CAMINADA HEADLAND
BEACH AND DUNE RESTORATION
INCREMENT II (BA-143)

APPENDIX H

OFFSHORE PUMP-OUT AREAS AND CONVEYANCE CORRIDORS SURVEY REPORTS

LAFOURCHE & JEFFERSON PARISHES, LOUISIANA

STATE OF LOUISIANA
COASTAL PROTECTION AND RESTORATION AUTHORITY

MARCH 2014

Note: Offshore No.1 Pump-Out Area known as Offshore West and Offshore No.2 Pump-Out Area known as Offshore East for Caminada Headland Increment I (BA-45)

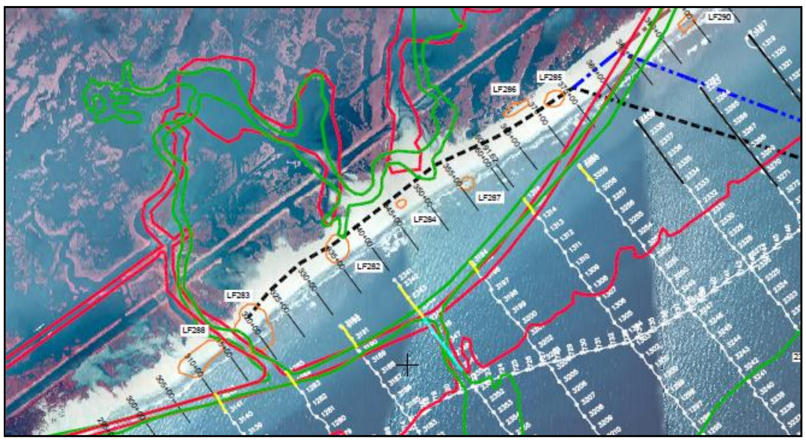
FINAL REPORT

Caminada Headland Beach and Dune Restoration Project (BA-45)

Marine Archaeological Sensitivity Assessment of the Underwater Portions of the Belle Pass (Lower and Upper), Pass Fourchon, and Offshore (West and East) Dredged Materials Conveyance Corridor and Pump-Out Alternatives

Lafourche Parish, Louisiana

February 2012



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INTRODUCTION

This report presents the results of a marine archaeological sensitivity assessment of the underwater portions of three conceptual dredged materials conveyance corridor and pump-out alternatives located in Lafourche Parish, Louisiana. The study was performed by Fathom Research, LLC ("Fathom"), under a sub-contract with Ocean Surveys, Inc. ("OSI"), on behalf of Coastal Engineering Consultants, Inc. ("CEC") and the State of Louisiana's Coastal Protection and Restoration Authority ("CPRA") between December 2010 and February 2012 (Figures 1 and 2). CPRA is serving as the local sponsor for the Caminada Headland Beach and Dune Restoration Project (BA-45) (the "Project"), which is part of the Coastal Impact Assistance Program ("CIAP").

The Project involves restoration through beach and dune fill placement (utilizing an offshore sand resource) approximately 31,000 feet ("ft") of shoreline to create 330 acres ("ac") of beach and dune habitat at the western end of the Caminada Headland between the east jetty at Belle Pass (Station 0+00) eastward to the approximate location of Bayou Moreau (Station 315+00) (Figure 3). CEC is working with OSI and Project team members Gulf Engineers & Consultants ("GEC"), GeoEngineers ("GEO"), and Picciola & Associates, Inc. ("Picciola") to assist CPRA with the planning, engineering and environmental permitting of the Project.

PROJECT LOCATION AND DESCRIPTION

The specific research foci of this marine archaeological sensitivity assessment are the underwater portions of three conceptual dredged materials conveyance corridor and pump-out areas identified as the "Belle Pass (Lower and Upper)," "Pass Fourchon," and "Offshore" (West and East) alternatives (see Figure 2 herein, as well as Figure 2 in OSI 2012b). The three conveyance corridor/pump-out area alternatives have been designed to convey the sand from hopper dredges or scow barges to the Headland restoration template.

The Belle Pass Alternative (Lower and Upper)

The Belle Pass alternative consists of "Lower" and "Upper" proposed pump-out areas (see Figure 2). The Lower Belle Pass pump-out area is proposed for a location near the inner end of the east jetty at the mouth of Belle Pass in charted water depths of four to nine ft. The Upper Belle Pass pump-out area is proposed for a location approximately 6,000 ft up Belle Pass, along its eastern bank, in charted water depths of two to 15 ft. If selected, some dredging would be required in both the lower and upper portions of the area to facilitate the siting of a booster pump/pump-out barge against the shoreline, moored alongside the hopper dredge or scow barges. From their locations, the discharge pipe would be laid along the water-bottom of Belle Pass, parallel to the shoreline, maintaining a buffer distance from navigational channel limits and extending to the fill template near the northern terminus on the eastern jetty.

The Pass Fourchon Alternative

The proposed Pass Fourchon alternative is situated along the Pass's southern bank between its junction with Belle Pass and its southeastern terminus on the backside of the Headland in charted water depths of three to 26 ft (see Figure 2). If selected, this alternative would require some dredging between the channel and the eastern jetty to avoid interference with vessel traffic. As currently planned, the discharge pipe would be placed in Pass Fourchon along its southern bank and routed eastward along the course of the Pass before crossing over to its eastern bank at the British Petroleum ("B.P.") canal. From that point, the pipe would then cross the Chevron facility access road before extending out onto the Headland. The sediment pipeline would be ballasted to an adequate water depth, so as to not impede vessel traffic where it would cross Pass Fourchon. At the proposed sediment pipeline crossing of the access road to the Chevron facility, a vehicular access ramp across the sediment pipeline would be constructed. This conveyance "corridor method" has been used in the past during previous episodes of Pass Fourchon maintenance dredging.

The Offshore Alternative (West and East Options)

The proposed Offshore alternative consists of the originally proposed option (i.e., the "West Option") and an additional "East Option" added in 2011 (see Figure 2 in OSI 2012b), which are situated approximately five nautical miles ("nm") east of Belle Pass in Louisiana State waters of the Gulf of Mexico (see Figures 2 and 4). The proposed West Option location was originally selected by Project engineers based, in part, on their review of historic databases, later verified through the magnetometer survey conducted by Picciola (2011), which indicated that the proposed West Option's route would avoid existing submarine pipelines.

The configuration and orientation of the West Option was revised slightly and the East Option was added in 2012 in response to concerns regarding the Project's possible impacts to archaeological deposits comprising the Cathy 1 Site (16LF283) and the potential for the archaeologically sensitive natural levees of a submerged and buried bend of Bayou Moreau to be preserved near shore.

In either option of the proposed Offshore alternative, sand resources handled within it would be either dumped directly onto the seafloor from hopper dredges or scow barges where they would be re-handled by a cutter-head dredge to convey them towards shore, or the sand resource could be discharged directly to the fill template through use of a booster pump/pump-out barge. Both methods would require a temporary discharge pipeline be laid on the sea floor. Use of bottom-dump scows or hopper dredges would likely require the excavation of a containment pit to accumulate sufficient volume for a cutter-head dredge to efficiently re-handle the sediment. Once the containment pit was loaded, the cutter-head dredge would empty it and then shut down until it was refilled. Use of a floating or jack-up booster/pump-out barge is another technically feasible option under consideration.

STUDY GOALS AND OBJECTIVES

The phases of any marine archaeological investigation reflect the preservation planning standards for the identification, evaluation, registration, and treatment of cultural resources (National Park Service ["NPS"] 1983). The two primary goals of this marine archaeological investigation were: 1) to evaluate the archaeological sensitivity of the three alternatives; and 2) to provide management recommendations concerning the need and scope of additional marine archaeological investigations that could be warranted within the study areas based on the results of the assessment.

These goals were met by completing several principal objectives. These objectives were to:

- briefly summarize the region's environmental setting and cultural history;

- provide a brief synopsis of the results from previously completed archaeological investigations, as well as those of pertinent recently completed environmental investigations conducted by the Consultant team in and near the study areas; and

- inventory previously identified archaeological sites (e.g., submerged former terrestrial sites, as well as any shipwrecks or abandoned watercraft, such as those documented elsewhere in Louisiana's waters [Louisiana Office of Cultural Development ("OCD") 2011:12]).

PROJECT AUTHORITY

As the overall Project requires review and permitting by a federal agency (i.e., the U.S. Army Corps of Engineers ["USACE"], as well as the U.S. Department of the Interior's Bureau of Ocean Energy Management ["BOEM"], and other federal agencies), in addition to state, local and tribal authorities that are also involved in its review, it constitutes a federal "undertaking" for which compliance with Section 106 of the National Historic Preservation Act ("NHPA") of 1966, as amended (36 CFR 800), is required. Section 106 of the NHPA requires federal agencies take into account the effects of their undertakings on cultural resources listed or eligible for listing in the National Register of Historic Places ("NRHP") (36 CFR 60). The agency must also afford the Advisory Council on Historic Preservation the opportunity to comment on the undertaking. The Section 106 process is coordinated at the state level by the State Historic Preservation Offices ("SHPO"). The issuance of federal agency permits will depend, in part, on obtaining comments from the Louisiana State Historic Preservation Office ("LASHPO"), which operates within the Louisiana Department of Culture, Recreation & Tourism's ("CRT") Office of Cultural Development's Division of Archaeology ("LADOA") and Division of Historic Preservation ("DOHP").

RESEARCH DESIGN AND METHODS

This marine archaeological sensitivity assessment is designed as a preliminary step in the Section 106 historic properties identification process, which in this case focuses primarily on the identification of submerged cultural resources. The assessment is intended to provide information that will assist CPRA in their evaluation of the alternatives and in their consultation with federal, state and tribal agencies regarding the Project.

Research performed for this marine archaeological sensitivity assessment obtained information from a wide variety of sources. These sources included:

- USACE's *Louisiana Coastal Area Barataria Basin Barrier Shoreline Restoration Draft Construction Report and Draft Environmental Impact Statement* (2011);

- CEC's *Caminada Headland Beach and Dune Restoration Project (BA-45) Draft Project Narrative, CEC File No. 11.111* (2011);

- GEC's *Caminada Headland Beach and Dune Restoration (BA-45), Lafourche Parish, Louisiana, Final Reconnaissance Report* (2011);

- Cultural resource survey and archaeological site location index maps, reports, and archaeological site files (for areas within one mi of the alternatives) held at the LADOA, Baton Rouge and the LADOA's online Louisiana Cultural Resources GIS database (http://kronos.crt.state.la.us/website/ larchweb/viewer.htm);

- Historic maps archived in Tulane University's Howard-Tilton Memorial Library's Special Collections, New Orleans, as well as those that are available from the

National Oceanic and Atmospheric Administration's ("NOAA's") Office of Coast Survey Historical Map and Chart Collection (http://historicalcharts.noaa.gov/);

- Regional and local historical and archaeological background information contained in cultural resource survey technical reports, books, articles, and unpublished theses and reports held at LADOA, the Louisiana Collection of the Louisiana State Library, and in Special Collections of the Hill Memorial Library, Louisiana State University, Baton Rouge (e.g., Braud 2006; Nowak et al. [2008 and 2010]; Michot and Doucet [1996]; Pitre [1983]; Thoede 1976, and; Uzee [1985]);

- NOAA navigation charts and on-line Automated Wreck and Obstruction Information System ("AWOIS");

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

- Environmental survey results (i.e., Picciola & Associates, Inc.'s ["Picciola"] *Caminada Headland Beach & Dune Restoration Project (BA-45), Lafourche and Jefferson Parish, Louisiana, Final Survey Report* [2011] [excerpts of which are included as Appendix A at the back of this report]; OSI's *Interim Report I: Geophysical Investigations & Borrow Area Sampling, Caminada Headland Restoration Project (BA-45), Gulf of Mexico, Louisiana* [2010] [data from which is included in Appendix B at the back of this report]; and OSI's *Geophysical Investigations Proposed Offshore Pump-Out Areas and Pipeline Conveyance Corridors, Caminada Headland Restoration Project (BA-45), Gulf of Mexico, Louisiana (OSI Report No. 11ES091)* [OSI 2012b] [Appendix C at the back of this report]);

- Descriptions and chronologies of the development of Port Fourchon and the maintenance of Belle Pass channel and Pass Fourchon, as reported in Anonymous (a) n/d; Anonymous (b) n/d; Curole and Huval 2005; Hughes et al. 2002; Keithly 2001; and Sargent and Bottin, Jr. 1989, and;

- An informal telephone interview on June 24, 2011 with Mr. Forrest Travirca, III, a founding member of the Louisiana Archaeological Society, as well as a Property Manager of the Wisner Foundation, which holds title to a significant amount of shorefront property within the Caminada Headlands area.

The USACE, CEC and GEC's reports provided the basic descriptions of the Project that are presented herein. The LADOA's archaeological site maps, site files, and archaeological survey coverage maps, as well as the technical reports produced by professional archaeological consultants during previous investigations (e.g., Braud 2006; Coastal Environments, Inc. 1997; Goodwin and Selby 1984; Neuman 1984; Nowak et al. 2008 and 2010; Pearson and Faught 2009; Pearson et al. 1986; Robinson et al. 2004; and Weinstein 1994) served as the primary data sources for identifying previously surveyed areas and previously documented archaeological sites, as well for information on the region's environmental and cultural histories.

Historic maps, navigational charts, and the results from the recently completed environmental studies performed for the project (i.e., Kelley et al. 1984; Picciola 2011; OSI 2010 and 2012), provided information for describing and assessing the study areas' past and current environmental conditions, as well as for analyzing changes in and disturbances to the landscape, coastlines, and seafloor substrate within and in vicinity to the Project area. Review of the post-processed geophysical/remote sensing survey data acquired during the environmental studies also provided an indication regarding the possible presence/absence of remote sensing anomalies and sidescan sonar targets with potential to be submerged cultural resources.

An inventory of reported shipwrecks within the study areas and vessel types common to the region's bayous and Gulf waters were developed primarily through reviews of navigation charts, the NOAA-AWOIS database, Berman's *Encyclopedia of American Shipwrecks* (1972), the *Louisiana Submerged Cultural Resource Management Plan* (Terrell n/d) and submerged cultural resource management technical reports (e.g., Glenn 137; Kelley et al. 2008; Nowak et al. 2008 and 2010; Robinson and Seidel 1997; Watts and Finkle 2005). Descriptions and chronologies of Port Fourchon's development, and the maintenance of Belle Pass and the network of nearby navigation channels as documented in: Anonymous (a) (n/d); Anonymous (b) (n/d); Curole and Huval (2005); Hughes et al. (2002); Keithly (2001), and; Sargent and Bottin, Jr. (1989) provided an indication of the extent of disturbances within the Belle Pass and Pass Fourchon alternatives.

Finally, an informal telephone interview with Wisner Foundation Property Manager and founding member of the Louisiana Archaeological Society, Mr. Forrest Travirca, provided first-hand local knowledge regarding the presence of known and recently documented archaeological sites in and around the alternatives, particularly the Offshore alternative and its landfall on the Headland.

Assessment of archaeological deposits or built resources within the terrestrial/intertidal portions of the overall Project area was not included as part of the scope of this particular study. Assessment of archaeological deposits within the federal waters portion of the overall Project (i.e., the Ship Shoal Borrow Area) are also not addressed here, but, instead, are covered in the appendices of OSI's 2011 *Final Report: Geophysical Investigations & Borrow Area Sampling, Caminada Headland Beach Restoration Project (BA-45), Gulf of Mexico, Louisiana, Geophysical and Geotechnical Surveys of Ship Shoal* (OSI Report No. 11ES008-F) (OSI 2012a).

RESULTS

Environmental Setting

Environmental settings and the availability of natural resources are important variables to consider when assessing the potential of a particular study area to contain archaeological sites. Archaeological and historical research performed to date throughout coastal Louisiana indicates that pre- and post-European contact period land-use patterns are tied very closely to specific environments and the availability of certain resources (Uzee 1985; Nowak et al. 2008 and 2010). Settings that provide diverse resources with predictable availability on either a seasonal or year-round basis generally exhibit a greater likelihood or "archaeological sensitivity" for containing cultural deposits. This is in contrast with those places where resources are less predictable in their availability, limited in their abundance, or are difficult to acquire. Areas such as this that lack any or have comparatively few previously reported archaeological sites are considered to have comparatively low archaeological sensitivity.

Settings particularly abundant in predictably available resources include alluvial and coastal zones where water and land meet (e.g., stream banks, beaches, margins of estuaries, natural levees, etc.) (Davis 1976:3; Weinstein and Gagliano 1985:133). Similarly, post-contact period settlement and land-use patterns are also frequently linked to environmental settings that provide favorable agricultural conditions, raw materials, and/or access to water resources and transportation corridors. As Weinstein and Gagliano (1985:131) note: "The provision of food, water, appropriate shelter, and general security is basic," and "…opportunities for trade, intergroup contact, ceremony, and other social amenities are sought or a least accepted."

The clear pattern of preferred pre-contact period site locations that has emerged from previous archaeological investigations on the Mississippi River deltaic plain is on natural levees, particularly those at the juncture of distributaries (Weinstein and Gagliano 1985:133). Among the most important reasons for this is that transportation within the delta during the pre-contact period was water oriented. Trunk channels provided major avenues or arteries for transportation; lesser distributaries provided access into the particularly rich fish and wildlife resource areas of the fringing backswamps and interdistributary basin environments. The types of pre-contact period sites that are found in these deltaic environments include shell middens, earth middens, beach deposits, shell mounds and earth mounds (Weinstein and Gagliano 1985:133). Post-contact period resources would include the wrecks of ships/boats and historic coastal infrastructure.

The existing Louisiana shoreline where the proposed conveyance alternatives are situated is the result of the deposition of Mississippi River sediments over approximately 9,000 years, and of the action on those soil deposits by the waters of the Gulf of Mexico (Calhoun, ed. 2008). The shoreline consists of lands bordering the Gulf, and of the many sounds, bays, lakes, rivers, bayous, and other water bodies that extend inland from the Gulf. Areas immediately adjacent to the shoreline are mostly low, grassy marshlands, natural levees along the existing or abandoned streams, beach ridges or *chenieres*, and isolated barrier islands (Calhoun, ed. 2008; Weinstein and Gagliano 1985:127).

Natural environmental conditions within the alluvial and coastal environments of southern Louisiana in and around the Project's proposed conveyance alternatives have at different times throughout their history been favorable locales for both pre-contact and post-contact human settlement and utilization. Generally speaking, southern Louisiana's coastal region contains a wide and exceptionally rich range of floral and faunal species, as well as abundant nearby fresh and marine water resources, and offers easy access to inland and coastal waterborne transportation corridors (Weinstein and Gagliano 1985:129).

More specifically, the pattern of human use of deltaic landscapes has been found to generally follow the cyclical phases of a delta lobe's formation, florescence and deterioration. Changes in the biological resources of a delta lobe parallel the evolutionary life cycle of the delta, itself, which progresses through a series of stages: progradation, abandonment and transgression (submergence).

Given that all of the alternatives being evaluated are located within a river delta, which, in this case, happens to be the 1,700 to 700 year old and most recently abandoned Lafourche delta (that is undergoing its final or trangressive phase in a delta's existence), a basic understanding of the underlying mechanisms comprising the life cycle of a river delta is instructive for determining the alternatives' archaeological sensitivity and assessing whether or not additional archaeological investigation of any of them is warranted (Davis 1985:151; Schiffer 1987; Stein and Farrand 2001; and Stright et al. 1999).

The Life Cycle of a River Delta

The life cycle of a river delta begins with an upstream avulsion, usually in the form of a break or "crevasse" in a river's natural walls or levee, through which the river's flow and fluvial sediment deposition shift to a shallow, interdistributary basin situated between lobes or complexes. Initial sedimentation occurs as pro-delta silts and clays are deposited basin-wide from materials carried in suspension during major flood events. Off of the mouth of the newly formed river channel, deposits of delta-front silty sands and clays begin to accumulate rapidly in shoal waters as mudflats and distributary mouth bars, which eventually grow to the point of subaerial emergence and are quickly vegetated with freshwater marsh plants (Waters 1992).

Over time, natural levees and crevasse deposits or “splays” are incrementally formed along each side of a channel as a result of the deposition and accumulation of coarse-to-fine-grained sediments and clays into the adjacent marsh following periodic overbank flooding events. As the velocity of the water decreases rapidly the further away it gets from the channel, most of the coarse-grained sediments are deposited immediately adjacent to the channel margin. This deposition results in the upward aggradation or vertical accretion of the floodplain, thus forming a natural levee on either side of the channel. Because of their nearly continuous exposure, natural levees are one of the most prominent features of the flood plain, and are commonly heavily vegetated with deciduous hardwoods (inland) and salt-tolerant shrubs at their Gulf-side ends. Plant debris is often incorporated into the sediment matrices of natural levees, which are also frequently inter-bedded with paleosols (Waters 1992:134).

As a river channel grows wider and deeper to accommodate its increased discharge, its natural levees grow larger, too, taking on a characteristic wedge shape. At the same time that they are growing, the denser and heavier levees are also subsiding into the less-dense underlying floating marsh deposits onto which they are built. As they subside, the levees depress and then compress the marsh around and under them. Freshwater marshes begin to develop around the growing river delta, replacing shallow brackish waters of the interdistributary basin. With their growth in height and width, crevasse breaches of the levee become increasingly less common; however, when they do occur they are usually larger and more persistent. Each crevasse that forms creates one or more distributary channels that radiate out from the breach in the natural levee. River flow is redirected through the distributary created by the crevasse out into the adjacent inter-distributary wetlands, thus creating a miniature delta lobe (Waters 1992).

A delta lobe reaches abandonment stage after the lobe has built vertically and horizontally seaward to the extent where the river channel’s stream gradient and hydraulic efficiency are reduced to points that favor an upstream avulsion or diversion. As this abandonment process happens, the river’s discharge rate declines, as does its sedimentation rate, which is no longer able to keep up with the levee’s rate of subsidence. Upstream, an abandoned river channel slowly and progressively fills and evolves into a slack-water stream or swamp-filled depression. Downstream, the abandonment process is quicker and more dramatic. Near-shore marine processes of wave action and long-shore current erode and rework river mouths, forming beaches and spits that have migrated progressively landward (Waters 1992).

As the delta lobe is abandoned and its sedimentation rate slows, subsidence and the submersion and reworking of the delta’s matrix associated with the marine transgressive process become the dominant geological regimes driving the deterioration of the delta lobe and the shaping of the barrier shoreline. Above the river’s deltaic plain, subsidence and salt-water intrusion change the formerly resource-rich fresh water marsh into, first, a brackish marsh, and then a salt water marsh. Eventually, the marsh begins to break up into tidal channels, and lakes and bays become larger and more numerous. Levees progressively get lower from south to north as they subside and are encroached upon laterally by the adjacent wetlands. The hardwood forests of the levees die out as the surrounding wetlands become increasingly saline salt marshes. Over more time, the seaward ends of the abandoned delta subside below sea level and are discernable only from the different vegetation types they support as compared to the surrounding marsh, and by marsh drainage patterns. The final phase of an abandoned delta lobe's existence, as described by Penland et al. (1985), follows a three-stage process wherein the lobe is transformed from an erosional headland with flanking barriers ("Stage 1") to a transgressive barrier island arc ("Stage 2"), and, finally, to a subaqueous inner shelf shoal ("Stage 3") (Nowak et al. 2008:30; Penland et al. 1985).

Human occupation of a delta lobe usually commences shortly after a subaerial deltaic plain is established. As the plain expands over time and its biological diversity and productivity increase, occupation and human usage intensifies as well. During this period in the life of a major river delta, human habitation sites and the archaeological deposits they leave behind are most usually situated above the deltaic wetlands on the natural levees and at the junctions of distributary channels fanning across the deltaic lobe (Waters 1992:285).

As described above, periodic avulsion of the river upstream from the delta lobe eventually causes the river to abandon its course to create a new lobe (Waters 1992:285). Occupation of the abandoned lobe continues even after the lobe is no longer active, until its biological productivity starts declining. Once this begins taking place, the lobe is slowly abandoned by its human inhabitants and the intensity of its human occupation and activity shifts, just like the river, to the new delta lobe that is active (Waters 1992:1985).

Marine Transgression and Site Preservation

While environmental variables are an important element in the selection of suitable locations for human habitation, they also play a key role in site formation processes, and are equally relevant to the preservation and distribution of archaeological sites within a given area. The deposition of underwater archaeological sites along the south coast of Louisiana results from two primary causes – watercraft sinking or formerly terrestrial sites becoming submerged through inundation as a result of land subsidence and eustatic sea level rise. This latter form of submergence occurs through one of two marine transgressive processes: "shore-face" retreat, when the coastline slowly regresses inland; or "stepwise" retreat, when in-place drowning of coastal features occurs (Waters 1992). Generally speaking, episodes of marine transgression are essentially periods of erosion, a destructive process that creates less than ideal depositional sequences from an archaeological perspective.

Shore-face retreat describes the erosion of previously deposited sediments by wave and current processes as the shoreline transgresses. It is the dominant inundation regime during the marine transgression process (Waters 1992). As sea level rises, beach-face and shore-face erosional zones, offshore of the present Louisiana coastline, have sequentially passed across the subaerially exposed portions of the Mississippi River deltaic plain. Older sediments that had been deposited in coastal and terrestrial environments inland of the earlier shoreline get reworked, first by the swash and backwash processes of beach face and then by the waves and currents associated with the upper shore-face breaker and surf zones. The erosion associated with the continuous transgression of the sea reworking these deposits into a thin unconformable geological unit of transgressive lag (i.e., gravel and coarse sand deposits) forms the top of a time-transgressive geological unit known as a "marine unconformity" (i.e., the surface defined by the top of the buried paleosol and the base of the overlying marine deposit). Reworking terrestrial and coastal sediments are referred to as "palimpsest sediments," and the erosional surface marked by the depth of the maximum disturbance by transgression is called the "ravinement" surface. This ravinement surface often shows up quite clearly in sub-bottom profiler data and can be a useful indicator for the presence of relict paleolandforms (Waters 1992).

Shore-face retreat would have probably been the prevailing marine transgressive regime in the unprotected portions of barrier shorelines within the proposed conveyance alternatives, especially since the regional rate of sea level rise appears to have slowed considerably several thousands of years before the Lafourche Delta Lobe even had formed. As the shoreface moved landward with its shoreline, the upper 18 to 30 ft of the delta complex's depositional units would be eroded. Material eroded from the headland would be redistributed by longshore currents, which would in turn create barrier islands on the flanks of either side of the headland (Braud 2006:[2]6).

Alternatively and to a lesser extent, marine transgression also occurs by the process of stepwise retreat, which is the sudden inundation or in-place drowning of coastal landforms and sediments, which has been shown to preserve inundated sites (Waters 1992). Stepwise retreat most commonly occurs at times and in areas of rapidly rising sea level, where the coast is quickly subsiding and the gradient of the transgressed surface is shallow. In this case, instead of the waves and currents of the shore-face and beach face sequentially reworking older sediments during transgression, the breaker and surf zones jump from the active shoreline to a point farther inland, submerging the older coastal landforms and sediments in an area seaward of the more destructive breaker and surf zones. The surf and breaker zones then stabilize and develop a new shoreline farther inland (Rees 2010:314; Waters 1992:275-280) (Figure 4).

In order for stratified, formerly terrestrial archaeological deposits to be preserved underwater in meaningful contexts, intact elements of the paleo-landsurface in which they were deposited must be present. Such deposits would need to have survived the marine transgression process and the subsequent disturbances from modern marine or fluvial processes and/or human activities. Preservation of any inundated pre-contact archaeological deposits that potentially exist in the proposed alternatives is dependent upon their location and depth of burial relative to natural and human impacts on sediments.

Environmental Chronology

The Project's proposed conveyance alternatives are located along the Caminada Headland, a barrier beach in south-central Louisiana within the abandoned delta plain of the Lafourche Delta Complex, an area encompassed and dominated by the great southern projection of the present Mississippi River deltaic plain physiographic region containing most of the state's tidal shoreline (Kelley et al. 1984:11) (Figure 5). The Mississippi River deltaic complex is a relatively thin, seaward-thickening, composite Holocene formation overlying older Pleistocene deposits. According to Texas A&M University geoarchaeologist, Michael Waters, the complex consists of a series of "at least nine" different coalesced delta plains and their delta complexes and lobes that were formed by an upstream diversion of river flow occurring cyclically over the last 12,000 years (Nowak et al. 2008; Waters 1992:285; Weinstein 1994:5) (Figure 6). As a result of subsidence and sea level rise, each lobe has experienced a constructional or progradational phase dominated by fluvial processes. As described above, these fluvial processes are usually followed by a destructive transgressive phase, which is dominated by marine processes (Nowak et al 2008; Waters 1992).

The Lafourche deltaic lobe where the conveyance alternatives are located was one of nine deltas to form within the river's larger plain since 12,000 years B.P. The oldest of these nine deltas was composed of three separate sub-deltas that pro-graded out into the Gulf of Mexico where sea level was 50 to 82 ft lower than it is today. PaleoIndian and early Archaic peoples who occupied the Lafayette Delta lobe and their sites have been found on the floodplain and on the edge of an embayment in association with a salt dome (i.e., at Avery Island). After about 8,500 years B.P., sea level rose to an elevation of about -40 ft, and the river began flowing to the east within the

Maringouin delta lobe. The Maringouin lobe grew until approximately 6,000 years B.P., after which marine processes associated with rising sea levels submerged and reworked much of the Lafayette and Maringouin delta lobes and a new delta lobe, the Sale-Cypremort, which developed slightly to the east. The Metairie delta lobe began to form about 4,000 B.P. The Lafourche delta developed slowly over the older Teche lobe circa ("ca." 2,000 years B.P.), and was the seventh deltaic sequence of the Mississippi River to form within the river's larger delta plain since 12,000 B.P., prior to the river's flow switches to the Plaquemines delta complex at ca. 1,000 B.P. and to the Balize, or modern delta complex, at ca. 600 B.P. (Waters 1992; Weinstein 1994) (see Figure 6).

The Lafourche Delta Complex where the Project area and the conveyance alternatives are located on what once was an active distributary of the Mississippi River between about 2,000 and 100 years B.P., and was dominated throughout the Holocene by deltaic and fluvial processes associated with several principle deltaic distributaries (e.g., bayous Lafourche and Moreau), but is now a rapidly deteriorating deltaic lobe in its initial stage as a natural erosional headland (i.e., the Caminada Headland). The natural levees of bayous Lafourche and Moreau form the highest ground within the local delta plain, although they lie less than one ft above sea level within the Project region. These bayous' natural levees have a maximum width of 500 ft. At the mouth of the Bayou Lafourche sub-delta, a regressive network of accretionary sand ridges developed to form the headland, which is comprised of delta front sheet sands shaped by the combined forces of wind, wave, tidal and longshore transport processes (Weinstein 1994).

The Lafourche Delta Complex is a mappable allostratigraphic unit consisting of unconsolidated sediments defined and identifiable based on its bounding discontinuities that can either be an erosional unconformity or a construction (i.e., depositional) surface. The stratigraphy of the complex consists of three major depositional facies (a basal unconformity consisting of sheet sand; a middle unit with a characteristic sequence of deltaic sediments consisting of fine-grained progradational sediments; and an upper delta plain unit of aggradational natural levee and marsh sediments that forms its upper surface. Prior to the formation of the lobe, either a pre-existing coastal or deltaic plain was inundated by the Gulf of Mexico as a result of rising sea level. The Lafourche delta lobe consists of a 25 to 30 ft thick deltaic sequence. Between distributaries, the delta sequence consists of 3 ft of salt marsh overlying about 23 to 26 feet of prodelta and interdistributary sediments. Beneath the natural levees of Bayou Lafourche, Belle Pass, Pass Fourchon, Bayou Moreau and other distributaries, the delta sequence consists of natural levee material overlying delta-front and prodelta deposits. The prodelta deposits lie uncomformably upon interdistributary deposits associated with older deltaic lobes (Braud 2006:[2]8-10).

The Headland consists of narrow beaches and associated dunes, overwash fans, back barrier marshes, as well as chenier ridges containing mangrove and coastal dune shrub patches, lagoons, and small bayous. The headland protects interior coastal wetlands and Port Fourchon. Its erosional shoreline is slightly convex gulfward and is flanked by two nearly symmetrical barrier island systems – Grand Isle to the east and the Timbaliers to the west. The back-barrier marsh of the headland is separated from the maritime forest habitat of the elevated ridges of the chenier by a pipeline canal. Periodically, the marshes of the delta complex are over-swept and covered with 5 to 10 ft of water from storm surges associated with hurricanes and other strong storms.

The Caminada Headland is an abandoned delta lobe in the initial stage of a natural erosional phase. It has experienced some of the highest rates of shoreline retreat on the Gulf Coast as a result of both natural and anthropogenic causes. After the Mississippi River had changed its course away from the Lafourche delta, sediment and freshwater supplies to the Caminada Headland decreased significantly. By 1850, Bayou Lafourche received only 15 percent of the

Mississippi River's flow. A dam constructed in 1904 at the junction of the Mississippi and Bayou Lafourche essentially eliminated the source of river sediments to the headland, leaving Bayou Lafourche a sediment-starved relict distributary of the Mississippi River. The combined effects of this natural and artificially induced sediment deficit, the depth of Holocene sediments in the delta plain's geosyncline, and eustatic sea level rise have produced a subsidence rate along the Caminada Headland exceeding 0.4 in per year (Weinstein 1994).

The natural shape and anthropogenic alterations to the shoreline, and the area's dominant wave direction have caused the longshore transport of sands eroded from the headland to follow two directions – to both the east and the west, where it becomes part of the flanking barrier islands. The net result of sediment deficit, subsidence, long-shore transport, and a high frequency of storm events are shoreline regression rates between a low of 43.6 ft per year (1887 to 1988) (Williams et al. 1992), and a high of 133.2 ft per year (1887 to 1934) (Williams et al. 1992) recorded at various times and locations along the headland during the 100-year period between 1887 and 1988. Shoreline regression totals recorded during this geologically brief time-frame are 6,566 ft (1887 and 1932) and 9,842 ft (1887 and 1988) (Williams et al. 1992). Without intervention, subsidence and regression of the headland will continue through two more stages – the headland will become a transgressional barrier island arc (i.e., like the Chandeleur Islands), and then, finally, a subaqueous inner shelf shoal (i.e., like Ship Shoal) (Nowak 2008:30).

Given that the geological history of Lafourche Parish from an archaeological perspective only dates back in time approximately 2,000 years, sea level was (at most) only 3 to 9 ft lower than today (Nowak et al 2008). As a consequence of the dynamic nature of the Mississippi River deltaic plain, human inhabitants of southern Lafourche Parish during both pre- and post-European contact periods were forced to choose specific locations in which to establish settlements and exploit the region's rich and varied natural resources. Wetlands were and are vast and plentiful in southern Lafourche Parish, but habitable land was and is scarce. The natural levees would have provided the only permanently habitable, arable land in the area. Consequently, the only formerly terrestrial archaeological sites will likely be found on the natural levee deposits. Unfortunately, however, the subsidence and inundation of the coastal plain and the shore-face retreat that accompanies it, are marine processes that erode, rework and redeposit the levees' facies and destroy the contextual integrity of whatever archaeological deposits they may contain (Nowak et al. 2008).

Cultural History

Pre-Contact Period Ancient Native American Cultural Chronology

Louisiana's *Comprehensive Archaeological Plan* (Smith et al. 1983) organizes Louisiana's archaeological resources into six management units (one underwater and five terrestrial units). The Project area is located within Management Units V and VI – land created by the Mississippi River and the state's underwater bottom lands, respectively. The pre-contact ancient Native American cultural chronology of Management Unit V is composed of six cultural units: Mound Building (i.e., Poverty Point); Tchefuncte; Marksville; Troyville-Coles Creek; Plaquemine, and; Mississippian. The pre-contact ancient Native American cultural chronology of Management Unit VI is encompassed by a catch-all "Submerged Archaeological Sites" category (Davis 1984; Kniffen et al. 1987; Smith et al. 1983).

Understanding the regional long-term land-use and settlement patterns of any project area is critical to predicting and assessing its archaeological sensitivity. The following discussion provides a brief summary overview of the Native American cultural chronology within the

Lafourche Delta Complex encompassing the three conveyance alternatives and provides descriptions of the types of archaeological deposits typically associated with them.

Approximately 13,500 years of human history has been studied and documented throughout Louisiana, and although debate continues on precisely how and to what extent broad patterns of settlement relate to each other, archaeologists and anthropologists have reached a general consensus regarding the organization of pre-contact through post-contact Native American settlement in Louisiana and divide it into five major cultural periods: "Paleo-Indian" (11,500 to 8000 B.C.[13,500 to 10,000 B.P.]); "Archaic" (8000 to 800 B.C. [10,000 to 2800 B.P.]); "Woodland" (800 B.C. to A.D. 1200 [2800 to 800 B.P.]); "Mississippian" (A.D. 1200 to 1700 [800 to 300 B.P.]); and "Historic" (A.D. 1700 to present [300 B.P. to present]). These five periods are further divided by archaeologists and anthropologists into categories of "Sub-Periods" and "Cultures" based on cultural adaptations and artifacts forms for particular regions (Figure 7).

While this organizational scheme for settlement patterning is generally accepted, it was developed exclusively from terrestrial archaeological data and, therefore, must be considered to be biased in favor of durable materials recovered from inland sites that have resisted naturally- and culturally-derived degradation and disturbance. As a result, the available archaeological data comprise a material record that likely represents only a partial view of the full breadth of pre-contact Native American culture, particularly for the earlier Paleo-Indian and Archaic periods, whose populations were likely to have utilized and inhabited areas that are now submerged below present sea level and deeply buried beneath deltaic sediments (Westley and Dix 2006). The systematic detection, documentation and analysis of submerged pre-contact period cultural resources offer a potential opportunity for researchers to acquire data sets that are not presently available to archaeologists, anthropologists and historians working on land in Louisiana. Such data, if acquired, would be beneficial in refining or revising current perceptions regarding pre-contact cultures and their settlement patterns.

It is just within the last decade that a growing trend of focused effort has been expended on developing effective methodologies for predicting, identifying and excavating intact inundated terrestrial settlements by underwater archaeologists. Site preservation underwater is generally dependent on site burial in topographically protected terrestrial environments prior to their transgression by rising ocean waters.

Recognizing its aforementioned bias, the settlement pattern information that follows is provided to establish a general context, or framework from which predictions regarding the potential archaeological sensitivity of the submerged portions of the conveyance alternatives may be made.

While Paleo-Indian, Archaic, and other earlier period sites are known from other locations within coastal Louisiana, the earliest intact and accessible landforms within the study areas are related to and post-date the formation of the Lafourche Delta Complex spanning the last 2,000 years. The following discussion begins with the Middle Woodland's Marksville sub-period and culture dating from 2000 to 1600 B.P.; however, given the location of the alternatives at the southern or seaward edge of the Lafourche Delta Complex, pre-contact period ancient Native American archaeological sites are likely to date no earlier than the late Coles Creek period and mostly from the Plaquemines-Mississippian periods (i.e., circa 1100 to 1700 A.D.).

Marksville Cultural Period (1 to 400 A.D.)

The term Marksville refers to the town in Avoyelles Parish in central Louisiana where the type-site for the sub-period (i.e., Marksville [16 AV 1]), a C-shaped earthen embankment enclosing a

40-ac area and six earthen mounds, is located. Ceramic vessels found on the site are stylistically similar to those found in mounds in Ohio and identified as part of the Hopewell culture. By extension, the Marksville site, time period and culture became associated with Hopewell culture of the Midwest. Hopewell is a remarkable cultural expression in the archaeological record, characterized by its elaborate earthworks, raw material exchange, distinctive artifact styles and burial of honored dead within discrete tombs. Variations of Hopewell traits may be found in the archaeological record from Florida to Kansas City and New York to Louisiana (Rees 2010:120-134).

Excavations of Marksville sites over the last several decades have indicated that the archaeological definitions of the Marksville period and culture are open to interpretation. Marksville period sites are recognized in the archaeological record on the basis of their distinctive ceramic decorative styles, which include incised geometric and zoned rocker-stamped designs. Sherds with these diagnostic designs can be found across the state, but are most common in the within the Mississippi Valley and its adjoining uplands. Although distinctive for the period, the incised geometric and zoned rocker-stamped designs persist well beyond the arbitrary end of the Marksville Period (Rees 2010:120-134).

The Marksville Period is not associated with a distinctive lithic assemblage. Kent and Gary projectile point types are commonly found on Marksville Period sites, but are not exclusive to the time or cultural period. Stone tool production from the period emphasizes the use of local gravel cherts for points and bifaces with very few other stone tools present in the Marksville period archaeological record. Relatively small amounts of foreign materials present on most Marksville sites indicate that long-distance trade was uncommon for the culture and period. Marksville sites and cemeteries suggest that Marksville society was largely egalitarian with little class differentiation. Long-term subsistence patterns dating from at least the Middle Archaic period reflect hunting and gathering of locally available foods – a trend that continued through and beyond the Marksville period.

While there is evidence for the domestication of cultigens in contemporaneous Midwestern Hopewell communities, there is no evidence for the domestication of similar cultigens in Louisiana during the Marksville period. In fact, there archaeological record of Marksville subsistence practices is under-represented in Louisiana. Available data document a lower frequency of fish in Marksville assemblages than found on earlier and later sites. Available data also indicates people were hunters and gatherers throughout the Marskville period. While people lived in a wide variety of environments throughout the period, most Marksville communities were small villages situated by a bayou or a stream, lacking thick deposits of refuse, suggesting that village sites were only occupied for a few years before groups moved on to other locations. It may be that some groups moved more frequently to take advantage of seasonally available resources, such as nuts, spawning fish and clams. Artifact assemblages from Marksville sites include Gary and Kent projectile points, stone knives and scrapers, and ceramic vessels (e.g., small cups, bowls and larger storage jars) (Rees 2010:120-134).

Baytown Cultural Period (400 to 700 A.D.)

The Baytown Period is one of two major culture-historical units (the other being the Coles Creek Period) defining the Late Woodland period in the Lower Mississippi Valley and marks a time when populations in the southern Lower Mississippi Valley became increasingly differentiated and adopted cultural practices and strategies that later contributed to development of the more complex societies of subsequent periods. The period is named after the multi-mound Baytown site located in east-central Arkansas. Sites associated with the Baytown culture are found both in the northern Lower Mississippi Valley, from the Yazoo Basin northward, and to the south and west in Louisiana where they are generally associated with the Troyville culture. Although initially defined as a period of cultural decline marking the transitional period between the Middle Woodland Marksville and subsequent Mississippian cultures, the Baytown Period is now regarded, as a result of recent archaeological research, as a relatively dynamic time of population growth and culture change with related socioeconomic and political developments that served as a foundation for the development of the more complex Coles Creek period culture (Rees 2010:136-156).

Baytown period peoples continued long-standing traditions of building earthen mounds for public ceremonies, civic events, and interment of the deceased. The also engaged in long-distance trade with other Gulf Coastal Plain groups to the east, as indicated by the discoveries of *Busycon* shell artifacts, sharks' teeth, and ceramics with similar decorations. The bow-and-arrow, introduced sometime between A.D. 600 and 700, was extensively used for the first time in the Lower Mississippi Valley during the Baytown period, reflecting a transition from the atlatl and dart points (Braud et al. 2006). The advent of this new technology is reflected in the different projectile point types and likely led to changes in hunting techniques as well as in warfare. Pottery vessels decorated with bi-chrome and polychrome painted designs are another innovation associated with the Baytown period (Rees 2010:136-156).

Baytown societies are interpreted to correspond with a tribal or local level of sociopolitical organization with communal civic rituals and ceremonies performed at mound sites and on mound summits. Among their communal activities were large feasts held periodically, as evidenced by large, bathtub-shaped pits associated with food preparation during civic ceremonies and burial rituals. Results from the excavation of a small number of non-mound Baytown sites indicate that most of the people during the Baytown period lived in small, dispersed hamlets. What little is known of domestic structures suggests that they were oval in plan and lacked prepared floors. Although settlement patterning appears to have been highly variable, the beginnings of hierarchical settlement patterns associated with this period have been inferred. Subsistence data from excavated Baytown sites in Louisiana provide evidence for a broad-based diet of fish, deer, and smaller mammals. Important fish species included gar, fresh-water drum, bowfin and catfish. Plants harvested included goosefoot (chenopod), knotweed, may grass, little barley, marsh elder, sunflower, and gourd, although it appears from the archaeological record that Baytown populations of the southern Mississippi River Valley had not domesticated any of these plants. Seasonally collected fleshy fruits included persimmon, grapes and berries. Acorns, hickory nuts, and pecans were the most commonly collected nut species from the region's mast-producing trees. Mortuary practices appear to have varied with no consistent method of burial during the Baytown period – some were buried immediately after death, while others were entombed in charnel buildings, or cremated. Together, the egalitarian nature of the Baytown mortuary practices suggests little or no individual status differentiation (Rees 2010:136-156).

Situated on the west bank of the Black River in Jonesville, Catahoula Parish, Louisiana, the Troyville site (16CT7) is the type site for Troyville culture and the largest mound site of the Baytown period in the southern Lower Mississippi Valley. Initially considered to be a contemporaneous distinct culture-historical unit with Baytown, Troyville is now viewed as one of several regional archaeological cultures within the Baytown period. Examination of the site is the key to understanding the Baytown period throughout the southern Lower Mississippi River Valley. Related sites of a Coastal Troyville – Coles Creek culture have been found in the Mississippi Delta and along the coast.

Coles Creek Cultural Period (700 to 1200 A.D.)

The Coles Creek culture that developed in the southern Lower Mississippi Valley at around A.D. 700 represents an important socio-cultural transition from the relatively egalitarian cultures of the preceding Baytown period to hierarchical polities of the Plaquemine culture of the Mississippian cultural period (A.D. 1200 to 1700), and is separated from the preceding Troyville culture by distinct differences in settlement patterns, mortuary practices, and ceramic technology and decoration. Coles Creek culture is best known for its distinctive ceremonial centers consisting of earthen platform mounds situated around level plazas, which served as the focal points for Coles Creek communities. Over the course of the period, these settlements became less dispersed and more aggregated around mound centers, with modifications and construction efforts at some Coles Creek mound sites rivaling in extent and scale later Mississippian mound sites (Rees 2010:157-172).

The social change that occurred during the Coles Creek period is represented in the mound construction techniques, cultural remains on the mounds, and the plan and architecture of the mound sites. In the earlier Baytown and Marksville periods, most mounds were constructed to cover group burials; in the Coles Creek period, most mounds were built for activities beyond mortuary practices, and served as platforms for activities and buildings that are interpreted to have likely included residences, charnel (mortuary) houses, and council houses. While platform mounds were occasionally constructed in the Lower Mississippi Valley prior to the Coles Creek period, they were a ubiquitous element of Coles Creek mound sites and were often their largest and most prominent feature.

The development and formalization of the mound-and-plaza ceremonial center is inferred to have been a reflection of changes in religious beliefs and institutions, and the increased political influence of social leaders within Coles Creek Societies. While similarities have been drawn between the mound-based settlements of the Coles Creek societies and subsequent Mississippian cultures, and the Coles Creek culture has sometimes been presented as a regional variant of early or emergent Mississippian culture, Coles Creek culture actually followed a different developmental path than that which is seen in Mississippian societies elsewhere in the Southeast. Long-distance trade networks and maize agriculture were not significant elements of the social and ceremonial developments in the Coles Creek region. Instead, Coles Creek culture is hypothesized to have developed from indigenous cultural changes that were tied to dramatic changes in subsistence practices.

Excavations of Coles Creek mound centers generally don't result in the recovery of status symbols and ritual items like those found at Mississippian mound centers; however, faunal analyses does indicate that better cuts of meat were consumed on or near mounds compared to non-mound contexts. Artifact assemblages from mound and non-mound occupations are generally only subtly different from each other, and differences in status and wealth are not reflected in the variations in grave preparations and offerings (Rees 2010:157-172).

Widespread similarities in the public architecture and other archaeological remains of the Coles Creek culture found in much of the Lower Mississippi Valley and Louisiana coastal region indicates that while extensive interaction with external groups was rare, interaction between groups within the Coles Creek region was frequent. This is reflected in the similarities between mound sites that suggest that the large mound-and-plaza sites were constructed according to rigidly considered plans that were widely disseminated among the Coles Creek society's members. Most Coles Creek mound sites consist of two to four mounds less than 20 ft high situated around a single plaza that was kept free from debris. Excavations at mound sites such as

Bayou Grande Cheniere (16PL159) and others have revealed, too, that many Coles Creek mound sites were used and expanded over periods spanning hundreds of years (Rees 2010:157-172).

In addition to the larger scale of mound construction taking place during the Coles Creek period, the emergence of a multi-tiered, mound-centered settlement pattern in which non-mound settlement sites developed around and surrounded mound sites, suggests that Coles Creek societies were more centralized and focused on mound centers than were previous cultures in the region. Settlement types included mound centers, small villages, and hamlets. Although the mound-and-plaza sites were an integral element of Coles Creek settlement systems in Louisiana, most people lived in non-mound settlements. Coles Creek mound centers are interpreted to have functioned as ceremonial centers, with a small group of resident high-status individuals. The existence of possible residences on the summits of Coles Creek mounds has been interpreted as marking an important change in social organization – a system of rule by hereditary elites. The Coles Creek period may, consequently, mark a pivotal point in the development of hereditary chiefdoms in the Lower Mississippi Valley – and the transformation of communal-ceremonial centers into semi-private chiefly domains (Rees 2010:157-172).

Similar settlement patterns existed along the Louisiana coast, though coastal mound sites tend to be smaller than their interior counterparts. Coles Creek people inhabiting the coastal region selected locations for their settlements that were along secondary streams with easy access to both a principal waterway as well as the marshes that lined the inhabitable natural-levee systems. Some researchers (Weinstein and Kelley 1992:351) have argued that Coles Creek mound centers were strategically placed along natural levees and within adjacent marshes as a means of controlling access to the coastal margin's rich and abundant natural resources. Coles Creek platform mounds were built generally on the natural levees of relict distributary systems, or in the western coastal region of the Chenier Plain on remnant beach ridges. Villages were usually situated at junctures of tributaries or smaller streams, while smaller camps and resource-procurement locales were dispersed between villages (Rees 2010:157-172).

Artifact assemblages from Coles Creek sites indicate that Coles Creek communities did not participate extensively in long-distance trade of goods. Ceramics and stone tools found in Coles Creek contexts generally derive from local materials. Stone tool technology was relatively simple. Formal chipped or ground stone tools are not common in Coles Creek contexts. Bow-and-arrow technology was introduced to the Lower Mississippi Valley during the Baytown period, and arrow points became the most common type of projectile point in Coles Creek deposits around A.D. 700. Cole Creek ceramics tend to be hard and well-made and are tempered with grog (crushed pieces of ceramic or fired clay). They exhibit common decorations throughout the region with some, but little, variation. Rectilinear incised designs restricted to the rims of vessels were the most common Coles Creek ceramic decoration. Curvilinear incised designs, punctations, rocker stamping, and combinations of these decorating techniques are also found with paddle-stamped pottery also common at sites found along the coast. The most common ceramic vessel forms are fairly simple and include restricted orifice jars, beakers, and unrestricted and globular bowls (Rees 2010:157-172).

Coles Creek subsistence relied on wild plants and animals readily available in areas surrounding the culture's settlement sites. Research has shown that maize played little or no role in subsistence until the very end of the Coles Creek period. Domesticated versions of native grasses, such as may grass, chenopod, and knotweed, have been identified at Coles Creek sites. Grass seed remains from other Coles Creek sites appear to be wild, indicating cultivation was not a widespread subsistence practice. Recent bio-archaeological research supports the idea that Coles Creek subsistence was predominantly based on a hunter-gatherer economy. While consumption of starchy plants increased during the Coles Creek period, maize remained only a minor part of the Coles Creek diet. Acorns and hickory nuts were staple plant foods, and berries, tubers, grass seeds, and greens played an important, yet supplemental role in the diet. In coastal regions, alligator and muskrat were commonly exploited (Rees 2010:157-172).

Mississippi Cultural Period (1200 to 1700 A.D.)

The Mississippian Period in the southern Lower Mississippi Valley, including present day Louisiana, spans an approximately 500 year period from 1200 to 1700 A.D. and represents a turning point in the Louisiana archaeological record when the undocumented past transitions to an "historic" past that includes contemporaneous interpretations of Louisiana's indigenous cultures as recorded in the surviving written documents and illustrations produced by European explorers and colonists. Despite the broad application of the term, "Mississippian," to define this period in Louisiana's ancient Native American archaeological record, its origin in archaeological literature and the principal culture to which it is ascribed lies up river and outside of present-day Louisiana, buried beneath the sediments of the vast flood plain between the Arkansas and Missouri rivers. "*Mississippi*" is an Ojibwa or Algonquian word meaning "great water" that was taught to French *coureurs des bois* (fur trappers) in the seventeenth century (Rees 2010:173-194).

The Mississippi period in the Louisiana cultural chronology encompasses both the Mississippian and Plaquemine cultures. Mississippian culture has been traditionally defined as a series of complex societies or chiefdoms that evolved from the Late Woodland cultures of the Central Mississippi Valley after A.D. 900, whose densely populated settlements focused around large mound-and-plaza complexes that served as political, economic, and ceremonial centers, and whose inhabitants were largely dependent upon maize agriculture. Other traditionally defined Mississippian culture traits include rectangular buildings with wall-trench architecture, platform mounds, exotic/non-local long-distance trade items, chipped stone hoes, triangular projectile points, ground stone artifacts and an elaborate iconography on culturally distinctive artifacts fashioned from ceramic, stone, shell and copper. Mississippian culture was first recognized in the archaeological record by distinctive types of ceramics, particularly shell-tempered wares. More than earthen mounds or any other class of artifact, shell-tempered ceramics and the presence of pulverized mussel shell in them identify Mississippian culture. The presence or absence of shell-tempered ceramics has been used to distinguish Mississippian sites from contemporaneous Plaquemine and earlier Coles Creek phases at sites in the Mississippi Delta. Mississippian sites are found throughout the southeastern United States, from eastern Oklahoma to the Atlantic Coast and from the Midwest to the Gulf Coast. The nature of Mississippian culture's presence and expansion in the region, either by movement of people or ideas, and its relationship to the contemporaneous Plaquemine culture, are subjects of debate (Rees 2010:173-194; Braud et al. 2006).

The Plaquemine culture is a geographically related and overlapping tradition with the Mississippian culture, although the temporal and geographic extent of the Plaquemine was not as great as was the Mississippian. The most visible indicators of Plaquemine culture are earthen mounds (larger and more frequent in number than those of the preceding Coles Creek cultural period, but comparatively smaller than mounds of the Mississippian culture). A majority of the culture's people, however, lived in small, dispersed communities without mounds. Documented Plaquemine sites are distributed from the vicinity of present-day Greenville, Mississippi, southward to the Gulf Coast, spanning southeast Arkansas, southwest Mississippi, and east Louisiana, including the Mississippi River Deltaic Plain from the prairie terrace and Chenier Plain on the west to the Pontchartrain and Pearl River basins on the east. Plaquemine is, consequently, centered on the Lower Mississippi Valley with cultural roots that extend back to the Coles Creek culture (Rees 2010:173-194). Three regional phases of early Plaquemine culture occur in south Louisiana: the Medora phase (West Baton Rouge Parish); the Barataria phase (Barataria Basin, principally along bayous des Families and Barataria); and the Burk Hill (Cote Blanche Island) phase. All three phases are identified principally on the basis of differences in their ceramic types and varieties.

Artifact assemblages and settlement site morphologies exhibit strong continuities between the Coles Creek and Plaquemine cultures, particularly in south-central Louisiana (Braud et al. 2006:3-7). Ceramic vessels with a brushed appearance (i.e., "Plaquemine Brushed) are typical, as are vessels with incised rims (a continuation of a Coles Creek ceramic tradition), engraving, grog (fired clay or crushed pottery) and some minor amounts of pulverized mussel shell (Rees 2010:174). A vast majority of pottery from Plaquemine sites is classified as "Baytown Plain," an undecorated, grog-tempered type. Other artifacts generally associated with Plaquemine culture include smoking pipes made of ceramic and stone, stone celts, discoidals or disks, and small, stemmed projectile points (Rees 2010:175). The relative scarcity of stone projectile points and artifacts in the southern Lower Mississippi Valley suggest that bone, antler, shell and other less durable materials were used in tool-making in the region – a region with little naturally occurring rock.

Unlike Mississippian culture, which is regarded as non-local or intrusive, Plaquemine culture is considered to be more indigenous to Louisiana and the Lower Mississippi Valley. Coastal Plaquemine communities were also more similar to local Coles Creek than Mississippian cultures in terms of their more self-sufficient subsistence economies, which included harvesting of consistent and reliable backswamp, marsh and estuarine resources (i.e., fish, alligator, shellfish, other fauna and wild plants) in floodplain and coastal environments. This subsistence strategy isn't surprising, given that the low-lying delta and coastal marsh environment where coastal Plaquemine communities lived on natural levees of the alluvial plain were less suitable for large scale agriculture. Among communities in the Delta and coastal zone, maize agriculture may, in fact, have been regarded as impractical and largely unnecessary (Rees 2010:174-180).

After about A.D. 1400, ceramic styles observed in the archaeological record indicates that the Plaquemine communities of the eastern Delta began to engage increasingly in the coastal interchange of objects, people and ideas. The eastern Delta became a crossroads for east-west social relations and exchange as indicated by local and non-local designs on various combinations of grog- and shell-tempered ceramics. Mississippian styles and iconography appear to have been reinterpreted by local residents of the Delta through the exchange of food/food containers, intermarriage, and emulation of unfamiliar manufacturing and decorative techniques. The capabilities to engage in inter-regional exchange easily and efficiently are supported by historical descriptions of large canoes and canoe flotillas on the Mississippi River, as well as the archaeological recovery of such watercraft (Rees 2010:190-191).

