Phase I Remote-Sensing Submerged Cultural Resource Survey of Pipeline Corridors located in Lafourche Parish, Louisiana in Association with the West Belle Pass Barrier Headland Restoration Project

Prepared for

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23 September 2010

Phase I Remote-Sensing Submerged Cultural Resource Survey of Pipeline Corridors located in Lafourche and Terrebonne Parish, Louisiana Parish, Louisiana in Association with the West Belle Pass Barrier Headland Restoration Project

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Abstract

The West Belle Pass Barrier Headland is located immediately west of Port Fourchon in the Bayou Lafourche Delta Complex. The headland provides storm protection for a large marsh complex in Lafourche Parish and the western flank of Port Fourchon. The proposed project is designed to increase headland longevity, restore valuable habitat, and construct a beach and dune system that will improve protection for the bayside marsh and Port Fourchon. Material for the restoration will come through pipelines from two offshore borrow sites in the Gulf of Mexico. Coastal Planning and Engineering, Inc. (CPE) is the consulting geotechnical engineering firm for the West Belle Pass Barrier Headland restoration project. In order to determine the effect of deploying temporary material handling pipelines on potentially significant submerged cultural resources, CPE contracted with Tidewater Atlantic Research, Inc. (TAR) of Washington, North Carolina to analyze the data from an archaeological and geotechnical remote-sensing survey of two proposed material handling pipeline corridors. Analysis of the magnetic and acoustic data from that survey identified a total of 318 magnetic targets in the West Pipeline Corridor and 110 magnetic targets in the East Pipeline Corridor. Five clusters of anomalies in the West Pipeline Corridor are recommended for avoidance and have protective buffers based on their remote-sensing signatures. The remaining anomalies in the West Pipeline Corridor appear to be associated with small single objects, moderate single objects, seawalls or pipelines. No additional investigation of these targets is recommended. Two clusters of anomalies in the East Pipeline Corridor are recommended for avoidance and have protective buffers based on their remote-sensing signatures. The remaining anomalies in the East Pipeline Corridor appear to be associated small single objects, moderate single objects and pipelines. No additional investigation of these targets is recommended. A total of five contacts were identified in the sonar data from the pipeline corridors. One of the sonar image from the East Pipeline Corridor survey images the remains of a vessel. Two sonar contacts are associated with buffered anomalies in the West Pipeline Corridor. Additional investigation of the buffered sites is recommended if avoidance is not possible. Analysis of the seismic data confirmed that no relict landforms with potential associations with prehistoric habitation are present in either pipeline corridor.

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Preface

The West Belle Pass material handling pipeline corridors submerged cultural resource remote-sensing survey was carried out by Coastal Planning & Engineering, Inc. (CPE) of Boca Raton, Florida and Tidewater Atlantic Research Inc. (TAR) of Washington, North Carolina. CPE is the consulting geotechnical engineering firm for the headland restoration project. In order to determine the project's effect on potentially significant submerged cultural resources, CPE contracted with TAR to analyze the data from an archaeological and geotechnical remote-sensing survey of two proposed material handling pipeline corridors. Data was collected under the supervision of CPE archaeologist Mr. Brian Thomas. Analysis of the data was carried out by Gordon P. Watts and Joshua Daniel. This report document was prepared by Dr. Watts, Mr. Daniel and Ms. Robin Arnold.

Introduction

The West Belle Pass Barrier Headland is located immediately west of Port Fourchon in the Bayou Lafourche Delta Complex. It is approximately two miles long and is bounded on the east by the Bayou Lafourche Waterway west jetty and on the west by Timbalier Bay. The headland provides storm protection for a large marsh complex in Lafourche Parish and the western flank of Port Fourchon. The barrier shoreline provides unique habitat for coastal fisheries and provides a barrier that protects inshore wetlands and coastal communities from tidal inundation, storm surge and wave action. The Terrebonne shoreline and associated wetlands represent some of the most rapidly eroding wetlands in the U.S. Since 1932, the Terrebonne Basin has lost more than 20% of its wetlands. Due to sea-level rise and coastal storms the West Belle Pass Barrier Headland has been severely degraded and is experiencing high shoreline retreat rates averaging approximately 55 feet per year. A large breach in the headland has developed along the western segment. The proposed project is designed to increase headland longevity, restore valuable habitat, and construct a beach and dune system that will improve protection for the bayside marsh and Port Fourchon.

The West Belle Pass Barrier Headland restoration project is jointly sponsored by the Louisiana Department of Natural Resources and the National Marine Fisheries Service. Funding for the restoration is provided through the Coastal Wetlands Planning, Protection and Restoration Act. Coastal Planning & Engineering, Inc. (CPE) is the consulting geotechnical engineering firm for the restoration project. In order to determine the effect of deploying temporary material handling pipelines on potentially significant submerged cultural resources, CPE contracted with Tidewater Atlantic Research, Inc. (TAR) of Washington, North Carolina to analyze the data generated by a submerged cultural resource and geotechnical survey of the corridors.

The survey was carried out on 6, 7, 9 and 10 May 2010. To reliably identify anomalies associated with submerged cultural resources, the survey was designed to include both magnetic and acoustic remote-sensing, employing a cesium vapor marine magnetometer, sidescan sonar, and sub-bottom profiler. Bathymetric data were generated using a survey grade precision depth recorder. Navigation and data collection were accomplished using differential global positioning and computer survey software. Survey line spacing was 30-meters.

Analysis of the magnetic and acoustic data from that survey identified a total of 318 magnetic targets in the West Pipeline Corridor and 110 magnetic targets in the East Pipeline Corridor. Five clusters of anomalies in the West Pipeline Corridor are recommended for avoidance and have protective buffers based on their remote-sensing signatures. The remaining anomalies in the West Pipeline Corridor appear to be associated with small single objects, moderate single objects, seawalls or pipelines. No additional investigation of these targets is recommended.

Two clusters of anomalies in the East Pipeline Corridor are recommended for avoidance and have protective buffers based on their remote-sensing signatures. The remaining anomalies in the East Pipeline Corridor appear to be associated small single objects, moderate single objects and pipelines.. No additional investigation of these targets is recommended. A total of five contacts were identified in the sonar data from the pipeline corridors. One of the sonar images from the East Pipeline Corridor survey is associated with the remains of a vessel. Additional investigation is recommended if avoidance is not possible. Two sonar contacts are associated with buffered anomalies in the West Pipeline Corridor. Analysis of the seismic data confirmed that no relict landforms with potential associations with prehistoric habitation are present in either pipeline corridor.

All portions of the remote-sensing survey were conducted in accordance with guidelines adopted by the Louisiana Division of Archaeology. All TAR personnel associated with the conduct of historical and literature research, data analysis and report preparation meet, or exceed, the minimum standards of the U.S. Department of Interior. Personnel included Bob Mayne, captain of the R/V *Aqua Quest*. CPE field personnel consisted of archaeologist Mr. Brian Thomas and geophysicist Mr. Chris Dougherty. Data analysis and illustrations were prepared by Dr. Gordon Watts and Mr. Joshua Daniel. Historical and cartographical research was carried out by Dr. Watts and historian Ms. Robin Arnold. Dr. Watts, Mr. Daniel and Ms. Arnold prepared this report.

Project Location and Survey Areas

Two material handling pipeline corridors for the West Belle Pass Barrier Headland restoration project have been identified off Timbalier Island in Lafourche Parish, Louisiana. The West Pipeline Corridor lies offshore and runs parallel to Timbalier Island before angling northeast into Timbalier Bay. The East Pipeline Corridor extends northeast into Timbalier Bay from the Gulf of Mexico and covers and area of 555.45 acres (Figure 1). Water depths in the West Pipeline Corridor ranged from 8 to 22 feet. Coordinates in Louisiana South State Plane, NAD 83, U.S. Survey Foot for points that define the perimeter of the West Pipeline Corridor survey area are:

Point	X	Y
A	3621366.6	214444.1
B	3621806.1	214556.5
C	3619188.7	210167.4
D	3619094.7	209930.3
E	3584807.5	199147.3
F	3584652.4	199757.2
G	3618724.2	210464.2
H	3618889.0	210427.0

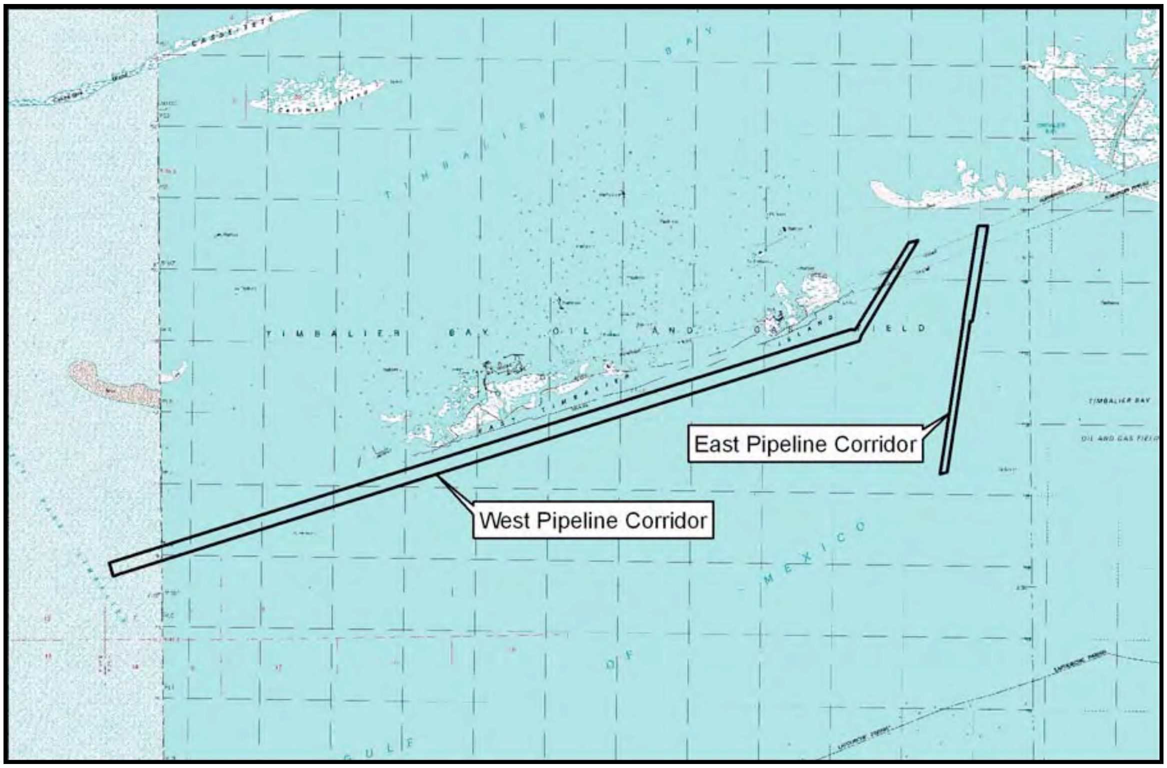

Figure 1. Project location map (USGS. "Calumet Island quadrangle, Louisiana" and "Timbalier Island quadrangle, Louisiana" 1:24,000.)

Water depths in the East Pipeline Corridor ranged from 8 to 31 feet. This survey area covers 96.61 acres. Coordinates in Louisiana South State Plane, NAD 83, U.S. Survey Foot for the East Pipeline Corridor survey area are:

Point	X	Y
I	3624551.1	215211.0
J	3624999.0	215221.0
K	3624285.7	210841.1
L	3624197.5	210837.2
M	3623135.9	203905.7
N	3622795.4	203827.2
O	3623886.9	210904.9
P	3623854.9	210917.9

Environmental Background

The West Belle Pass barrier restoration project lies in the Mississippi Deltaic Plain Physiographic Region. The survey areas are located in the shallow inshore waters where depths range from 11 to 24 feet below MLW water. In the survey area, the bottom surface slopes generally to the south and consists of unconsolidated sand formed by water column motion into waves and shoals.

Area Geological Setting

The geological environment in the project vicinity, northern Gulf of Mexico, is dominated by the sedimentary geology and geomorphology of the Mississippi River Delta Plain. Since the Late Jurassic, Mississippi River alluvium has been forming coastal Louisiana. A sedimentary pile over 15 km in thickness accumulated during the Mesozoic and Cenozoic (Coleman et al., 1991). Along the northern margin of the Gulf of Mexico Basin, Tertiary and Quaternary sedimentation prograded the shelf edge by 300 km. The rate of progradation was approximately 5 to 6 km per ka (thousand years).

Quaternary glacio-eustatic fluctuations were accompanied by marine regressions and transgressions. The last glacial advance (Last Glacial Maximum [LGM]) occurred during late Wisconsin time about 18,000 to 20,000 years ago. Sea level during the LGM was about 394 to 426 ft (120 to 130 m) lower than present sea level (Saucier 1994).

As the shoreline regressed seaward across the continental shelf, Pleistocene sediments were exposed to subaerial weathering and erosion. During Quaternary lowstands, rivers flowed seaward across the shelf to lowered base levels (as determined by a falling sea level). Shelf gradients induced intricate channel networks that cut into Pleistocene sediments (Figure 2). Late Pleistocene and Holocene marine transgressions, resulting from deglaciation (glacial retreat) caused a landward shift in deltaic sedimentation and shoreface erosion (Berryhill 1986). During sea-level rise, estuaries were infilled, subaerial landforms were submerged and eroded and exposed sediments were reworked (Saltus et al. 2003).

Although Quaternary marine transgressions and regressions impacted near-surface (shallow) geology in the project area, the primary influence on local sedimentation was avulsion and shifting of Mississippi River delta lobes. The West Belle Pass survey area lies within the Lafourche/Terrebonne Delta Complex, a constructional landform assemblage comprised by numerous lakes, channels and swamps. These features were formed by Mississippi River delta building, abandonment and associated land erosion and subsidence to form the present landscape.

In an active deltaic environment, net deposition (sedimentary accumulation) exceeds net subsidence (compaction and loss of volume). Thus, when sedimentary build-up exceeds the rate of subsidence, land is created. When sedimentary accumulation decreases, subsidence dominates and there is land loss (by drowning) over time. Faulting, sea-level rise, geosynclinal down-warping and displacement from fluid withdrawal are other factors that contribute to subsidence (Penland et al. 1989; Saucier 1994).

Seven different delta complexes were built and abandoned by the Mississippi River over the last 9,000 years. For the last 600 years, the Mississippi River has occupied the Balize (modern) Delta (Figure 3). In the study area, delta formation began approximately 1,500 BP as the Mississippi River began to shift its course westward, forming the Lafourche/Terrebonne Delta Complex. According to Saucier (1994), approximately 150 to

400 ft (46 to 122 m) of deltaic silts and clays accumulated in this area during the Holocene. These thick deltaic units form a wide delta front. These deltaic deposits contain very fine-grained sediments (i.e. silt and clay).

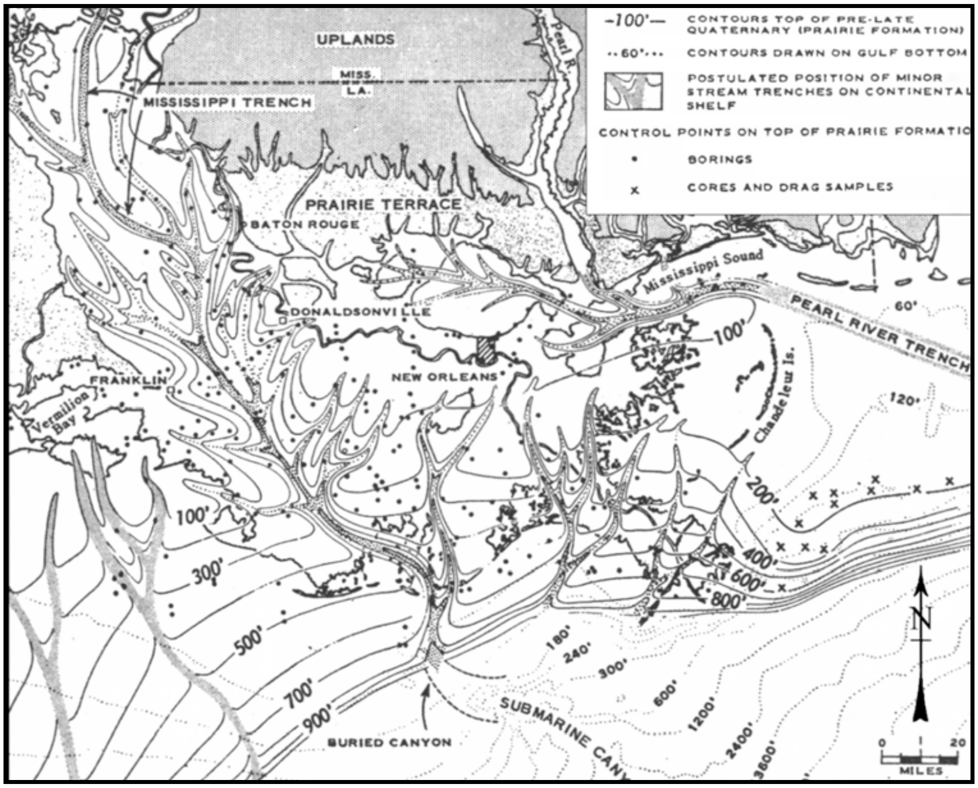

Figure 2. Pleistocene channels (adapted from Fisk and McFarlan 1955).

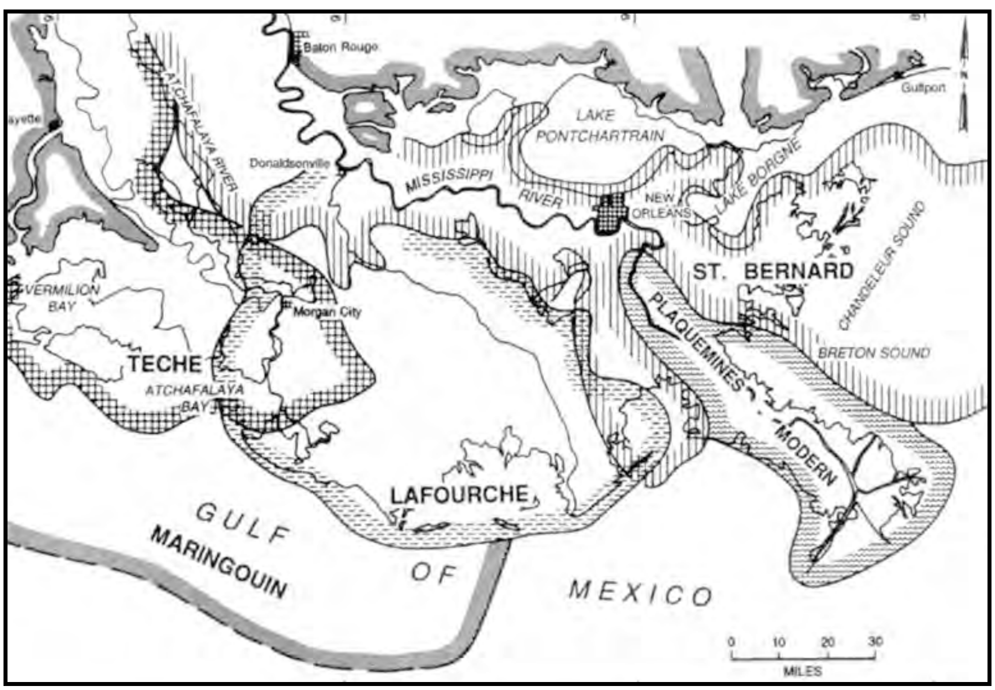

Figure 3. Map showing project area in relation to deltaic lobes (after Frazier 1967).

The Terrebonne Basin is an interdistributary wetland system located in the center of the abandoned Lafourche/Terrebonne delta complex. The basin, varying between 18 and 70 miles wide, contains over 1.71 million acres. To the north the basin is bounded by the Mississippi River, in the east by Bayou Lafourche and on the west by the Atchafalaya Basin. A series of barrier islands separate the basin from the Gulf of Mexico to the south. Reworked sands from distributary sediments, formed on the perimeter of delta lobes, are deposited on beaches (Figure 4). Isles Dernieres are barrier islands that formed during the retreat of the Lafourche/Terrebonne Delta Complex approximately 600 to 800 years ago (Birchett and Pearson 1998).

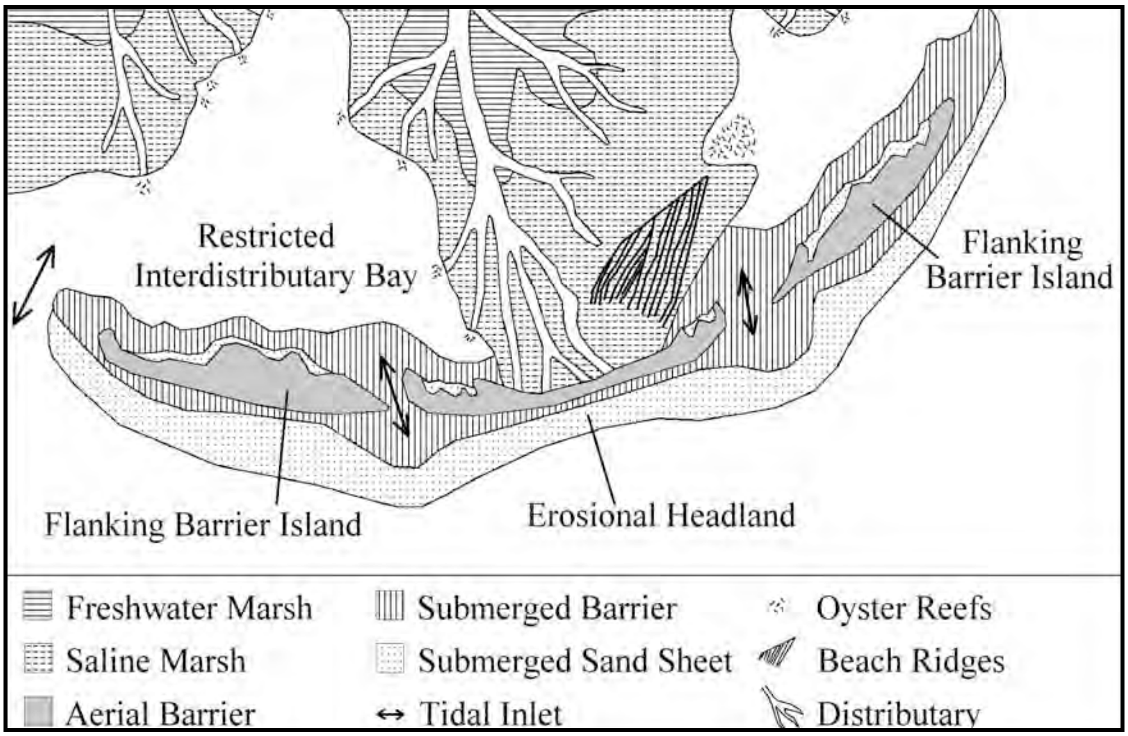

Figure 4. Barrier island formation at delta mouth (adapted from Penland et al. 1988).

The present delta, a system of distributaries that form a distinct pattern (in plan view), is referred to as a birds-foot delta. It includes subdelta formations that are created when trunk channels silt up and new channels follow hydrodynamic paths of least resistance. This type of delta growth depends on sediment supply being greater than dispersal by current and wave action (Krumbein and Sloss 1953). Delta growth may be slow or fast, depending on various factors. Lobeck (1939), for example, notes an average Mississippi River deltaic growth rate at seaward passes (in 1908) as 250 ft (76 m) per year. He also states that a levee break at Garden Island Bay (in 1912) advanced a crevasse splay by 2,000 ft (610 m) in only a few months.

In floods, coarser sediments drop out of suspension, as water velocity decreases, along trunk and distributary channels (Saucier 1994) to form natural levees. During delta construction, intervening areas between sublobes are enclosed by natural levees to form broad basins and lakes. Marshes form in these basins.

Natural levees provide elevated dry locations for human settlement. Many prehistoric and historic sites are located on active and relict natural levees in the coastal zone (Hunter et al. 1988). The natural levees created by the deltaic channels eventually subside over time. Sediment deposition from low velocity interdistributary streams and/or subsequent deltaic episodes buries these landforms and their identification becomes problematic. Archaeological testing and core-hole data have identified several buried natural levees, but most remain hidden beneath more recent sediments (Hunter et al. 1988).

Climate

The West Belle Pass project area lies in the Louisiana Gulf Coast subtropical zone. This Louisiana Gulf Coast area has been characterized by mild winters and hot humid summers with average temperatures ranging from 54 degrees in January/February to 81 degrees in July/August. Rainfall is heaviest during the storm season between April and September and annually averages 59 inches. The storm season is characterized by summer thunderstorms and hurricanes that sporadically pass through the area. Winds in southern Louisiana are predominately southeasterly but shift sporadically to the north for periods during the winter months (Matthews 1983).

Tides/Currents

The inshore waters of the Gulf Coast off Terrebonne are influenced by both local weather and the general patterns of the Gulf of Mexico. In the Open Gulf, the Loop Current flows into the Gulf of Mexico between the Yucatan Peninsula and Cuba. It flows north toward the Mississippi Delta before heading east-northeast toward the Cape San Blas region of Florida. The loop is completed when the current heads southeast before turning east and flowing through the straits between Cuba and the Florida Keys (Garrison et al. 1989).

Littoral currents in the project area are influenced by shoreline trends, regional winds and to a degree, eddies associated with the Loop Current. During the year from September to May counter clockwise circulation dominates the pattern on the Gulf Coast Continental Shelf. That flow is driven by prevailing easterly winds. During the summer months from June through August, winds prevail from the southwest resulting in a reverse of the inshore currents along the Gulf Coast (Blumberg and Mellor 1981; Andrews 1978). With the exception of periods of extreme weather currents along the Gulf of Mexico continental shelf are generally about one half knot (Garrison et al. 1989).

As the borrow area is located in the vicinity of a pass, tides also influence the water column environment. Normally, the lunar tidal range is approximately 2 feet in the Terrebonne region. However, winds frequently have a greater impact on the tide than the moon. Strong winds out of the south can significantly increase both tide heights and currents. Winds from the north can also impact tide elevations, reducing the amount of water flowing into the shallow bays behind the barrier islands. Wave patterns and heights are also a factor of weather. While wave heights of one meter or less represent the norm, storms can generate swells in excess of three meters (McGrail and Carnes 1983). Due to the combined impact of the lunar influence and weather, currents in the area are strong enough to create shoals in the vicinity of the passes (Matthews 1983).

Cultural Background

Terrebonne Region Prehistoric Overview

The prehistory of Louisiana is divided into five stages based on archaeologically recognized cultural aspects. These five stages, Paleo-Indian (ca. 12,000 to 8,000 B.P.), Archaic (ca. 8,000 to 3,500 B.P.), Gulf Formational (ca. 4,500 to 2,000 B.P.), Woodland (ca. 2,000 to 800 B.P.) and Mississippian (ca. 800 to 300 B.P.), conform to general developmental trends that have been documented archaeologically across the southeastern United States. Each of these stages is further sub-divided by distinct subsistence and settlement patterns and/or artifact assemblages prevalent during certain time periods and usually representing regional preferences.

