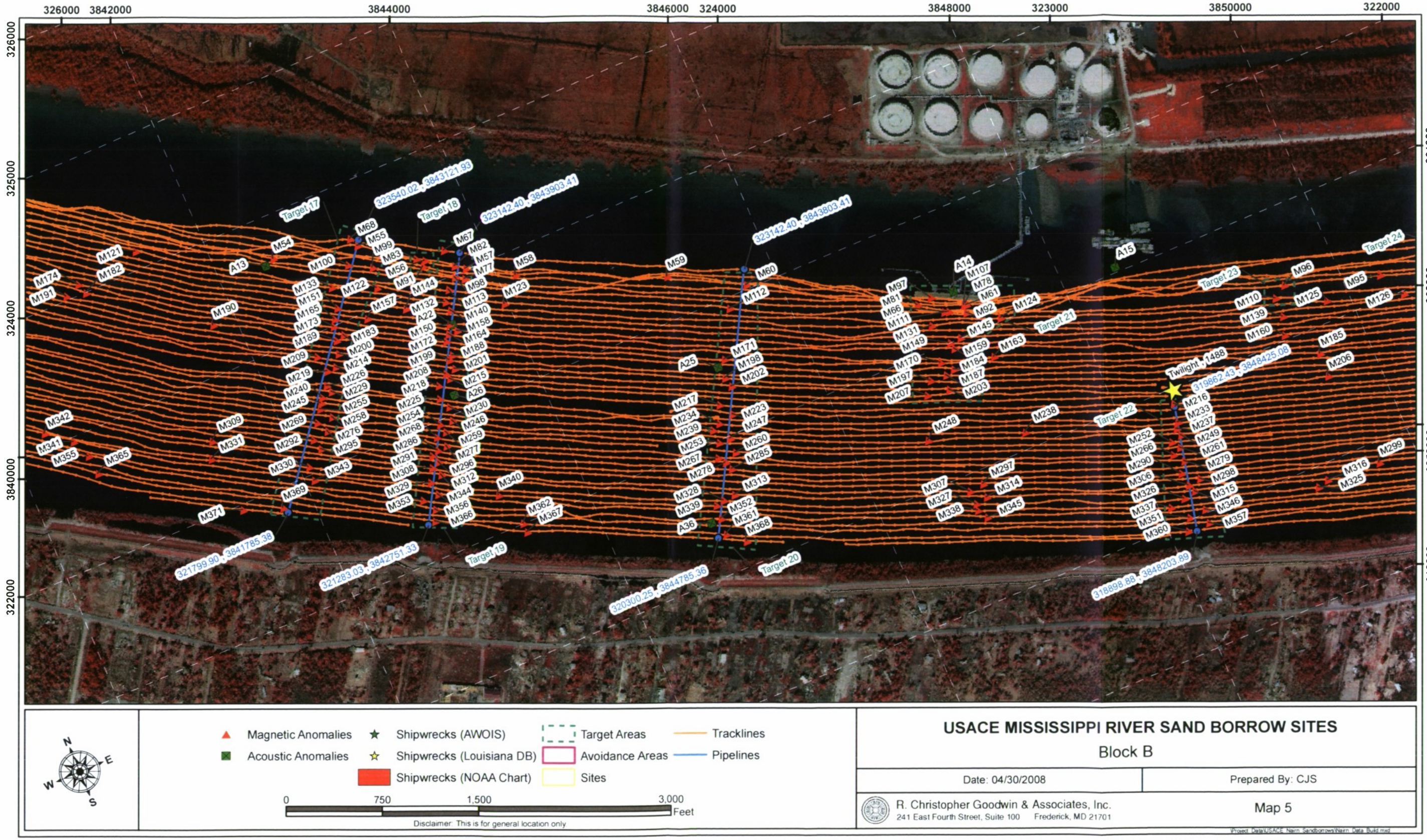

Figure 2. Map of the survey area showing transects, anomalies, and targets (Map 5 of 6)

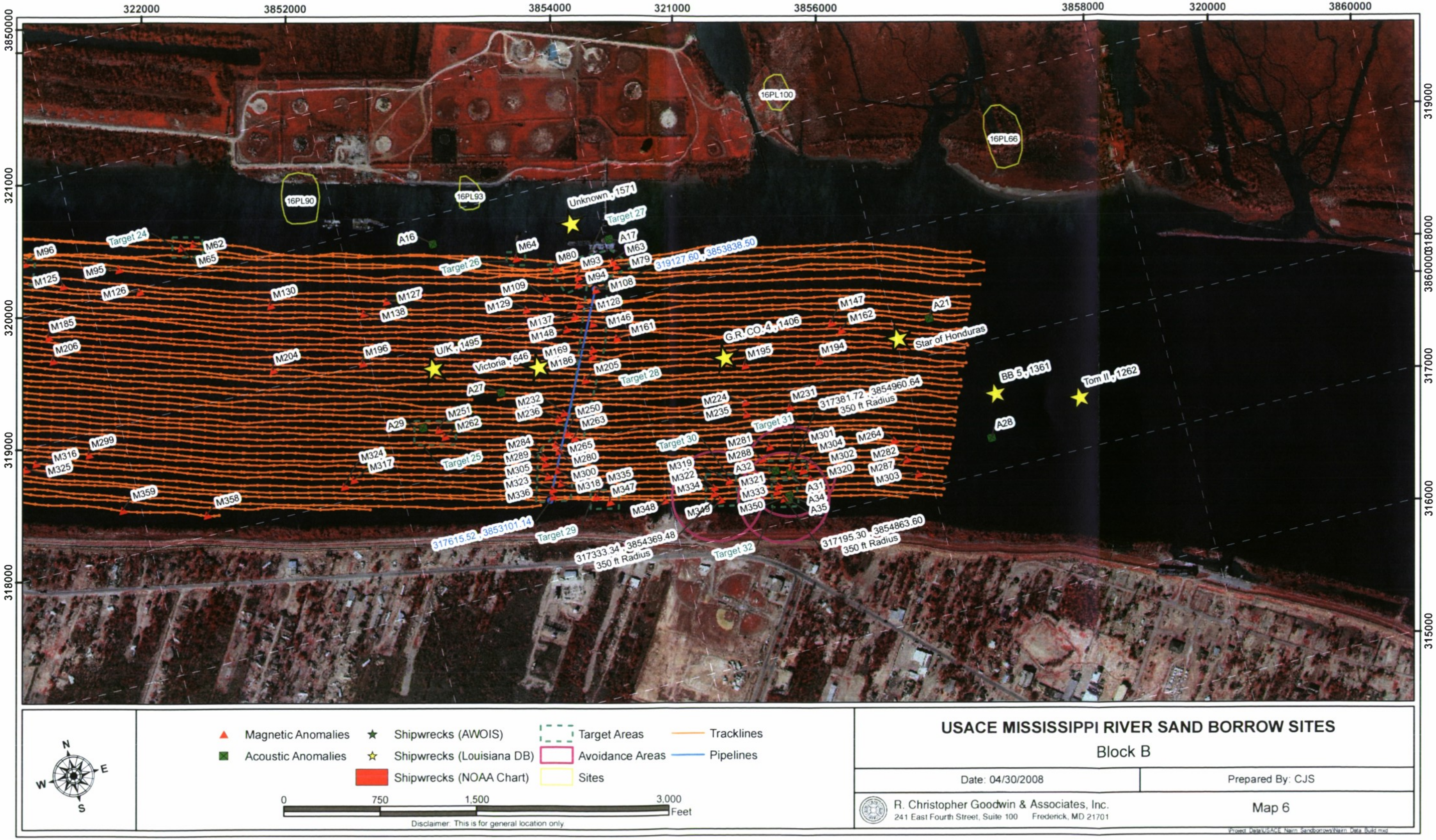

Figure 2. Map of the survey area showing transects, anomalies, and targets (Map 6 of 6)