Sometime between A.D. 1550 and 1650, one or more groups of Mississippian culture people moved into the area around Vermilion Bay. The new arrivals were attracted by the saline springs of Avery Island and used them to produce salt, which may have been used in long-distance trade. Based on dissimilarities with contemporaneous Plaquemine components in the surrounding region, as well as with ceramics from up-river, it may be that the Petite Anse component at Salt Mine Valley represents a migration of people from the Lower Yazoo Basin of Mississippi. These people may have been ancestors of the Tunica, Taensa or Koroa, who are known to have traded salt. The nature of the interaction between these Mississippians and the local populations of Plaquemine culture peoples is unknown, as the Petite Anse region would be abandoned within the next century as the arrival of Europeans and African populations to the region eclipses both the Plaquemine and Mississippian cultures. Virulent diseases brought to the region by European explorers wiped out entire families, destroyed communities, forced the relocation of survivors and transformed a once densely populated landscape into a seemingly deserted wilderness. Although catastrophic epidemics, warfare, and colonialism wrought havoc on native peoples of Louisiana, the pre-Columbian Native American past was politically, economically, and socially dynamic and their survival and continued resistance is demonstrated in alliances, migrations, sustained presence, and reuse of ancestral villages and mounds. Historically known tribes, such as the Bayougoula, Chitimacha, Houma, Natchez, Taensa, and Tunica enter the documentary record at the end of this period, followed by the arrival of the Apalachee, Biloxi, Choctaw, Koasati (Coushatta), and other displaced tribal communities (Rees 2010:190-191).

The Chitimacha tribal people occupied the lower Louisiana coast along Bayou Lafourche and the lower Mississippi River and controlled most of the upper Barataria Basin. The earliest historical record of the eastern Chitimacha inhabiting the area between the Atchafalaya and the Mississippi Rivers dates from 1702, when they were recorded living in present-day Iberville, Assumption, St. James, Lafourche, St. Martin, and Terrebonne Parishes. The relative inaccessibility of their settlements is attributed as one of the principle reasons for their survival into the twenty-first century. Chitimacha tribal people presently reside along Bayou Teche near Charenton, Louisiana (Nowak et al. 2010).

Post-Contact Period: Native and Euro-American Cultural Chronologies

Early Exploration and Colonization

The Spanish were the first Europeans to claim the region encompassing present-day Louisiana. The first European incursions into the Mississippi Delta were those of either Alonso Alvarez de Pineda in 1519 or the survivors from the Panfilo de Narvaez expedition in 1528. The first European to explore the interior of Louisiana was Hernando deSoto, when he led an expedition across the southeastern United States and crossed the Mississippi River near the present Tennessee/Mississippi border in 1541. De Soto died during the expedition somewhere along the Mississippi River between Memphis and Baton Rouge in 1542. Expedition survivors eventually built five vessels and descended down the Mississippi and were continuously harassed by Native American groups along the way. While stopped for a period of several days near the mouth of the Mississippi, the Spaniards made contact with a group of coastal Louisiana tribal people, believed to be Bayou Petre phase people. The encounter led to conflict, during which the Indians used atlatl's to throw leisters (i.e., fishing spears) at the Spanish exploration party. This Bayou Petre phase group had strong ceramic ties with eastern Gulf groups of the Mississippi and Alabama coasts who were considered to be Pensacola variants of the Mississippian culture (Braud et al, 2006; Nowak et al. 2008).

Over the next century, French interest in the Louisiana area grew while Spain's interests waned. In 1673, Louis Jolliet and Father Jacques Marquette journeyed southward down the Mississippi to the mouth of the Arkansas River. Convinced that the river continued to the Gulf, they returned to French Canada. Jolliet and Marquette's exploration of the Mississippi was followed in 1682 by Robert Cavelier, Sieur de la Salle's journey to the mouth of the river from a fortified base in Illinois. This expedition, followed by de la Salle's later, ill-fated attempt to establish a French settlement on the Gulf Coast stimulated renewed interest and exploratory forays into the region by the Spanish between 1694 and 1693 (Braud et al. 2006; Nowak et al. 2010).

In 1698, French Naval Minister, Jerome Phelypeaux de Maurepas, the count of Pontchartrain, dispatched the navigator, Pierre Le Moyne, Sieur de Iberville, to lead another expedition to the Mississippi Region for the purposes of claiming it as French territory. Iberville entered the

Mississippi River and reclaimed it for the French in 1699 (Braud et al. 2006). Iberville and his younger brother, Jean Baptiste Le Moyne, Sieur de Bienville, founded the initial French settlements along the Gulf Coast. Shortly after the turn of the century, Iberville was killed in a naval battle in the Caribbean and his brother was dismissed from his administrative role for defrauding the French government. The French government subsequently turned to private companies, such as that of Antoine Crozat, to manage the colony and develop and extract Louisiana's resources. The French crown turned over the colony to the Company of the West, after Crozat abandoned the Louisiana colony in 1717. The Company of the West, in turn, transferred its interests to the west, toward relations with New Spain. Natchitoches and New Orleans were founded in 1714 and 1718, respectively, and the colonial population center of Louisiana shifted from the eastern edge of the Mississippi Valley towards New Orleans. The Company of the West was superseded by the more successful Company of the Indies, which lasted until royal control was reestablished in 1731 (Braud et al. 2006:4-6).

Early Exploration and Settlement

The first documented European incursion into Bayou Lafourche ("*fourche*" is a French word for "fork") was by Bienville, younger brother of Iberville, in 1699. Bienville was sent there as an emissary from the French settlement at Biloxi to assess the bayou's navigability and to establish relations with the Ourcha tribal people of Bayou Lafourche. Led by a Bayagoula Indian guide, Bienville's party traveled as far as present-day Labadieville, before it was attacked and repelled back to the Mississippi River by the local population. Despite this inauspicious beginning, the French and Ourcha eventually became allies. One significant result from this exploratory effort, was that it produced what may be the first European account of Belle Pass, which it describes as one of two branches that the Lafourche divides into that has "insufficient water in summer for the passage of a *pirogue*" or dugout canoe (Braud 2006:4-7).

Three years later (1702), Bayou Lafourche was the site of a slave raid on a Chitimacha Indian village, which French officer Louis Juchereau de St. Denis called the "River of the Chitimachas." The French were at war with the Chitimacha for 11 years, and used the Ouacha and Chaouacha as guides and allies to help guide them through the Chitimacha-occupied Bayou Lafourche region. French historic accounts indicate that Bayou Lafourche was inhabited by three tribal populations: the Ouacha, the Chaouacha and the Chitimacha with the latter relatively new to the region (Braud 2006).

During this period, watercraft served as the principal means of transportation throughout Louisiana. For inland waters, the French adapted from the region's Native inhabitants use of the dugout canoe (i.e., the *pirogue*), which were fabricated from large cypress trees, and continued to use the typically open, shallow drafted, sail-powered *bateaux*, *chalands* (flatboats), *esquifs* (skiffs) and *chaloupes* (shallops). The open ocean waters of the Gulf were navigated in sloops, schooners, brigantines and barks (Nowak et al. 2010).

Change of Governments

The French colonial era in the Americas drew to a close in the middle eighteenth century as a result of the "French and Indian," or "Seven Years War" (1756-1763) fought between France, Britain and Spain in a struggle for domination of the New World. Hostilities erupted initially between France and Britain, as a result of conflicting claims in the Ohio Valley. As the war progressed and France's losses mounted, Spain entered into the war as an ally of France. While France looked forward to a speedy cessation of hostilities, Spain hoped to regain some of its New World losses to Britain. To encourage Spain to assist them in bringing the war to a conclusion, and compensate Spain for its losses during the war, France offered Louisiana and Spain accepted. On November 3, 1762, all of Louisiana west of the Mississippi and the Isle d'Orleans was signed over to Spain. The end of the war came soon thereafter with the signing of the Treaty of Paris of 1763. With the war's end came an end to France's holdings in the Americas, as the part of Louisiana east of the Mississippi and all of French Canada were ceded to Britain (Braud 2006).

The first Spanish governor of Louisiana, Antonio de Ulloa y de la Torre Guiral, arrived in New Orleans with about 90 men in 1766. That same year the first Acadians settled along the Mississippi River to protect Spain's new holding from British attack. The Acadians had lived in a French colony in present-day Nova Scotia and New Brunswick until their violent deportation by the British. Ulloa's rule was short-lived, as he was forced to leave two years later as result of a general revolt in New Orleans. Spanish rule over Louisiana was strengthened under the leadership of Governor Don Alexander and his contingent of governmental troops, beginning in 1769 (Braud 2006).

A steady flow of Acadians continued to settle in the LaFourche region between the middle 1700s and 1785, along the relatively dry western bank of the bayou (Pitre 1983:7). By 1785, Lafourche's population had reached 333 whites and 273 slaves. Spaniards from the Canary Islands also settled along Bayou Lafourche. As the number of Europeans settling in upper Lafourche increased, conflicts with the indigenous Houmas Indians rose. The Houmas were eventually displaced to the south near present-day Houma. By 1788, the Houmas were completed gone from the upper Lafourche area (Braud 2006).

Early American Period

Spain ceded Louisiana back to France in 1800 as part of the negotiations that led to the Louisiana Purchase of 1803. The United States' purchase of the Isle d'Orleans at the mouth of the Mississippi River and the Louisiana Purchase of 1803, secured free navigation of the river and its mouth, and, therefore, control of the commerce of the western United States. American control of Louisiana ushered in numerous changes to the territory, which was formerly established as such in 1804. Division of the territory into twelve parishes and statehood (1812) followed shortly thereafter. Under American control, the number of Anglo-Americans settling in Louisiana grew dramatically, particularly after the West Florida Rebellion of 1810 (Braud 2006).

Lafourche's planters first settled the upper reaches of the bayou near the Mississippi. As population increased, the lower bayou was settled, as well, primarily by Acadians. Euro-American settlements extended as far south down both sides of the bayou as the Chitamachas. While the broad natural levees of the upper Lafourche were almost as extensive as those of the Mississippi, the natural levees of Bayou Lafourche shrunk in size south of Larose (Braud 2006).

Lafourche Parish first appears in the archival record as the County of Lafourche in 1805. Two years later, the county was divided into two parishes – Assumption, near the Mississippi, and Lafourche (or the "Parish of the Lafourche Interior") to which it was referred, lower down on its namesake bayou. Lafourche Parish's present boundaries were defined in 1822 when Louisiana legislature removed Terrebonne from the Parish of Lafourche Interior. That same year, Henry Schuyler Thibodaux purchased the property that later became the Town of Thibodaux, which was incorporated in 1830 (Braud 2006).

Mouth of Bayou Lafourche

Although settlements of the upper reaches of Bayou Lafourche saw growth during the nineteenth century, population of the lower bayou remained low. Among the settlements of the lower bayou settled by 1816 were Donaldsonville, Daspit, Flowers, Sawmill and D'Eagle. Daspit and Flowers were located opposite of Little Lake, while Sawmill and D'Eagle were near Golden Meadow. By 1857, the Louisiana Coast Directory listed settlers as far south as Lockport, located over 50 mi from Donaldsonville. Nearly all of these settlements were sugar plantations.

Caminada-Moreau Headlands

At the time of the Louisiana Purchase in 1803, most of the Caminada-Moreau Headlands were apparently owned by Jacques Terrebonne. Terrebonne was followed in property ownership in the area by Joseph Perillat, who dug "Canal Perillat," from the hooked tip of Bayou Fort Blanc to a lake at the eastern end of Bayou Moreau. Establishment of the canal made it possible to reach Bayou Lafourche from Bayou Moreau. This east-west water route between New Orleans and Bayou Lafourche became economically important, and became a focus of residential and commercial activities (Braud 2006).

In the years before the Civil War, significant advances were made in ship design and construction. Swifter sailing vessels and the use of steam power were increasing. Iron and steel components were also seeing increasing use in ship construction. Use of large clipper ships declined following the economic Panic of 1857, the Civil War and the expansion of rail systems (Nowak et al. 2010)

The Civil War

Louisiana severed ties with the Union government of the United States to join the other Confederate states in January 1861. At the start of the Civil War, Lafourche parish had become a well-established, compact society. In 1861, Confederate forces erected a bulwark (Fort Guion) on the lower Lafourche, "extending from swamp to swamp on either side of the bayou," which was garrisoned in January of 1862 and armed with two 32-pounders and more than a 1,000 pounds of powder. Less than a year after the fort's construction, it was abandoned following the fall of New Orleans to Union forces. Bayou Lafourche was the site of two brief, yet bitter, skirmishes fought at Lafourche Crossing in 1863, which resulted in a disproportionate number of Confederate casualties. A description of vessels on the bayou is provided by a member of a Massachusetts regiment stationed in Donaldsonville, who noted that, "Sloops and schooners of considerable tonnage sail up and down the bayou, and one full-sized clipper ship lies at anchor just opposite us" (Braud 2006:25). Although Union in name, the Lafourche country's swamps and marshes remained under control of Confederate irregulars (Braud 2006). Union naval blockades suppressed most of southern Louisiana's maritime commerce, although Confederate supply vessels and blockade runners remained active in the region's offshore waters. Vessels engaged in these activities included everything from small coastal vessels to large steamships.

Post-Bellum Louisiana and the Early Twentieth Century

Louisiana's economy was dealt a severe blow by the Civil War and its aftermath. Isolated from a majority of the war's military actions; however, most of the Caminada area's residents were not as affected by the conflict as others were throughout the South. Southern Louisiana is among the most productive natural areas in the United States and the world (Pitre 1983:36). Therefore, it's not surprising that many in the region turned to fishing for a living after the Civil War, working within the growing shrimp and oyster fisheries, which expanded with the advent of canning in the region in the late 1860s. Until ice became economically feasible late in the nineteenth century, distance and heat restricted access to markets and commercial fishing was limited to small-scale operators who lived off their catch (Pitre 1983). The most commonly employed ships in these fisheries were 20 to 40 ft luggers or “canots,” which were a distinctive Acadian vessel powered by red lateen sails tanned with bark. The canot resembled a gaff-headed sloop, with an outboard rudder, open cockpit, and a closed forecastle with a hatch. Other smallcraft frequenting southern Louisiana’s coastal waters in use at the time included sloops, cat boats, and schooners, which were used for recreational excursions, fishing and bird hunting (Nowak et al. 2010).

Following the removal of the Union blockade of southern ports, commercial shipping resumed along the Gulf Coast, although the American merchant marine never regained its antebellum status due to lost markets and increased costs related to insurance, crews and shipbuilding. The new traffic that moved along coastal Louisiana and along new traffic patterns to Gulf ports and ports all over the world (e.g., the Caribbean, the East Coast of the U.S.; Europe, and South America) was increasingly controlled by foreign interests. Steamers hauled freight and towed barges in the Gulf and on the bays, rivers and bayous (Nowak et al. 2010).

Middle to Late Twentieth Century

The significant contribution of shipping and fishing to the economy of southern Louisiana continued into the middle and late twentieth century. Two new commodities (oil and natural gas) discovered during the late nineteenth and early twentieth centuries quickly became the dominant forces in not only Louisiana’s economy, but in the world economy.

The discovery of these energy resources off of the southern shore of Louisiana in the late 1940s ushered in a new era in the history of human settlement and activity in the region. Numerous enterprises have explored Lafourche Parish and its waters, as well as waters further offshore in the Gulf, in search of oil and natural gas, building numerous offshore pipelines and facilities in the immediate vicinity of the Project area and the locations of the conveyance alternatives. Chief among these facilities is Port Fourchon, located near the mouth of Bayou Lafourche in southern Lafourche Parish. As the only major Louisiana port situated directly on the Gulf of Mexico, Port Fourchon occupies an important and unique position in Louisiana’s offshore economy. The port is the primary land-based support terminal for the offshore oil and gas industries in the Central Gulf of Mexico region. Port Fourchon’s growth and economic viability have been directly related to the development of exploration and production activities associated with the offshore oil and gas industries operating in the Federal waters of the Gulf of Mexico. The Port also serves as a logistical support hub for several other types of economic activities, which include the Louisiana Offshore Oil Port (“LOOP”), waterborne commerce, and commercial fishing. As of 2002, the Port covered approximately 3,600 ac and extended approximately 3 mi along the east side of Bayou Lafourche from its junction with Belle Pass and Pass Fourchon to the Flotation Canal.

Port Fourchon’s waterway connections are vital to its port functions. It has links to the Gulf of Mexico via a navigation canal dredged through Bayou Lafourche and Belle Pass out to the Gulf. The Belle Pass channel has been deepened, widened and moved since the first sheet-pile jetties were installed at the Pass’s mouth in 1939 (Sargent and Bottin 1989).

The Pass has experienced significant modifications to its width, depth, levees, and the location of its mouth into the Gulf of Mexico over the last century, suggesting that the proposed locations for the alternative (upper and lower) are areas that are likely to have been disturbed by past activities. Belle Pass dredging and jetty construction began in 1940 when the depth and width of the channel was expended to unspecified dimensions and parallel rock jetties 500 ft in length and 200 ft wide were added in the 1940s and 1950s (Curole and Huval 2005; Sargent and Bottin 1989). Specifically, the jetties were extended by 300 ft in 1945 due to shoreline erosion. In 1958, the navigation channel was enlarged to a depth of 12 ft and a width of 100 ft. The channel was then relocated to the west of the original jetties (leaving only an eastern jetty) and further expanded to a 125 ft bottom-width in 1968 (Figure 8) (Sargent and Bottin 1989). A western jetty was installed in 1974, and Belle Pass was dredged to a depth of 20 ft and 300 ft width in 1975. In 1980, the jetties were extended to their current 2,600 ft length-x-1,200 ft width. Finally, the navigation channel was dredged to a depth of 27 ft in 2001 (Curole and Huval 2005; Sargent and Bottin 1989). Charted water depths in the area of the proposed Belle Pass alternative range between 2 and 16 ft.

Channels are maintained by the Federal Government with the exception of the reach (section) extending from Port Fourchon to the Gulf. This section is maintained by the Greater Lafourche Port Commission. While this waterway is of primary importance to the Port's business, Fourchon is also connected by a canal dredged in Bayou Lafourche north to Lockport. At Larose, this canal bisects the southern arm of the Intercoastal Waterway, thus providing Port Fourchon access to this pathway of waterborne commerce, as well (Hughes et al. 2002).

Although modern navigation improvements, like the maintenance of the Belle Pass channel and addition of jetties to the mouth of Belle Pass/Bayou Lafourche, and the advent of radar and GPS, have greatly reduced the chance for shipwrecks to occur, numerous fishing and recreational watercraft, as well as barges, tugboats, and work boats have all been lost in the waters in vicinity of the conveyance alternatives. Numerous hurricanes and tropical storms have also hit the area during this period and up to the present (i.e., 1909, 1915, 1920, 1928, 1934, 1949, 1956, 1957 (Esther), 1965 (Betsy), 1974 (Carmen), 1977 (Babe), 1979 (Bob), 1985 (Juan), 1992 (Andrew), Hermine (1998), and 2005 (Katrina and Rita), which has produced significant vessel casualties in Louisiana's waters, as well (Nowak et al. 2010).

Previous Investigations

Archaeological Investigations

Review of LADOA's cultural resource survey maps indicates that a total of seven previous cultural resource management investigations (six terrestrial surveys and one underwater survey) have been conducted between 1976 and 2010 within one mi of the three proposed conveyance alternatives (Figure 9). These investigations include the following:

Belle Pass Conveyance Alternative (Upper and Lower)

- Report No. 22-2: Gagliano, et al. (1976) – *Archaeological Survey of the Port Fourchon Area, Lafourche Parish, Louisiana*;

- Report No. 22-645: Beavers and Lamb (1980) – *A Level I Cultural Resources Survey and Assessment of Fourchon Island, Lafourche Parish, Louisiana*;

- Report No. 22-1793: Weinstein (1994) – *Cultural Resources Investigations Related to the West Belle Pass Headland Restoration Project, Lafourche Parish, Louisiana*, and;

- Report No. 22-3433: Nowak et al. (2010) – *Cultural Resources Assessment/Probability Study for the Terrebonne Basin Barrier Shoreline Restoration, Terrebonne and Lafourche Parishes, Louisiana*

Pass Fourchon Conveyance Alternative

- Report No. 22-2: Gagliano, et al. (1976) (title cited above), and;

- Report No. 22-645: Beavers and Lamb (1980) (title cited above);

Offshore Conveyance Alternative (West and East Options)

- Report No. 22-2966: Braud (2006) – *Cultural Resources Survey of the Caminada Headland Restoration Feasibility Study, Lafourche and Jefferson Parishes, Louisiana*;

- Report No. 22-2952: Nowak et al. (2008) – *Phase I Underwater Remote Sensing Survey of the Caminada Headland Borrow Area for the Louisiana Coastal Area Barrier Shoreline Restoration Project, Lafourche Parish, Louisiana, and*;

- A forthcoming report on archaeological investigations conducted in 2010 by HDR, Inc. ("HDR"), Metairie, Louisiana, as part of the environmental impacts assessment and clean-up effort associated with the 2010 British Petroleum's ("B.P.") Macondo or Mississippi Canyon 252 ("MC252") oil spill.

In advance of the development of the port facility near the mouth of Bayou Lafourche, Gagliano et al. (1976) performed a terrestrial archaeological survey of the Port Fourchon area. The survey consisted of a pedestrian walkover survey and the surface collection of artifacts. Four archaeological sites (16LF7, 16LF8, 16LF9, and 16LF34) originally identified by McIntyre in 1958 were relocated, and five new sites were identified (16LF82, 16LF83, 16LF84, 16LF85, and 16LF86) as a result of Gagliano et al.'s 1976 survey. Two of these sites (16LF82 and 16LF86) straddle the east and west banks of the Belle Pass portion of Bayou Lafourche. They and three others (16LF7, 16LF84 and 16LF85) are proximal to the Belle Pass Conveyance Alternative.

At the time of the 1976 study, Sites 16LF82 and 16LF86 were reported by Gagliano et al. to have yielded "the best and largest collections of artifacts thus far found in southern Bayou Lafourche area," and both sites were recommended for additional testing to evaluate their eligibility for inclusion in the NRHP (Gagliano et al. 1976). Site 16LF82 on the west bank of Belle Pass, was described as a "wave-washed oyster midden" containing a large amount of shell and aboriginal pottery dating from the Late Medora Phase to the Natchezan Phase (A.D. 1200-A.D. 1650), none of which, they reported, appeared to be *in situ*.

Directly across the bayou (and probably related to Site 16LF82) is Site 16LF86, which was identified and described as a "badly disturbed midden," the contextual integrity of which was compromised by episodes of canal cutting and artificial levee construction. Although mostly disturbed, Gagliano et al. (1976) noted that there was a portion of the midden that appeared to be comparatively intact, and that, upon further investigation, might warrant the site's nomination to the NRHP. The remaining sites, including 16LF7, 16LF8, 16LF9, 16LF84 and 16LF85, which are all proximal to either the Belle Pass or the Pass Fourchon Conveyance Alternative, were assessed as being "very disturbed" by erosion and dredging and of no or little archaeological significance (Gagliano et al. 1976:38-39).

In 1980, Beavers and Lamb completed a survey of Fourchon Island (now the roughly hemispheric-shaped stretch of the Headland's beach and marsh situated between Belle Pass to the west and Pass Fourchon to the east.) No new archaeological sites were identified as a result of Beavers and Lamb's survey. Moreover, sites identified in 1976 by Gagliano et al., were determined to have suffered damages from wave action, dredging and marine transgression to the extent that they, including Site 16LF86, no longer "had any probability of contributing to an understanding of the regional cultural landscape" (Nowak et al. 2008:50).

Weinstein's 1994 subsequent cultural resources investigation of the West Belle Pass Restoration Project area, which involved pedestrian field survey and sub-surface testing over 2,188 acres, either discovered or revisited five pre-contact period Native American archaeological sites. The 1994 investigation essentially confirmed the findings of Beavers and Lamb's 1980 study – that sites 16LF82, 16LF83 and 16LF84 were disturbed to the point that they were not significant with no further investigation warranted at any of them (Weinstein 1994).

Braud (2006) completed a Phase I terrestrial cultural resources survey of an approximately 10,345 ac area comprising the Caminada Headland Restoration Feasibility Study area (exclusive of the Shell Island portion of the Study area). Field survey involved systematic surface collection and systematic auger testing, and covered an area that encompassed both land and the intertidal zone bounded by Caminada Pass to the east, Belle Pass to the west, Louisiana Highway No. 1 (LA 1) to the north and the Gulf of Mexico to the south. Four archaeological sites were recorded during the survey: 16LF271, 16LF272, 16LF273 and 16LF274. Only the last of these (16LF274) is located within one mi of any of the three conveyance alternatives (i.e., the Offshore Conveyance Alternative). Site 16LF274 was identified offshore within the intertidal zone and consisted of 25 grog-tempered aboriginal ceramic sherds, one sherd of Mississippi Plain, animal bone, *Rangia* shell and oyster shell. Periodic site visits were recommended for Site 16LF274, which was assessed as being at risk for destruction by wave action and beach erosion.

Nowak et al. (2008) performed a Phase I marine archaeological remote sensing survey of a 1,500 ft wide-x-15,100 ft long (520 ac) area situated approximately 4.7 mi southwest of Caminada Pass, in Lafourche Parish. The study consisted of archival investigations and remote sensing field survey. Archival investigations indicated a low probability for the area to contain submerged pre-contact period sites, as the area was determined by Nowak et al. to have been continuously submerged during Pleistocene and Holocene sea level lowstands. The study area was also assessed to have low to moderate probability for containing post-contact period sites, based on the absence of reported shipwrecks within a 5 mi radius of the survey area, its proximity to the inhabited areas of Port Fourchon and Grand Isle, and the volume of vessel traffic in the vicinity of the study area during the nineteenth and twentieth centuries. Remote sensing survey conducted at a 50 ft trackline interval recorded 100 magnetic anomalies, 40 side scan sonar anomalies, and 19 subbottom profiler reflectors. All were determined to be associated with either modern debris or geological features; no submerged cultural resources were identified and no further investigation was recommended.

Nowak et al. (2010) analyzed the probability for the presence of significant cultural resources within six Terrebonne Basin Barrier Shoreline Restoration project areas on Raccoon Island, Whiskey Island, Trinity and East Islands, Wine Island, Timbalier Island, and East Timbalier Island. The analysis was conducted to assist in the evaluation of alternative designs for the shoreline restoration project. Primary and secondary documentary sources of existing archaeological, geomorphological and historical data were reviewed to examine the probability for cultural resources to be present within the project's coastal APE.

This review resulted in the assessment that there was a low probability for significant pre-contact period archaeological sites or watercraft within any of the project APEs considered during the study, because any pre-contact period archaeological remains in these areas likely would consist of reworked and/or redeposited accumulations of cultural materials lacking integrity of location. Pre-contact sites were not considered to be either a likely or major constraint to implementing the proposed barrier shoreline restoration project activities.

Nowak et al. (2010)'s review also indicated that there was a low probability for significant post-contact archaeological sites or standing structures to be present, since no documented occupations were noted on *terra firma* within the historical records of the various project APEs. However, varied probabilities ranging from high to low for the potential presence of post-contact period shipwrecks in the project areas were noted, with an area near Raccoon Point identified as high probability, east of Raccoon Point, the northwestern portion of the Whiskey Island APE, and the Wine Island APE all identified as moderate probability, and the remaining other project areas all identified as low probability. Finally, Nowak et al. (2010) noted that there were no previously recorded traditional cultural properties located within, or expected to exist within, the various project APE's.

HDR's 2010 archaeological investigations performed as part of the BP/MC252 oil spill response effort recorded eight new pre-contact period archaeological deposits located within approximately 1 mi of the Offshore conveyance alternative (16LF282 ["Wisner 1 Site"], 16LF283 ["Cathy 1 Site"], 16LF284 ["Breach Site"], 16LF285 ["Pitre 2 Site"], 16LF286 ["Pitre 1 Site"], 16LF287 ["Eleanor Site"], 16LF288 ["Cathy 2 Site"] and 16LF 290 ["Ocho Site"]). Except for the Cathy 1 Site, the assemblage from which appears to be associated with the Coles Creek culture and contains human remains and was recommended for additional investigation, all of the other sites were interpreted by HDR to be out of context, redistributed beach wash deposits of ceramic sherds and faunal remains associated with Late Mississippian cultures for which no additional investigation or monitoring is recommended by HDR due to the deposits' lack of contextual integrity.

Environmental Investigations

Picciola's 2011 Bathymetric/Magnetometer Survey of Conveyance Alternatives

In support of the CPRA Project's engineering design and planning, Project team member, Picciola, performed topographic, bathymetric, and magnetometer surveys in 2011 at each location where the three conveyance corridor and re-handling/pump-out alternatives are proposed. Utilizing a combination of a global position system ("GPS") and real time kinematic ("RTK") positioning interfaced with virtual reference station ("VRS"), total station, a fathometer and a magnetometer integrated through Hypack hydrographic survey software, the Picciola surveys established measured baselines and recorded bathymetric cross-sections along Belle Pass, Pass Fourchon and out 5,000 ft offshore from the Caminada headland. Survey transects included a centerline and a series of parallel tracklines oriented perpendicular to the centerline and spaced 125 to 500 ft apart. The purpose of the survey was to characterize the alternatives areas solely for engineering purposes through the establishment of survey baselines and the development of a vicinity map, site plans, plan views, and cross-sections. The magnetometer survey was performed to determine the locations of any pipelines and other anomalies within the alternatives areas where the proposed Project may encounter existing obstructions.

Pertinent excerpted results from the Picciola (2011) study consisting of an overall survey area map, area-specific plans showing the locations of the surveyed tracklines and magnetic anomalies within each alternative, and tables of the magnetic anomalies with their identification numbers, size and locations are included in Appendix A at the back of this report. Results from the survey may be summarized as follows:

- Belle Pass: 43 magnetic anomalies ranging from 40 to 1,390 gammas in amplitude were inventoried and plotted. The largest concentration of anomalies occurs at the lower end of the Belle Pass area. All of the anomalies appear to be located either within the maintained channel or along its immediate margins, suggesting that the sources of the anomalies are disturbed deposits, modern debris, or submerged pipelines/port-related infrastructure. Measured water depths ranged from a maximum of approximately 32 ft at the Pass's northern or "upper" end to less than 5 ft on the pass-side flank of the eastern jetty (and approximately 26 ft in the channel) at the Pass's mouth or "lower" end, and less than 3 ft along the Pass's margins;

- Pass Fourchon: 18 magnetic anomalies ranging from 58 to 3,316 gammas in amplitude were inventoried and plotted. A majority of the recorded anomalies in the Pass Fourchon survey area are concentrated at the southeastern end of the Pass. All appear to be related to modern debris or submerged pipelines and port-related infrastructure. Measured water depths ranged from a maximum of approximately 33 ft at the Pass's intersection with Belle Pass at its western end to 10 ft and less at its southeastern end and along the Pass's margins;

- Offshore (original [i.e., West Option] only): 4 magnetic anomalies ranging from 21 to 52 gammas in amplitude were inventoried and plotted; all are within the conveyance corridor portion (versus the pump-out portion) of the original Offshore West Option alternative. All are interpreted to be modern isolated debris associated vessel traffic into and out of Port Fourchon. Measured water depth in the original Offshore alternative ranged from a maximum of approximately 33 ft at the southern or Gulfward side of the pump-out area to approximately 7 ft at the northern or Headland end of the conveyance corridor.

While not designed as an archaeological survey, the Picciola (2011) investigation nonetheless provided depth and magnetic data that was useful for further defining the alternatives' environmental setting, and were indicative of the modern and/or disturbed submerged cultural materials detectable with a marine magnetometer that would likely be encountered within them.

OSI's 2010 Subbottom Profiling Survey of Nearshore Waters off Caminada Headland

In 2010, OSI performed a subbottom profiler, push-probe and grab-sample survey of a one nm-x-11.5 nm area of the nearshore waters of the Caminada Headland to map the limits of sand currently existing immediately off of the Headland between Belle Pass and Caminada Pass. The survey was performed on behalf of the CPRA as one of the initial investigations conducted to aid them in their design and engineering of the Caminada Headland Beach and Dune Restoration Project (BA-45). The survey involved acquisition of CHIRP subbottom profiler data along a series of 62 parallel lines oriented perpendicular to the headland (coincident with hydrographic survey tracklines surveyed earlier by Picciola) and spaced 1,000 ft apart, as well as a single tie-line oriented parallel to the headland extending the full length of the study area. In total, OSI acquired more than 85 mi of subbottom data, performed more than 430 push probes and acquired 17 grab samples (OSI 2010).

Subbottom records documented a very mixed sediment sequence within approximately 15 ft of the seafloor's surface overlaying a semi-continuous "basal" reflector tracked throughout much of the survey area. Correlation of the subbottom records with push probe and grab sample results, as well as core logs from a 2000 USGS investigation suggested that a thin (0.5 ft) veneer of nearshore sand existed in the survey area. This surficial sand layer appeared to be somewhat thicker in the eastern section of the site near Caminada Pass, perhaps as much as 4 ft thick locally. This sand-rich deposit may be the result of reworking of the Caminada Pass ebb tide delta. In general, fine grained sand was prevalent at the surface in the very nearshore area and clay in the offshore portion of the survey area. Push probe and grab sample data were relied on to a significant degree to make this distinction. While the transition between surficial sediment types was distinct in some areas, in other areas the data suggested that the transition occurs gradually, with the surficial sediments alternating between sand and clay (OSI 2010).

As in the case of the 2011 Picciola environmental study described above, in addition to assisting with the engineering and design of the restoration Project, the subbottom data acquired during the 2010 OSI survey provided important information for assessing the degree of disturbance of the intertidal and nearshore submerged substrate in and adjacent to the Offshore alternative. Seven of the tracks intersect and define the preserved limits of a submerged and buried relict paleochannel feature, the location of which coincides closely with the historic position of the Bayou Moreau meander.

The paleochannel subbottom features visible in the profiles are interpreted to be the acoustically reflective buried deposits of coarser materials from the bottom and lower portions of the bayou channel distributed in an otherwise more or less level stratum. Evidence suggesting that the bayou's archaeologically sensitive natural levees that once straddled the channel survived the marine transgression intact appears to be absent from the subbottom record. Instead, the subbottom profiles indicate that the combined effects from subsidence, sea level rise and longshore drift that have caused the Headland's shoreline to retreat rapidly northward have also eroded and truncated the natural levees that once existed along the margins of Bayou Moreau through the common transgressive process of shoreface retreat, rather than having inundated and preserved them in place in a process of stepwise retreat. In its destruction of the natural levees of Bayou Moreau, the erosive shoreface retreat process appears to have destroyed and reworked the levees' prismatic sediment matrix and transported and redeposited displaced artifacts contained within it along the shoreline in the swash zone of the intertidal nearshore waters where they are presently found.

The absence of evidence in the subbottom profiling data for intact natural levee features associated with submerged Bayou Moreau meander correlates with the findings of HDR's archaeologists who identified its associated archaeological sites earlier in 2011 and assessed all but one of them (i.e., the "Cathy 1 Site" [16LF283]) on the site forms as, "eroded and subsequently redeposited resources…[that] lack context and integrity."

OSI's 2011 Geophysical Survey of the Offshore Alternative (West and East Options)

Marine geophysical/remote sensing field survey of the Offshore Alternative (West and East) conveyance corridor and pump-out option was completed for the Project by OSI late in 2011 and reported on in 2012 (see Appendix C). Primary survey tracklines for the geophysical/remote sensing survey were spaced 98 ft (30 m) apart with secondary survey tie-lines oriented perpendicular to the primary lines spaced 500 ft (152.5 m) and a 1,000 ft (305 m) apart in the conveyance corridors and pump-out areas, respectively. Due to the presence of a pipeline detected in the pump-out area of the West option, survey coverage was expanded and the proposed West option pump-out area was shifted closer to shore - approximately 2,200 ft (670.5 m) to the northwest (see Appendix C [OSI 2012b], Figure 2, and Drawing 1 – "Tracklines" [Sheets 1 and 2]).

Equipment utilized during the 2011 OSI geophysical/remote survey of the Offshore Alternative conveyance corridor and pump-out West and East options consisted of:

- HYPACK navigation and data logging computer system
- Trimble 212 differential global positioning system ("DGPS")
- Odom Echotrac single frequency depth sounder
- Klein 3000 100/500 kHz dual-frequency digital side scan sonar system
- Geometrics G881 cesium marine magnetometer (towed at an altitude of less than 20 ft [6 m] above the sea floor)
- EdgeTech Xstar CHIRP subbottom profiling system equipped with an SB216 tow vehicle.

Analysis of hydrographic data recorded water depths in both the West and East options of the Offshore Alternative ranging from approximately 9 to 34 ft (3 to 10 m) below NAVD88, and gradually sloping, relatively featureless, seafloor with no bathymetric targets suggestive of an intact shipwreck or scattered shipwreck materials extending above the seafloor visible in the plot (see Appendix C [OSI 2012b], Drawing 2 – "Hydrography" [Sheets 1 and 2]).

Analysis of the magnetometer data identified a total of 239 magnetic anomalies in the West option and 88 magnetic anomalies in the East option of the Offshore Alternative (see Appendix C [OSI 2012b], Appendix 3 – "Summary Tables of Magnetic Anomalies and Sidescan Sonar Targets," and Drawing 3 – "Sidescan Sonar Mosaic and Residual Magnetic Field Contours" [Sheets 1 and 2]). In the West option, recorded magnetic anomalies ranged from 1.5 to 3,253 gammas in amplitude and approximately nine to 589 ft (3 to 195 m) in duration (OSI 2012b). A linear alignment of anomalies correlating to the aforementioned pipeline and two large areas of clustered magnetic anomalies associated with the charted locations of oil/gas platforms recorded within the originally proposed West option's pump-out area were responsible for its relocation to the West option's current configuration. The majority of the remaining anomalies in the West option were isolated and less than 10 gammas in amplitude (OSI 2012b). Several of the detected anomalies grouped together on the northern edge of the West option's conveyance corridor, which lacked any correlative sonar target(s), may represent shallow water hazards (OSI 2012b), but neither they, nor any of the other magnetic anomalies recorded within the West option, are interpreted to represent probable submerged cultural resources. In the East option of the Offshore Alternative, recorded magnetic anomalies ranged from 1.8 to 2,320.2 gammas in amplitude and from approximately 33 to 316 ft (10 to 100 m) in duration (OSI 2012b). The majority of the anomalies in the East option were less than 10 gammas; only 16 anomalies exhibited amplitudes greater than 20 gammas (OSI 2012b). Most anomalies detected in the East option appeared to be isolated and were detected on just a single survey line (OSI 2012b). None of the magnetic anomalies recorded within the East option are interpreted to represent probable submerged cultural resources.

Analysis of the sidescan sonar data recorded a total of 65 individual sidescan sonar targets in the West option and 86 targets in the East option of the Offshore Alternative (see Appendix C [OSI 2012b], Appendix 3 – "Summary Tables of Magnetic Anomalies and Sidescan Sonar Targets," and Drawing 3 – "Sidescan Sonar Mosaic and Residual Magnetic Field Contours" [Sheets 1 and 2]). In the West option, targets ranged in size from approximately 1.8 to 169 ft (0.5 to 51.5 m) long and less than 1 ft (0.3 m) to 46.6 ft (14 m) wide (the 46.6 ft- [14 m-] wide target was identified by OSI [2012] as an oil/gas platform). Many of the targets identified within the West option were detected southeast of the proposed West option's pump-out area and, as in the case of the magnetic anomalies, correlate to a pipeline and charted oil/gas platforms in the area. The remaining targets, some of which have correlative magnetic anomalies, appear to be relatively small linear features with minimal relief (less than 1 ft [0.3 m]) and width, measuring in most cases (n=42) less than 2 ft (0.6 m) wide. None of the sonar targets recorded within the West option was interpreted to represent probable submerged cultural resources. In the East option, targets ranged in size from less than 1 ft (0.3 m) to approximately 127 ft (36 m) long, and less than 1 ft (0.3 m) to approximately 43 ft (13 m) wide. Most of the recorded sidescan sonar targets appear to be relatively small with minimal relief (less than 1 ft [0.3 m]) and width (n=58 targets less than 3 ft [1 m] wide). The majority of sonar targets identified appear to be linear features. Several sonar targets had correlative magnetic anomalies associated, but none of the sidescan sonar targets recorded within the East option was interpreted to represent probable submerged cultural resources.

Analyses of the subbottom profiling data recorded in the Offshore Alternative (West and East) documented the upper five to 15 ft (3.5 to 5 m) of the substrate below the seafloor surface throughout all of surveyed West and East options with the exception a relatively small area crossing the conveyance corridor portion of the West option where near-surface gaseous sediments inhibited penetration of the subbottom profiler's acoustic signal (see Appendix C [OSI 2012b], Drawing 1 – "Tracklines" [Sheet 2]). The subbottom data records a high degree of variability both along-line and from line-to-line in the substrate, suggesting that it is not composed of a single sediment type that can be distinctly mapped, but is instead characterized by mixed/disturbed sediments (OSI 2012b). A small, isolated/discontinuous segment of what may possibly be the bottom of a buried relict channel was detected six to 18 ft (2 to 5.5 m) below the seafloor surface along a short portion of a single survey line in the East option conveyance corridor, approximately 1,200 ft (365 m) offshore (see Drawing 1 – "Tracklines" [Sheet 1]).

CONCLUSIONS AND RECOMMENDATIONS

Belle Pass Alternative (Upper and Lower)

The shoreline adjacent to the Belle Pass (Upper and Lower) alternative and the area immediately surrounding it have been subjected to four previous cultural resource management archaeological investigations since 1976 (Gagliano, et al. 1976; Beavers and Lamb 1980; Weinstein 1994; and Nowak et al. 2010). These investigations resulted in the confirmation and identification of five archaeological sites within one mi of the proposed Belle Pass alternative. All five of the identified Mississippian culture archaeological sites have been assessed by the archaeologists conducting the investigations as badly/very disturbed or destroyed with compromised integrity of location due to natural and anthropogenic impacts from erosion, dredging, canal expansion and artificial levee construction. Furthermore, the archaeological sensitivity of the coastal area encompassing the alternative was assessed by Nowak et al. 2010 as low for pre- and post-contact sites on shore, and of variable sensitivity for shipwrecks.

Based on the results from Fathom's background research and review of existing archaeological and environmental survey data, the Belle Pass alternative is assessed as having low marine archaeological sensitivity. Consequently, no additional investigation is recommended; however, implementation of an unanticipated discovery plan is recommended. This plan should require formal sensitivity training prior to Project implementation for Project construction and administrative staff on the importance of historic preservation, the types of features and artifacts that could be encountered while working on the Project, and the appropriate protocols and communication chain to follow if an unanticipated discovery of an archaeological deposit or human remains occurred.

Pass Fourchon Alternative

The shoreline adjacent to the Pass Fourchon alternative has been subjected to three previous cultural resource management archaeological investigations since 1976 (Gagliano, et al. 1976, Weinstein and Burden 1979, and Beavers and Lamb 1980). These investigations resulted in the confirmation and identification of three archaeological sites within one mi of the Pass Fourchon proposed alternative. All of the identified Mississippian culture archaeological sites were assessed to be badly/very disturbed or destroyed with compromised integrity of location due to natural and anthropogenic impacts from erosion, dredging, canal expansion and artificial levee construction.

Based on the results from Fathom's background research and review of existing archaeological and environmental survey data, the Pass Fourchon alternative is assessed as having low marine archaeological sensitivity. Consequently, no additional investigation is recommended; however, implementation of an UDP is recommended. This plan should require formal sensitivity training prior to Project implementation for Project construction and administrative staff on the importance of historic preservation, the types of features and artifacts that could be encountered while working on the Project, and the appropriate protocols and communication chain to follow if an unanticipated discovery of an archaeological deposit or human remains occurred.

Offshore Alternative (West and East Options)

The adjacent shoreline and portions of the Offshore Alternative (West and East options) had been subjected to three previous cultural resource management archaeological investigations since 2006 (Braud 2006, Nowak et al. 2008, and the field investigations completed in 2010 by HDR as part of the B.P./MC252 oil spill clean-up effort). These investigations resulted in the identification of nine documented Mississippian archaeological sites on the Headland's shore adjacent to and north of the submerged Bayou Moreau area (Stations 270+00 through 400+00) within proposed headland restoration fill template and within one mi of the proposed Offshore alternative's landfall, and no underwater sites in the nearshore waters within one mi of the proposed Offshore alternative. All of the identified Mississippian culture archaeological sites, except for the Cathy 1 Site (16LF283), which at the time of its recording by HDR appeared to contain *in situ* ancient human remains and cultural material, were described as, "eroded and subsequently redeposited resources…lack[ing] context and integrity" for which no further investigation was recommended by HDR (as recorded in the LADOA site files).

Based on the results from Fathom's background research and review of existing archaeological and environmental survey data, as well as concerns raised during the CPRA's September 2011 consultation with the SHPO, Chitimacha Tribe, and the Wisner Foundation, the Offshore alternative was assessed by Fathom in October 2011 as having variable (i.e., low to moderate) marine archaeological sensitivity. Additional onshore/intertidal investigation (i.e., a Phase II National Register eligibility evaluation performed under a LADOA Cultural Resources Investigation permit) was recommended for the Cathy 1 Site (16LF283), and a marine geophysical/remote sensing survey was recommended for the Offshore Alternative's underwater Project area to determine presence/absence of magnetic anomalies and sidescan sonar targets with probability of representing submerged cultural resources (i.e., shipwrecks), as well as to further confirm the disturbed/destroyed condition of the inundated paleolandscape within the Offshore

Alternative's underwater Project area. Options for realigning or shifting the location of the Offshore Alternative further to the east, so that it would completely avoid the previously identified archaeological sites, as well as the inundated relict course of a meander in Bayou Moreau, were also considered at this time.

Review of OSI's geophysical/remote sensing data acquired for the Project in the Offshore Alternative (West and East options) (OSI 2012b), combined with an examination of historic and current navigational charts depicting the rapidly retreating position of the Headland's shoreline and modern infrastructure related to the development of the offshore oil/gas industry, resulted in the final assessment that while both options of the Offshore Alternative contain relatively large numbers of magnetic and sidescan sonar anomalies, all of these anomalies and targets appear to be associated with modern activities and the infrastructural development of the local/regional offshore oil/gas industry. None of the detected anomalies or targets appeared to be suggestive of probable and potentially significant submerged cultural resources. Review of subbottom data acquired in the Offshore Alternative (West and East options) confirmed broader observations made as a result of OSI's 2010 subbottom survey (described above). It indicated that sediments comprising the substrate of the Offshore Alternative, like those observed in the 2010 data from the nearshore waters surrounding the Offshore Alternative, were mixed/disturbed with only small, isolated, and discontinuous segments of non-archaeologically sensitive buried paleochannel beds (with truncated archaeologically sensitive natural levees) present. Consequently, the Offshore Alternative (West and East options) is considered to have low marine archaeological sensitivity and no additional investigation is recommended; however, implementation of an UDP is recommended. This plan should require formal sensitivity training prior to Project implementation for Project construction and administrative staff on the importance of historic preservation, the types of features and artifacts that could be encountered while working on the Project, and the appropriate protocols and communication chain to follow if an unanticipated discovery of an archaeological deposit or human remains occurred.

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FIGURES

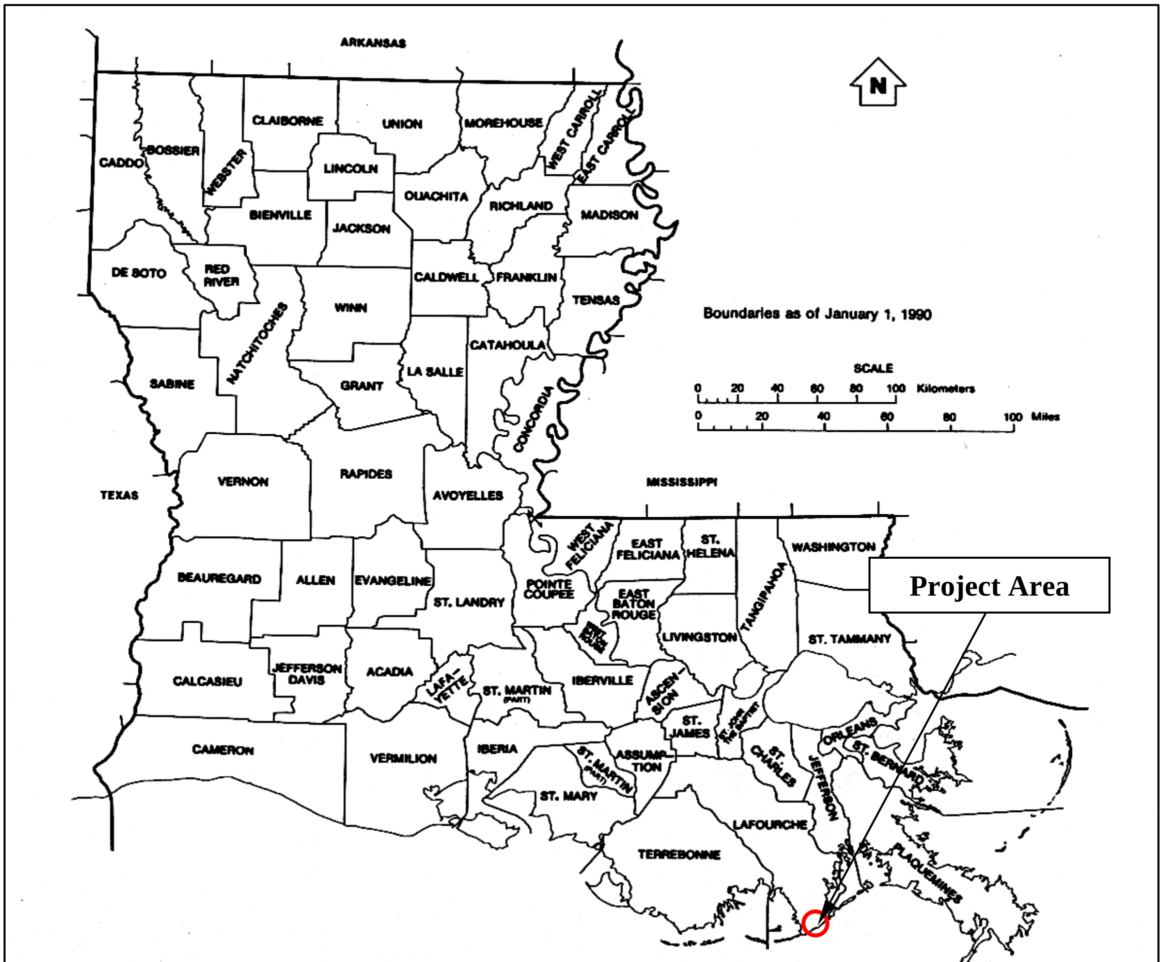

Figure 1. General Project area location within Lafourche Parish, Louisiana.

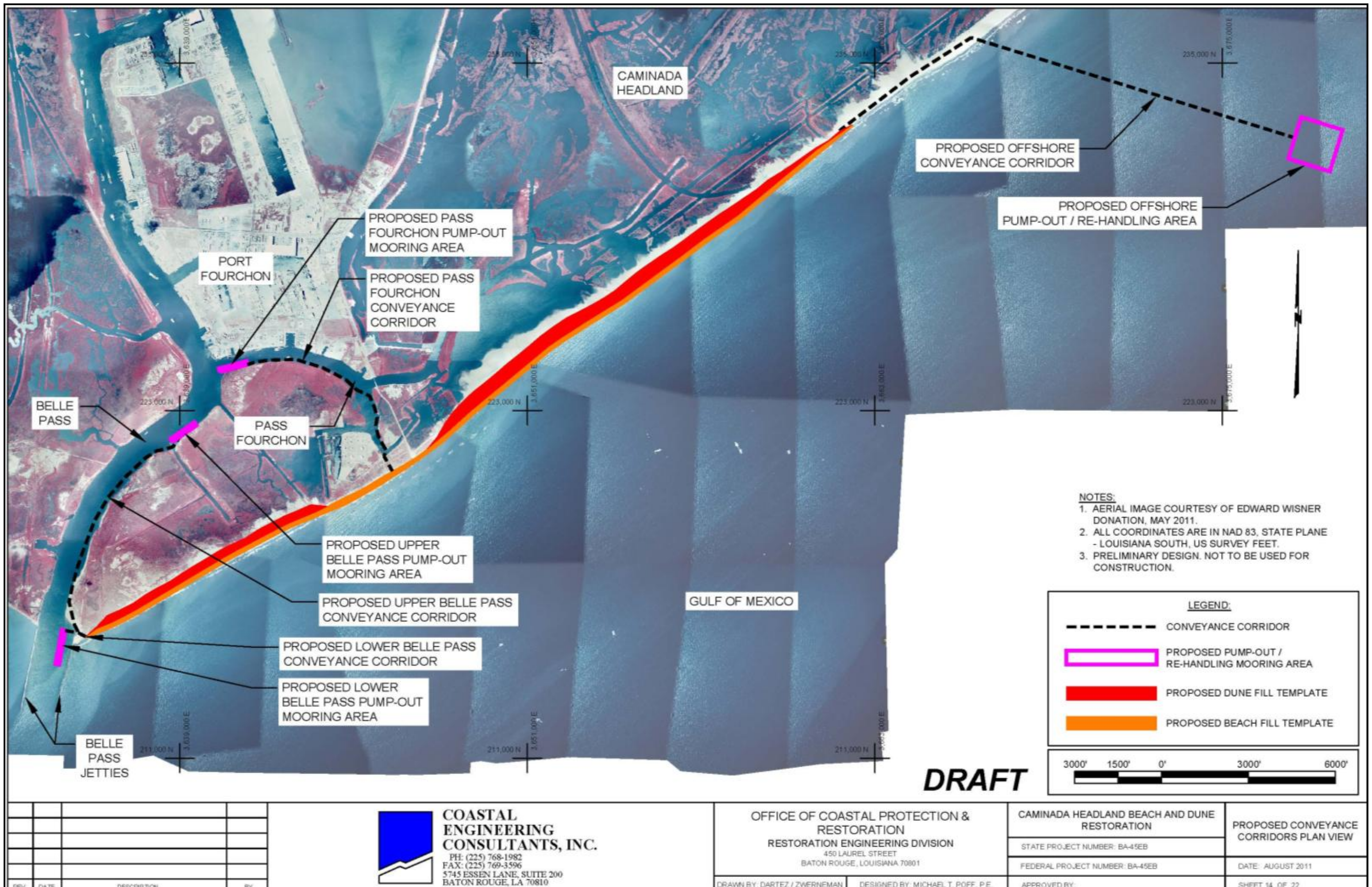

Figure 2. Proposed "Belle Pass," "Pass Fourchon" and "Offshore" conveyance corridor/pump-out area alternatives, Lafourche Parish, Louisiana (source: courtesy of CEC).

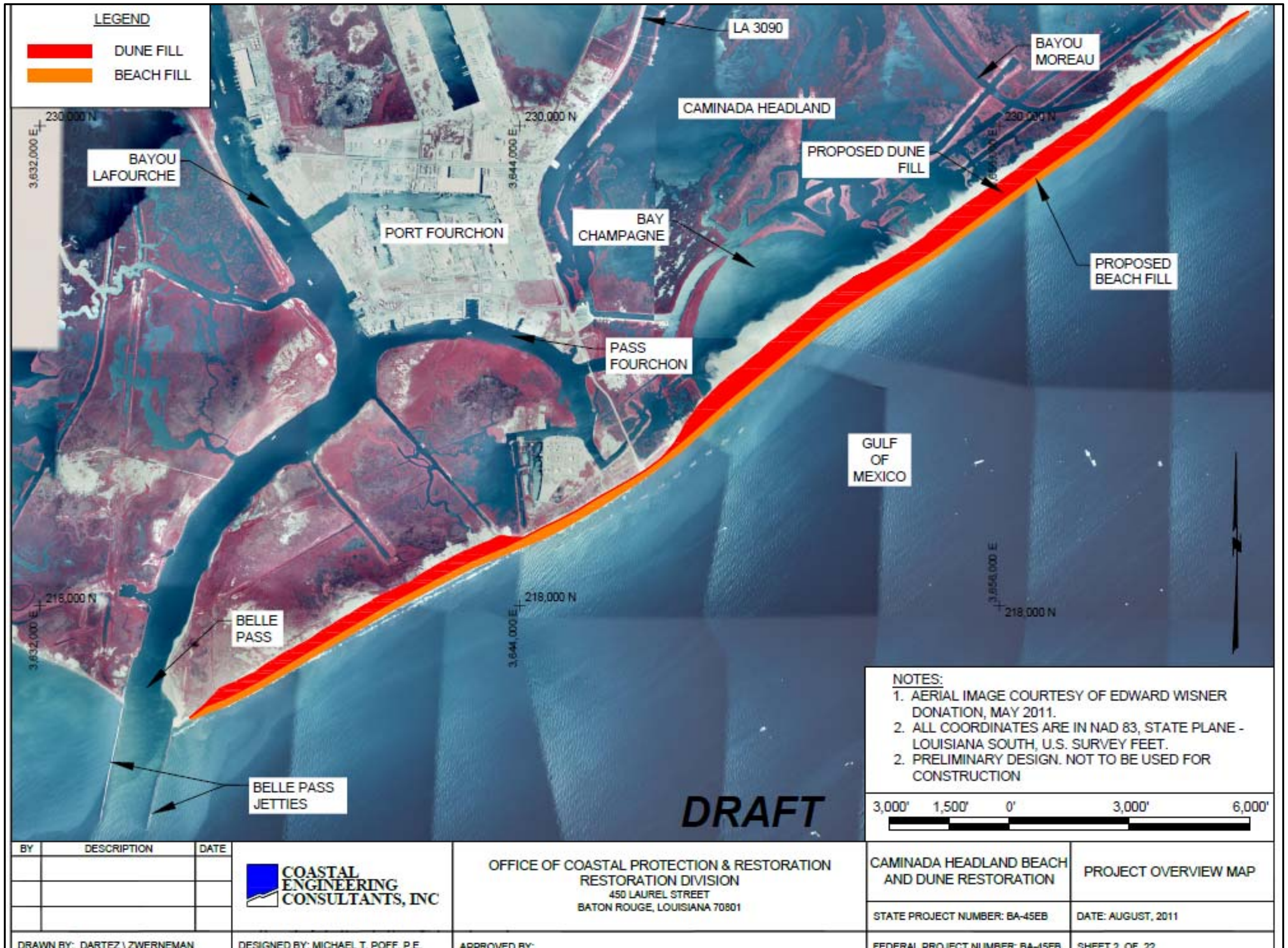

Figure 3. CPRA's proposed dune and beach fill template (red and orange areas) for restoring the western end of the Caminada Headland (source: courtesy of CEC).