Few archaeological sites have been located that pre-date the Tchula period of the late Gulf Formational stage in the coastal zone south of New Orleans. Those sites are on salt dome structures and remnant natural levees of the Teche complex. The natural levees associated with the eastern portion of this complex possibly were habitable between about 4,500 and 3,500 B.P. (Saucier 1994). Kniffen (1936) outlined four types of sites that were found in the coastal zone of southeast Louisiana: earthen mounds, shell mounds, shell middens and wave-washed shoreline deposits. Beavers (1977) and Gagliano (Gagliano et al. 1979) noted that most sites are located at the junction of two bodies of water; be they bayou and bayou, bayou and bay or bayou and lake.

In the southern portion of the Terrebonne Basin these older natural levees either are lacking or are deeply buried. Using core and seismic data Penland and Suter in 1983 identified a possible Teche delta complex revinement surface approximately 30 – 32 feet below sea level beneath Isle Dernieres (Pearson 2001:7). The oldest landforms in or near the current study area consist of barrier islands, which are estimated to be approximately 600 - 800 years old (Pearson 2001:10).

For the purpose of this report the discussion of prehistoric sequences will start with the Tchula period in Louisiana, which is the earliest culture likely to be encountered in the current project area. Earlier occupations of the area unquestionably occurred, but any sites would be so deeply buried by Holocene deposits that the chances of encountering them during dredging would be remote.

Late Gulf Formational Stage (ca. 3,000 to 2,000 B.P.)

The Late Gulf Formational stage (ca. 3,000 to 2,000 B.P.) contrasts significantly with the preceding Poverty Point period of the Archaic stage. During this period, small, low earthen mounds were favored over the monumental earthworks of the past. The extensive trade networks developed during the Poverty Point period declined and local resources were emphasized. Gibson (1974) originally proposed that the decline of the Poverty Point culture was caused by a breakdown in the hierarchy. His reasoning stemmed from observations that exotic goods increased at the Poverty Point Site (16WC5), while decreasing at regional centers and their peripheral hamlets. This was viewed as the result of the elite taking more and giving less. At approximately the same time that the Poverty Point Site was abandoned, the Tchefuncte culture arose in the Lower Mississippi Valley and along the coast.

Tchula Period (ca. 2,500 to 2,000 B.P.)

Ford and Quimby (1945) defined the Tchefuncte culture from investigations at the Tchefuncte Site (16ST1) on the north shore of Lake Pontchartrain. The cultural period is referred to as the Tchula period (ca. 2,500 to 2,000 B.P.), named for a town near the Jaketown Site (22HU505), where a substantial number of Tchefuncte ceramics were recovered (Ford et al. 1955). Subsequent excavations at Bayou Jasmine (16SJB2), Beau Mire (16AN17), Morton Shell Mound (16IB3), Big Oak Island (16OR6), Little Oak Island (16OR7) and other sites contributed in establishing attributes of the culture and defining regional phases (Byrd 1994; Neuman 1984; Shenkel 1974, 1982; Weinstein and Rivet 1978). The artifact assemblage of the Tchefuncte culture was very similar to that of the preceding period. First, baked clay Poverty Point objects, while still manufactured, were less abundant and restricted to a few forms during the Tchula period (Ford and Quimby 1945). Next, while exotic lithic materials are not as common on Tchefuncte sites, worked shell and bone artifacts appear in relatively high frequencies (Ford and Quimby 1945; Kidder and Barondess 1982; Shenkel 1974). Last, the Tchefuncte people are identified as the first culture in Louisiana to manufacture ceramic in quantities indicative of everyday usage (Ford and Quimby 1945; Neuman 1984).

Throughout the southeast fiber-tempered ceramics were being replaced by sand, grit and clay-tempered ceramics (Walthall 1980). Weinstein (1995) states that the present evidence suggests that the untempered Tchefuncte ceramic tradition and its northern equivalent, Tchula ceramics, developed out of the Wheeler fiber-tempered ceramic tradition. This reasoning stems from the fact that early Tchefuncte ceramics at Beau Rivage (16LY5) and early Tchula ceramics in the Yazoo Basin contain decorations identical to those found on Wheeler ceramics in the same deposits.

Subsistence during the Tchula period combined the utilization of shellfish, fish, turtle, alligator, large and small mammals and native cultigens (Byrd 1994; Shenkel 1982). One of the more notable features of the Tchula period along the coast is their large *Rangia* shell middens. Most of these middens are several meters thick, attesting to their heavy consumption of shellfish. At the Morton Shell Mound (16IB3) in southern Louisiana, Byrd (1994) found evidence of squash and gourd suggesting that small-scale agriculture also was practiced during this period.

As originally defined by Ford and Quimby (1945), Tchula period sites contain Tchefuncte Incised, Tchefuncte Stamped, Tammany Punctated, Lake Borgne Incised and Orleans Punctated ceramics, along with Pontchartrain and Macon projectile points. Socketed bone points also were produced and are more common at coastal sites than at inland sites. Tchefuncte Stamped and Tchefuncte Incised ceramic types occur in higher frequencies than the other decorated ceramic types. In the Pontchartrain Basin, Tchefuncte sites generally are restricted to the shores of Lakes Pontchartrain, Borgne and Maurepas, and the lower portions of the bayous and rivers that drain into these lakes (Ford and Quimby 1945; Smith et al. 1983). Along natural levees and adjacent terraces of the Mississippi River and its tributaries from approximately Baton Rouge to the head of Bayou Lafourche late Tchula sites exhibit thinner ceramics. In this region Tammany Punctated sherds occur more frequently than the other types, while Tchefuncte Stamped sherds are a minority (Weinstein and Rivet 1978).

Hays and Weinstein (1999), after a reexamination of ceramic sherds recovered from the Bayou Jasmine site (16SJB2), have designated a new ceramic type for the Tchula period. Chene Blanc Plain is described as "relatively thick, well-made sherds with nonlaminated [*sic*] pastes that contain specks of hematite, bone, possibly shell and sometimes grog" (Hays and Weinstein 1999). Chene Blanc Plain, *var. Chene Blanc* was identified in the upper portion of the Bayou Jasmine midden, thus a late Tchula type. Chene Blanc Plain, *var. Fountain* was found to occur in the very top portion of the midden, indicating a very late Tchula or very early Marksville association.

Carbon samples from the Bayou Jasmine site (16SJB2) recently submitted by Hays (1995) yielded uncalibrated dates from ca. 140 B.C. (2,140 B.P.) to ca. 980 B.C. (2,980 B.P.). Most of these uncalibrated radiocarbon dates ranged between ca. 630 B.C. (2,630 B.P.) and ca. 880 B.C. (2,880 B.P.). If these dates are upheld, the currently recognized temporal span of the Tchefuncte culture will need readjusting. These radiocarbon dates also could substantiate Gibson's (1974) original theory that the Tchefuncte people actually were the Poverty Point people that had migrated into the Mississippi River floodplain during the waning decades prior to the abandonment of the Poverty Point site ca. 700 B.C. (2,700 B.P.). In fact, Hays and Weinstein (1999) agree that the Tchefuncte culture has ties to the Poverty Point culture, but the relationship is not wholly understood. Gibson (1995) notes that the occurrence of Tchefuncte-like ceramics in Poverty Point cultural contexts at the type site (16WC5) could mark the appearance of ceramics in the Lower Mississippi Valley, but widespread manufacture of ceramic vessels did not occur until the Tchula period.

An unnamed phase of the late Tchula period occurs in Assumption and Terrebonne Parishes (Weinstein 1995). Coastal Environments (CI) identified two sites (16TR211 and 16TR212) of this phase located on subsided natural levees that were assumed to have been dated post-Tchula in age (Weinstein and Kelley 1992). Ceramics recovered from these sites included Lake Borgne Incised, *vars. Cross Bayou* and *Lake Borgne*, Orleans Punctated, *var. Boothe*, Tammany Punctated, *vars. Brittany* and *Tammany*, Tchefuncte Incised, *var. Bayou Braud* and Tchefuncte Plain, *var. Tchefuncte*.

North of the current study area Tchula period shell midden sites (16JE91 and 16JE93) have been recorded along Bayou Dupont (Gagliano et al. 1979). These sites yielded Orleans Punctated, *var. Boothe* and Tchefuncte Plain, *var. Tchefuncte* ceramic sherds. Like the sites in lower Assumption and Terrebonne Parishes, no phase has been assigned to Tchula sites in this area.

Woodland Stage (ca. 2,000 - 800 B.P.)

Typically, the Woodland stage (ca. 2,500 to 800 B.P.) in the Southeast is seen as a time when ceramics composed a significant portion of the artifact assemblage, native inhabitants practiced ceremonial burials and plant husbandry or agriculture was practiced to some degree (Walthall 1980). While several criteria have been used to define the Woodland stage in the Southeast, it is generally considered that those three traits together define the period.

The Early Woodland period does not occur in southern Louisiana, as it does in other parts of the Southeast. The transitional Tchefuncte culture (ca. 2,500 to 2,000 B.P.) flourished instead (Green 1999). The Tchefuncte were the first peoples in Louisiana to produce pottery in quantity, however monumental earthen mound construction, ritual interments and agriculture were not common (Ford and Quimby 1945; Neuman 1984).

Marksville Period (ca. 2,000 to 1,600 B.P.)

The first true Woodland culture in Louisiana was the Marksville culture (ca. 2,000 to 1,600 B.P.). The Marksville culture, named for the Marksville site (16AV1) in Avoyelles Parish, originally was described as the southern expression of the Hopewell culture, which was located primarily in Illinois and Ohio (Ford 1936; Toth 1988). Toth (1988) argues that the origins of the Marksville culture appeared during the Tchula period. This argument primarily stems from the presence of rocker-stamping, and other ceramic traits that occur on late Tchefuncte ceramics and are present on early Marksville period ceramic wares. Accordingly, the transformation of the Tchefuncte culture into the Marksville culture was initiated by the Hopewellian intrusion into the Lower Mississippi Valley (Toth 1988). While there has been little doubt as to the similarity of Marksville decorative motifs and vessel forms to those of the Hopewell, influences in ceramic decorations also can be correlated with coeval cultures to the east (Neuman 1984; Walthall 1980). Walthall (1980) notes that these ceramic traditions, Swift Creek, Porter and Santa Rosa cultures in southern Alabama and Georgia, and northwest Florida, were also the result of Hopewell interaction. The most compelling evidence of the ties that these cultures had to the Hopewell culture manifest itself in exotic trade goods and ceremonial objects. Copper and mica artifacts identical to those recovered from Hopewell sites have been found at the numerous sites of the same time period with similar ceramic decorations and forms (Neuman 1984). Zoomorphic pipes, typically associated with the Hopewell, also appeared at sites in the Southeast during this same period (Walthall 1980).

The Marksville culture is seen as having a highly organized social structure demonstrated by the presence of burial mounds for the elite containing special items apparently manufactured expressly for internment with the burials. Several Marksville sites also exhibit log tomb burial chambers similar in construction to those found on Hopewell sites (Toth 1988).

Subsistence during the Marksville period was similar to prior periods. In southeast Louisiana, Marksville sites generally were located on natural levees and terraces along the lakes, rivers and bayous. Gagliano (1964) suggests that the Marksville practiced a cyclical seasonal pattern. During the summer, sites on or adjacent to lakes and streams were occupied to take advantage of shellfish, turtles, alligators, fish and mammals. Permanent or semi-permanent camps were occupied in the uplands and on the Prairie terrace during the fall and winter in order to exploit available nuts and acorns, as well as local fauna.

No phases have been designated for the Marksville period in the present study area. Ceramics recovered from Bayou Cutler and other sites in the area indicate that both the early and late Marksville period are represented. Early Marksville ceramics found on these sites consist of Baytown Plain, *var. Marksville*, Churupa Punctated, *vars. Boyd*, *Hill Bayou* and *unspecified*, Indian Bay Stamped, *var. Cypress Bayou*, Mabin Stamped, *vars. Mabin*, *Point Lake* and *unspecified*, Marksville Incised, *var. Sunflower*, Marksville Stamped, *vars. Marksville* and *Old River* and crosshatched rims (Gagliano et al. 1979). Late Marksville ceramics include Baytown Plain, *var. Satartia* and Marksville Incised, *var. Yokena* (Gagliano et al. 1979).

Coles Creek Period (1,200 to 800 B.P.)

By circa 1,300 B.P., the cultural traits that define the Coles Creek culture had taken shape. Coles Creek sites appear to be larger, more numerous and more complex than earlier sites. The emergence of a chiefdom-like society could be implied from the complexity of the Coles Creek mound system. A sizable labor force must have been necessary to build, maintain and utilize these mounds and it could be assumed that a central authority figure controlled the labor force (Muller 1983). Evidence for the elite residential or mortuary structures often said to be associated with Coles Creek mounds remains elusive prior to ca. 1,000 B.P. (Fritz and Kidder 1993; Smith 1975; Steponaitis 1983). Nevertheless, both the form of the platform mounds and their arrangement around plazas are possibly indicative of Meso-American influence (Willey 1958; Williams and Brain 1983). The general population occupied the region surrounding the large ceremonial centers (Neuman 1984).

The Coles Creek ceramic complex consisted primarily of simple rectilinear designs usually present on the upper half of the vessel. French Fork Incised, a ceramic type originating during the Troyville period, was an exception (Phillips 1970; Springer 1977). Interestingly, Coles Creek designs suggest that the culture had contact with the Weeden Island culture along the Northwest Florida Gulf Coast (Willey 1949). French Fork Incised motifs are identical to those found on Weeden Island Incised vessels. Other parallels can include Evansville Punctated and Carabelle Punctated; Hollyknowe Ridged Pinched and Tucker Ridged Pinched; Mazique Incised and Carabelle Incised and Pontchartrain Check Stamped and Wakulla Check Stamped. These ceramic decorative parallels were not temporal, suggesting the infusion of these decorative motifs into the Coles Creek culture as their popularity was waning with the Weeden Island culture. Another less common decoration along the coast during the Coles Creek period, with parallels in the Swift Creek and Weeden Island cultures of Florida, was complicated stamping (Brown 1980, 1982, 1984; Neuman 1981). Brown (1984) assigned the sherds recovered from the Morgan site (16VM9) to the Gainesville Complicated Stamped ceramic type, typically found in the Gainesville Lake area of Mississippi and Alabama (Jenkins 1981). Saunders and Stoltman (1999) decided that a new ceramic type, Cameron Complicated Stamped, was warranted after petrographic studies of the ceramic pastes indicated that they were of local manufacture during the Coles Creek period. Cameron Complicated Stamped has been recovered from the Bayou Cutler I site (16JE3) north of the current study area.

Only limited archaeological evidence has been found to support the theory of subsistence based on maize agriculture during the Coles Creek period (Kidder 1992a). Archaeological efforts have resulted in the recovery of only the smallest amounts of maize from Coles Creek midden deposits. Tooth enamel decay indicative of the consumption of maize was thought to be attributed to the consumption of starchy foods other than maize (Kidder 1992b; Steponaitis 1986). Evidence now available suggests that the growth and consumption of maize was not widespread in the Lower Mississippi Valley until after the Coles Creek period, ca. 800 B.P. (Fritz and Kidder 1993; Kidder 1992b). A better example of subsistence in the Lower Mississippi Valley during this time period can be demonstrated by the faunal remains recovered from the St. Gabriel Site (16IV128), a late Coles Creek/early Plaquemine site in Iberville Parish. These remains included both large and small game such as bear, deer, opossum, rabbit, squirrel, raccoon and alligator. Evidence of several native species of waterfowl, fish and turtle were also recovered. Botanical remains recovered included maize, honey locust, persimmon and grape (Woodiel 1993). Ramenofsky (1989) found evidence of intensive usage of acorns during the Coles Creek period and also notes that the use of acorns increased over time.

A large majority of inland Coles Creek sites have been found to occur along stream systems and particularly on the natural levees of old cutoffs and inactive channels. Soils in these locations would provide nutrients for agriculture (Neuman 1984). Small Coles Creek sites consisted mostly of hamlets with no mounds, while the larger Coles Creek sites contain one or more mounds. Coles Creek mounds typically are larger, and exhibit more building phases than the earlier Marksville burial mounds. Plazas are associated with multiple mound sites (Gibson 1985). Shell middens are the most common forms of Coles Creek period sites in the coastal zone. These middens are commonly on higher portions of natural levees (Springer 1974) along bayous and streams, and along lake shorelines.

The Coles Creek period in southeast Louisiana is divided into three phases: Bayou Cutler, Bayou Ramos and St. Gabriel. Kniffen (1936) designated the Bayou Cutler phase (ca. 1,300 to 1,150 B.P.) of the early Coles Creek period based on his examination of materials from the Bayou Cutler I site (16JE3) in Jefferson Parish. Phillips (1970), relying on information supplied by McIntire (1958), interpreted the ceramics described by Kniffen as endemic of this phase to include Coles Creek Incised, *vars. Coles Creek* and *Chase*, Beldeau Incised, Chevalier Stamped, Pontchartrain Check Stamped, *var. Ponchartrain*, Evansville Punctated, *var. Rhinehart*, Mazique Incised, *var. Mazique* and several varieties of French Fork Incised.

The Bayou Ramos phase (ca. 1,150 to 1,000 B.P.) was described by Weinstein from information obtained during excavations at the Bayou Ramos I site (16SMY133) in St. Mary Parish. The ceramic assemblage of the Bayou Ramos phase consists of Avoyelles Punctated, *var. Avoyelles*, Beldeau Incised, *var. Beldeau*, Coles Creek Incised, *var. Mott*, Mazique Incised, *var. Mazique* and Pontchartrain Check Stamped, *var. Tiger Island* (Weinstein et al. 1978). Bayou Ramos phase sites primarily occur west of the Terrebonne Basin.

St. Gabriel (ca. 1,000 to 800 B.P.) was established by Brown (1985) based on Woodiel's (1980, 1993) excavation of the St. Gabriel site (16IV128) in Iberville Parish. Woodiel concluded that the St. Gabriel site (16IV128) contained a very late Coles Creek occupation just prior to changes that would define the Plaquemine period. Ceramics typical of the St. Gabriel phase include Addis Plain, *var. Addis*, Coles Creek Incised, *var. Hardy*, Evansville Punctated, *var. Wilkinson*, Harrison Bayou Incised, *var. Harrison Bayou*, Mazique Incised, *var. Manchac* and small amounts of Plaquemine Brushed, *var. Plaquemine* (Brown 1985; Weinstein 1987; Woodiel 1980, 1993).

Archaeological findings suggest that by the end of the Coles Creek period the population had increased and became more socially and politically complex. Large-scale mound construction occurs. The implication of the reemergence of a chiefdom-like society is evidenced by the return of long-distance trade of a scale not seen since the Poverty Point period (Muller 1983). The introduction of sociopolitical and material concepts into the Lower Mississippi Valley from the established Mississippian traits associated with Cahokia in southeastern Missouri (Kelly 1990) possibly initiated the transformation of Coles Creek cultural traits into what is now recognized as the Plaquemine culture about 800 B.P.

Mississippian Stage

During the late prehistoric period, Mississippian influence radiated from the middle Mississippi River Valley across the Southeast (Haag 1971). Mississippian sites in Louisiana typically are located along the Mississippi River and the southeastern coast (Neuman 1984). Mississippian culture continued to influence the lifeways of indigenous southern Louisiana populations until contact with European cultures.

The consistent variation of Mississippian sites suggests that the Mississippian culture was a complex, non-egalitarian, stratified society. Larger sites contain flat-topped, truncated pyramidal mounds facing onto a central plaza which probably served, at least in part, as platforms for the residences of high-status families. Low-status families occupied single room, rectangular wattle-and-daub buildings (Walthall 1980).

The cultivation of maize, beans, squash and pumpkins; gathering of local plants, nuts and seeds; and fishing and hunting of local faunal species served as the basis of Mississippian subsistence. Terrestrial faunal remains from Mississippian sites indicate that approximately 70 percent of the animals consumed were deer, raccoon, squirrel or turkey. These animals utilized both maize and mast for their own dietary needs and were the hunted game (Neumann 1989). Increased consumption of opossum is evident (Neumann 1984). A byproduct of the swidden horticulture practiced during this time was the growth of persimmon groves on the abandoned fields; persimmons were exploited heavily by both human and animal populations.

The inclusion of shell tempering in the Mississippian pottery enabled potters to create larger vessels. Typical Mississippian ceramic vessels include globular jars, plates and bottles, and loop- and strap-handled pots. These vessels were decorated by engraving, negative painting and incising. Modeled animal heads and anthropomorphic images were also used to decorate ceramics. Chipped and ground stone tools; shell items such as hairpins, beads and gorgets and mica and copper artifacts are a few of the items recovered from Mississippian sites (Neuman 1984; Steponaitis 1983; Walthall 1980).

Plaquemine Culture (ca. 800 - 300 B.P.)

Previously thought to be a transitional phase from the Coles Creek culture to a pure Mississippian culture (Neuman 1984) recent investigations categorize the Plaquemine culture (ca. 800 to 300 B.P.) as Mississippian (Kidder 1988, 1990). The intensification of agriculture, sociopolitical structure and religious ceremonialism suggests the development of a complex social hierarchy.

Plaquemine subsistence was probably based mainly on agriculture and supplemented by native plants and animals. Kidder (1992a) notes that the Emerson Site (16TE104), a late Plaquemine site in the Tensas Basin yielded a large volume of maize, but the quantity of acorn remains from the site indicate that this resource was intensely utilized. In the coastal zone, Williams (1999) identified substantial amounts of *zea maize* associated with late Plaquemine cultural deposits at the Discovery Site (16LF66).

Settlement patterns, economic organization and religious practices of the Plaquemine peoples continued in the tradition of the earlier Coles Creek period. Sites are typically characterized as ceremonial sites with multiple mounds surrounding a central plaza, with dispersed villages and small hamlets (Neuman 1984; Smith et al. 1983). According to Gregory (1969), Plaquemine sites are generally found in lowland areas, including swamps and marshes. Numerous *Rangia cuneata* shell midden sites in the coastal zone contain Plaquemine components, not unlike the preceding Coles Creek period. Identified Plaquemine sites in the region include 16JE2, 16JE45, 16LF29, 16LF31 and 16LF37 (Neuman 1977).

Plaquemine ceramic decorations demonstrate their Coles Creek tradition, while late Plaquemine ceramics reflect an interaction with cultures to the north and east (Kidder 1999; Phillips 1970). Typical early Plaquemine ceramic types included Leland Incised, Coles Creek Incised, *var. Hardy*, L'Eau Noire Incised, Anna Incised and Plaquemine Brushed (Quimby 1951). The inland Plaquemine culture apparently had evolved into a true Mississippian culture by ca. 550 B.P. (Kidder 1988). In the coastal zone of Louisiana, the Plaquemine culture adopted fewer Mississippian cultural traits. Kidder (1990, 1999) notes that Mississippian ceramics represent a minority of the ceramics found on Plaquemine sites in this region dating to the same time period. The Plaquemine culture also did not adopt shell tempering to the same degree as other indigenous cultures in the Southeast. Instead, the Plaquemine people continued utilizing grog as a tempering agent.

Two phases have been established for the Plaquemine culture along the coastal region of Louisiana. The early Plaquemine culture is represented by the Barataria phase. The Barataria phase (ca. 800 to 500 B.P.) was created based on excavations at the Fleming site (16JE36) in Jefferson Parish (Holley and DeMarcay 1977). Ceramics defining the Barataria phase include Anna Incised, *vars. Anna* and *Evangeline*, Carter Engraved, L'Eau Noire Incised, *vars. L'Eau Noire* and *Bayou Bourbe*, Mazique Incised, *var. Manchac*, Maddox Engraved and minor amounts of Plaquemine Brushed (Weinstein 1987). Ceramic decorations also include Southern Cult motifs, particularly on L'Eau Noire Incised vessels. The Delta-Natchezan phase (ca. 500 to 300 B.P.) represents the late Plaquemine culture in the region (Phillips 1970). Ceramics during this phase include early Plaquemine types, along with Addis Plain, *vars. Addis* and *Greenville*, Fatherland Incised, *vars. Bayou Goula* and *Fatherland*, Maddox Engraved, *var. Emerald*, Mazique Incised, *var. Manchac* and Plaquemine Brushed (Brain 1988; Phillips 1970; Weinstein 1987). The latter two types generally occur in minor frequencies. Another trait of the late Plaquemine culture is the occasional presence of Moundville Incised and Pensacola Incised, indicating some form of contact with Mississippian societies to the east (Kidder 1999).

Historic Contact

The great social disruption suffered by aboriginal groups after the De Soto expedition between 1539 to 1543 has caused difficulty in understanding historic Indian cultures of the southeastern United States. Severe population depletions, a result of epidemics caused from a lack of immunity to normal European illnesses (Ramenofsky 1982; Smith 1986) created extreme circumstances that necessitated major social reorganization. The breakdown of the complex Mississippian societies during the terminal prehistoric period, the social and demographic reorganizations during the Protohistoric period (ca. A.D. 1539 to 1673), and even the better documented, but little studied, colonial period yield little information concerning the cultural continuity of most historic aboriginal groups in the region (Peebles and Kus 1977; Peebles and Mann 1981; Welch 1991). This lack of information has lead to difficulty delineating the ancestral archaeological cultures from which the historic groups were derived. Historic Native Americans continued with many practices of the Late Mississippian and Plaquemine peoples. Maize, beans, squash and pumpkin were the principle agricultural crops. The gathering of wild plants along with hunting and fishing remained important components of the aboriginal subsistence system.

Villages remained similar to those observed at Plaquemine and Mississippian sites. The larger villages featured one or more truncated pyramidal mounds surmounted by elite houses and temples; the remaining villagers lived in the area surrounding the mounds and in satellite hamlets. Houses apparently were rectangular in shape and were constructed of poles placed in the ground with wattle and daub walls and thatched roofs (Swanton 1946).

Initial European contact with the Houma tribe occurred at the tribe's primary village near the confluence of the Mississippi and Red Rivers, at the present site of Angola, when La Salle visited there in 1682. The Houma houses were rectangular, and were arranged in a large circle surrounding a central plaza. By the early eighteenth century, the tribe had been driven from the region by the Tunica. They settled briefly along Bayou St. Jean (Bayou St. John), near New Orleans, and eventually moved to the Great Houmas Village (16AN35) and Little Houmas, both located near the Mississippi River approximately 8 km (5 mi.) down river from Donaldsonville. These lands were sold in 1776. The tribal remnants moved into the coastal swamps and marshes near present-day Houma (Kniffen et al. 1987).