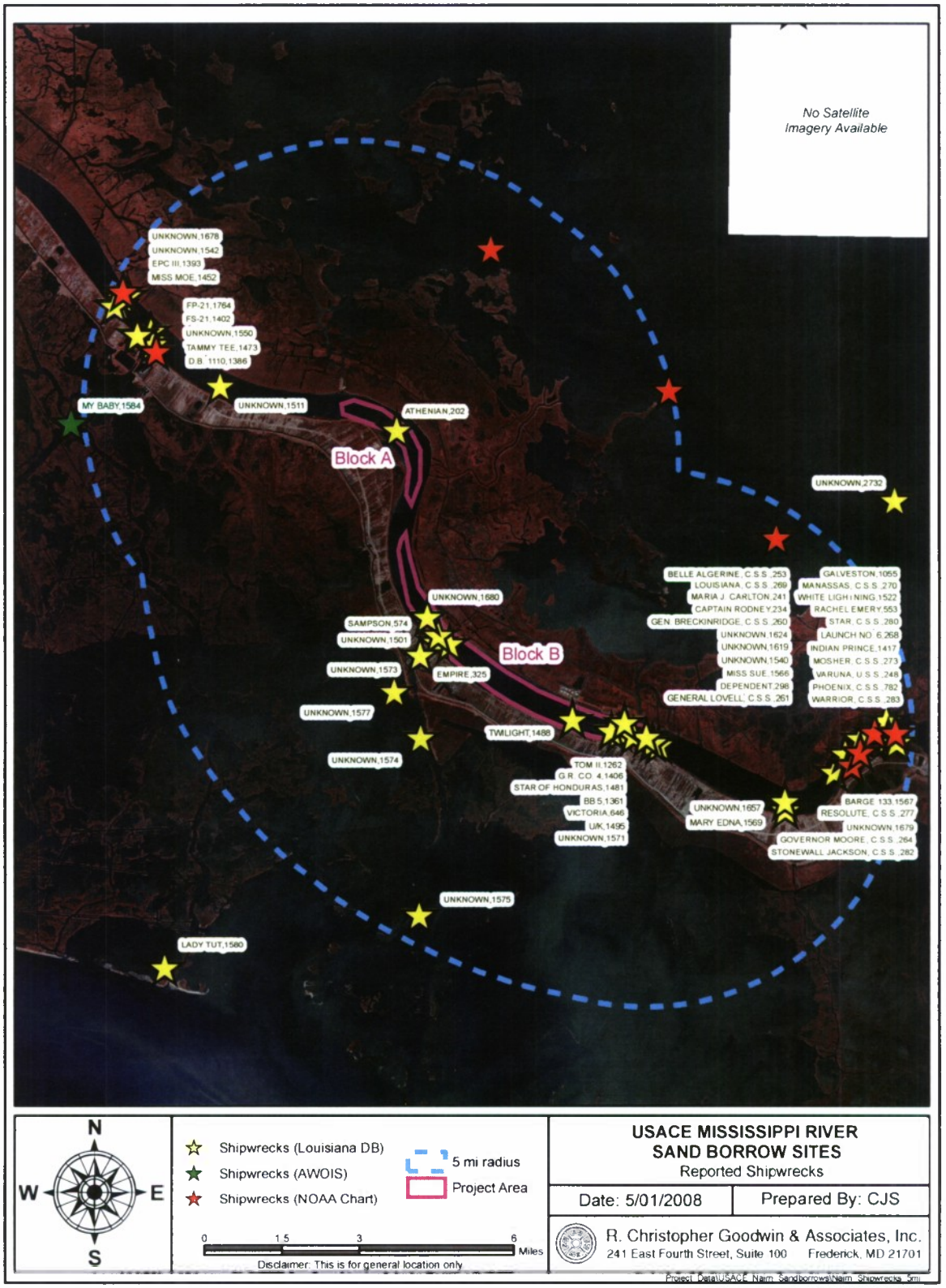

Figure 3. Map of shipwreck locations within 5.0 mi (8.0 km) of the study area

APPENDIX II

TABLES

Table 1. Inventory of known shipwrecks and obstructions within 5.0 mi (8.0 km) of the Proposed Mississippi River sand borrow sites

Record No.*	Vessel Name	Date Lost	LAT	LONG	Block
202	ATHENIAN	7/15/1841	29-27-00	89-36-22	A
234	CAPTAIN RODNEY	1981	29-21-58	89-27-02	N/A
241	MARIA J. CARLTON	4/19/1962	29-21-40	89-27-00	N/A
248	VARUNA, U.S.S.	4/24/1862	29-21-40	89-27-00	N/A
253	BELLE ALGERINE, C.S.S.	4/24/1862	29-21-40	89-27-00	N/A
260	GEN. BRECKINRIDGE, C.S.S.	4/24/1862	29-21-40	89-27-00	N/A
261	GENERAL LOVELL, C.S.S.	4/24/1862	29-21-40	89-27-00	N/A
264	GOVERNOR MOORE, C.S.S.	4/24/1862	29-21-40	89-27-00	N/A
268	LAUNCH NO. 6	4/24/1862	29-21-40	89-27-00	N/A
269	LOUISIANA, C.S.S.	4/28/1862	29-21-40	89-27-00	N/A
270	MANASSAS, C.S.S.	4/24/1862	29-21-40	89-27-00	N/A
273	MOSHER, C.S.S.	4/24/1862	29-21-40	89-27-00	N/A
277	RESOLUTE, C.S.S.	4/24/1862	29-21-07	89-21-03	N/A
280	STAR, C.S.S.	4/24/1862	29-21-40	89-27-00	N/A
282	STONEWALL JACKSON, C.S.S.	4/24/1862	29-21-40	89-27-00	N/A
283	WARRIOR, C.S.S.	4/24/1862	29-21-40	89-27-00	N/A
298	DEPENDENT	2/6/1932	29-21-40	89-27-00	N/A
325	EMPIRE	3/7/1905	29-23-24	89-35-39	B
553	RACHEL EMERY	5/27/1911	29-21-40	89-27-00	N/A
574	SAMPSON	12/22/1920	29-23-22	89-35-25	B
646	VICTORIA	11/1/1927	29-21-50	89-32-10	B
782	PHOENIX, C.S.S.	4/24/1862	29-21-40	89-27-00	N/A
1055	GALVESTON/GENERAL QUITMAN, C.S.S.	4/24/1862	29-21-40	89-27-00	N/A
1262	TOM II	9/29/1915	29-21-37	89-31-25	N/A
1361	BB 5	12/17/1963	29-21-39	89-31-32	N/A
1386	D.B. 1110	9/19/1947	29-28-34	89-41-06	N/A
1393	EPC 111	9/8/1974	29-29-18	89-41-38	N/A
1402	FS-21	9/29/1976	29-28-43	89-41-05	N/A
1406	G.R. CO. 4	7/19/1957	29-21-47	89-31-54	B
1417	INDIAN PRINCE	1/22/1958	29-21-25	89-27-50	N/A
1452	MISS MOE	9/8/1974	29-29-11	89-41-43	N/A
1473	TAMMY TEE	1959	29-28-30	89-41-03	N/A
1481	STAR OF HONDURAS	11/22/1952	29-21-45	89-31-39	B
1488	TWILIGHT	12/2/1965	29-22-04	89-33-04	B
1495	U/K	5/23/1979	29-21-52	89-32-19	B
1501	UNKNOWN	1/19/1963	29-23-31	89-35-38	B
1511	UNKNOWN	8/18/1978	29-27-47	89-39-46	N/A
1522	WHITE LIGHTNING	10/28/1975	29-21-40	89-27-32	N/A
1540	UNKNOWN	8/17/1969	29-21-40	89-27-32	N/A
1542	UNKNOWN	11/18/1969	29-29-20	89-41-32	N/A
1550	UNKNOWN	1976	29-28-40	89-41-22	N/A
1566	MISS SUE	1977	29-21-36	89-26-50	N/A
1567	BARGE 133	3/25/1978	29-21-14	89-27-45	N/A
1569	MARY EDNA	1959	29-20-30	89-29-00	N/A
1571	UNKNOWN	1979	29-22-00	89-32-04	B
1573	UNKNOWN	1982	29-23-11	89-35-59	N/A
1574	UNKNOWN	1984	29-21-48	89-36-00	N/A
1575	UNKNOWN	1982	29-18-49	89-36-05	N/A
1577	UNKNOWN	1979	29-22-35	89-36-30	N/A
1619	UNKNOWN	8/17/1969	29-21-40	89-27-32	N/A
1624	UNKNOWN	4/8/1972	29-21-40	89-27-32	N/A