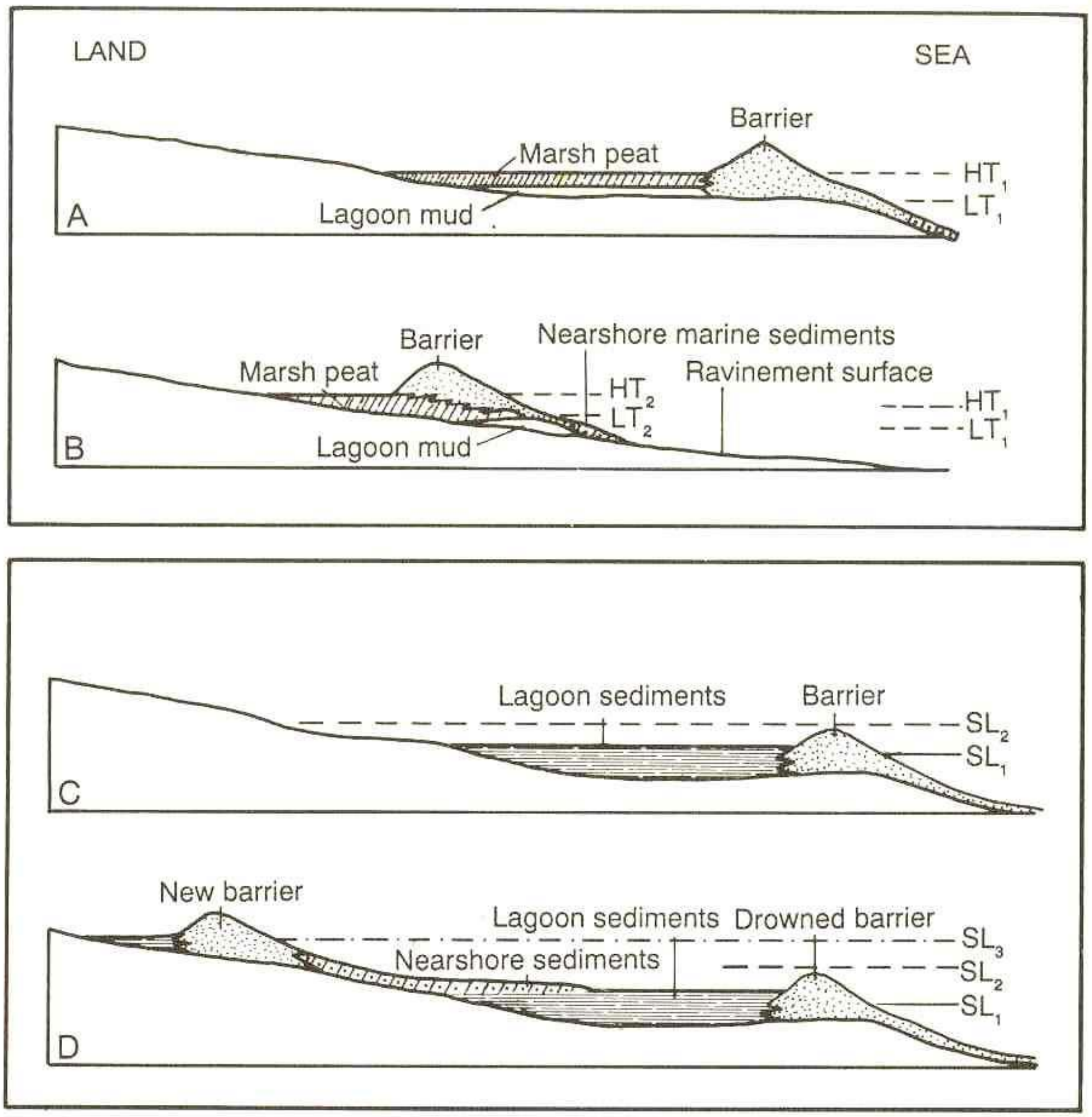

Figure 4. Two forms of marine transgression: destructive shoreface retreat (A and B [top]) and the more preservative stepwise retreat (C and D [bottom]). In A and B, erosion associated with sea level rise removes the older barrier island deposits and creates an erosional "ravinement" surface (HT/LT). In C and D, the shoreline jumps landward as sea level rises rapidly from the lower position to a higher one (SL_1, SL_2, and SL_3). Consequently, the erosional surf and swash zones have little time to erode the older barrier island sequence, thus preserving it (source: Waters 1996:276).

Figure 5. Map of the major river drainages and physiographic regions of Louisiana. The Project area is located within the Bayou Lafourche River Drainage of the Mississippi River Deltaic Plain physiographic region (source: after Rees [2010]).

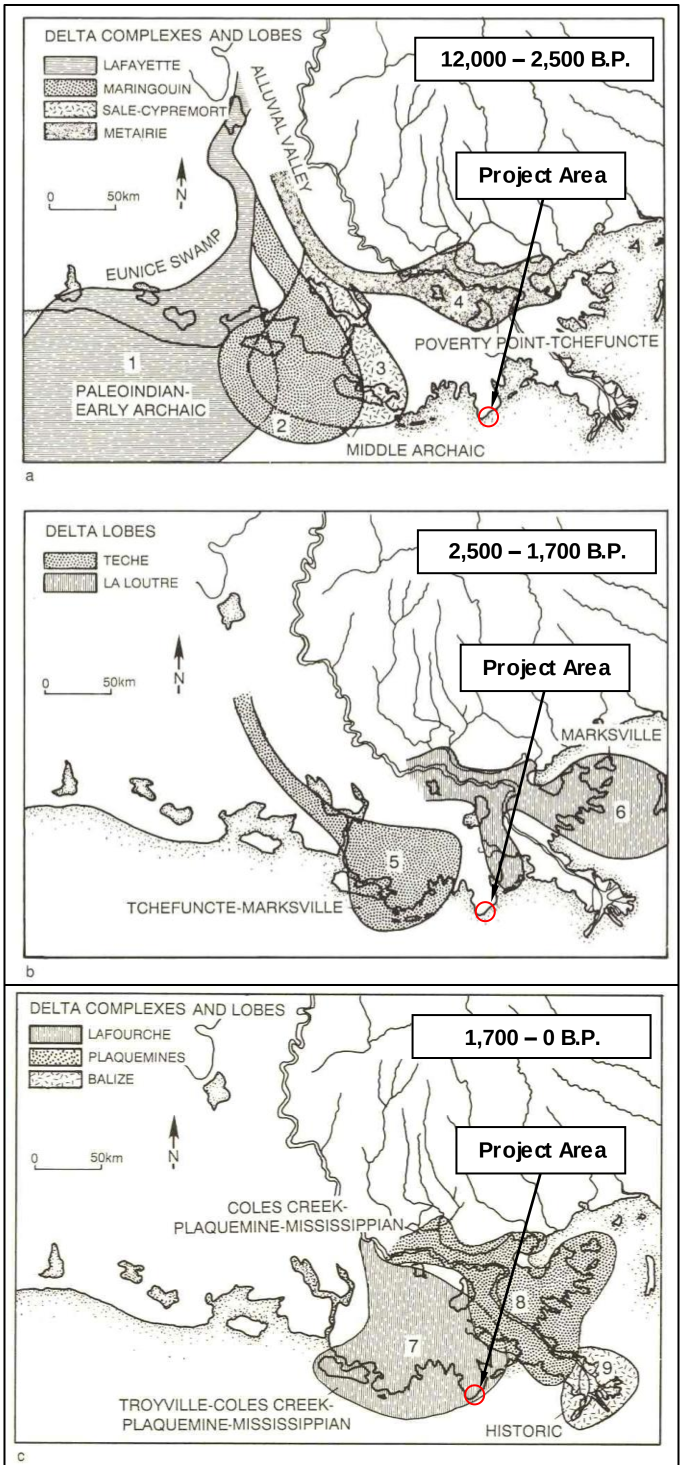

Figure 6. Evolution of the Mississippi Delta and the succession of the delta lobes and the cultures that occupied them (12,000 B.P. – present) (source: Waters 1992).

STAGE	PERIOD	CULTURE	TIME INTERVAL	PHASES: Eastern Area	PHASES: Central Area	PHASES: Western Area
FORMATIVE	Historic	Various Cultures	Present	← Various Tribes	Various Tribes	Various Tribes → / Little Pecan
FORMATIVE	Mississippi	Natchezan, Mississippian, Plaquemine	A.D. 1700, A.D. 1600, A.D. 1300	Delta Natchezan, Bayou Petre	Petite Anse / Burk Hill	Bayou Chene
FORMATIVE	Mississippi	Plaquemine	A.D. 1000	Medora	Three Bayou	Holly Beach
FORMATIVE	Coles Creek	Coles Creek	A.D. 850	Bayou Ramos / Bayou Cutler	Morgan / White Lake / ?	Jeff Davis / Welsh
FORMATIVE	Baytown	Baytown	A.D. 700	Whitehall	?	Roanoke
FORMATIVE	Marksville	Hopewellian-Marksville	A.D. 400, A.D. 200	Gunboat Landing, Magnolia / Smithfield, LaBranche	Mandalay / Jefferson Island	Veazey; Lake Arthur / Lacassine
FORMATIVE	Tchula	Tchefuncte	0, 250 B.C.	Beau Mire / Pontchartrain	Lafayette	Grand Lake
ARCHAIC	Poverty Point	Poverty Point	500 B.C., 1000 B.C.	Garcia / Bayou Jasmine	Beau Rivage, Rabbit Island	?
ARCHAIC	Late Archaic	Archaic	1500 B.C., 3000 B.C.	Pearl River	Copell	Bayou Blue
ARCHAIC	Middle Archaic	Archaic		Monte Sano, Amite River	Banana Bayou	?
ARCHAIC	Early Archaic	Archaic	5000 B.C.	St. Helena	?	?
LITHIC	Late Paleo	Paleo-Indian	6000 B.C.	Jones Creek	Vatican	Strohe
LITHIC	Early Paleo	Paleo-Indian	8000 B.C.	?	Avery Island	
LITHIC	Pre-Projectile Point	?	10,000 B.C., ?	?	?	?

Figure 7. Coastal Louisiana Native American cultural chronology based on archaeological and ethnohistorical evidence (source: Uzee 1985).

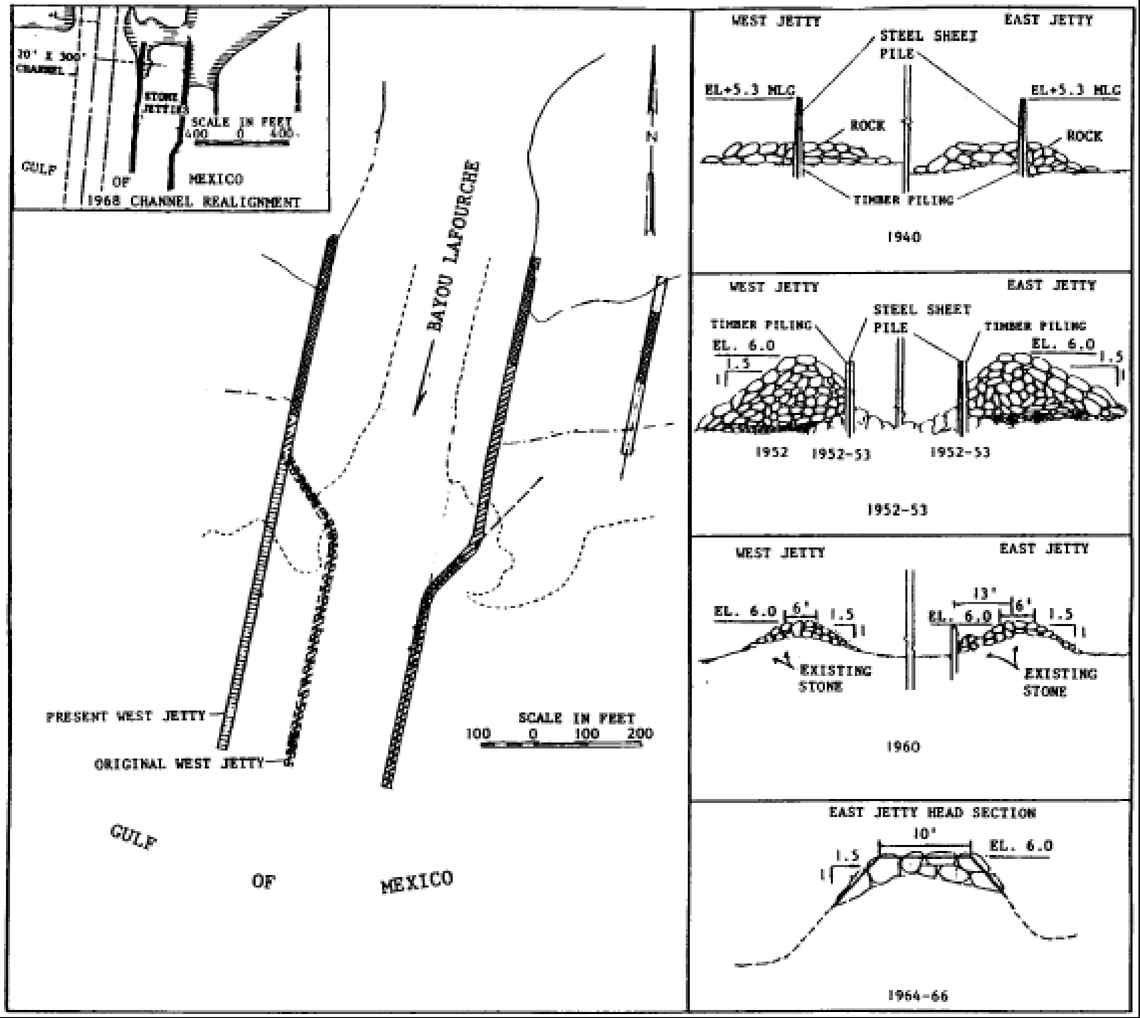

Figure 8. Pre- and post-1968 Belle Pass westward channel realignment and jetty plans (source: Sargent and Bottin 1989:46.)

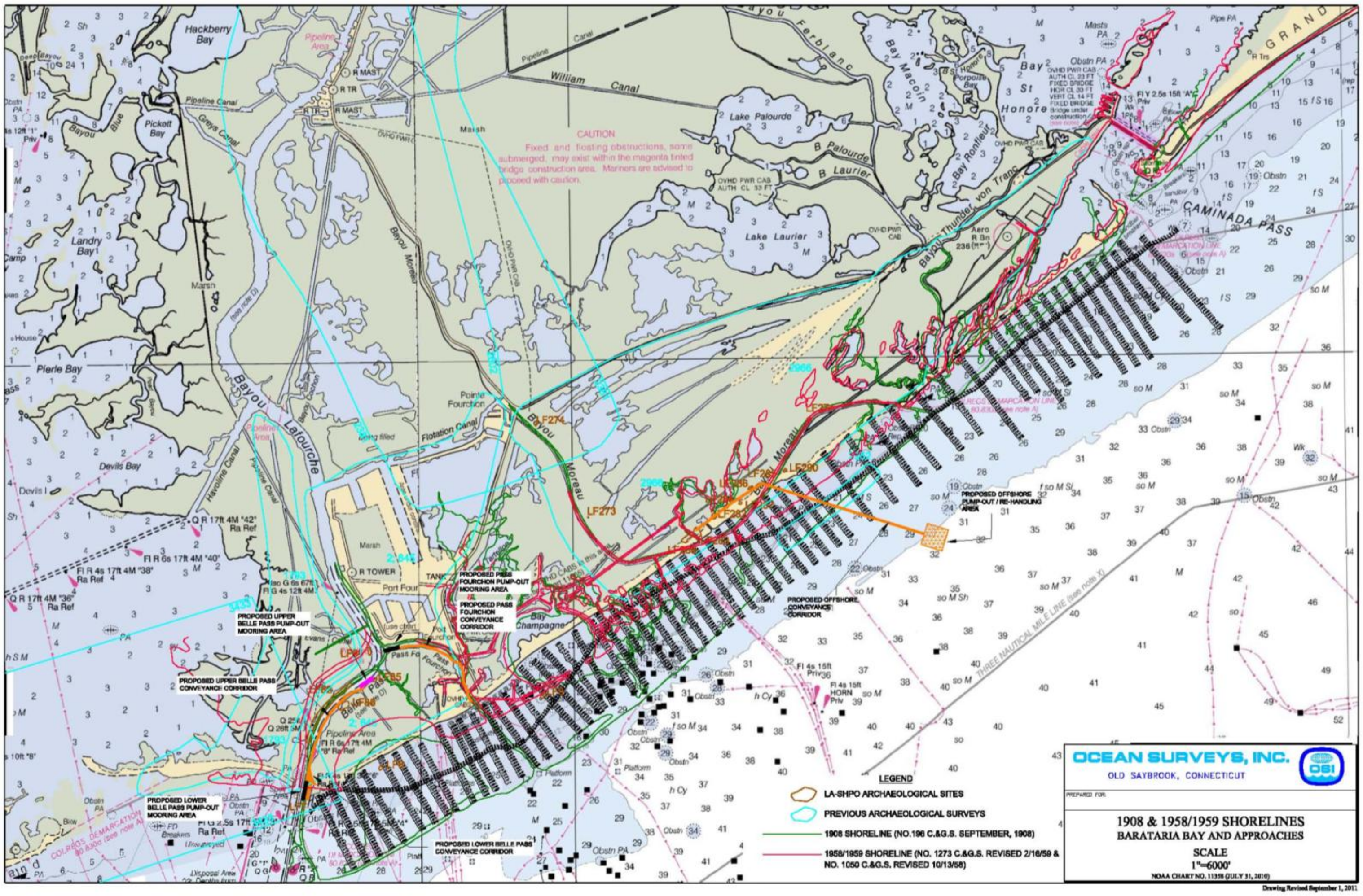

Figure 9. Locations of the proposed conveyance and re-handling/pump-out alternatives (orange), LADOA-inventoried archaeological sites (brown) and previous archaeological surveys (light blue with LADOA report number), historic shorelines and course of Bayou Moreau (ca. 50 years [red] and 100 years [green] ago), and survey tracklines (black) from the 2010 OSI subbottom profiler survey (source: OSI).

APPENDICES

APPENDIX A:

EXCERPTED RESULTS FROM PICCIOLA (2011)

BATHYMETRY AND MAGNETOMETER

ENGINEERING SURVEY

BELLE PASS ALTERNATIVE

BELLE PASS BASELINE INFORMATION				
POINT	COORDINATES	SEGMENT DISTANCE (FT)	SEGMENT BEARING	P.I. STATION
A	X=3639519.47, Y=225417.68	AB – 700.08	AB – S 29°45'27" E	120+00
B	X=3639866.94, Y=224809.92	BC – 500.01	BC – S 12°53'02" E	127+00.02
C	X=3639978.43, Y=224322.50	CD – 500.00	CD – S 02°58'18" W	132+00
D	X=3639952.51, Y=223823.17	DE – 500.00	DE – S 19°15'38" W	137+00
E	X=3639787.58, Y=223351.16	EF – 500.00	EF – S 35°19'11" W	142+00
F	X=3639498.51, Y=222943.19	FG – 500.00	FG – S 50°53'38" W	147+00
G	X=3639110.52, Y=222627.81	GH – 1500.00	GH – S 55°18'38" W	152+00
H	X=3637877.15, Y=221774.12	HI – 1000.01	HI – S 52°48'22" W	167+00
I	X=3637080.55, Y=221169.60	IJ – 999.99	IJ – S 42°45'10" W	177+00.01
J	X=3636401.72, Y=220435.32	JK – 1000.01	JK – S 32°13'52" W	186+99.99
K	X=3635868.38, Y=219589.41	KL – 600.00	KL – S 23°47'36" W	197+00
L	X=3635626.32, Y=219040.41	LM – 1400.00	LM – S 19°51'00" W	203+00
M	X=3635150.94, Y=217723.59	MN – 1000.00	MN – S 13°36'51" W	217+00
N	X=3634915.56, Y=216751.69	NO – 5300.00	NO – S 10°32'36" W	227+00
O	X=3633945.76, Y=211541.17			280+00

BELLE PASS SURVEY - PLAN VIEW

500 0 500 1000 1500

SCALE: 1" = 500'

J.N. 1222-1002

REVISIONS:

DATE: REMARKS:

PICCIOLA & ASSOCIATES, INC.
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LAND SURVEYORS MARINE ENGINEERS
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COASTAL ENGINEERING CONSULTANTS, INC.

CAMINADA HEADLAND BEACH AND DUNE RESTORATION PROJECT (BA-45EB)
C.E.C. PROJECT: 10.140 – TASK 2.4.3 CONVEYANCE CORRIDORS AND SEDIMENT RE-HANDLING/PUMP-OUT AREAS SURVEYS, BELLE PASS SURVEY PLAN VIEW
LAFOURCHE PARISH, LA

DESIGNED BY: J.C.P.

DRAWN BY: L.J.G.

CHECKED BY: J.C.P.

DATE: JUNE 29, 2011

SCALE: AS SHOWN

SHEET NO. 16 OF 36

DRAWING PLOTTED AT HALF SCALE

ORIGINAL

ORIGINAL

10.140 CONVEYANCE CORRIDOR MAGNETOMETER SURVEY, MAY 17, 2011 – BELLE PASS

LINE	LINE NAME	*ASSIGNED POINT NO.	X	Y	LATITUDE	LONGITUDE	TYPE	GAMMA READING
WEST MOST CL OFFSET	005_1318	BP-01	3638887.51	222733.49	90 12.730042	29 06.457987	MONO	62
WEST MOST CL OFFSET	005_1318	BP-02	3638177.19	222325.41	90 12.864234	29 06.391802	MONO	88
WEST MOST CL OFFSET	005_1318	BP-03	3638085.31	222221.47	90 12.881686	29 06.374806	MONO	163
WEST MOST CL OFFSET	005_1318	BP-04	3635918.05	220033.39	90 13.292821	29 06.017289	DIPOLE	203
WEST MOST CL OFFSET	005_1318	BP-05	3635797.59	219842.13	90 13.315798	29 05.985927	DIPOLE	57
WEST MOST CL OFFSET	005_1318	BP-06	3635505.19	219276.20	90 13.371754	29 05.893026	MONO	153
WEST MOST CL OFFSET	005_1318	BP-07	3634244.55	214285.04	90 13.617616	29 05.071581	MONO	89
WEST MOST CL OFFSET	005_1318	BP-08	3634120.62	213520.39	90 13.642278	29 04.945625	MONO	467
EAST MOST CL OFFSET	001_1348	BP-09	3634273.06	212138.35	90 13.616153	29 04.717370	DIPOLE	126
EAST MOST CL OFFSET	001_1348	BP-10	3634305.23	212302.55	90 13.609814	29 04.744408	MONO	215
EAST MOST CL OFFSET	001_1348	BP-11	3634332.42	212454.70	90 13.604430	29 04.769468	DIPOLE	338
EAST MOST CL OFFSET	001_1348	BP-12	3634397.26	212804.43	90 13.591619	29 04.827064	DIPOLE	717
EAST MOST CL OFFSET	001_1348	BP-13	3634467.06	213118.20	90 13.577940	29 04.878720	DIPOLE	723
EAST MOST CL OFFSET	001_1348	BP-14	3634574.14	213806.44	90 13.556581	29 04.992096	DIPOLE	245
EAST MOST CL OFFSET	001_1348	BP-15	3634764.53	214895.54	90 13.518842	29 05.171475	DIPOLE	130
EAST MOST CL OFFSET	001_1348	BP-16	3634932.03	215773.57	90 13.485786	29 05.316067	DIPOLE	68
EAST MOST CL OFFSET	001_1348	BP-17	3635016.53	216205.34	90 13.469130	29 05.387167	MONO	213
EAST MOST CL OFFSET	001_1348	BP-18	3635060.29	216409.32	90 12.460540	29 05.420750	DIPOLE	318
EAST MOST CL OFFSET	001_1348	BP-19	3635306.52	217502.39	90 14.412301	29 05.600695	DIPOLE	206
EAST MOST CL OFFSET	001_1348	BP-20	3635395.45	217771.76	90 13.395106	29 05.644995	MONO	105
EAST MOST CL OFFSET	001_1348	BP-21	3637043.46	220825.80	90 13.079963	29 06.145219	DIPOLE	89
WEST CL OFFSET	004_1434	BP-22	3639824.99	223806.59	90 12.551959	29 06.633514	DIPOLE	40
WEST CL OFFSET	004_1434	BP-23	3637435.29	221564.48	90 13.005002	29 06.267460	MONO	44
WEST CL OFFSET	004_1434	BP-24	3635591.97	219272.49	90 13.355460	29 05.892276	DIPOLE	86
WEST CL OFFSET	004_1434	BP-25	3634937.67	217372.32	90 13.481822	29 05.579825	MONO	50
WEST CL OFFSET	004_1434	BP-26	3634717.65	216282.73	90 13.525128	29 05.400412	DIPOLE	23
WEST CL OFFSET	004_1434	BP-27	3634580.34	215581.44	90 13.552194	29 05.284931	MONO	123
WEST CL OFFSET	004_1434	BP-28	3634554.64	215372.11	90 13.559278	29 05.250451	DIPOLE	66
WEST CL OFFSET	004_1434	BP-29	3634214.21	213490.47	90 13.624754	29 04.940539	MONO	107
WEST CL OFFSET	004_1434	BP-30	3633972.31	212064.46	90 13.672772	29 04.705658	MONO	99
CL – EAST CL OFFSET	003_1505	BP-31	3634333.09	213571.28	90 13.602279	29 04.953682	MONO	74
CL – EAST CL OFFSET	003_1505	BP-32	3634429.07	214175.67	90 13.583157	29 05.053243	MONO	468
CL – EAST CL OFFSET	003_1505	BP-33	3634884.14	216446.19	90 13.493559	29 05.427115	DIPOLE	54
CL – EAST CL OFFSET	003_1505	BP-34	3635357.76	218015.53	90 13.401744	29 05.685273	MONO	1390
CL – EAST CL OFFSET	003_1505	BP-35	3637270.40	221171.03	90 13.036698	29 06.202812	MONO	173
CL – EAST CL OFFSET	003_1505	BP-36	3637981.03	221721.71	90 12.902193	29 06.292521	MONO	82
CL – EAST CL OFFSET	003_1505	BP-37	3638725.28	222266.62	90 12.761377	29 06.381223	DIPOLE	94
CL – EAST CL OFFSET	003_1505	BP-38	3639105.60	222531.48	90 13.689442	29 06.424306	MONO	83
CENTERLINE	003_1552	BP-39	3637851.52	221777.54	90 12.926420	29 06.301941	MONO	55
CENTERLINE	003_1552	BP-40	3636839.67	220930.04	90 13.118054	29 06.163745	MONO	77
CENTERLINE	003_1552	BP-41	3636586.14	220641.94	90 13.166208	29 06.116619	DIPOLE	66
CENTERLINE	003_1552	BP-42	3634816.97	216335.51	90 13.506378	29 05.408961	MONO	49
CENTERLINE	003_1552	BP-43	3634276.29	213448.92	90 13.613171	29 04.933586	DIPOLE	46

*REFERENCE SURVEY PLAN VIEW SHEET 16 OF 36

REVISIONS: DATE: REMARKS:

PICCIOLA & ASSOCIATES, INC.
CIVIL ENGINEERS · NAVAL ARCHITECTS · LAND SURVEYORS · MARINE ENGINEERS
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COASTAL ENGINEERING CONSULTANTS, INC.
CAMINADA HEADLAND BEACH AND DUNE RESTORATION PROJECT (BA-45EB)
C.E.C. PROJECT: 10.140 – TASK 2.4.3 CONVEYANCE CORRIDORS AND SEDIMENT
RE-HANDLING/PUMP-OUT AREAS SURVEYS, MAGNETOMETER SURVEY DATA
LAFOURCHE PARISH, LA

DESIGNED BY: J.C.P.
DRAWN BY: L.J.G.
CHECKED BY: J.C.P.
DATE: JUNE 29, 2011
SCALE: NOT TO SCALE
SHEET NO. 19 OF 36

STATE OF LOUISIANA · Joseph C. Picciola · REG. No. 4916 · REGISTERED PROFESSIONAL LAND SURVEYOR

J.N. 1222-1002

DRAWING PLOTTED AT HALF SCALE

ORIGINAL

ORIGINAL

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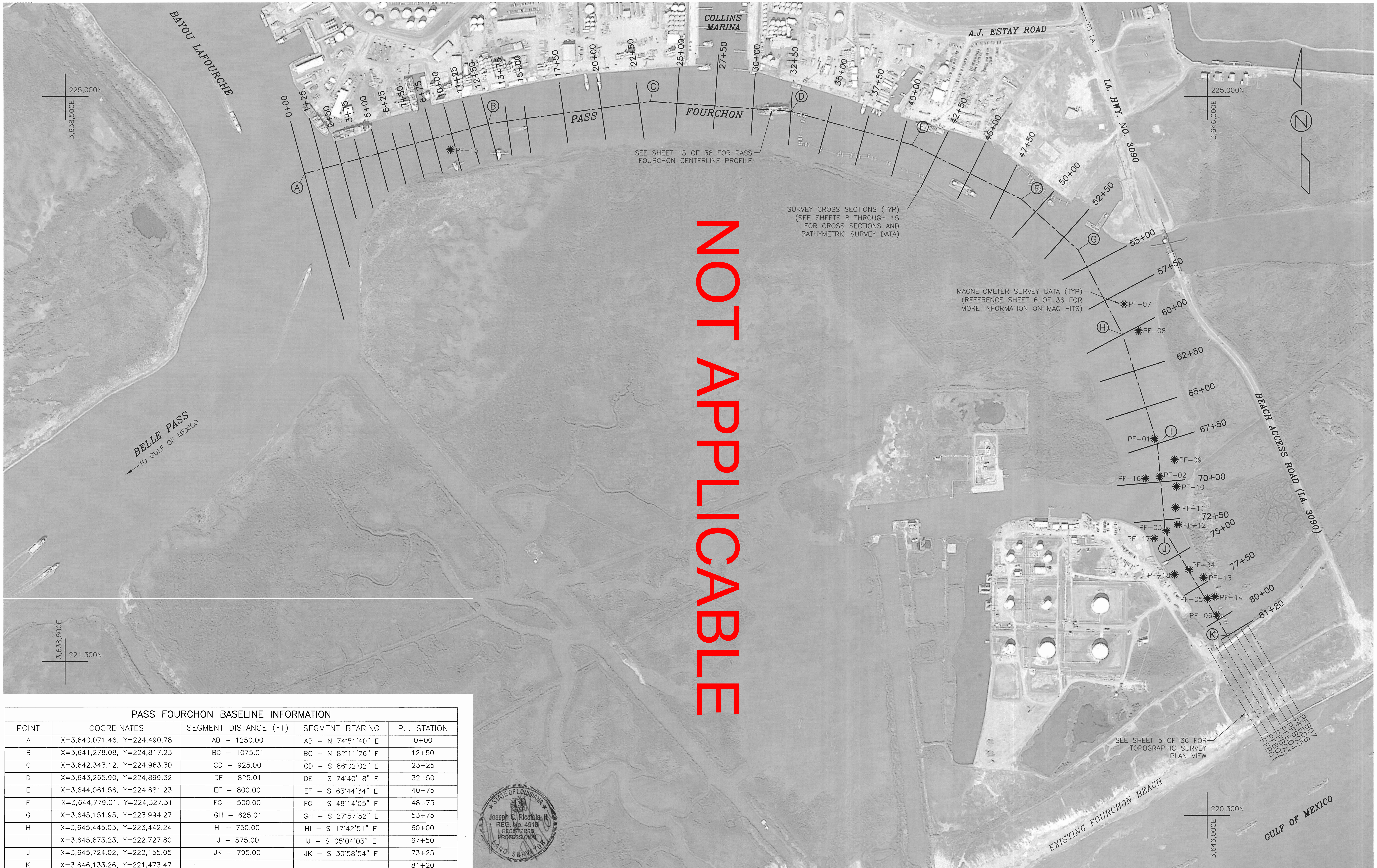
PASS FOURCHON ALTERNATIVE

NOT APPLICABLE



PASS FOURCHON BASELINE INFORMATION				
POINT	COORDINATES	SEGMENT DISTANCE (FT)	SEGMENT BEARING	P.I. STATION
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C	X=3,642,343.12, Y=224,963.30	CD – 925.00	CD – S 86°02'02" E	23+25
D	X=3,643,265.90, Y=224,899.32	DE – 825.01	DE – S 74°40'18" E	32+50
E	X=3,644,061.56, Y=224,681.23	EF – 800.00	EF – S 63°44'34" E	40+75
F	X=3,644,779.01, Y=224,327.31	FG – 500.00	FG – S 48°14'05" E	48+75
G	X=3,645,151.95, Y=223,994.27	GH – 625.01	GH – S 27°57'52" E	53+75
H	X=3,645,445.03, Y=223,442.24	HI – 750.00	HI – S 17°42'51" E	60+00
I	X=3,645,673.23, Y=222,727.80	IJ – 575.00	IJ – S 05°04'03" E	67+50
J	X=3,645,724.02, Y=222,155.05	JK – 795.00	JK – S 30°58'54" E	73+25
K	X=3,646,133.26, Y=221,473.47			81+20

PASS FOURCHON SURVEY - PLAN VIEW

SCALE: 1" = 300'

2008 BELLE PASS NW DOQQ

COASTAL ENGINEERING CONSULTANTS, INC.

CAMINADA HEADLAND BEACH AND DUNE RESTORATION PROJECT (BA-45EB)
C.E.C. PROJECT: 10.140 – TASK 2.4.3 CONVEYANCE CORRIDORS AND SEDIMENT RE-HANDLING/PUMP-OUT AREAS SURVEYS, PASS FOURCHON SURVEY PLAN VIEW
LAFOURCHE PARISH, LA

PICCIOLA & ASSOCIATES, INC.
CIVIL ENGINEERS
LAND SURVEYORS
NAVAL ARCHITECTS
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DESIGNED BY:	J.C.P.
DRAWN BY:	L.J.G.
CHECKED BY:	J.C.P.
DATE:	JUNE 29, 2011
SCALE:	AS SHOWN
SHEET NO.	4 of 36

REVISIONS: DATE: REMARKS:

DRAWING PLOTTED AT HALF SCALE

ORIGINAL

J.N. 1222-1002

E:\10-0IR\12221002 Coastal Engineering Consultants - Caminada Headlands Restoration\ACAD\CURRENT\Deliverables_LJG\Survey Plans_07-14-2011_Steve Markups\04-SHT_PLAN VIEW_PASS FOURCHON.dwg, PLAN VIEW-PASS FOURCHON, 7/19/2011 8:46:04 AM, lee

ORIGINAL

NOT APPLICABLE

MAGNETOMETER SURVEY, MAY 17, 2011 – PASS FOURCHON

LINE	LINE NAME	∗ASSIGNED POINT NO.	X	Y	LATITUDE	LONGITUDE	TYPE	GAMMA READING
CENTERLINE	003–1035	PF–01	3645652.72	222761.34	90 11.459050	29 06.451558	DIPOLE	93
CENTERLINE	003–1035	PF–02	3645687.65	222511.80	90 11.452880	29 06.410840	MONO	784
CENTERLINE	003–1035	PF–03	3645730.67	222159.42	90 11.445532	29 06.352123	DIPOLE	1019
CENTERLINE	003–1035	PF–04	3645881.44	221903.27	90 11.417689	29 06.309613	DIPOLE	90
CENTERLINE	003–1035	PF–05	3646002.71	221714.92	90 11.395261	29 06.278340	DIPOLE	761
CENTERLINE	003–1035	PF–06	3646062.88	221609.13	90 11.384155	29 06.260787	MONO	683
NORTH CL OFFSET	002–1058	PF–07	3645453.71	223641.64	90 11.494789	29 06.597118	DIPOLE	95
NORTH CL OFFSET	002–1058	PF–08	3645549.58	223466.64	90 11.477105	29 06.568088	MONO	80
NORTH CL OFFSET	002–1058	PF–09	3645786.32	222623.86	90 11.424208	29 06.428656	MONO	3316
NORTH CL OFFSET	002–1058	PF–10	3645797.76	222449.23	90 11.432.386	29 06.399825	MONO	922
NORTH CL OFFSET	002–1058	PF–11	3645792.08	222310.71	90 11.433714	29 06.376981	MONO	2077
NORTH CL OFFSET	002–1058	PF–12	3645808.17	222200.06	90 11.430898	29 06.358700	MONO	728
NORTH CL OFFSET	002–1058	PF–13	3645976.23	221854.10	90 11.399973	29 06.301345	MONO	524
NORTH CL OFFSET	002–1058	PF–14	3646050.66	221727.19	90 11.386229	29 06.280284	DIPOLE	1752
SOUTH CL OFFSET	004–1126	PF–15	3641028.99	224646.14	90 12.324197	29 06.770073	MONO	58
SOUTH CL OFFSET	004–1126	PF–16	3645592.61	222501.69	90 11.470829	29 06.408817	DIPOLE	1435
SOUTH CL OFFSET	004–1126	PF–17	3645651.24	222109.59	90 11.460549	29 06.343954	DIPOLE	509
SOUTH CL OFFSET	004–1126	PF–18	3645785.14	221872.59	90 11.435837	29 06.304710	MONO	564

∗REFERENCE SURVEY PLAN VIEW SHEET 4 OF 36

REVISIONS:
DATE: REMARKS:

PICCIOLA & ASSOCIATES, INC.
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LAND SURVEYORS MARINE ENGINEERS
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COASTAL ENGINEERING CONSULTANTS, INC.
CAMINADA HEADLAND BEACH AND DUNE RESTORATION PROJECT (BA-45EB)
C.E.C. PROJECT: 10.140 – TASK 2.4.3 CONVEYANCE CORRIDORS AND SEDIMENT RE-HANDLING/PUMP-OUT AREAS SURVEYS, MAGNETOMETER SURVEY DATA
LAFOURCHE PARISH, LA

DESIGNED BY: J.C.P.
DRAWN BY: L.J.G.
CHECKED BY: J.C.P.
DATE: JUNE 29, 2011
SCALE: NOT TO SCALE
SHEET NO. 6 OF 36

STATE OF LOUISIANA
Joseph C. Picciola
REG. No. 4916
REGISTERED PROFESSIONAL LAND SURVEYOR

J.N. 1222–1002

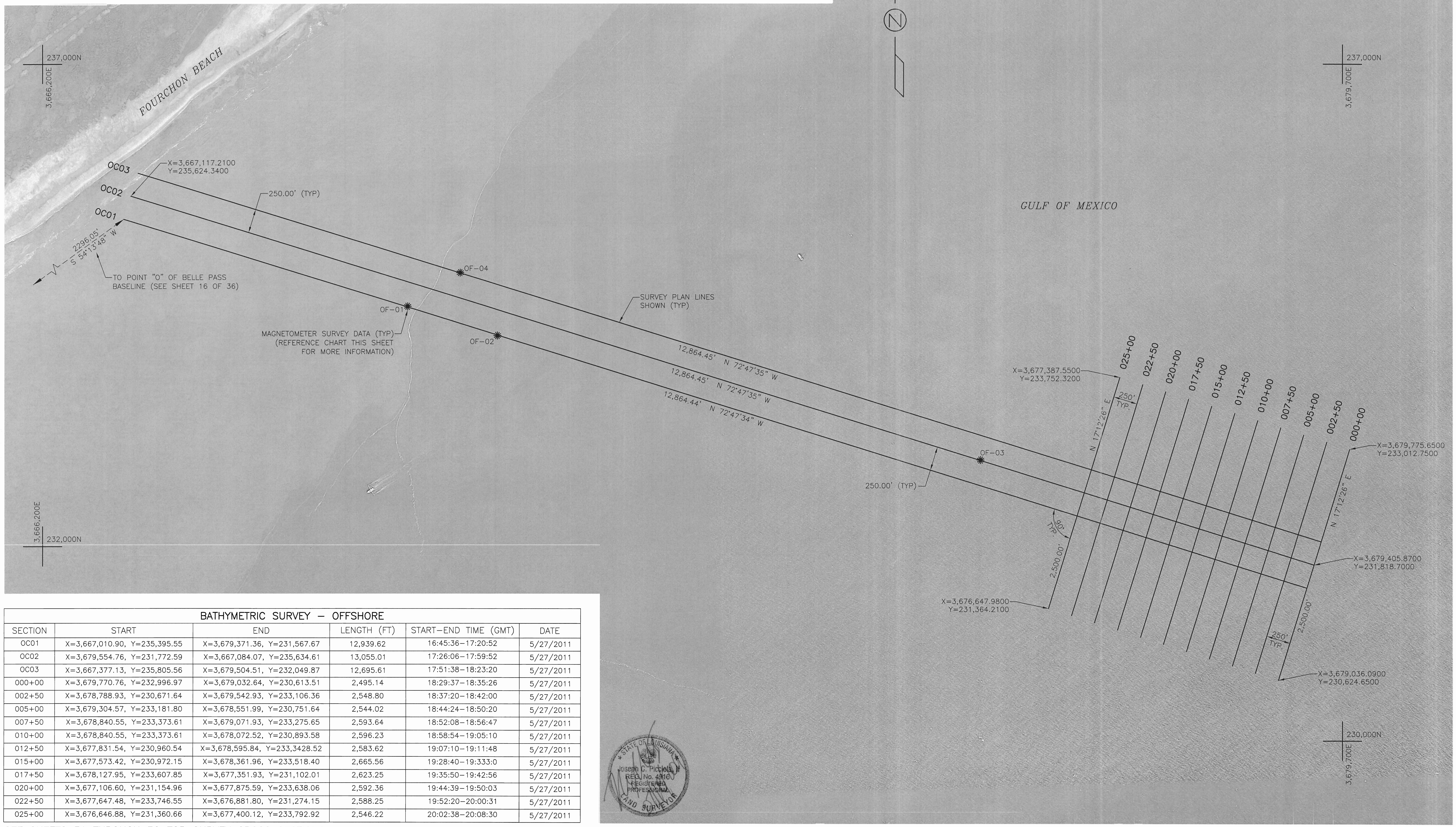
DRAWING PLOTTED AT HALF SCALE

ORIGINAL

ORIGINAL

OFFSHORE ALTERNATIVE

MAGNETOMETER SURVEY, MAY 27, 2011 – OFFSHORE								
LINE	LINE NAME	ASSIGNED POINT NO.	X	Y	LATITUDE	LONGITUDE	TYPE	GAMMA READING
CORRIDOR-SOUTH OFFSET	OC01D	OF-01	3,669,991.77	234,478.71	90 06.863233	29 08.343344	DIPOLE	32
CORRIDOR-SOUTH OFFSET	OC01D	OF-02	3,670,924.00	234,178.86	90 06.688648	29 08.292236	MONO	21
CENTERLINE	OC02	OF-03	3,675,941.33	232,896.29	90 05.748397	29 08.071751	DIPOLE	39
CORRIDOR-NORTH OFFSET	OC03	OF-04	3,670,538.50	234,829.51	90 06.759789	29 08.400259	DIPOLE	52



BATHYMETRIC SURVEY – OFFSHORE					
SECTION	START	END	LENGTH (FT)	START–END TIME (GMT)	DATE
OC01	X=3,667,010.90, Y=235,395.55	X=3,679,371.36, Y=231,567.67	12,939.62	16:45:36–17:20:52	5/27/2011
OC02	X=3,679,554.76, Y=231,772.59	X=3,667,084.07, Y=235,634.61	13,055.01	17:26:06–17:59:52	5/27/2011
OC03	X=3,667,377.13, Y=235,805.56	X=3,679,504.51, Y=232,049.87	12,695.61	17:51:38–18:23:20	5/27/2011
000+00	X=3,679,770.76, Y=232,996.97	X=3,679,032.64, Y=230,613.51	2,495.14	18:29:37–18:35:26	5/27/2011
002+50	X=3,678,788.93, Y=230,671.64	X=3,679,542.93, Y=233,106.36	2,548.80	18:37:20–18:42:00	5/27/2011
005+00	X=3,679,304.57, Y=233,181.80	X=3,678,551.99, Y=230,751.64	2,544.02	18:44:24–18:50:20	5/27/2011
007+50	X=3,678,840.55, Y=233,373.61	X=3,679,071.93, Y=233,275.65	2,593.64	18:52:08–18:56:47	5/27/2011
010+00	X=3,678,840.55, Y=233,373.61	X=3,678,072.52, Y=230,893.58	2,596.23	18:58:54–19:05:10	5/27/2011
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SEE SHEETS 31 THROUGH 36 FOR SURVEY CROSS SECTIONS.

STATE OF LOUISIANA
Joseph C. Picciola, II
REG. No. 4316
REGISTERED PROFESSIONAL LAND SURVEYOR

OFFSHORE SURVEY - PLAN VIEW

500 0 500 1000 1500
SCALE: 1" = 500'

2008 CAMINADA PASS SW DOQQ

J.N. 1222–1002

REVISIONS:	
DATE:	REMARKS:

PICCIOLA & ASSOCIATES, INC.
CIVIL ENGINEERS · NAVAL ARCHITECTS
LAND SURVEYORS · MARINE ENGINEERS
P.O. BOX. 687
CUT OFF, LOUISIANA 70345
(985) 632-5786

COASTAL ENGINEERING CONSULTANTS, INC.
CAMINADA HEADLAND BEACH AND DUNE RESTORATION PROJECT (BA-45EB)
C.E.C. PROJECT: 10.140 – TASK 2.4.3 CONVEYANCE CORRIDORS AND SEDIMENT RE-HANDLING/PUMP-OUT AREAS SURVEYS, OFFSHORE SURVEY PLAN VIEW
LAFOURCHE PARISH, LA

DESIGNED BY: J.C.P.
DRAWN BY: L.J.G.
CHECKED BY: J.C.P.
DATE: JUNE 29, 2011
SCALE: AS SHOWN
SHEET NO. 30 OF 36

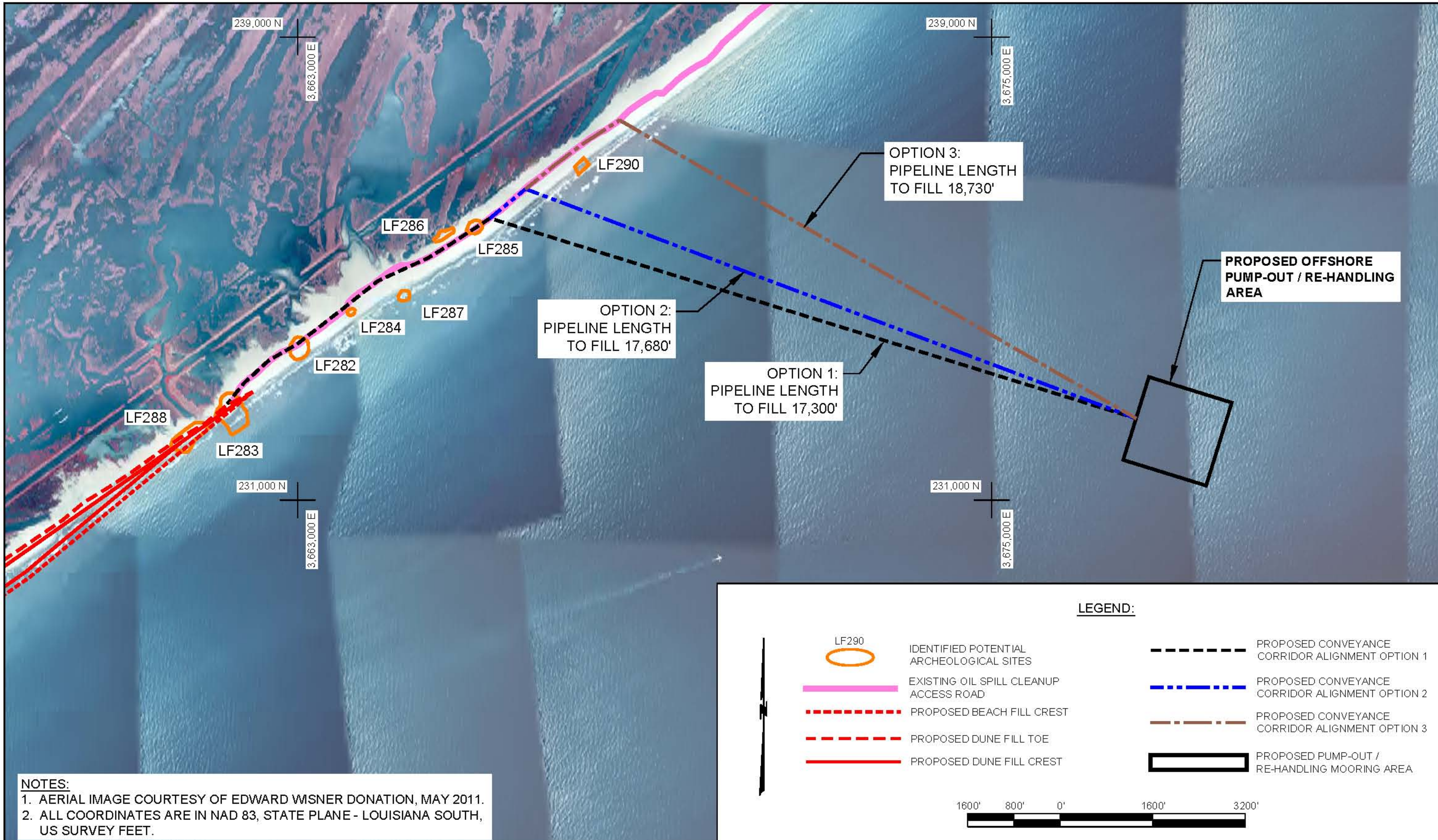
DRAWING PLOTTED AT HALF SCALE

ORIGINAL

ORIGINAL

APPENDIX B:

OSI 2010 SUBBOTTOM PROFILER DATA, OFFSHORE ALTERNATIVE OPTIONS 1, 2, & 3, HISTORIC BAYOU MOREAU AND 50 AND 100 YEAR SHORLINE PLOTS



NOTES:
1. AERIAL IMAGE COURTESY OF EDWARD WISNER DONATION, MAY 2011.
2. ALL COORDINATES ARE IN NAD 83, STATE PLANE - LOUISIANA SOUTH, US SURVEY FEET.

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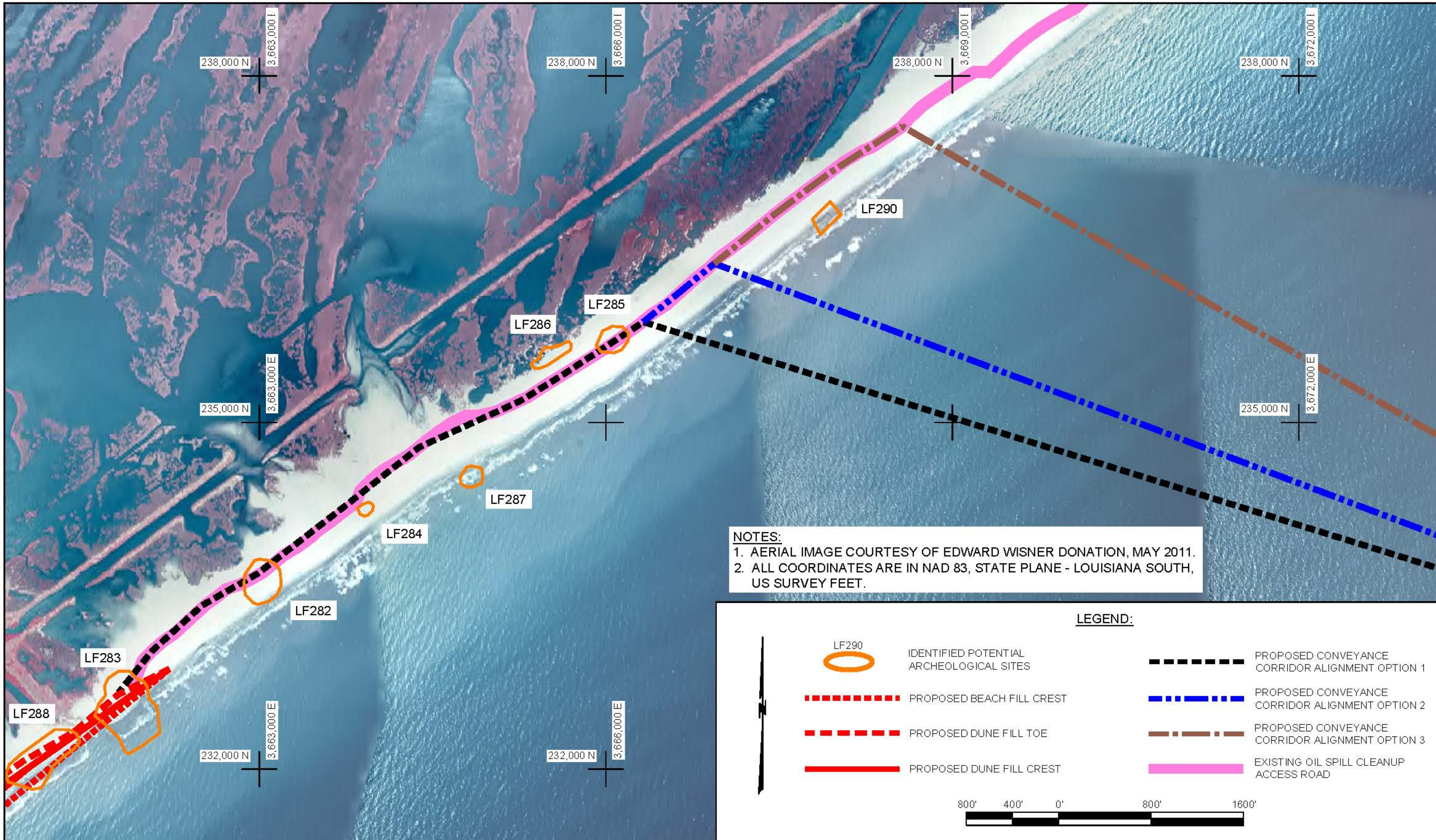
BATON ROUGE, LA 70810

CAMINADA HEADLAND BEACH AND DUNE RESTORATION (BA-45EB)

OFFSHORE CONVEYANCE CORRIDOR OPTIONS OVERVIEW

DRAWN BY: DARTEZ / ZWERNEMAN	DESIGNED BY: MICHAEL T. POFF, P.E.	SEPTEMBER 08, 2011	SHEET 1 OF 7



NOTES:
1. AERIAL IMAGE COURTESY OF EDWARD WISNER DONATION, MAY 2011.
2. ALL COORDINATES ARE IN NAD 83, STATE PLANE - LOUISIANA SOUTH, US SURVEY FEET.

LEGEND:

- LF290 — IDENTIFIED POTENTIAL ARCHEOLOGICAL SITES
- PROPOSED BEACH FILL CREST
- PROPOSED DUNE FILL TOE
- PROPOSED DUNE FILL CREST
- PROPOSED CONVEYANCE CORRIDOR ALIGNMENT OPTION 1
- PROPOSED CONVEYANCE CORRIDOR ALIGNMENT OPTION 2
- PROPOSED CONVEYANCE CORRIDOR ALIGNMENT OPTION 3
- EXISTING OIL SPILL CLEANUP ACCESS ROAD

800' 400' 0' 800' 1600'

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CAMINADA HEADLAND BEACH AND DUNE RESTORATION (BA-45EB)

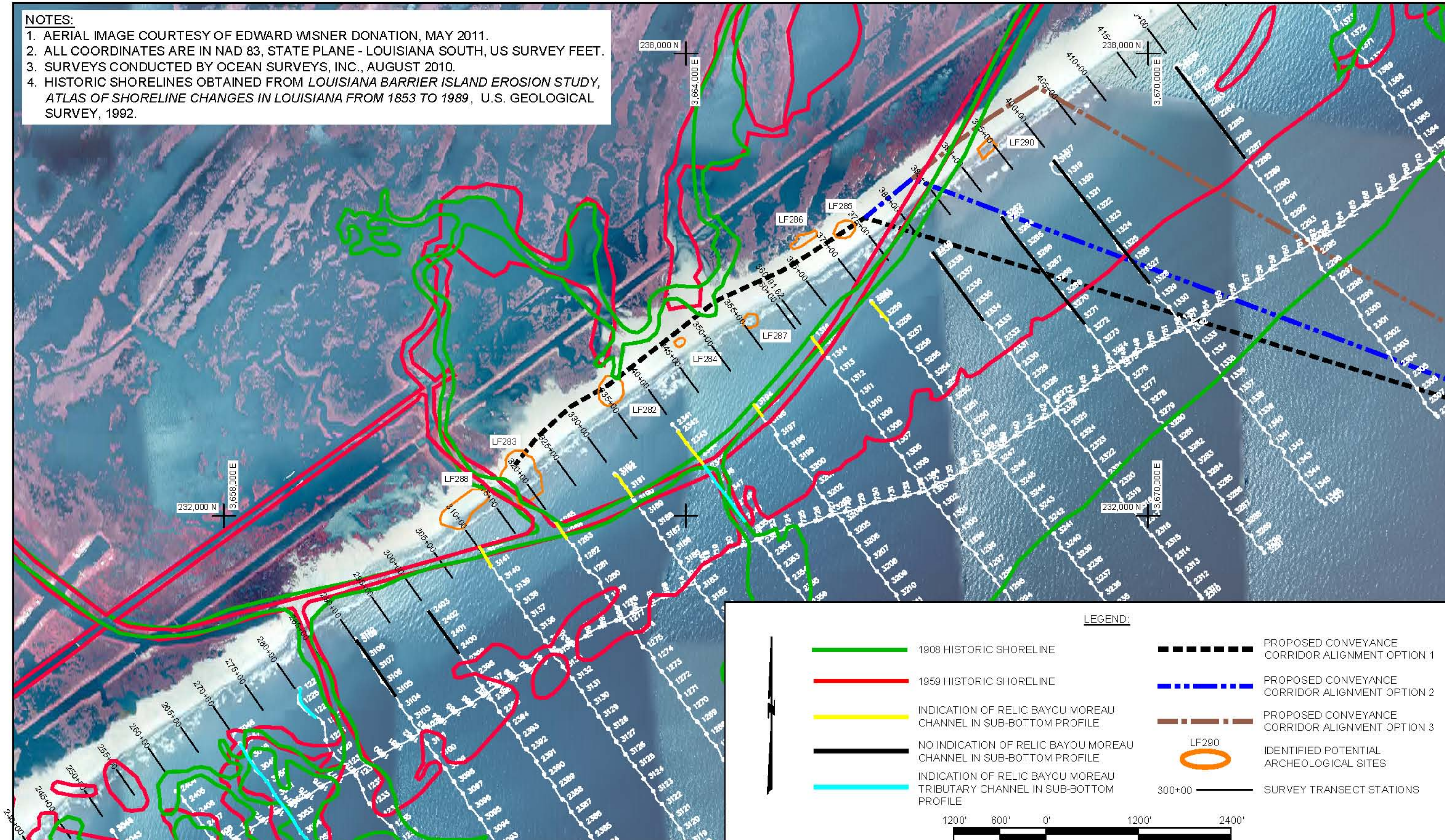
OFFSHORE CONVEYANCE CORRIDOR OPTIONS DETAIL

DRAWN BY: DARTEZ / ZWERNEMAN | DESIGNED BY: MICHAEL T. POFF, P.E.