Numerous tribes resident in southeastern Louisiana at various times likely utilized the hunting and fishing resources of Terrebonne Bay and its margins. In the period of initial contact between the French and the Native Americans, Terrebonne was near the border of the areas occupied by Muskogean-speaking Indians to the east and Chitimachan-speaking Indians to the west. In 1682, the Quinipisa-Mugulasha were resident on the west bank of Jefferson Parish, but by the turn of the eighteenth century, they had moved further up the Mississippi River. In 1700, the Chawasha (or Chaouacha) were centered on Bayou Lafourche in the vicinity of modern Lockport and the Washa (or Ouacha) were resident above modern Thibodaux. Both tribes moved closer to New Orleans in the early eighteenth century.

The late-seventeenth-century Chitimacha tribe apparently controlled much of the coastal parishes along both Bayou Lafourche and the Mississippi River. Their population was decimated during the eighteenth century by disease, war and cultural pressures applied by the French settlers. In response to increasing pressure from the European settlers, the tribe moved into the largely unpopulated areas of southeastern Louisiana, enabling it to survive as an entity into the twentieth century (Kniffen et al. 1987; Swanton 1946). Prehistoric Plaquemine period pottery designs identified at the Discovery Site (16LF66) in Lafourche Parish share several similarities with traditional designs used by the Chitimacha tribe. This suggests that the Chitimacha possibly are the descendants of the coastal Plaquemine people (Miller et al. 1999).

Several other tribes, including the Bayou goula, the Quinapisa, the Acolapissa, the Mugulasha, the Okelousa and the Tangipahoa, frequented the lower Mississippi River during the early eighteenth century. As French and Spanish settlement expanded during the eighteenth century, these tribes died out, moved westward or were assimilated into remnant tribes scattered throughout the unpopulated portions of southern Louisiana (Kniffen et al. 1987).

Potential for Prehistoric Resources

Wisconsin Period glacial advances produced world wide lower sea levels. From 60,000 to 50,000 and 24,000 to 20,000 years ago the bottomlands of the Gulf of Mexico were exposed almost to the edge of the Continental Shelf. During this period sea level was some

90 to 300 feet lower than present. The development of vegetation and adaptation of natural resources would have made the exposed continental shelf attractive to human populations (Fisk and McFarlan 1955).

The Gulf Continental Shelf region was drier than today and was characterized open pine forests with stands of oak and hickory (Borremans 1990). Areas where rivers, streams or springs provided additional moisture supported forests of oak and pine. These wetter environments also sustained a host of animal life and would have attracted Paleo-Indian groups arriving from the north. By 10,000 BP, the Continental Shelf environment began to change. Additional rainfall allowed forests to expand farther south. These environmental changes coincide with the introduction of Archaic cultures. Sea level was still low during this period; the present coastlines were not established until around 2,000 and 4,000 BP. As a consequence, many Early Archaic sites lie inundated like their Paleo predecessors.

The fluctuation of sea level during and following the Wisconsin Glaciation is an important factor for reconstructing paleoenvironment and determining the potential for Native American sites on drowned continental shelf surfaces. Sea level fluctuation and its role in archaeological interpretation was postulated by Goggin in 1948 (Murphy 1990). The bands of Paleo-Indian groups that moved onto the exposed Continental Shelf as early as 12,000 BP occupied areas adjacent to streams and rivers (Fisk and McFarlan 1955). Confluences of streams and rivers, river levees and river and coastal terraces have proven to be high probability areas for terrestrial Paleo-Indian sites (Coastal Environments [CE] 1986). On the Continental Shelf, those inundated geomorphological features are considered prime indicators for submerged prehistoric archaeological sites. In 1966, Emery and Edwards established a relative sea level curve and noted its implications for archaeological sites: Paleoindian and Archaic sites were most likely submerged offshore and sites of particular periods could be located at specific depths (Murphy 1990). Those authors also speculated “that little might remain offshore beyond some tools, because of the advancing seas and the scattering of materials produced by the passage of the surf zone over the sites” (Murphy 1990:17-18). Others postulate that deltaic and esturine sediment deposition associated with rising sea level possibly protected sites from erosion associated with the Holocene trangression (Belknap 1983).

The survival of prehistoric cultural material associated with human occupation of the Gulf Continental Shelf has been documented from Florida to Texas (Aten and Good 1985; Johnson and Stright 1992; Stright 1990). Research along the west coast of Florida suggests that the rise of sea level in low energy environments served to preserve sites during the inundation process. CE documented submerged prehistoric material in association with relict features of the Sabine River. Those remains included subaerial shell middens and associated pollen deposits that reflect features associated with terrestrial archaeological sites. The relict Sabine River deposits were identified approximately 55 to 60 feet below present sea level and 15 to 20 feet below the bottom surface. Material recovered from the deposit was dated approximately 8,100 years B.P. using radiocarbon analysis (CE 1986). Lithic material suggestive of tools or the tool making process and dating to the period from 13,000 to 10,000 years B.P. was recovered from dredge spoil from Galveston Bay (Aten 1983). The coastal marshes of Avery Island, Louisiana contain well-preserved Paleo-

Indian sites (Gagliano 1967). Investigation of those sites produced both artifacts and associated faunal remains that date from 12,000 to 10,950 years B.P. (Coastal Environments [CE] 1977).

Because the confluences of streams and rivers, river levees and river and coastal terraces have proven to be high probability areas for terrestrial Paleo-Indian sites, relict channels and other submerged geological features have been identified as potential markers for submerged cultural resources. While those features suggest a high potential association with prehistoric human activity, the inundation process associated with marine transgression could have destroyed much of the archaeological record (Murphy 1990). However, there is nothing in the sub-bottom records to suggest that the landforms that might have attracted early man to this area of the Continental Shelf survive in the upper sediments of the Terrebonne survey area.

Terrebonne Region Historic Overview

The Spanish were the first Europeans to lay claim to the Mississippi Delta and northern Gulf of Mexico. In 1519, Admiral Alonzo Álvarez de Pineda explored and mapped the northern Gulf for the Spanish Governor of Jamaica. Ten years later, Pánfilo de Narváez, the sixth governor of La Florida, led another expedition of five vessels and 400-armed men to the Gulf. Due to mistreatment of the natives, Narváez and his men were continuously harassed as they reconnoitered the region. Eight years later, four survivors of the original party of 400 reached Mexico. One of those survivors, Alvar Núñez Cabeza de Vaca, wrote an account of the expedition including a detailed description of the Mississippi River and the southern Louisiana coastline.

In 1539, Hernando de Soto arrived on the west coast of Florida to establish a colony and search for gold. De Soto landed in the Tampa Bay area and, recognizing the futility of finding gold there, marched his men northward. His quest for gold brought him through the entire southeast and possibly as far west as Texas. The conquistador left a legacy of destruction and violence in his quest for gold that ended in May 1543 with his death near the Mississippi River. Spain's interest in the northern Gulf waned as it became evident that the region held little in the way of treasure and other sources of wealth.

In 1682, the French began exploratory ventures down the Mississippi River from their outposts along the Great Lakes. In April of that year, Réné Robert Cavalier, Sieur de la Salle traveled to the mouth of the river. There, along the shores of the Gulf, LaSalle claimed the following territory for King Louis XIV: "the seas, harbors, ports, bays, adjacent straits, and all nations, peoples, provinces, cities, towns, villages, minerals, fisheries, streams and rivers within the extent of Louisiana" (Nuzum 1971:31).

French colonization began at the turn of the eighteenth century. In late 1698, Pierre Le Moyne, Sieur d' Iberville departed from Brest, France with five ships and more than 200 men to reconnoiter along the northern coast of the Gulf of Mexico. After encountering Spaniards at Pensacola Bay, they continued their expedition, navigating westward along the Gulf coastline. Although they had intended to establish settlements along the Mississippi, its swampy shoreline deterred the Le Moyne party. Soon thereafter, the French explorers set up an encampment called Fort de Maurepas (at contemporary Ocean Springs, Mississippi) (Nuzum 1971:32).

In 1699, Pierre sent his brother, Jean Baptiste Le Moyne, to conduct further exploratory missions along the Mississippi. During his travels he visited "la Fourche des Chetimachas" along the upper Laforche Bayou near present day Donaldsonville. Lands were granted along the Mississippi in the hopes of establishing a colony, but fears of native attacks and little support from France, resulted in failure (Goodwin et al. 1998:61). However, the French did not give up on settling the Mississippi, and by 1718, New Orleans was founded. The settlement grew slowly, spreading along the banks of the river. The bayous were virtually ignored by the French, being exploited by only a few fur trappers and the Houma tribe, who moved into the Terrebonne Basin during the first quarter of the eighteenth century.

In the 1762 Treaty of Fontainebleau, Spain acquired New Orleans and all French territory west of the Mississippi River. During their 38-year rule, the Spanish expanded the Louisiana colony. Among the many grants given out were those to Acadians relocating from Nova Scotia. The Acadians settled along Bayou Lafourche, preferring that region for its isolation that allowed them to maintain their traditional culture with little interference (Goodwin et al. 1998:61). Terrebonne received its name from these settlers; the word means "the good earth," after the richness of the surrounding lands. They quickly adapted to their new homeland growing corn, cotton, beans and figs. In addition, the Acadians exploited the natural resources of the region through fishing, trapping and hunting. The swampland forests also offered timber for shipbuilding and domestic construction.

It was during this period that the first canals were cut through the marshes. These canals were used to drain farmlands, provide access for trapping and to provide navigable waterways for shipping goods to New Orleans. Many of these canals have become artificial bayous and many are still maintained and used to this day (Goodwin et al. 1998:62).

In 1803, Spain ceded its control of Louisiana to France. The French hoped to reestablish an empire in the Americas. Fearing that French control would upset American trade through New Orleans, President Thomas Jefferson authorized the negotiation for the purchase of the city. However, French setbacks in Haiti and coming war with Britain induced France to offer the entire territory to the United States for 15 million. The purchase of Louisiana essentially doubled the size of the country and opened the door to expansion to the Pacific coast.

Following American acquisition, Louisiana was partitioned into 12 counties. In 1807, that system was abandoned and the territory was reorganized into parishes. By 1822, the population of La Fourche Parish had grown to such an extent to warrant the creation of a new Parish. In that year, Senator Henry Schuyler Thibodaux sponsored legislation to create Terrebonne Parish. La Fourche was split along Bayou Blue with the western portion becoming Terrebonne Parish and the eastern portion remaining La Fourche. Bayou Cane was originally designated the Parish seat, but in 1834, the new town of Houma was selected. Houma was incorporated in 16 March 1843 (Goodwin et al. 1998:64). At that time the town was confined to the south bank of Bayou Terrebonne. By 1847, settlement had spread to the north bank and in 1899, the city limits were expanded to include that section (Birchett and Pearson 1998:9).

During the antebellum period, Terrebonne Parish became a center for sugar production. As Anglo-American planters moved into the region the Acadians were pushed into more remote locations along the coast. The first plantation in Terrebonne was established by Michel Theriot in 1839. By 1846, there were 106 plantations in Terrebonne cultivating sugar cane (Goodwin et al. 1998:64). Of these, 12 were located in lower Terrebonne.

Terrebonne was only minimally impacted by events of the Civil War. In 1861, an earthen battery was constructed on Grand Caillou Bayou. Originally named Fort Butler, but later renamed Fort Quitman, the fortification was built to protect blockade runners putting into Grand Caillou and to prevent Federal raids into the region (Goodwin et al. 1998:64). The fort was manned by 141 men and armed with two 32-pounder smoothbores (Goodwin et al. 1998:64). Fort Quitman would never see action, it was abandoned by Confederate forces soon after the Union fleet, under the command of Flag Officer David G. Farragut, bypassed the forts at the mouth of the Mississippi River and captured New Orleans in April 1862. In 1863, Federal troops occupied Thibodaux, and Terrebonne and La Fourche Parishes saw no further military activity for the remainder of the war.

Terrebonne and much of the surrounding region was slow to recover after the cessation of hostilities. Much of the local economy was destroyed during the war. Like before the war, sugar cane production formed the principal economic activity of the post war years. However, unlike before, the industry now relied on free labor for production. Major plantations that survived the war and continued production into the twentieth century included Ashland, Terrebonne, Red Star and Hard Scrabble plantations. The Terrebonne Sugar Mill opened in Montegut in 1891 as a central processing plant for the plantations operating in lower Terrebonne (Birchett and Pearson 1998:10). In addition to sugar, the region produced cotton, hay, potatoes, corn, beans, cattle and dairy products

A by-product of cane production, bagasse, became a major industrial concern during the twentieth century. In 1922, the Celotex Company began turning bagasse into insulation board (Goodwin et al. 1998:69). In 1927, Celotex formed the South Coast Company and purchased 26 plantations, including Ashland and Terrebonne. The endeavor lasted until the 1970s when cane production at Terrebonne Plantation was shut down.

Marine resources also became an important industry in the region by the end of the nineteenth century. In 1865, Chinese immigrant Lee Yim introduced a method for drying shrimp which prevent spoilage (Goodwin et al. 1998:69). With trawling, which was introduced during WWI, shrimp could now be caught and process in large numbers. Oysters provided a second source of export for Terrebonne residents. Oysters were off loaded from luggers by air suction and conveyed to steamers to be brined and cook in the shell; once cooked they were mechanically shucked (Birchett and Pearson 1998:10). As the industry expanded a number of canning houses opening in Houma, and soon the city became one of the largest shrimp and oyster shipping ports in the world (Birchett and Pearson 1998:10).

In 1917, a discovery was made that would change the face of coastal Louisiana, as well as the entire Gulf coast. On 17 March of that year, the first commercial gas well was struck at the Lirette Gas Field near Montegut. Nearly 100 million cubic feet of gas was produced from the well (Goodwin et al. 1998:69). By 1938, the total annual production of oil in Terrebonne reached over 8 million barrels and that of natural gas over 63 million cubic feet (Goodwin et al. 1998:70). By the following year, natural gas production had increased over eight times to more than 528,810,000 cubic feet (Goodwin et al. 1998:70). To support the growing industry, canals were cut through the marshes to service the well heads and to transport oil products for shipping. Port Fourchon was later developed as a deepwater access for tankers servicing the wells of Terrebonne and the surrounding region.

Navigational History of the Terrebonne Region

Boat travel was the main form of transportation along the bayous of Terrebonne Parish. Roads were virtually nonexistent, and those few present were confined to high ground along the levees. Because of the importance of water travel, maintenance of waterways were a primary concern of area residents. As early as 1823, landowners in Terrebonne were required to keep clear a 10-foot-wide channel along the bayous that border their lands (Birchett and Pearson 1998:10). In 1825, a canal was cut between bayous Lafourche and Terrebonne. Though shallow, the canal served as the main shipping route to the Thibodaux. During the 1840s, the Barataria Canal was dredged creating a continuous waterway between Morgan City and New Orleans. Products shipped via the canal included lumber, sugar, moss and molasses (Birchett and Pearson 1998:10). By the first decade of the twentieth century the canal had decline, being used mainly by luggers hauling fish and vegetables.

A variety of craft were employed in the waters of Terrebonne. These included: pirogues, chalands, esquifs, bateaus, flats, keelboats, luggers, sloops, schooner and steamboats. All of these varieties were involved in the moving of people and goods to markets in New Orleans or regional centers such as Houma, Thibodaux or Donaldsonville. Goods shipped to market consisted of rice, corn, cotton, sugar, molasses, indigo, tafia and lumber. Sugar, molasses and rice was typically transported to New Orleans in sailing craft such as pirogues, luggers, sloops and schooners (Birchett and Pearson 1998:10-11).

For bulk shipments flats were the preferred watercraft. Flats were well suited to shallow waters of the bayous and were cheap to build and maintain. Even after the introduction of the steamboat flats continued to be popular. One popular regional type was the Cordelle boat, which was a flat pulled by a rope by men or draft animals along the levees.

Steamboats arrived in the shallow marshes of Terrebonne Parish during the 1830s. One of the first to operate exclusively in the parish was the *S. F. Archer*. The *Archer* was owned by the J. J. Schaffer & Company. The steamer travel along Bayou Black bringing regional goods and passengers to the Railroad terminal at Tigerville (Birchett and Pearson 1998:12). The Daigle Barge Line operated a number of steamers in Terrebonne including the *Harry*, *Laura*, *N. H. Breaux* and the *Sadie Downman*. These steamers usually towed barges loaded with agricultural products to New Orleans and returned to Houma with foodstuffs, dry goods and other supplies. The *Harry* and *Laura* were also employed in the shipping of Beaumont Oil. When shipping oil, the steamers towed long streams of barges, as many as ten with the last barge trailing an anchor to keep the entire train from swinging in the channel (Birchett and Pearson1998:13). The Daigle Company built and maintained their own barges and often dredged the bayou to keep their steamers in operation.

Houma served as the head of navigation on Bayou Terrebonne and developed into the main port for the region during the nineteenth century. Prior to the Civil War flats traveled throughout the lower bayou collecting freight from the plantations for shipment at Houma by rail or sailing vessel to New Orleans. After the Civil War, steamers supplanted the flatboats. The bulk of these cargoes consisted of sugar and molasses. Other important cargoes included lumber, grain, fertilizer, oil and potatoes. By the early decades of the twentieth century oyster and shrimp became major exports. Between 1888 and 1935 tonnage shipped through Terrebonne increased from 5,416 to 115,666 (Birchett and Pearson 1998:16). During that period vessel traffic increased from 15 steamers and 9 barges to 252 steamers and 2,184 barges (Birchett and Pearson 1998:16).

The reliance on water travel led to the development of a local shipbuilding industry. Though a vast majority of area boats were built for personal use there were a few commercial builders within Terrebonne by the end of the nineteenth century. Cypress was the wood of choice among area builders. One prominent builder was John A. Boyne and his sons; John Madison, Andrew and Bill (Birchett and Pearson 1998:11). The Boyne's yard was located in lower Terrebonne at Madison's Canal and was comprised of two slipways. Another area builder, Ernest Rhodes, established one of the first and largest slipways in Terrebonne (Birchett and Pearson 1998:12). The Rhodes boatyard was located near Bush Canal. Ernest's two son's also became boat builders, and one, Elie, made boats for the Houma Boat Company, a branch of the Higgins Company which produced boats for the U.S. Navy during World War II.

Nature of the Archaeological Record (Re: Watercraft)

There are only few well-documented watercraft which have been investigated in Louisiana. Although watercraft terms are frequently mentioned in the historic literature knowledge of what they refer to is dubious. E. W. White (1957) wrote with regards to inshore fishing boats. "When consideration is given to the inshore fishing-boats, the earlier history of these craft is even more obscure than that to their larger relations for such familiar objects offered little or no attraction to artists either of the middle Ages or of a much later period." For this reason archaeological mention or investigation of watercraft within the lower bayous have been included in an attempt to understand the nature and depth of this knowledge. These watercraft include the Elmer's Island Dugout, the Lake Salvador Canoe, the Bois Chactas Canoe, the Little Lake Canoe, the McBoat-Morgan City, the 10 watercraft at Adams Camp (Site 16SMY55/56), the School Boat Stop (Site 16SMY58), the three watercraft at Oyster Camp (Site 16SMY61), the lugger *Champion,* the lugger *Denver,* the Mellon wreck, the M/V *Fox* and the steamer *Joe Webre.*

The four dugout watercraft including the Elmer's Island Dugout (LA-DC-85-6), the Lake Salvador Canoe (Site 16SC49 and LA-DC-85-1), the Bois Chactas Canoe (LA-DC-85-3) and the Little Lake Canoe (Site 16LF87 and LA-DC-00-3) all represent hollowed out logs with diagnostic platform bows. Radiocarbon samples submitted for the Little Lake Canoe and the Lake Salvador Canoe returned dates of ca. A.D. 1438 to A.D. 1662 and ca. A.D. 1600, respectively. The Bois Chactas Canoe, constructed using reduction by fire, was associated with a shell midden (Site 16SC4). All of these partial dugouts appear to be late prehistoric watercraft of the type best represented by the sixteenth-century Swan Lake Canoe, Site 22WS776, discovered in the bank of Steele Bayou, Swan Lake, Mississippi (Fuller 1992).

The Grand Isle Dugout is the only historic dugout documented as found in the area. It represents a type of large, wide pirogue found throughout southeast Louisiana. This dugout style was still being fabricated in the 1950s as a working watercraft.

McBoat represents a chaland, a flat bottom boat constructed by two sill timbers, end sills and cross ties with a planked bottom, forming a raft-like structure. This style of watercraft was similar to the simplified construction of a coal flat. The craft was found at Morgan City (Goodwin and Selby 1984). Its floor timbers with holes, sawdust and open ladder-like ramp timbers suggest a boat that delivered ice along the waterfront.

A total of 10 watercraft were documented at Adams Camp (Site 16SMY55/56) along Bayou Shaffer in St. Mary Parish. Abandoned watercraft left at or close to their landings, as in the case of this site, represent a far larger percentage of our maritime resources than shipwrecks (Saltus 1988). These 10 craft consisted of: WC1) Lafitte Skiff, WC2) Flat, WC3) Flat - John Boat, WC4) pirogue (pirogue en plache), WC5) plywood skiff, WC6) skiff, WC7) skiff, WC8) known cypress buried boat, WC9) motorized lugger, mostly buried location recorded, but not investigated, WC10) large dredge fitted wooden scow barge. A site map of a portion of Site 16SMY55/56 illustrates the nature of historic landings with multiple resources including land structures, activity areas, landing features and watercraft. These watercraft were the topic of a paper, "Watercraft Assemblages in Inland Waters" (Saltus 2000), given in Gdansk, Poland and published by the Polish Maritime Museum Gdansk 2000 in *Down the River to the Sea).* Variability in the watercraft of this area appears to be far greater than anticipated. The skiff in Louisiana was reported to have three types: Mississippi skiff, Creole Skiff and Lake Skiff (Comeaux 1985). Skiffs representing four styles were found at Adam's Camp (Site16SMY55/56). WC4 represents a plank pirogue (pirogue en plache) unlike any of the six plank pirogues commissioned by the Center for Traditional Louisiana Boatbuilding, Nicholls State University in Thibodaux, Louisiana. The ethnographic exercise in the 1990s had six boat builders across southern Louisiana construct a pirogue. No two were alike and several other styles have been noted in the photographic record. This variation could reflect environmental or ethnographic differences. A single example of a watercraft is insufficient to establish a pattern, trend or type.

Just below Adams Camp is the School Boat Stop (Site 16SMY58), a partially submerged watercraft. This craft originally was constructed as a World War II U.S. Mine Sweeper, then was converted to a Menhaden "pogy" boat. Later it was retired and used as a school "bus" stop prior to being totally abandoned in the late 1950s. In this case, the school bus that picked up the children on Bayou Shaffer was a boat. The Adams children waited for the school boat at the site.

Just north of Adams Camp and across the bayou is the Oyster Camp (Site 16SMY61). Here three watercraft were found including WC1) a coal flat, WC2) a possible lugger or sloop and WC3) a flat bottom skiff. The coal flat and the possible lugger or sloop were only sampled to determine basic data including general age, size and relative vessel type. WC1 is a coal flat, sill on sill construction, two 17-inch sill timbered side, 34-inch side, thwart planking. WC2 is a possible lugger or sloop**,** rudder gudgon located, longitudinal bulkhead or centerboard compartment and WC3 is a flat bottom skiff with no rocker. Only the skiff was fully documented.

Lugger as a watercraft term is common in the literature. However, only two Louisiana luggers have been discussed at any length (Brassieur 2000), including the luggers *Champion* and *Denver*. Neither of these craft has been documented using Historic American Engineering Record standards. The term lugger has referred to many different watercrafts using or not using a lug sail. Henry Hall (1880) stated "In model the luggers are sharp, and are mostly keel-boats with a yawl stern." Howard Chapelle (1951) in *American Small Sailing Craft* noted of the New Orleans lugger "early luggers were keel yawl-boats in model and the center board developed from these." Stanley Faye (1940) quoting Carl W. Mitman's Catalogue of *Watercraft Collection in the National Museum* (Mitman 1923) discusses the genealogy as "[w]ith the paranzelleo's original triangular sail (sheet to a boom) still represented by a trapezoidal hanging lug, the fellouca persisted into the twentieth century as the "New Orleans lugger … of the shrimping fleets" (Faye 1940:122). Ray Brassieur (2000) notes "the ancient French term for these relatively small open boats is "canot" (the final "T" is pronounced). Louisiana Cajuns still use the French term "canot" to refer to luggers. Kanoa was the term that the French used to describe the largest of the sailing dugout canoes used by the Carib Indians.

Brassieur in his *Brief History of the Lugger* (2000) suggests the following lugger subtypes:

a. single masted open sailing lugger (not decked; ca. 1700 to1850)
b. double masted sailing lugger (early nineteenth century)
c. Late nineteenth century oyster sailing lugger
d. Motorized Louisiana lugger (rounded fantail)
e. Motorized Biloxi lugger (square transom)
f. Motorized oyster dredge boat
g. Motorized trawling lugger (after 1920)

h. Ice boat/fisheries supply lugger (ca. 1930 to 1940)
i. Motorized passenger and crew transport lugger
j. Oil field auxiliary boat/lugger tug

The *Mellon Wreck* (Site 16SM92) is one of the few documented watercraft in the area. The vessel was pulled out of the river by a riparian landowner. He notified the local historical group after seeing that it represented an old watercraft. The craft, containing both cut and wire nails, represents a centenary watercraft. Its form is long and narrow, with a length of 41 ft (12.5 m), a width of 6.58 ft (2.0 m) and a depth of hold of 1.67 ft (.5 m). The long, narrow and shallow form suggests the remains of the keelboat/barge tradition after the advent of steam. The history of the craft has not been ascertained, but the form and construction has been documented. How and where it fits in our maritime history is still unknown and awaits further physical data but at least we now know we have one that needs further research.

The M/V *Fox* is another of the few documented watercraft. The vessel was built at New Orleans in 1875, with Larose, Louisiana listed as its last home port. It was abandoned 1934. The vessel type is similar to a “double ender,” not a keelboat as noted by CE (Pearson et al. 1989). The vessel, as documented by Goodwin and Selby (1984), is 37.83 ft (11.5 m) long by 9.25 ft (2.8 m) wide with a 3.5 ft (1.1 m) depth of hold. Photographic and pictorial data suggests that this vessel form ranged along the Mississippi River from Empire at the mouth of the river to New Orleans and its associated waterways.

The locomotive engine, propeller and shaft of the steamer *Joe Webre* reportedly were recovered off Grand Isle. Little else is known about this vessel other than its sparse history related to its loss. This makeshift maritime motive technology may provide insight into economic responses. Another economic response is provided by C. J. Christ (2001) in his discussion of the loss of the Standard Oil tanker *Benjamin Brewster* off Grand Isle in 1942, where he notes the use of a tiny Coast Guard patrol boat, as a converted fishing vessel with a farm tractor engine. Variability of these types in the local maritime heritage could represent change in response to economic stimuli. Empirical data concerning watercraft is dependent upon the identification and documentation of these cultural resources. The ability to study and understand watercraft evolution, ethnicity, secondary use, variability, association with land based activities and relationship to other watercraft are all lost when their remains are not thoroughly investigated prior to their destruction.