Record No.*	Vessel Name	Date Lost	LAT	LONG	Block
1678	UNKNOWN	3/16/1968	29-29-10	89-41-47	N/A
1679	UNKNOWN	2/14/1969	29-21-40	89-27-32	N/A
1680	UNKNOWN	9/17/1968	29-23-50	89-35-50	B
1764	FP-21	1976	29-28-39	89-41-21	N/A
N/A	NOAA 1	UNKNOWN	29-29-24	89-40-37	N/A
N/A	NOAA 2	UNKNOWN	29-28-22	89-40-59	N/A
N/A	NOAA 3	UNKNOWN	29-30-00	89-34-30	N/A
N/A	NOAA 4	UNKNOWN	29-27-35	89-31-07	N/A
N/A	NOAA 5	UNKNOWN	29-25-04	89-29-05	N/A
N/A	NOAA 6	UNKNOWN	29-21-14	89-27-41	N/A
N/A	NOAA 7	UNKNOWN	29-21-26	89-27-32	N/A
N/A	NOAA 8	UNKNOWN	29-21-46	89-27-16	N/A
N/A	NOAA 9	UNKNOWN	29-21-45	89-26-52	N/A

*Record Nos. correspond with those found in *A Database of Louisiana Shipwrecks* (Clune and Wheeler, 1991).

Table 2. Inventory of magnetic anomalies from Phase I marine archeological remote sensing survey of the proposed Mississippi River sand borrow sites for the Louisiana Coastal Area Barrier Shoreline Restoration Project, Plaquemines Parish, Louisiana. Coordinates in Louisiana State Plane [South 1702], NAD 83, survey ft. nT(nanoTesla); MC (multi-component); D (dipole); M (monopole)

Anomaly	Block	Line	Duration (seconds)	Amplitude (nT)	Signature	N	E	Target
M1	A	8	00:08.3	45.0	MC	351976.60	3827566.80	N/A
M2	A	14	01:48.5	50.1	D	349542.70	3831273.70	N/A
M3	A	18	01:01.0	12.9	D	351062.60	3828594.80	N/A
M4	A	19	01:50.9	20.0	D	351073.40	3828397.90	N/A
M5	A	20	01:25.5	14.8	D	350993.70	3828494.70	N/A
M6	A	22	02:31.5	17.4	- M	348645.60	3831647.40	N/A
M7	A	23	00:58.5	286.7	D	348893.40	3831321.30	N/A
M8	A	24	02:18.9	53.3	D	343114.80	3832331.20	5
M9	A	24	02:49.4	28.4	- M	350928.00	3828053.50	N/A
M10	A	25	02:47.7	79.8	MC	343171.20	3832290.90	5
M11	A	25	02:21.0	15.2	- M	350061.50	3829931.40	N/A
M12	A	26	02:34.1	127.1	D	343120.30	3832229.60	5
M13	A	26	00:34.7	26.3	+ M	350394.10	3829202.80	N/A
M14	A	27	02:18.6	121.1	D	343194.60	3832190.10	5
M15	A	28	00:32.5	15.2	D	351397.90	3826208.80	N/A
M16	A	28	00:35.6	30.3	D	350285.70	3829147.20	3
M17	A	28	01:46.1	114.9	D	343155.80	3832143.30	N/A
M18	A	29	01:35.4	124.7	D	343233.10	3832094.50	5
M19	A	29	00:18.4	22.2	- M	347962.60	3831772.90	4
M20	A	29	00:33.0	29.3	- M	350267.00	3829126.90	3
M21	A	30	00:46.2	69.3	- M	347894.60	3831730.20	4
M22	A	30	01:43.0	107.5	D	343183.40	3832040.50	5
M23	A	31	02:09.8	89.1	D	343258.90	3831999.40	5
M24	A	31	05:53.8	385.4	D	350783.60	3827458.70	2
M25	A	32	03:34.3	35.0	D	343202.80	3831939.60	2
M25a	A	32	03:44.7	27.3	D	350613.11	3827739.53	2
M26	A	33	04:15.4	24.2	D	343256.10	3831891.50	N/A
M27	A	33	04:35.2	18.4	- M	347788.30	3831610.70	N/A
M28	A	33	04:59.9	37.0	MC	350590.70	3827692.70	2
M29	A	34	06:52.7	66.2	MC	350577.50	3827568.30	2
M30	A	34	03:01.7	16.2	D	343175.20	3831832.10	N/A
M31	A	35	03:59.8	48.8	D	343311.10	3831803.30	N/A
M32	A	35	05:01.3	67.5	D	350859.10	3826679.80	N/A
M33	A	36	03:49.5	202.4	MC	350571.50	3827322.30	2
M34	A	37	05:04.8	622.4	MC	350421.80	3827564.50	2
M35	A	37	00:31.0	27.8	D	346393.80	3831747.50	N/A
M36	A	38	06:41.0	869.9	MC	350459.07	3827331.82	2
M37	A	39	00:50.9	50.1	+ M	348968.10	3830074.07	N/A
M38	A	39	01:00.0	34.7	- M	351209.56	3825051.98	N/A
M39	A	39	04:49.7	674.0	MC	350522.15	3827209.08	2
M40	B	1	01:48.0	86.4	D	337774.89	3831590.73	7
M41	B	3	01:52.9	86.3	D	337814.77	3831466.52	7
M42	B	3	00:25.9	51.9	D	334209.09	3832370.08	N/A
M43	B	3	00:24.2	106.3	D	333204.47	3832650.74	N/A
M44	B	4	02:13.3	72.8	D	337802.97	3831416.51	7
M45	B	4	00:39.1	18.9	D	335184.16	3832034.39	N/A
M46	B	4	00:18.0	21.3	D	331899.01	3833487.88	N/A
M47	B	5	01:00.7	61.1	MC	334598.37	3832136.00	N/A
M48	B	5	00:31.0	19.8	D	332576.47	3832969.43	N/A