SEPTEMBER 08, 2011

SHEET 2 OF 7

NOTES:
1. AERIAL IMAGE COURTESY OF EDWARD WISNER DONATION, MAY 2011.
2. ALL COORDINATES ARE IN NAD 83, STATE PLANE - LOUISIANA SOUTH, US SURVEY FEET.
3. SURVEYS CONDUCTED BY OCEAN SURVEYS, INC., AUGUST 2010.
4. HISTORIC SHORELINES OBTAINED FROM *LOUISIANA BARRIER ISLAND EROSION STUDY, ATLAS OF SHORELINE CHANGES IN LOUISIANA FROM 1853 TO 1989*, U.S. GEOLOGICAL SURVEY, 1992.



LEGEND:

1908 HISTORIC SHORELINE	PROPOSED CONVEYANCE CORRIDOR ALIGNMENT OPTION 1
1959 HISTORIC SHORELINE	PROPOSED CONVEYANCE CORRIDOR ALIGNMENT OPTION 2
INDICATION OF RELIC BAYOU MOREAU CHANNEL IN SUB-BOTTOM PROFILE	PROPOSED CONVEYANCE CORRIDOR ALIGNMENT OPTION 3
NO INDICATION OF RELIC BAYOU MOREAU CHANNEL IN SUB-BOTTOM PROFILE	LF290 IDENTIFIED POTENTIAL ARCHEOLOGICAL SITES
INDICATION OF RELIC BAYOU MOREAU TRIBUTARY CHANNEL IN SUB-BOTTOM PROFILE	300+00 SURVEY TRANSECT STATIONS

1200' 600' 0' 1200' 2400'

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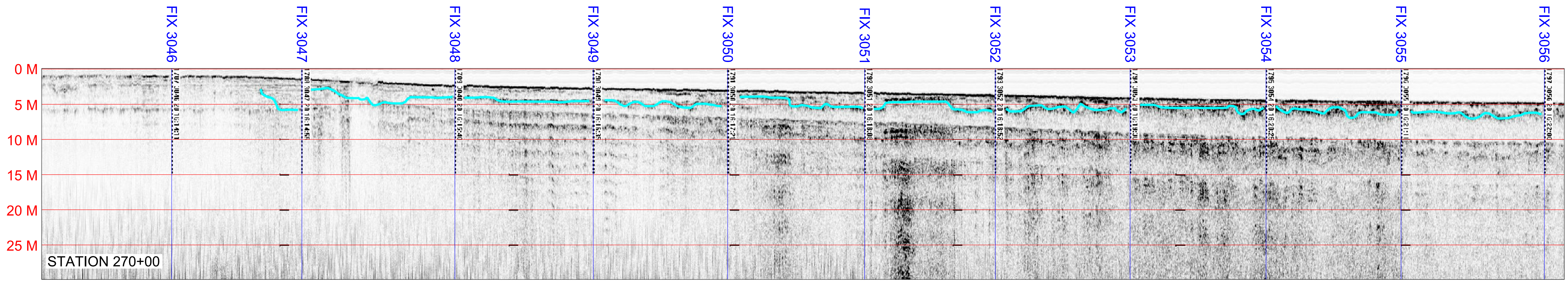
CAMINADA HEADLAND BEACH AND DUNE RESTORATION (BA-45EB)

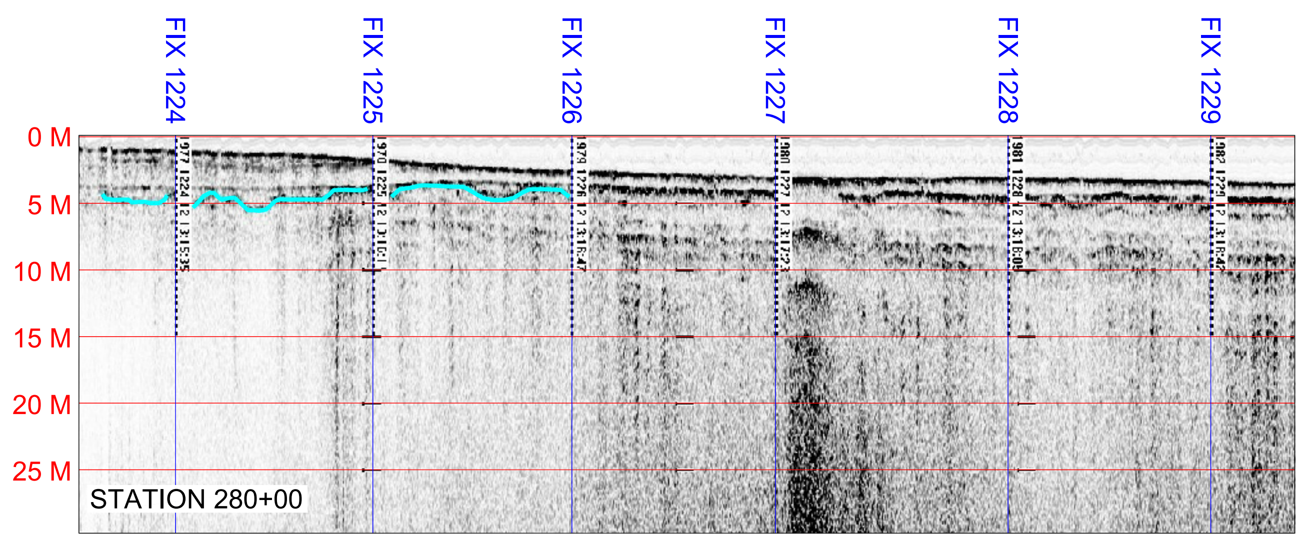
DRAWN BY: DARTEZ

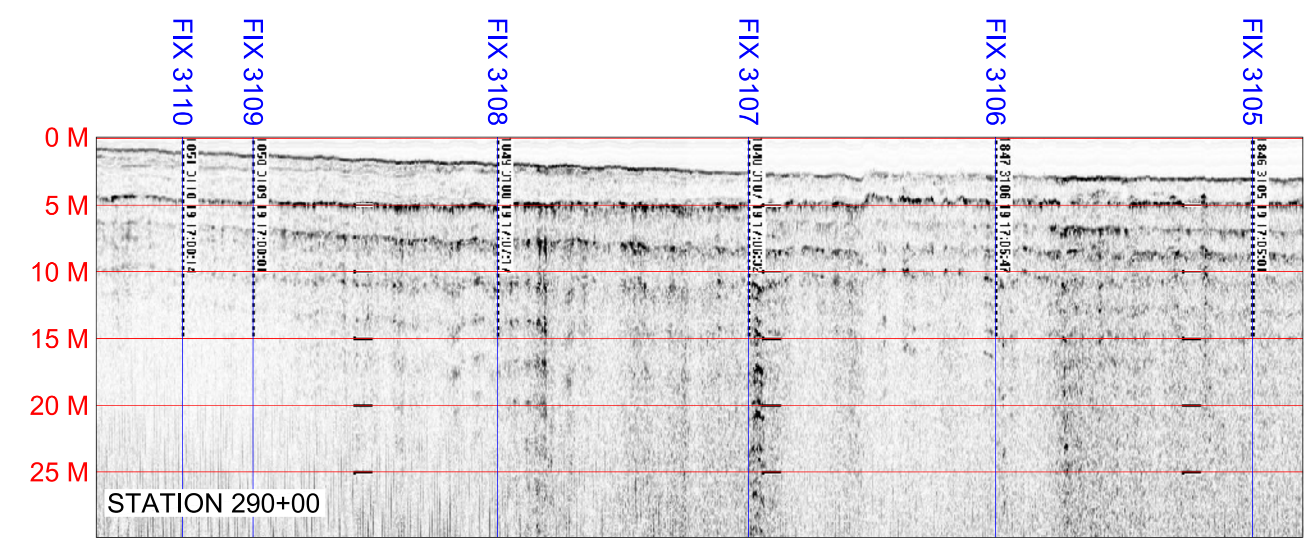
HISTORIC BAYOU MOREAU AND SUB-BOTTOM SONAR SURVEY COMPARISON

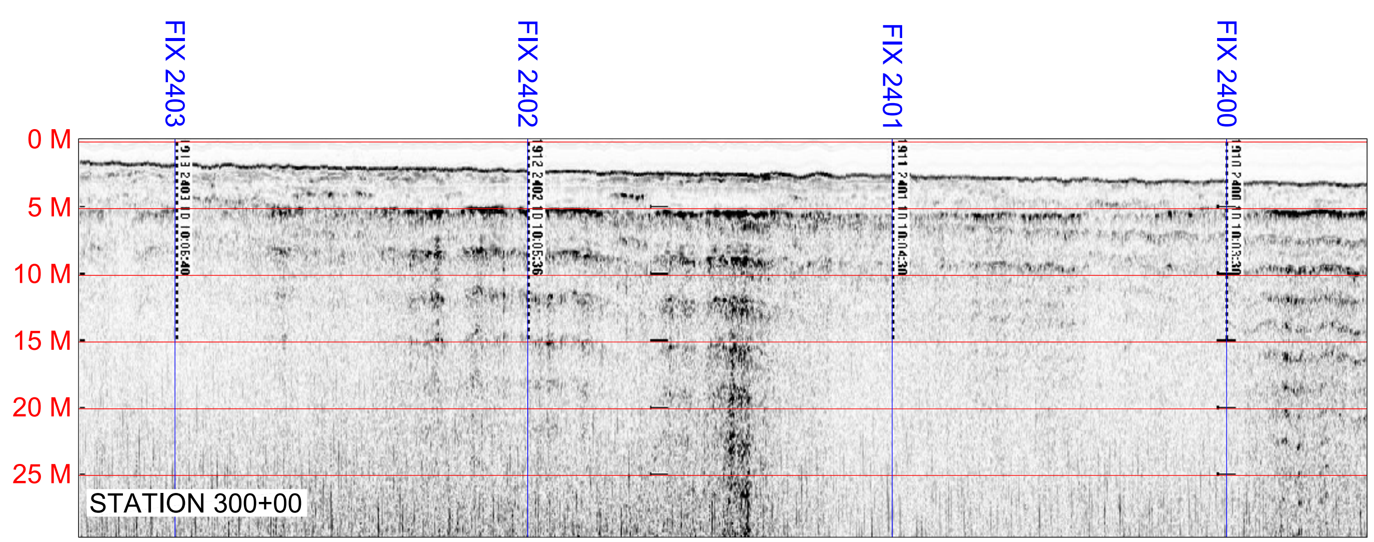
SEPTEMBER 08, 2011

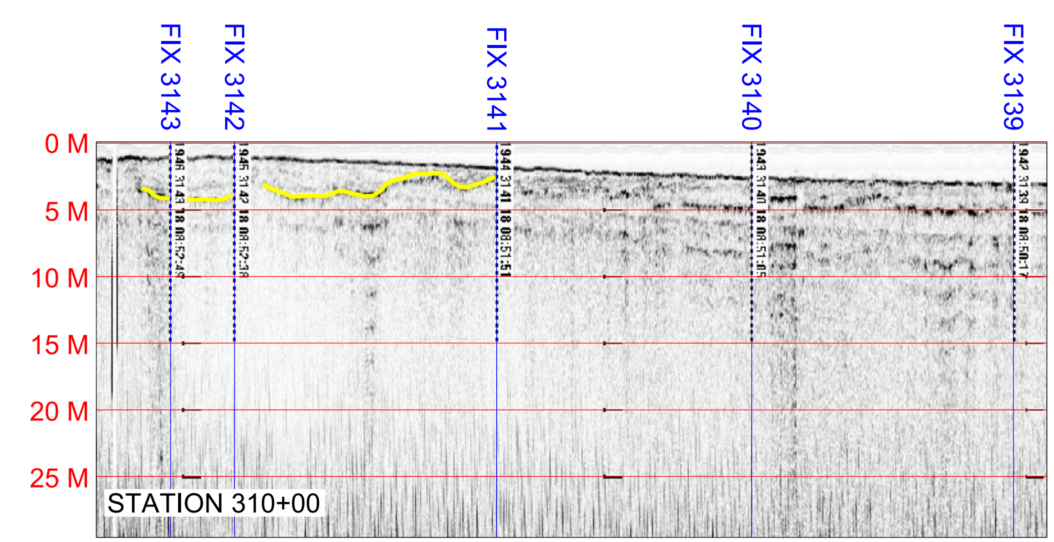
SHEET 3 OF 7











NOTES: 1) SURVEYS CONDUCTED BY OCEAN SURVEYS, INC. AUGUST 2010. 2) VERTICAL SCALES REFERENCED TO PROFILER.

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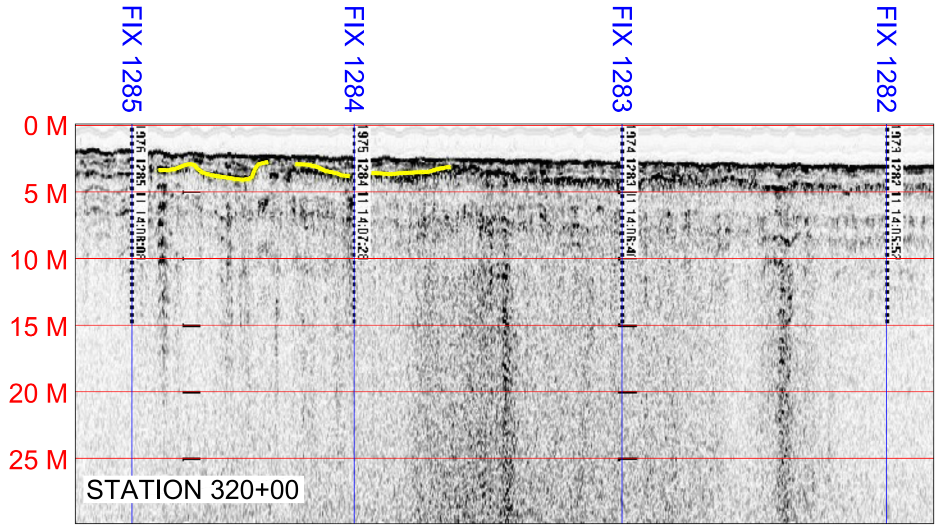
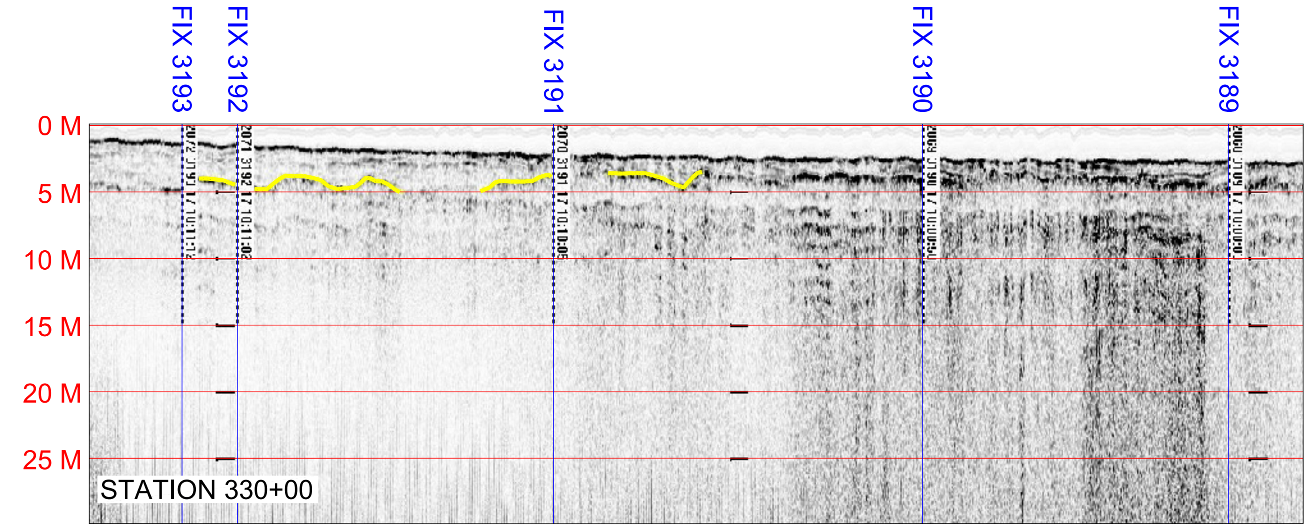
CAMINADA HEADLAND BEACH AND DUNE RESTORATION (BA-45EB)

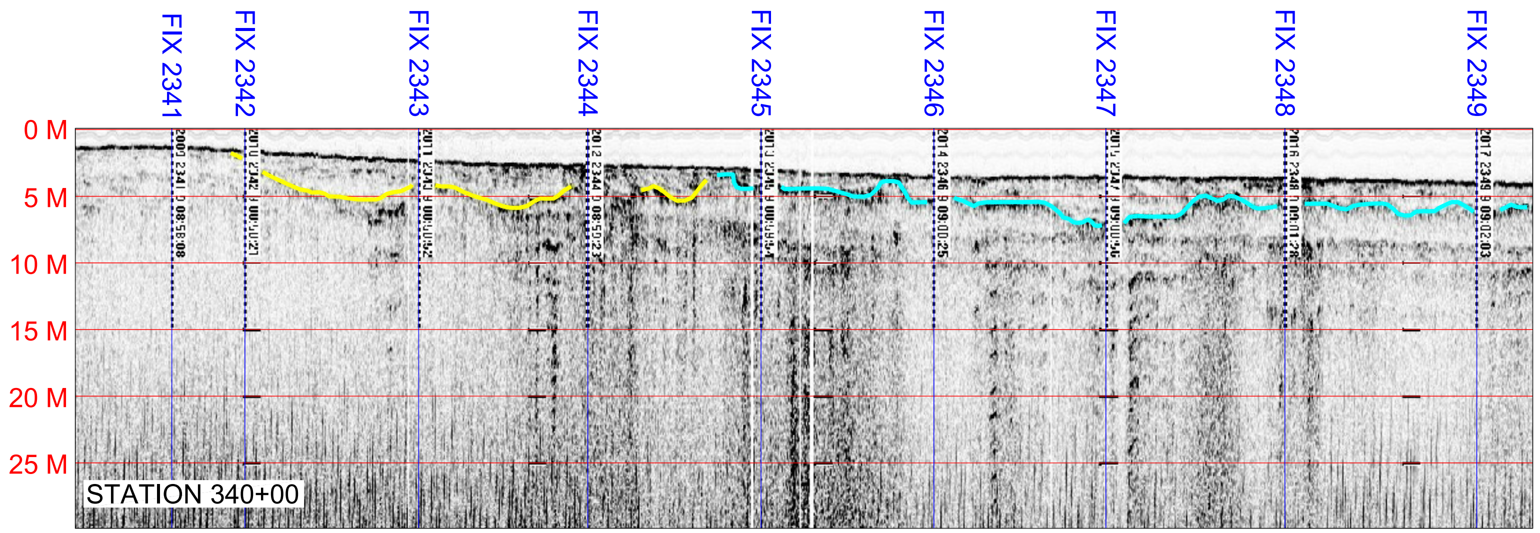
SUB-BOTTOM SONAR PROFILES STATIONS 270+00, 280+00, 290+00, 300+00, AND 310+00

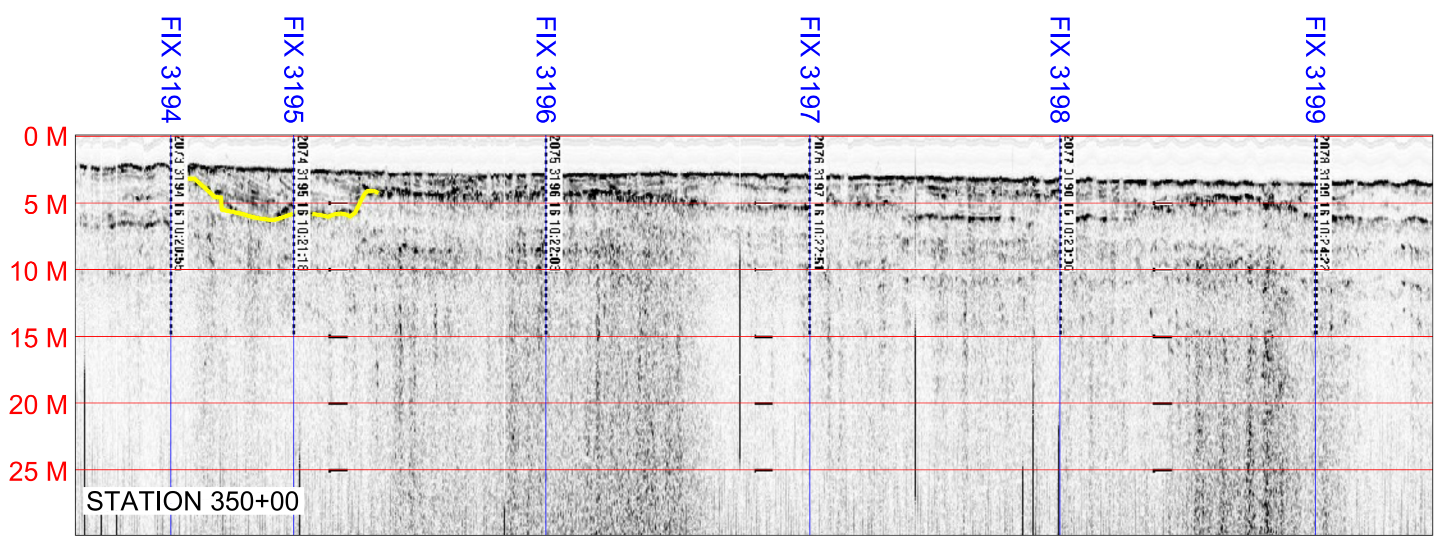
DRAWN BY: DARTEZ

SEPTEMBER 08, 2011









NOTES:
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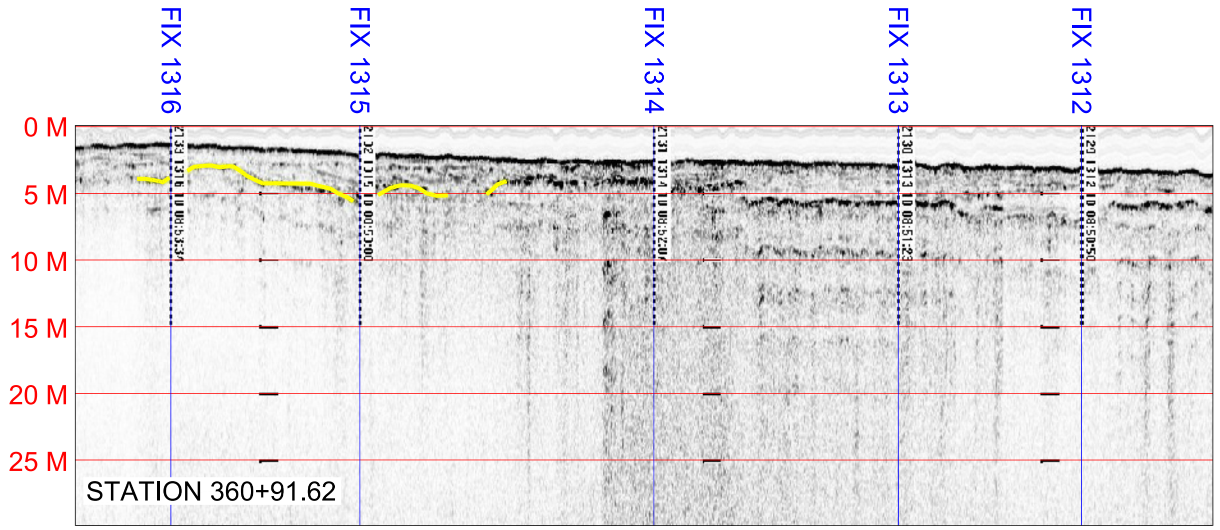
CAMINADA HEADLAND BEACH AND DUNE RESTORATION (BA-45EB)

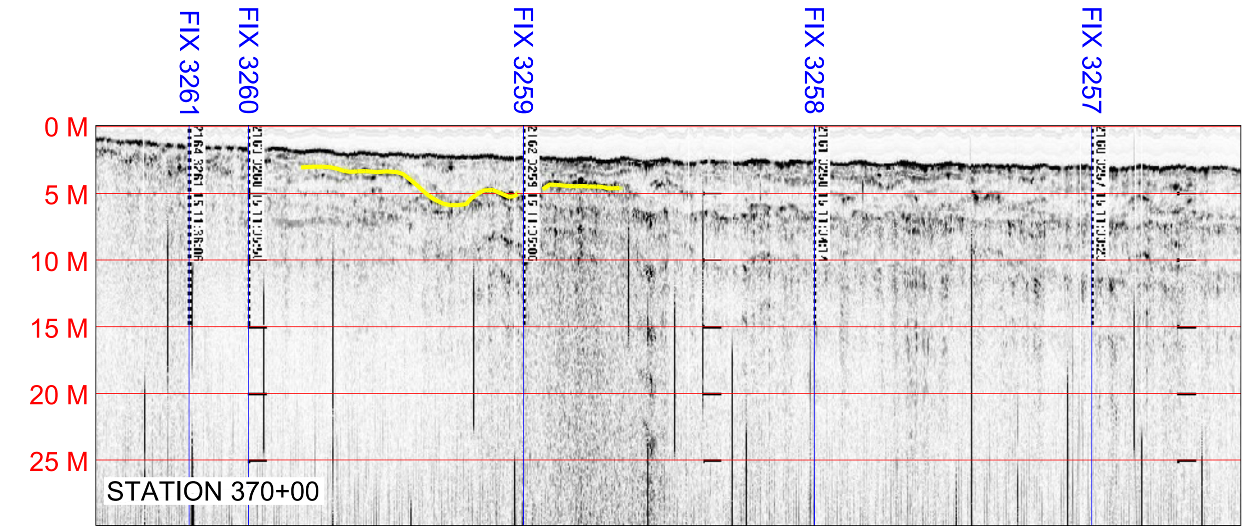
DRAWN BY: DARTEZ

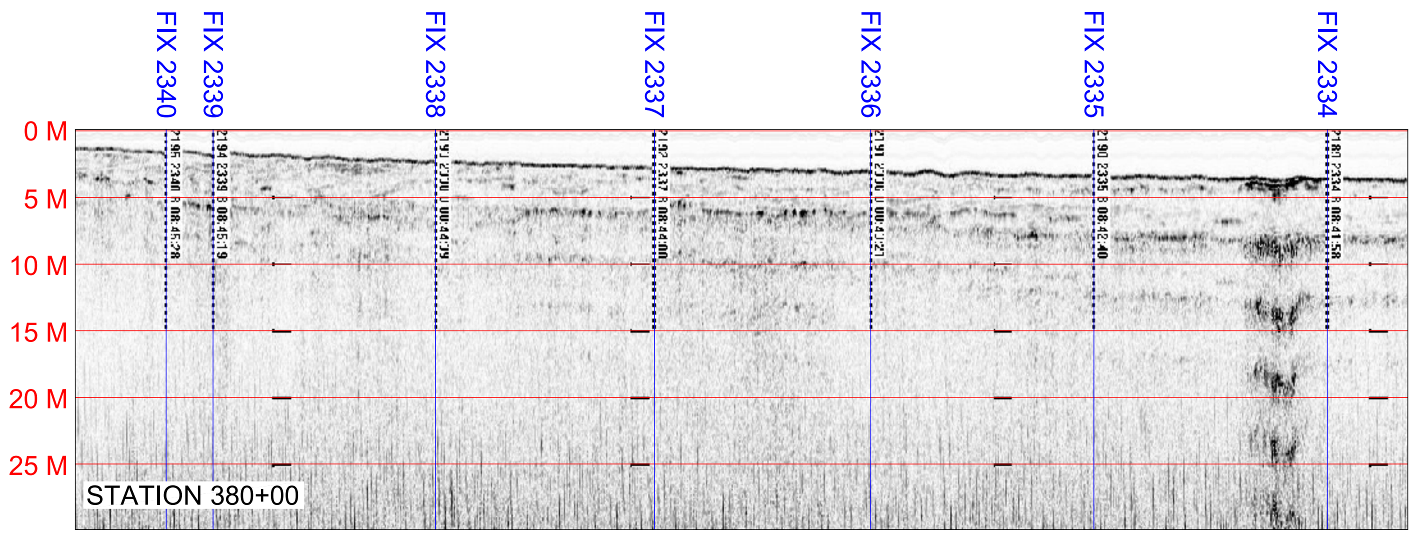
SUB-BOTTOM SONAR PROFILES STATIONS 320+00, 330+00,340+00, AND 350+00

SEPTEMBER 08, 2011

SHEET 5 OF 7







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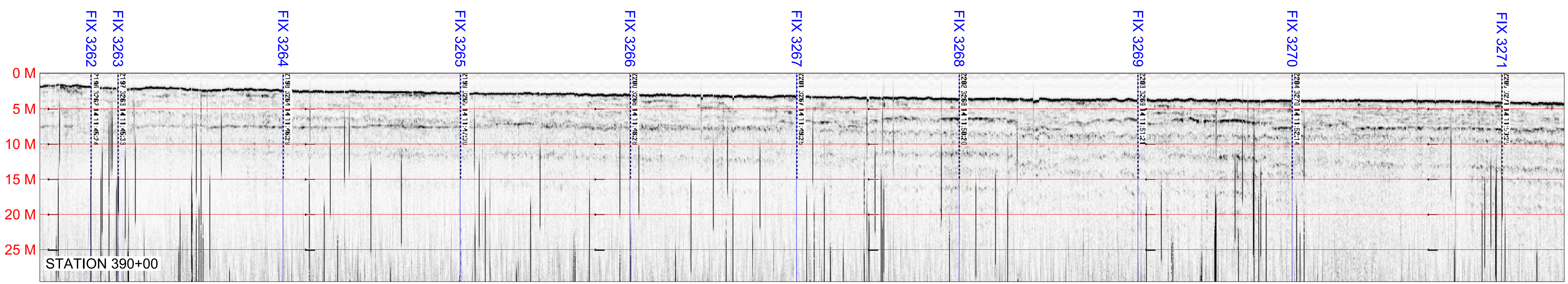
2) VERTICAL SCALES REFERENCED TO PROFILER.



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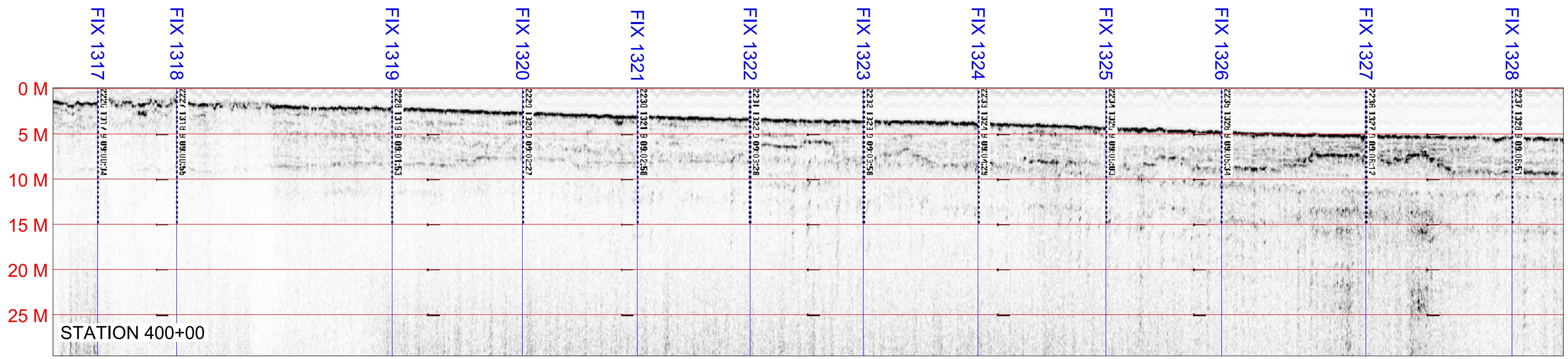
CAMINADA HEADLAND BEACH AND DUNE RESTORATION (BA-45EB)

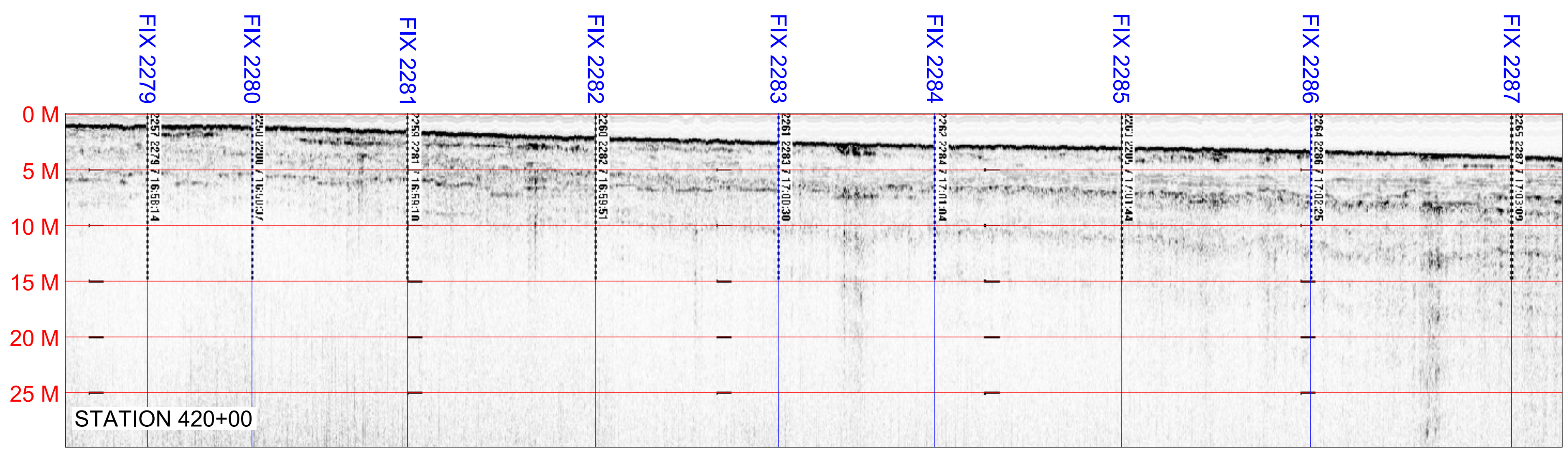
DRAWN BY: DARTEZ

SUB-BOTTOM SONAR PROFILES STATIONS 360+91.62, 370+00, 380+00, AND 390+00

SEPTEMBER 08, 2011

SHEET 6 OF 7





NOTES:
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2) VERTICAL SCALES REFERENCED TO PROFILER.

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CAMINADA HEADLAND BEACH AND DUNE RESTORATION (BA-45EB)

DRAWN BY: DARTEZ

SUB-BOTTOM SONAR PROFILES
STATIONS 400+00 AND 420+00

SEPTEMBER 08, 2011

SHEET 7 OF 7

APPENDIX C:

Geophysical Survey Investigations Proposed Offshore Pump-Out Areas and Pipeline Conveyance Corridors, Caminada Headland Restoration Project (BA-45), Gulf of Mexico, Louisiana (OSI Report No. 11ES091) **(OSI 2012)**

FINAL REPORT

GEOPHYSICAL INVESTIGATIONS
PROPOSED OFFSHORE PUMP-OUT AREAS
AND PIPELINE CONVEYANCE CORRIDORS
CAMINADA HEADLAND RESTORATION PROJECT (BA-45)
GULF OF MEXICO, LOUISIANA

OSI REPORT NO. 11ES091

Prepared For: Coastal Engineering Consultants, Inc.
3106 S. Horseshoe Drive
Naples, FL 34104

Prepared By: Ocean Surveys, Inc.
129 Mill Rock Road E.
Old Saybrook, CT 06475

17 February 2012

TABLE OF CONTENTS

Page

APPENDICES

John D. Sullivan
Principal Investigator
Manager Geophysical Surveys
OCEAN SURVEYS, INC.

FINAL REPORT

GEOPHYSICAL INVESTIGATIONS
PROPOSED OFFSHORE PUMP-OUT AREAS
AND PIPELINE CONVEYANCE CORRIDORS
CAMINADA HEADLAND RESTORATION PROJECT (BA-45)
GULF OF MEXICO, LOUISIANA

1.0 INTRODUCTION

During the period 2 December 2011 to 15 January 2012, Ocean Surveys, Inc. (OSI) performed multi-sensor marine geophysical surveys in the Gulf of Mexico in two sites located offshore Caminada Headland, Louisiana. These investigations were completed under subcontract to Coastal Engineering Consultants, Inc. (CEC) for the Louisiana Coastal Protection and Restoration Authority (CPRA) to support the Caminada Headland Beach and Dune Restoration Project (BA-45). The project includes restoring the western end of the Caminada Headland through beach and dune fill placement utilizing offshore sand resources from Ship Shoal within two Bureau of Ocean Energy Management (BOEM) lease areas: "South Pelto Lease Blocks 13 and 14" (Figure 1).

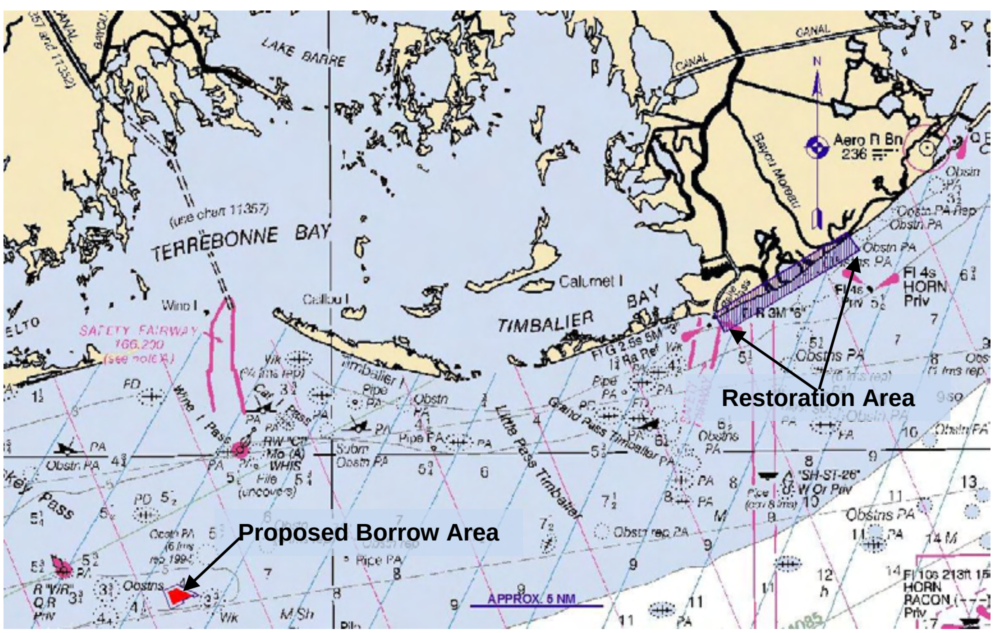


Figure 1. Location of Proposed Borrow Area (red) on Ship Shoal and restoration area along Caminada Headland in LaFourche Parish, Louisiana (NOAA Nautical Chart 11340 in background).

2.0 PROJECT SUMMARY

2.1 Project Background and Objectives

OSI was subcontracted to perform several tasks in support of the restoration project. While previous investigations focused on documenting conditions on Ship Shoal in the proposed borrow area and identifying features present that might potentially impede mining the sand including those deemed as being potentially archaeologically significant. Several sites around the headland are being considered for re-handling sediment transported from Ship Shoal prior to transferring it to the restoration area. One option includes an offshore site that would allow for hopper dredges or scows to dump their sediment to be re-handled by a dedicated cutter-head dredge and pumped ashore through a submerged discharge pipeline that extends to the fill template.

This report presents the results of multi-sensor marine geophysical surveys performed in two proposed offshore re-handling sites (referred to as “pump-out areas”) and associated pipeline conveyance corridors currently being considered (Figure 2). The objective of these surveys was to document any hazards or submerged cultural resources that might impact the project. All field investigations were planned and performed to meet or exceed BOEM and the Louisiana State Historic Preservation Office (LASHPO) guidelines for archaeological field surveys. Results of these investigations have been provided to Fathom Research, LLC (Fathom) to enable them to complete a marine archaeological sensitivity assessment of the restoration project and offshore pump-out options. The Marine Archaeological Sensitivity Assessment Report is not included herein but will be submitted under separate cover.

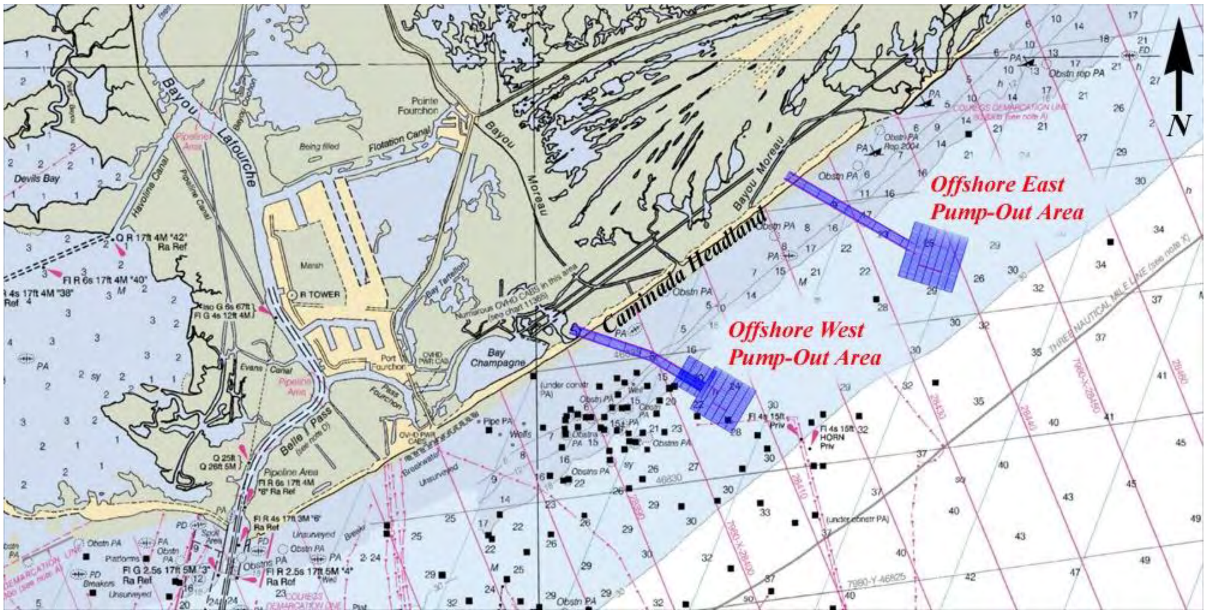


Figure 2. Location of proposed Offshore East and West Pump-out Areas and associated conveyance corridors investigated (NOAA Nautical Chart 11358 in background).

2.2 Summary of Field Survey and Equipment

As illustrated in Figure 2, geophysical investigations were completed in two offshore sites and conveyance corridors located within approximately 2 nautical miles (nm) of shore. The two site locations were initially chosen to avoid charted obstructions and known archaeologically sensitive areas. The original survey plan included data acquisition along a series of planned lines within the proposed pump-out areas (including a 1,000 foot buffer zone) and 500-foot wide conveyance corridors. Primary tracklines were spaced at 98-foot (30-meter) intervals with secondary tie lines oriented perpendicular to primary lines and spaced at 500-foot intervals for the pump-out areas and 1,000-foot intervals for the conveyance corridors. Due to the presence of a pipeline detected in the offshore west pump-out area, survey coverage was expanded and the proposed pump-out area was shifted approximately 2,200 feet to the northwest, as illustrated in Figure 2.

Investigations were conducted by a two-man survey team aboard OSI's *R/V Abel II*, a shallow draft 25-foot fiberglass survey vessel equipped with a fully-enclosed cabin, dual-outboard motors and the following survey instrumentation:

- *Trimble 212 Differential Global Positioning System (DGPS)*
- *HYPACK Navigation and Data-Logging Computer System*
- *Odom Single-Frequency Hydrotrac Depth Sounder*
- *Klein 3000 100/500 kHz Dual- Frequency Digital Side Scan Sonar System*
- *Geometrics G881 Cesium Marine Magnetometer*
- *EdgeTech Xstar Chirp Subbottom Profiling System equipped with SB216 Tow Vehicle*

Specification sheets for equipment used during the survey are available upon request. Operational procedures employed to collect the data can be found in Appendix 1. Figure 3 illustrates the equipment configuration used onboard the survey vessel. The single-frequency depth sounder transducer was hard mounted to the starboard side of the vessel; the side scan sonar towfish was towed from the stern mounted A-frame with the magnetometer sensor in tandem 25.5 feet (8 meters) behind; the Chirp SB216 was towed from a davit located approximately midships on the port side of the vessel. The side scan sonar system employed a 165-foot (50-meter) sweep range and the magnetometer was maintained at a tow height generally less than 20 feet (6 meters) above the bottom where depth permitted.

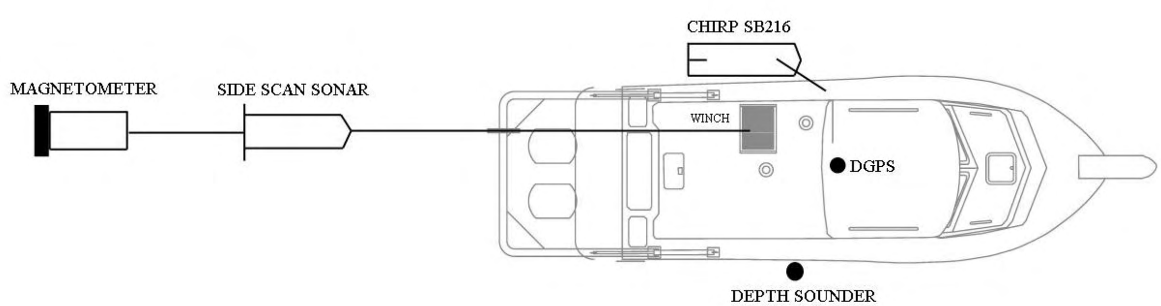


Figure 3. General equipment configuration and layout aboard the *R/V Able II*.

2.3 Horizontal and Vertical Control

Project horizontal reference is the LA State Plane Coordinate System, South Zone (1702), NAD 83 in US Survey Feet. The horizontal positioning of the survey vessel was accomplished using a DGPS interfaced with a computer running a version of HYPACK PC-based navigation and data logging software package. Navigation checks were performed at the beginning and end of each survey day to ensure the positioning system was functioning properly and delivering the horizontal accuracy required for the project.

Project vertical reference is the North American Vertical Datum of 1988 (NAVD88), in feet. Water depths were adjusted to the project datum based on NOAA predicted tides at Port Fourchon (Station ID 8762075), which are referenced to Mean Lower Low Water (MLLW). CEC provided the conversion to NAVD88 based on an installed tide gauge at Port Fourchon: 0 feet MLLW = +0.48 feet NAVD88.

2.4 Chronology of Field Operations and Acquisition Summary

Approximately 86 nm of multi-sensor trackline data were acquired in the two pump-out area sites and associated conveyance corridors during the course of the field investigation. Table 1 provides a chronology of field operations:

Table 1
Chronology of Field Investigation

Task	Date	Description
Mobilize vessel onsite	2 Dec 2011	OSI crew arrive in Port Fourchon, LA, begin on-site mobilization of *R/V Able II*
Finalize on-site mobilization and perform testing/calibration	3 Dec 2011	Complete vessel mobilization, perform testing/calibration of equipment
Survey operations	4-12 Dec 2011	Conduct survey operations.
Offsite standby	13 Dec2011 – 4 Jan 2012	Due to adverse weather and holiday schedule crew demobilize vessel and standby offsite
Re-mobilize vessel onsite	5 Jan 2012	OSI crew return to site and remobilize vessel for continued operations
Finalize on-site mobilization and perform testing/calibration	6 Jan 2012	Complete vessel remobilization, perform testing/calibration of equipment
Survey operations	7-13 Jan 2012	Continue survey operations.
Demobilize vessel	14 Jan 2012	Survey completed vessel and crew demobilize on-site and depart

3.0 DATA PROCESSING AND PRODUCTS

Following completion of the field investigation, the acquired data sets were processed, interpreted, and provided to the project archaeologist (Fathom) for review. For a more detailed discussion of processing and analysis methods followed by OSI refer to Appendix 2. Appendix 3 provides tables summarizing the magnetic anomalies and side scan sonar targets identified during the investigation. Thumbnail images for each sonar target are also included in this appendix.

Final data are presented in plan view at a scale of 1 inch = 1,000 feet on six drawing sheets (11 by 17 inches). The drawings are included in Appendix 4. Digital drawing files (AutoCAD 2007 format) and a copy of this report (PDF format) are provided on a disc included in a sleeve at the end of the original copy of this report.

Table 2 summarizes the data presented on each project drawing; note each drawing is comprised of two sheets, Sheet 1 presents results for the Offshore East Pump-Out area and Sheet 2 presents results for the Offshore West Pump-Out area. To aid in the archaeological review of the data the 1909 and 1958 charted shorelines (based on NOAA chart NOS. 196 & 1050, respectively) are overlain on all project drawing sheets.

Table 2
Overview of Project Drawings

Drawing	Data Presented
1 –Tracklines	Includes all survey vessel tracklines and an overview of potential relict landforms/paleo channels detected in the subsurface (via review of the subbottom profile data).
2 – Hydrography	One-foot depth contours based on processed sounding data.
3 – Side Scan Sonar Mosaic & Residual Magnetic Field Contours	Side scan sonar targets, magnetic anomalies (color-coded based on size), and 5 gamma contour of the modeled residual magnetic field overlain on side scan sonar mosaic.

4.0 DATA DISCUSSION

Hydrographic, subbottom profiling and magnetometer data together with side scan sonar imagery documented current seafloor and subsurface conditions within both proposed pump-out areas and associated conveyance corridors. The following sections present findings for each area. Seasonal variations, storm events, and/or man's influence since the time of the surveys may have altered conditions reported herein.

4.1 Offshore East Pump-Out Area & Conveyance Corridor

Hydrographic data acquired within the Offshore East Pump-Out area survey limits (including buffer area) ranged from approximately 28 to 34 feet below NAVD88. Depths within the proposed pump-out area ranged from approximately 30-32 feet below NAVD88.

Side scan sonar imagery shows the seafloor throughout the site to be generally featureless with no large scale bedforms present. Eighty-six (86) individual sonar targets were identified within the survey limits, all appear to be relatively small with minimal relief (<1 foot) and only nine are located within the current pump-out area limits. The majority of sonar targets identified appear to be linear features. Several sonar targets had correlative magnetic anomalies associated but none of the targets identified appear as recognizable features.

Analysis of magnetic data identified eighty-eight (88) individual magnetic anomalies in the site. The vast majority of these anomalies (52) were less than 10 gammas and only sixteen anomalies exhibited greater than 20 gammas. Most anomalies detected appear to be isolated and were only detected on a single survey line.

The subbottom profiler achieved approximately 5-20 feet of penetration below the seafloor throughout the area and resolved several undulating subsurface reflectors. Subbottom data show that the subsurface acoustic characteristics alternate between those of sand and clay. This changing character was highly variable both along line and from line to line, suggesting the shallow subsurface is not comprised of a single sediment type that can be distinctly mapped but is instead characterized by mixed sediments. A possible paleo channel was detected along a single survey line in the conveyance corridor approximately 1,200 feet offshore. The paleo feature was localized and not resolved on adjacent survey lines in the area. This subsurface feature is identified on the survey trackline plot (Drawing 1, Sheet 1).

4.2 Offshore West Pump-Out Area & Conveyance Corridor

The Offshore West Pump-Out area survey coverage was expanded to the northwest to avoid a pipeline which was detected during the field survey traversing through the original citied location. Hydrographic data acquired within the survey limits (including buffer area) ranged from approximately 27 to 34 feet below NAVD88. Depths within the current proposed pump-out area ranged from approximately 27.5-29.5 feet below NAVD88.

Side scan sonar imagery shows the seafloor to be generally featureless with no large scale bedforms present. Sixty-four (64) individual sonar targets were identified in the site. Many of the targets identified were detected in the buffer area southeast of the original proposed pump-out area and appear to be related to several pipelines and an oil-related platform in the area. The remaining targets appear to be relatively small linear features with minimal relief (<1 foot) with only two (SS90 & 143) actually located within the current pump-out area. Several sonar targets had correlative magnetic anomalies including SS90. With the exception of the targets detected in the southeast buffer zone none of the remaining sonar targets identified appear as recognizable features.

Analysis of magnetic data identified two-hundred and thirty-nine (239) individual magnetic anomalies in the site. A large portion of these anomalies are associated with oil-related structures and pipelines located southeast of the pump-out area. One alignment of anomalies, suggestive of a buried pipeline, was detected passing through the approximate center of the originally proposed pump-out area and was responsible for relocating the proposed pump-out area to its current location. Several anomalies were detected on the northern side of the conveyance corridor approximately 6,000 feet offshore that could potentially be problematic. The anomalies, ranging in size from several to 420 gammas, are grouped together on the northern side of the corridor and have no correlative sonar target(s). Since it is unclear what the magnetometer is detecting in this area, it is recommended that these anomalies either be avoided or more fully investigated prior to installing the conveyance pipeline to better understand the source of the anomalies. The vast majority of the remaining anomalies (75) detected in the site and corridor were isolated and less than 10 gammas.

The subbottom profiler achieved approximately 5-15 feet of penetration below the seafloor throughout much of the area and resolved several undulating subsurface reflectors. Subbottom data show that the subsurface acoustic characteristics alternate between sand and clay. This changing character was highly variable both along line and from line to line, suggesting the shallow subsurface is not comprised of a single sediment type that can be distinctly mapped but is instead characterized by mixed sediments. No paleo channels or relic shoreline features were resolved in the survey area. In one area along the conveyance corridor, approximately 2,500 feet offshore, subbottom penetration was limited below the surface and no subbottom reflectors could be resolved. This is likely attributed to concentrations of organic material and/or gas generated as a by-product of the decomposition of organic matter present in the sediment, which limit the ability of the profiler signal to penetrate deeper into the subsurface. This area of limited subbottom penetration has been delineated on the survey trackline plot (Drawing 1, Sheet 2).

5.0 SUMMARY AND RECOMMENDATIONS

Current Louisiana Coastal Protection and Restoration Authority (CPRA) plans are to restore the beach and dune features along the Caminada Headland using sediment resources identified on Ship Shoal. OSI has been subcontracted to perform several tasks supporting this project. The investigation described herein consisted of acquisition and analysis of multi-sensor marine geophysical data (sounding, side scan sonar, marine magnetometer and subbottom profile data) acquired in two proposed offshore pump-out areas and associated pipeline conveyance corridors located offshore of the headland. The objectives of these surveys were to document current conditions and identify any objects that might impact (be impacted by) the project. The results of these investigations have been provided to Fathom Research, LLC in support of a marine archaeological sensitivity assessment of the restoration project and offshore pump-out options.

Water depths within the proposed Offshore East Pump-Out area range from approximately 30-32 feet and in the Offshore West area range from 27.5-29.5 feet below NAVD88. Side scan sonar imagery shows the seafloor throughout the offshore pump-out areas and corridors to be generally featureless with no large scale bedforms present. Numerous side scan sonar targets and magnetic anomalies were identified in both sites. The majority of the features and anomalies are small, isolated, and unrecognizable. Several anomalies and targets were identified in the southeast corner of the Offshore West Pump-Out area related to oil-field pipelines and platforms in the area. The Offshore West Pump-Out area originally proposed was moved to the northwest to avoid a pipeline detected traversing through the original citied location. No pipelines or oil-related structures were detected in either of the conveyance corridors or the Offshore East Pump-Out area. It is unlikely that a target of significant ferrous mass or shallow pipeline trending across these areas would have remained undetected at the trackline spacing and magnetometer sensor tow height maintained during the survey. Several magnetic anomalies without correlative side scan sonar targets were detected on the northern side of the Offshore West Pump-Out area conveyance corridor, approximately 6,000 feet offshore. Since it is unclear what the magnetometer is detecting in this area, it is recommended that these anomalies either be avoided or more fully investigated prior to installing the conveyance pipeline to better understand the source of the anomalies.

APPENDIX 1

EQUIPMENT OPERATIONS AND PROCEDURES

Trimble DSM 212 Differential Global Positioning System

HYPACK Navigation Software

ODOM Hydrotrac Depth Sounder

Geometrics G881 Cesium Marine Magnetometer

Klein 3000 Dual-Frequency Digital Side Scan Sonar System

EdgeTech 3100 Chirp Subbottom Profiling System

EQUIPMENT OPERATIONS AND PROCEDURES

Trimble DSM 212 Differential Global Positioning System

A Trimble DSM 212 differential global satellite positioning system (GPS) provides reliable, high-precision positioning and navigation for a wide variety of operations and environments. The unique feature of this system is its integration of a standard 12-channel GPS receiver with a U.S. Coast Guard beacon receiver all in one package. Both antennas are combined in a single housing and the receiver electronics are similarly contained within one topside control box. The complete system includes the topside control unit, a GPS volute antenna and cable, RS232 output and input data cables, and a 12 volt DC power cable. The proprietary MSK beacon receiver used in the system has been designed to provide enhanced signal reception at large distances from the reference station and under inclement weather conditions. The low noise MSK receiver is also an automatic, dual-channel system providing seamless switching between multiple beacons when necessary. The DSM 212 outputs one position per second to the HYPACK navigation computer. The manufacturer reports submeter accuracy of the system under suitable operating conditions.