Potential for Historic Resources

A survey of historical and archaeological literature and archival background research confirmed considerable evidence of maritime activity in the northern Gulf of Mexico. The patterns of maritime activity in the vicinity of the proposed project include navigation associated with colonization, development, agriculture, industry, trade, shipbuilding, commerce, warfare, transportation and fishing. Documented navigation covers the entire history of European activity from the earliest exploration in the first decade of the sixteenth century. As the scope of European settlement increased dramatically in the eighteenth century the intensity and regularity of maritime activity reflected that development. By the nineteenth century a complex web of commercial enterprise connected the ports of the Gulf Coast of the United States with the world. Prior to the American Civil War, New Orleans was second only to New York in the volume of maritime commerce. That trend continued throughout the twentieth century as trade, transportation and fishing developed to support expanded navigation. Clearly, the historical record confirms that waterborne transportation, communication, trade and fishing dominated life in the Terrebonne region of Louisiana.

As a consequence of those international, national and regional maritime activities, the Gulf Coast of Louisiana has been identified as a high probability area for shipwreck resources. Human error, storms and warfare have resulted in the loss of ships in every period of Gulf Coast history. Central Coastal Louisiana and the coast from Isles Dernieres east to include the Mississippi River Delta has been identified as a high probability area for shipwrecks and shipwreck preservation (Garrison et al. 1989). Statistical probability suggests that most shipwrecks in the project area would date from the post-World War II period and were associated with the coastal trade, fishing or oil and gas industry (Pearson et al. 2003, II:4-58). However, the limitations of earlier historical records cannot preclude the distinct possibility of earlier wrecks in the area. In addition, small coastal and fishing vessels lost in the area might never have been reported.

The potential for those submerged cultural resources is high in the vicinity of the proposed borrow area. Current National Oceanic and Atmospheric Administration (NOAA) chart 11357 and the *Underwater Obstruction Removal Program* (UORP) database identify two shipwrecks within a half mile or less of the borrow site and a derelict site within a mile and a half. Of these resources, one of the designated wrecks appears to lie within the proposed borrow site. It is unclear from the NOAA Automated Wreck and Obstruction Information System (AWOIS) database as to whether that vessel's remains have been totally removed or that some parts of the hull or superstructure remain on and/or below the bottom surface. In addition, the Louisiana Department of Natural Resources' Sonris database lists one abandoned oil well adjacent to the borrow area on its west side. The presence of charted wrecks in the vicinity of the West Belle Pass borrow sites reinforces the high potential for shipwrecks established by the Minerals Management Service (MMS) (Garrison et al. 1989).

Because the West Belle Pass project area has a high documented potential for shipwreck sites, magnetic and acoustic anomalies identified during the survey should be given careful consideration. The patterns of navigation identified by historical research confirms that the spectrum of vessels employed in the vicinity of the project includes everything from small coastal craft to international merchant and warships. While larger and more modern vessels generate a more readily detectable magnetic and acoustic signature, small coastal craft can be very difficult, if not impossible, to detect. For that reason serious consideration must be given to each anomaly. Signature analysis is further complicated by the fact that in the northern Gulf of Mexico, the bottom is littered with modern debris. It can be difficult, if not impossible, to determine whether an anomaly represents a shipwreck, a coastal vessel or modern debris. While pipelines and wells can frequently be identified using charts and geographic information systems, much of the bottom surface debris is undocumented. The complex nature of signature analysis has been addressed by Saltus (1982), Gearhart (1988), Garrison et al. (1989) and Anuskiewicz (1992).

Previous Investigations

Three previous submerged cultural resources survey have been conducted in the offshore waters in the vicinity of the West Belle Pass project. In 1984, Floyd and Stucky conducted a remote-sensing survey in Blocks 2 and 9, south of Isle Dernieres (Floyd and Stucky 1984). The survey was conducted for the Texas Gas Transmission Corporation to determine the location of possible seafloor and sub-bottom hazards prior to the construction of a 10-inch pipeline in the area. Eleven targets were located during the survey. All eleven were determined to represent debris from previous construction activities.

In 1997, CE (Birchett and Pearson 1998) conducted a cultural resources survey of Cat Island Pass of the Houma Navigation Canal for the U.S. Army Corps of Engineers, New Orleans District. That work was performed in anticipation of maintenance dredging to realign the canal to reduce shoaling in the navigation channel. The results of the remote-sensing survey identified a large number of magnetic and acoustic anomalies, most of which were identified as modern debris. Four of the targets, however, were identified as displaying characteristics similar to known shipwrecks. Diver reconnaissance of the four target sites revealed that none represented potentially significance cultural resources.

In 2005, CPE and TAR carried out a remote-sensing survey of two borrow sites off Barataria Pass and Quatre Bayou Pass to identify sources of sand for restoration of Dernieres Island. The Terrebonne Louisiana barrier island complex was identified as a critical area for coastal erosion and Isles Dernieres was selected as a candidate area for the restoration projects under a federal law entitled “Coastal Wetlands Planning, Protection and Restoration Act” passed by Congress in 1990. Restoration plans for Isles Dernieres included consideration of an increase in beach/dune cross-section and improvement of the bayside marsh platform. The enhancement of the beach and dune provided increased protection from storm-related surge and wave attack, through the prevention of island breaching or loss of major portions of the islands. Restoration of the marsh platform behind the barrier islands reinforced the long-term stability of the island system against major storm events. The remote-sensing survey identified 69 anomalies in the New Cut borrow areas. Two of the anomalies appeared to be associated with an abandoned oil well and another 34 were found outside the area of proposed impact. Of the 33 anomalies that lie within the proposed borrow area and a 500-foot buffer, 22 appeared to be associated with modern debris and 11 contained signature characteristics suggestive of potentially significant submerged cultural resources. The aforementioned 11 anomalies were recommended for identification and assessment if avoidance was not an option.

A Phase I remote-sensing submerged cultural resource survey of offshore borrow sites located in Lafourche and Terrebonne Parish, Louisiana was carried out by CPE and TAR in association with the West Belle Pass Barrier Headland Restoration Project in 2009.

CPE served as the consulting geotechnical engineering firm for the project. The project was designed to increase headland longevity, restore valuable habitat, and construct a beach and dune system that will improve protection for the bayside marsh and Port Fourchon. Material for the restoration came from two offshore borrow sites in the Gulf of Mexico.

In order to determine the effect of project related dredging on potentially significant submerged cultural resources, CPE contracted with TAR to supervise the conduct of an archaeological and geotechnical remote-sensing survey of the proposed borrow sites. Analysis of the magnetic and acoustic data identified a total of 127 magnetic targets and 4 acoustic anomalies within two borrow areas. The first, Area A, contained 30 magnetic and 3 acoustic targets. Four clusters of magnetic anomalies appeared to be associated with well heads and another five individual magnetic targets were located in the buffer; the signature characteristics of these targets were considered to be suggestive of modern debris. Of the five anomalies located within Area A, all appeared to be associated with modern debris and/or a pipeline that runs across the northern part of this area. No additional investigation of these targets is recommended.

However, two magnetic targets and one associated acoustic target were located near a shipwreck symbol on NOAA Chart No. 11346. As these could be associated with that wreck, avoidance of those targets by the placement of a 300-foot radius conforming buffer zone that provides adequate protection for all material generating the magnetic signature was recommended.

The second area, Area E, contains 97 magnetic targets and one acoustic target. Ninety-three magnetic targets exhibited signature characteristics of modern debris. Two of these targets have an associated acoustic signature. No additional investigation of these targets was recommended. Two clusters, composed of four magnetic targets, have signature characteristics considered suggestive of potentially significant cultural resources. Avoidance of those two clusters was recommended by the placement of 300-foot radius conforming buffer zones for material generating the magnetic signatures. Additional investigation is recommended for those targets if avoidance was not determined to be possible.

Remote Sensing Survey

Remote-sensing surveys designed to identify submerged cultural resources are perhaps most frequently carried out in response to priorities for protection and management. They are designed to address two primary questions: (1) are there submerged cultural resources in a given area and (2) are those submerged cultural resources eligible for nomination to the National Register of Historic Places (NRHP). While most surveys are generated by such practical issues as are dictated by the 106 Review and Compliance process, the data they collect frequently contributes to the body of knowledge associated with important historical and anthropological questions. One of the more obvious of those issues regards developing and testing models for the spatial and temporal distribution of shipwrecks. A more specific example of research design issues often unspecified for Phase I surveys relates to the identification of shipwrecks that provide both clues to historical events and answers, or raises anthropological questions associated with human activity surrounding the vessel's construction and use.

The remote-sensing survey of the pipeline corridors at West Belle Pass was designed to identify potentially significant submerged cultural resources that could be impacted by proposed temporary deployment of material handling pipelines. The survey methodology and equipment was based on standards identified by the U.S. Department of the Interior, Minerals Management Service and the Louisiana Division of Archaeology. A combination of state-of-the-art seismic, magnetic and acoustic remote-sensing equipment was employed to generate sufficient data to reliably identify cultural material such as shipwreck sites. Remote-sensing data collection was controlled by an onboard computer running precision survey software and connected to a differential global positioning system (DGPS). Data was collected on survey lanes spaced 100 feet (30 meters) apart. That lane spacing was designed to provide complete lateral coverage with the sonar system and a representative sampling with the seismic and magnetometer systems. The survey was carried out using the research vessel *Aqua Quest* (Figure 5).

Figure 5. Research Vessel *Aqua Quest.*

Magnetometer

An EG&G Geometrics G-882 marine cesium vapor magnetometer capable of plus or minus 0.001 gamma resolution was employed to collect magnetic data in the survey areas (Figure 6). The cesium magnetometer provides a scalar measurement of the earth's magnetic field intensity expressed in gammas. To produce the most comprehensive magnetic record, data were collected at 10 samples per second. The magnetometer sensor was towed approximately 10 feet below the water surface at a speed of approximately 3 to 4 knots. Magnetic data were recorded as a data file associated with the computer navigation system. Data from the survey were contour plotted using QUICKSURF computer software to facilitate anomaly location and definition of target signature characteristics.

Sidescan Sonar

An EdgeTech 4200-HFL sidescan sonar system was employed to collect acoustic data in the borrow area (Figure 7). The 4200-HFL uses full-spectrum chirp technology to deliver wideband, high-energy pulses coupled with high-resolution and superb signal to noise ratio echo data. The sonar package included a portable laptop configuration running DISCOVER acquisition software and a 300/600 kHz dual frequency towfish running in high definition mode. Dual frequency provided a differential aid to interpretation. Due to shallow water in the survey area the sidescan sonar transducer was deployed and maintained between 8 and 10 feet below the water surface. Acoustic data were collected using a range scale of 150 meters (492 feet) to provide a combination of +300% coverage and high target signature definition. The digital sidescan data was merged with positioning data via the computer navigation system and logged to disk for post processing.

Figure 6. Deploying the EG&G Geometrics G-882 magnetometer.

Figure 7. Launching the EdgeTech 4200-HFL sidescan sonar.

Sub-Bottom Profiler

An EdgeTech 512i (Figure 8) towfish was employed with a Full Spectrum Sub-Bottom Topside Unit to collect seismic data. The sub-bottom profiler sends an acoustic signal through the ocean bottom to record surface and subsurface geological features. Each distinct layer in the bottom sediment is indicated as a surficial trace, which is recorded in an electronic format onboard the survey vessel. The chart shows the presence of the sediment surface and other distinct layers or features within the sediment, such as buried river channels. The topside unit was utilized to control the 512i towfish and to display and archive the data, which was merged with positioning data via the computer navigation system. The area was surveyed using the 2 KHz to 12 KHz 20ms FM pulse setting. The pulse repetition rate was typically six pulses per second.

Positioning and Data Collection

A TRIMBLE AgGPS was used to control navigation and data collection in the survey area. That system has an accuracy of plus or minus three feet, and can be used to generate highly accurate coordinates for the computer navigation system. The DGPS was interfaced with HYPACK, a state-of-the-art navigation and hydrographic surveying system (Figure 9). On-

Figure 8. Launching the EdgeTech 512i sub-bottom profiler.

Figure 9. Remote-sensing operators monitoring data collection on board R/V *Aqua Quest*.

line screen graphic displays include the pre-plotted survey lines, the updated boat track across the survey area, adjustable left/right indicator, as well as other positioning information such as boat speed, quality of fix and line bearing (Figure 10). Navigation fixes (shot points) were recorded at 100-foot intervals along all survey lines. All data obtained is recorded on the computer's hard disk and is transferred to an external hard drive to provide a backup of the raw survey data. Data generated was correlated to remote-sensing records by DGPS to facilitate target location and anomaly analysis. All data were plotted to Louisiana South State Plane coordinate system, NAD 83, U.S. Survey Foot.

Figure 10. Computer navigation system located at the research vessel helm.

Data Analysis

To ensure reliable target identification and assessment, analysis of the magnetic and acoustic data was carried out as it was generated. Using QUICKSURF contouring software, magnetic data generated during the survey was contour plotted at 10-gamma intervals for analysis and accurate location of the material generating each magnetic anomaly. Magnetic targets were isolated and analyzed in accordance with intensity, duration, areal extent and other signature characteristics. Sonogram signatures associated with magnetic targets were analyzed on the basis of configuration, areal extent, elevation, target intensity and contrast with background and shadow image.

Data generated by the remote-sensing equipment was developed to support an assessment of each magnetic and acoustic signature. Analysis of each target signature included consideration of magnetic and sonar signature characteristics previously demonstrated to be reliable indicators of historically significant submerged cultural resources. Sub-bottom data was also assessed for relict channels and the potential for prehistoric resources. Assessment of each target included recommendations for additional investigation to determine the exact nature of the cultural material generating the signature and its potential NRHP significance. A magnetic contour map of the survey area that illustrates the earth's magnetic background field and anomalies created by cultural material was produced to aid in the analysis of each target.

Signature Analysis and Target Assessment

While no absolute criteria for identification of potentially significant magnetic and/or acoustic target signatures exist, available literature confirm that reliable analysis must be made on the basis of certain characteristics. Magnetic signatures must be assessed on the basis of three basic factors. The first factor is intensity and the second is duration. The third consideration is the nature of the signature; e.g., positive monopolar, negative monopolar, dipolar or multi-component. Unfortunately, shipwreck sites have been demonstrated to produce each signature type under certain circumstances. Some shipwreck signatures are more apparent than others.

Large vessels, whether iron or wood produce signatures that can be reliably identified. Smaller vessels, or disarticulated vessel remains, are more difficult to identify. Their signatures are frequently difficult, if not impossible, to distinguish from single objects and/or modern debris. In fact, some small vessels produce little or no magnetic signature. Unless ordnance, ground tackle or cargo associated with the hull produces a detectable signature, some sites are impossible to identify magnetically. It is also difficult to magnetically distinguish some small wrecks from modern debris. As a consequence, magnetic targets must be subjectively assessed according to intensity, duration and signature characteristics. The final decision concerning potential significance must be made on the basis of anomaly attributes, historical patterns of navigation in the project area and a responsible balance between historical and economic priorities.

Acoustic signatures must also be assessed on the basis of several basic characteristics. Perhaps the most important factor in acoustic analysis is the configuration of the signature. As the acoustic record represents a reflection of specific target features, wreck signatures are often a highly detailed and accurate image of architectural and construction features. On sites with less structural integrity signatures often reflect more of a geometric pattern that can be identified as structural material. Where hull remains are disarticulated the pattern can be little more than a texture on the bottom surface representing structure, ballast or shell hash associated with submerged deposits. Unfortunately, shipwreck sites have been demonstrated to produce a variety of signature characteristics under different circumstances. Like magnetic signatures, some acoustic shipwreck signatures are more apparent than others. Large vessels, whether iron or wood, produce signatures that can be reliably identified.

Smaller vessels, or disarticulated vessel remains are inevitably more difficult. Their signatures are frequently difficult, if not impossible, to distinguish from concentrations of snags and/or modern debris. In fact, some small vessels produce little or no acoustic signature. As a consequence, acoustic targets must be subjectively assessed according to intensity of return over background, elevation above bottom and geometric image characteristics. The final decision concerning potential significance of less readily identifiable targets must be made on the basis of anomaly attributes, historical patterns of navigation in the project area and a responsible balance between historical and economic priorities.

West Pipeline Corridor

Analysis of the magnetic and acoustic data generated by the remote-sensing survey of the West Pipeline Corridor identified a total of 318 magnetic anomalies (Figures 11, 12, 13, 14, 15 and 16; Appendix A) and 4 acoustic signatures (Figure 17; Appendix B). Five of those anomalies are associated with charted seawalls and 224 are associated with pipelines. Small single objects account for 33 anomalies and moderate single objects generated 37 additional magnetic signatures. Seven anomalies appear to be associated with a wreck on NOAA Chart 11357 and are included in the West Pipeline Corridor buffer WBPW-3. Two additional anomalies are associated with sonar contacts WBPSS-2 and WBPSS-5 and both are buffered by WBPW-2 for avoidance. The remaining 10 anomalies, individually and/or collectively, have signature characteristics suggestive of potentially significant submerged cultural resources are associated with three buffered clusters identified as WBPW-1, WBPW-4 and WBPW-5. Two of the buffers, WBPW-4 and WBPW-5, could be associated with visible wrecks identified on NOAA Chart 11357 (Figure 18). Buffers WBPW-1 and WBPW-2 could be associated with obstructions identified on NOAA Chart 11357 (Figure 18).

Analysis of the West Pipeline Corridor sub-bottom data revealed no buried channels or other relict features in the survey area (Figure 19).

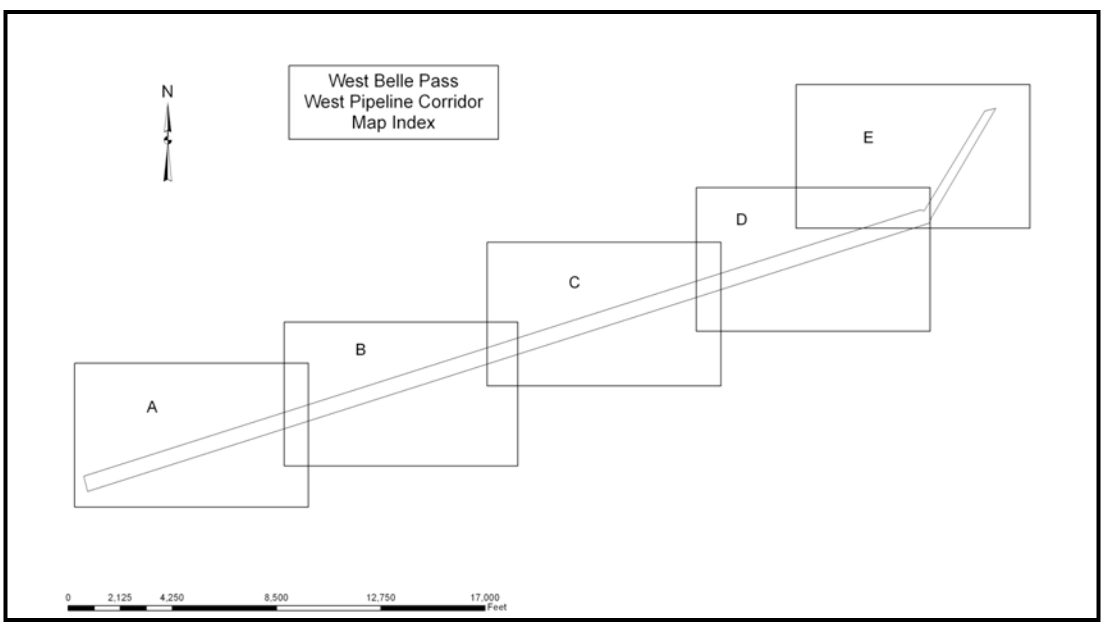

Figure 11. Magnetic contour map index.

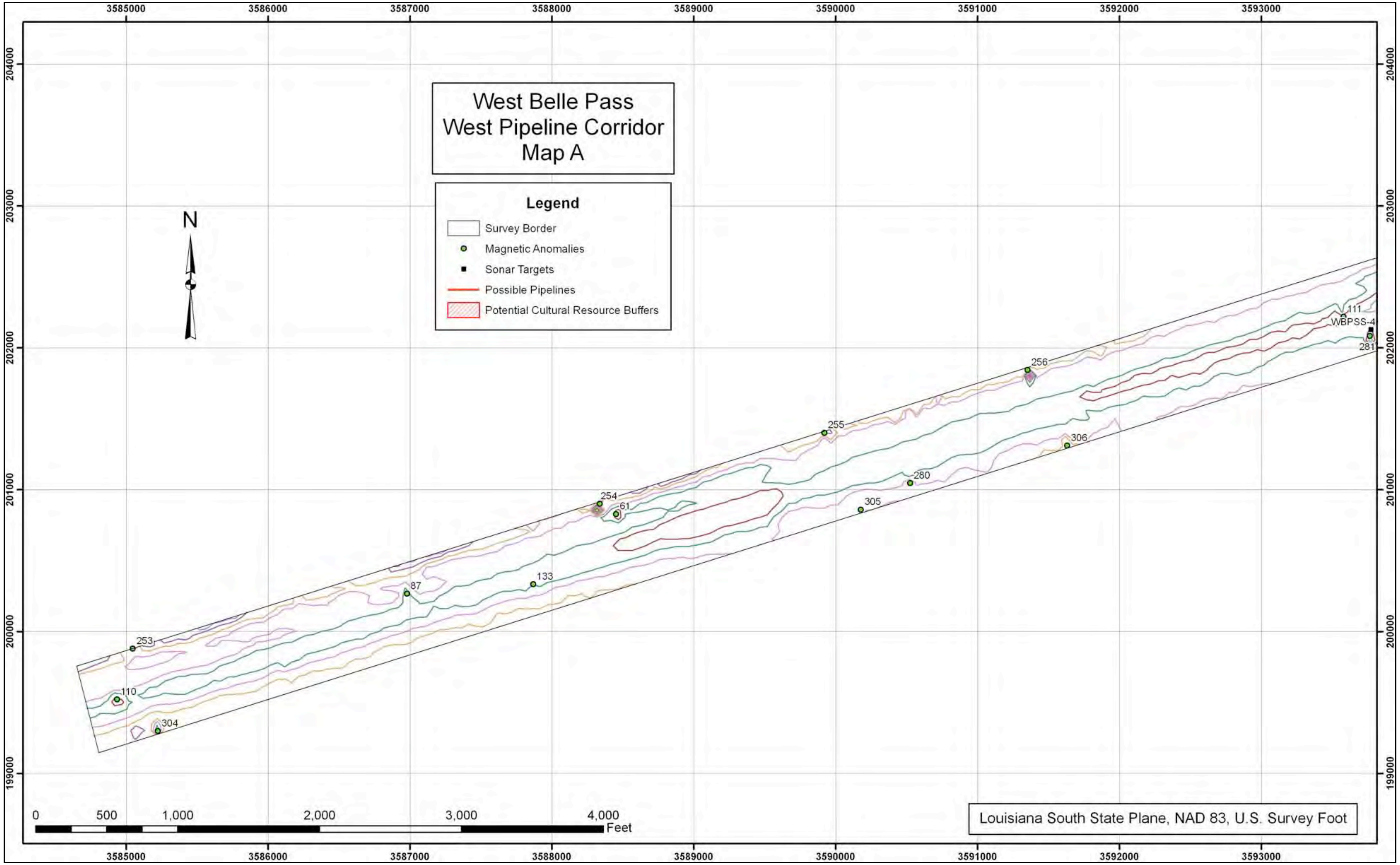

Figure 12. West Pipeline Corridor magnetic contour map A.

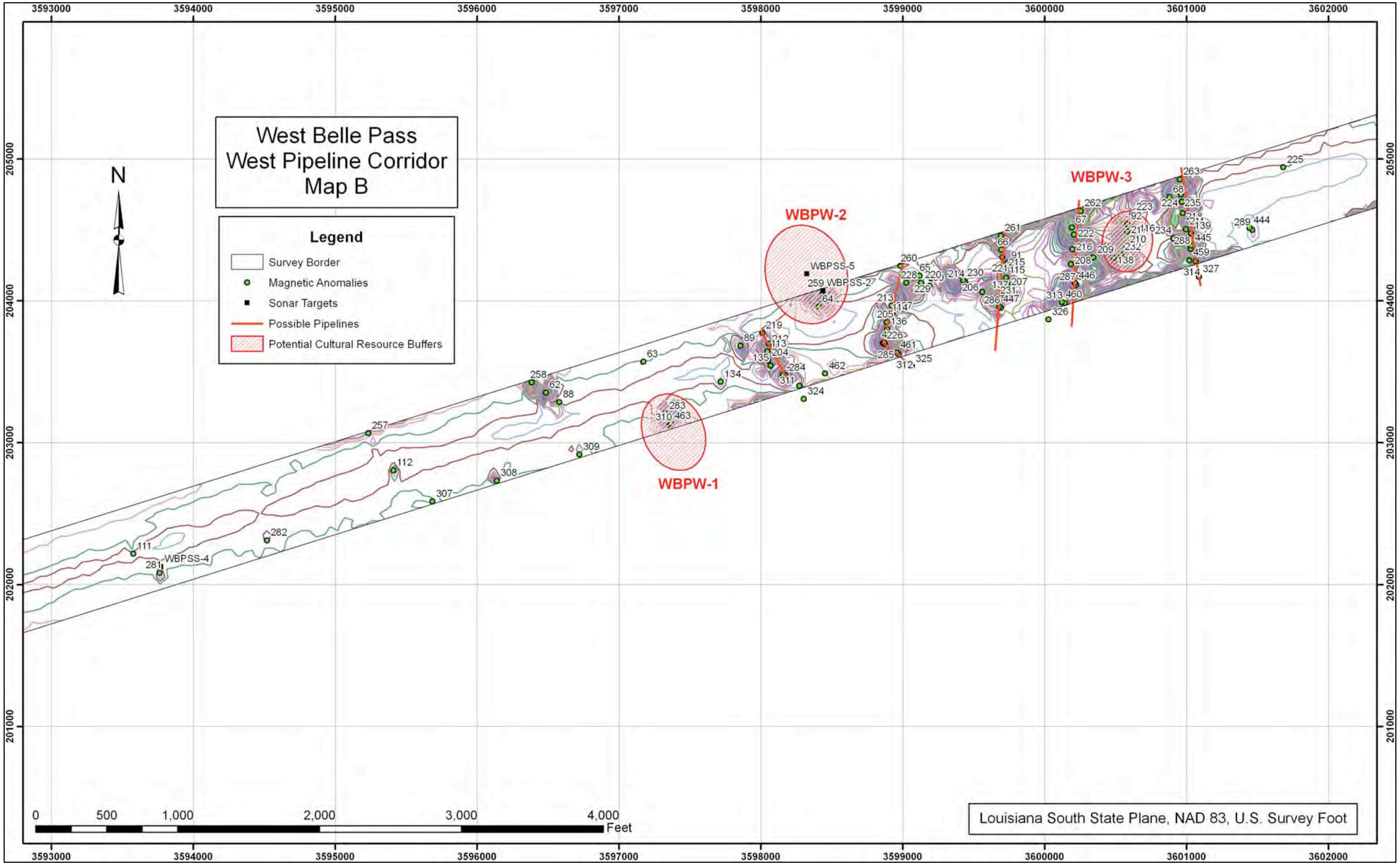

Figure 13. West Pipeline Corridor magnetic contour map B.