Anomaly	Block	Line	Duration (seconds)	Amplitude (nT)	Signature	N	E	Target
M49	B	5	00:12.2	24.4	D	331814.67	3833380.12	N/A
M50	B	5	00:42.5	36.0	D	329543.43	3834726.28	N/A
M51	B	5	00:19.4	50.1	D	327163.62	3837489.47	N/A
M52	B	5	00:19.1	29.5	D	326534.89	3838321.89	N/A
M53	B	5	00:23.5	23.4	D	326400.58	3838535.67	N/A
M54	B	5	00:23.8	52.6	- M	323673.10	3842449.47	N/A
M55	B	5	00:21.9	43.7	+ M	323509.45	3843093.93	17
M56	B	5	00:20.7	177.2	- M	323199.71	3843525.99	18
M57	B	5	00:28.3	84.7	D	323017.41	3843794.31	19
M58	B	5	00:24.9	24.3	D	322816.45	3844139.00	N/A
M59	B	5	00:22.2	40.9	D	322341.25	3845219.49	N/A
M60	B	5	00:24.6	60.9	D	322039.62	3845757.15	20
M61	B	5	06:42.8	1546.3	MC	321230.28	3847252.72	21
M62	B	5	00:23.2	231.9	D	320240.64	3850886.69	24
M63	B	5	05:23.4	1210.9	MC	319306.48	3854017.37	27
M64	B	6	04:22.3	3372.3	MC	319517.51	3853299.49	26
M65	B	6	00:34.2	162.8	D	320233.41	3850787.57	24
M66	B	6	05:14.2	914.8	MC	321247.40	3847075.31	21
M67	B	6	00:55.3	94.4	D	323213.15	3843694.48	19
M68	B	6	00:45.1	39.9	- M	323579.75	3843059.86	17
M69	B	6	01:16.6	73.2	- M	329935.56	3834406.21	N/A
M70	B	6	00:30.0	85.5	D	330538.62	3834105.58	11
M71	B	6	00:34.3	44.3	D	332626.65	3832895.47	N/A
M72	B	6	02:57.3	62.5	D	337944.62	3831304.30	7
M73	B	7	01:16.8	71.0	D	337865.92	3831256.85	7
M74	B	7	00:23.7	14.8	D	334121.00	3832183.67	N/A
M75	B	7	00:20.4	48.9	+ M	330535.80	3834198.34	11
M76	B	7	00:39.7	38.6	D	329580.23	3834822.66	N/A
M77	B	7	00:42.5	201.4	D	322945.46	3843754.56	19
M78	B	7	07:13.6	2190.1	MC	321246.44	3847256.61	21
M79	B	7	06:12.7	926.1	MC	319267.59	3854038.21	27
M80	B	8	05:55.8	1139.8	MC	319360.65	3853577.00	27
M81	B	8	06:32.8	1083.1	MC	321377.74	3846905.29	21
M82	B	8	00:29.0	75.0	D	323069.09	3843724.21	19
M83	B	8	00:21.0	111.1	- M	323236.47	3843471.00	18
M84	B	8	00:53.7	55.2	D	329622.41	3834714.86	N/A
M85	B	8	00:23.4	81.6	D	330555.93	3834143.80	11
M86	B	8	02:36.9	269.6	- M	335892.68	3831628.19	N/A
M87	B	8	01:26.6	69.5	D	337949.19	3831202.53	7
M88	B	9	01:27.5	82.6	D	337868.64	3831120.35	7
M89	B	9	00:27.1	61.4	D	330474.18	3834139.95	11
M90	B	9	01:02.7	41.8	D	329548.32	3834713.89	N/A
M91	B	9	02:30.0	149.7	MC	323161.81	3843497.02	18
M92	B	9	10:27.5	1005.9	MC	321175.22	3847231.24	21
M93	B	9	06:25.4	563.4	MC	319257.62	3853729.82	27
M94	B	10	04:52.9	335.6	- M	319201.18	3853715.22	27
M95	B	10	00:29.3	50.6	D	320188.21	3850278.33	N/A
M96	B	10	00:25.9	112.6	- M	320406.36	3849572.10	23
M97	B	10	05:26.9	4257.8	MC	321390.90	3847022.09	21
M98	B	10	00:33.9	117.1	D	322987.31	3843692.39	19
M99	B	10	00:22.7	25.1	D	323307.90	3843135.67	17
M100	B	10	00:25.3	62.5	D	323401.36	3842967.41	17
M101	B	10	00:38.1	58.8	D	327189.72	3837381.22	N/A
M102	B	10	02:39.8	47.9	D	329572.06	3834633.10	N/A

Anomaly	Block	Line	Duration (seconds)	Amplitude (nT)	Signature	N	E	Target
M103	B	10	00:40.4	41.9	D	331750.50	3833233.46	N/A
M104	B	10	00:51.1	19.8	D	336283.09	3831405.42	N/A
M105	B	10	02:14.1	78.2	D	337934.13	3831106.96	7
M106	B	11	01:17.4	83.5	D	337852.99	3831066.24	7
M107	B	11	04:01.0	1664.2	MC	321237.77	3847238.34	21
M108	B	11	03:28.6	216.9	MC	319127.64	3853838.48	28
M109	B	12	04:53.7	223.6	- M	319165.90	3853450.53	N/A
M110	B	12	00:27.7	102.8	- M	320339.87	3849469.10	23
M111	B	12	06:13.9	1208.8	MC	321234.41	3847110.27	21
M112	B	12	00:50.7	197.2	D	321921.50	3845565.51	20
M113	B	12	00:36.5	141.9	+ M	322917.95	3843611.77	19
M114	B	12	00:37.1	40.6	D	325296.69	3839993.96	N/A
M115	B	12	00:25.9	10.6	D	331745.10	3833139.95	N/A
M116	B	12	00:25.6	7.9	D	335066.58	3831654.46	N/A
M117	B	12	02:19.4	72.4	D	337920.37	3830999.57	7
M118	B	13	01:00.0	59.3	D	337873.30	3830962.46	7
M119	B	13	01:18.5	139.3	D	326962.69	3837442.18	N/A
M120	B	13	00:36.9	44.2	D	325751.37	3839231.58	N/A
M121	B	13	00:36.7	42.0	D	324147.09	3841484.12	N/A
M122	B	13	00:55.8	68.8	D	323147.42	3843104.11	N/A
M123	B	13	00:48.4	63.3	D	322643.14	3843968.61	N/A
M124	B	13	09:27.9	757.3	MC	321032.82	3847457.71	21
M125	B	13	00:45.8	34.8	- M	320167.17	3849821.78	N/A
M126	B	13	01:03.8	57.9	- M	319980.32	3850392.19	N/A
M127	B	13	00:40.2	77.8	D	319439.19	3852237.20	N/A
M128	B	13	04:22.6	158.1	- M	319047.09	3853690.37	N/A
M129	B	14	04:49.8	92.0	- M	319109.57	3853277.80	N/A
M130	B	14	00:49.3	152.3	D	319627.13	3851354.64	N/A
M131	B	14	06:29.0	550.7	MC	321185.97	3846945.07	21
M132	B	14	00:50.2	54.3	+ M	322839.06	3843550.04	19
M133	B	14	00:49.7	51.4	D	323287.81	3842781.44	17
M134	B	14	00:32.2	31.5	D	325129.27	3840062.16	N/A
M135	B	14	00:46.6	57.7	D	325814.40	3839078.43	N/A
M136	B	14	00:45.9	64.6	D	337968.99	3830895.87	7
M137	B	15	05:10.0	100.1	MC	318965.48	3853628.80	N/A
M138	B	15	00:37.6	62.3	D	319392.50	3852043.06	N/A
M139	B	15	00:29.9	46.7	D	320186.01	3849467.55	N/A
M140	B	15	00:49.7	86.6	D	322762.05	3843561.67	19
M141	B	15	01:00.5	74.1	D	337955.47	3830838.25	7
M142	B	16	00:36.3	10.9	D	327198.98	3836830.20	N/A
M143	B	16	00:34.1	76.1	D	325260.66	3839686.70	N/A
M144	B	16	02:54.2	157.6	MC	322909.76	3843246.14	N/A
M145	B	16	10:05.1	339.3	MC	321010.29	3847111.53	21
M146	B	16	06:08.2	133.6	MC	318876.58	3853755.19	28
M147	B	17	00:39.6	18.9	D	318433.58	3855544.69	N/A
M148	B	17	04:42.6	61.6	- M	318885.85	3853546.02	N/A
M149	B	17	08:16.2	193.8	MC	321004.29	3847022.47	21
M150	B	17	00:29.1	59.4	D	322664.40	3843512.06	19
M151	B	17	00:39.6	54.7	- M	323123.98	3842758.18	17
M152	B	17	00:28.3	93.6	D	325272.96	3839599.05	N/A
M153	B	18	01:20.6	27.8	D	336589.18	3830938.65	N/A
M154	B	18	00:31.9	47.8	D	325565.84	3839083.12	N/A
M155	B	18	00:30.5	31.2	D	325262.92	3839543.11	N/A
M156	B	18	00:16.8	9.6	D	325053.51	3839829.47	N/A