HYPACK Navigation Software

Survey vessel trackline control and position fixing were obtained by utilizing an OSI computer-based data logging package running HYPACK navigation software. The computer is interfaced with the DGPS system onboard the survey vessel. Vessel position data from the DGPS were updated at 1.0-second intervals and input to the HYPACK navigation system which processes the geodetic positions into State Plane coordinates used to guide the survey vessel accurately along preselected tracklines. The incoming data are logged on disk and processed in real time allowing the vessel position to be displayed on a video monitor and compared to each pre-plotted trackline as the survey progresses. A nautical chart background shows the shoreline, general water depths, and locations of existing structures, buoys, and control points on the monitor in relation to the vessel position. The OSI computer logging system combined with the HYPACK software thus provide an accurate visual representation of survey vessel location in real time, combined with highly efficient data logging capability and post-survey data processing and plotting routines.

Odom Hydrotrac Digital Depth Sounder

Precision water depth measurements were obtained by employing an Odom Hydrotrac digital depth sounder with a 200 kilohertz, 3° or 8° beam transducer. The Hydrotrac unit has been specifically designed for small boat surveys where equipment space is a premium and the potential for water contact is high (watertight, sealed keypad). The unit is compact, portable, and rugged, built to survive tough field conditions. The Hydrotrac recorder provides precise, high-resolution depth records using a solid-state thermal printer as well as digital data output (via RS232) which allows integration with the OSI computer-based navigation system including HYPACK software. Other features include internal or external eventing, gain sensitivity controls, power output control, auto scale changing, and auto pulse length selection, among others. The recorder also incorporates both tide and draft corrections plus a calibration capability for local water mass sound speed. A depth resolution of 0.1 foot is reported by the manufacturer.

Geometrics Model G-881 Cesium Vapor Marine Magnetometer

Total magnetic field intensity measurements are acquired along the survey tracklines using a Geometrics G881 cesium magnetometer which has an instrument sensitivity of 0.1 gamma. The G881 magnetometer system includes the sensor head with a coil and optical component tube, a sensor electronics package which houses the AC signal generator and mini-counter that converts the Larmor signal into a magnetic anomaly value in gammas, and a RS-232 data cable for transmitting digital measurements to a data logging system. The cesium-based method of magnetic detection allows a center or nose tow configuration off the survey vessel, simultaneously with other remote sensing equipment, while maintaining high quality, quiet magnetic data with ambient fluctuations of less than 1 gamma. The G881 outputs magnetic intensity readings at a 10 hertz sampling rate which were recorded on the OSI data logging computer by the HYPACK software.

The G881 magnetometer acquires information on the ambient magnetic field strength by measuring the variation in cesium electron energy level states. The presence of only one electron in the atom's outermost electron shell (known as an alkali metal) makes cesium ideal for optical pumping and magnetometry.

A beam of infrared light is passed through a cesium vapor chamber producing a Larmor frequency output in the form of a continuous sine wave. This radio frequency field is generated by an H1 coil wound around a tube containing the optical components (lamp oscillator, optical filters and lenses, split-circular polarizer, and infrared photo detector). The Larmor frequency is directly proportional to the ambient magnetic intensity, and is exactly 3.49872 times the ambient magnetic field measured in gammas or nanoteslas. Changes in the ambient magnetic field cause different degrees of atomic excitation in the cesium vapor which in turn allows variable amounts of infrared light to pass, resulting in fluctuations in the Larmor frequency.

Although the earth's magnetic field does change with both time and distance, over short periods and distances the earth's field can be viewed as relatively constant. The presence of magnetic material and/or magnetic minerals, however, can add to or subtract from the earth's magnetic field creating a magnetic anomaly. Rapid changes in total magnetic field intensity which are not associated with normal background fluctuations mark the locations of these anomalies.

Determination of the location of an object producing a magnetic anomaly depends on whether or not the magnetometer sensor passed directly over the object and if the anomaly is an apparent monopole or dipole. A magnetic dipole can be thought of simply as a common bar magnet having a positive and negative end or pole. A monopole arises when the magnetometer senses only one end of a dipole as it passes over the object. This situation occurs mainly when the distance between opposite poles of a dipole is much greater than the distance between the magnetometer and the sensed pole, or when a dipole is oriented nearly perpendicular to the ambient field thus shielding one pole from detection. For dipolar anomalies, the location of the object is at the point of maximum gradient between the two poles. In the case of a monopole, the object associated with the anomaly is located below the maximum or minimum magnetic value.

Klein 3000 Dual-Frequency Side Scan Sonar System

Side scan sonar images of the bottom are collected using a Klein 3000 dual frequency, high-resolution sonar system operating at frequencies of 100 and 500 kilohertz. The system consists of a topside computer, monitor, keyboard, mouse, tow cable, and sonar towfish. All system components are interfaced via a local network hub and cable connections. The system contains an integrated navigational plotter which accepts standard NMEA 0183 input from a GPS system. This allows vessel position to be displayed on the monitor and speed information to be used for controlling sonar ping rate. Sonar sweep can also be plotted in the navigation window for monitoring bottom coverage in the survey area.

The hardware is interfaced to the Klein SonarPro data acquisition and playback software package which runs on the topside computer. All sonar images are stored digitally and can be enhanced real-time or post-survey by numerous mathematical filters available in the program software. Imagery is displayed in a waterfall window in either normal or ground range (water column removed) formats. Other software functions that are available during data acquisition include; changing range scale and delay, display color, automatic or manual TVG (time variable gain), speed over bottom, multiple enlargement zoom, target length, height, and area measurements, logging and saving of target images, and annotation frequency and content. The power of this system is its real-time processing capability for determining precise dimensions of targets and areas on the bottom.

As with many other marine geophysical instruments, the side scan sonar derives its information from reflected acoustic energy. A set of transducers mounted in a compact towfish generate the short duration acoustic pulses required for extremely high resolution. The pulses are emitted in a thin, fan-shaped pattern that spreads downward to either side of the fish in a plane perpendicular to its path. As the fish progresses along the trackline this acoustic beam sequentially scans the bottom from a point directly beneath the fish outward to each side of the survey trackline.

Acoustic energy reflected from any bottom discontinuities is received by the set of transducers in the towfish, amplified and transmitted to the survey vessel via the tow cable where it is further amplified, processed, and converted to a graphic record by the side scan recorder. The sequence of reflections from the series of pulses is displayed on a video monitor and/or dual-channel graphic recorder on which paper is incrementally advanced prior to printing each acoustic pulse. The resulting output is essentially analogous to a high angle oblique "photograph" providing detailed representation of bottom features and characteristics. This system allows display of positive relief (features extending above the bottom) and negative relief (such as depressions) in either light or dark opposing contrast modes on the video monitor. Examination of the images thus allows a determination of significant features and objects present on the bottom within the survey area.

<u>EdgeTech 3200-XS 2-16 kHz "Chirp" Subbottom Profiler</u>
(functionally equivalent to EdgeTech 3100 used for this investigation)

Information concerning subsurface stratigraphy was explored through use of an EdgeTech 3200-XS "Chirp" subbottom profiler system operating at frequencies of 2 to 16 kilohertz. The subbottom profiler consists of three components: the deck unit (XStar topside computer, amplifier, monitor, keyboard, and trackball), an underwater cable, and a Model SB216 towed vehicle housing the transducers. Data are acquired, logged, and displayed using the Discover Subbottom software.

The 3200 XS Chirp sonar is a versatile subbottom profiler that generates cross-sectional images and collects normal incidence reflection data over many frequency ranges. The system transmits and receives an FM pulse signal generated via a streamlined towed vehicle (subsurface transducer array). The outgoing FM pulse is linearly swept over a full spectrum range of 2-16 kHz for a period of approximately 20 milliseconds. The acoustic return received at the hydrophone array is cross-correlated with the outgoing FM pulse and sent to the deck unit for display and archiving, generating a high-resolution image of the subbottom stratigraphy. Because the FM pulse is generated by a converter with a wide dynamic range and a transmitter with linear components, the energy, amplitude, and phase characteristics of the acoustic pulse can be precisely controlled and enhanced.

During data acquisition, all records were annotated with relevant supporting information, field observations, line number, run number, navigation event marks and numbers for later interpretation and correlation with vessel position data.

APPENDIX 2

DATA PROCESSING AND ANALYSIS METHODS

DATA PROCESSING AND ANALYSIS METHODS

Navigation Data

During the field investigation, vessel navigation files were continuously processed and entered into AutoCAD drawings to verify survey coverage and assist with the onsite review of geophysical data. Upon completion of the field work, vessel tracklines were exported utilizing the HYPACK software as a DXF file and entered into the AutoCAD drawing files to show survey coverage.

Hydrographic Data

Upon completion of the field work, the single beam data were processed using HYPACK single beam editor. Digital depth data were first checked against the graphic sounding records for verification of depth quality. Erroneous digital depths caused by floating and drifting debris, air bubbles from passing ship's wake, or fish in the water column were filtered out of the data. The editing process is performed with care to eliminate points attributed to objects in the water column (fish, floating line, etc.) while preserving small features important to the project (potential obstructions). The digital files containing vessel position and hydrographic data were then processed to correct for field calibrations and adjust the sounding data to the required datum.

Depth data points were exported out of HYPACK and used to generate surface models that placed the depth data into cell bins of a sufficient size to preserve the features of interest. Shaded rendering maps were generated within the software program Global Mapper, Version 10. The processed x, y, z data for the survey areas were then contoured at an appropriate interval using Quicksurf operating within AutoCAD (Autodesk).

Magnetic Intensity Measurements

The objective of the magnetic survey was to locate any ferrous objects lying on or buried beneath the seafloor within the project site. Anomalies of man-made origin typically have short wavelengths and high amplitudes. In contrast, most geological features generate anomalies that are large in amplitude and often cover a much greater area. Magnetometer data were initially processed with HYPACK software package Single Beam Editor and then contoured utilizing the Geometrics' software package MagPick (V. 3.2). Magnetic anomaly tables were constructed based on a review of the processed data.

For discrete anomalies, determination of the location of the anomaly-producing object depends upon whether the anomaly is an apparent monopole or dipole and upon whether or not the magnetometer passed directly over the object. A magnetic dipole can be thought of in terms of a common bar magnet having a positive and a negative pole. Monopoles arise when the magnetometer senses only one pole of a dipole. This situation most commonly arises when the distance between opposite poles of a dipole is greater than the distance between the magnetometer sensor and the sensed pole or when a dipole is oriented nearly perpendicular to the ambient field thus shielding one pole from detection. For dipolar anomalies, the closest point of detection of the related object is determined to be at the point of maximum gradient between the two poles. Whereas the closest point of detection for objects which exhibit monopolar characteristics is typically the peak of maximum fluctuation.

Side Scan Sonar Imagery

Side scan sonar mosaics were created using Chesapeake Technologies, Inc. SonarWiz Version 5.03 software. Imagery was reviewed and interpreted to detect individual targets with the intent of identifying any man-made objects. This served two purposes: it provided information on potential obstructions and data to support the marine archaeological assessment of the area. Each target is interpreted and measured individually. A spreadsheet summarizes specific information for each target such as ID number, position, size, relief, brief description, and magnetic associations. The target positions were also imported in AutoCAD and plotted in plan view.

Chirp Subbottom Profile Data

Subbottom profile data were processed (filtered and gain applied) to generate jpeg images of the data utilizing EdgeTech's Discover-Sub-Bottom, Version 3.36, software package. Subsurface data were analyzed to understand current subsurface conditions in the area and map potential relict landforms and channels in the project area. This interpretation is presented as an overlay to the survey trackline plot presented on Drawing 1.

APPENDIX 3

SUMMARY TABLES OF
MAGNETIC ANOMALIES & SIDE SCAN SONAR TARGETS

MAGNETIC ANOMALY SUMMARY TABLE

Magnetic Anomaly Designation	Easting[1]	Northing[1]	Type[2]	Amplitude[3]	Duration (feet)	Sensor height (feet)	Sonar Target	Site	Corridor/ Pump-out Area
M1	3680195	232598	D	20	81.5	18		East	Pump-out
M2	3679798	231320	D	77	92.3	18		East	Pump-out
M3	3678893	230165	-M	401	81.1	18		East	Pump-out
M4	3678961	230440	D	6	91.4	18		East	Pump-out
M5	3679661	232643	+M	4	57.3	18		East	Pump-out
M6	3679854	233270	+M	4	45.0	18		East	Pump-out
M7	3679136	232655	-M	8	51.8	18		East	Pump-out
M8	3678499	232228	D	17	71.9	18	SS52	East	Pump-out
M9	3678683	232834	-M	6	56.7	18		East	Pump-out
M10	3678944	233710	D	5	57.2	18		East	Pump-out
M11	3678258	233162	-M	9	56.4	18		East	Pump-out
M12	3676980	230785	D	20	129.5	18		East	Pump-out
M13	3676416	232188	-M	5	60.5	18		East	Pump-out
M14	3679220	233704	D	25	73.7	18		East	Pump-out
M15	3680302	233372	+M	23	70.0	18		East	Pump-out
M16	3679736	233344	-M	6	59.9	18		East	Pump-out
M17	3679871	233281	D	13	53.5	18		East	Pump-out
M18	3678957	233483	+M	3	35.0	18		East	Pump-out
M19	3679624	233283	+M	4	40.6	18		East	Pump-out
M20	3679593	233182	D	15	88.5	18		East	Pump-out
M21	3679081	233333	D	7	64.5	18		East	Pump-out
M22	3678531	233507	D	11	62.8	18	SS44	East	Pump-out
M23	3676907	234020	-M	6	54.3	18		East	Pump-out
M24	3677367	233564	-M	5	39.6	18		East	Pump-out

Magnetic Anomaly Designation	Easting[1]	Northing[1]	Type[2]	Amplitude[3]	Duration (feet)	Sensor height (feet)	Sonar Target	Site	Corridor/ Pump-out Area
M25	3680216	232550	+M	11	74.3	18		East	Pump-out
M26	3678848	233001	+M	6	41.8	18		East	Pump-out
M27	3678275	233166	-M	18	41.8	18		East	Pump-out
M28	3677867	233316	D	23	106.7	18		East	Pump-out
M29	3680063	232506	-M	18	67.7	18		East	Pump-out
M30	3678650	232866	D	58	84.2	18		East	Pump-out
M31	3677605	233078	D	8	53.9	18		East	Pump-out
M32	3678208	232880	+M	3	47.7	18		East	Pump-out
M33	3677843	232918	+M	16	78.3	18		East	Pump-out
M34	3679853	232168	-M	5	48.5	18		East	Pump-out
M35	3679385	232112	-M	6	109.6	18		East	Pump-out
M36	3679747	231908	+M	7	60.8	18		East	Pump-out
M37	3677864	232487	D	4	73.9	18	SS57	East	Pump-out
M38	3676796	232504	-M	4	44.4	18		East	Pump-out
M39	3678543	231860	+M	6	44.5	18		East	Pump-out
M40	3676586	232365	D	4	55.0	18		East	Pump-out
M41	3679522	231464	-M	519	74.3	18		East	Pump-out
M42	3679765	231299	+M	12	147.8	18		East	Pump-out
M43	3678093	231601	-M	2	58.2	18		East	Pump-out
M44	3678256	231332	-M	39	73.7	18		East	Pump-out
M45	3676420	231908	+M	2	46.7	18		East	Pump-out
M46	3679550	230729	D	7	65.8	18		East	Pump-out
M47	3678589	231057	D	34	71.9	18	SS69	East	Pump-out
M48	3676549	231464	-M	4	47.2	18		East	Pump-out
M49	3676471	231494	D	5	60.5	18	SS80	East	Pump-out

Magnetic Anomaly Designation	Easting[1]	Northing[1]	Type[2]	Amplitude[3]	Duration (feet)	Sensor height (feet)	Sonar Target	Site	Corridor/ Pump-out Area
M50	3672880	235075	+M	6	73.3	18		East	Corridor
M51	3670014	236736	D	10	39.0	7		East	Corridor
M52	3669686	236921	D	25	45.5	5		East	Corridor
M53	3671097	235990	-M	9	69.7	14		East	Corridor
M54	3671387	235817	-M	9	33.8	14		East	Corridor
M55	3671433	235796	D	47	50.9	14	SS21	East	Corridor
M56	3672464	235200	D	8	73.6	17		East	Corridor
M57	3673153	234797	-M	3	58.8	19		East	Corridor
M58	3673443	234632	D	9	77.7	19		East	Corridor
M59	3672377	235143	-M	3	44.8	18		East	Corridor
M60	3669785	236641	+M	3	37.5	7		East	Corridor
M61	3669697	236689	D	14	49.3	6		East	Corridor
M62	3672548	234925	D	18	90.8	18		East	Corridor
M63	3672557	235375	+M	20	46.2	18		East	Corridor
M64	3671331	236085	D	15	103.4	15		East	Corridor
M65	3669997	236854	-M	8	33.4	7		East	Corridor
M66	3670849	236470	D	28	71.0	12		East	Corridor
M67	3674434	234404	+M	6	52.2	22		East	Corridor
M68	3676361	233409	-M	17	75.6	24		East	Corridor
M69	3674855	234273	D	7	86.8	22		East	Corridor
M70	3674187	234662	D	5	74.7	21		East	Corridor
M71	3670863	236583	D	9	40.6	11		East	Corridor
M72	3670232	236942	D	2320	68.5	8		East	Corridor
M73	3676395	233413	+M	17	54.1	24		East	Corridor
M74	3678152	230857	+M	6	62.1	18	SS85	East	Pump-out

Magnetic Anomaly Designation	Easting[1]	Northing[1]	Type[2]	Amplitude[3]	Duration (feet)	Sensor height (feet)	Sonar Target	Site	Corridor/ Pump-out Area
M75	3678677	230592	D	4	86.5	18		East	Pump-out
M76	3676790	230972	D	2	55.0	18		East	Pump-out
M77	3676243	231135	D	4	63.9	18		East	Pump-out
M78	3676958	230815	D	20	78.5	18		East	Pump-out
M79	3678831	230233	+M	125	120.7	18		East	Pump-out
M80	3678828	230141	D	53	316.0	18		East	Pump-out
M81	3676972	230706	D	4	58.0	18		East	Pump-out
M82	3678490	232236	D	8	83.8	18	SS59	East	Pump-out
M83	3678678	232845	-M	8	96.7	18		East	Pump-out
M84	3678951	233717	D	4	66.5	18		East	Pump-out
M85	3679864	233296	D	11	51.9	18		East	Pump-out
M86	3678895	230172	-M	125	203.9	18		East	Pump-out
M87	3679780	231319	D	20	102.4	18		East	Pump-out
M88	3680175	232608	-M	3	49.2	18		East	Pump-out
M89	3660946	225782	D	52	116.3	20		West	Corridor
M90	3660650	225957	D	7	128.5	19		West	Corridor
M91	3658681	226639	+M	5	78.2	16		West	Corridor
M92	3658523	226691	-M	4	65.2	16		West	Corridor
M93	3658324	226762	-M	8	85.0	16		West	Corridor
M94	3657935	226892	-M	2	52.9	14		West	Corridor
M95	3657352	227091	+M	11	64.7	10		West	Corridor
M96	3656767	227286	-M	9	42.8	8		West	Corridor
M97	3656227	227471	D	12	44.8	5		West	Corridor
M98	3656017	227434	D	30	40.1	4		West	Corridor
M99	3656127	227394	+M	70	50.1	5		West	Corridor

Magnetic Anomaly Designation	Easting[1]	Northing[1]	Type[2]	Amplitude[3]	Duration (feet)	Sensor height (feet)	Sonar Target	Site	Corridor/ Pump-out Area
M100	3656708	227201	+M	8	50.2	8		West	Corridor
M101	3657207	227028	D	8	77.1	10		West	Corridor
M102	3657624	226889	D	3	63.3	13		West	Corridor
M103	3658460	226614	D	6	75.7	16		West	Corridor
M104	3659762	226160	D	7	64.3	18		West	Corridor
M105	3660721	225797	+M	2	44.8	20		West	Corridor
M106	3660794	225753	+M	2	44.1	20		West	Corridor
M107	3662803	224437	D	26	109.1	18	SS90	West	Pump-out
M108	3660527	225801	+M	4	79.2	20		West	Corridor
M109	3660081	225960	D	5	109.6	19		West	Corridor
M110	3658733	226412	+M	5	66.3	17		West	Corridor
M111	3658274	226571	-M	17	112.2	16		West	Corridor
M112	3657201	226931	+M	17	150.9	11		West	Corridor
M113	3656327	227233	D	14	33.6	7		West	Corridor
M114	3656047	227321	+M	29	51.7	5		West	Corridor
M115	3655853	227281	+M	15	65	5		West	Corridor
M116	3656041	227220	+M	5	29.5	6		West	Corridor
M117	3656492	227069	D	4	36.9	8		West	Corridor
M118	3656672	227007	D	6	69.9	9		West	Corridor
M119	3657583	226700	-M	13	95	13		West	Corridor
M120	3657888	226596	D	4	54.8	15		West	Corridor
M121	3658415	226412	D	10	70.1	17		West	Corridor
M122	3659095	226187	D	27	100.6	18		West	Corridor
M123	3660925	225444	D	14	82.5	21		West	Corridor
M124	3660942	225895	D	24	105.1	20		West	Corridor

Magnetic Anomaly Designation	Easting[1]	Northing[1]	Type[2]	Amplitude[3]	Duration (feet)	Sensor height (feet)	Sonar Target	Site	Corridor/ Pump-out Area
M125	3660853	225953	D	12	101	20		West	Corridor
M126	3660592	226100	D	4	83.9	19		West	Corridor
M127	3660271	226213	D	3	46.1	19		West	Corridor
M128	3659089	226605	D	7	65.6	16		West	Corridor
M129	3658484	226810	-M	2	55.6	16		West	Corridor
M130	3658408	226831	-M	2	41	16		West	Corridor
M131	3657524	227130	+M	14	36.6	12		West	Corridor
M132	3657055	227294	-M	10	76.9	9		West	Corridor
M133	3656844	227363	+M	6	34.1	8		West	Corridor
M134	3656388	227520	-M	29	36.1	6		West	Corridor
M135	3656128	227609	D	5	32.6	4		West	Corridor
M136	3656593	227550	+M	10	28.7	7		West	Corridor
M137	3657679	227182	+M	7	37.7	12		West	Corridor
M138	3658296	226971	D	4	53.9	15		West	Corridor
M139	3658536	226880	-M	11	97.8	15		West	Corridor
M140	3658673	226847	D	6	56.9	16		West	Corridor
M141	3658757	226818	+M	10	63.5	17		West	Corridor
M142	3658992	226732	+M	2	34	17		West	Corridor
M143	3659430	226594	+M	4	47.1	18		West	Corridor
M144	3661371	225747	D	49	583.1	20		West	Corridor
M145	3661497	225789	+M	420	368.9	21		West	Corridor
M146	3660016	226497	-M	27	73.6	19		West	Corridor
M147	3659606	226631	D	18	89.6	18		West	Corridor
M148	3659162	226785	D	5	46.6	16		West	Corridor
M149	3658600	226978	-M	24	56.2	15		West	Corridor

Magnetic Anomaly Designation	Easting[1]	Northing[1]	Type[2]	Amplitude[3]	Duration (feet)	Sensor height (feet)	Sonar Target	Site	Corridor/ Pump-out Area
M150	3657593	227317	D	10	55	11		West	Corridor
M151	3657182	227456	+M	20	34.9	9		West	Corridor
M152	3656442	227706	+M	11	46.4	5		West	Corridor
M153	3656332	227744	-M	8	40.3	5		West	Corridor
M154	3656246	227773	+M	9	45.4	4		West	Corridor
M155	3656094	227547	D	24	17.7	4		West	Corridor
M156	3656042	227394	+M	98	25.1	5		West	Corridor
M157	3656029	227336	+M	77	43.3	5		West	Corridor
M158	3655974	227227	-M	8	9.3	5		West	Corridor
M159	3656888	226785	D	93	58.7	11		West	Corridor
M160	3657072	227315	+M	17	46.6	9		West	Corridor
M161	3660585	225508	+M	6	46.6	20		West	Corridor
M162	3660826	225910	D	12	104.5	20		West	Corridor
M163	3663748	222299	+M	987	63.4	18		West	Pump-out
M164	3664028	222140	D	413	80	18		West	Pump-out
M165	3664227	222021	-M	149	46.6	18		West	Pump-out
M166	3664419	221907	-M	484	125.4	18		West	Pump-out
M167	3664699	221735	+M	1973	108	18		West	Pump-out
M168	3665666	221272	D	107	143.9	18		West	Pump-out
M169	3665306	221488	D	17	46.7	18		West	Pump-out
M170	3664818	221792	+M	884	77.6	18		West	Pump-out
M171	3664735	221831	-M	146	40.5	18		West	Pump-out
M172	3664675	221862	-M	178	92.4	18		West	Pump-out
M173	3664395	222038	+M	119	57.6	18		West	Pump-out
M174	3664230	222136	-M	925	76.4	18	SS95	West	Pump-out

Magnetic Anomaly Designation	Easting[1]	Northing[1]	Type[2]	Amplitude[3]	Duration (feet)	Sensor height (feet)	Sonar Target	Site	Corridor/ Pump-out Area
M175	3663934	222316	+M	1190	82.3	18		West	Pump-out
M176	3663223	222739	D	36	43	18		West	Pump-out
M177	3664665	221985	D	67	65.1	18	SS103	West	Pump-out
M178	3663003	222979	D	172	59.7	18		West	Pump-out
M179	3664707	221960	-M	48	43.2	18	SS103	West	Pump-out
M180	3664039	222359	-M	270	68.9	18		West	Pump-out
M181	3664157	222287	+M	317	79.3	18		West	Pump-out
M182	3664909	221830	D	2267	116	18	SS101	West	Pump-out
M183	3665460	221513	D	52	70.9	18	SS98	West	Pump-out
M184	3665499	221599	D	8	35	18		West	Pump-out
M185	3665025	221889	-M	2308	123.7	18	SS100	West	Pump-out
M186	3664757	222060	D	62	47.4	18		West	Pump-out
M187	3664674	222092	-M	285	71.8	18	SS104	West	Pump-out
M188	3664428	222246	D	297	67.8	18		West	Pump-out
M189	3664374	222279	D	141	50.2	18		West	Pump-out
M190	3664091	222448	D	40	41.6	18		West	Pump-out
M191	3663106	223139	D	19	69.3	18		West	Pump-out
M192	3664263	222448	-M	27	39.6	18		West	Pump-out
M193	3664427	222353	-M	9	29.2	18		West	Pump-out
M194	3664778	222148	-M	547	76.1	18		West	Pump-out
M195	3664853	222100	D	759	88.5	18	SS108	West	Pump-out
M196	3665180	221901	-M	1204	81	18		West	Pump-out
M197	3665297	221840	+M	163	56.6	18		West	Pump-out
M198	3665938	221565	+M	90	54.2	18		West	Pump-out
M199	3665314	221940	D	1336	89.2	18	SS109	West	Pump-out

Magnetic Anomaly Designation	Easting[1]	Northing[1]	Type[2]	Amplitude[3]	Duration (feet)	Sensor height (feet)	Sonar Target	Site	Corridor/ Pump-out Area
M200	3665155	222048	D	1602	170.3	18	SS107	West	Pump-out
M201	3664997	222132	D	98	147.1	18		West	Pump-out
M202	3664164	222625	+M	4	31.1	18		West	Pump-out
M203	3663880	222803	D	5	70.1	18		West	Pump-out
M204	3663211	223198	+M	4	34.2	18		West	Pump-out
M205	3663862	222924	-M	3	39.5	18		West	Pump-out
M206	3663940	222879	+M	4	31.7	18		West	Pump-out
M207	3663976	222853	+M	3	32.4	18		West	Pump-out
M208	3664662	222444	-M	9	41.4	18		West	Pump-out
M209	3664728	222404	+M	15	47.5	18		West	Pump-out
M210	3665691	221826	+M	1088	209.1	18		West	Pump-out
M211	3665878	221716	-M	3253	89.7	18		West	Pump-out
M212	3665430	222108	-M	2124	457.9	18	SS109	West	Pump-out
M213	3664651	222563	D	20	67.3	18		West	Pump-out
M214	3664520	222649	+M	3	34.6	18		West	Pump-out
M215	3663357	223453	+M	175	94.2	18		West	Pump-out
M216	3663486	223373	-M	17	32.4	18		West	Pump-out
M217	3664664	222670	-M	32	87.3	18		West	Pump-out
M218	3664949	222497	D	23	56.2	18		West	Pump-out
M219	3665505	222172	-M	455	589.4	18	SS109	West	Pump-out
M220	3665793	222113	-M	291	100	18	SS111	West	Pump-out
M221	3664782	222720	D	4	62	18		West	Pump-out
M222	3664523	222870	D	34	61.2	18		West	Pump-out
M223	3663606	223427	+M	24	40.3	18		West	Pump-out
M224	3663567	223448	D	59	44.9	18		West	Pump-out

Magnetic Anomaly Designation	Easting[1]	Northing[1]	Type[2]	Amplitude[3]	Duration (feet)	Sensor height (feet)	Sonar Target	Site	Corridor/ Pump-out Area
M225	3663780	223430	D	95	107.7	18		West	Pump-out
M226	3664720	222983	-M	5	33.4	18		West	Pump-out
M227	3663998	223416	D	25	59.4	18		West	Pump-out
M228	3663960	223440	-M	80	113.7	18		West	Pump-out
M229	3663479	223834	D	151	88.1	18		West	Pump-out
M230	3664149	223438	D	71	134.2	18		West	Pump-out
M231	3665265	222769	D	58	60.9	18		West	Pump-out
M232	3665419	222672	D	9	60.1	18		West	Pump-out
M233	3665769	222467	-M	10	45.8	18		West	Pump-out
M234	3665808	222442	+M	5	29.1	18		West	Pump-out
M235	3665922	222380	-M	15	42	18		West	Pump-out
M236	3666037	222307	-M	15	46.3	18		West	Pump-out
M237	3664378	223422	D	128	182.2	18		West	Pump-out
M238	3663429	223446	-M	214	89.8	18		West	Pump-out
M239	3664008	223440	-M	30	66.9	18		West	Pump-out
M240	3663895	222288	D	1115	124.6	18		West	Pump-out
M241	3664325	222018	+M	527	77.6	18	SS96	West	Pump-out
M242	3664453	222234	-M	81	83.6	18		West	Pump-out
M243	3664663	222600	+M	53	48.1	18		West	Pump-out
M244	3664952	222098	-M	896	61.3	18		West	Pump-out
M245	3664754	221773	-M	1415	77.9	18		West	Pump-out
M246	3665299	221680	-M	76	44.2	18		West	Pump-out
M247	3665494	222043	-M	2111	284.9	18	SS109	West	Pump-out
M248	3665889	221726	-M	1324	83.5	18		West	Pump-out
M249	3665632	221271	+M	46	65.9	18		West	Pump-out

Magnetic Anomaly Designation	Easting[1]	Northing[1]	Type[2]	Amplitude[3]	Duration (feet)	Sensor height (feet)	Sonar Target	Site	Corridor/ Pump-out Area
M250	3666118	222491	D	5	47.8	18		West	Pump-out
M251	3665948	222588	D	8	93.7	18		West	Pump-out
M252	3664568	223412	-M	175	136.7	18		West	Pump-out
M253	3663962	223887	-M	15	51.3	18		West	Pump-out
M254	3664736	223424	D	129	114.9	18		West	Pump-out
M255	3664983	223281	+M	5	38.8	18		West	Pump-out
M256	3666399	222432	-M	11	35.4	18		West	Pump-out
M257	3664910	223435	D	98	140.1	18		West	Pump-out
M258	3665085	223445	D	99	167.8	18		West	Pump-out
M259	3665247	223466	-M	99	152.4	18		West	Pump-out
M260	3665409	223479	D	116	233.7	18		West	Pump-out
M261	3665682	223319	-M	6	19.7	18		West	Pump-out
M262	3665566	223510	D	73	199.4	18		West	Pump-out
M263	3665702	223536	D	74	138.1	18		West	Pump-out
M264	3666541	223034	D	104	76.4	18		West	Pump-out
M265	3666809	222878	D	205	72.6	18		West	Pump-out
M266	3666451	223206	D	7	60.6	18		West	Pump-out
M267	3666081	223422	D	15	55.1	18		West	Pump-out
M268	3665841	223568	D	100	110.2	18		West	Pump-out
M269	3664542	224342	+M	7	71.8	18	SS120	West	Pump-out
M270	3665984	223600	-M	81	143.4	18		West	Pump-out
M271	3666610	223336	D	10	167.1	18		West	Pump-out
M272	3666120	223633	-M	73	152.3	18		West	Pump-out
M273	3665330	224106	+M	13	71.1	18		West	Pump-out
M274	3665090	224249	+M	14	207.2	18		West	Pump-out

Magnetic Anomaly Designation	Easting[1]	Northing[1]	Type[2]	Amplitude[3]	Duration (feet)	Sensor height (feet)	Sonar Target	Site	Corridor/ Pump-out Area
M275	3665302	224234	+M	41	90.2	18	SS130	West	Pump-out
M276	3666256	223665	D	115	168.9	18		West	Pump-out
M277	3666641	223428	-M	34	71.5	18		West	Pump-out
M278	3666623	223564	+M	4	45.3	18		West	Pump-out
M279	3666391	223697	D	70	108.9	18		West	Pump-out
M280	3666182	223818	-M	5	53.7	18		West	Pump-out
M281	3666116	223861	D	17	52.9	18	SS132	West	Pump-out
M282	3666053	223902	+M	4	32	18	SS126	West	Pump-out
M283	3666532	223723	D	73	87.3	18		West	Pump-out
M284	3667157	223473	D	15	63	18		West	Pump-out
M285	3666689	223751	-M	65	121.8	18		West	Pump-out
M286	3664843	224853	D	33	57.8	18	SS136	West	Pump-out
M287	3666936	223713	D	46	56.3	18		West	Pump-out
M288	3666972	223692	D	44	65.5	18		West	Pump-out
M289	3667200	223676	D	121	112.5	18		West	Pump-out
M290	3666685	223975	+M	4	39.9	18		West	Pump-out
M291	3667071	223694	D	78	79.8	18		West	Pump-out
M292	3665887	221724	-M	1446	93.3	18		West	Pump-out
M293	3665626	221283	+M	38	33.9	18		West	Pump-out
M294	3665293	221682	-M	117	58.4	18		West	Pump-out
M295	3665484	221917	-M	998	95	18	SS109	West	Pump-out
M296	3666497	223701	-M	104	107.2	18		West	Pump-out
M297	3665522	222025	-M	2052	233.8	18	SS109	West	Pump-out
M298	3666632	223925	D	13	51.4	18		West	Pump-out
M299	3666035	223899	D	11	64	18	SS126	West	Pump-out

Magnetic Anomaly Designation	Easting[1]	Northing[1]	Type[2]	Amplitude[3]	Duration (feet)	Sensor height (feet)	Sonar Target	Site	Corridor/ Pump-out Area
M300	3665835	223576	D	61	135.6	18		West	Pump-out
M301	3664948	222099	-M	758	74.6	18		West	Pump-out
M302	3664761	221775	-M	1728	104.9	18		West	Pump-out
M303	3664324	222018	+M	477	107.5	18	SS96	West	Pump-out
M304	3664448	222232	-M	70	83.5	18		West	Pump-out
M305	3664576	222449	-M	11	54.4	18		West	Pump-out
M306	3664663	222586	D	142	70.4	18		West	Pump-out
M307	3665179	223446	D	133	132.7	18		West	Pump-out
M308	3664571	223415	-M	88	109.1	18		West	Pump-out
M309	3663901	222281	D	1405	137.5	18		West	Pump-out
M310	3664005	223434	-M	60	77.3	18		West	Pump-out
M311	3664561	224364	D	54	67.2	18	SS120	West	Pump-out
M312	3664842	224835	+M	18	38.1	18	SS136	West	Pump-out
M313	3663429	223447	-M	207	124.1	18		West	Pump-out
M314	3663403	223438	D	148	148.8	18		West	Pump-out
M315	3663150	223590	-M	3	35.7	18		West	Pump-out
M316	3662418	224140	D	36	49.9	18		West	Pump-out
M317	3662551	224057	-M	8	41.3	18		West	Pump-out
M318	3663579	223438	D	91	99.2	18		West	Pump-out
M319	3663791	223432	D	95	68.4	18		West	Pump-out
M320	3663491	223844	D	145	83.6	18		West	Pump-out
M321	3662760	224397	+M	3	71.3	18		West	Pump-out
M322	3663635	223876	D	2	51.7	18		West	Pump-out
M323	3663986	223844	+M	4	72.9	18		West	Pump-out
M324	3663741	223429	D	53	287.7	18		West	Pump-out

Magnetic Anomaly Designation	Easting[1]	Northing[1]	Type[2]	Amplitude[3]	Duration (feet)	Sensor height (feet)	Sonar Target	Site	Corridor/ Pump-out Area
M325	3663184	223444	-M	104	95.7	18		West	Pump-out
M326	3662423	224139	-M	12	41.1	18		West	Pump-out
M327	3662487	224257	-M	10	81.1	18		West	Pump-out

[1] - Coordinates are in feet and are referenced to the Louisiana State Plane South Zone (LA-1702).

[2] - +M - positive monopole, -M - negative monopole, D - dipole.

[3] - Amplitude is measured in gammas.

SIDE SCAN SONAR TARGET SUMMARY TABLE

Target ID[1]	Easting[2]	Northing[2]	Length[3] (ft)	Width[3] (ft)	Height or Relief[4] (ft)	Acoustic Interpretation	Magnetic Correlation
Offshore East Pump-Out Area and Conveyance Corridor							
SS1	3675606	233467	20.8	3.7	0	Linear Target	
SS2	3676604	232700	7.2	2.2	0.1	Linear Target	
SS3	3676224	233065	11.1	3	0.2	Oblong Target	
SS4	3674314	234602	9	1.1	0	Linear Target	
SS5	3674363	234602	6.3	1.6	0.3	Linear Target	
SS6	3674093	234397	11.7	1.9	0.1	Oblong Target	
SS7	3674136	234388	4.3	2.1	0.1	6 Oblong Targets	
SS8	3673960	234137	14.7	7.7	0.1	2 Linear Targets	
SS9	3673595	234328	23.3	2.4	0.1	Linear Target	
SS10	3673668	234281	10	2	0.1	Linear Target	
SS11	3676407	232692	19.8	5.9	0	Oblong Target	
SS12	3673883	234206	9	2.7	0.3	Linear Target	
SS13	3673295	234542	11.3	6.3	0.3	3 Linear Targets	
SS14	3675562	233248	9.2	2.1	0	Linear Target	
SS15	3674454	233899	5.2	3.1	0	Rectangular Target	
SS16	3669893	236455	10.1	3.6	0.2	Linear Target	
SS17	3674001	234118	15.2	9.4	0	3 Linear Targets	
SS18	3670934	235914	9.1	1.2	0	Linear Target	
SS19	3669607	236842	7.9	5.6	0.1	Oblong Target 5 Linear Targets	
SS20	3671109	236065	7.6	2.4	0.2	Linear Target	
SS21	3671450	235798	13.5	7.5	0.4	Rectangular Target	M55
SS22	3673024	234964	6.5	2.1	0	Linear Target	
SS23	3673305	234929	17.9	7.4	0	3 Linear Targets	
SS24	3673556	234577	15.2	9.1	0	3 Linear Targets	
SS25	3674375	234168	8	5.1	0	Triangular Target	
SS26	3674744	233949	76.6	1.1	0	Linear Target	
SS27	3676484	232958	16.4	1.6	0	Triangular Target	
SS28	3676195	233189	14.2	1.6	0.2	Linear Target	
SS29	3675405	233667	3.8	3.3	0	Square Target	

Target ID[1]	Easting[2]	Northing[2]	Length[3] (ft)	Width[3] (ft)	Height or Relief[4] (ft)	Acoustic Interpretation	Magnetic Correlation
SS30	3674887	233996	18.2	2	0	Linear Target	
SS31	3672704	235237	8.4	43.1	0	6 Linear Targets	
SS32	3671437	235918	27.9	3.8	0	Series of Linear Targets	
SS33	3670820	236329	14	2.2	0.2	Linear Target	
SS34	3670678	236429	5.7	3.2	0	Triangular Target	
SS35	3672951	235205	8.7	1.9	0	Linear Target	
SS36	3671491	236029	33.7	8	0.2	Linear Target	
SS37	3675466	233871	85.8	1.5	0	Linear Target	
SS38	3678775	233888	11.2	2.4	0.5	Linear Target	
SS39	3677807	234016	126.9	1.1	0	Linear Target	
SS40	3679975	233332	109.6	1	0	Linear Target	
SS41	3679620	233226	7	1.1	0.3	Linear Target	
SS43	3676988	233778	57.8	1.5	0	Linear Target	
SS44	3678528	233501	7.5	0.5	0	Linear Target	M22
SS45	3678554	233473	5.6	2	0.3	Linear Target	
SS46	3680421	232797	16.2	2.6	0.4	2 Linear Targets	
SS47	3680330	232838	8.3	2.1	0	Linear Target	
SS48	3678345	233413	10.2	1.7	0	Linear Target	
SS49	3678189	233214	24.5	7.6	0	Series of Linear Targets	
SS50	3677965	233007	12.1	2.5	0.2	Linear Target	
SS51	3679537	231880	50.6	1.9	0.2	2 Linear Targets	
SS52	3678480	232218	5.8	0.8	0	Several Small Targets	M8
SS53	3678355	232458	9.2	3.4	0.2	2 Oblong Targets	
SS55	3676769	232793	7.1	2	0.5	Linear Target	
SS56	3676845	232790	6	2.6	0.3	Linear Target	
SS57	3677914	232468	8.1	1.4	0.1	2 Linear Targets	M37
SS58	3678259	232367	11.5	5.9	0.6	Oblong Target	
SS59	3678493	232267	8	2.5	0.1	Linear Target	M82
SS60	3678582	232239	8.9	1.1	0.2	2 Linear Targets	
SS61	3678989	232095	5.1	1.5	0.4	Linear Target	
SS62	3679121	232084	10	9.3	0.5	Linear Target	
SS63	3677034	232506	32.3	1.5	0.2	Linear Target	

Target ID[1]	Easting[2]	Northing[2]	Length[3] (ft)	Width[3] (ft)	Height or Relief[4] (ft)	Acoustic Interpretation	Magnetic Correlation
SS64	3679969	231628	35.1	1.5	0.2	2 Linear Targets	
SS65	3676715	232000	9.3	2.8	0.3	2 Linear Targets	
SS66	3677749	231678	8.3	1.5	0.1	Linear Target	
SS67	3679608	231086	41.4	1.9	0.2	3 Linear Targets	
SS68	3679127	231100	69.6	0.8	0	Linear Target	
SS69	3678596	231055	10.4	0.9	0	Oblong Target	M47
SS70	3679118	230973	95.1	2	0.4	Linear Target	
SS72	3679079	230966	10.5	7.9	0.3	Triangular Target	
SS73	3676676	231689	11.5	4.1	0.9	Linear Target	
SS74	3676489	231805	11.2	2.8	0	Linear Target	
SS75	3676460	231796	8.6	2	0.3	Linear Target	
SS76	3676434	231786	5.6	2	0.4	Oblong Target	
SS77	3676417	231804	5.1	1.7	0.3	Oblong Target	
SS78	3676388	231832	15.9	2.1	0.2	Linear Target	
SS80	3676451	231531	7.8	1.7	0.3	3 Linear Targets	M49
SS81	3679296	230734	12.8	2.6	0.3	Linear Target	
SS82	3678522	230969	13.1	3.6	0.3	Linear Target	
SS83	3676621	231508	8.8	2.4	0.6	Oblong Target	
SS84	3676485	231410	8.2	1.5	0.1	Linear Target	
SS85	3678186	230873	26.4	1.5	0.3	2 Linear Targets	M74
SS86	3677575	230668	3.9	1.2	0	Rectangular Target	
Offshore West Pump-Out Area and Conveyance Corridor							
SS87	3660355	225810	35.2	1	0.1	Linear Target	
SS88	3662773	224343	11.2	2.4	0.1	Linear Target	
SS89	3660330	225830	25.1	1.6	0	Linear Target	
SS90	3662851	224431	7	2.4	0.1	Linear Target	M107
SS91	3661967	225096	4.2	2.4	0.4	Triangular Target	
SS92	3663666	224211	1.8	2.2	0.2	Triangular Target	
SS93	3664011	222026	99.4	1	0.1	Linear Target-Pipe	
SS94	3664120	222152	120.7	2.1	0.3	Linear Targets-Pipe	
SS95	3664203	222131	148.1	1	0.1	Linear Target-Pipe	M174

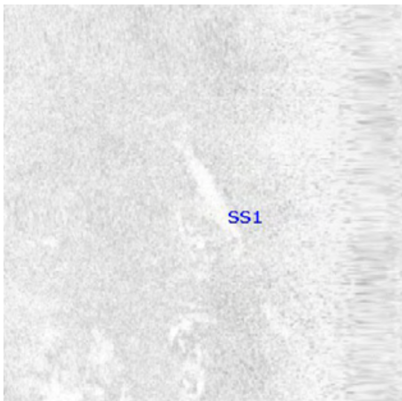
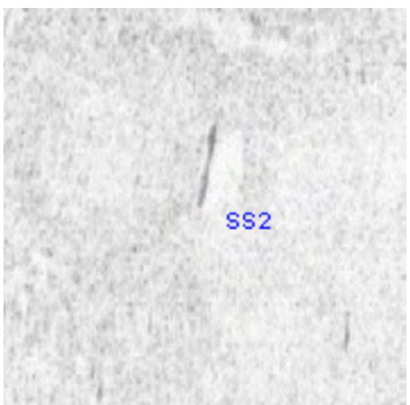
Target ID[1]	Easting[2]	Northing[2]	Length[3] (ft)	Width[3] (ft)	Height or Relief[4] (ft)	Acoustic Interpretation	Magnetic Correlation
SS96	3664336	222024	47.2	1.6	0.1	Linear Targets-3 Pipe Crossing	M303, M241
SS97	3664684	221831	77.1	0.7	0.2	Linear Target-Pipe	
SS98	3665475	221530	76	0.9	0.1	Linear Target-Pipe	M183
SS99	3665239	221824	13.7	0.7	0.1	Linear Target	
SS100	3665091	221819	87.6	1.3	0.3	Linear Target-Pipe	M185
SS101	3664947	221827	30.6	0.9	0	Linear Target-Pipe	M182
SS102	3664894	221844	51	1	0.2	Linear Target-Pipe	
SS103	3664836	221942	153.1	1.4	0.2	Linear Target-Pipe	M179, M177
SS104	3664733	222119	169.4	1.3	0.3	Linear Target-Pipe	M187
SS105	3664528	222058	112.7	1.2	0.1	2 Linear Targets-Pipes	
SS106	3664235	222301	158.7	1.4	0.1	Linear Target-Pipe	
SS107	3665125	222031	67.6	0.8	0.4	Linear Target-Pipe	M200
SS108	3664872	222124	162.3	0.9	0.1	Linear Target-Pipe	M195
SS109	3665427	221994	35.6	46.6	0	Rectangular Target-Oil Well	M297, M295, M247, M219, M219, M212, M199
SS110	3665734	222111	40.3	1.1	1	Linear Target-In Water Column	
SS111	3665789	222108	29.5	5.7	0.4	Linear Target	M220
SS112	3663895	224003	3.3	1.3	0	Rectangular Target	
SS113	3664022	223995	15.7	0.5	0	Linear Target	
SS114	3664743	223559	6.7	1.1	0	Linear Target	
SS116	3665547	223665	12.2	1.1	0.2	4 Linear Targets	
SS118	3664239	224403	27.6	6.5	0.3	Linear Target	
SS119	3664497	224410	28.8	1.3	0.2	Linear Target	
SS120	3664557	224367	5.1	2	0	Rectangular Target	M311, M269
SS121	3665958	223862	110.4	1.7	0	Linear Target-Possible Drag Mark	

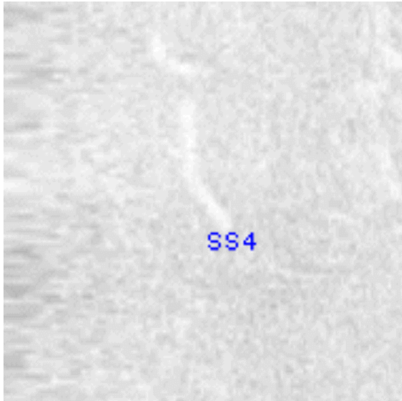
Target ID[1]	Easting[2]	Northing[2]	Length[3] (ft)	Width[3] (ft)	Height or Relief[4] (ft)	Acoustic Interpretation	Magnetic Correlation
SS122	3665148	224124	121.4	1	0.1	Linear Target-Pipe	
SS123	3665272	224204	62.5	0.9	0.2	Linear Target-Pipe	
SS125	3665490	224082	117.6	0.4	0	Linear Target-Pipe	
SS126	3666043	223890	145.8	1.1	0.1	Linear Target-Pipe	M299, M282
SS127	3666260	223735	93.9	0.6	0	Linear Target-Pipe	
SS128	3666036	223805	143.5	1.1	0	Linear Target-Pipe	
SS129	3665593	224085	89.7	0.6	0	Linear Target-Pipe	
SS130	3665341	224255	17.6	1	0.2	Linear Target	M275
SS131	3665702	224137	111.4	2.2	0	Linear Target-Possible Drag Mark	
SS132	3666125	223846	117	0.9	0.1	Linear Target-Pipe	M281
SS133	3666308	223928	84.8	1	0	Linear Target-Possible Drag Mark	
SS134	3665568	224362	91.7	2	0	Linear Target-Possible Drag Mark	
SS135	3664464	225018	8	1.4	0.2	Linear Target	
SS136	3664856	224869	21	1.5	0	Linear Target	M312, M286
SS137	3666134	224106	78.5	1.3	0	Linear Target-Possible Drag Mark	
SS138	3664992	224897	4	1.7	0.4	Oblong Target	
SS139	3662893	224064	8.1	2.8	0.4	Rectangular Target	
SS142	3663817	224136	7.5	6.1	0.3	Round Target	
SS143	3663505	224414	10.1	1.9	0	3 Linear Targets	
SS146	3664230	224403	20.5	1	0.5	Linear Target	
SS149	3663208	225518	24.1	1.8	0.2	Linear Target	
SS150	3664014	225165	17	1.8	0.3	Linear Target	
SS151	3662886	225887	6.7	4.2	0	2 Rectangular Targets	

[1]Target IDs may be non-sequential.
[2]Coordinates are referenced to the State Plane Louisiana South, NAD83, in feet.
[3]The dimensions and acoustic interpretations listed above are for the target reflections and may not be representative of the object(s) generating the reflection. Natural features could thus be man-made objects and vice versa.
[4]Relief measurements of zero means there was no visible shadow on the sonar imagery; however, there still could be minimal height associated with the target, likely less than 0.5-1 foot.