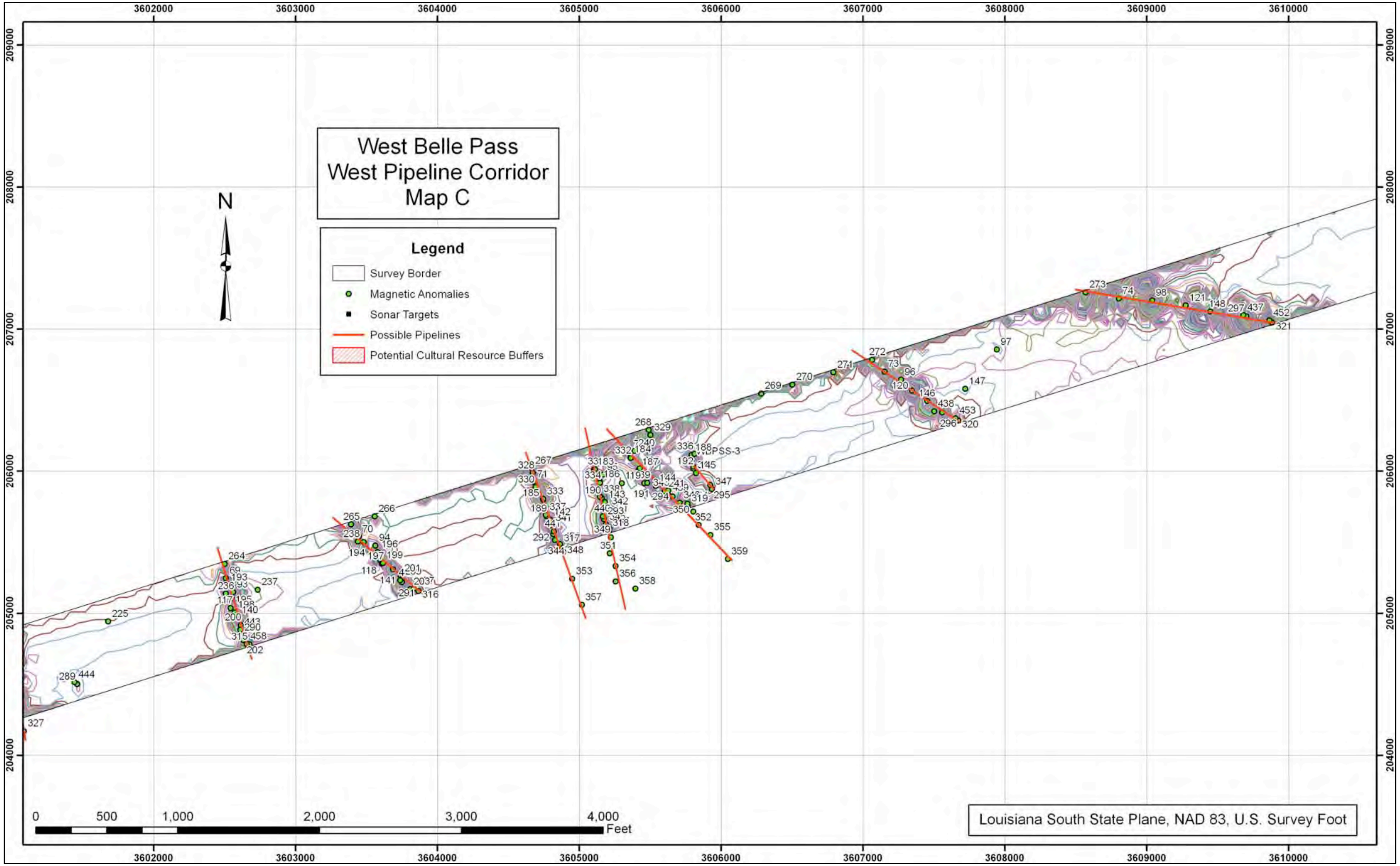

Figure 14. West Pipeline Corridor magnetic contour map C.

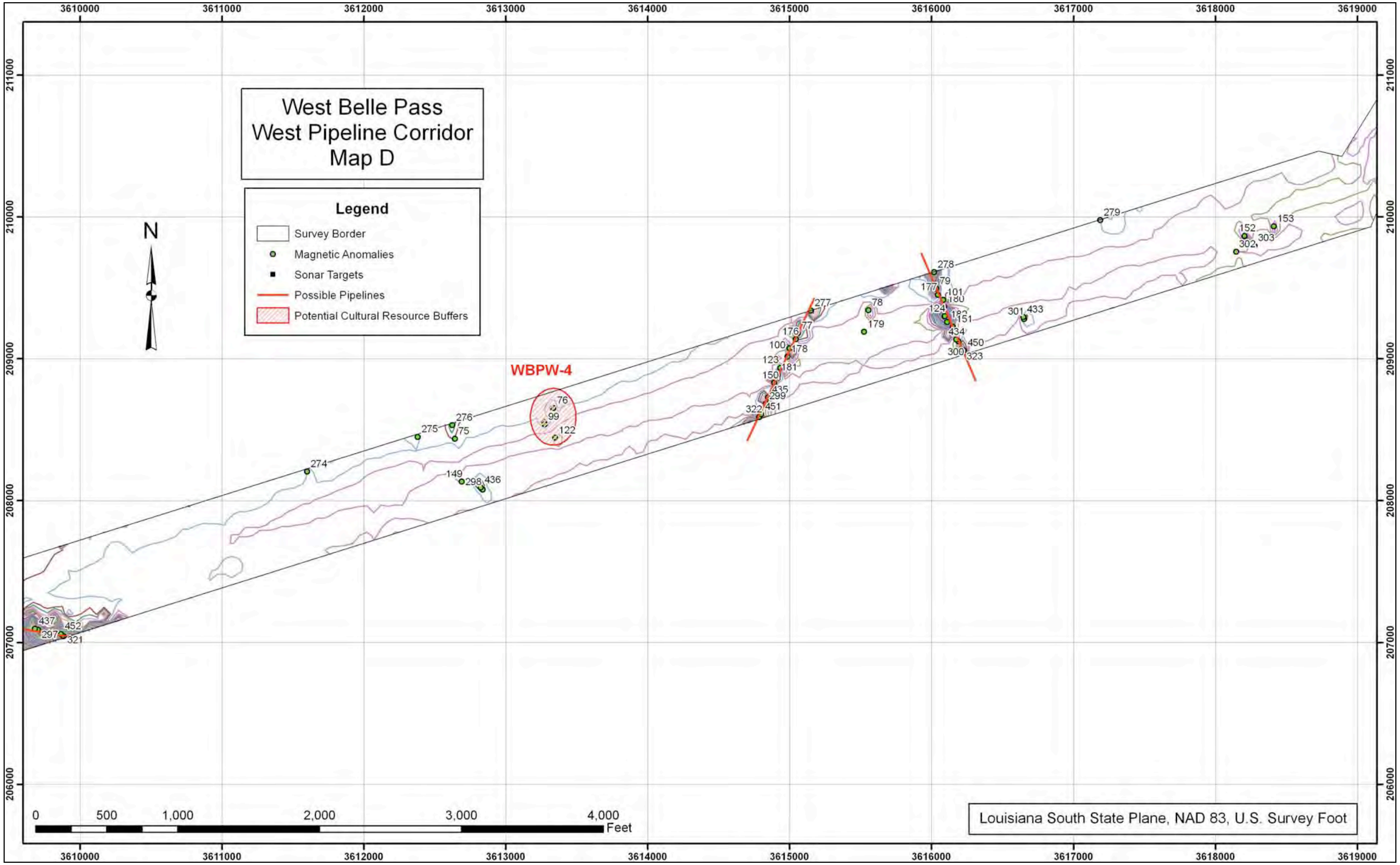

Figure 15. West Pipeline Corridor magnetic contour map D.

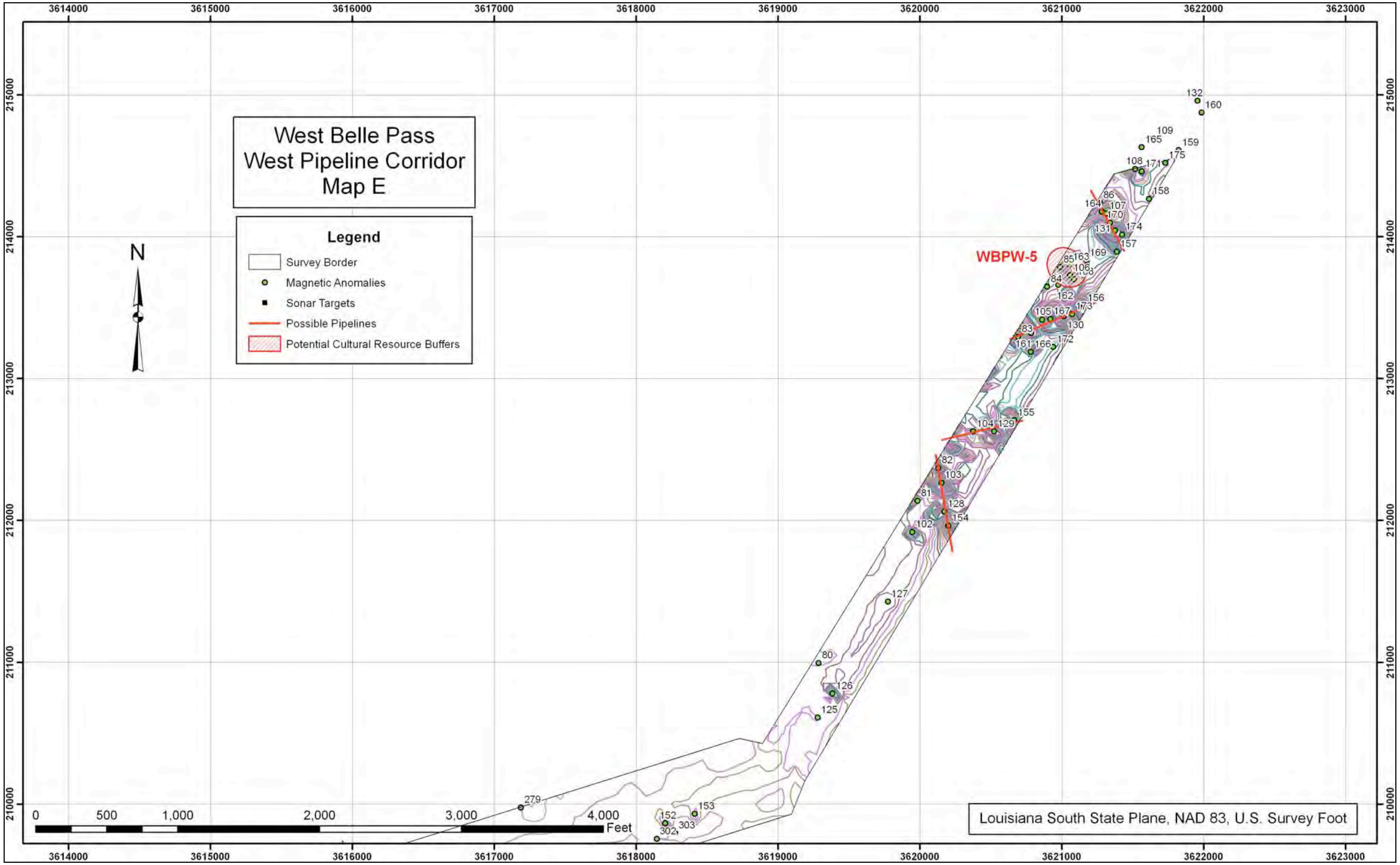

Figure 16. West Pipeline Corridor magnetic contour map E.

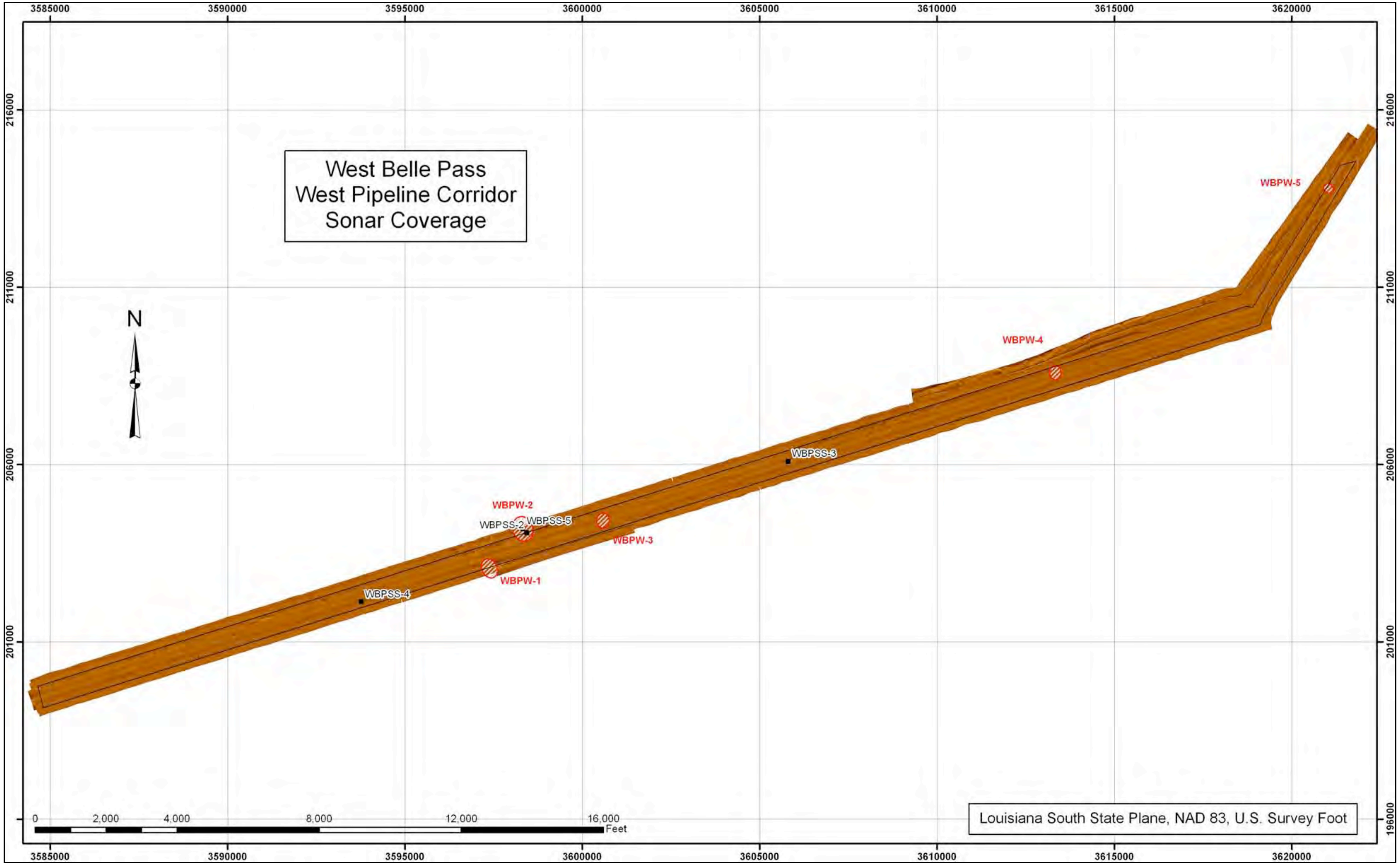

Figure 17. West Pipeline Corridor sonar coverage mosaic with contacts and buffers identified.

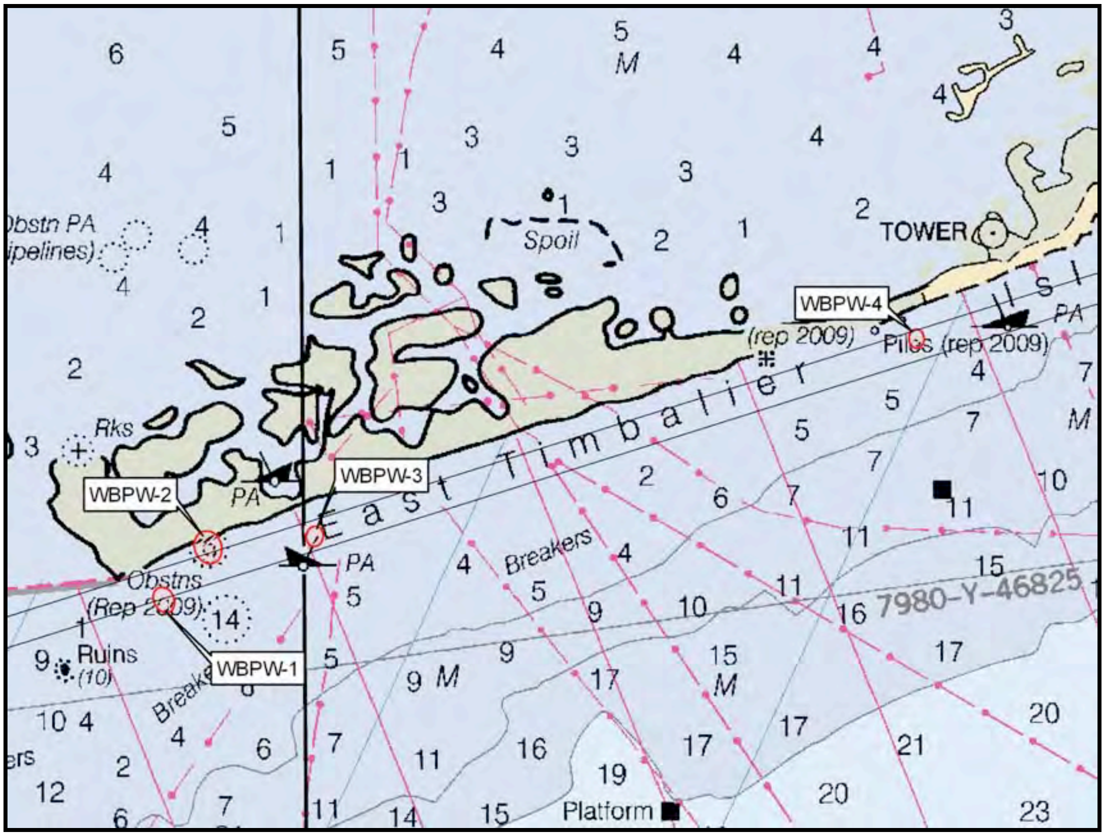

Figure 18. NOAA Chart 11357 showing wreck sites possibly associated with buffers WBPW-3 and WBPW-4 and obstructions possibly associated with WBPW-2 and WBPW-4.

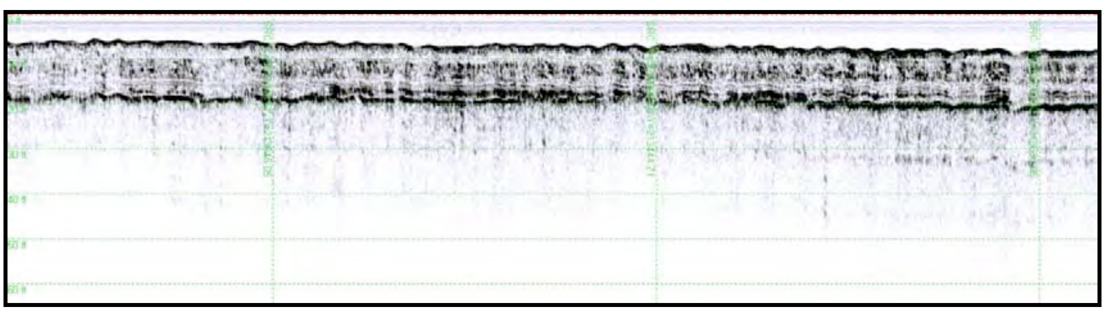

Figure 19. Sub-bottom profiler data sample from the West Pipeline Corridor.

East Pipeline Corridor

Analysis of the magnetic and acoustic data generated by the remote-sensing survey of the East Pipeline Corridor identified a total of 110 magnetic anomalies (Figure 20, 21 and Figure 22; Appendix C) and 1 acoustic signature (Figure 23; Appendix B). Fifty-eight of those anomalies are associated with pipelines. Small single objects account for 30 anomalies and moderate single objects generated 11 additional magnetic signatures. Four anomalies are associated with the sonar image of a wreck and are included in the East Pipeline Corridor buffer WBPE-1.

The remaining 7 anomalies, individually and/or collectively, have signature characteristics suggestive of potentially significant submerged cultural resources are included in buffer WBPE-2. Anomalies in that buffer could be associated with a charted wreck on NOAA Chart 11357 (Figure 24).

Analysis of the East Pipeline Corridor sub-bottom data revealed no buried channels or other relict features in the survey area (Figure 25).

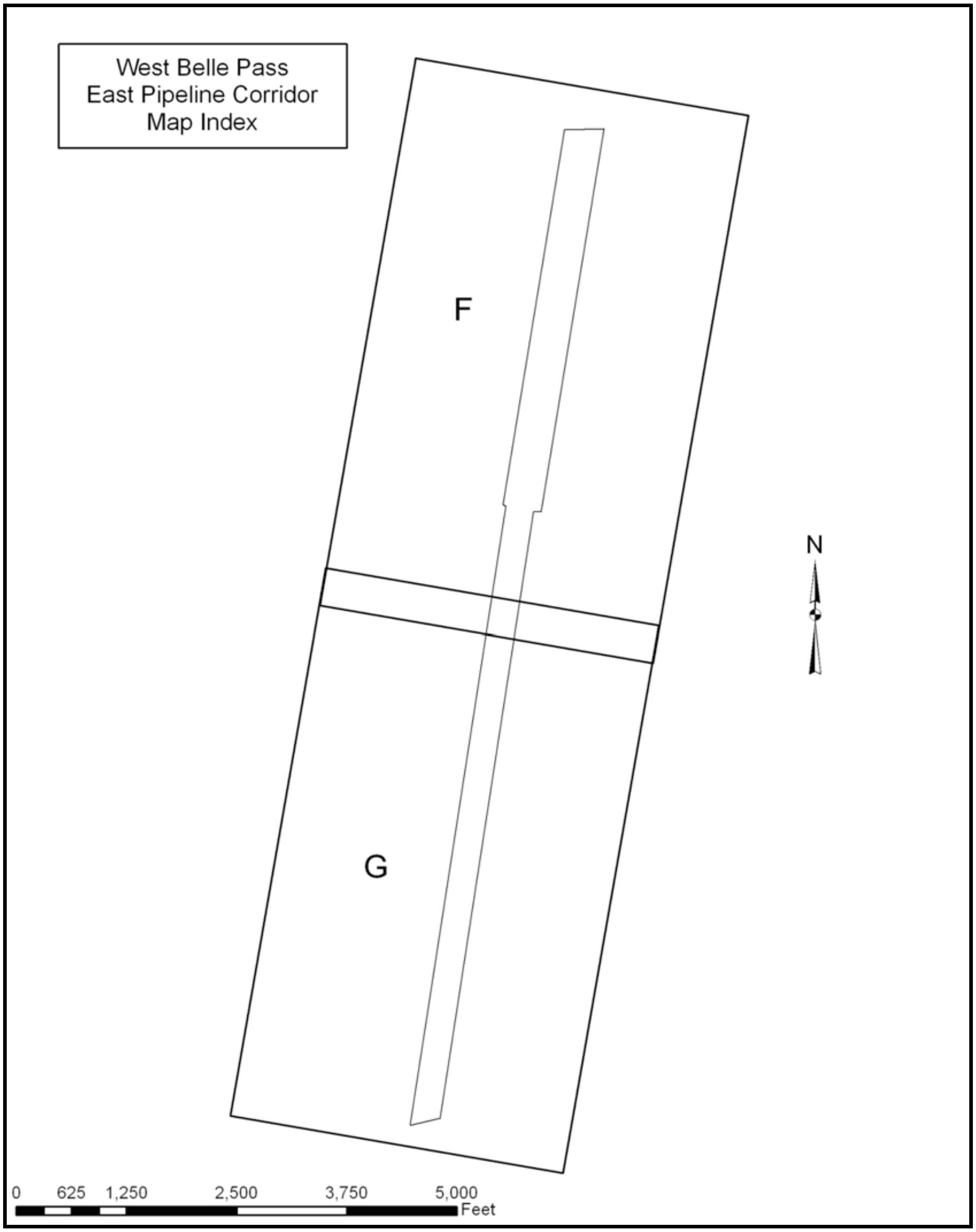

Figure 20. East Pipeline Corridor magnetic contour map index.