Anomaly	Block	Line	Duration (seconds)	Amplitude (nT)	Signature	N	E	Target
M157	B	18	01:37.6	42.0	D	322955.01	3842938.31	N/A
M158	B	18	00:47.1	109.9	D	322596.95	3843542.10	19
M159	B	18	10:04.7	199.7	MC	320953.12	3847034.88	21
M160	B	18	00:47.1	28.5	D	320044.32	3849421.11	N/A
M161	B	18	06:07.8	78.5	MC	318724.06	3853906.99	N/A
M162	B	18	00:42.5	20.4	D	318362.39	3855607.91	N/A
M163	B	19	10:19.9	165.4	MC	320773.72	3847294.91	N/A
M164	B	19	00:53.0	134.7	D	322598.37	3843474.38	19
M165	B	19	00:57.3	29.5	- M	323051.26	3842706.44	17
M166	B	19	00:33.2	15.8	D	325263.41	3839454.92	N/A
M167	B	19	00:37.9	38.9	D	325581.10	3838977.35	N/A
M168	B	19	00:57.5	44.8	D	336661.81	3830878.02	8
M169	B	20	07:57.1	45.3	MC	318681.69	3853701.84	28
M170	B	20	09:57.1	156.2	MC	320892.54	3846895.05	21
M171	B	20	00:33.3	21.5	D	321572.09	3845372.10	20
M172	B	20	00:56.2	86.1	D	322552.94	3843433.15	19
M173	B	20	00:35.9	14.9	+ M	323001.92	3842677.35	17
M174	B	20	00:51.9	5.0	D	324087.21	3840972.61	N/A
M175	B	20	02:01.2	29.5	- M	325441.50	3839071.08	N/A
M176	B	20	00:41.7	15.5	D	326004.43	3838233.88	N/A
M177	B	20	00:58.7	41.3	D	336648.30	3830831.79	8
M178	B	21	00:42.4	17.2	D	336540.58	3830805.39	N/A
M179	B	21	00:31.3	9.3	+ M	327685.86	3835701.34	N/A
M180	B	21	00:37.4	11.1	D	325946.64	3838248.57	N/A
M181	B	21	00:22.2	13.7	D	325303.63	3839200.18	N/A
M182	B	21	00:32.4	20.1	D	324002.33	3841001.85	N/A
M183	B	21	00:47.9	48.6	+ M	322910.88	3842723.07	17
M184	B	21	08:52.0	135.6	MC	320807.01	3846967.41	21
M185	B	21	00:36.0	6.6	D	319806.69	3849616.27	N/A
M186	B	21	05:22.8	32.9	MC	318629.53	3853685.36	28
M187	B	22	10:10.9	121.5	MC	320788.11	3846896.81	21
M188	B	22	00:34.5	19.6	- M	322435.87	3843435.64	19
M189	B	22	00:47.6	24.7	D	322892.05	3842654.26	17
M190	B	22	00:39.0	8.4	D	323381.23	3841816.36	N/A
M191	B	22	00:25.3	8.1	D	324038.23	3840850.40	N/A
M192	B	22	00:37.2	7.6	D	325953.32	3838144.17	N/A
M193	B	22	00:47.7	8.7	D	327675.29	3835676.43	N/A
M194	B	23	00:41.7	-9.2	+ M	318168.10	3855381.21	N/A
M195	B	23	00:28.4	6.4	- M	318275.27	3854821.50	N/A
M196	B	23	00:45.8	13.4	D	319015.47	3851941.61	N/A
M197	B	23	07:13.9	74.7	MC	320794.97	3846769.45	21
M198	B	23	00:55.7	23.7	D	321436.41	3845321.78	20
M199	B	23	00:56.0	68.0	- M	322409.42	3843402.25	19
M200	B	24	00:39.4	15.1	- M	322792.65	3842628.15	17
M201	B	24	00:56.7	48.2	- M	322331.74	3843410.05	19
M202	B	24	00:49.0	41.2	+ M	321358.62	3845340.90	20
M203	B	24	06:10.0	63.2	- M	320674.84	3846875.54	21
M204	B	24	00:59.3	231.9	- M	319134.55	3851250.82	N/A
M205	B	25	09:02.4	24.1	MC	318464.67	3853589.52	28
M206	B	25	01:21.9	12.0	- M	319620.17	3849605.22	N/A
M207	B	25	08:59.0	96.9	MC	320700.49	3846700.44	21
M208	B	25	00:56.2	25.0	D	322320.44	3843333.72	19
M209	B	25	01:18.6	36.5	D	322835.30	3842465.89	17
M210	B	25	01:17.7	9.2	- M	328941.69	3834139.96	N/A