Side Scan Sonar Target Report

Offshore East Pump-Out Area and Conveyance Corridor

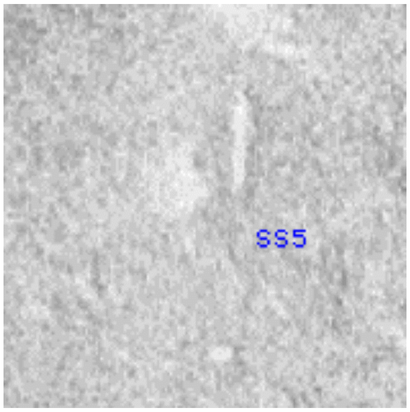
Contact Image	Contact Info	User Entered Info
	**SS1** • (X) 3675606 (Y) 233467	**Dimensions** Target Height: 0.0 US Feet Target Length: 20.8 US Feet Target Width: 3.7 US Feet Description: Linear Target
	**SS2** • (X) 3676604 (Y) 232700	**Dimensions** Target Height: 0.1 US Feet Target Length: 7.2 US Feet Target Width: 2.2 US Feet Description: Linear Target
	**SS3** • (X) 3676224 (Y) 233065	**Dimensions** Target Height: 0.2 US Feet Target Length: 11.1 US Feet Target Width: 3.0 US Feet Description: Oblong Target



SS4

- (X) 3674314 (Y) 234602

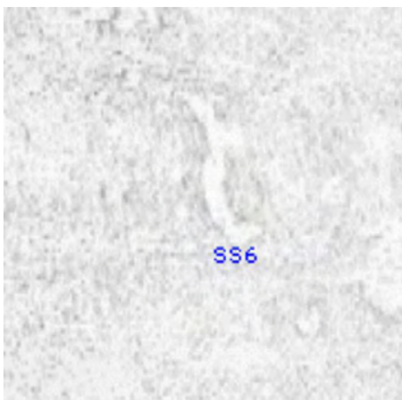
Dimensions
Target Height: 0.0 US Feet
Target Length: 9.0 US Feet
Target Width: 1.1 US Feet
Description: Linear Target



SS5

- (X) 3674363 (Y) 234602

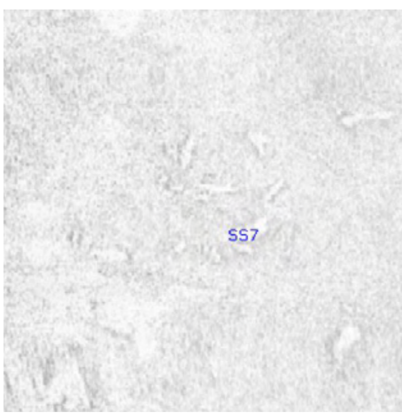
Dimensions
Target Height: 0.3 US Feet
Target Length: 6.3 US Feet
Target Width: 1.6 US Feet
Description: Linear Target



SS6

- (X) 3674093 (Y) 234397

Dimensions
Target Height: 0.1 US Feet
Target Length: 11.7 US Feet
Target Width: 1.9 US Feet
Description: Oblong Target



SS7

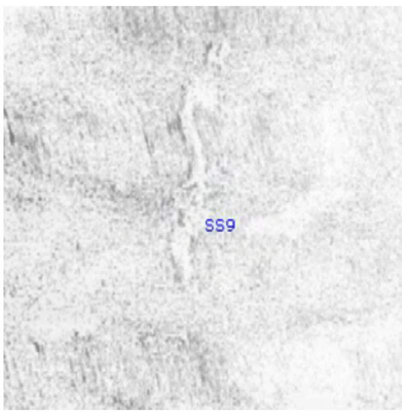
- (X) 3674136 (Y) 234388

Dimensions
Target Height: 0.1 US Feet
Target Length: 4.3 US Feet
Target Width: 2.1 US Feet
Description: 6 Oblong Targets

SS8

- (X) 3673960 (Y) 234137

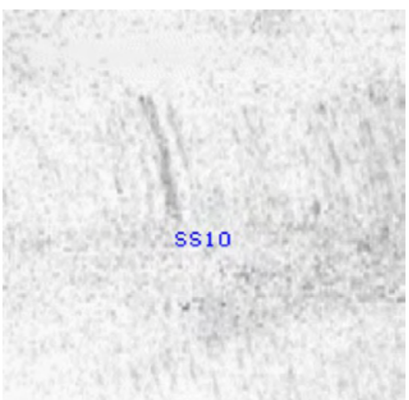
Dimensions
Target Height: 0.1 US Feet
Target Length: 14.7 US Feet
Target Width: 7.7 US Feet
Description: 2 Linear Targets



SS9

- (X) 3673595 (Y) 234328

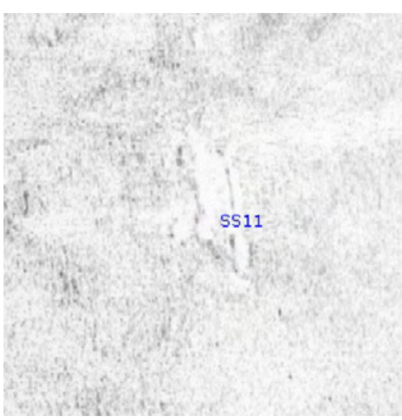
Dimensions
Target Height: 0.1 US Feet
Target Length: 23.3 US Feet
Target Width: 2.4 US Feet
Description: Linear Target



SS10

- (X) 3673668 (Y) 234281

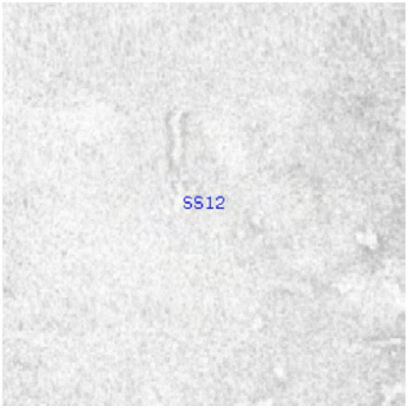
Dimensions
Target Height: 0.1 US Feet
Target Length: 10.0 US Feet
Target Width: 2.0 US Feet
Description: Linear Target



SS11

- (X) 3676407 (Y) 232692

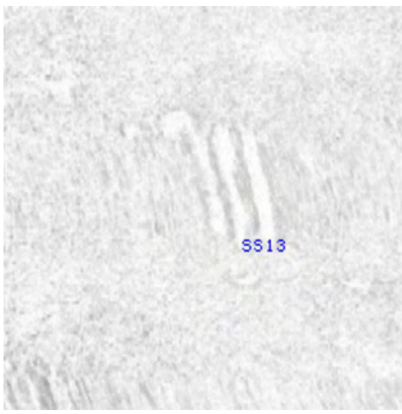
Dimensions
Target Height: 0.0 US Feet
Target Length: 19.8 US Feet
Target Width: 5.9 US Feet
Description: Oblong Target



SS12

- (X) 3673883 (Y) 234206

Dimensions
Target Height: 0.3 US Feet
Target Length: 9.0 US Feet
Target Width: 2.7 US Feet
Description: Linear Target



SS13

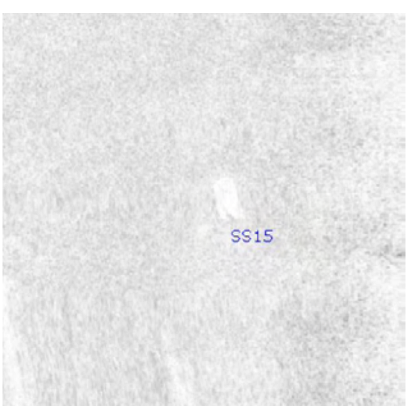
- (X) 3673295 (Y) 234542

Dimensions
Target Height: 0.3 US Feet
Target Length: 11.3 US Feet
Target Width: 6.3 US Feet
Description: 3 Linear Targets

SS14

- (X) 3675562 (Y) 233248

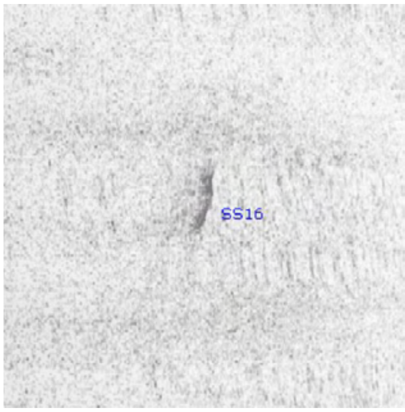
Dimensions
Target Height: 0.0 US Feet
Target Length: 9.2 US Feet
Target Width: 2.1 US Feet
Description: Linear Target



SS15

- (X) 3674454 (Y) 233899

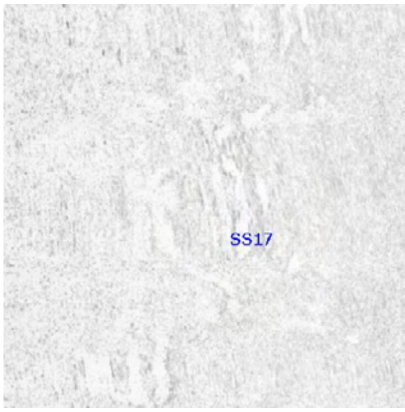
Dimensions
Target Height: 0.0 US Feet
Target Length: 5.2 US Feet
Target Width: 3.1 US Feet
Description: Rectangular Target



SS16

- (X) 3669893 (Y) 236455

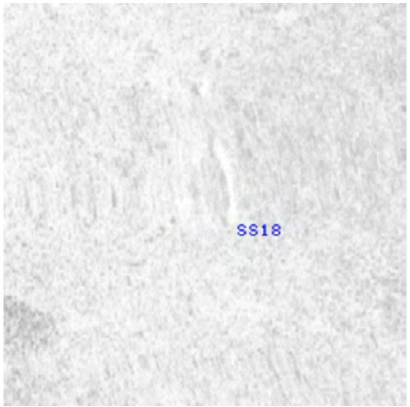
Dimensions
Target Height: 0.2 US Feet
Target Length: 10.1 US Feet
Target Width: 3.6 US Feet
Description: Linear Target



SS17

- (X) 3674001 (Y) 234118

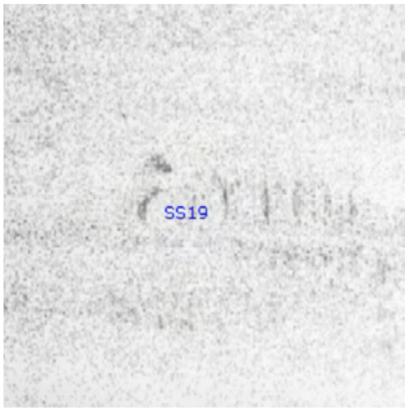
Dimensions
Target Height: 0.0 US Feet
Target Length: 15.2 US Feet
Target Width: 9.4 US Feet
Description: 3 Linear Targets



SS18

- (X) 3670934 (Y) 235914

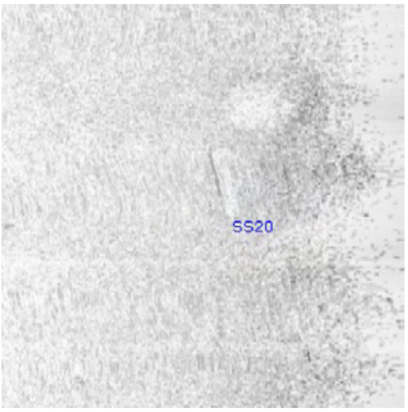
Dimensions
Target Height: 0.0 US Feet
Target Length: 9.1 US Feet
Target Width: 1.2 US Feet
Description: Linear Target



SS19

- (X) 3669607 (Y) 236842

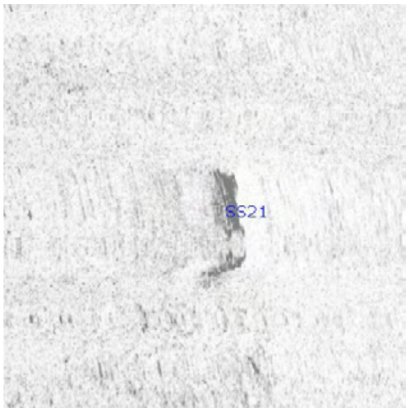
Dimensions
Target Height: 0.1 US Feet
Target Length: 7.9 US Feet
Target Width: 5.6 US Feet
Description: Oblong Target, 5 Linear Targets



SS20

- (X) 3671109 (Y) 236065

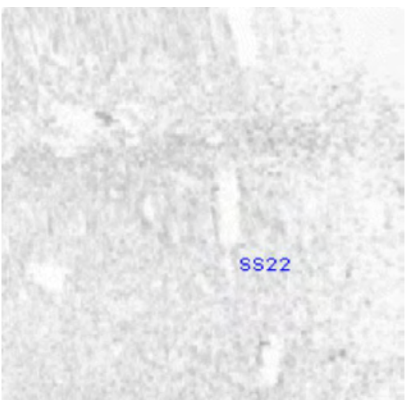
Dimensions
Target Height: 0.2 US Feet
Target Length: 7.6 US Feet
Target Width: 2.4 US Feet
Description: Linear Target



SS21

- (X) 3671450 (Y) 235798

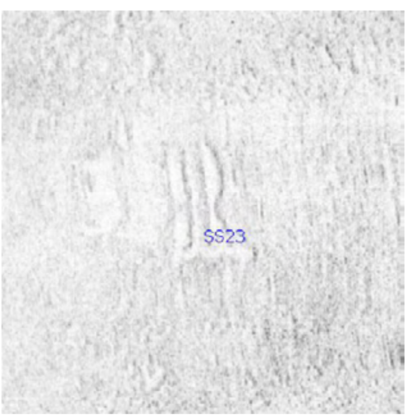
Dimensions
Target Height: 0.4 US Feet
Target Length: 13.5 US Feet
Target Width: 7.5 US Feet
Description: Rectangular Target



SS22

- (X) 3673024 (Y) 234964

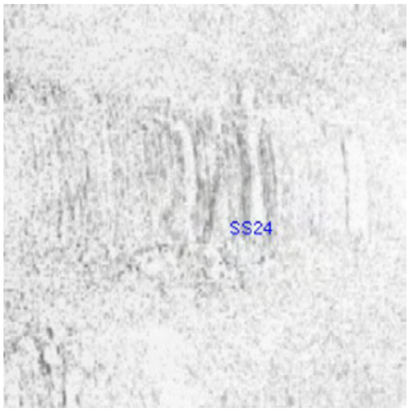
Dimensions
Target Height: 0.0 US Feet
Target Length: 6.5 US Feet
Target Width: 2.1 US Feet
Description: Linear Target



SS23

- (X) 3673305 (Y) 234929

Dimensions
Target Height: 0.0 US Feet
Target Length: 17.9 US Feet
Target Width: 7.4 US Feet
Description: 3 Linear Targets



SS24

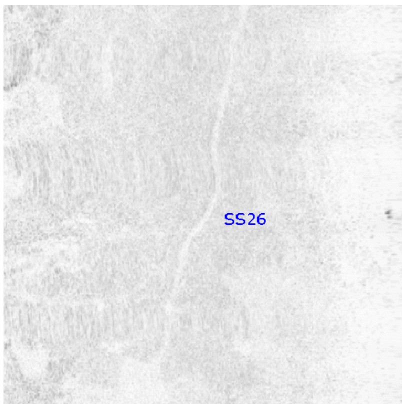
- (X) 3673556 (Y) 234577

Dimensions
Target Height: 0.0 US Feet
Target Length: 15.2 US Feet
Target Width: 9.1 US Feet
Description: 3 Linear Targets

SS25

- (X) 3674375 (Y) 234168

Dimensions
Target Height: 0.0 US Feet
Target Length: 8.0 US Feet
Target Width: 5.1 US Feet
Description: Triangular Target



SS26

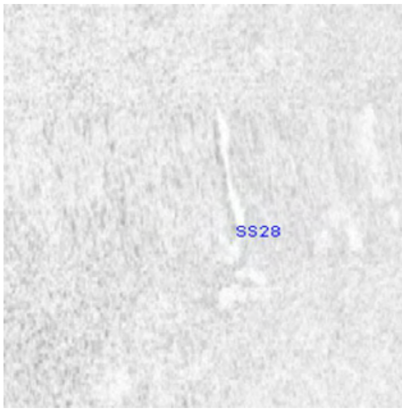
- (X) 3674744 (Y) 233949

Dimensions
Target Height: 0.0 US Feet
Target Length: 76.6 US Feet
Target Width: 1.1 US Feet
Description: Linear Target

SS27

- (X) 3676484 (Y) 232958

Dimensions
Target Height: 0.0 US Feet
Target Length: 16.4 US Feet
Target Width: 1.6 US Feet
Description: Triangular Target



SS28

- (X) 3676195 (Y) 233189

Dimensions
Target Height: 0.2 US Feet
Target Length: 14.2 US Feet
Target Width: 1.6 US Feet
Description: Linear Target

SS29

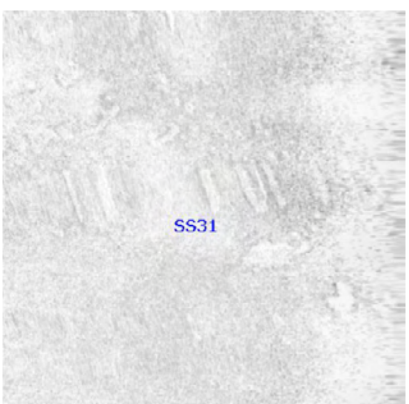
- (X) 3675405 (Y) 233667

Dimensions
Target Height: 0.0 US Feet
Target Length: 3.8 US Feet
Target Width: 3.3 US Feet
Description: Square Target

SS30

- (X) 3674887 (Y) 233996

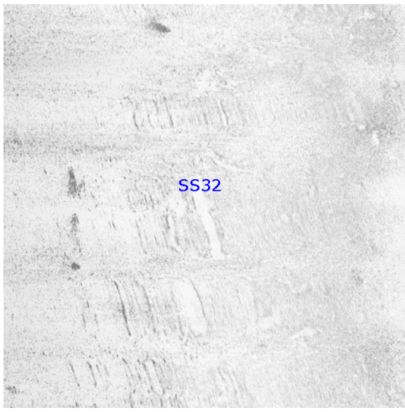
Dimensions
Target Height: 0.0 US Feet
Target Length: 18.2 US Feet
Target Width: 2.0 US Feet
Description: Linear Target



SS31

- (X) 3672704 (Y) 235237

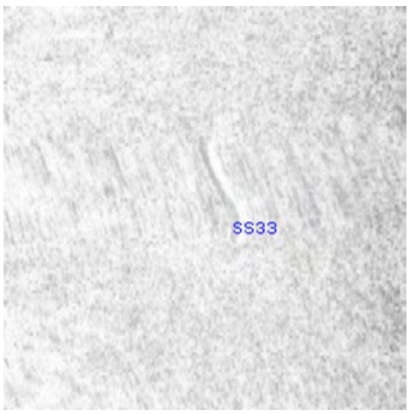
Dimensions
Target Height: 0.0 US Feet
Target Length: 8.4 US Feet
Target Width: 43.1 US Feet
Description: 6 Linear Targets



SS32

- (X) 3671437 (Y) 235918

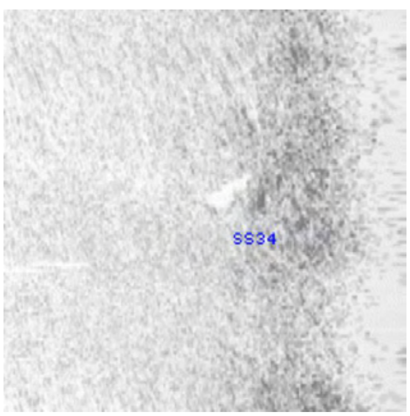
Dimensions
Target Height: 0.0 US Feet
Target Length: 27.9 US Feet
Target Width: 3.8 US Feet
Description: Series of Linear Targets



SS33

- (X) 3670820 (Y) 236329

Dimensions
Target Height: 0.2 US Feet
Target Length: 14.0 US Feet
Target Width: 2.2 US Feet
Description: Linear Target



SS34

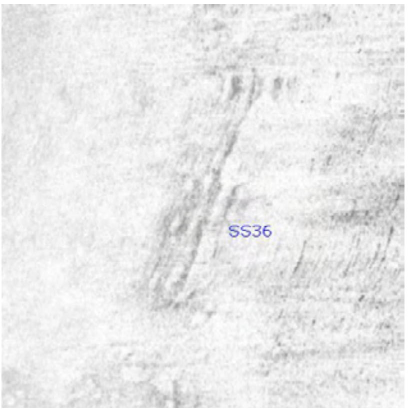
- (X) 3670678 (Y) 236429

Dimensions
Target Height: 0.0 US Feet
Target Length: 5.7 US Feet
Target Width: 3.2 US Feet
Description: Triangular Target

SS35

- (X) 3672951 (Y) 235205

Dimensions
Target Height: 0.0 US Feet
Target Length: 8.7 US Feet
Target Width: 1.9 US Feet
Description: Linear Target



SS36

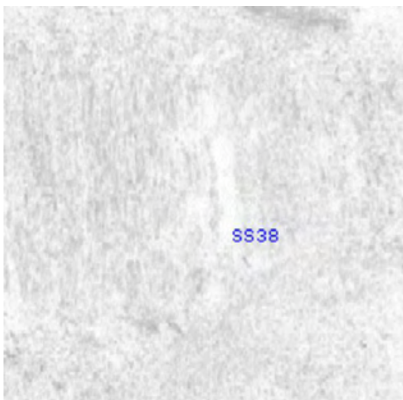
- (X) 3671491 (Y) 236029

Dimensions
Target Height: 0.2 US Feet
Target Length: 33.7 US Feet
Target Width: 8.0 US Feet
Description: Linear Target

SS37

- (X) 3675466 (Y) 233871

Dimensions
Target Height: 0.0 US Feet
Target Length: 85.8 US Feet
Target Width: 1.5 US Feet
Description: Linear Target



SS38

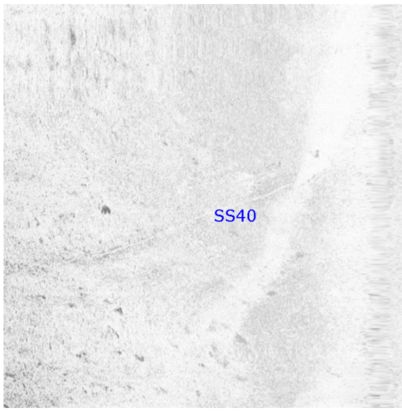
- (X) 3678775 (Y) 233888

Dimensions
Target Height: 0.5 US Feet
Target Length: 11.2 US Feet
Target Width: 2.4 US Feet
Description: Linear Target

SS39

- (X) 3677807 (Y) 234016

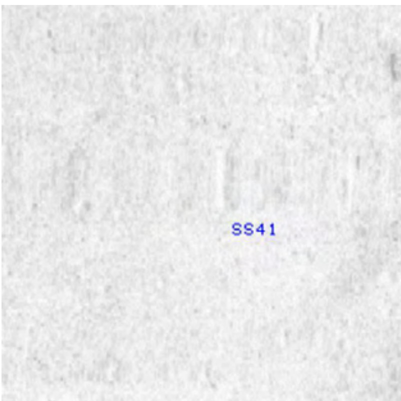
Dimensions
Target Height: 0.0 US Feet
Target Length: 126.9 US Feet
Target Width: 1.1 US Feet
Description: Linear Target



SS40

- (X) 3679975 (Y) 233332

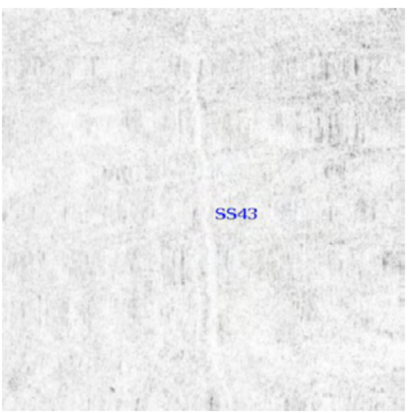
Dimensions
Target Height: 0.0 US Feet
Target Length: 109.6 US Feet
Target Width: 1.0 US Feet
Description: Linear Target



SS41

- (X) 367962 (Y) 233226

Dimensions
Target Height: 0.3 US Feet
Target Length: 7.0 US Feet
Target Width: 1.1 US Feet
Description: Linear Target



SS43

- (X) 3676988 (Y) 233778

Dimensions
Target Height: 0.0 US Feet
Target Length: 57.8 US Feet
Target Width: 1.5 US Feet
Description: Linear Target

SS44

- (X) 3678528 (Y) 233501

Dimensions
Target Height: 0.0 US Feet
Target Length: 7.5 US Feet
Target Width: 0.5 US Feet
Description: Linear Target

SS45

- (X) 3678554 (Y) 233473

Dimensions
Target Height: 0.3 US Feet
Target Length: 5.6 US Feet
Target Width: 2.0 US Feet
Description: Linear Target

SS46

- (X) 3680421 (Y) 232797

Dimensions
Target Height: 0.4 US Feet
Target Length: 16.2 US Feet
Target Width: 2.6 US Feet
Description: 2 Linear Targets

SS47

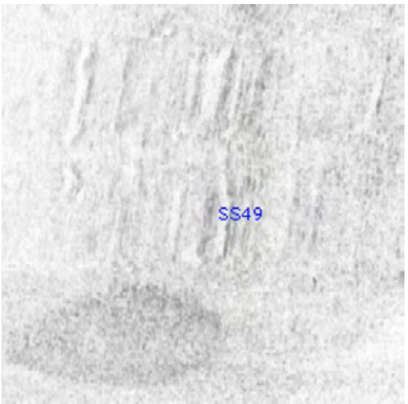
- (X) 3680330 (Y) 232838

Dimensions
Target Height: 0.0 US Feet
Target Length: 8.3 US Feet
Target Width: 2.1 US Feet
Description: Linear Target

SS48

- (X) 3678345 (Y) 233413

Dimensions
Target Height: 0.0 US Feet
Target Length: 10.2 US Feet
Target Width: 1.7 US Feet
Description: Linear Target



SS49

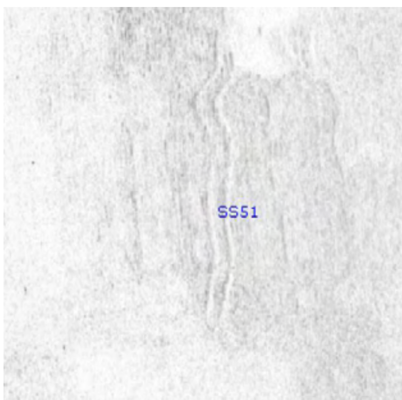
- (X) 3678189 (Y) 233214

Dimensions
Target Height: 0.0 US Feet
Target Length: 24.5 US Feet
Target Width: 7.6 US Feet
Description: Series of Linear Targets

SS50

- (X) 3677965 (Y) 233007

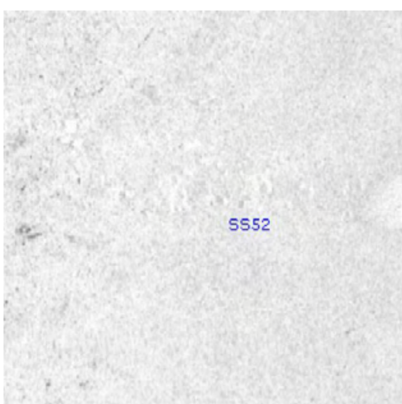
Dimensions
Target Height: 0.2 US Feet
Target Length: 12.1 US Feet
Target Width: 2.5 US Feet
Description: Linear Target



SS51

- (X) 3679537 (Y) 231880

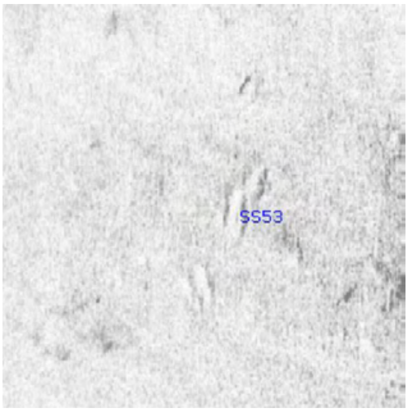
Dimensions
Target Height: 0.2 US Feet
Target Length: 50.6 US Feet
Target Width: 1.9 US Feet
Description: 2 Linear Targets



SS52

- (X) 3678480 (Y) 232218

Dimensions
Target Height: 0.0 US Feet
Target Length: 5.8 US Feet
Target Width: 0.8 US Feet
Description: Several Small Targets



SS53

- (X) 3678355 (Y) 232458

Dimensions
Target Height: 0.2 US Feet
Target Length: 9.2 US Feet
Target Width: 3.4 US Feet
Description: 2 Oblong Targets

SS55

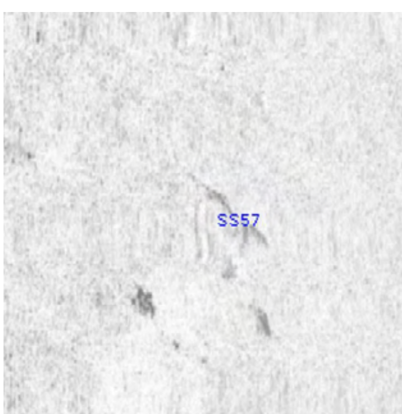
- (X) 3676769 (Y) 232793

Dimensions
Target Height: 0.5 US Feet
Target Length: 7.1 US Feet
Target Width: 2.0 US Feet
Description: Linear Target

SS56

- (X) 3676845 (Y) 232790

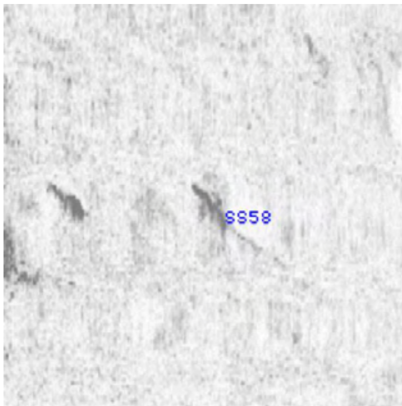
Dimensions
Target Height: 0.3 US Feet
Target Length: 6.0 US Feet
Target Width: 2.6 US Feet
Description: Linear Target



SS57

- (X) 3677914 (Y) 232468

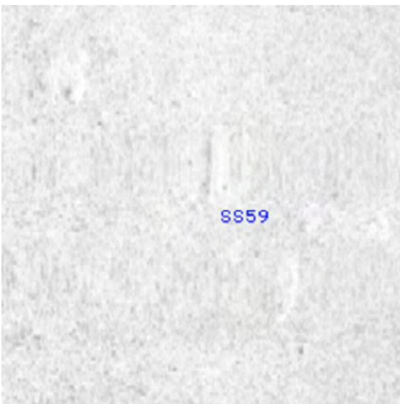
Dimensions
Target Height: 0.1 US Feet
Target Length: 8.1 US Feet
Target Width: 1.4 US Feet
Description: 2 Linear Targets



SS58

- (X) 3678259 (Y) 232367

Dimensions
Target Height: 0.6 US Feet
Target Length: 11.5 US Feet
Target Width: 5.9 US Feet
Description: Oblong Target



SS59

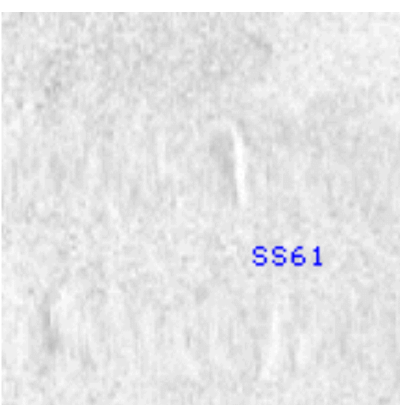
- (X) 3678493 (Y) 232267

Dimensions
Target Height: 0.1 US Feet
Target Length: 8.0 US Feet
Target Width: 2.5 US Feet
Description: Linear Target

SS60

- (X) 3678582 (Y) 232239

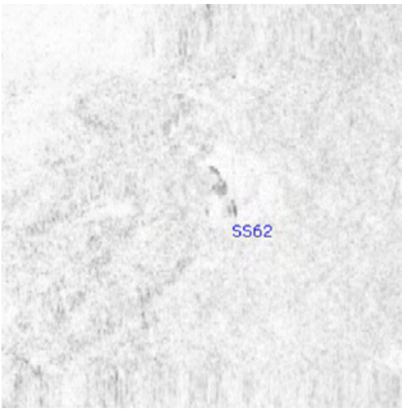
Dimensions
Target Height: 0.2 US Feet
Target Length: 8.9 US Feet
Target Width: 1.1 US Feet
Description: 2 Linear Targets



SS61

- (X) 3678989 (Y) 232095

Dimensions
Target Height: 0.4 US Feet
Target Length: 5.1 US Feet
Target Width: 1.5 US Feet
Description: Linear Target



SS62

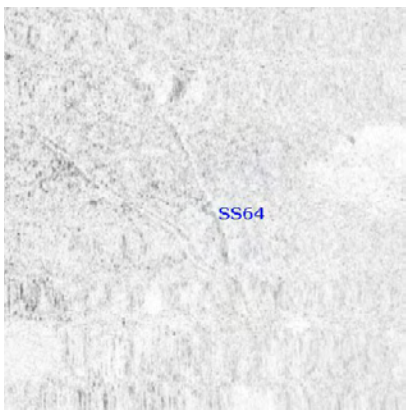
- (X) 3679121 (Y) 232084

Dimensions
Target Height: 0.5 US Feet
Target Length: 10.0 US Feet
Target Width: 9.3 US Feet
Description: Linear Target

SS63

- (X) 3677034 (Y) 232506

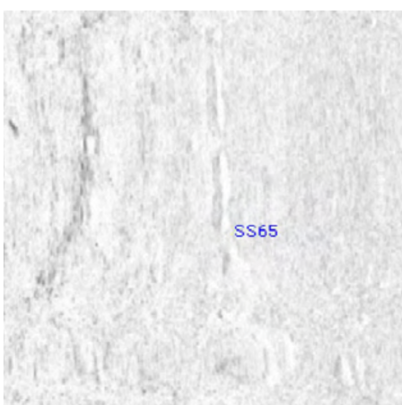
Dimensions
Target Height: 0.2 US Feet
Target Length: 32.3 US Feet
Target Width: 1.5 US Feet
Description: Linear Target



SS64

- (X) 3679969 (Y) 231628

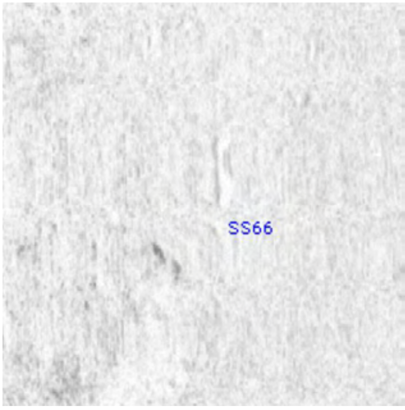
Dimensions
Target Height: 0.2 US Feet
Target Length: 35.1 US Feet
Target Width: 1.5 US Feet
Description: 2 Linear Targets



SS65

- (X) 3676715 (Y) 232000

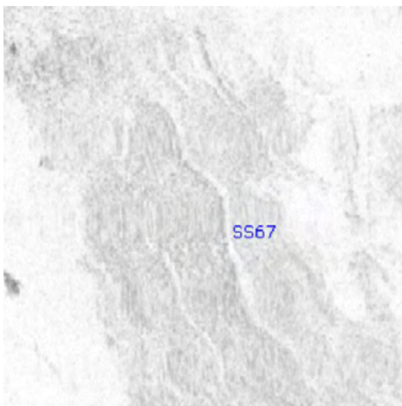
Dimensions
Target Height: 0.3 US Feet
Target Length: 9.3 US Feet
Target Width: 2.8 US Feet
Description: 2 Linear Targets



SS66

- (X) 3677749 (Y) 231678

Dimensions
Target Height: 0.1 US Feet
Target Length: 8.3 US Feet
Target Width: 1.5 US Feet
Description: Linear Target



SS67

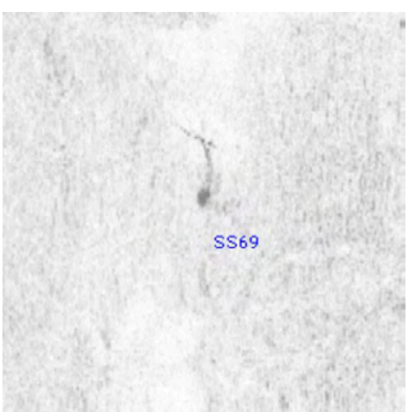
- (X) 3679608 (Y) 231086

Dimensions
Target Height: 0.2 US Feet
Target Length: 41.4 US Feet
Target Width: 1.9 US Feet
Description: 3 Linear Targets

SS68

- (X) 3679127 (Y) 231100

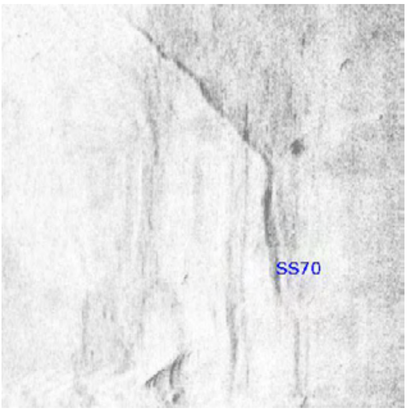
Dimensions
Target Height: 0.0 US Feet
Target Length: 69.6 US Feet
Target Width: 0.8 US Feet
Description: Linear Target



SS69

- (X) 3678596 (Y) 231055

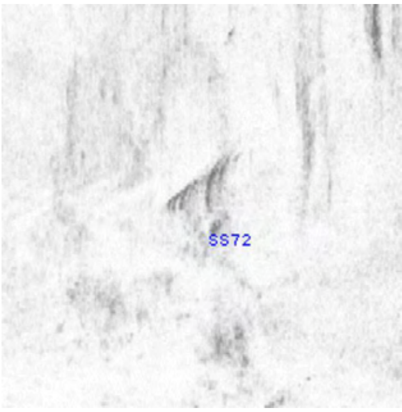
Dimensions
Target Height: 0.0 US Feet
Target Length: 10.4 US Feet
Target Width: 0.9 US Feet
Description: Oblong Target



SS70

- (X) 3679118 (Y) 230973

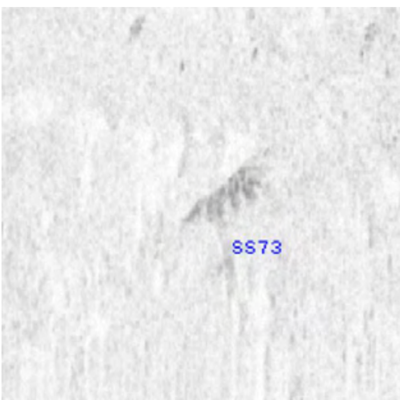
Dimensions
Target Height: 0.4 US Feet
Target Length: 95.1 US Feet
Target Width: 2.0 US Feet
Description: Linear Target



SS72

- (X) 3679079 (Y) 230966

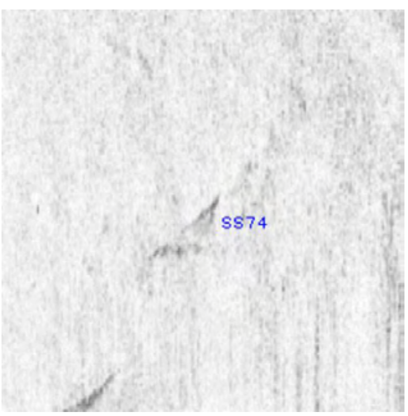
Dimensions
Target Height: 0.3 US Feet
Target Length: 10.5 US Feet
Target Width: 7.9 US Feet
Description: Triangular Target



SS73

- (X) 3676676 (Y) 231689

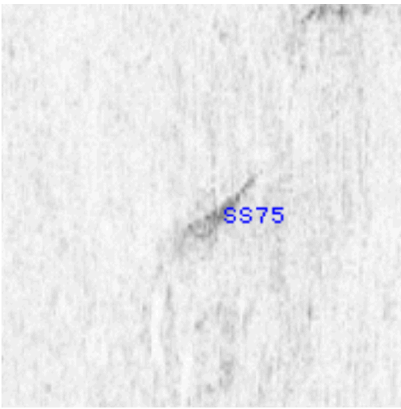
Dimensions
Target Height: 0.9 US Feet
Target Length: 11.5 US Feet
Target Width: 4.1 US Feet
Description: Linear Target



SS74

- (X) 3676489 (Y) 231805

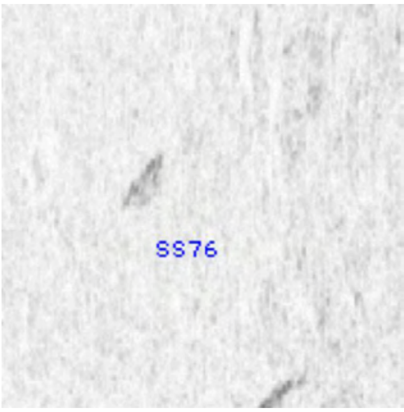
Dimensions
Target Height: 0.0 US Feet
Target Length: 11.2 US Feet
Target Width: 2.8 US Feet
Description: Linear Target



SS75

- (X) 3676460 (Y) 231796

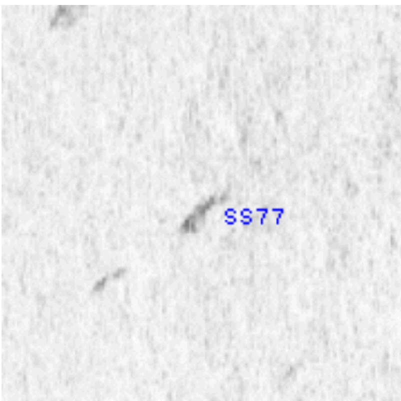
Dimensions
Target Height: 0.3 US Feet
Target Length: 8.6 US Feet
Target Width: 2.0 US Feet
Description: Linear Target



SS76

- (X) 3676434 (Y) 231786

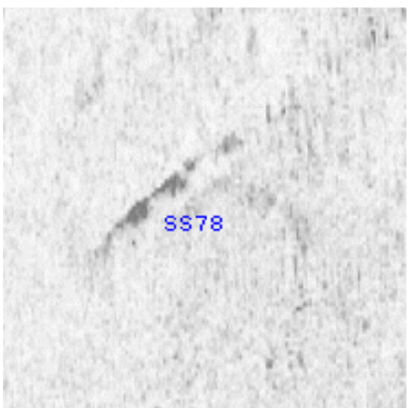
Dimensions
Target Height: 0.4 US Feet
Target Length: 5.6 US Feet
Target Width: 2.0 US Feet
Description: Oblong Target



SS77

- (X) 3676417 (Y) 231804

Dimensions
Target Height: 0.3 US Feet
Target Length: 5.1 US Feet
Target Width: 1.7 US Feet
Description: Oblong Target



SS78

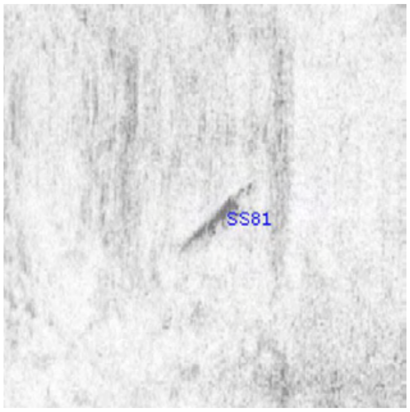
- (X) 3676388 (Y) 231832

Dimensions
Target Height: 0.2 US Feet
Target Length: 15.9 US Feet
Target Width: 2.1 US Feet
Description: Linear Target

SS80

- (X) 3676451 (Y) 231531

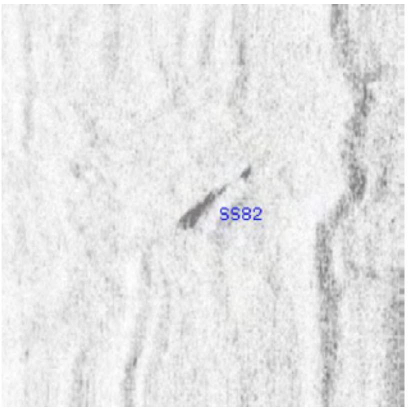
Dimensions
Target Height: 0.3 US Feet
Target Length: 7.8 US Feet
Target Width: 1.7 US Feet
Description: 3 Linear Targets



SS81

- (X) 3679296 (Y) 230734

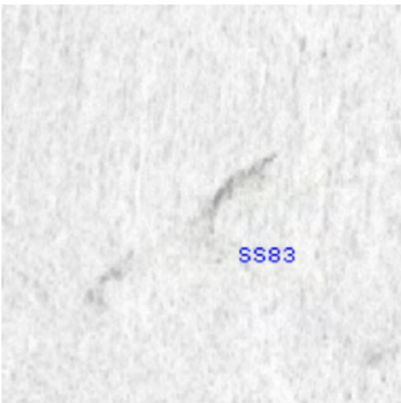
Dimensions
Target Height: 0.3 US Feet
Target Length: 12.8 US Feet
Target Width: 2.6 US Feet
Description: Linear Target



SS82

- (X) 3678522 (Y) 230969

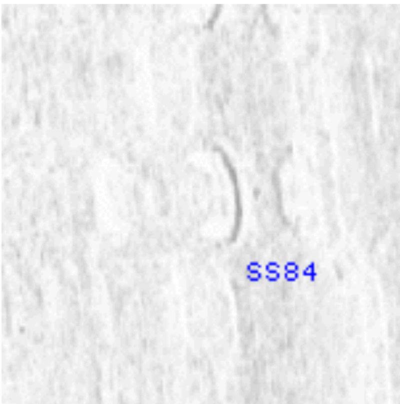
Dimensions
Target Height: 0.3 US Feet
Target Length: 13.1 US Feet
Target Width: 3.6 US Feet
Description: Linear Target



SS83

- (X) 3676621 (Y) 231508

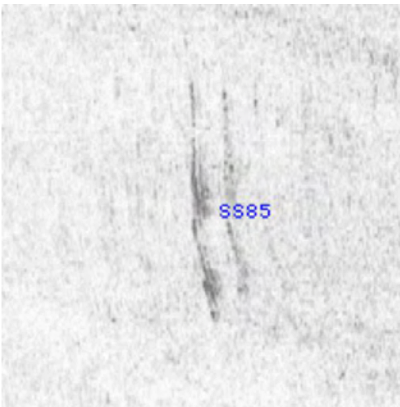
Dimensions
Target Height: 0.6 US Feet
Target Length: 8.8 US Feet
Target Width: 2.4 US Feet
Description: Oblong Target



SS84

- (X) 3676485 (Y) 231410

Dimensions
Target Height: 0.1 US Feet
Target Length: 8.2 US Feet
Target Width: 1.5 US Feet
Description: Linear Target

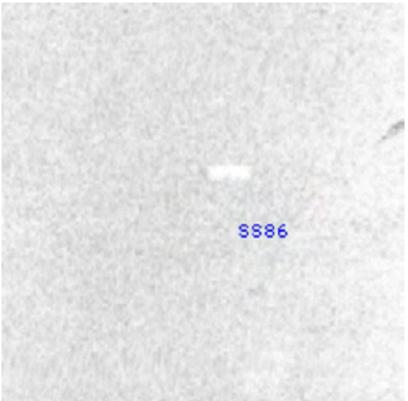


SS85

- (X) 3678186 (Y) 230873

Dimensions
Target Height: 0.3 US Feet
Target Length: 26.4 US Feet
Target Width: 1.5 US Feet
Description: 2 Linear Targets

Offshore West Pump-Out Area and Conveyance Corridor



SS86

- (X) 3677575 (Y) 230668

Dimensions
Target Height: 0.0 US Feet
Target Length: 3.9 US Feet
Target Width: 1.2 US Feet
Description: Rectangular Target

SS87

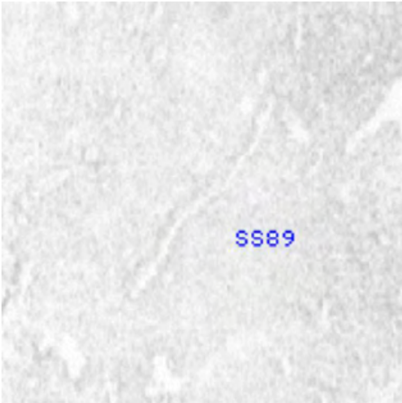
- (X) 3660355 (Y) 225810

Dimensions
Target Height: 0.1 US Feet
Target Length: 35.2 US Feet
Target Width: 1.0 US Feet
Description: Linear Target

SS88

- (X) 3662773 (Y) 224343

Dimensions
Target Height: 0.1 US Feet
Target Length: 11.2 US Feet
Target Width: 2.4 US Feet
Description: Linear Target



SS89

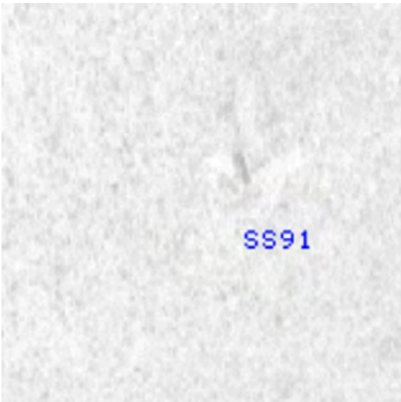
- (X) 3660330 (Y) 225830

Dimensions
Target Height: 0.0 US Feet
Target Length: 25.1 US Feet
Target Width: 1.6 US Feet
Description: Linear Target

SS90

- (X) 3662851 (Y) 224431

Dimensions
Target Height: 0.1 US Feet
Target Length: 7.0 US Feet
Target Width: 2.4 US Feet
Description: Linear Target



SS91

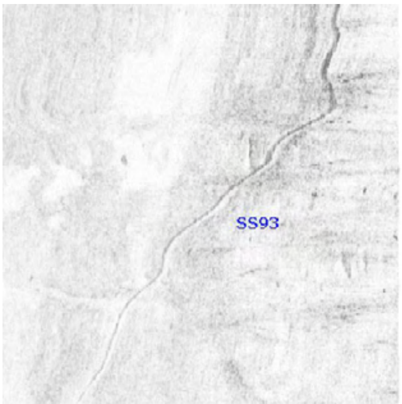
- (X) 3661967 (Y) 225096

Dimensions
Target Height: = 0.4 US Feet
Target Length: 4.2 US Feet
Target Width: 2.4 US Feet
Description: Triangular Target

SS92

- (X) 3663666 (Y) 224211

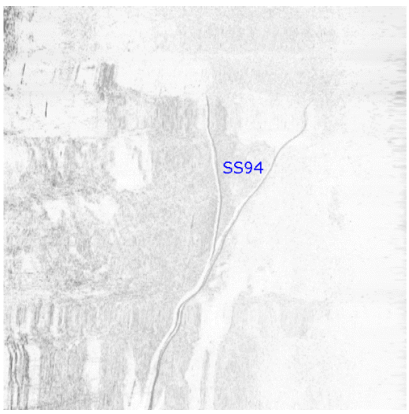
Dimensions
Target Height: 0.2 US Feet
Target Length: 1.8 US Feet
Target Width: 2.2 US Feet
Description: Triangular Target



SS93

- (X) 3664011 (Y) 222026

Dimensions
Target Height: 0.1 US Feet
Target Length: 99.4 US Feet
Target Width: 1.0 US Feet
Description: Linear Target-Pipe



SS94

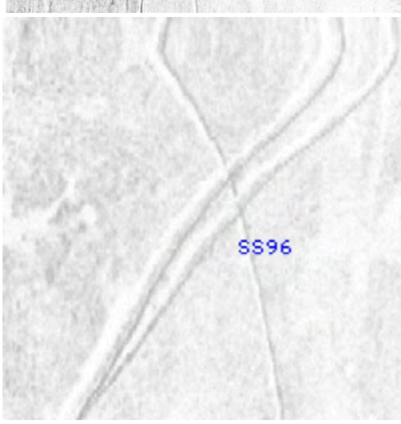
- (X) 3664120 (Y) 222152

Dimensions
Target Height: 0.3 US Feet
Target Length: 120.7 US Feet
Target Width: 2.1 US Feet
Description: Linear Targets-Pipe

SS95

- (X) 3664203 (Y) 222131

Dimensions
Target Height: 0.1 US Feet
Target Length: 148.1 US Feet
Target Width: 1.0 US Feet
Description: Linear Target-Pipe



SS96

- (X) 3664336 (Y) 222024

Dimensions
Target Height: 0.1 US Feet
Target Length: 47.2 US Feet
Target Width: 1.6 US Feet
Description: Linear Targets-3
Pipe Crossing

SS97

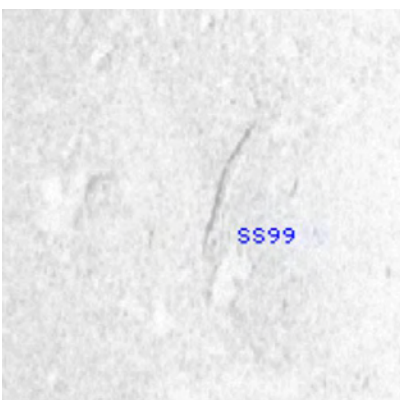
- (X) 3664684 (Y) 221831

Dimensions
Target Height: 0.2 US Feet
Target Length: 77.1 US Feet
Target Width: 0.7 US Feet
Description: Linear Target-Pipe

SS98

- (X) 3665475 (Y) 221530

Dimensions
Target Height: 0.1 US Feet
Target Length: 76.0 US Feet
Target Width: 0.9 US Feet
Description: Linear Target-Pipe



SS99

- (X) 3665239 (Y) 221824

Dimensions
Target Height: 0.1 US Feet
Target Length: 13.7 US Feet
Target Width: 0.7 US Feet
Description: Linear Target

SS100

- (X) 3665091 (Y) 221819

Dimensions
Target Height: 0.3 US Feet
Target Length: 87.6 US Feet
Target Width: 1.3 US Feet
Description: Linear Target-Pipe

SS101

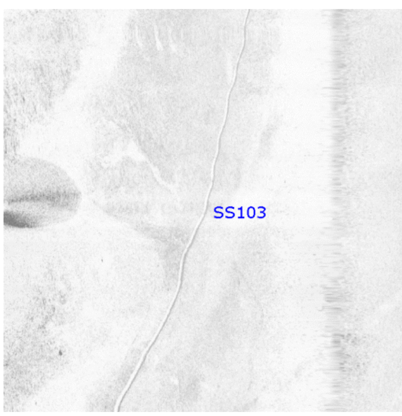
- (X) 3664947 (Y) 221827

Dimensions
Target Height: 0.0 US Feet
Target Length: 30.6 US Feet
Target Width: 0.9 US Feet
Description: Linear Target-Pipe

SS102

- (X) 3664894 (Y) 221844

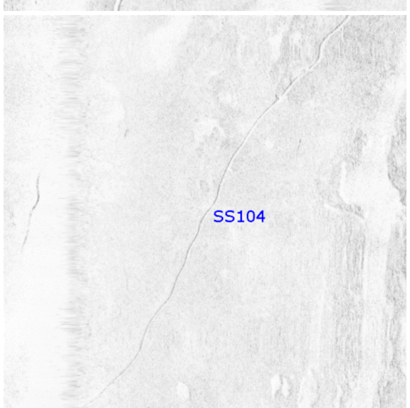
Dimensions
Target Height: 0.2 US Feet
Target Length: 51.0 US Feet
Target Width: 1.0 US Feet
Description: Linear Target-Pipe



SS103

- (X) 3664836 (Y) 221942

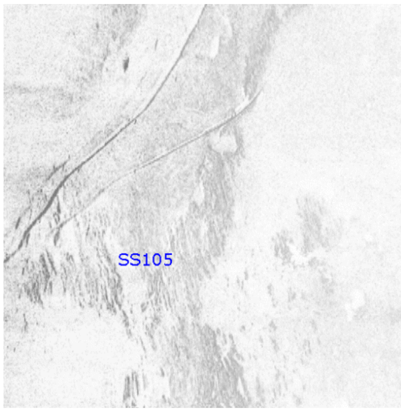
Dimensions
Target Height: 0.2 US Feet
Target Length: 153.1 US Feet
Target Width: 1.4 US Feet
Description: Linear Target-Pipe



SS104

- (X) 3664733 (Y) 222119

Dimensions
Target Height: 0.3 US Feet
Target Length: 169.4 US Feet
Target Width: 1.3 US Feet
Description: Linear Target-Pipe



SS105

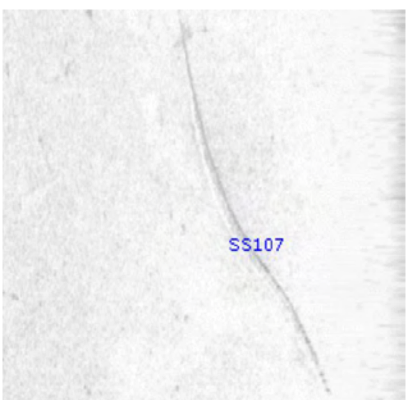
- (X) 3664528 (Y) 222058

Dimensions
Target Height: 0.1 US Feet
Target Length: 112.7 US Feet
Target Width: 1.2 US Feet
Description: 2 Linear Targets-Pipes

SS106

- (X) 3664235 (Y) 222301

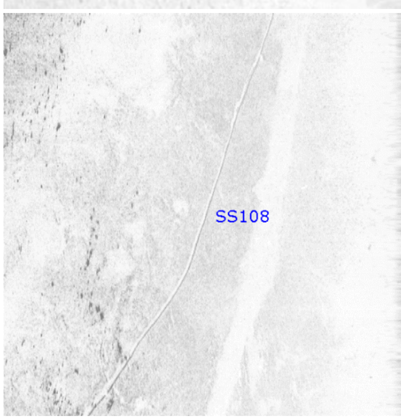
Dimensions
Target Height: 0.1 US Feet
Target Length: 158.7 US Feet
Target Width: 1.4 US Feet
Description: Linear Target-Pipe



SS107

- (X) 3665125 (Y) 222031

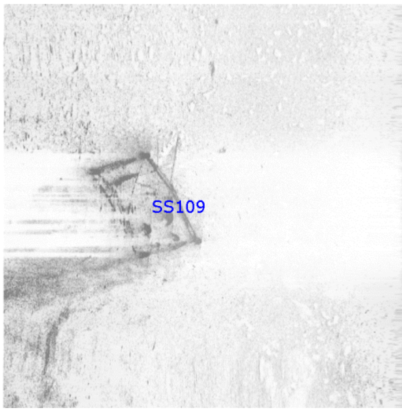
Dimensions
Target Height: 0.4 US Feet
Target Length: 67.6 US Feet
Target Width: 0.8 US Feet
Description: Linear Target-Pipe



SS108

- (X) 3664872 (Y) 222124

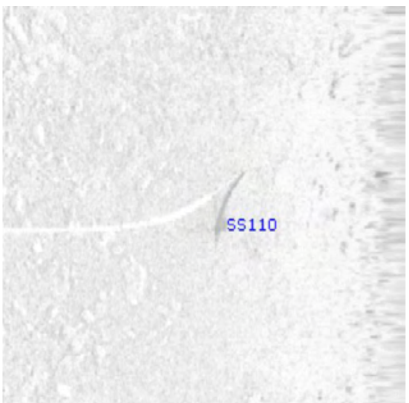
Dimensions
Target Height: 0.1 US Feet
Target Length: 162.3 US Feet
Target Width: 0.9 US Feet
Description: Linear Target-Pipe



SS109

- (X) 3665427 (Y) 221994

Dimensions
Target Height: 0.0 US Feet
Target Length: 35.6 US Feet
Target Width: 46.6 US Feet
Description: Rectangular Target-Oil Well



SS110

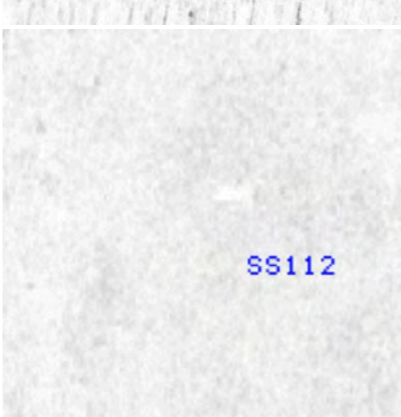
- (X) 3665734 (Y) 222111

Dimensions
Target Height: 1.0 US Feet
Target Length: 40.3 US Feet
Target Width: 1.1 US Feet
Description: Linear Target-In Water Column

SS111

- (X) 3665789 (Y) 222108

Dimensions
Target Height: 0.4 US Feet
Target Length: 29.5 US Feet
Target Width: 5.7 US Feet
Description: Linear Target



SS112

- (X) 3663895 (Y) 224003

Dimensions
Target Height: 0.0 US Feet
Target Length: 3.3 US Feet
Target Width: 1.3 US Feet
Description: Rectangular Target

SS113

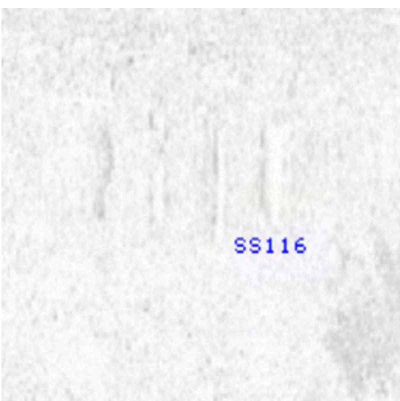
- (X) 3664022 (Y) 223995

Dimensions
Target Height: 0.0 US Feet
Target Length: 15.7 US Feet
Target Width: 0.5 US Feet
Description: Linear Target

SS114

- (X) 3664743 (Y) 223559

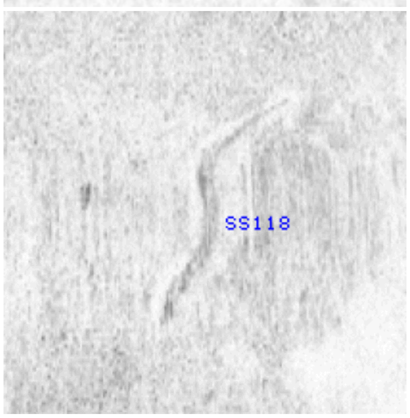
Dimensions
Target Height: 0.0 US Feet
Target Length: 6.7 US Feet
Target Width: 1.1 US Feet
Description: Linear Target



SS116

- (X) 3665547 (Y) 223665

Dimensions
Target Height: 0.2 US Feet
Target Length: 12.2 US Feet
Target Width: 1.1 US Feet
Description: 4 Linear Targets



SS118

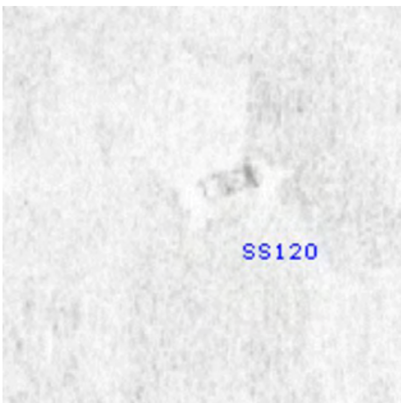
- (X) 3664239 (Y) 224403

Dimensions
Target Height: 0.3 US Feet
Target Length: 27.6 US Feet
Target Width: 6.5 US Feet
Description: Linear Target

SS119

- (X) 3664497 (Y) 224410

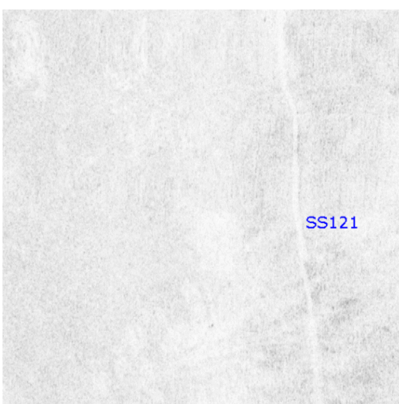
Dimensions
Target Height: 0.2 US Feet
Target Length: 28.8 US Feet
Target Width: 1.3 US Feet
Description: Linear Target



SS120

- (X) 3664557 (Y) 224367

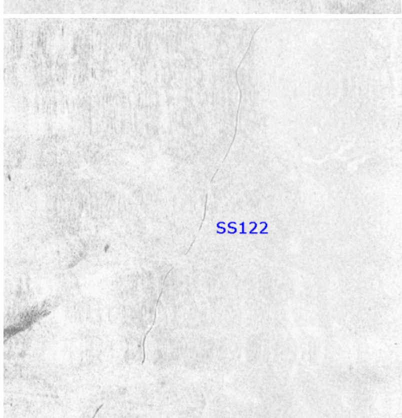
Dimensions
Target Height: 0.0 US Feet
Target Length: 5.1 US Feet
Target Width: 2.0 US Feet
Description: Rectangular Target



SS121

- (X) 3665958 (Y) 223862

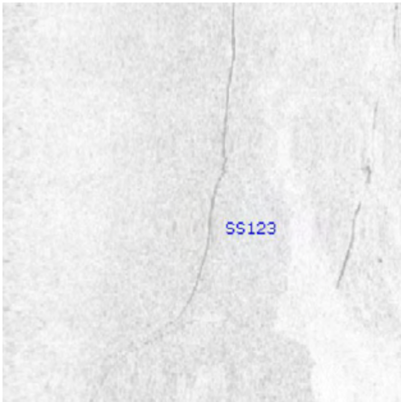
Dimensions
Target Height: 0.0 US Feet
Target Length: 110.4 US Feet
Target Width: 1.7 US Feet
Description: Linear Target-
Possible Drag Mark



SS122

- (X) 3665148 (Y) 224124

Dimensions
Target Height: 0.1 US Feet
Target Length: 121.4 US Feet
Target Width: 1.0 US Feet
Description: Linear Target-Pipe