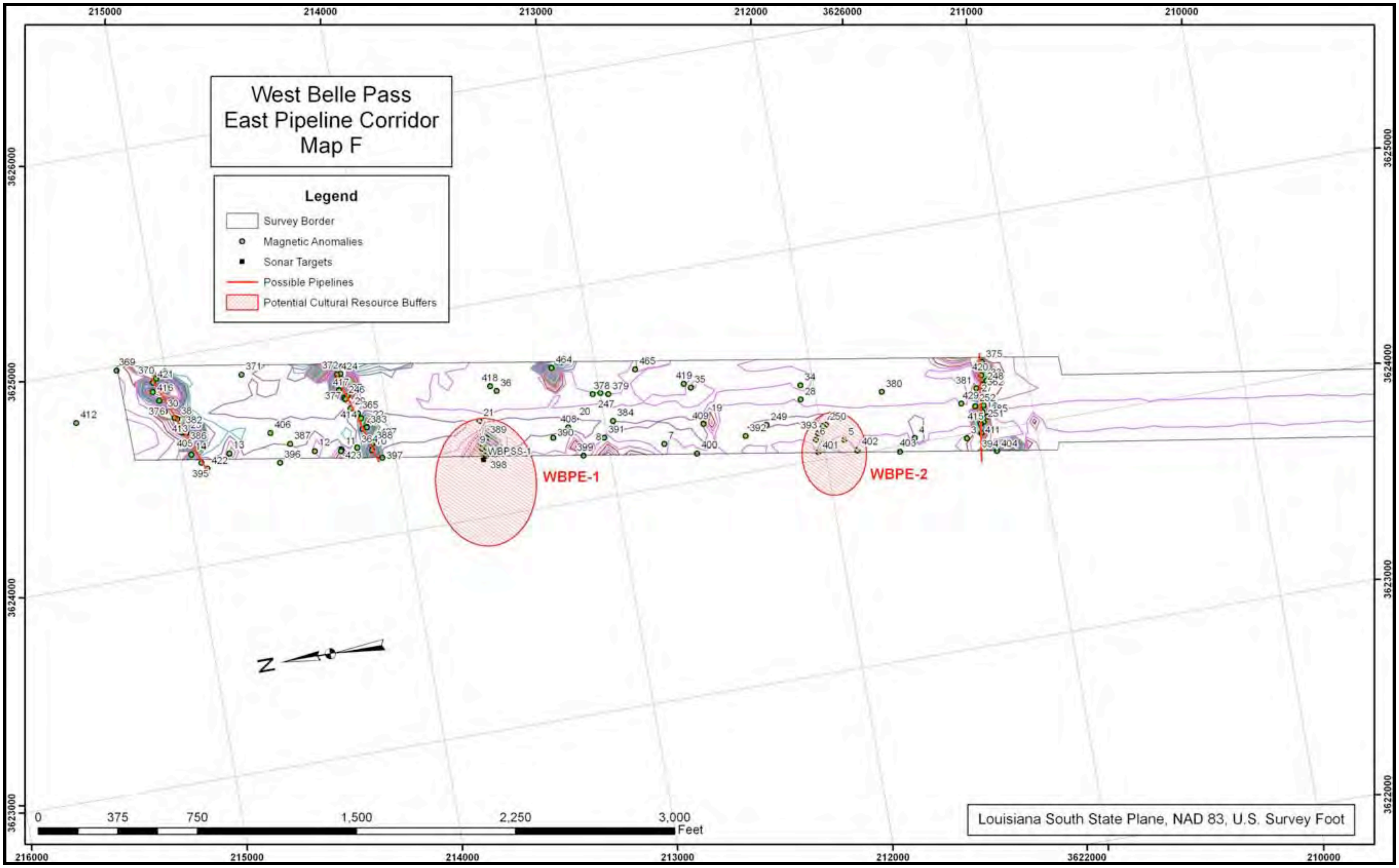

Figure 21. East Pipeline Corridor magnetic contour Map F.

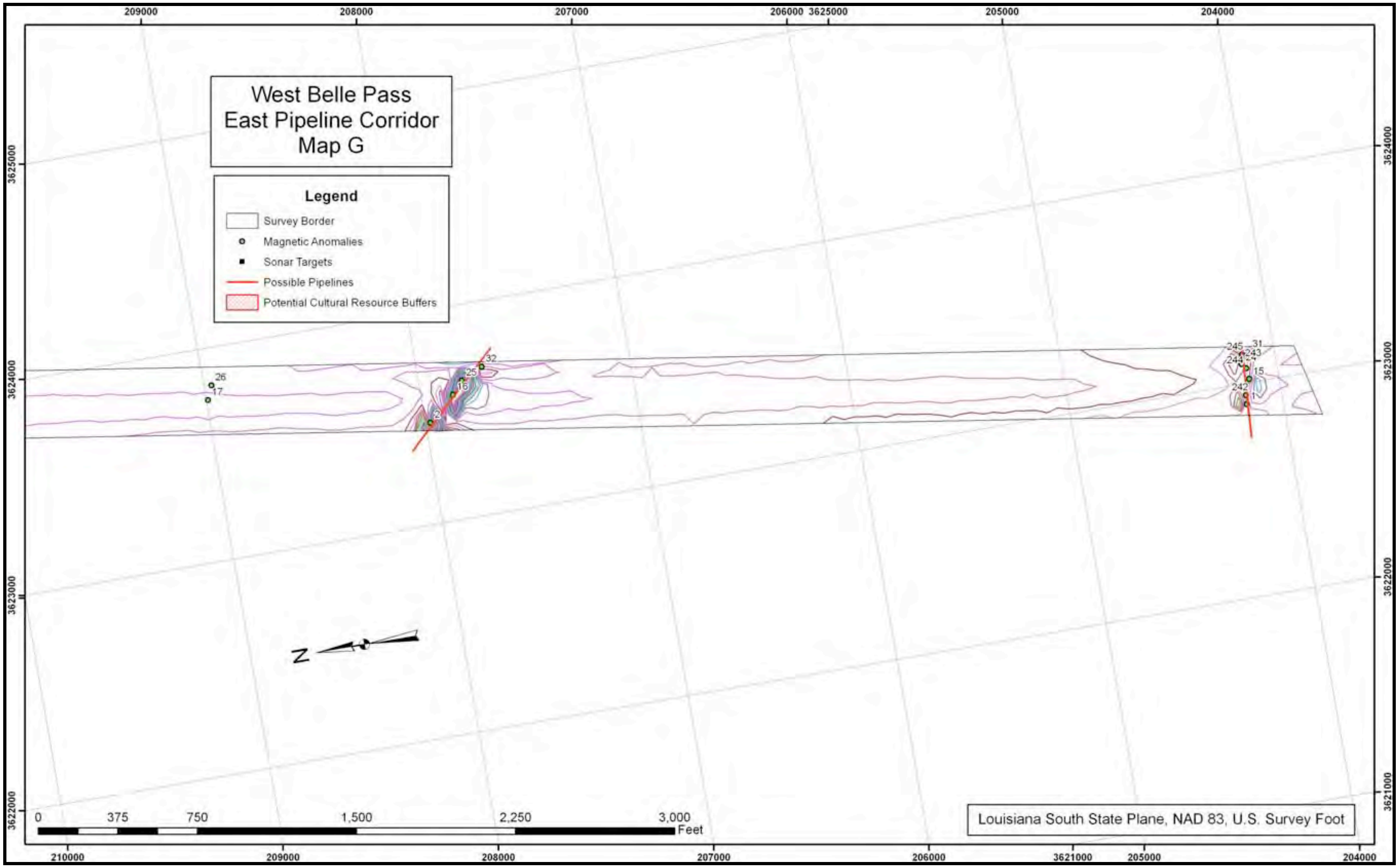

Figure 22. East Pipeline Corridor magnetic contour map G.

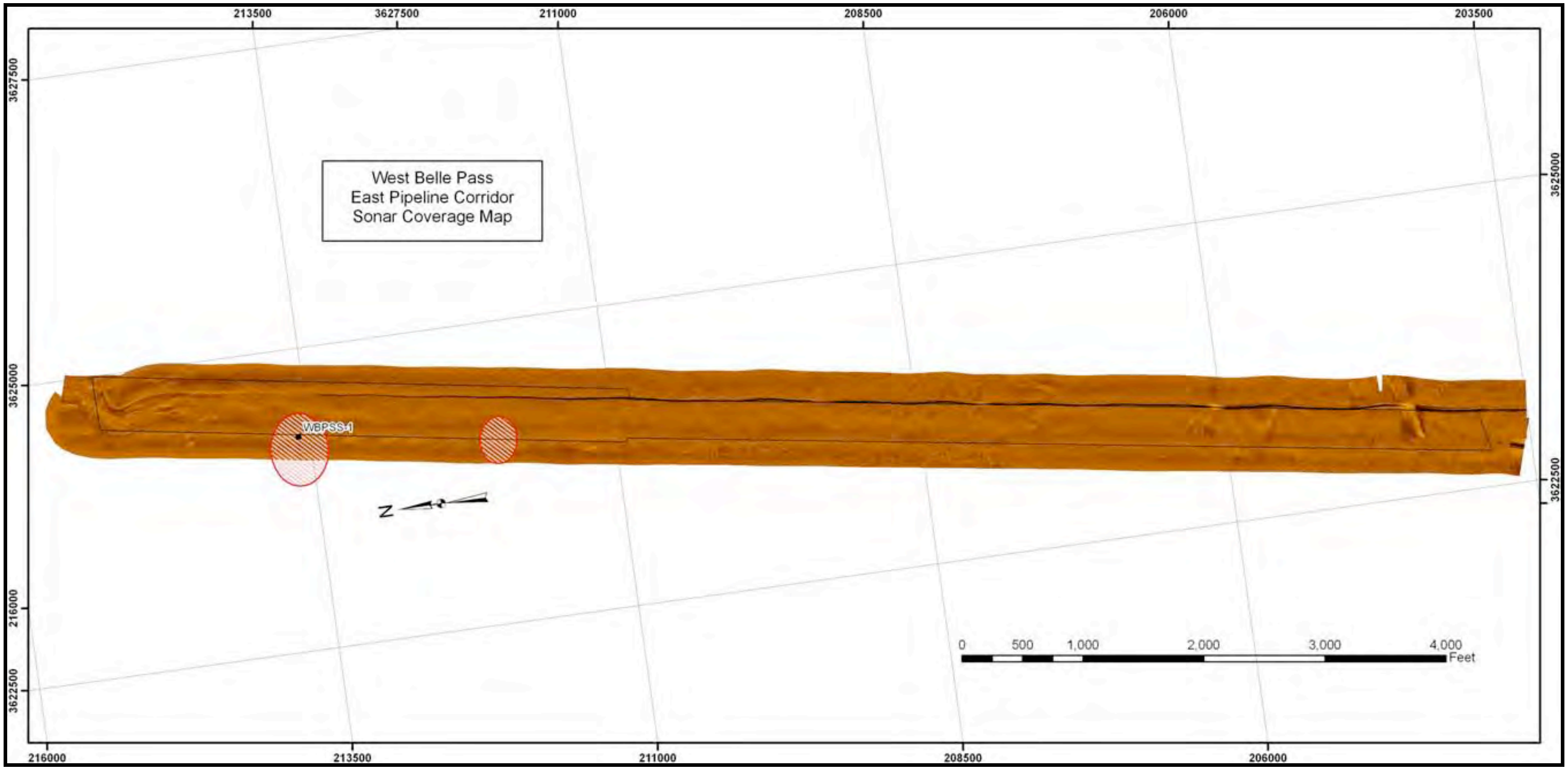

Figure 23. East Pipeline Corridor sonar coverage mosaic with contacts and buffers identified.

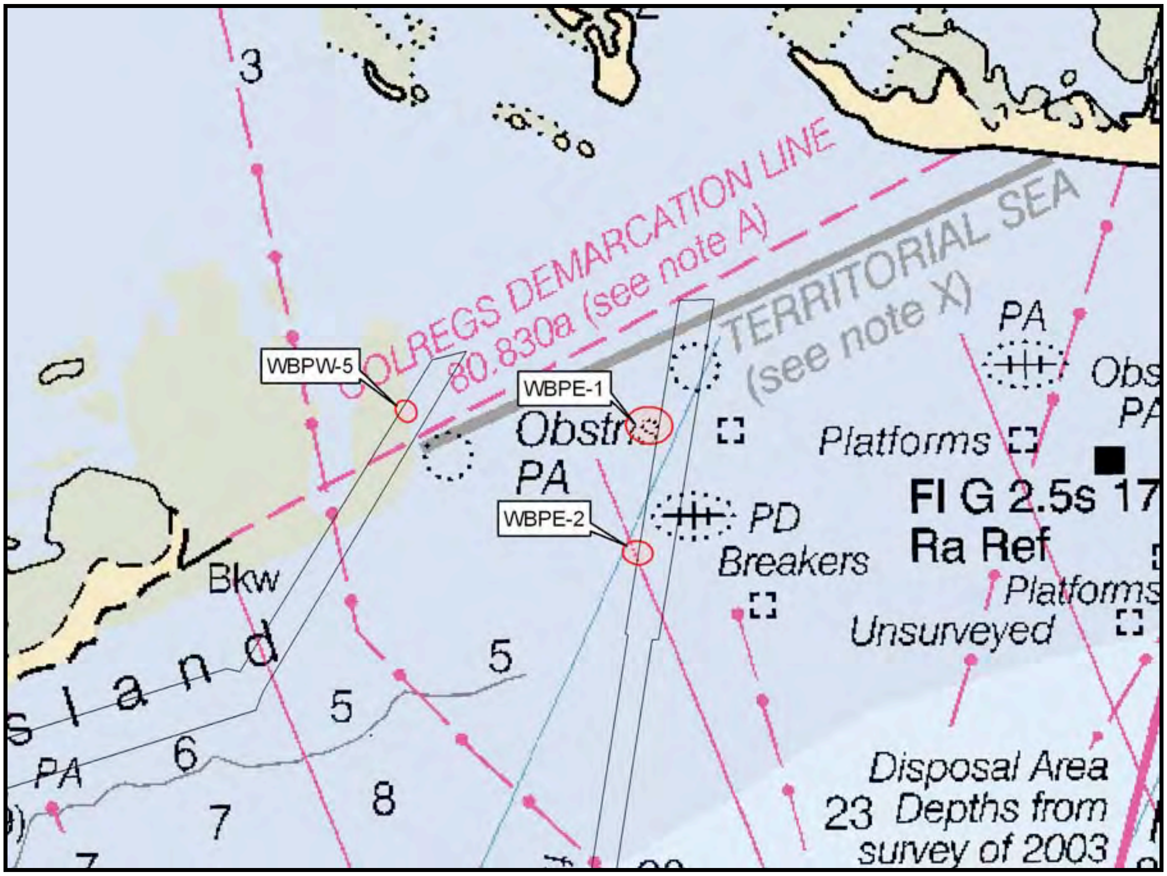

Figure 24. NOAA Chart 11357 showing obstructions and wreck sites associated with buffers WBPW-5, WBPE-1 and WBPE-2.

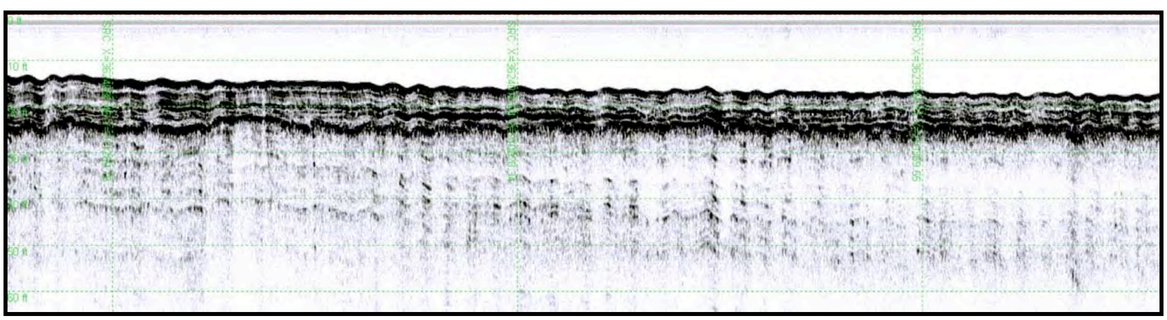
Figure 25. Sub-bottom profiler data sample from the East Pipeline Corridor.

Conclusions and Recommendations

Literature and historical research has confirmed that the maritime traditions of the West Belle Pass region of the Louisiana Gulf Coast reflect the entire spectrum of navigation in the Gulf of Mexico. Documented shipwrecks in the Gulf of Mexico date from the earliest decades of the sixteenth century. They reflect the patterns of maritime activity associated with colonization, development, agriculture, industry, trade, shipbuilding, commerce, warfare, transportation and fishing. As the scope of European settlement increased dramatically in the eighteenth century, the intensity and regularity of maritime activity reflected that development. The historical record confirms that waterborne transportation, communication, trade and fishing has dominated life in the West Belle Pass region of Louisiana.

As a consequence of those international, national and regional maritime activities, the Gulf Coast of Louisiana has been identified as a high probability area for shipwreck resources. Human error, storms and warfare have resulted in the loss of ships in every period of Gulf Coast history. Central Coastal Louisiana and the coast from Isles Dernieres east to the Mississippi River Delta has been identified by MMS as a high probability area for shipwrecks and shipwreck preservation. Statistical probability suggests that most shipwrecks in the project area date from the post-World War II period and were associated with the coastal trade, fishing or oil and gas industry (Pearson et al. 2003, II:4-58). However, the limitations of earlier historical records cannot preclude the distinct possibility of earlier wrecks in the area. In addition, small coastal and fishing vessels lost in the area might never have been reported.

Because the West Belle Pass project area has a high documented potential for shipwreck sites, magnetic and acoustic anomalies identified during the survey should be given careful consideration. The patterns of navigation identified by historical research confirms that the spectrum of vessels employed in the vicinity of the project includes everything from small coastal craft to international merchant and warships. While larger and more modern vessels generate more readily identifiable magnetic and acoustic signatures, small coastal craft can be difficult to detect and identify. For that reason, serious consideration must be given to each anomaly. Unfortunately, maritime activity and natural resource utilization in this region has also produced a considerable volume of modern debris. It can be difficult, to determine whether some anomalies represent a shipwreck, a coastal vessel or modern debris. While pipelines and wells can frequently be identified using charts and geographic information systems data, much of the bottom surface debris is undocumented.

Analysis of the magnetic and acoustic data generated by the remote-sensing survey of the West Pipeline Corridor identified a total of 318 magnetic anomalies and 4 acoustic signatures. The majority are associated with pipelines, seawalls and single objects. The remaining anomalies are considered to have a high potential association with historically significant submerged cultural resources. All are buffered and recommended for avoidance or additional investigation designed to identify and assess material generating the signature. Seven of those anomalies have signature characteristics considered to be indicative of submerged cultural resources and appear to be associated with a wreck on NOAA Chart 11357. Those anomalies are included in buffer WBPW-3. Two potentially significant anomalies are associated with sonar contacts WBPSS-2 and WBPSS-5 and both are included in buffer WBPW-2 for avoidance. The remaining 10 anomalies, individually and/or collectively, have signature characteristics suggestive of potentially significant submerged cultural resources are included in three buffered clusters identified as WBPW-1, WBPW-4 and WBPW-5. All are recommended for avoidance or additional investigation designed to identify and assess material generating the signature.

Analysis of the magnetic and acoustic data generated by the remote-sensing survey of the East Pipeline Corridor identified a total of 110 magnetic anomalies. The majority, 99 anomalies, are associated with pipelines and single ferrous objects. The remaining 11 anomalies are considered to have a high potential association with historically significant submerged cultural resources. All are buffered and recommended for avoidance or additional investigation designed to identify and assess material generating the signature. Four anomalies are associated with the sonar image of a vessel and are included in the East Pipeline Corridor buffer WBPE-1. The remaining 7 anomalies, individually and/or collectively, have signature characteristics suggestive of potentially significant submerged cultural resources are included in buffer WBPE-2. Anomalies in that buffer could be associated with a charted wreck on NOAA Chart 11357. All of the buffered anomalies and the vessel are recommended for avoidance or additional investigation designed to identify and assess material generating the signature.

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Appendix A

West Pipeline Corridor Magnetic Anomalies

(All coordinates Louisiana South State Plane, NAD 83, U.S. Survey Foot)

Cluster	Designation	Characteristics	X	Y	Comments
WBPW-1	283	106-4-pm17g208f	3597327.7	203206.9	Signature characteristics are suggestive of potentially significant cultural material. Avoidance is recommended.
	310	107-7-dp2112g312f	3597358.9	203125.5	Signature characteristics are suggestive of potentially significant cultural material. Avoidance is recommended.
	463	040-14-dp1989g296f	3597366.4	203135.1	Signature characteristics are suggestive of potentially significant cultural material. Avoidance is recommended.
WBPW-2	64	100-4-mc61g551f	3598408.9	203958.4	Signature characteristics are suggestive of potentially significant cultural material. Associated with sonar targets WBPSS-2 and WBPSS-5. Avoidance is recommended.
	259	104-7-dp138g512f	3598434.7	204067.7	Signature characteristics are suggestive of potentially significant cultural material. Associated with sonar targets WBPSS-2 and WBPSS-5. Avoidance is recommended.
WBPW-3	92	101-6-mc928g1246f	3600583.2	204542.8	Magnetic signature characteristics are suggestive of potentially significant cultural material. As this target is located in the proximity of a shipwreck noted on NOAA Chart No. 11357, avoidance is recommended.
	116	102-7-mc589g1219f	3600642.2	204455.7	Magnetic signature characteristics are suggestive of potentially significant cultural material. As this target is located in the proximity of a shipwreck noted on NOAA Chart No. 11357, avoidance is recommended.
	138	103-6-mc2231g780f	3600486.9	204301.6	Magnetic signature characteristics are suggestive of potentially significant cultural material. As this target is located in the proximity of a shipwreck noted on NOAA Chart No. 11357, avoidance is recommended.
	210	D3-7-dp376g252f	3600574.4	204379.9	Magnetic signature characteristics are suggestive of potentially significant cultural material. As this target is located in the proximity of a shipwreck noted on NOAA Chart No. 11357, avoidance is recommended.
	217	D2-6-dp272g315f	3600581.9	204489.9	Magnetic signature characteristics are suggestive of potentially significant cultural material. As this target is located in the proximity of a shipwreck noted on NOAA Chart No. 11357, avoidance is recommended.

WBPW-3, cont'd	223	D1-5-mc83g377f	3600619.1	204608.2	Magnetic signature characteristics are suggestive of potentially significant cultural material. As this target is located in the proximity of a shipwreck noted on NOAA Chart No. 11357, avoidance is recommended.
	232	104-1-mc1155g298f	3600537.8	204326.3	Magnetic signature characteristics are suggestive of potentially significant cultural material. As this target is located in the proximity of a shipwreck noted on NOAA Chart No. 11357, avoidance is recommended.
WBPW-4	76	100-16-dp16g172f	3613335.3	208652.3	Signature characteristics are suggestive of potentially significant cultural material. Avoidance is recommended.
	99	101-13-mc13g117f	3613273.9	208537.2	Signature characteristics are suggestive of potentially significant cultural material. Avoidance is recommended.
	122	102-13-pm14g80f	3613347.9	208443.6	Signature characteristics are suggestive of potentially significant cultural material. Avoidance is recommended.
WBPW-5	85	100-25-mc66g233f	3620986.6	213784.7	Signature characteristics are suggestive of potentially significant cultural material. Avoidance is recommended.
	106	101-20-pm147g113f	3621057.4	213726.3	Signature characteristics are suggestive of potentially significant cultural material. Avoidance is recommended.
	163	D16-3-dp11g147f	3621051.4	213803.2	Signature characteristics are suggestive of potentially significant cultural material. Avoidance is recommended.
	168	D17-3-pm16g157f	3621084.5	213699.8	Signature characteristics are suggestive of potentially significant cultural material. Avoidance is recommended.

Individual Targets

Designation	Characteristics	X	Y	Comments
61	100-1-pm10g176f	3588453.4	200827.9	Moderate Single Object
62	100-2-mc679g181f	3596485.9	203353.2	Associated with a seawall
63	100-3-dp10g100f	3597173.4	203571.5	Small Single Object
65	100-5-mc19g715f	3599119.0	204178.5	Moderate Single Object
66	100-6-nm178g208f	3599694.4	204360.1	Pipeline Associated
67	100-7-dp2045g780f	3600192.1	204517.5	Pipeline Associated
68	100-8-mc825g605f	3600878.2	204731.4	Pipeline Associated
69	100-9-dp128g1176f	3602510.2	205245.2	Pipeline Associated
70	100-10-mc77g427f	3603446.5	205537.3	Pipeline Associated
71	100-11-dp112g477f	3604678.7	205924.7	Pipeline Associated

72	100-12-mc211g1375f	3605361.0	206136.8	Pipeline Associated
73	100-13-dp500g558f	3607151.6	206700.9	Pipeline Associated
74	100-14-mc2577g1305f	3608804.0	207214.4	Pipeline Associated
75	100-15-nm16g101f	3612641.1	208435.4	Associated with a seawall
77	100-17-dp53g282f	3615057.8	209178.9	Pipeline Associated
78	100-18-pm30g116f	3615554.1	209340.9	Moderate Single Object
79	100-19-mc150g443f	3616031.4	209494.0	Pipeline Associated
80	100-20-dp10g214f	3619285.5	210995.0	Moderate Single Object
81	100-21-nm10g74f	3619982.5	212137.5	Small Single Object
82	100-22-mc654g535f	3620128.0	212370.1	Pipeline Associated
83	100-23-mc940g325f	3620692.1	213294.7	Pipeline Associated
84	100-24-dp43g80f	3620895.8	213647.2	Small Single Object
86	100-26-mc356+g539+f	3621267.9	214238.9	Pipeline Associated
87	101-1-pm11g157f	3586980.0	200266.3	Moderate Single Object
88	101-2-mc38g263f	3596580.9	203286.9	Associated with a seawall
89	101-3-mc187g551f	3597855.9	203683.3	Pipeline Associated
90	101-4-mc499g688f	3599189.6	204107.2	Pipeline Associated
91	101-5-pm89g261f	3599738.3	204266.5	Pipeline Associated
93	101-7-pm273g633f	3602562.1	205148.4	Pipeline Associated
94	101-8-mc52g263f	3603563.8	205476.3	Pipeline Associated
95	101-9-mc487g1608f	3605169.7	205974.3	Pipeline Associated
96	101-10-dp262g533f	3607268.8	206643.6	Pipeline Associated
97	101-11-nm10g108f	3607944.6	206855.7	Moderate Single Object
98	101-12-mc1249g983f	3609039.3	207201.4	Pipeline Associated
100	101-14-mc84g161f	3614998.9	209074.0	Pipeline Associated
101	101-15-mc29g372f	3616082.4	209413.8	Pipeline Associated
102	101-16-mc96g295f	3619946.3	211918.0	Moderate Single Object
103	101-17-mc472g440f	3620151.1	212266.0	Pipeline Associated
104	101-18-mc73g381f	3620374.7	212626.9	Pipeline Associated
105	101-19-mc1131g367f	3620860.1	213415.3	Pipeline Associated
107	101-21-mc301g401f	3621310.5	214163.4	Pipeline Associated
108	101-22-dp47g76f	3621516.3	214477.6	Small Single Object
109	101-23-pm58g27f	3621641.9	214693.0	Small Single Object