Anomaly	Block	Line	Duration (seconds)	Amplitude (nT)	Signature	N	E	Target
M211	B	26	01:54.4	32.4	D	328910.62	3834092.28	N/A
M212	B	26	00:38.6	9.9	D	325334.90	3838715.57	N/A
M213	B	26	01:06.8	23.1	- M	324425.86	3839972.84	N/A
M214	B	26	00:37.2	9.4	D	322705.27	3842567.80	17
M215	B	26	00:30.8	99.3	+ M	322273.05	3843348.03	19
M216	B	27	01:14.4	125.1	D	319891.60	3848427.18	22
M217	B	27	00:34.2	11.7	D	321260.95	3845198.94	20
M218	B	27	01:01.5	83.8	+ M	322256.96	3843246.28	19
M219	B	27	00:33.3	18.3	+ M	322702.44	3842494.86	17
M220	B	27	00:37.5	8.2	D	325336.30	3838601.43	N/A
M221	B	27	01:32.6	44.5	D	328880.91	3834041.34	N/A
M222	B	28	02:13.5	62.3	D	328798.17	3834039.36	N/A
M223	B	28	00:32.8	62.1	+ M	321153.27	3845265.87	20
M224	B	29	00:36.3	18.0	+ M	317994.27	3854752.48	N/A
M225	B	29	00:43.7	56.5	D	322160.57	3843211.24	19
M226	B	29	00:42.9	16.3	+ M	322599.82	3842447.48	17
M227	B	30	01:19.6	48.1	MC	328761.63	3833960.31	12
M228	B	30	00:37.3	13.0	- M	328006.61	3834456.51	N/A
M229	B	30	00:23.0	30.5	+ M	322540.61	3842464.90	17
M230	B	30	00:32.3	41.9	D	322074.30	3843258.48	19
M231	B	30	03:01.9	33.8	D	317871.61	3855078.29	N/A
M232	B	30	01:30.3	-9.4	+ M	318258.80	3853367.51	N/A
M233	B	30	02:10.8	107.7	D	319745.51	3848396.49	22
M234	B	30	00:40.9	31.7	+ M	321128.14	3845140.99	20
M235	B	31	01:13.2	15.1	+ M	317903.35	3854739.06	N/A
M236	B	31	01:33.4	15.3	+ M	318223.66	3853314.18	N/A
M237	B	31	01:51.9	95.1	D	319704.41	3848368.97	22
M238	B	31	00:40.5	9.6	+ M	320136.94	3847282.86	N/A
M239	B	31	01:11.1	33.4	D	321098.69	3845072.79	20
M240	B	31	00:48.7	28.3	+ M	322528.84	3842377.02	17
M241	B	31	00:35.3	6.4	D	325852.70	3837486.49	N/A
M242	B	31	01:11.8	23.9	MC	328847.04	3833845.34	12
M243	B	32	01:16.7	21.4	MC	328759.69	3833842.36	12
M244	B	32	00:35.6	9.7	D	325764.19	3837517.65	N/A
M245	B	32	01:00.2	24.6	D	322490.46	3842354.90	17
M246	B	32	00:39.1	46.6	+ M	321966.69	3843236.93	19
M247	B	32	00:51.1	52.1	- M	320986.33	3845173.32	20
M248	B	32	01:10.1	167.8	- M	320372.02	3846568.45	N/A
M249	B	32	01:46.2	84.5	D	319642.84	3848381.28	22
M250	B	33	01:11.2	34.9	D	318099.83	3853356.23	28
M251	B	33	01:06.1	52.1	MC	318368.18	3852384.96	25
M252	B	33	02:08.9	73.3	MC	319621.79	3848293.62	22
M253	B	33	00:41.3	35.6	- M	320989.53	3845083.23	20
M254	B	33	00:39.7	13.5	+ M	321975.71	3843136.62	19
M255	B	33	00:43.7	32.0	- M	322451.32	3842329.68	17
M256	B	34	00:27.7	32.6	+ M	327607.29	3834695.58	N/A
M257	B	34	00:48.2	10.4	D	325940.63	3837083.07	N/A
M258	B	34	00:48.0	0.0	- M	322358.10	3842389.13	17
M259	B	34	00:40.2	26.0	D	321904.93	3843157.27	19
M260	B	34	00:44.5	19.8	D	320869.49	3845167.47	20
M261	B	34	02:32.5	71.6	D	319557.99	3848335.68	22
M262	B	34	00:40.1	23.5	D	318305.65	3852420.25	25
M263	B	34	00:59.1	56.8	D	318046.96	3853397.02	28
M264	B	35	01:09.4	6.1	D	317425.84	3855795.65	N/A

Anomaly	Block	Line	Duration (seconds)	Amplitude (nT)	Signature	N	E	Target
M265	B	35	01:02.2	46.4	D	318034.62	3853248.84	28
M266	B	35	02:37.4	77.1	D	319524.66	3848266.99	22
M267	B	35	00:37.2	20.2	+ M	320883.28	3845024.93	20
M268	B	35	00:37.9	15.6	D	321892.33	3843075.73	19
M269	B	35	00:25.8	6.1	+ M	322362.24	3842267.28	17
M270	B	35	00:47.6	6.9	D	325942.08	3836979.33	N/A
M271	B	36	01:00.1	97.4	- M	329526.74	3833164.74	N/A
M272	B	36	01:04.3	4.4	D	326740.71	3835738.44	N/A
M273	B	36	00:39.3	2.5	D	326410.56	3836220.33	N/A
M274	B	36	00:47.7	3.5	D	325866.30	3837005.92	N/A
M275	B	36	01:16.1	15.5	- M	323803.55	3839984.50	N/A
M276	B	36	00:45.7	4.9	+ M	322270.70	3842315.25	17
M277	B	36	00:46.9	53.0	+ M	321801.66	3843118.12	19
M278	B	36	00:39.3	15.6	+ M	320828.86	3845067.32	20
M279	B	36	01:39.0	107.6	D	319447.20	3848325.21	22
M280	B	36	01:11.5	159.6	D	317977.95	3853258.03	28
M281	B	36	00:43.5	-13.9	+ M	317613.50	3854851.07	N/A
M282	B	36	00:50.4	22.3	- M	317329.48	3855951.52	N/A
M283	B	37	01:27.4	19.8	- M	329927.31	3832820.98	N/A
M284	B	37	02:35.6	723.8	D	317960.45	3853134.69	28
M285	B	37	00:25.7	356.6	D	320762.36	3845090.39	20
M286	B	37	00:51.7	47.2	+ M	321795.27	3843041.05	19
M287	B	38	00:26.4	20.4	+ M	317259.24	3855849.23	N/A
M288	B	38	00:42.3	11.8	+ M	317535.35	3854771.61	N/A
M289	B	38	01:20.1	2215.3	D	317909.85	3853130.72	28
M290	B	38	01:28.4	61.5	D	319365.30	3848266.06	22
M291	B	38	00:54.2	23.0	+ M	321774.51	3842984.34	19
M292	B	38	00:38.4	16.3	+ M	322250.56	3842187.96	17
M293	B	38	00:50.6	8.6	D	326706.93	3835629.67	N/A
M294	B	39	00:22.7	20.2	+ M	326702.32	3835539.96	N/A
M295	B	39	00:34.7	21.6	+ M	322160.15	3842212.64	17
M296	B	39	00:48.8	32.0	+ M	321710.49	3843013.25	19
M297	B	39	01:00.9	44.6	- M	319892.57	3846828.51	N/A
M298	B	39	01:39.7	73.2	D	319274.77	3848381.50	22
M299	B	39	01:36.4	177.3	- M	318842.52	3849701.29	N/A
M300	B	39	01:07.2	4211.1	D	317835.69	3853216.90	28
M301	B	39	01:20.4	48.5	D	317421.67	3854981.36	31
M302	B	39	01:06.9	41.3	- M	317396.47	3855132.77	N/A
M303	B	40	00:48.1	53.8	- M	317129.83	3855912.64	N/A
M304	B	40	01:01.5	47.9	- M	317370.07	3855055.76	31
M305	B	40	01:09.2	2098.7	D	317809.34	3853129.11	28
M306	B	40	01:33.4	72.7	D	319258.13	3848282.92	22
M307	B	40	00:43.2	18.8	D	319881.05	3846711.01	N/A
M308	B	40	00:48.4	31.4	+ M	321686.08	3842946.94	19
M309	B	40	00:33.7	21.4	- M	322551.58	3841455.18	N/A
M310	B	40	00:47.5	25.3	D	326599.01	3835613.58	N/A
M311	B	41	00:33.5	50.0	D	326515.41	3835648.72	N/A
M312	B	41	00:41.7	23.2	D	321611.15	3842993.28	19
M313	B	41	00:48.6	20.1	D	320567.90	3845030.94	20
M314	B	41	00:37.6	54.9	+ M	319788.20	3846812.45	N/A
M315	B	41	01:05.0	84.6	D	319198.93	3848307.07	22
M316	B	41	00:36.2	12.3	D	318875.93	3849282.47	N/A
M317	B	41	00:36.0	9.1	D	318152.01	3851657.16	N/A
M318	B	41	01:45.3	825.5	D	317731.80	3853213.44	28