SS123

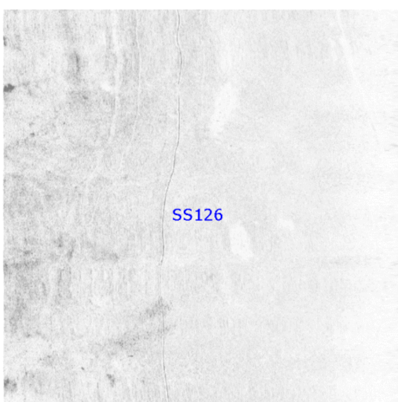
- (X) 3665272 (Y) 224204

Dimensions
Target Height: 0.2 US Feet
Target Length: 62.5 US Feet
Target Width: 0.9 US Feet
Description: Linear Target-Pipe

SS125

- (X) 3665490 (Y) 224082

Dimensions
Target Height: 0.0 US Feet
Target Length: 117.6 US Feet
Target Width: 0.4 US Feet
Description: Linear Target-Pipe



SS126

- (X) 3666043 (Y) 223890

Dimensions
Target Height: 0.1 US Feet
Target Length: 145.8 US Feet
Target Width: 1.1 US Feet
Description: Linear Target-Pipe

SS127

- (X) 3666260 (Y) 223735

Dimensions
Target Height: 0.0 US Feet
Target Length: 93.9 US Feet
Target Width: 0.6 US Feet
Description: Linear Target-Pipe

SS128

- (X) 3666036 (Y) 223805

Dimensions
Target Height: 0.0 US Feet
Target Length: 143.5 US Feet
Target Width: 1.1 US Feet
Description: Linear Target-Pipe

SS129

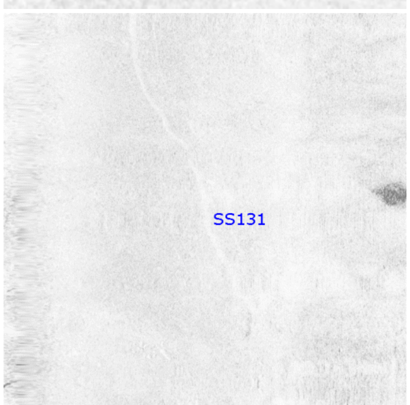
- (X) 3665593 (Y) 224085

Dimensions
Target Height: 0.0 US Feet
Target Length: 89.7 US Feet
Target Width: 0.6 US Feet
Description: Linear Target-Pipe

SS130

- (X) 3665341 (Y) 224255

Dimensions
Target Height: 0.2 US Feet
Target Length: 17.6 US Feet
Target Width: 1.0 US Feet
Description: Linear Target



SS131

- (X) 3665702 (Y) 224137

Dimensions
Target Height: 0.0 US Feet
Target Length: 111.4 US Feet
Target Width: 2.2 US Feet
Description: Linear Target-Possible Drag Mark

SS132

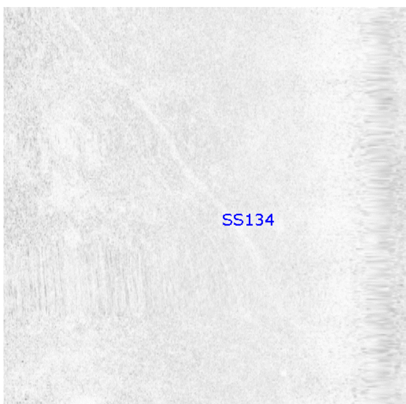
- (X) 3666125 (Y) 223846

Dimensions
Target Height: 0.1 US Feet
Target Length: 117.0 US Feet
Target Width: 0.9 US Feet
Description: Linear Target-Pipe

SS133

- (X) 3666308 (Y) 223928

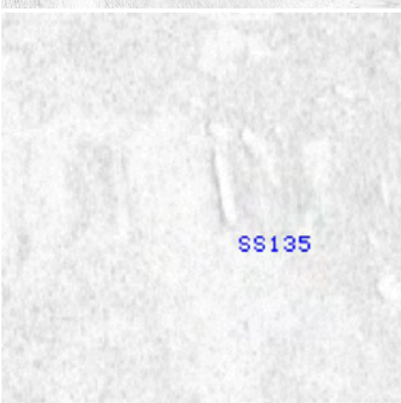
Dimensions
Target Height: 0.0 US Feet
Target Length: 84.8 US Feet
Target Width: 1.0 US Feet
Description: Linear Target-Possible Drag Mark



SS134

- (X) 3665568 (Y) 224362

Dimensions
Target Height: 0.0 US Feet
Target Length: 91.7 US Feet
Target Width: 2.0 US Feet
Description: Linear Target-Possible Drag Mark



SS135

- (X) 3664464 (Y) 225018

Dimensions
Target Height: 0.2 US Feet
Target Length: 8.0 US Feet
Target Width: 1.4 US Feet
Description: Linear Target

SS136

- (X) 3664856 (Y) 224869

Dimensions
Target Height: 0.0 US Feet
Target Length: 21.0 US Feet
Target Width: 1.5 US Feet
Description: Linear Target

SS137

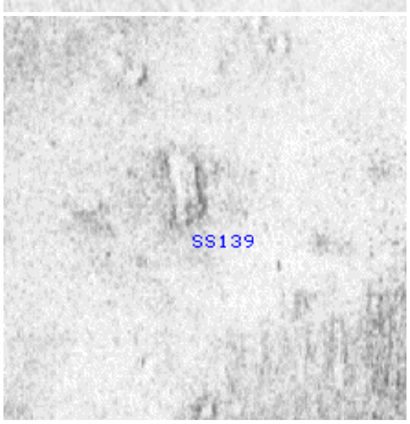
- (X) 3666134 (Y) 224106

Dimensions
Target Height: 0.0 US Feet
Target Length: 78.5 US Feet
Target Width: 1.3 US Feet
Description: Linear Target-Possible Drag Mark

SS138

- (X) 3664992 (Y) 224897

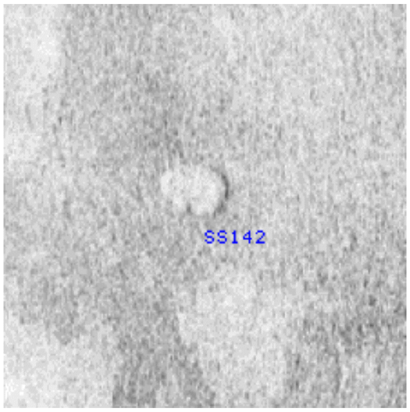
Dimensions
Target Height: 0.4 US Feet
Target Length: 4.0 US Feet
Target Width: 1.7 US Feet
Description: Oblong Target



SS139

- (X) 3662893 (Y) 224064

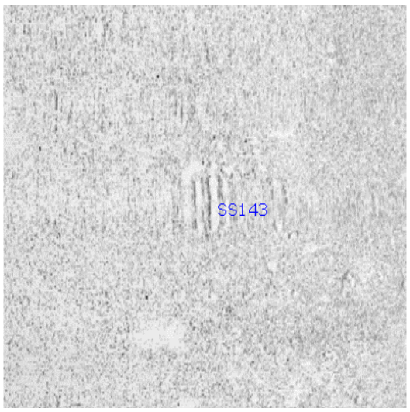
Dimensions
Target Height: 0.4 US Feet
Target Length: 8.1 US Feet
Target Width: 2.8 US Feet
Description: Rectangular Target



SS142

- (X) 3663817 (Y) 224136

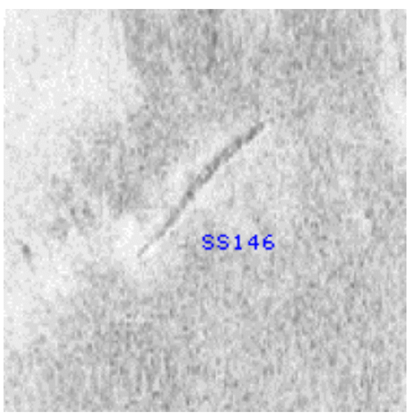
Dimensions
Target Height: 0.3 US Feet
Target Length: 7.5 US Feet
Target Width: 6.1 US Feet
Description: Round Target



SS143

- (X) 3663505 (Y) 224414

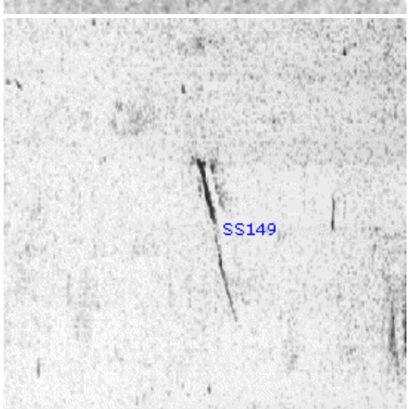
Dimensions
Target Height: 0.0 US Feet
Target Length: 10.1 US Feet
Target Width: 1.9 US Feet
Description: 3 Linear Targets



SS146

- (X) 3664229.60 (Y) 224402.59

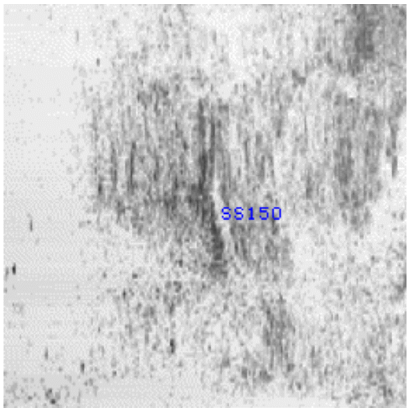
Dimensions
Target Height: 0.5 US Feet
Target Length: 20.5 US Feet
Target Width: 1.0 US Feet
Description: Linear Target



SS149

- (X) 3663208 (Y) 225518

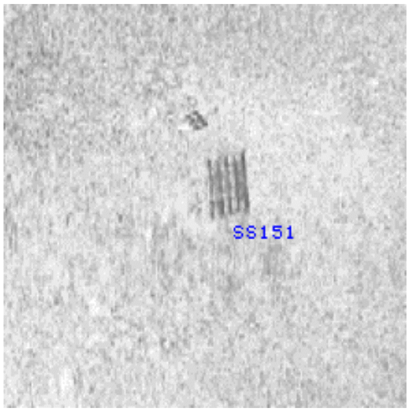
Dimensions
Target Height: 0.2 US Feet
Target Length: 24.1 US Feet
Target Width: 1.8 US Feet
Description: Linear Target



SS150

- (X) 3664014 (Y) 225165

Dimensions
Target Height: 0.3 US Feet
Target Length: 17.0 US Feet
Target Width: 1.8 US Feet
Description: Linear Target



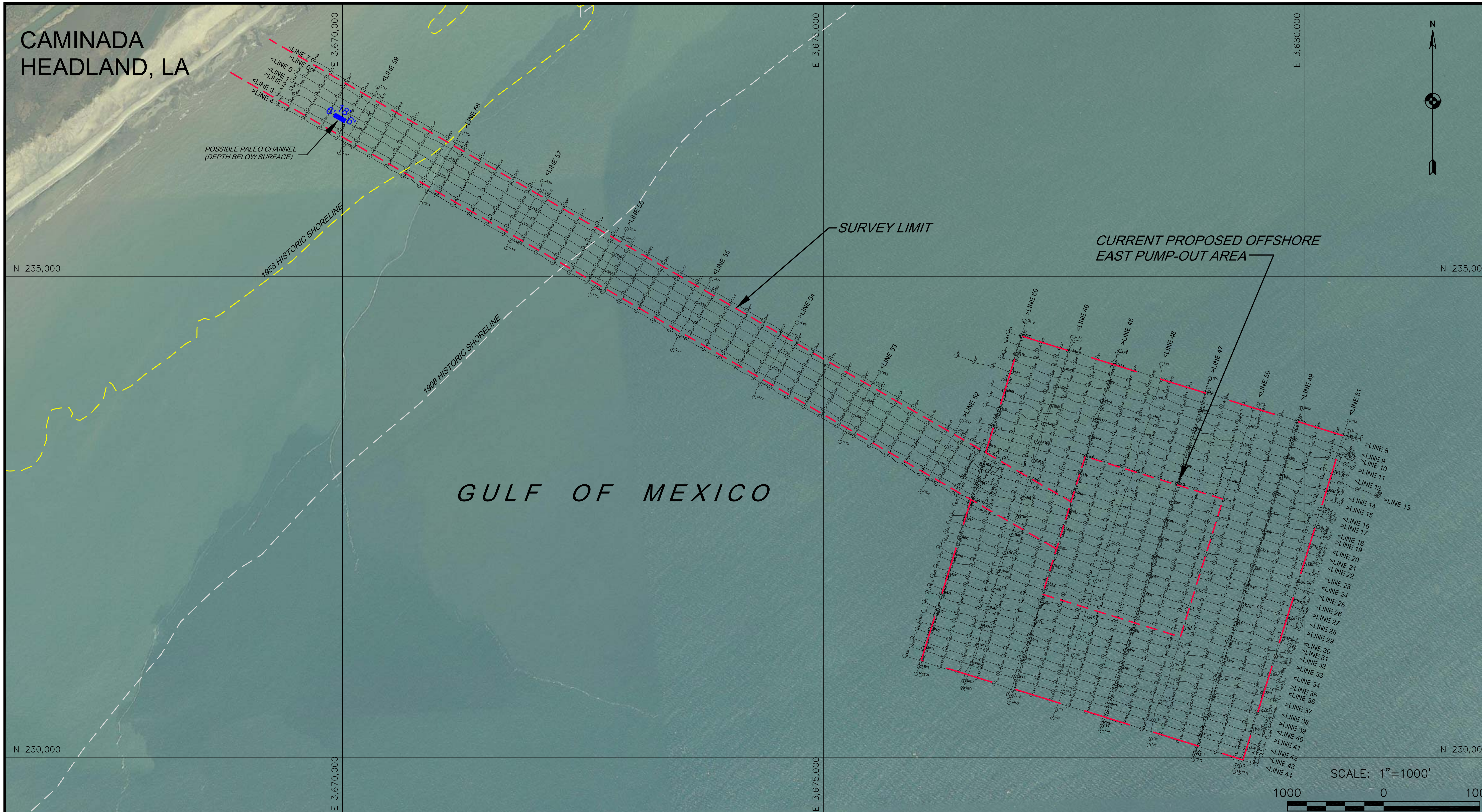
SS151

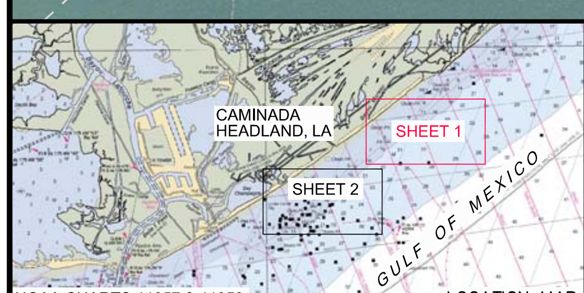
- (X) 3662886 (Y) 225887

Dimensions
Target Height: 0.0 US Feet
Target Length: 6.7 US Feet
Target Width: 4.2 US Feet
Description: 2 Rectangular Targets

APPENDIX 4

PROJECT DRAWINGS





LOCATION MAP

NOTES

1. GRID SYSTEM IS IN FEET AND IS THE LOUISIANA STATE PLANE COORDINATE SYSTEM, ZONE 600, NAD 83.
2. LAND IMAGERY ARE PORTIONS OF DIGITAL ORTHOPHOTO QUADRANGLES OBTAINED FROM THE UNITED STATES GEOLOGICAL SURVEY (USGS).
3. 1908 AND 1958 HISTORIC SHORELINES ARE BASED ON NOAA CHART NUMBER 196 (DATED SEPTEMBER 1908) AND 1050 (DATED OCTOBER 1958).
4. THE INFORMATION PRESENTED ON THIS DRAWING REPRESENTS THE RESULTS OF A SURVEY PERFORMED BY OCEAN SURVEYS, INC. DURING THE PERIOD OF 2–12 DECEMBER 2011 AND 5–15 JANUARY 2012 AND CAN ONLY BE CONSIDERED AS INDICATING THE CONDITIONS EXISTING DURING THAT TIME. REUSE OF THIS INFORMATION BY CLIENT OR OTHERS BEYOND THE SPECIFIC SCOPE OF WORK FOR WHICH IT WAS ACQUIRED SHALL BE AT THE SOLE RISK OF THE USER AND WITHOUT LIABILITY TO OSI.

LEGEND

<LINE 59 — SURVEY VESSEL TRACKLINE WITH LINE NUMBER & DIRECTION

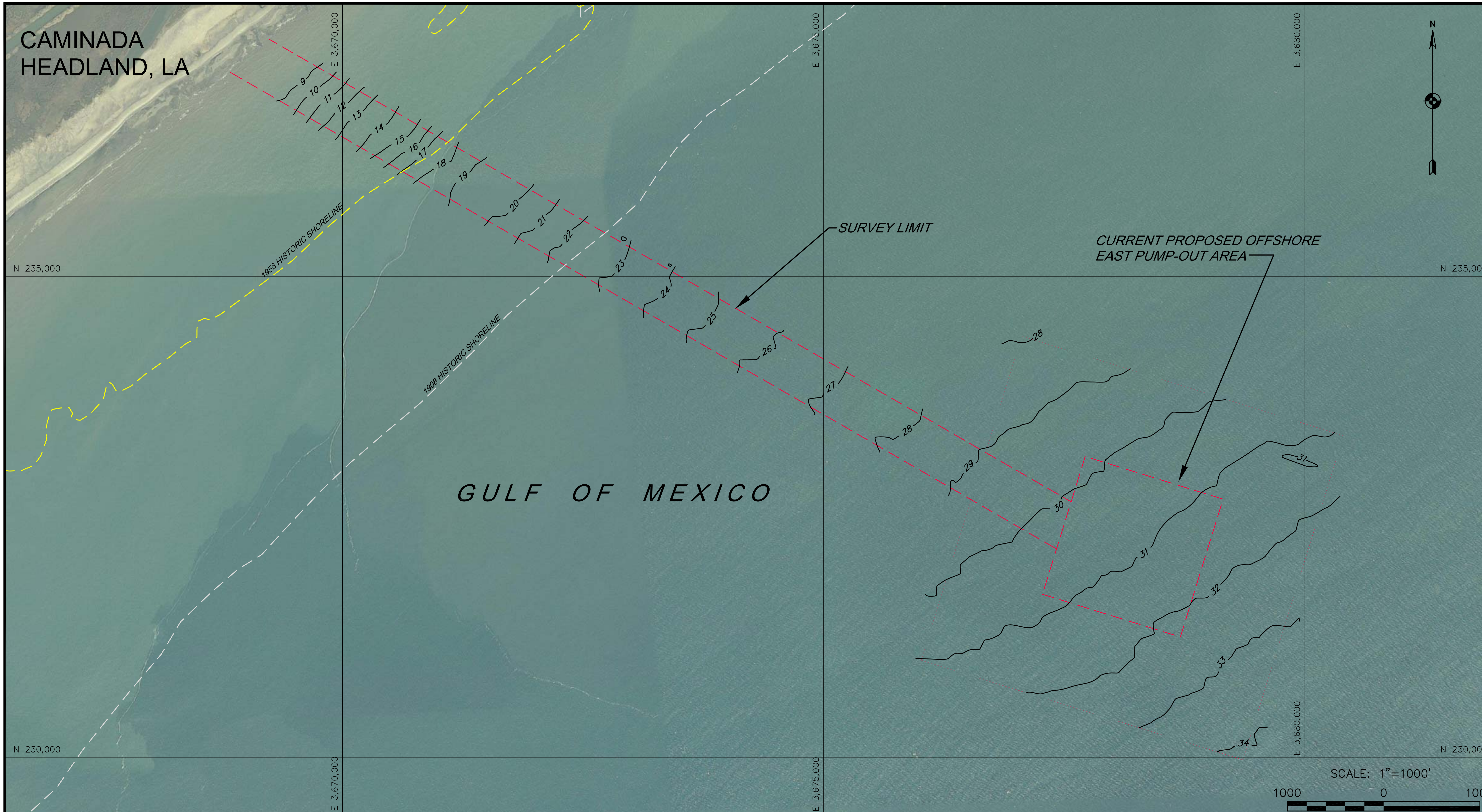
OCEAN SURVEYS, INC.
OLD SAYBROOK, CONNECTICUT

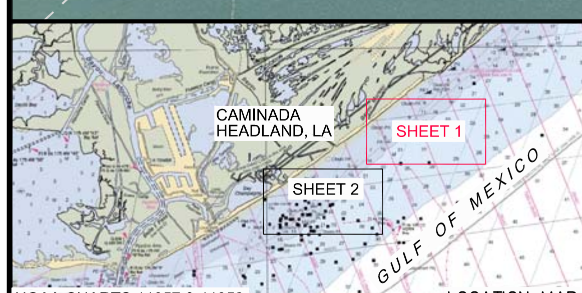
PREPARED FOR: COASTAL ENGINEERING CONSULTANTS, INC.

TRACKLINES

OFFSHORE EAST PUMP-OUT AREA & CONVEYANCE CORRIDOR
GULF OF MEXICO
CAMINADA HEADLAND, LOUISIANA

DRAWING 1 SHEET 1 OF 2
OSI JOB NO. 11ES091





NOTES

1. GRID SYSTEM IS IN FEET AND IS THE LOUISIANA STATE PLANE COORDINATE SYSTEM, ZONE 600, NAD 83.
2. DEPTHS ARE IN FEET AND ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88). WATER DEPTHS WERE ADJUSTED TO THE PROJECT DATUM BASED ON NOAA PREDICTED TIDES AT PORT FOURCHON (STATION ID 8762075). CEC PROVIDED THE CONVERSION TO NAVD88 BASED ON AN INSTALLED TIDE GAUGE AT PORT FOURCHON: 0 FEET MLLW = +0.48 FEET NAVD88.
3. CONTOUR INTERVAL IS 1 FOOT. CONTOURS WERE COMPUTER GENERATED USING "QUICKSURF" VERSION 5.1 (SCHREIBER INSTRUMENTS, INC.) OPERATING WITHIN "AUTOCAD" VERSION 2004 (AUTODESK).
4. LAND IMAGERY ARE PORTIONS OF DIGITAL ORTHOPHOTO QUADRANGLES OBTAINED FROM THE UNITED STATES GEOLOGICAL SURVEY (USGS).
5. 1908 AND 1958 HISTORIC SHORELINES ARE BASED ON NOAA CHART NUMBER 196 (DATED SEPTEMBER 1908) AND 1050 (DATED OCTOBER 1958).
6. THE INFORMATION PRESENTED ON THIS DRAWING REPRESENTS THE RESULTS OF A SURVEY PERFORMED BY OCEAN SURVEYS, INC. DURING THE PERIOD OF 2–12 DECEMBER 2011 AND 5–15 JANUARY 2012 AND CAN ONLY BE CONSIDERED AS INDICATING THE CONDITIONS EXISTING DURING THAT TIME. REUSE OF THIS INFORMATION BY CLIENT OR OTHERS BEYOND THE SPECIFIC SCOPE OF WORK FOR WHICH IT WAS ACQUIRED SHALL BE AT THE SOLE RISK OF THE USER AND WITHOUT LIABILITY TO OSI.

LEGEND

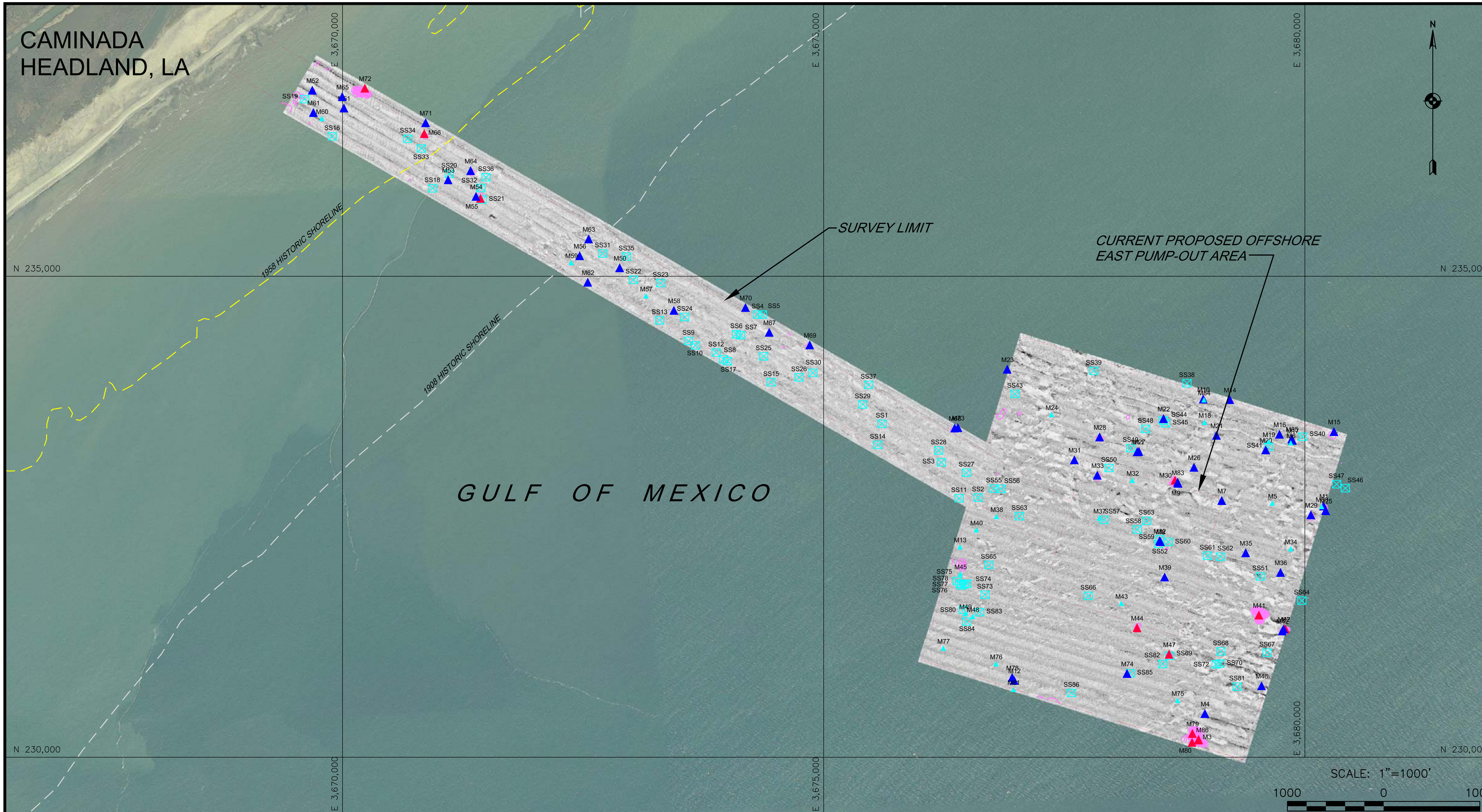
—10— HYDROGRAPHIC CONTOURS (CONTOUR INTERVAL = 1 FOOT)

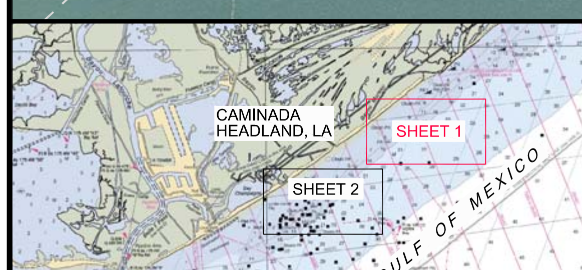
OCEAN SURVEYS, INC.
OLD SAYBROOK, CONNECTICUT

PREPARED FOR: COASTAL ENGINEERING CONSULTANTS, INC.

HYDROGRAPHY
OFFSHORE EAST PUMP-OUT AREA & CONVEYANCE CORRIDOR
GULF OF MEXICO
CAMINADA HEADLAND, LOUISIANA

DRAWING 2 SHEET 1 OF 2
OSI JOB NO. 11ES091





NOAA CHARTS 11357 & 11358
LOCATION MAP

NOTES

1. GRID SYSTEM IS IN FEET AND IS THE LOUISIANA STATE PLANE COORDINATE SYSTEM, ZONE 600, NAD 83.
2. GEOLOGICAL INTERPRETATIONS ARE BASED ON THE ANALYSIS OF HYDROGRAPHIC, SIDE SCAN SONAR, MAGNETOMETER AND SUBBOTTOM PROFILE DATA. FOR ADDITIONAL INFORMATION REGARDING THE INTERPRETATION PRESENTED REFER TO OSI FINAL REPORT NO. 11ES091.
3. CONTOUR INTERVAL IS 5 GAMMAS. MAGNETIC FIELD CONTOURS WERE COMPUTER GENERATED USING MAGPICK VERSION 3.2 GEOMETRICS.
4. LAND IMAGERY ARE PORTIONS OF DIGITAL ORTHOPHOTO QUADRANGLES OBTAINED FROM THE UNITED STATES GEOLOGICAL SURVEY (USGS).
5. 1908 AND 1958 HISTORIC SHORELINES ARE BASED ON NOAA CHART NUMBER 196 (DATED SEPTEMBER 1908) AND 1050 (DATED OCTOBER 1958).
6. THE INFORMATION PRESENTED ON THIS DRAWING REPRESENTS THE RESULTS OF A SURVEY PERFORMED BY OCEAN SURVEYS, INC. DURING THE PERIOD OF 2–12 DECEMBER 2011 AND 5–15 JANUARY 2012 AND CAN ONLY BE CONSIDERED AS INDICATING THE CONDITIONS EXISTING DURING THAT TIME. REUSE OF THIS INFORMATION BY CLIENT OR OTHERS BEYOND THE SPECIFIC SCOPE OF WORK FOR WHICH IT WAS ACQUIRED SHALL BE AT THE SOLE RISK OF THE USER AND WITHOUT LIABILITY TO OSI.

LEGEND

SS93 — SIDE SCAN SONAR TARGET

MAGNETIC ANOMALY CLASSIFICATIONS

M207 — < 5 GAMMAS

M191 — 5 - < 25 GAMMAS

M168 — > 25 GAMMAS

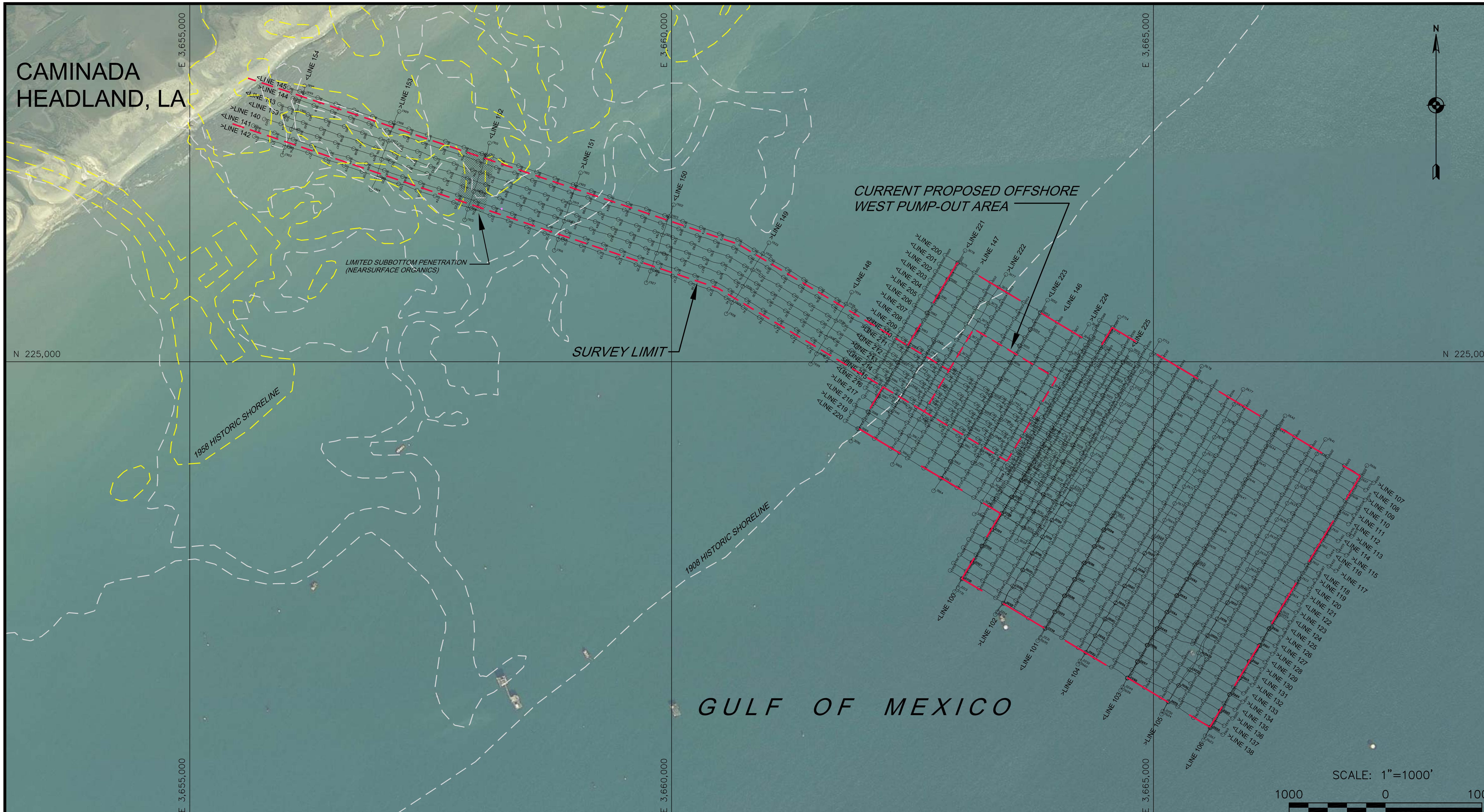
MAGNETIC FIELD CONTOURS (CONTOUR INTERVAL = 5 GAMMAS)

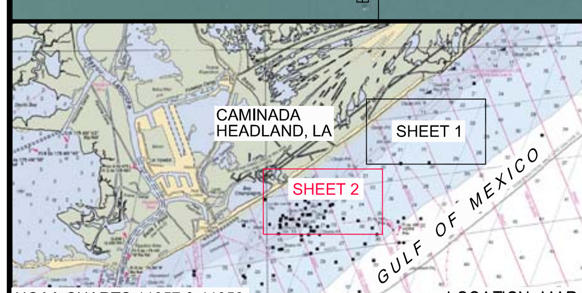
OCEAN SURVEYS, INC.
OLD SAYBROOK, CONNECTICUT

PREPARED FOR: COASTAL ENGINEERING CONSULTANTS, INC.

SIDE SCAN SONAR MOSAIC &
RESIDUAL MAGNETIC FIELD CONTOURS
OFFSHORE EAST PUMP-OUT AREA & CONVEYANCE CORRIDOR
GULF OF MEXICO
CAMINADA HEADLAND, LOUISIANA

DRAWING 3 SHEET 1 OF 2
OSI JOB NO. 11ES091





NOTES

1. GRID SYSTEM IS IN FEET AND IS THE LOUISIANA STATE PLANE COORDINATE SYSTEM, ZONE 600, NAD 83.
2. LAND IMAGERY ARE PORTIONS OF DIGITAL ORTHOPHOTO QUADRANGLES OBTAINED FROM THE UNITED STATES GEOLOGICAL SURVEY (USGS).
3. 1908 AND 1958 HISTORIC SHORELINES ARE BASED ON NOAA CHART NUMBER 196 (DATED SEPTEMBER 1908) AND 1050 (DATED OCTOBER 1958).
4. THE INFORMATION PRESENTED ON THIS DRAWING REPRESENTS THE RESULTS OF A SURVEY PERFORMED BY OCEAN SURVEYS, INC. DURING THE PERIOD OF 2–12 DECEMBER 2011 AND 5–15 JANUARY 2012 AND CAN ONLY BE CONSIDERED AS INDICATING THE CONDITIONS EXISTING DURING THAT TIME. REUSE OF THIS INFORMATION BY CLIENT OR OTHERS BEYOND THE SPECIFIC SCOPE OF WORK FOR WHICH IT WAS ACQUIRED SHALL BE AT THE SOLE RISK OF THE USER AND WITHOUT LIABILITY TO OSI.

LEGEND

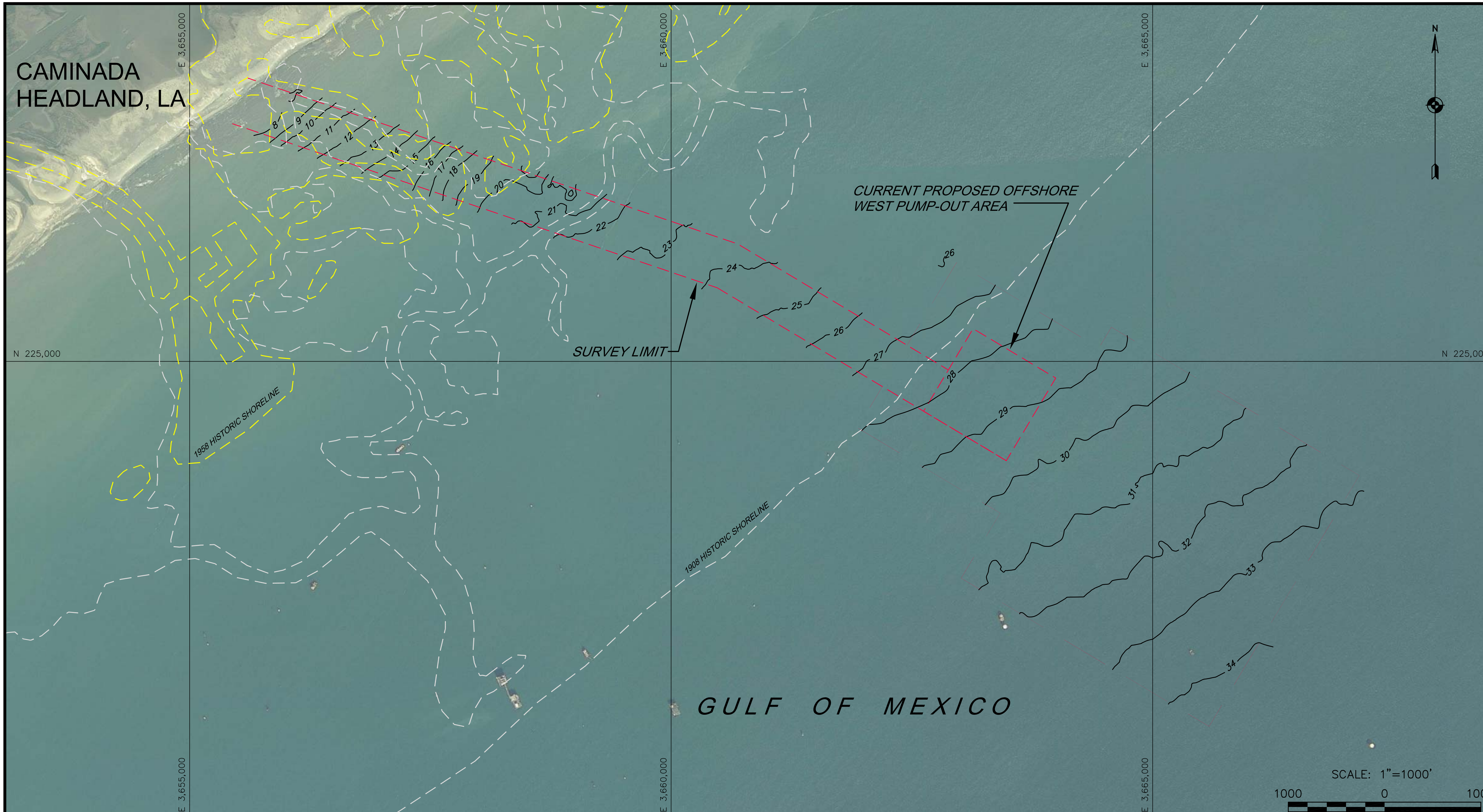
<LINE 59 — SURVEY VESSEL TRACKLINE WITH LINE NUMBER & DIRECTION

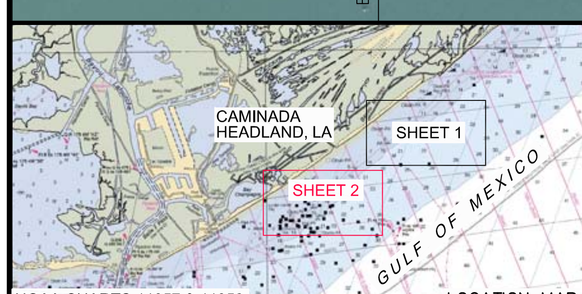
OCEAN SURVEYS, INC.
OLD SAYBROOK, CONNECTICUT

PREPARED FOR: COASTAL ENGINEERING CONSULTANTS, INC.

TRACKLINES
OFFSHORE WEST PUMP-OUT AREA & CONVEYANCE CORRIDOR
GULF OF MEXICO
CAMINADA HEADLAND, LOUISIANA

DRAWING 1 SHEET 2 OF 2
OSI JOB NO. 11ES091





NOTES

1. GRID SYSTEM IS IN FEET AND IS THE LOUISIANA STATE PLANE COORDINATE SYSTEM, ZONE 600, NAD 83.
2. DEPTHS ARE IN FEET AND ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88). WATER DEPTHS WERE ADJUSTED TO THE PROJECT DATUM BASED ON NOAA PREDICTED TIDES AT PORT FOURCHON (STATION ID 8762075). CEC PROVIDED THE CONVERSION TO NAVD88 BASED ON AN INSTALLED TIDE GAUGE AT PORT FOURCHON: 0 FEET MLLW = +0.48 FEET NAVD88.
3. CONTOUR INTERVAL IS 1 FOOT. CONTOURS WERE COMPUTER GENERATED USING "QUICKSURF" VERSION 5.1 (SCHREIBER INSTRUMENTS, INC.) OPERATING WITHIN "AUTOCAD" VERSION 2004 (AUTODESK).
4. LAND IMAGERY ARE PORTIONS OF DIGITAL ORTHOPHOTO QUADRANGLES OBTAINED FROM THE UNITED STATES GEOLOGICAL SURVEY (USGS).
5. 1908 AND 1958 HISTORIC SHORELINES ARE BASED ON NOAA CHART NUMBER 196 (DATED SEPTEMBER 1908) AND 1050 (DATED OCTOBER 1958).
6. THE INFORMATION PRESENTED ON THIS DRAWING REPRESENTS THE RESULTS OF A SURVEY PERFORMED BY OCEAN SURVEYS, INC. DURING THE PERIOD OF 2–12 DECEMBER 2011 AND 5–15 JANUARY 2012 AND CAN ONLY BE CONSIDERED AS INDICATING THE CONDITIONS EXISTING DURING THAT TIME. REUSE OF THIS INFORMATION BY CLIENT OR OTHERS BEYOND THE SPECIFIC SCOPE OF WORK FOR WHICH IT WAS ACQUIRED SHALL BE AT THE SOLE RISK OF THE USER AND WITHOUT LIABILITY TO OSI.

LEGEND

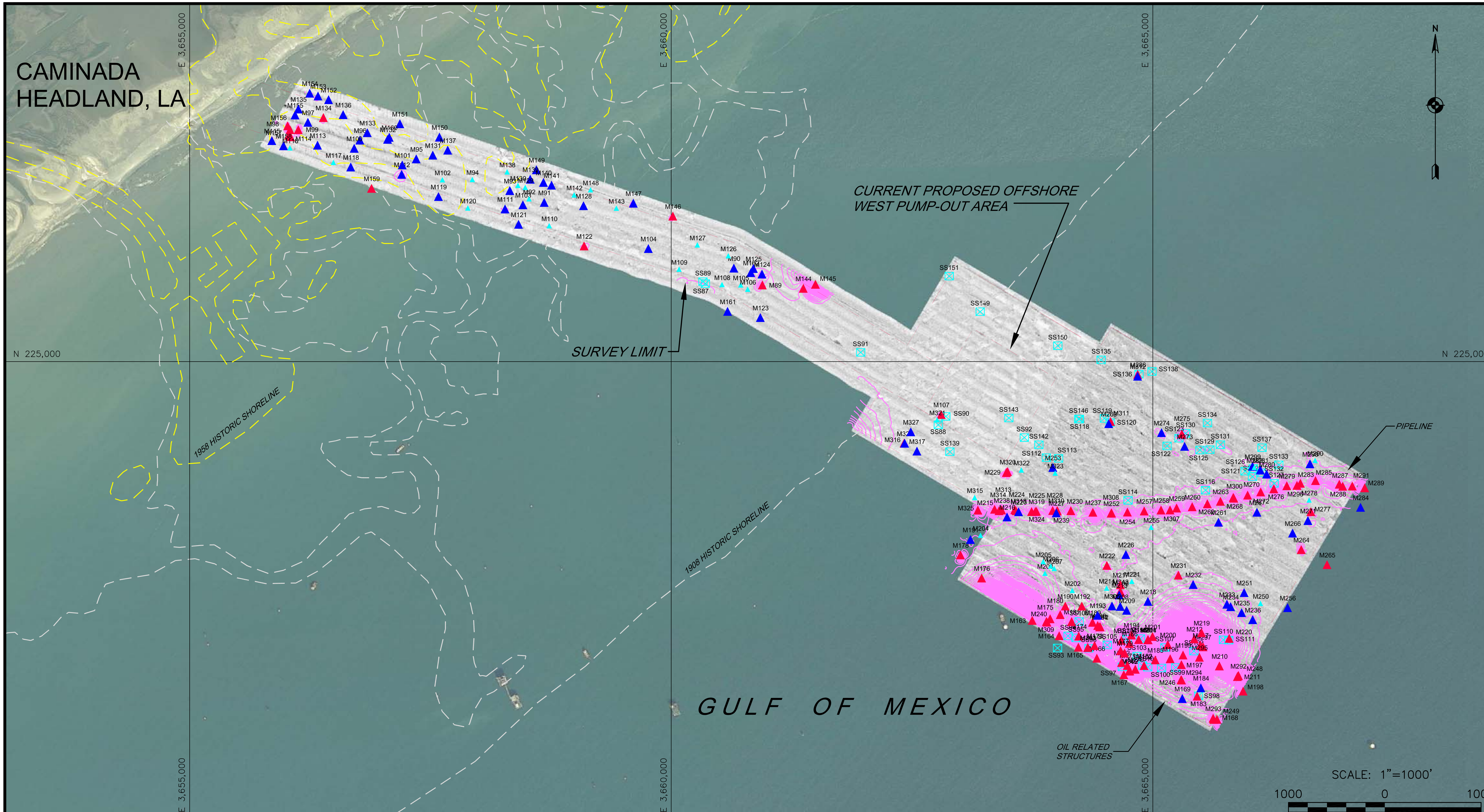
——10—— HYDROGRAPHIC CONTOURS (CONTOUR INTERVAL = 1 FOOT)

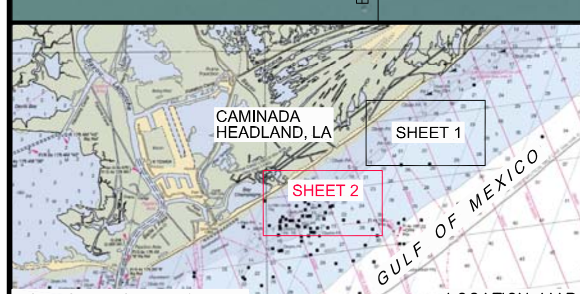
OCEAN SURVEYS, INC.
OLD SAYBROOK, CONNECTICUT

PREPARED FOR: COASTAL ENGINEERING CONSULTANTS, INC.

HYDROGRAPHY
OFFSHORE WEST PUMP-OUT AREA & CONVEYANCE CORRIDOR
GULF OF MEXICO
CAMINADA HEADLAND, LOUISIANA

DRAWING 2 SHEET 2 OF 2
OSI JOB NO. 11ES091





NOTES

1. GRID SYSTEM IS IN FEET AND IS THE LOUISIANA STATE PLANE COORDINATE SYSTEM, ZONE 600, NAD 83.
2. GEOLOGICAL INTERPRETATIONS ARE BASED ON THE ANALYSIS OF HYDROGRAPHIC, SIDE SCAN SONAR, MAGNETOMETER AND SUBBOTTOM PROFILE DATA. FOR ADDITIONAL INFORMATION REGARDING THE INTERPRETATION PRESENTED REFER TO OSI FINAL REPORT NO. 11ES091.
3. CONTOUR INTERVAL IS 5 GAMMAS. MAGNETIC FIELD CONTOURS WERE COMPUTER GENERATED USING MAGPICK VERSION 3.2 GEOMETRICS.
4. LAND IMAGERY ARE PORTIONS OF DIGITAL ORTHOPHOTO QUADRANGLES OBTAINED FROM THE UNITED STATES GEOLOGICAL SURVEY (USGS).
5. 1908 AND 1958 HISTORIC SHORELINES ARE BASED ON NOAA CHART NUMBER 196 (DATED SEPTEMBER 1908) AND 1050 (DATED OCTOBER 1958).
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LEGEND

SS93 ⊠ SIDE SCAN SONAR TARGET

MAGNETIC ANOMALY CLASSIFICATIONS

M207 ▲ < 5 GAMMAS

M191 ▲ 5 - < 25 GAMMAS

M168 ▲ > 25 GAMMAS

MAGNETIC FIELD CONTOURS (CONTOUR INTERVAL = 5 GAMMAS)

OCEAN SURVEYS, INC.
OLD SAYBROOK, CONNECTICUT

PREPARED FOR: COASTAL ENGINEERING CONSULTANTS, INC.

SIDE SCAN SONAR MOSAIC &
RESIDUAL MAGNETIC FIELD CONTOURS
OFFSHORE WEST PUMP-OUT AREA & CONVEYANCE CORRIDOR
GULF OF MEXICO
CAMINADA HEADLAND, LOUISIANA

DRAWING 3 SHEET 2 OF 2
OSI JOB NO. 11ES091

FINAL REPORT

OFFSHORE NO. 3 PUMP-OUT AREA AND CONVEYANCE CORRIDOR GEOPHYSICAL/CULTURAL RESOURCE SURVEY CAMINADA HEADLAND BEACH AND DUNE RESTORATION PROJECT INCREMENT II (CAM-II) GULF OF MEXICO, LOUISIANA

OSI REPORT NO. 12ES018

Prepared For: Coastal Engineering Consultants, Inc.
3106 S. Horseshoe Drive
Naples, FL 34104

Prepared By: Ocean Surveys, Inc.
129 Mill Rock Road E.
Old Saybrook, CT 06475

20 June 2012

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John D. Sullivan
Principal Investigator
Manager Geophysical Surveys
OCEAN SURVEYS, INC.

FINAL REPORT

OFFSHORE NO. 3 PUMP-OUT AREA AND CONVEYANCE CORRIDOR GEOPHYSICAL/CULTURAL RESOURCE SURVEY CAMINADA HEADLAND BEACH AND DUNE RESTORATION PROJECT INCREMENT II (CAM-II) GULF OF MEXICO, LOUISIANA

1.0 INTRODUCTION

During the period 24-29 April 2012, Ocean Surveys, Inc. (OSI) performed a multi-sensor marine geophysical survey in the Gulf of Mexico in a site located offshore Caminada Headland, Louisiana. This investigation was completed under subcontract to Coastal Engineering Consultants, Inc. (CEC) for the Louisiana Coastal Protection and Restoration Authority (CPRA) to support the Caminada Headland Beach and Dune Restoration Project Increment II (CAM-II) (BA-45). The project includes restoring the western end of the Caminada Headland through beach and dune fill placement utilizing offshore sand resources from Ship Shoal within two Bureau of Ocean Energy Management (BOEM) lease areas: “South Pelto Lease Blocks 13 and 14” (Figure 1).

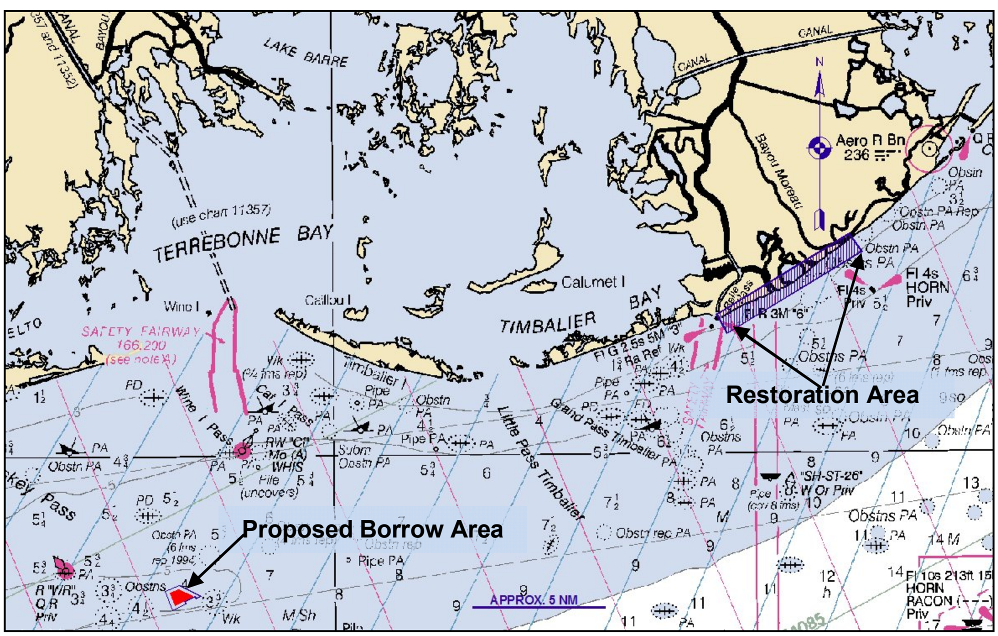


Figure 1. Location of Proposed Borrow Area (red) on Ship Shoal and restoration area along Caminada Headland in LaFourche Parish, Louisiana (NOAA Nautical Chart 11340 in background).

2.0 PROJECT SUMMARY

2.1 Project Background and Objectives

Previous investigations focused on documenting conditions on Ship Shoal in the proposed borrow area and in several alternate pump-out areas further west on the headland where sediments transported from Ship Shoal will be re-handled prior to transferring it to the restoration area.

This report presents the results of a multi-sensor marine geophysical survey performed in a proposed offshore pump-out site (referred to as a “Proposed Offshore No.3 Pump-Out Area”) and associated pipeline conveyance corridor located east of two pump-out areas and pipeline corridors previously investigated on Caminada Headland (Figure 2). The objective of this survey was to document any hazards or submerged cultural resources that might impact the project. All field investigations were planned and performed to meet or exceed BOEM and the Louisiana State Historic Preservation Office (LASHPO) guidelines for archaeological field surveys.

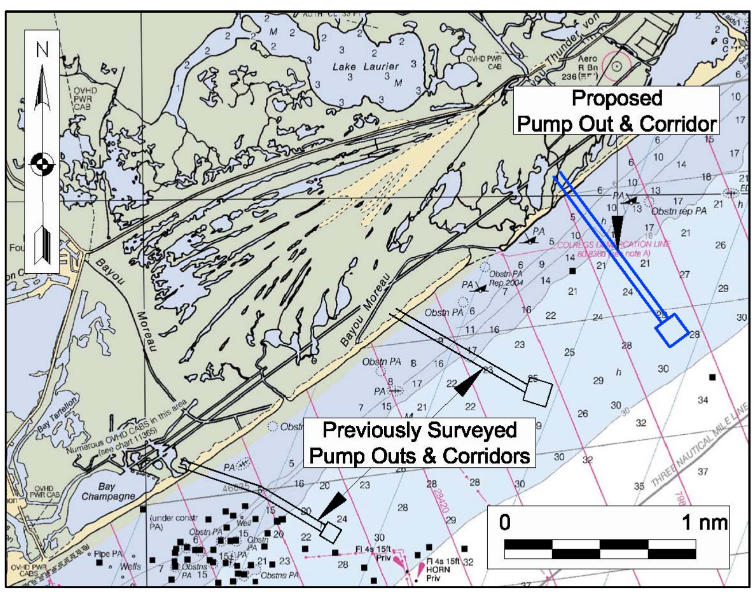


Figure 2. Location of proposed Pump-out Area and Pipeline Corridor as well as previously surveyed Pump Out Areas and Pipeline Corridors (NOAA Nautical Chart 11358 in background).

Results were provided to R. Christopher Goodwin & Associates, Inc. (Goodwin) in support of a marine archaeological sensitivity assessment of the restoration project and offshore pump-out area. The Marine Archaeological Sensitivity Assessment Report is not included herein but will be submitted under separate cover.

2.2 Summary of Field Survey and Equipment

The site location was chosen to avoid charted obstructions and known archaeologically sensitive areas. The survey plan included data acquisition along a series of planned lines within the proposed pump-out area (including a 1,000 foot buffer zone) and 500-foot wide conveyance corridor. Primary tracklines were spaced at 98-foot (30-meter) intervals with secondary tie lines oriented perpendicular to primary lines and spaced at 500-foot intervals (152-meter) for the pump-out area and 1,000-foot (305-meter) intervals for the conveyance corridor.

A two-man survey team conducted the operations aboard OSI's *R/V Able II*, a shallow draft 25-foot fiberglass survey vessel equipped with a fully-enclosed cabin, dual-outboard motors and the following survey instrumentation:

- *Trimble 212 Differential Global Positioning System (DGPS)*
- *HYPACK Navigation and Data-Logging Computer System*
- *Odom Mark III Dual-Frequency Depth Sounder*
- *Klein 3000 100/500 kHz Dual-Frequency Digital Side Scan Sonar System*
- *Geometrics G882 Cesium Marine Magnetometer*
- *EdgeTech Xstar Chirp Subbottom Profiling System equipped with SB216 Tow Vehicle*

Specification sheets for equipment used during the survey are available upon request. Operational procedures employed to collect the data can be found in Appendix 1. Figure 3 illustrates the equipment configuration used onboard the survey vessel. The dual-frequency depth sounder transducer was hard mounted to the starboard side of the vessel; the side scan sonar towfish was towed from the stern mounted A-frame with the magnetometer sensor in tandem 25 feet (7.6 meters) behind; the Chirp SB216 was towed from a davit located approximately midships on the port side of the vessel. The side scan sonar system employed a 165-foot (50-meter) sweep range and the magnetometer was maintained at a tow height generally less than 20 feet (6 meters) above the bottom where depth permitted.