110	102-1-pm10g187f	3584938.0	199521.0	Moderate Single Object
111	102-2-dp14g129f	3593578.4	202217.9	Moderate Single Object
112	102-3-nm31g130f	3595411.6	202805.3	Moderate Single Object
113	102-4-mc628g748f	3598046.2	203644.2	Pipeline Associated
114	102-5-mc215g626f	3598900.4	203897.4	Pipeline Associated
115	102-6-mc173g709f	3599726.4	204163.1	Pipeline Associated
117	102-8-dp81g1062f	3602542.8	205036.5	Pipeline Associated
118	102-9-dp159g380f	3603597.2	205376.9	Pipeline Associated
119	102-10-mc391g1876f	3605299.8	205915.0	Pipeline Associated
120	102-11-mc571g985f	3607346.6	206566.0	Pipeline Associated
121	102-12-mc142g1264f	3609275.2	207166.2	Pipeline Associated
123	102-14-dp57g181f	3614935.0	208936.3	Pipeline Associated
124	102-15-pm396g397f	3616093.3	209299.2	Pipeline Associated
125	102-16-nm24g100f	3619278.2	210610.6	Moderate Single Object
126	102-17-dp283g171f	3619383.9	210779.5	Moderate Single Object
127	102-18-pm18g63f	3619774.2	211427.1	Small Single Object
128	102-19-mc274g609f	3620172.2	212063.1	Pipeline Associated
129	102-20-mc567g413f	3620522.6	212627.6	Pipeline Associated
130	102-21-mc1737g532f	3621013.2	213439.7	Pipeline Associated
131	102-22-dp477g649f	3621373.7	214044.7	Pipeline Associated
132	102-23-dp64g50f	3621955.7	214957.4	Small Single Object
133	103-1-dp10g82f	3587868.9	200334.2	Small Single Object
134	103-2-pm17g174f	3597717.9	203428.9	Moderate Single Object
135	103-3-mc65g613f	3598068.2	203543.8	Pipeline Associated
136	103-4-dp97g380f	3598889.2	203800.8	Pipeline Associated
137	103-5-mc485g479f	3599702.6	204057.1	Pipeline Associated
139	103-7-mc248g456f	3601030.3	204475.5	Pipeline Associated
140	103-8-dp301g721f	3602596.3	204969.2	Pipeline Associated
141	103-9-pm188g188f	3603688.0	205308.3	Pipeline Associated
142	103-10-dp204g280f	3604797.0	205656.9	Pipeline Associated
143	103-11-dp143g336f	3605181.7	205781.0	Pipeline Associated
144	103-12-dp351g256f	3605539.2	205896.5	Pipeline Associated
145	103-13-nm22g256f	3605822.8	205986.0	Pipeline Associated

146	103-14-mc345g255f	3607452.5	206492.8	Pipeline Associated
147	103-15-dp13g119f	3607721.3	206579.4	Moderate Single Object
148	103-16-mc1719g1598f	3609447.7	207122.9	Pipeline Associated
149	103-17-pm10g89f	3612689.1	208134.1	Small Single Object
150	103-18-mc78g263f	3614889.9	208828.9	Pipeline Associated
151	103-19-mc58g395f	3616149.2	209225.0	Pipeline Associated
152	103-20-dp34g169f	3618203.7	209865.5	Moderate Single Object
153	103-21-pm19g183f	3618411.7	209932.5	Moderate Single Object
154	103-22-mc674g389f	3620200.5	211962.0	Pipeline Associated
155	103-23-mc814g528f	3620665.1	212705.8	Pipeline Associated
156	103-24-dp804g395f	3621156.5	213514.9	Pipeline Associated
157	103-25-dp62g98f	3621385.9	213894.4	Pipeline Associated
158	103-26-pm15g160f	3621614.6	214267.3	Moderate Single Object
159	103-27-mc64g274f	3621822.8	214609.8	Moderate Single Object
160	103-28-mc20g315f	3621984.1	214874.3	Moderate Single Object
161	D16-1-mc2282g337f	3620782.3	213320.0	Pipeline Associated
162	D16-2-mc16g82f	3620975.0	213660.1	Small Single Object
164	D16-4-mc53g439f	3621281.3	214177.5	Pipeline Associated
165	D16-5-pm17g36f	3621562.0	214630.7	Small Single Object
166	D17-1-dp45g60f	3620781.2	213187.8	Small Single Object
167	D17-2-mc1180g377f	3620917.5	213419.3	Pipeline Associated
169	D17-4-mc23g94f	3621170.2	213833.1	Small Single Object
170	D17-5-dp7203g466f	3621339.2	214098.4	Pipeline Associated
171	D17-6-pm29g162f	3621562.0	214460.1	Moderate Single Object
172	D18-1-dp24g59f	3620939.5	213222.2	Small Single Object
173	D18-2-mc821g484f	3621072.6	213455.1	Pipeline Associated
174	D18-3-mc179g350f	3621423.7	214015.6	Pipeline Associated
175	D18-4-pm49g105f	3621728.0	214520.5	Small Single Object
176	D13-1-dp69g222f	3615041.7	209137.0	Pipeline Associated
177	D13-2-pm59g88f	3616044.1	209451.1	Pipeline Associated
178	D14-1-dp62g144f	3614984.2	209014.9	Pipeline Associated
179	D14-2-dp151g170f	3615523.6	209189.5	Moderate Single Object
180	D14-3-pm246g200f	3616088.5	209366.2	Pipeline Associated

181	D15-1-dp91g146f	3614915.2	208885.5	Pipeline Associated
182	D15-2-mc360g360f	3616108.8	209258.9	Pipeline Associated
183	D7-1-dp106g345f	3605104.4	206011.1	Pipeline Associated
184	D7-2-dp138g236f	3605363.6	206099.6	Pipeline Associated
185	D8-1-mc295g326f	3604746.3	205798.2	Pipeline Associated
186	D8-2-dp306g333f	3605145.9	205924.7	Pipeline Associated
187	D8-3-dp168g269f	3605418.9	206009.4	Pipeline Associated
188	D8-4-mc37g138f	3605791.8	206112.0	Pipeline, associated with sonar target WBPSS-3
189	D9-1-dp257g197f	3604771.3	205682.5	Pipeline Associated
190	D9-2-dp198g362f	3605159.0	205810.2	Pipeline Associated
191	D9-3-dp211g280f	3605458.7	205915.1	Pipeline Associated
192	D9-4-mc238g369f	3605803.8	206016.0	Pipeline Associated
193	D4-1-pm81g247f	3602521.4	205198.4	Pipeline Associated
194	D4-2-pm188g161f	3603482.6	205501.2	Pipeline Associated
195	D5-1-dp345g610f	3602551.9	205105.1	Pipeline Associated
196	D5-2-pm297g187f	3603580.3	205430.0	Pipeline Associated
197	D6-1-nm467g190f	3603606.1	205347.8	Pipeline Associated
198	D6A-1-dp192g517f	3602571.2	205005.5	Pipeline Associated
199	D6A-2-nm488g225f	3603616.5	205352.8	Pipeline Associated
200	D6B-1-dp112g339f	3602616.4	204916.3	Pipeline Associated
201	D6B-2-dp600g362f	3603743.3	205262.7	Pipeline Associated
202	D6C-1-pm395g356f	3602631.6	204810.4	Pipeline Associated
203	D6C-2-pm181g382f	3603808.2	205168.4	Pipeline Associated
204	D3-1-mc1304g613f	3598050.2	203580.8	Pipeline Associated
205	D3-2-nm189g378f	3598888.2	203848.9	Pipeline Associated
206	D3-nm70g231f	3599561.2	204063.5	Pipeline Associated
207	D3-4-pm362g207f	3599737.4	204118.3	Pipeline Associated
208	D3-5-nm323g201f	3600186.4	204258.5	Pipeline Associated
209	D3-6-mc129g238f	3600343.5	204306.4	Pipeline Associated
211	D3-8-mc770g455f	3600995.2	204505.3	Pipeline Associated
212	D2-1-mc667g569f	3598053.6	203698.6	Pipeline Associated
213	D2-2-dp330g345f	3598920.4	203966.3	Pipeline Associated
214	D2-3-mc92g429f	3599440.0	204135.5	Pipeline Associated

215	D2-4-nm413g257f	3599719.1	204217.2	Pipeline Associated
216	D2-5-mc94g457f	3600194.9	204363.9	Pipeline Associated
218	D2-7-mc560g417f	3600972.0	204619.0	Pipeline Associated
219	D1-1-pm19g226f	3598010.2	203773.8	Pipeline Associated
220	D1-2-mc425g707f	3599129.2	204128.2	Pipeline Associated
221	D1-3-pm173g290f	3599702.2	204306.6	Pipeline Associated
222	D1-4-mc225g498f	3600206.8	204466.7	Pipeline Associated
224	D1-6-mc756g307f	3600966.0	204698.3	Pipeline Associated
225	D1-7-pm82g104f	3601681.5	204941.2	Moderate Single Object
226	006-1-dp670g492+f	3598859.5	203702.5	Pipeline Associated
227	005-1-mc263g296f	3598927.2	203909.5	Pipeline Associated
228	003-1-nm449g192f	3599025.0	204127.3	Pipeline Associated
229	001-1-nm466g140f	3599197.1	204159.7	Pipeline Associated
230	016-1-dp75g264f	3599428.0	204144.1	Pipeline Associated
231	014-1-mc106g316f	3599662.1	204017.7	Pipeline Associated
234	100-1-mc409g463f	3600906.6	204440.6	Pipeline Associated
235	098-1-mc1472g511f	3600959.5	204749.9	Pipeline Associated
236	119-1-mc970g621f	3602508.9	205137.0	Pipeline Associated
237	117-1-dp8g109f	3602734.2	205165.3	Small Single Object
238	092-1-mc357g254f	3603440.8	205504.0	Pipeline Associated
239	090-1-dp475g221f	3603748.3	205239.3	Pipeline Associated
240	063-1-mc1336g577+f	3605390.8	206142.8	Pipeline Associated
241	064-1-pm133g302f	3605603.2	205856.9	Pipeline Associated
253	104-1-pm8g247f	3585047.4	199878.9	Moderate Single Object
254	104-2-dp71g182f	3588339.1	200900.6	Moderate Single Object
255	104-3-pm13g160f	3589920.9	201400.9	Moderate Single Object
256	104-4-dp39g112f	3591352.9	201843.0	Moderate Single Object
257	104-5-mc23g157f	3595233.6	203066.6	Moderate Single Object
258	104-6-mc173g382f	3596385.5	203425.8	Associated with a seawall
260	104-8-nm10g92f	3598984.4	204245.9	Pipeline Associated
261	104-9-pm503g480f	3599692.0	204459.4	Pipeline Associated
262	104-10-mc341g753f	3600253.9	204634.2	Pipeline Associated
263	104-11-dp843g355f	3600950.9	204857.6	Pipeline Associated

264	104-12-nm214g441f	3602501.2	205346.7	Pipeline Associated
265	104-13-pm467g256f	3603393.6	205625.5	Pipeline Associated
266	104-14-nm11g128f	3603559.4	205680.7	Moderate Single Object
267	104-15-pm263g325f	3604664.8	206020.3	Pipeline Associated
268	104-16-mc2966g1285f	3605489.6	206289.8	Pipeline Associated
269	104-17-dp12g152f	3606283.2	206546.6	Moderate Single Object
270	104-18-dp23g90f	3606502.5	206609.1	Small Single Object
271	104-19-dp85g195f	3606792.4	206695.4	Moderate Single Object
272	104-20-dp1082g263f	3607064.6	206784.3	Pipeline Associated
273	104-21-mc2486g1402f	3608569.0	207258.7	Pipeline Associated
274	104-22-pm13g81f	3611599.2	208203.9	Small Single Object
275	104-23-dp22g82f	3612378.9	208448.7	Small Single Object
276	104-24-nm13g148f	3612622.4	208531.9	Associated with a seawall
277	104-25-dp47g318f	3615149.2	209339.6	Pipeline Associated
278	104-26-pm273g157f	3616016.8	209610.1	Pipeline Associated
279	104-27-dp10g69f	3617187.0	209976.4	Small Single Object
280	106-1-dp12g81f	3590524.6	201046.4	Small Single Object
281	106-2-pm19g90f	3593764.4	202083.2	Small Single Object, associated with sonar target WBPSS-4
282	106-3-pm13g67f	3594520.5	202311.9	Small Single Object
284	106-5-pm97g280f	3598172.3	203475.3	Pipeline Associated
285	106-6-pm408g373f	3598875.2	203694.8	Pipeline Associated
286	106-7-dp22g375f	3599692.6	203949.6	Pipeline Associated
287	106-8-mc848g534f	3600221.1	204113.8	Pipeline Associated
288	106-9-mc342g657f	3601030.0	204368.1	Pipeline Associated
289	106-10-pm14g98f	3601462.2	204500.3	Small Single Object
290	106-11-dp115g444f	3602615.2	204846.5	Pipeline Associated
291	106-12-dp276g353f	3603750.8	205218.8	Pipeline Associated
292	106-13-dp95g286f	3604817.2	205556.6	Pipeline Associated
293	106-14-dp164g399f	3605174.0	205663.4	Pipeline Associated
294	106-15-pm58g477f	3605659.0	205821.2	Pipeline Associated
295	106-16-nm28g110f	3605922.5	205901.9	Pipeline Associated
296	106-17-dp232g877f	3607559.2	206412.0	Pipeline Associated
297	106-18-mc1734g1484f	3609701.9	207090.2	Pipeline Associated

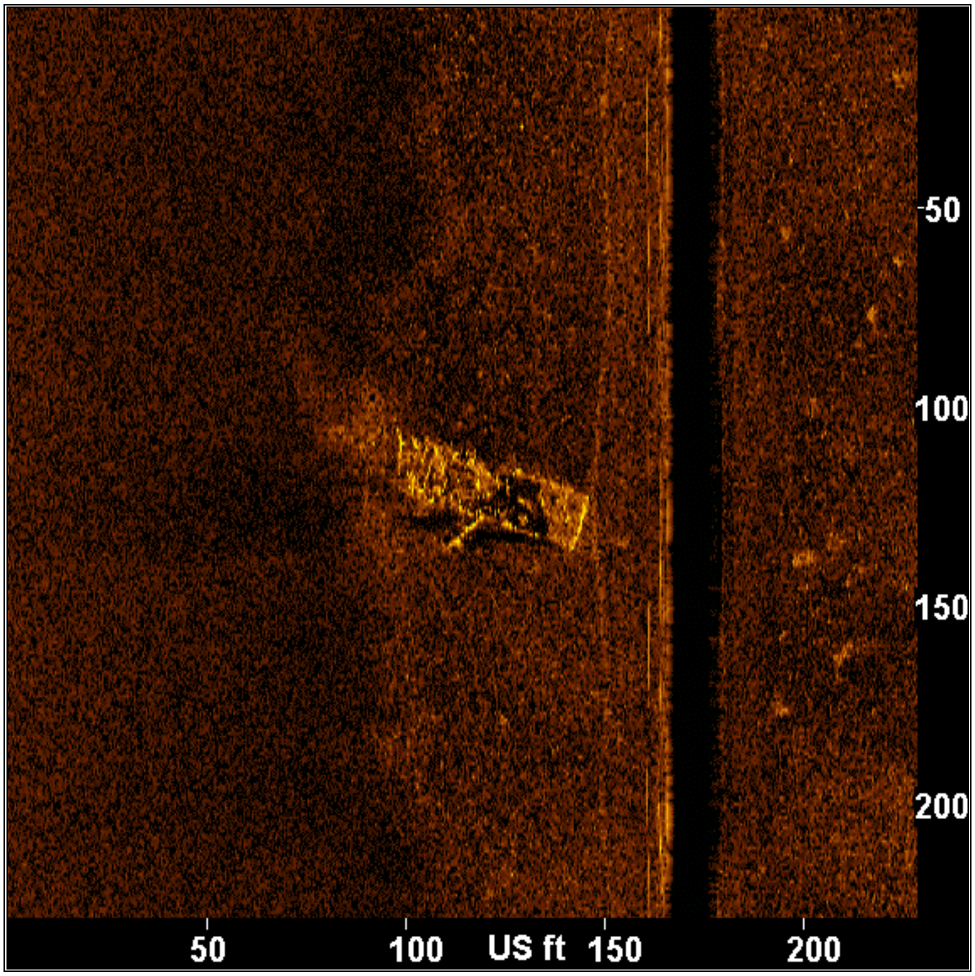
298	106-19-nm28g108f	3612837.8	208076.7	Small Single Object
299	106-20-mc49g226f	3614831.9	208683.9	Pipeline Associated
300	106-21-dp12g124f	3616188.5	209123.7	Pipeline Associated
301	106-22-dp12g179f	3616650.6	209278.6	Moderate Single Object
302	106-23-dp8g119f	3618146.9	209754.1	Small Single Object
303	106-24-nm5g107f	3618274.8	209796.9	Small Single Object
304	107-1-mc29g379f	3585224.6	199298.4	Moderate Single Object
305	107-2-pm12g127f	3590177.6	200859.5	Moderate Single Object
306	107-3-dp10g87f	3591631.2	201310.0	Small Single Object
307	107-4-dp26g129f	3595686.8	202586.2	Moderate Single Object
308	107-5-pm30g111f	3596140.7	202732.9	Moderate Single Object
309	107-6-mc25g386f	3596722.1	202916.4	Moderate Single Object
311	107-8-pm17g66f	3598272.0	203400.4	Small Single Object
312	107-9-nm519g419f	3598971.2	203624.1	Pipeline Associated
313	107-10-mc376g645f	3600141.0	203984.0	Pipeline Associated
314	107-11-mc291g477f	3601064.6	204278.9	Pipeline Associated
315	107-12-dp81g411f	3602676.1	204781.1	Pipeline Associated
316	107-13-dp252g396f	3603867.4	205156.0	Pipeline Associated
317	107-14-pm237g412f	3604865.3	205472.3	Pipeline Associated
318	107-15-dp145g405f	3605210.6	205580.6	Pipeline Associated
319	107-16-dp140g432f	3605764.9	205753.4	Pipeline Associated
320	107-17-mc102g629f	3607671.3	206356.7	Pipeline Associated
321	107-18-mc1136g803f	3609883.2	207045.2	Pipeline Associated
322	107-19-dp36g230f	3614785.4	208588.8	Pipeline Associated
323	107-20-dp53g163f	3616221.1	209054.6	Pipeline Associated
324	108-1-dp89g139f	3598302.7	203308.4	Small Single Object
325	108-2-pm348g261f	3599065.3	203541.2	Pipeline Associated
326	108-3-mc2085g1003f	3600026.3	203868.5	Pipeline Associated
327	108-4-mc137g465f	3601087.3	204169.7	Pipeline Associated
328	001-1-dp72g185f	3604673.7	205987.9	Pipeline Associated
329	001-2-mc327g930f	3605502.4	206253.7	Pipeline Associated
330	002-1-pm265g270f	3604691.9	205887.8	Pipeline Associated
331	002-dp93g306f	3605111.9	206013.3	Pipeline Associated

332	002-3-nm86g247f	3605364.0	206091.4	Pipeline Associated
333	003-1-mc156g310f	3604747.2	205804.7	Pipeline Associated
334	003-2-dp216g306f	3605146.3	205916.4	Pipeline Associated
335	003-3-nm189g234f	3605427.8	206019.6	Pipeline Associated
336	003-4-mc33g135f	3605812.0	206120.1	Pipeline, associated with sonar target WBPSS-3
337	004-1-dp172g238f	3604765.5	205692.9	Pipeline Associated
338	004-2-dp84g323f	3605145.6	205821.1	Pipeline Associated
339	004-3-mc119g208f	3605480.2	205917.3	Pipeline Associated
340	004-4-mc364g366f	3605804.3	206030.8	Pipeline Associated
341	005-1-dp41g240f	3604806.8	205617.0	Pipeline Associated
342	005-2-mc95g416f	3605204.0	205732.8	Pipeline Associated
343	005-3-pm128g394f	3605626.8	205863.1	Pipeline Associated
344	066-1-pm269g254f	3604829.3	205514.4	Pipeline Associated
345	006-2-dp116g402f	3605187.0	205625.3	Pipeline Associated
346	006-3-mc55g215f	3605709.0	205777.1	Pipeline Associated
347	006-4-pm20g88f	3605934.8	205873.3	Pipeline Associated
348	007-1-nm147g122f	3604888.5	205432.1	Pipeline Associated
349	007-2-dp131g276f	3605222.5	205534.4	Pipeline Associated
350	007-3-dp109g317f	3605804.2	205715.8	Pipeline Associated
351	008-1-dp112g284f	3605214.9	205420.9	Pipeline Associated
352	008-2-mc223g273f	3605842.5	205620.8	Pipeline Associated
353	009B-1-pm359g230f	3604950.9	205241.8	Pipeline Associated
354	009B-2-dp116g279f	3605256.8	205332.0	Pipeline Associated
355	009B-3-pm371g250f	3605924.8	205550.7	Pipeline Associated
356	010-1-mc155g1217f	3605257.6	205223.8	Pipeline Associated
357	011-1-pm57g104f	3605018.8	205057.8	Pipeline Associated
358	011-2-mc570g919f	3605396.9	205173.4	Pipeline Associated
359	011-3-pm96g194f	3606047.7	205380.8	Pipeline Associated
433	041-1-dp56g193f	3616645.6	209293.7	Moderate Single Object
434	041-2-mc45g153f	3616174.1	209136.0	Pipeline Associated
435	041-3-dp148g219f	3614846.8	208726.6	Pipeline Associated
436	041-4-pm32g95f	3612822.2	208092.1	Small Single Object
437	041-5-mc508g939f	3609681.3	207096.8	Pipeline Associated

438	041-6-nm129g623f	3607501.6	206420.1	Pipeline Associated
439	041-7-pm97g286f	3605629.3	205829.2	Pipeline Associated
440	041-8-dp154g465f	3605167.7	205682.1	Pipeline Associated
441	041-9-dp68g150f	3604820.4	205576.0	Pipeline Associated
442	041-10-dp585g364f	3603737.7	205230.8	Pipeline Associated
443	041-11-mc146g387f	3602612.3	204883.4	Pipeline Associated
444	041-12-nm27g91f	3601443.6	204514.4	Small Single Object
445	041-13-nm521g408f	3601031.4	204389.4	Pipeline Associated
446	041-14-mc1212g807f	3600212.5	204124.9	Pipeline Associated
447	041-15-dp32g404f	3599680.1	203958.8	Pipeline Associated
448	041-16-pm504g359f	3598869.0	203706.4	Pipeline Associated
449	041-17-pm151g229f	3598157.0	203480.4	Pipeline Associated
450	040-1-dp63g195f	3616225.5	209058.4	Pipeline Associated
451	040-2-pm46g120f	3614798.9	208608.3	Pipeline Associated
452	040-3-mc1803g1250f	3609864.6	207059.6	Pipeline Associated
453	040-4-dp114g846f	3607652.3	206371.7	Pipeline Associated
454	040-5-dp241g438f	3605763.8	205771.6	Pipeline Associated
455	040-6-dp80g367f	3605213.8	205593.6	Pipeline Associated
456	040-7-pm286g404f	3604866.1	205485.3	Pipeline Associated
457	040-8-pm165g397f	3603836.6	205173.4	Pipeline Associated
458	040-9-dp91g301f	3602656.7	204784.1	Pipeline Associated
459	040-10-dp647g541f	3601019.2	204286.3	Pipeline Associated
460	040-11-dp676g987f	3600121.5	203992.2	Pipeline Associated
461	040-12-nm419g413f	3598957.9	203634.5	Pipeline Associated
462	040-13-dp11g77f	3598452.4	203487.7	Small Single Object

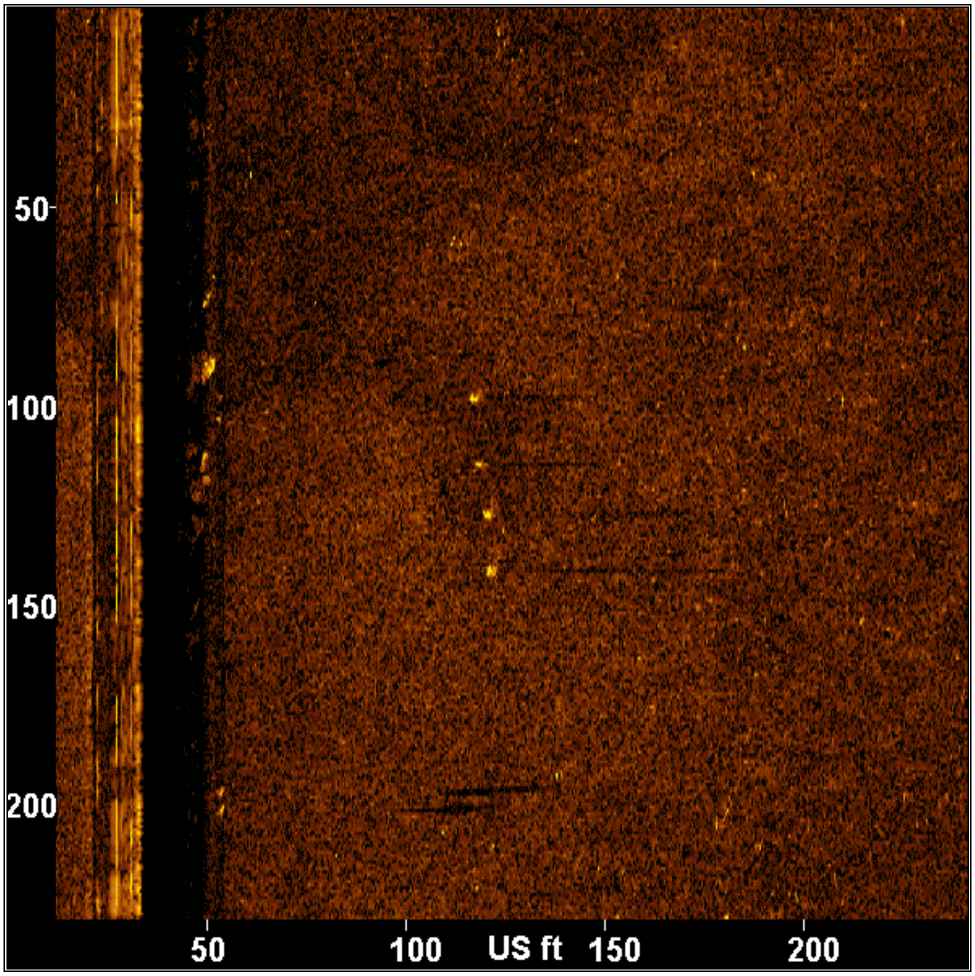
Appendix B
Sonar Contacts

WBPSS-1



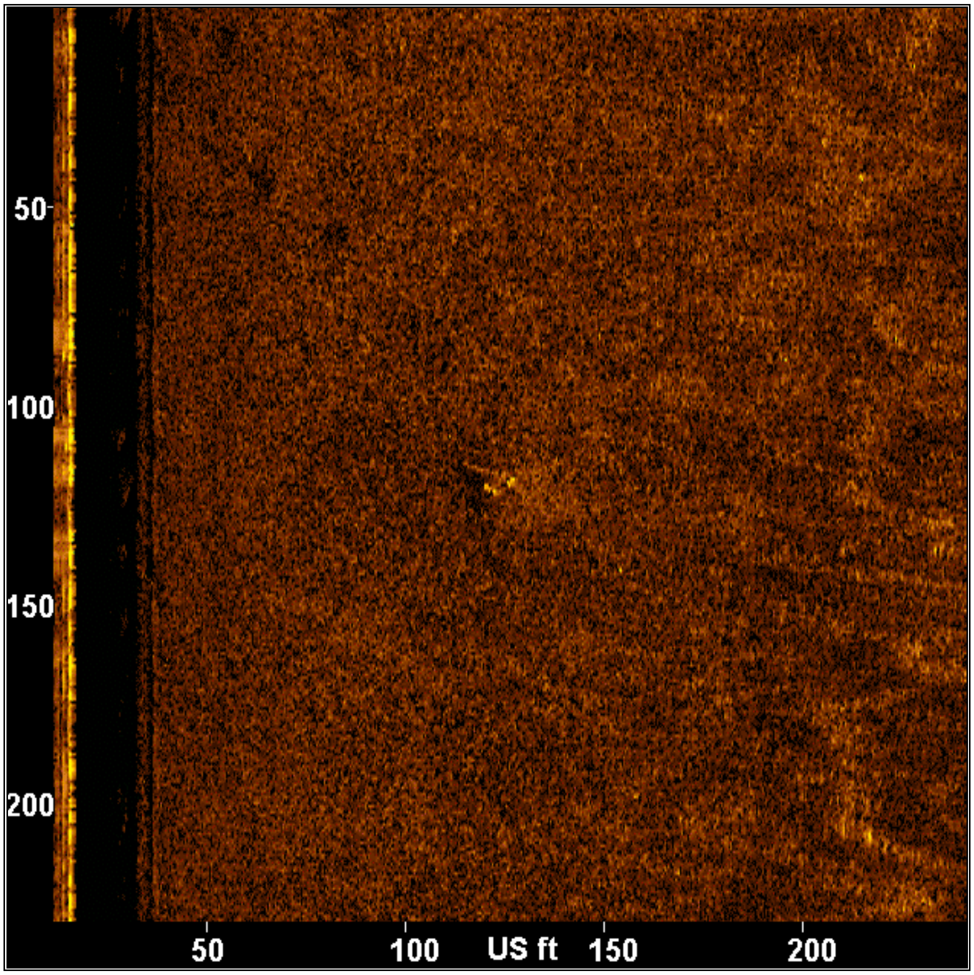
Contact Info: WBPSS-1	User Entered Info
• Sonar Time at Target: 05/06/2010 09:17:20 • Click Position (Lat/Lon Coordinates) 29.0828819275 -90.2582015991 (WGS84) • Click Position (Projected Coordinates) (X) 3624271.00 (Y) 213591.72 • Map Proj: • Acoustic Source File: G:\WBP GEOPHYS\SSS\WBP_PC_001_NE.jsf • Ping Number: 40494 • Range to Target: 15.50 US Feet • Fish Height: 1.44 US Feet • Event Number: 0 • Line Name: WBP_PC_001_NE	Target Height >= 0.0 US Feet Target Length0.0 US Feet Target Shadow:0.0 US Feet Target Width:0.0 US Feet Mag Anomaly: Avoidance Area: Classification 1: Wreck Classification 2: Area: Block: Description: Wreck