Anomaly	Block	Line	Duration (seconds)	Amplitude (nT)	Signature	N	E	Target
M319	B	41	00:53.6	65.1	- M	317430.86	3854482.29	30
M320	B	41	01:28.6	226.8	D	317290.67	3855099.19	N/A
M321	B	42	01:10.3	457.8	- M	317299.14	3854843.57	32
M322	B	42	00:56.1	366.6	- M	317408.09	3854359.07	30
M323	B	42	01:34.8	441.1	D	317699.29	3853138.96	28
M324	B	42	00:44.5	13.2	D	318119.44	3851570.63	N/A
M325	B	42	00:45.9	6.8	D	318852.04	3849196.56	N/A
M326	B	42	02:15.7	74.2	D	319177.54	3848210.73	22
M327	B	42	01:01.8	42.8	+ M	319771.80	3846718.59	N/A
M328	B	42	00:57.7	22.9	D	320560.59	3844938.03	20
M329	B	42	01:11.1	51.4	- M	321589.28	3842891.17	19
M330	B	42	00:44.0	21.5	+ M	322069.27	3842070.47	17
M331	B	42	01:58.7	287.2	- M	322424.16	3841395.81	N/A
M332	B	42	00:47.7	31.3	- M	326306.93	3835855.62	13
M333	B	43	00:54.8	925.0	- M	317260.08	3854818.97	32
M334	B	43	00:34.1	931.9	- M	317362.94	3854348.99	30
M335	B	43	00:35.4	101.1	- M	317562.60	3853451.94	29
M336	B	43	01:29.3	218.3	D	317645.93	3853126.76	28
M337	B	43	01:41.5	585.3	- M	319154.26	3848090.00	22
M338	B	43	00:53.5	33.1	+ M	319719.19	3846709.31	N/A
M339	B	43	00:41.6	20.5	D	320546.96	3844869.34	20
M340	B	43	00:54.4	570.9	- M	321286.35	3843344.53	N/A
M341	B	43	00:29.6	794.9	D	322970.07	3840459.86	N/A
M342	B	44	01:51.3	270.6	- M	323118.84	3840277.25	N/A
M343	B	44	00:37.1	10.7	- M	321955.38	3842069.13	17
M344	B	44	01:47.5	59.4	- M	321479.58	3842910.83	19
M345	B	44	00:45.0	16.4	+ M	319640.37	3846755.28	N/A
M346	B	44	01:32.4	35.7	- M	319036.25	3848325.70	22
M347	B	44	00:28.4	302.9	D	317497.20	3853545.42	29
M348	B	44	00:35.1	169.8	D	317403.92	3853965.00	N/A
M349	B	44	00:36.6	5149.4	D	317304.24	3854386.13	30
M350	B	44	01:10.1	3055.0	D	317195.34	3854863.60	32
M351	B	45	00:36.8	35.4	D	319024.51	3848191.82	22
M352	B	45	00:43.4	41.2	- M	320439.27	3844863.96	20
M353	B	45	01:06.7	25.3	- M	321482.37	3842785.20	19
M354	B	45	01:47.3	652.1	- M	324968.22	3837551.06	N/A
M355	B	46	01:27.2	12.2	- M	322820.37	3840524.78	N/A
M356	B	46	01:24.9	53.7	D	321379.63	3842845.42	19
M357	B	46	00:31.7	98.1	D	318929.87	3848311.64	22
M358	B	47	00:18.3	83.3	D	318164.50	3850479.08	N/A
M359	B	47	00:31.8	35.7	D	318358.46	3849854.42	N/A
M360	B	47	00:29.8	49.2	D	318932.75	3848139.17	22
M361	B	47	00:28.5	36.3	D	320309.78	3844852.79	20
M362	B	47	00:21.4	30.0	D	321009.40	3843437.33	N/A
M363	B	47	02:53.9	86.4	- M	323676.31	3839242.83	N/A
M364	B	48	00:27.9	16.2	+ M	324318.18	3838216.34	N/A
M365	B	48	01:19.1	32.7	MC	322666.03	3840539.48	N/A
M366	B	48	00:45.0	108.9	D	321294.50	3842808.35	19
M367	B	48	00:40.8	94.1	D	320935.53	3843436.35	N/A
M368	B	48	01:07.3	113.0	D	320198.49	3844977.62	20
M369	B	49	00:34.1	31.4	D	321856.99	3841761.02	17
M370	B	49	00:49.5	1370.2	- M	323437.34	3839405.37	16
M371	B	50	00:21.8	35.9	D	321962.45	3841467.25	N/A

Table 3. Acoustic anomalies from phase I marine remote sensing cultural resources investigation of the proposed Mississippi River sandborrow sites for the Louisiana Coastal Area Barrier Shoreline Restoration Project, Plaquemines Parish, Louisiana. Coordinates inLouisiana State Plane [South 1702], NAD83, survey ft.