WBPSS-2



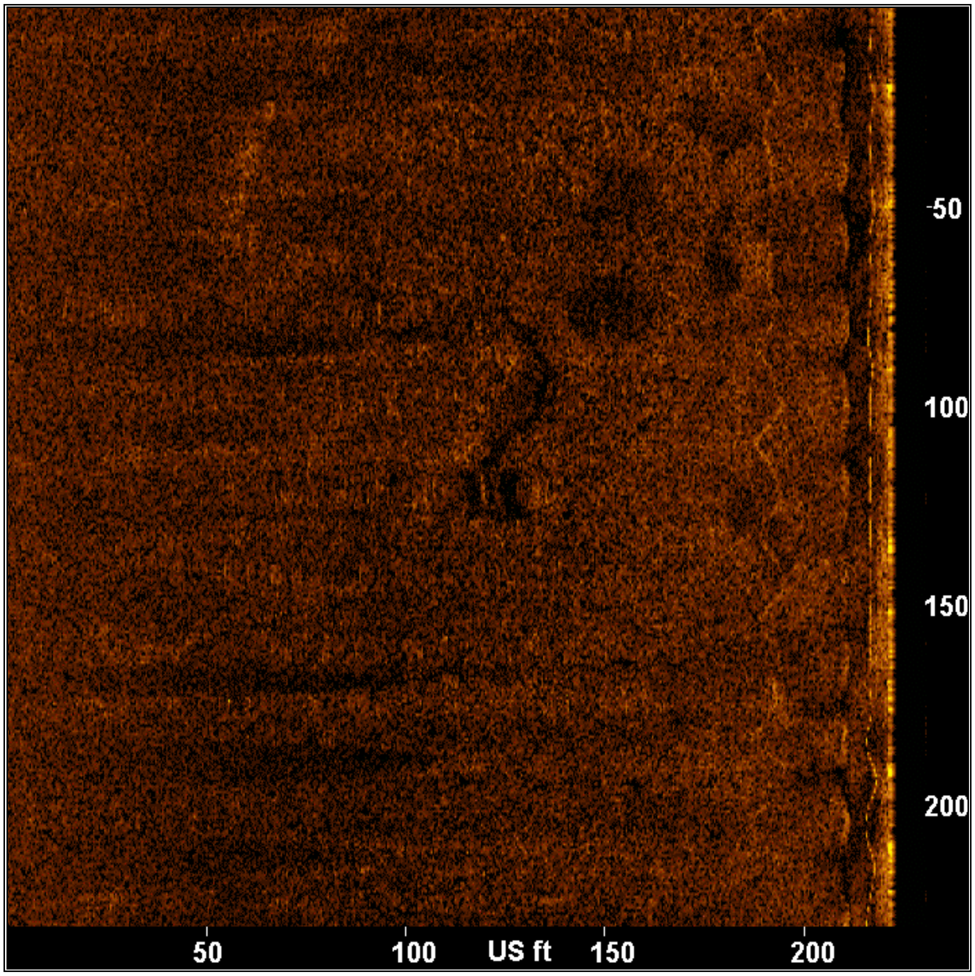
Contact Info: WBPSS-2	User Entered Info
• Sonar Time at Target: 05/06/2010 14:29:00 • Click Position (Lat/Lon Coordinates) 29.0573463440 -90.3393249512 (WGS84) • Click Position (Projected Coordinates) (X) 3598437.50 (Y) 204072.19 • Map Proj: • Acoustic Source File: G:\WBP GEOPHYS\SSS\WBP_PC_100_SW.002.jsf • Ping Number: 172380 • Range to Target: 25.16 US Feet • Fish Height: 1.44 US Feet • Event Number: 0 • Line Name: WBP_PC_100_SW.002	Target Height >= 0.0 US Feet Target Length0.0 US Feet Target Shadow:0.0 US Feet Target Width:0.0 US Feet Mag Anomaly: Avoidance Area: Classification 1: Classification 2: Area: Block: Description: Four Pilings

WBPSS-3



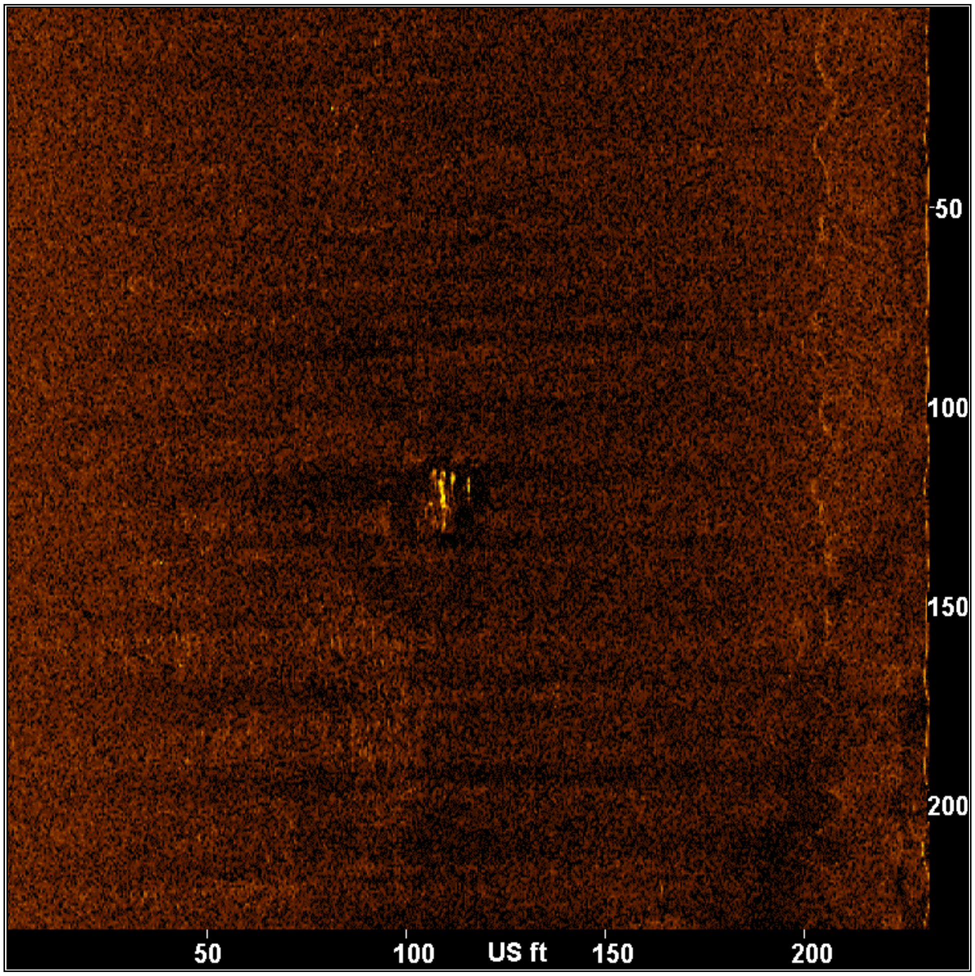
Contact Info: WBPSS-3	User Entered Info
• Sonar Time at Target: 05/06/2010 15:59:04 • Click Position (Lat/Lon Coordinates) 29.0627040863 -90.3162384033 (WGS84) • Click Position (Projected Coordinates) (X) 3605797.00 (Y) 206085.22 • Map Proj: • Acoustic Source File: G:\WBP GEOPHYS\SSS\WBP_PC_101_NE.001.jsf • Ping Number: 222873 • Range to Target: 30.32 US Feet • Fish Height: 1.44 US Feet • Event Number: 0 • Line Name: WBP_PC_101_NE.001	Target Height >= 0.0 US Feet Target Length0.0 US Feet Target Shadow:0.0 US Feet Target Width:0.0 US Feet Mag Anomaly: Avoidance Area: Classification 1: Classification 2: Area: Block: Description: Debris

WBPSS-4



Contact Info: WBPSS-4	User Entered Info
• Sonar Time at Target: 05/09/2010 14:47:33 • Click Position (Lat/Lon Coordinates) 29.0521068573 -90.3539733887 (WGS84) • Click Position (Projected Coordinates) (X) 3593773.00 (Y) 202126.44 • Map Proj: • Acoustic Source File: H:\WBP GEOPHYS\SSS\WBP_PC_107_NE.jsf • Ping Number: 119824 • Range to Target: 32.47 US Feet • Fish Height: 1.44 US Feet • Event Number: 0 • Line Name: WBP_PC_107_NE	Target Height >= 0.0 US Feet Target Length0.0 US Feet Target Shadow:0.0 US Feet Target Width:0.0 US Feet Mag Anomaly: Avoidance Area: Classification 1: Classification 2: Area: Block: Description:

WBPSS-5



Contact Info: WBPSS-5	User Entered Info
• Sonar Time at Target: 05/09/2010 12:04:29 • Click Position (Lat/Lon Coordinates) 29.0576725006 -90.3396835327 (WGS84) • Click Position (Projected Coordinates) (X) 3598323.50 (Y) 204189.50 • Map Proj: • Acoustic Source File: H:\WBP GEOPHYS\SSS\WBP_PC_104_NE.001.jsf • Ping Number: 28407 • Range to Target: 39.50 US Feet • Fish Height: 1.44 US Feet • Event Number: 0 • Line Name: WBP_PC_104_NE.001	Target Height >= 0.0 US Feet Target Length0.0 US Feet Target Shadow:0.0 US Feet Target Width:0.0 US Feet Mag Anomaly: Avoidance Area: Classification 1: Classification 2: Area: Block: Description:

Appendix C

East Pipeline Corridor Magnetic Anomalies

(All coordinates Louisiana South State Plane, NAD 83, U.S. Survey Foot)

Cluster	Designation	Characteristics	X	Y	Comments
WBPE-1	9	001-9-mc222g489f	3624324.8	213590.6	Associated with a wreck visible in sonar target WBPSS-1. Avoidance is recommended.
	21	002-7-mc9g510f	3624452.4	213581.0	Associated with a wreck visible in sonar target WBPSS-1. Avoidance is recommended.
	389	026-4-dp30g366f	3624367.9	213563.0	Associated with a wreck visible in sonar target WBPSS-1. Avoidance is recommended.
	398	027-4-mc1158g358f	3624287.8	213575.0	Associated with a wreck visible in sonar target WBPSS-1. Avoidance is recommended.
WBPE-2	5	001-5-mc10g138f	3624070.8	211901.0	Magnetic signature characteristics suggest that material generating the anomaly could be associated with the remains of a vessel or potentially significant culture resource. Avoidance is recommended.
	6	001-6-pm30g86f	3624094.5	212033.6	Magnetic signature characteristics suggest that material generating the anomaly could be associated with the remains of a vessel or potentially significant culture resource. Avoidance is recommended.
	250	D19-2-mc42g110f	3624156.2	211974.2	Magnetic signature characteristics suggest that material generating the anomaly could be associated with the remains of a vessel or potentially significant culture resource. Avoidance is recommended.
	393	026-8-mc63g158f	3624121.7	212017.6	Magnetic signature characteristics suggest that material generating the anomaly could be associated with the remains of a vessel or potentially significant culture resource. Avoidance is recommended.
	401	027-7-pm11g69f	3624037.2	212030.6	Magnetic signature characteristics suggest that material generating the anomaly could be associated with the remains of a vessel or potentially significant culture resource. Avoidance is recommended.
	402	027-8-mc114g162f	3624014.1	211847.7	Magnetic signature characteristics suggest that material generating the anomaly could be associated with the remains of a vessel or potentially significant culture resource. Avoidance is recommended.
	410	025-6-mc35g135f	3624152.4	211989.1	Magnetic signature characteristics suggest that material generating the anomaly could be associated with the remains of a vessel or potentially significant culture resource. Avoidance is recommended.

Individual Anomalies

Designation	Characteristics	X	Y	Comments
1	001-1-dp90g1637f	3622901.2	204170.7	Pipeline Associated
2	001-2-mc327g402f	3623472.9	207977.2	Pipeline Associated
3	001-3-mc127g385f	3623979.3	211330.6	Pipeline Associated
4	001-4-dp46g103f	3624022.4	211573.0	Moderate Single Object
7	001-7-mc26g142f	3624197.4	212740.4	Moderate Single Object
8	001-8-mc76g348f	3624248.8	213079.0	Moderate Single Object
10	001-10-dp172g199f	3624406.4	214102.4	Pipeline Associated
11	001-11-mc14g101f	3624432.2	214243.1	Small Single Object
12	001-12-nm34g56f	3624447.4	214368.2	Small Single Object
13	001-13-mc47g116f	3624505.0	214767.0	Moderate Single Object
14	001-14-mc826g232f	3624529.4	214944.2	Pipeline Associated
15	002-1-dp88g1187f	3623017.6	204138.6	Pipeline Associated
16	002-2-dp224g574f	3623584.3	207848.7	Pipeline Associated
17	002-3-dp12g125f	3623757.0	208990.9	Moderate Single Object
18	002-4-dp263g281f	3624089.3	211236.7	Pipeline Associated
19	002-5-dp114g151f	3624291.5	212517.9	Moderate Single Object
20	002-6-mc27g100f	3624381.7	213133.8	Small Single Object
22	002-8-dp147g265f	3624534.0	214094.2	Pipeline Associated
23	002-9-mc1820g410f	3624631.6	214950.3	Pipeline Associated
24	003-1-fp65g1617f	3623091.6	204162.3	Pipeline Associated
25	003-2-dp259g663f	3623642.9	207796.2	Pipeline Associated
26	003-3-mc5g140f	3623822.7	208963.4	Moderate Single Object
27	003-4-mc111g470f	3624165.3	211247.4	Pipeline Associated
28	003-5-mc11g168f	3624293.3	212071.2	Moderate Single Object
29	003-6-mc101g199f	3624613.9	214168.2	Pipeline Associated
30	003-7-mc630g616f	3624749.4	215035.0	Pipeline Associated
31	004-1-dp70g983f	3623142.5	204121.4	Pipeline Associated
32	004-2-nm127g209f	3623691.3	207693.2	Pipeline Associated
33	004-3-dp69g931f	3624230.3	211192.1	Pipeline Associated
34	004-4-dp9g40f	3624359.4	212061.1	Small Single Object
35	004-5-dp36g99f	3624437.3	212572.3	Small Single Object

36	004-6-nm15g97f	3624577.9	213476.7	Small Single Object
37	004-7-dp417g261f	3624675.5	214171.9	Pipeline Associated
38	004-8-mc264g437+f	3624704.8	214982.3	Pipeline Associated
242	D22-1-dp79g512f	3622943.2	204166.8	Pipeline Associated
243	D23A-1-dp58g439f	3623106.3	204163.3	Pipeline Associated
244	D23B-1-nm109g333f	3623068.6	204144.1	Pipeline Associated
245	D24-1-dp69g477f	3623135.2	204152.0	Pipeline Associated
246	D21-1-dp173g170f	3624668.1	214189.2	Pipeline Associated
247	D21-2-mc24g118f	3624485.5	212996.3	Small Single Object
248	D21-3-mc118g442f	3624216.8	211212.3	Pipeline Associated
249	D19-1-dp53g110f	3624203.0	212250.1	Moderate Single Object
251	D19-3-dp358g483f	3624042.5	211238.9	Pipeline Associated
252	D20-1-mc40g152f	3624122.3	211266.8	Pipeline Associated
362	006-1-mc922g519f	3624189.1	211217.1	Pipeline Associated
364	013-1-pm12g40f	3624427.8	214168.1	Small Single Object
365	013-2-mc234g289f	3624585.9	214138.6	Pipeline Associated
369	020-1-dp15g34f	3624978.9	215224.5	Small Single Object
370	020-2-mc1192g203f	3624909.0	215048.2	Pipeline Associated
371	020-3-dp11g37f	3624859.2	214648.2	Small Single Object
372	020-4-dp881g194f	3624783.6	214187.7	Pipeline Associated
375	020-7-nm474g143f	3624321.0	211199.9	Pipeline Associated
376	022-1-mc751g233f	3624805.2	215050.0	Pipeline Associated
377	022-2-dp271g136f	3624661.4	214184.6	Pipeline Associated
378	022-3-pm14g41f	3624485.9	213032.5	Small Single Object
379	022-4-nm25g65f	3624472.7	212959.8	Small Single Object
380	022-5-pm10g50f	3624263.7	211689.0	Small Single Object
381	022-6-dp644g384f	3624204.8	211246.7	Pipeline Associated
382	024-1-dp1313g416f	3624657.9	214969.2	Pipeline Associated
383	024-2-mc148g242f	3624512.7	214109.5	Pipeline Associated
384	024-3-dp32g75f	3624345.6	212960.1	Small Single Object
385	024-4-mc49g150f	3624063.5	211218.6	Pipeline Associated
386	026-1-mc298g474f	3624581.3	214960.6	Pipeline Associated
387	026-2-dp24g80f	3624498.7	214477.6	Small Single Object

388	026-3-mc164g121f	3624434.5	214096.0	Pipeline Associated
390	026-5-dp17g49f	3624314.7	213251.5	Small Single Object
391	026-6-pm23g66f	3624274.2	213014.8	Small Single Object
392	026-7-dp16g83f	3624168.0	212355.9	Small Single Object
394	026-9-dp373g317f	3623992.6	211258.3	Pipeline Associated
395	027-1-dp902g308f	3624484.9	214903.9	Pipeline Associated
396	027-2-dp10g102f	3624421.6	214538.8	Small Single Object
397	027-3-dp102g211f	3624362.7	214060.0	Pipeline Associated
399	027-5-dp13g72f	3624209.4	213124.0	Small Single Object
400	027-6-dp28g79f	3624128.7	212595.3	Small Single Object
403	027-9-pm10g46f	3623973.1	211651.5	Small Single Object
404	027-10-mc188g220f	3623899.4	211201.1	Pipeline Associated
405	025-1-mc634g438+f	3624638.6	214972.7	Pipeline Associated
406	025-2-nm10g109f	3624564.8	214560.7	Small Single Object
407	0258-3-dp133g235f	3624509.0	214128.9	Pipeline Associated
408	025-4-mc41g105f	3624351.4	213172.8	Small Single Object
409	025-5-dp140g105f	3624258.0	212542.8	Moderate Single Object
411	025-7-dp186g391f	3624035.4	211254.0	Pipeline Associated
412	023-1-pm13g54+f	3624768.1	215454.1	Small Single Object
413	023-2-mc367g513f	3624712.7	214992.4	Pipeline Associated
414	023-3-nm341g89f	3624559.6	214127.9	Pipeline Associated
415	023-4-mc56g296f	3624119.0	211226.3	Pipeline Associated
416	021-1-mc685g339f	3624850.0	215072.9	Pipeline Associated
417	021-2-dp505g235f	3624707.4	214207.0	Pipeline Associated
418	021-3-nm12g81f	3624605.6	213501.8	Small Single Object
419	021-4-pm37g67f	3624460.6	212602.1	Small Single Object
420	021-5-dp54g719f	3624260.8	211212.9	Pipeline Associated
421	037-1-dp2239g514f	3624893.7	215065.0	Pipeline Associated
422	038-1-mc594g455f	3624452.4	214882.1	Pipeline Associated
423	035-1-dp10g41f	3624425.3	214246.4	Small Single Object
424	035-2-mc301g326f	3624782.1	214204.8	Pipeline Associated
427	036-2-mc281g216f	3624445.2	214075.0	Pipeline Associated
429	033-2-pm15g70f	3624145.0	211328.8	Small Single Object

464	020-5-dp101g92f	3624640.7	213203.1	Moderate Single Object
465	020-6-dp44g86f	3624566.8	212815.5	Small Single Object


Legend
SIDESCAN TARGETS
BREAKWATER/GROIN FIELD
CHARTED PIPELINES
AS RUN TRACKLINES
OIL/GAS PIPELINE AVOIDANCE BUFFERS
CULTURAL RESOURCE BUFFERS
PROPOSED PIPELINE CORRIDOR
N
S
E
W
CPE
COASTAL PLANNING & ENGINEERING
0
2,250
4,500
9,000
Feet
0
0.25
0.5
1
Nautical Miles
Caillou Boca
Gas and Oil Well Structures
Obstn PA
(Exposed pipelines)
Spoil
TOWER
Breakers
Little Pass Timbalier
Platforms
Subm pip PA
7980-Y-4682
COLREGS DEMARCATION LINE
80.830a (see note A)
Legend
MAGNETOMETER TARGETS
POTENTIAL SUBBOTTOM TARGETS
SIDESCAN TARGET
JET PROBE DIVE
1) UNCONFIRMED CHARTED PIPELINE
2) UNCONFIRMED CHARTED PIPELINE
3) UNCONFIRMED CHARTED PIPELINE
4) CONFIRMED PIPELINE MAGNETOMETER CONFIRMATION SUBBOTTOM CONFIRMATION (1-2 FT OF COVER)
5) CONFIRMED PIPELINE MAGNETOMETER CONFIRMATION SUBBOTTOM CONFIRMATION (4-5 FT OF COVER)
6) CONFIRMED PIPELINE MAGNETOMETER CONFIRMATION
7) CONFIRMED PIPELINE MAGNETOMETER CONFIRMATION SUBBOTTOM CONFIRMATION (2-3 FT OF COVER)
8) CONFIRMED PIPELINE MAGNETOMETER CONFIRMATION SUBBOTTOM CONFIRMATION (0-6 FT OF COVER) SIDESCAN CONTACT CONFIRMATION
9) UNCONFIRMED CHARTED PIPELINE
10) CONFIRMED PIPELINE MAGNETOMETER CONFIRMATION SUBBOTTOM CONFIRMATION (0-2 FT OF COVER) SIDESCAN CONTACT CONFIRMATION
11) CONFIRMED PIPELINE MAGNETOMETER CONFIRMATION SUBBOTTOM CONFIRMATION (1-2 FT OF COVER)
12) CONFIRMED PIPELINE MAGNETOMETER CONFIRMATION SUBBOTTOM CONFIRMATION (1-2 FT OF COVER)
13) CONFIRMED PIPELINE MAGNETOMETER CONFIRMATION
14) CONFIRMED PIPELINE MAGNETOMETER CONFIRMATION SUBBOTTOM CONFIRMATION (1-5 FT OF COVER) DIVER CONFIRMATION (3 FT OF COVER)
15) CONFIRMED PIPELINE MAGNETOMETER CONFIRMATION SUBBOTTOM CONFIRMATION (2-3 FT OF COVER)
16) CONFIRMED PIPELINE MAGNETOMETER CONFIRMATION SUBBOTTOM CONFIRMATION (1-7 FT OF COVER)
17) CONFIRMED PIPELINE MAGNETOMETER CONFIRMATION SUBBOTTOM CONFIRMATION (0-4 FT OF COVER) SIDESCAN CONTACT CONFIRMATION
18) CONFIRMED PIPELINE MAGNETOMETER CONFIRMATION SUBBOTTOM CONFIRMATION (1-6 FT OF COVER) DIVER CONFIRMATION (2 FT OF COVER)
19) CONFIRMED PIPELINE MAGNETOMETER CONFIRMATION SUBBOTTOM CONFIRMATION (0.5-1 FT OF COVER) DIVER CONFIRMATION (1.5 FT OF COVER)
20) CONFIRMED PIPELINE MAGNETOMETER CONFIRMATION SUBBOTTOM CONFIRMATION (6-7 FT OF COVER)
21) CONFIRMED PIPELINE MAGNETOMETER CONFIRMATION SUBBOTTOM CONFIRMATION (1-2 FT OF COVER) SIDESCAN CONTACT CONFIRMATION
22) CONFIRMED PIPELINE MAGNETOMETER CONFIRMATION SUBBOTTOM CONFIRMATION (0.5-4 FT OF COVER)
23) CONFIRMED PIPELINE MAGNETOMETER CONFIRMATION SUBBOTTOM CONFIRMATION (1-2 FT OF COVER)
24) CONFIRMED PIPELINE MAGNETOMETER CONFIRMATION SUBBOTTOM CONFIRMATION (0.5-8 FT OF COVER)
25) CONFIRMED PIPELINE MAGNETOMETER CONFIRMATION SUBBOTTOM CONFIRMATION (2-8 FT OF COVER)
26) CONFIRMED PIPELINE MAGNETOMETER CONFIRMATION
27) CONFIRMED PIPELINE MAGNETOMETER CONFIRMATION SUBBOTTOM CONFIRMATION (1-2.5 FT OF COVER) DIVER CONFIRMATION (3 FT OF COVER)
28) CONFIRMED PIPELINE MAGNETOMETER CONFIRMATION SUBBOTTOM CONFIRMATION (1-2 FT OF COVER)