Anomaly	Block	Line	Dimensions (ft)	Relief (ft)	N	E	Identification	Target
A1	A	15	134.0 x 42.0	5.6	349210.40	3831823.88	Scouring	N/A
A2	A	15	188.0 x 75.0	2.0	349922.69	3831105.94	Scouring	N/A
A3	A	16	whole record	N/A	351029.13	3828382.09	Sand Waves	N/A
A4	A	25	whole record	N/A	347287.58	3831977.08	Sand Waves	N/A
A5	A	26	3.2 x 0.7	N/A	347929.57	3831741.90	Pipe Segment	N/A
A6	A	29	11.0 x 8.0	N/A	348002.42	3831748.75	ATON Mooring	N/A
A7	A	34	87.0 x 38.0	N/A	350313.92	3827698.39	Dock	2
A8	A	36	45.0 x 6.0	N/A	350660.08	3827418.93	Mooring	2
A9	A	39	112.0 x 30.0	7.5	349736.19	3828743.69	Bank Failure	1
A10	B	1	222.0 x 4.0	N/A	338623.02	3831237.18	Bottom Disturbance and Debris	6
A11	B	1a	11.0 x 12.0	N/A	333146.04	3833053.82	Pilings	N/A
A12	B	3	25.0 x 7.6	4.0	333989.25	3832497.03	Debris	N/A
A13	B	5	40.0 x 17.0	N/A	323638.96	3842374.39	Debris	N/A
A14	B	5	355.0 x 60.0	N/A	321358.71	3847205.46	Dock	21
A15	B	5	330.0 x 110.0	N/A	321042.52	3848428.88	Mooring	N/A
A16	B	15	450.0 x 65.0	N/A	319780.99	3852692.51	Mooring	N/A
A17	B	6	450.0 x 65.0	N/A	319479.58	3854035.28	Dock	N/A
A18	B	7	120.0 x 35.0	3.6	330999.04	3833853.31	Bank Failure	N/A
A19	B	9	11.0 x 8.0	N/A	332394.52	3833021.14	ATON Mooring	N/A
A20	B	13	8.0 x 7.0	N/A	325534.34	3839408.41	Bottom Disturbance	14
A21	B	13	135.0 x 56.0	N/A	318279.05	3856286.41	Debris	N/A
A22	B	15	13.0 x 10.0	2.0	322647.56	3843532.71	Mooring Anchor	N/A
A23	B	16	6.0 x 2.0	1.0	325251.01	3839866.12	Debris	15
A24	B	17	24.0 x 14.0	N/A	331417.78	3832885.71	Debris	9
A25	B	24	12.0 x 12.0	1.0	321528.70	3845305.25	Debris	N/A
A26	B	26	78.0 x 40.0	2.0	322137.10	3843330.87	Pipeline Matting	19
A27	B	30	36.0 x 2.0	N/A	318527.63	3852935.17	Pipe Segment	N/A
A28	B	30	33.0 x 5.7	N/A	317257.90	3856530.85	Linear feature	N/A
A29	B	31a	220.0 x 70.0	N/A	318409.36	3852273.28	Bank Failure	25
A30	B	36	163.0 x 70.0	3.0	330791.69	3832208.33	Bank Failure	10
A31	B	38	175.0 x 40.0	10.0	317382.31	3854962.43	Possible Shipwreck	31
A32	B	38	175.0 x 40.0	11.0	317416.96	3854853.03	Possible Shipwreck	31
A33	B	41	30.0 x 14.0	5.0	326209.16	3835844.46	Possible Shipwreck	13
A34	B	41	220.0 x 30.0	10.0	317199.65	3854911.14	Possible Shipwreck	32
A35	B	43	220.0 x 30.0	12.0	317169.72	3854896.21	Possible Shipwreck	32
A36	B	47	124.0 x 30.0	N/A	320429.59	3844785.45	Bank Failure	20
A37	B	43	90.0 x 30.0	2.0	317305.02	3854369.84	Possible Shipwreck	30

Table 4. Targets from phase I marine remote sensing cultural resources investigation of the proposed Mississippi River sand Louisiana Coastal Area Barrier Shoreline Restoration Project, Plaquemines Parish, Louisiana. Coordinates in Louisiana State (South 1702), NAD83, survey ft.

Target	Magnetic Anomalies	Acoustic Anomalies	N*	E*	Block	Identification	Recommendation
1	N/A	A9	349736.19	3828743.69	A	Bank Failure	N/A
2	M24, M25, M25a, M28, M29, M33, M34, M36, M39	A7, A8	350598.17	3827469.11	A	Dock and Barge Mooring	N/A
3	M16, M20	N/A	350277.69	3829139.73	A	Debris	N/A
4	M19, M21	A5, A6	347959.96	3831744.77	A	ATON	N/A
5	M8, M10, M12, M14, M18, M22, M23, M25, M26, M30, M31	N/A	343157.12 3433265.80	3832366.65 3831775.63		Pipeline and Debris	N/A
6	N/A	A10	338623.02	3831237.18	B	Bottom Disturbance and Debris	N/A
7	M40, M41, M44, M72, M73, M87, M88, M105, M106, M117, M118, M136, M141	N/A	337841.94 337954.56	3831589.29 3830807.81	B	Pipeline	N/A
8	M168, M177	N/A	336656.39	3830857.70	B	Debris	N/A
9	N/A	A24	331417.78	3832885.71	B	Debris	N/A
10	N/A	A30	330791.69	3832208.33	B	Bank Failure	N/A
11	M70, M75, M85, M89	N/A	330522.07	3834144.37	B	Debris	N/A
12	M227, M242, M243	N/A	328815.64	3833907.67	B	Debris	N/A
13	M332	A33	326209.16	3835844.46	B	Possible Shipwreck	Avoidance
14	N/A	A20	325534.34	3839408.41	B	Bottom Disturbance	N/A
15	N/A	A23	325251.01	3839866.12	B	Debris	N/A
16	M370	N/A	323437.30	3839405.40	B	Debris	N/A

Target	Magnetic Anomalies	Acoustic Anomalies	N*	E*	Block	Identification	Recommendation
17	M55, M68, M99, M100, M133, M151, M165, M173, M183, M189, M200, M209, M214, M219, M226, M229, M240, M245, M255, M258, M269, M276, M292, M295, M330, M343, M369	N/A	323540.02 321799.90	3843121.93 3841785.38	B	Pipeline	N/A
18	M56, M83, M91	N/A	323197.78	3843488.21	B	Debris	N/A
19	M57, M67, M77, M82, M98, M113, M132, M140, M150, M158, M164, M172, M188, M199, M201, M208, M215, M218, M225, M230, M246, M254, M259, M268, M277, M286, M291, M296, M308, M312, M329, M344, M353, M356, M366	A26	323142.40 321283.03	3843803.41 3842751.33	B	Pipeline	N/A
20	M60, M112, M171, M198, M202, M217, M223, M234, M239, M247, M253, M260, M267, M278, M285, M313, M328, M339, M352, M361, M368	A36	322153.72 320300.25	3845792.89 3844785.36	B	Pipeline	N/A
21	M61, M66, M78, M81, M92, M97, M107, M111, M124, M131, M145, M149, M159, M170, M184, M187, M197, M203, M207	A14	321139.50	3847118.05	B	Tanker Loading Dock	N/A

Target	Magnetic Anomalies	Acoustic Anomalies	N*	E*	Block	Identification	Recommendation
22	M216, M233, M237, M249, M252, M261, M266, M279, M290, M298, M306, M315, M326, M337, M346, M351, M357, M360	N/A	319862.43 318898.88	384825.08 3848203.89	B	Pipeline and Debris	N/A
23	M96, M110	N/A	320374.81	3849515.80	B	Debris	N/A
24	M62, M65	N/A	320232.34	3850835.78	B	Debris	N/A
25	M251, M262	A29	318367.71	3852333.84	B	Debris	N/A
26	M64	N/A	319517.50	3853299.50	B	Barge Mooring	N/A
27	M63, M79, M80, M93, M94	N/A	319302.86	3853915.82	B	Barge Mooring and Debris	N/A
28	M108, M146, M169, M186, M205, M250, M263, M265, M280, M284, M289, M300, M305, M318, M323, M336	N/A	317615.52 319127.60	3853101.14 3853838.50	B	Pipeline	N/A
29	M335, M347	N/A	317531.40	3853494.50	B	Debris	N/A
30	M319, M322, M334, M349	A37	317333.34	3854369.48	B	Possible Shipwreck	Avoidance
31	M301, M304	A31, A32	3177381.72	3854960.64	B	Possible Shipwreck	Avoidance
32	M321, M333, M350	A34, A35	317195.30	3854863.60	B	Possible Shipwreck	Avoidance

* Coordinates to centerpoint or the ends of linear targets