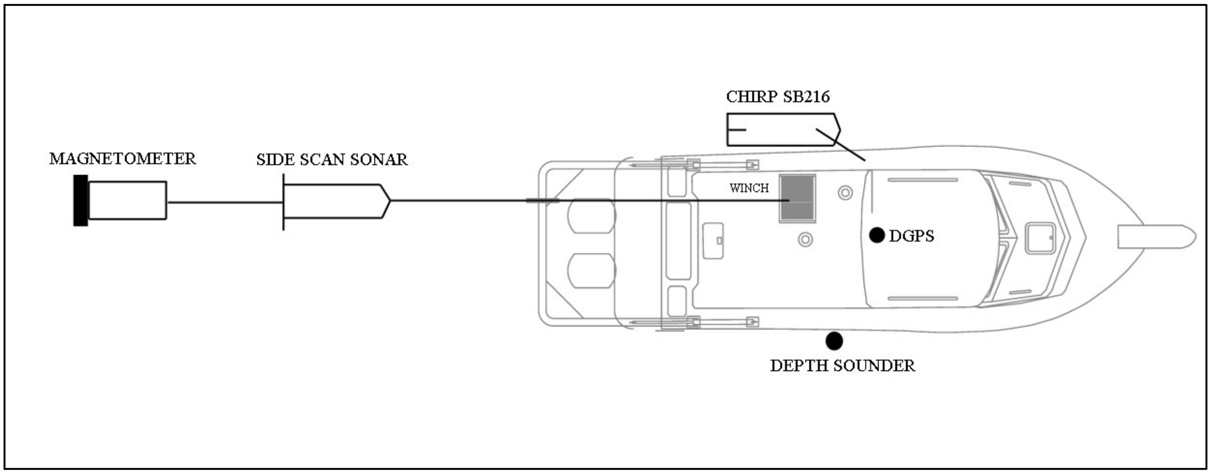


Figure 3. General equipment configuration and layout aboard the *R/V Able II*.

2.3 Horizontal and Vertical Control

Project horizontal reference is the LA State Plane Coordinate System, South Zone (1702), NAD 83 in US Survey Feet. The horizontal positioning of the survey vessel was accomplished using a DGPS interfaced with a computer running a version of HYPACK PC-based navigation and data logging software package. Navigation checks were performed periodically to ensure the positioning system was functioning properly and delivering the required horizontal accuracy.

Project vertical reference is the North American Vertical Datum of 1988 (NAVD88), in feet. Water depths were adjusted to the project datum based on NOAA predicted tides at Port Fourchon (Station ID 8762075), which are referenced to Mean Lower Low Water (MLLW). CEC provided the conversion to NAVD88 based on an installed tide gauge at Port Fourchon: 0 feet MLLW = +0.48 feet NAVD88.

2.4 Field Operations and Acquisition Summary

Approximately 42 nautical miles (nm) of multi-sensor trackline data were acquired in the pump-out area and associated conveyance corridor during the course of the field investigation (summarized in Table 1).

Table 1
Chronology of Field Investigation

Task	Date	Description
Mobilize vessel	April 19-21, 2012	Arrive at UNO, mobilize *R/V Able II*.
On-site mobilization and perform testing/calibration	April 21-22, 2012	Arrive at Port Fourchon, complete vessel mobilization, perform testing/calibration of equipment.
Weather standby	April 23, 2012	Seas too rough to work.
Survey operations	April 24-25, 2012	Conduct survey operations.
Weather standby	April 26-27, 2012	Seas too rough to work.
Survey operations	April 28-29, 2012	Conduct survey operations.
Demobilize vessel	April 29, 2012	Survey completed, vessel and crew demobilize on-site and depart.

3.0 DATA PROCESSING AND PRODUCTS

Following completion of the field investigation, the acquired data sets were processed, interpreted, and provided to the project archaeologist (Goodwin) for review. For a more detailed discussion of processing and analysis methods followed by OSI refer to Appendix 2. Appendix 3 provides tables summarizing the magnetic anomalies and side scan sonar targets identified during the investigation. Thumbnail images for each sonar target are also included in this appendix.

Final data are presented in plan view at a scale of 1 inch = 1,000 feet on three drawing sheets (11 by 17 inches). The drawings are included in Appendix 4. Digital drawing files (AutoCAD 2007 format) and a copy of this report (PDF format) are provided on a disc included in a sleeve at the end of the original copy of this report.

Table 2 summarizes the data presented on each project drawing. To aid in the archaeological review of the data the 1909 and 1958 charted shorelines (based on NOAA Chart NOS. 196 & 1050, respectively) are overlain on all project drawing sheets.

Table 2
Overview of Project Drawings

Drawing	Data Presented
1 –Tracklines	Survey vessel tracklines and an overview of potential relict landforms/paleo channels detected in the subsurface (via review of the subbottom profile data).
2 – Hydrography	One-foot depth contours.
3 – Side Scan Sonar Mosaic & Residual Magnetic Field Contours	Side scan sonar targets, magnetic anomalies (color-coded based on size), and 5 gamma contours of the modeled residual magnetic field overlain on side scan sonar mosaic.

4.0 DATA DISCUSSION

Hydrographic, subbottom profiling and magnetometer data together with side scan sonar imagery documented current seafloor and subsurface conditions within the proposed pump-out area and associated conveyance corridor. The following section presents findings for these areas. Seasonal variations, storm events, and/or man's influence since the time of the surveys may have altered conditions reported herein.

Hydrographic data acquired within the Offshore Pump-Out and Conveyance Corridor survey limits (including buffer area) ranged from approximately 7-34 feet below NAVD88. Depths within the proposed pump-out area ranged from approximately 30-34 feet below NAVD88.
Side scan sonar imagery shows the seafloor throughout the site to be generally featureless with no large scale bedforms present. Thirty-nine (39) individual sonar targets were identified within the survey limits with only three located within the current pump-out area (SS18, SS22, SS26). All appear to be relatively small with minimal relief (<2 feet). The majority of sonar targets identified appear to be linear or oblong features. Several sonar targets had correlative magnetic anomalies associated but none of the targets identified appear as recognizable features.

Analysis of magnetic data identified sixty-five (65) individual magnetic anomalies in the site. The majority of these anomalies (37) were less than 10 gammas and only nineteen (19) anomalies were greater than 20 gammas. Most anomalies detected appear to be isolated and were only detected on a single survey line. Numerous anomalies were detected on the northern side of the conveyance corridor within approximately 2,000 feet of shore. Of these anomalies, one grouping is located within 1,000 feet of shore and includes anomalies up to 388 gammas (M37). The second grouping including M25 (2,276 gammas) and M21 (26 gammas) is approximately 2,000 feet from shore. Neither grouping of anomalies has associated sonar targets.

The subbottom profiler achieved approximately 3-15 feet of penetration below the seafloor throughout the area and resolved several undulating subsurface reflectors. Subbottom data show that the subsurface acoustic characteristics alternate between those of sand and clay. This changing character was highly variable both along line and from line to line, suggesting the shallow subsurface is not comprised of a single sediment type that can be distinctly mapped but is instead characterized by mixed sediments. Subbottom profile signatures indicative of paleochannels were detected along several survey lines in the conveyance corridor and pump-out area as illustrated in Figure 4. However, these paleo features (delineated in Drawing 1) were localized and not identified on adjacent survey lines in the area.

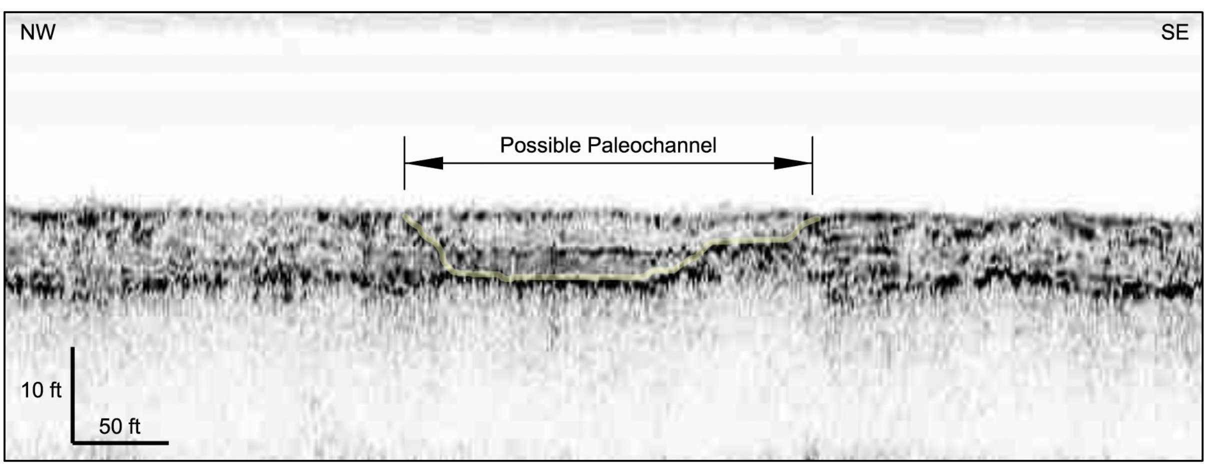


Figure 5. Chirp subbottom record illustrating a possible paleochannel (outlined in yellow).

5.0 SUMMARY AND RECOMMENDATIONS

The objectives of this survey were to document current conditions and identify any objects that might impact (or be impacted by) the restoration of beach and dune features along Caminada Headland. The results were provided to Goodwin in support of a marine archaeological sensitivity assessment of the restoration project and offshore pump-out options.

Water depths within the proposed Offshore Pump-Out area and Conveyance Corridor range from approximately 7-34 feet below NAVD88. Side scan sonar imagery shows the seafloor throughout the offshore pump-out areas and corridors to be generally featureless with no large scale bedforms present. Numerous small, isolated, and unrecognizable side scan sonar targets and magnetic anomalies were identified. Two groupings of magnetic anomalies were detected on the northern side of the conveyance corridor within approximately 2,000 feet of shore ranging in size from several to 2,276 gammas (M25). The first grouping of anomalies is within 1,000 feet of shore, does not have associated sonar targets. The second grouping is located approximately 2,000 feet from shore and includes magnetic anomaly M25 with a magnitude of 2,276 gammas. This grouping does not have associated sonar targets. Since it is unclear what the magnetometer is detecting in this area, it is recommended that these anomalies be more fully investigated prior to installing the conveyance pipeline to better understand their source. No obvious pipelines or oil-related structures were detected in either of the conveyance corridor or the Offshore Pump-Out Area. It is unlikely that a target of significant ferrous mass or shallow pipeline trending across these areas would have remained undetected at the trackline spacing and magnetometer sensor tow height maintained during the survey.

APPENDIX 1

EQUIPMENT OPERATIONS AND PROCEDURES

Trimble DSM 212 Differential Global Positioning System

HYPACK Navigation Software

ODOM Hydrotrac Depth Sounder

Geometrics G882 Cesium Marine Magnetometer

Klein 3000 Dual-Frequency Digital Side Scan Sonar System

EdgeTech Xstar Chirp Subbottom Profiling System

EQUIPMENT OPERATIONS AND PROCEDURES

Trimble DSM 212 Differential Global Positioning System

A Trimble DSM 212 differential global satellite positioning system (GPS) provides reliable, high-precision positioning and navigation for a wide variety of operations and environments. The unique feature of this system is its integration of a standard 12-channel GPS receiver with a U.S. Coast Guard beacon receiver all in one package. Both antennas are combined in a single housing and the receiver electronics are similarly contained within one topside control box. The complete system includes the topside control unit, a GPS volute antenna and cable, RS232 output and input data cables, and a 12 volt DC power cable. The proprietary MSK beacon receiver used in the system has been designed to provide enhanced signal reception at large distances from the reference station and under inclement weather conditions. The low noise MSK receiver is also an automatic, dual-channel system providing seamless switching between multiple beacons when necessary. The DSM 212 outputs one position per second to the HYPACK navigation computer. The manufacturer reports submeter accuracy of the system under suitable operating conditions.

HYPACK Navigation Software

Survey vessel trackline control and position fixing were obtained by utilizing an OSI computer-based data logging package running HYPACK navigation software. The computer is interfaced with the DGPS system onboard the survey vessel. Vessel position data from the DGPS were updated at 1.0-second intervals and input to the HYPACK navigation system which processes the geodetic positions into State Plane coordinates used to guide the survey vessel accurately along preselected tracklines. The incoming data are logged on disk and processed in real time allowing the vessel position to be displayed on a video monitor and compared to each pre-plotted trackline as the survey progresses. A nautical chart background shows the shoreline, general water depths, and locations of existing structures, buoys, and control points on the monitor in relation to the vessel position. The OSI computer logging system combined with the HYPACK software thus provide an accurate visual representation of survey vessel location in real time, combined with highly efficient data logging capability and post-survey data processing and plotting routines.

Odom Hydrotrac Digital Depth Sounder

Precision water depth measurements were obtained by employing an Odom Hydrotrac digital depth sounder with a 200 kilohertz, 3° or 8° beam transducer. The Hydrotrac unit has been specifically designed for small boat surveys where equipment space is a premium and the potential for water contact is high (watertight, sealed keypad). The unit is compact, portable, and rugged, built to survive tough field conditions. The Hydrotrac recorder provides precise, high-resolution depth records using a solid-state thermal printer as well as digital data output (via RS232) which allows integration with the OSI computer-based navigation system including HYPACK software. Other features include internal or external eventing, gain sensitivity controls, power output control, auto scale changing, and auto pulse length selection, among others. The recorder also incorporates both tide and draft corrections plus a calibration capability for local water mass sound speed. A depth resolution of 0.1 foot is reported by the manufacturer.

Geometrics Model G-882 Cesium Vapor Marine Magnetometer

Total magnetic field intensity measurements are acquired along the survey tracklines using a Geometrics G882 cesium magnetometer which has an instrument sensitivity of 0.1 gamma. The G882 magnetometer system includes the sensor head with a coil and optical component tube, a sensor electronics package which houses the AC signal generator and mini-counter that converts the Larmor signal into a magnetic anomaly value in gammas, and a RS-232 data cable for transmitting digital measurements to a data logging system. The cesium-based method of magnetic detection allows a center or nose tow configuration off the survey vessel, simultaneously with other remote sensing equipment, while maintaining high quality, quiet magnetic data with ambient fluctuations of less than 1 gamma. The G882 outputs magnetic intensity readings at a 10 hertz sampling rate which were recorded on the OSI data logging computer by the HYPACK software.

The G882 magnetometer acquires information on the ambient magnetic field strength by measuring the variation in cesium electron energy level states. The presence of only one electron in the atom's outermost electron shell (known as an alkali metal) makes cesium ideal for optical pumping and magnetometry.

A beam of infrared light is passed through a cesium vapor chamber producing a Larmor frequency output in the form of a continuous sine wave. This radio frequency field is generated by an H1 coil wound around a tube containing the optical components (lamp oscillator, optical filters and lenses, split-circular polarizer, and infrared photo detector). The Larmor frequency is directly proportional to the ambient magnetic intensity, and is exactly 3.49872 times the ambient magnetic field measured in gammas or nanoteslas. Changes in the ambient magnetic field cause different degrees of atomic excitation in the cesium vapor which in turn allows variable amounts of infrared light to pass, resulting in fluctuations in the Larmor frequency.

Although the earth's magnetic field does change with both time and distance, over short periods and distances the earth's field can be viewed as relatively constant. The presence of magnetic material and/or magnetic minerals; however, can add to or subtract from the earth's magnetic field creating a magnetic anomaly. Rapid changes in total magnetic field intensity which are not associated with normal background fluctuations mark the locations of these anomalies.

Determination of the location of an object producing a magnetic anomaly depends on whether or not the magnetometer sensor passed directly over the object and if the anomaly is an apparent monopole or dipole. A magnetic dipole can be thought of simply as a common bar magnet having a positive and negative end or pole. A monopole arises when the magnetometer senses only one end of a dipole as it passes over the object. This situation occurs mainly when the distance between opposite poles of a dipole is much greater than the distance between the magnetometer and the sensed pole, or when a dipole is oriented nearly perpendicular to the ambient field thus shielding one pole from detection. For dipolar anomalies, the location of the object is at the point of maximum gradient between the two poles. In the case of a monopole, the object associated with the anomaly is located below the maximum or minimum magnetic value.

Klein 3000 Dual-Frequency Side Scan Sonar System

Side scan sonar images of the bottom are collected using a Klein 3000 dual frequency, high-resolution sonar system operating at frequencies of 100 and 500 kilohertz. The system consists of a topside computer, monitor, keyboard, mouse, tow cable, and sonar towfish. All system components are interfaced via a local network hub and cable connections. The system contains an integrated navigational plotter which accepts standard NMEA 0183 input from a GPS system. This allows vessel position to be displayed on the monitor and speed information to be used for controlling sonar ping rate. Sonar sweep can also be plotted in the navigation window for monitoring bottom coverage in the survey area.

The hardware is interfaced to the Klein SonarPro data acquisition and playback software package which runs on the topside computer. All sonar images are stored digitally and can be enhanced real-time or post-survey by numerous mathematical filters available in the program software. Imagery is displayed in a waterfall window in either normal or ground range (water column removed) formats. Other software functions that are available during data acquisition include; changing range scale and delay, display color, automatic or manual TVG (time variable gain), speed over bottom, multiple enlargement zoom, target length, height, and area measurements, logging and saving of target images, and annotation frequency and content. The power of this system is its real-time processing capability for determining precise dimensions of targets and areas on the bottom.

As with many other marine geophysical instruments, the side scan sonar derives its information from reflected acoustic energy. A set of transducers mounted in a compact towfish generate the short duration acoustic pulses required for extremely high resolution. The pulses are emitted in a thin, fan-shaped pattern that spreads downward to either side of the fish in a plane perpendicular to its path. As the fish progresses along the trackline this acoustic beam sequentially scans the bottom from a point directly beneath the fish outward to each side of the survey trackline.

Acoustic energy reflected from any bottom discontinuities is received by the set of transducers in the towfish, amplified and transmitted to the survey vessel via the tow cable where it is further amplified, processed, and converted to a graphic record by the side scan recorder. The sequence of reflections from the series of pulses is displayed on a video monitor and/or dual-channel graphic recorder on which paper is incrementally advanced prior to printing each acoustic pulse. The resulting output is essentially analogous to a high angle oblique "photograph" providing detailed representation of bottom features and characteristics. This system allows display of positive relief (features extending above the bottom) and negative relief (such as depressions) in either light or dark opposing contrast modes on the video monitor. Examination of the images thus allows a determination of significant features and objects present on the bottom within the survey area.

EdgeTech 3100 2-16 kHz "Chirp" Subbottom Profiler

Information concerning subsurface stratigraphy was explored through use of an EdgeTech 3100 "Chirp" subbottom profiler system operating at frequencies of 2 to 16 kilohertz. The subbottom profiler consists of three components: the deck unit (XStar topside computer, amplifier, monitor, keyboard, and trackball), an underwater cable, and a Model SB216 towed vehicle housing the transducers. Data are acquired, logged, and displayed using the Discover Subbottom software.

The 3100 Chirp sonar is a versatile subbottom profiler that generates cross-sectional images and collects normal incidence reflection data over many frequency ranges. The system transmits and receives an FM pulse signal generated via a streamlined towed vehicle (subsurface transducer array). The outgoing FM pulse is linearly swept over a full spectrum range of 2-16 kHz for a period of approximately 20 milliseconds. The acoustic return received at the hydrophone array is cross-correlated with the outgoing FM pulse and sent to the deck unit for display and archiving, generating a high-resolution image of the subbottom stratigraphy. Because the FM pulse is generated by a converter with a wide dynamic range and a transmitter with linear components, the energy, amplitude, and phase characteristics of the acoustic pulse can be precisely controlled and enhanced.

During data acquisition, all records were annotated with relevant supporting information, field observations, line number, run number, navigation event marks and numbers for later interpretation and correlation with vessel position data.

APPENDIX 2

DATA PROCESSING AND ANALYSIS METHODS

Navigation Data

Hydrographic Data

Magnetometer Data

Side Scan Sonar Data

Chirp Subbottom Profile Data

DATA PROCESSING AND ANALYSIS METHODS

Navigation Data

During the field investigation, vessel navigation files were continuously processed and entered into AutoCAD drawings to verify survey coverage and assist with the onsite review of geophysical data. Upon completion of the field work, vessel tracklines were exported utilizing the HYPACK software as a DXF file and entered into the AutoCAD drawing files to show survey coverage.

Hydrographic Data

Upon completion of the field work, the single beam data were processed using HYPACK single beam editor. Digital depth data were first checked against the graphic sounding records for verification of depth quality. Digital "noise" caused by floating and drifting debris, air bubbles from passing ship's wake, or fish in the water column were filtered out of the data. The editing process is performed with care to eliminate points attributed to objects in the water column (fish, floating line, etc.) while preserving small features important to the project (potential obstructions). The digital files containing vessel position and hydrographic data were then processed to correct for field calibrations and adjust the sounding data to the required datum.

Depth data points were exported out of HYPACK and used to generate surface models that placed the depth data into cell bins of a sufficient size to preserve the features of interest. Shaded rendering maps were generated within the software program Global Mapper, Version 10. The processed x, y, z data for the survey areas were then contoured at an appropriate interval using Quicksurf operating within AutoCAD (Autodesk).

Magnetic Intensity Measurements

The objective of the magnetic survey was to locate any ferrous objects lying on or buried beneath the seafloor within the project site. Anomalies of man-made origin typically have short wavelengths and high amplitudes. In contrast, most geological features generate anomalies that are large in amplitude and often cover a much greater area. Magnetometer data were initially processed with HYPACK software package Single Beam Editor and then contoured utilizing the Geometrics' software package MagPick (V. 3.2). Magnetic anomaly tables were constructed based on a review of the processed data.

For discrete anomalies, determination of the location of the anomaly-producing object depends upon whether the anomaly is an apparent monopole or dipole and upon whether or not the magnetometer passed directly over the object. A magnetic dipole can be thought of in terms of a common bar magnet having a positive and a negative pole. Monopoles arise when the magnetometer senses only one pole of a dipole. This situation most commonly arises when the distance between opposite poles of a dipole is greater than the distance between the magnetometer sensor and the sensed pole or when a dipole is oriented nearly perpendicular to the ambient field thus shielding one pole from detection. For dipolar anomalies, the closest point of detection of the related object is determined to be at the point of maximum gradient between the two poles. Whereas the closest point of detection for objects which exhibit monopolar characteristics is typically the peak of maximum fluctuation.

Side Scan Sonar Imagery

Side scan sonar mosaics were created using Chesapeake Technologies, Inc. SonarWiz Version 5.03 software. Imagery was reviewed and interpreted to detect individual targets with the intent of identifying any man-made objects. This served two purposes: it provided information on potential obstructions and data to support the marine archaeological assessment of the area. Each target is interpreted and measured individually. A spreadsheet summarizes specific information for each target such as ID number, position, size, relief, brief description, and magnetic associations. The target positions were also imported in AutoCAD and plotted in plan view.

Chirp Subbottom Profile Data

Subbottom profile data were processed (filtered and gain applied) to generate jpeg images of the data utilizing EdgeTech's Discover-Sub-Bottom, Version 3.36, software package. Subsurface data were analyzed to understand current subsurface conditions in the area and map potential relict landforms and channels in the project area. This interpretation is presented as an overlay to the survey trackline plot presented on Drawing 1.

APPENDIX 3

MAGNETIC ANOMALIES & SIDE SCAN SONAR TARGET TABLES

MAGNETIC ANOMALIES

Magnetic Anomaly	Easting[1]	Northing[1]	Type[2]	Amplitude[3]	Duration (feet)	Sensor Height (feet)	Associated Sonar Target
M1	3684616	235975	M-	5	45	14	
M2	3685507	235436	D	4	83	14	
M3	3685230	236632	D	8	61	12	
M4	3686334	236782	M-	38	69	13	
M5	3686599	237256	M-	8	101	13	SS16
M6	3688669	235282	D	5	71	16	
M7	3687946	237089	D	3	66	14	
M8	3688044	236945	M-	13	85	14	
M9	3688191	236751	M+	2	68	14	
M10	3688498	236335	M-	3	71	14	
M11	3688857	235856	D	9	77	15	
M12	3685399	237727	M-	6	58	13	
M13	3683108	240487	D	7	79	12	
M14	3684081	239175	M+	5	54	14	
M15	3683201	241023	M+	5	53	13	
M16	3684355	239465	M-	8	39	12	
M17	3684540	239542	D	6	96	13	SS33
M18	3680179	244929	M+	26	40	3	
M19	3679686	245098	M-	91	23	2	
M20	3679719	245064	M-	43	20	2	
M21	3680562	244094	D	26	230	5	
M22	3680245	244517	D	6	32	4	
M23	3679981	244870	M+	17	18	2	
M24	3679903	244970	M-	27	25	2	
M25	3680604	244196	M+	2276	71	6	
M26	3680736	244027	M+	10	38	6	
M27	3682655	241923	D	35	95	13	
M28	3680915	244272	M-	12	28	6	
M29	3680314	245082	M-	12	44	2	
M30	3680274	245132	M+	23	38	2	
M31	3680208	245220	M-	43	26	2	
M32	3680146	245143	M+	220	23	3	
M33	3680577	244567	D	24	19	3	
M34	3682719	241673	M+	10	47	12	
M35	3679997	245107	M-	16	13	2	

Magnetic Anomaly	Easting[1]	Northing[1]	Type[2]	Amplitude[3]	Duration (feet)	Sensor Height (feet)	Associated Sonar Target
M36	3680096	245171	D	36	16	2	
M37	3680236	245267	M+	388	21	2	
M38	3685373	237879	D	8	59	13	
M39	3686623	238170	M+	6	65	12	SS5
M40	3687520	236975	M+	5	35	13	SS12
M41	3687093	236656	M+	4	61	14	
M42	3686322	236973	M+	3	41	15	
M43	3685681	234867	D	3	42	16	
M44	3685176	236049	M+	7	49	13	
M45	3685912	235218	M+	4	78	13	
M46	3685341	235987	M+	3	27	14	
M47	3685136	236927	M+	3	62	15	
M48	3685887	235913	M+	3	39	14	
M49	3685922	235867	M+	3	41	15	
M50	3685616	236764	D	5	64	14	
M51	3686281	236367	M-	3	43	14	
M52	3687718	234757	M+	8	69	14	
M53	3687425	235151	M-	16	44	14	
M54	3687244	236227	D	4	52	14	
M55	3686683	237308	M+	7	113	14	SS16
M56	3687430	236628	M+	4	55	14	
M57	3686653	238163	M+	121	78	14	SS5
M58	3688514	235658	D	42	69	11	
M59	3686956	237913	M+	7	71	14	
M60	3688120	236675	M+	142	79	13	
M61	3688947	235881	D	131	127	13	
M62	3688637	236131	D	9	69	12	
M63	3687937	237090	M+	4	40	13	
M64	3689084	235862	D	10	80	15	
M65	3687274	238307	D	31	82	14	

1 - Coordinates are in feet and are referenced to the Louisiana State Plane South Zone (LA-1702).

2 - +M - positive monopole, -M - negative monopole, D - Dipole.

3 - Amplitude is measured in gammas.

SIDE SCAN SONAR TARGETS

Sonar Target	Easting[1]	Northing[1]	Length[2]	Width[2]	Height[2]	Description	Associated Magnetic Anomaly
SS1	3688921	235370	12.0	7.2	0.3	Oblong target	
SS2	3688520	235927	16.7	1.4	NA	Linear target	
SS3	3688551	235678	13.6	1.1	1.8	Linear target	
SS4	3688665	235308	30.9	14.0	NA	Oblong target	
SS5	3686599	238177	139.7	1.1	NA	Linear target	M39, M57
SS6	3688148	235729	17.1	10.8	0.2	Oblong target	
SS7	3688925	235873	83.6	1.9	NA	Possible linear target	
SS8	3688468	236344	12.6	4.7	NA	Oblong target	
SS9	3687054	238322	11.9	5.5	NA	Oblong target	
SS10	3687099	238126	9.3	1.7	1.1	Oblong target	
SS11	3688141	236660	9.4	2.2	NA	Possible oblong target	
SS12	3687530	236948	24.0	3.9	NA	Oblong target	M40
SS13	3687257	237369	19.2	2.2	NA	Oblong target	
SS14	3686465	238166	42.8	0.8	NA	Linear target?	
SS15	3688271	235556	22.3	6.1	NA	Oblong target	
SS16	3686658	237282	15.9	10.4	NA	Oblong target	M5, M55
SS17	3688140	235186	19.2	4.9	NA	Oblong target	
SS18	3687300	236265	21.8	6.3	NA	Oblong target	
SS19	3686380	237492	21.9	7.1	NA	Oblong target	
SS20	3687646	235534	11.2	0.7	0.2	Linear target	
SS21	3687579	235513	13.6	4.7	NA	Oblong target	
SS22	3687260	235711	13.2	1.0	NA	Linear target	
SS23	3686008	237381	20.4	2.2	NA	Linear target	

Sonar Target	Easting[1]	Northing[1]	Length[2]	Width[2]	Height[2]	Description	Associated Magnetic Anomaly
SS24	3685902	237353	10.8	2.6	NA	Oblong target	
SS25	3686988	235019	9.5	3.5	NA	Oblong target	
SS26	3686383	235877	8.1	1.0	NA	Linear target	
SS27	3685621	236780	9.3	4.8	NA	Oblong target	
SS28	3686953	234726	13.4	1.7	NA	Linear target	
SS29	3685262	236644	4.3	2.8	NA	Oblong target	
SS30	3686948	234328	8.0	2.5	NA	Oblong target	
SS31	3685183	235330	3.1	1.3	NA	2 small oblong targets	
SS32	3684279	239829	154.9	1.2	NA	Linear feature - drag mark or line?	
SS33	3684552	239532	151.5	1.5	NA	Linear target - line?	M17
SS34	3680359	244905	23.3	7.8	NA	Oblong target	
SS35	3681358	243447	10.0	6.1	NA	Oblong target	
SS37	3685254	237776	5.2	1.2	0.3	Oblong target	
SS38	3684394	238715	4.9	2.4	NA	Oblong target	
SS39	3684928	237917	2.1	1.2	1.8	Oblong target	

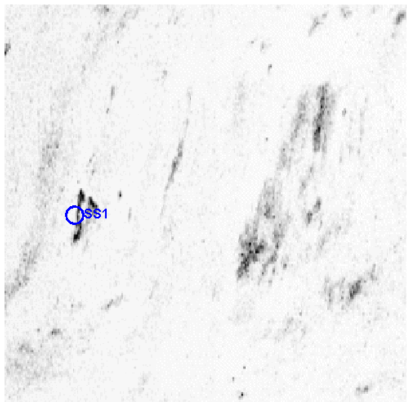
1 - Coordinates are in feet and are referenced to the Louisiana State Plane South Zone (LA-1702).

2 - All measurements are in feet.

Side Scan Sonar Target Report

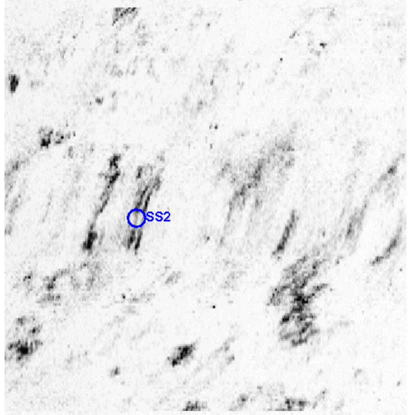
CAM II Offshore No. 3 Pump-Out Area and Conveyance Corridor

Contact Image | **Contact Info** | **User Entered Info**



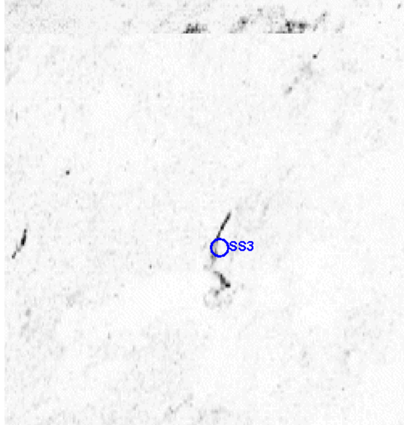
SS1
(X) 3688921 (Y) 235370

Dimensions
Target Height: 0.3 US Feet
Target Length: 12.0 US Feet
Target Width: 7.2 US Feet
Mag Anomaly:
Description: Oblong target



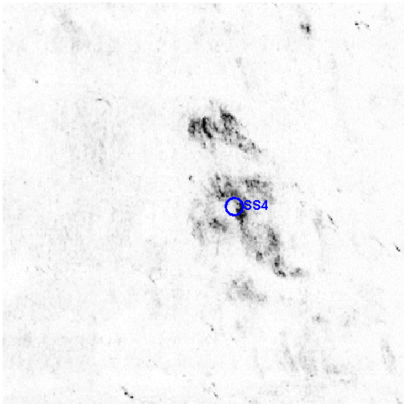
SS2
(X) 3688520 (Y) 235927

Dimensions
Target Height: NA
Target Length: 16.7 US Feet
Target Width: 1.4 US Feet
Mag Anomaly:
Description: Linear target



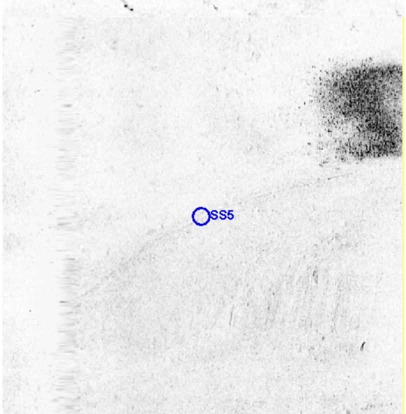
SS3
(X) 3688551 (Y) 235678

Dimensions
Target Height: 1.8 US Feet
Target Length: 13.6 US Feet
Target Width: 1.1 US Feet
Mag Anomaly:
Description: Linear target



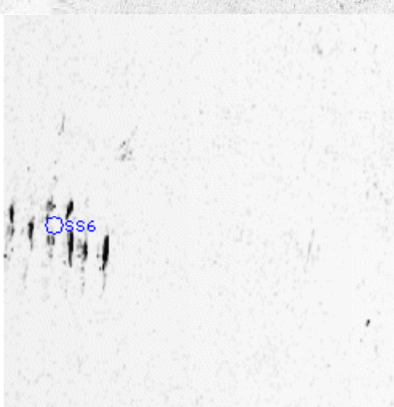
SS4
(X) 3688665 (Y) 235308

Dimensions
Target Height: NA
Target Length: 30.9 US Feet
Target Width: 14.0 US Feet
Mag Anomaly:
Description: Oblong target



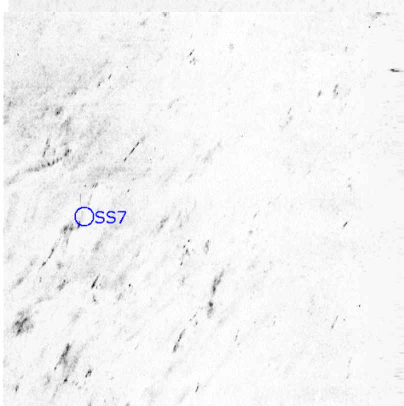
SS5
(X) 3686599 (Y) 238177

Dimensions
Target Height: NA
Target Length: 139.7 US Feet
Target Width: 1.1 US Feet
Mag Anomaly: M39, M57
Description: Linear target



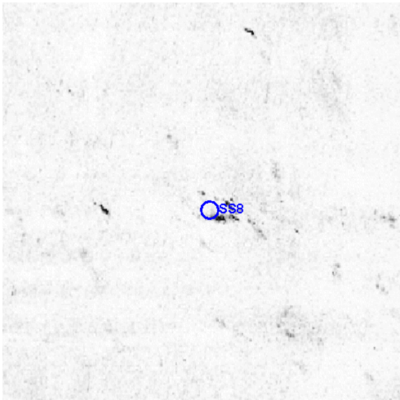
SS6
(X) 3688148 (Y) 235729

Dimensions
Target Height: 0.2 US Feet
Target Length: 17.1 US Feet
Target Width: 10.8 US Feet
Mag Anomaly:
Description: Oblong target



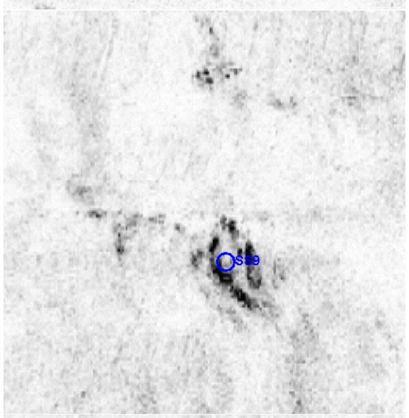
SS7
(X) 3688925 (Y) 235873

Dimensions
Target Height: NA
Target Length: 83.6 US Feet
Target Width: 1.9 US Feet
Mag Anomaly:
Description: Possible linear target



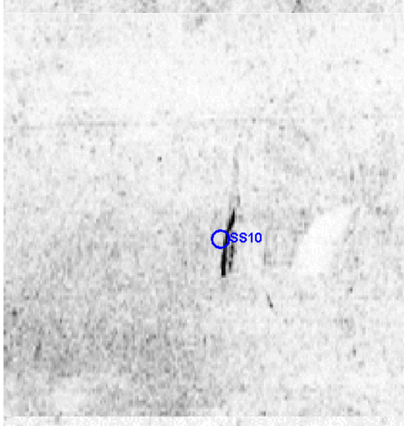
SS8
(X) 3688468 (Y) 236344

Dimensions
Target Height: NA
Target Length: 12.6 US Feet
Target Width: 4.7 US Feet
Mag Anomaly:
Description: Oblong target



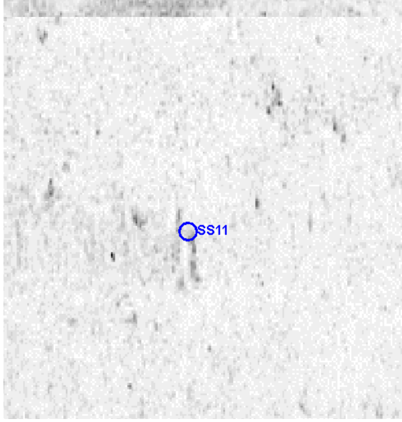
SS9
(X) 3687054 (Y) 238322

Dimensions
Target Height: NA
Target Length: 11.9 US Feet
Target Width: 5.5 US Feet
Mag Anomaly:
Description: Oblong target



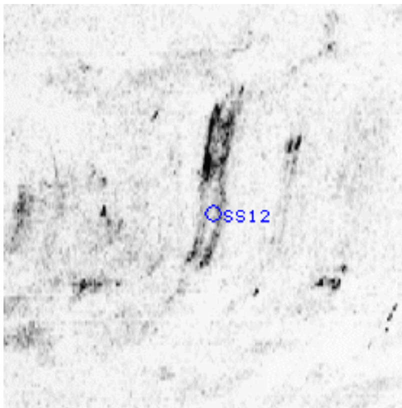
SS10
(X) 3687099 (Y) 238126

Dimensions
Target Height: 1.1 US Feet
Target Length: 9.3 US Feet
Target Width: 1.7 US Feet
Mag Anomaly:
Description: Oblong target



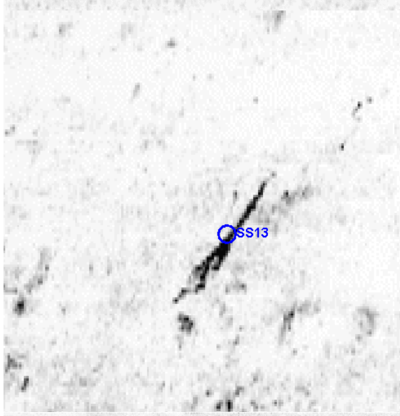
SS11
(X) 3688141 (Y) 236660

Dimensions
Target Height: NA
Target Length: 9.4 US Feet
Target Width: 2.2 US Feet
Mag Anomaly:
Description: Possible oblong target



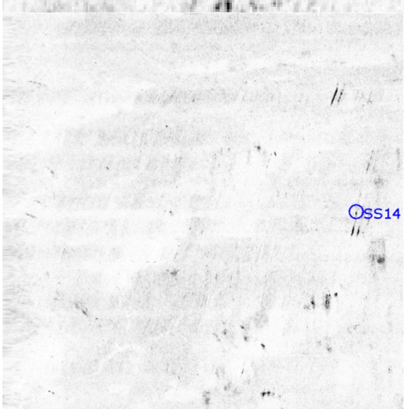
SS12
(X) 3687530 (Y) 236948

Dimensions
Target Height: NA
Target Length: 24.0 US Feet
Target Width: 3.9 US Feet
Mag Anomaly: M40
Description: Oblong target



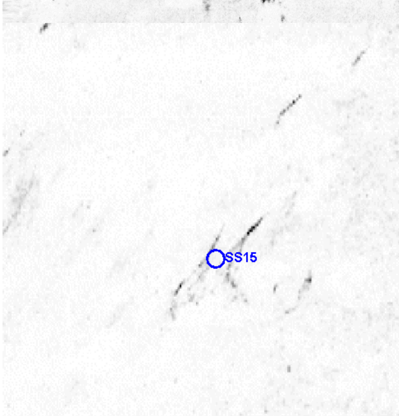
SS13
(X) 3687257 (Y) 237369

Dimensions
Target Height: NA
Target Length: 19.2 US Feet
Target Width: 2.2 US Feet
Mag Anomaly:
Description: Oblong target



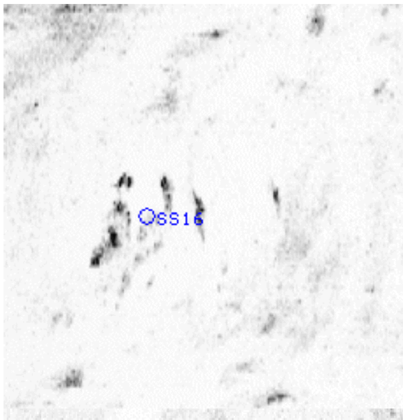
SS14
(X) 3686465 (Y) 238166

Dimensions
Target Height: NA
Target Length: 42.8 US Feet
Target Width: 0.8 US Feet
Mag Anomaly:
Description: Linear target?



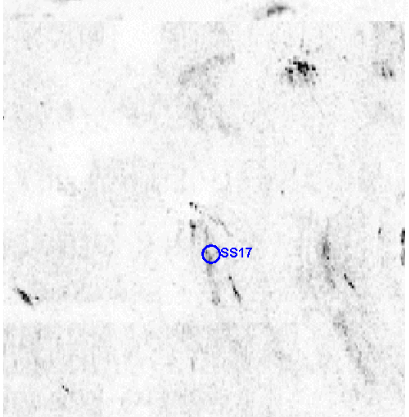
SS15
(X) 3688271 (Y) 235556

Dimensions
Target Height: NA
Target Length: 22.3 US Feet
Target Width: 6.1 US Feet
Mag Anomaly:
Description: Oblong target



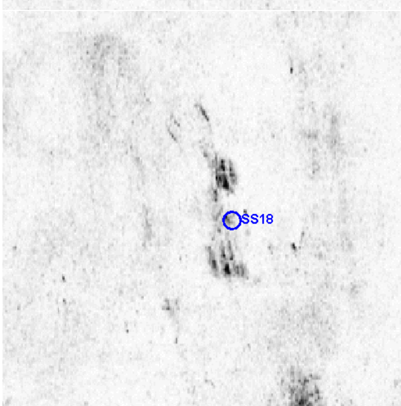
SS16
(X) 3686658 (Y) 237282

Dimensions
Target Height: NA
Target Length: 15.9 US Feet
Target Width: 10.4 US Feet
Mag Anomaly: M5, M55
Description: Oblong target



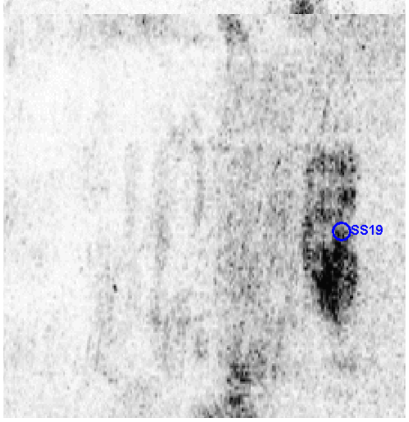
SS17
(X) 3688140 (Y) 235186

Dimensions
Target Height: NA
Target Length: 19.2 US Feet
Target Width: 4.9 US Feet
Mag Anomaly:
Description: Oblong target



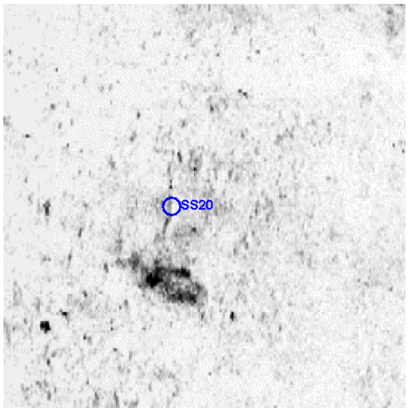
SS18
(X) 3687300 (Y) 236265

Dimensions
Target Height: NA
Target Length: 21.8 US Feet
Target Width: 6.3 US Feet
Mag Anomaly:
Description: Oblong target



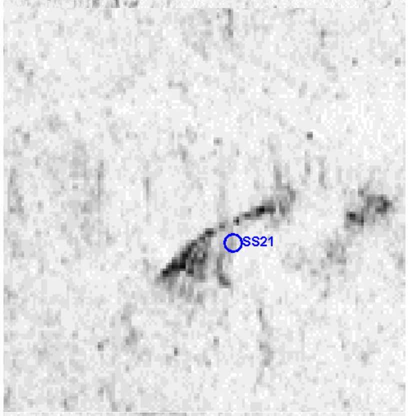
SS19
(X) 3686380 (Y) 237492

Dimensions
Target Height: NA
Target Length: 21.9 US Feet
Target Width: 7.1 US Feet
Mag Anomaly:
Description: Oblong target



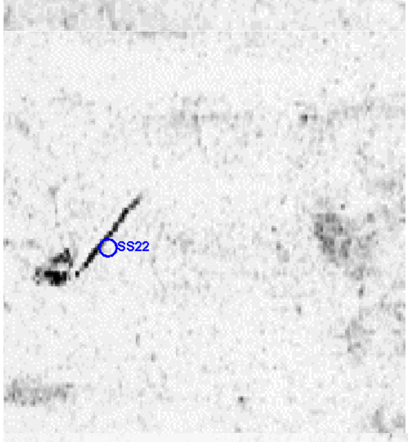
SS20
(X) 3687646 (Y) 235534

Dimensions
Target Height: 0.2 US Feet
Target Length: 11.2 US Feet
Target Width: 0.7 US Feet
Mag Anomaly:
Description: Linear target



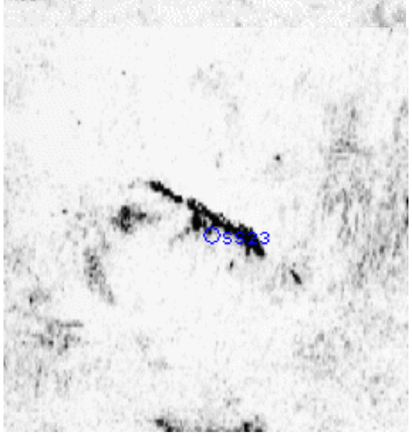
SS21
(X) 3687579 (Y) 235513

Dimensions
Target Height: NA
Target Length: 13.6 US Feet
Target Width: 4.7 US Feet
Mag Anomaly:
Description: Oblong target



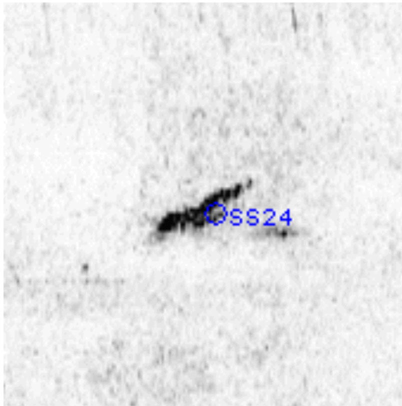
SS22
(X) 3687260 (Y) 235711

Dimensions
Target Height: NA
Target Length: 13.2 US Feet
Target Width: 1.0 US Feet
Mag Anomaly:
Description: Linear target



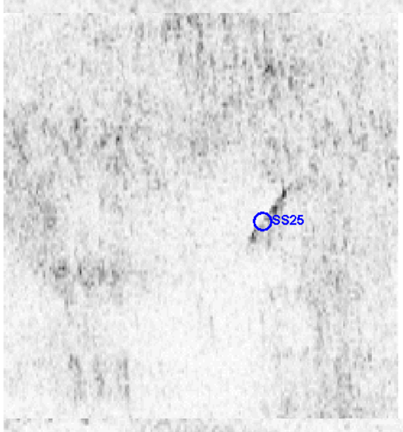
SS23
(X) 3686008 (Y) 237381

Dimensions
Target Height: NA
Target Length: 20.4 US Feet
Target Width: 2.2 US Feet
Mag Anomaly:
Description: Linear target



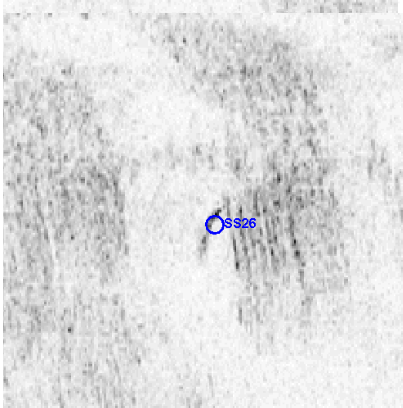
SS24
(X) 3685902 (Y) 237353

Dimensions
Target Height: NA
Target Length: 10.8 US Feet
Target Width: 2.6 US Feet
Mag Anomaly:
Description: Oblong target



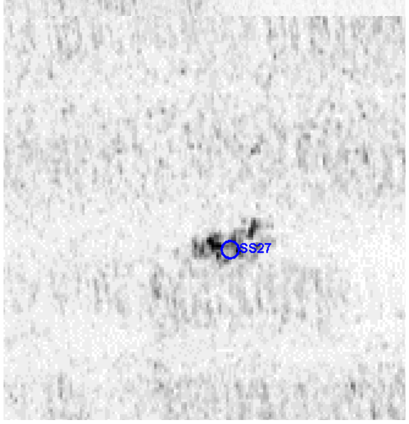
SS25
(X) 3686988 (Y) 235019

Dimensions
Target Height: NA
Target Length: 9.5 US Feet
Target Width: 3.5 US Feet
Mag Anomaly:
Description: Oblong target



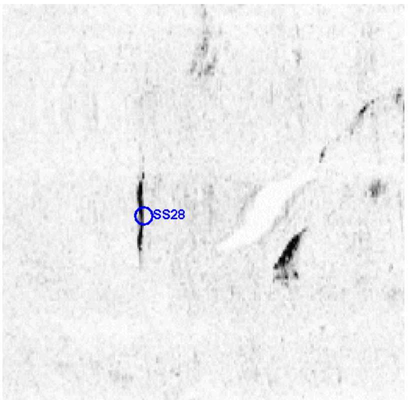
SS26
(X) 3686383 (Y) 235877

Dimensions
Target Height: NA
Target Length: 8.1 US Feet
Target Width: 1.0 US Feet
Mag Anomaly:
Description: Linear target



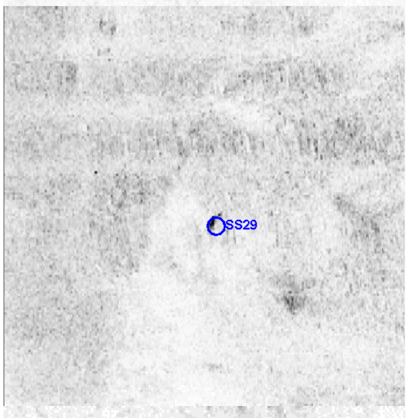
SS27
(X) 3685621 (Y) 236780

Dimensions
Target Height: NA
Target Length: 9.3 US Feet
Target Width: 4.8 US Feet
Mag Anomaly:
Description: Oblong target



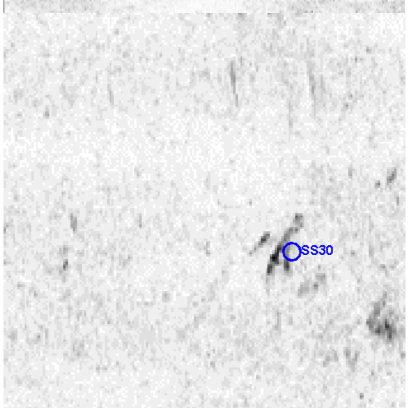
SS28
(X) 3686953 (Y) 234726

Dimensions
Target Height: NA
Target Length: 13.4 US Feet
Target Width: 1.7 US Feet
Mag Anomaly:
Description: Linear target



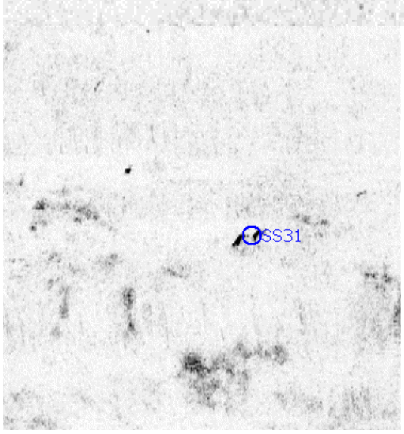
SS29
(X) 3685262 (Y) 236644

Dimensions
Target Height: NA
Target Length: 4.3 US Feet
Target Width: 2.8 US Feet
Mag Anomaly:
Description: Oblong target



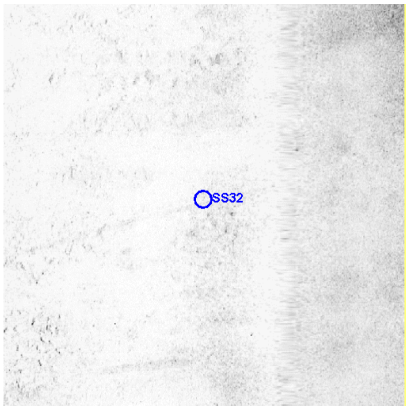
SS30
(X) 3686948 (Y) 234328

Dimensions
Target Height: NA
Target Length: 8.0 US Feet
Target Width: 2.5 US Feet
Mag Anomaly:
Description: Oblong target



SS31
(X) 3685183 (Y) 235330

Dimensions
Target Height: NA
Target Length: 3.1 US Feet
Target Width: 1.3 US Feet
Mag Anomaly:
Description: 2 small oblong targets

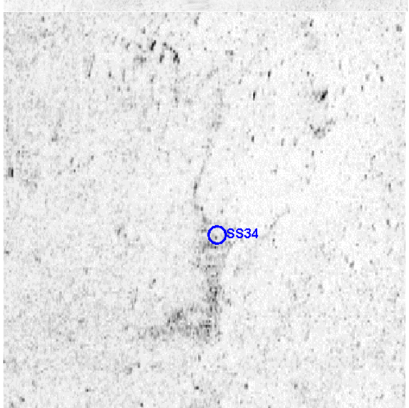


SS32
(X) 3684279 (Y) 239829

Dimensions
Target Height: NA
Target Length: 154.9 US Feet
Target Width: 1.2 US Feet
Mag Anomaly:
Description: Linear feature - drag mark or line?

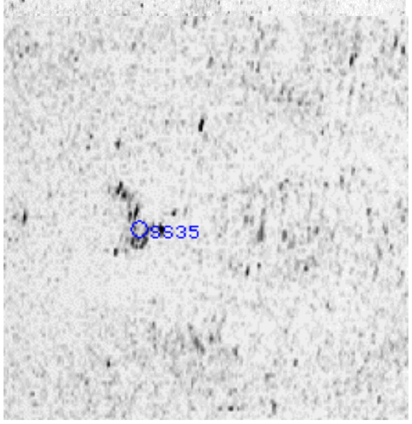
SS33
(X) 3684552 (Y) 239532

Dimensions
Target Height: NA
Target Length: 151.5 US Feet
Target Width: 1.5 US Feet
Mag Anomaly: M17
Description: Linear target - line?



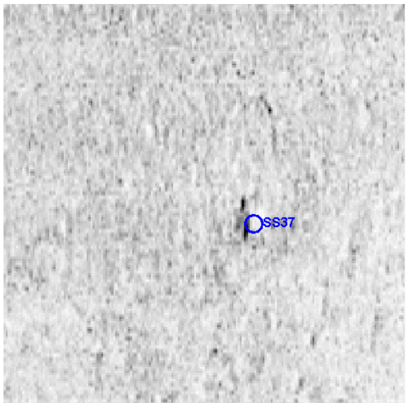
SS34
(X) 3680359 (Y) 244905

Dimensions
Target Height: NA
Target Length: 23.3 US Feet
Target Width: 7.8 US Feet
Mag Anomaly:
Description: Oblong target



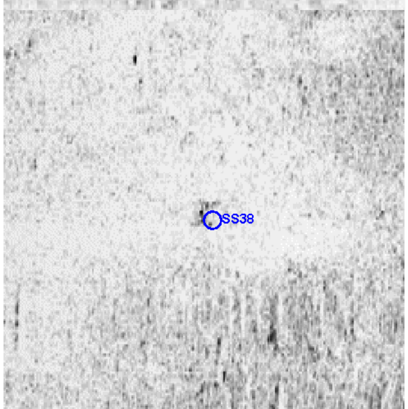
SS35
(X) 3681358 (Y) 243447

Dimensions
Target Height: NA
Target Length: 10.0 US Feet
Target Width: 6.1 US Feet
Mag Anomaly:
Description: Oblong target



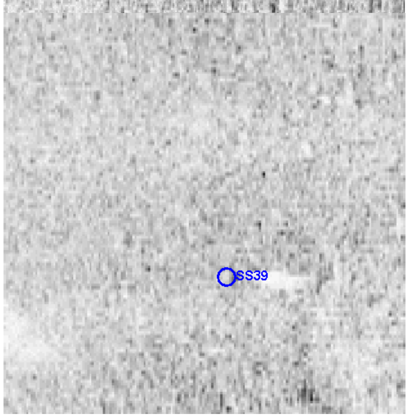
SS37
(X) 3685254 (Y) 237776

Dimensions
Target Height: 0.3 US Feet
Target Length: 4.9 US Feet
Target Width: 1.2 US Feet
Mag Anomaly:
Description: Oblong target



SS38
(X) 3684394 (Y) 238715

Dimensions
Target Height: NA
Target Length: 4.9 US Feet
Target Width: 2.4 US Feet
Mag Anomaly:
Description: Oblong target

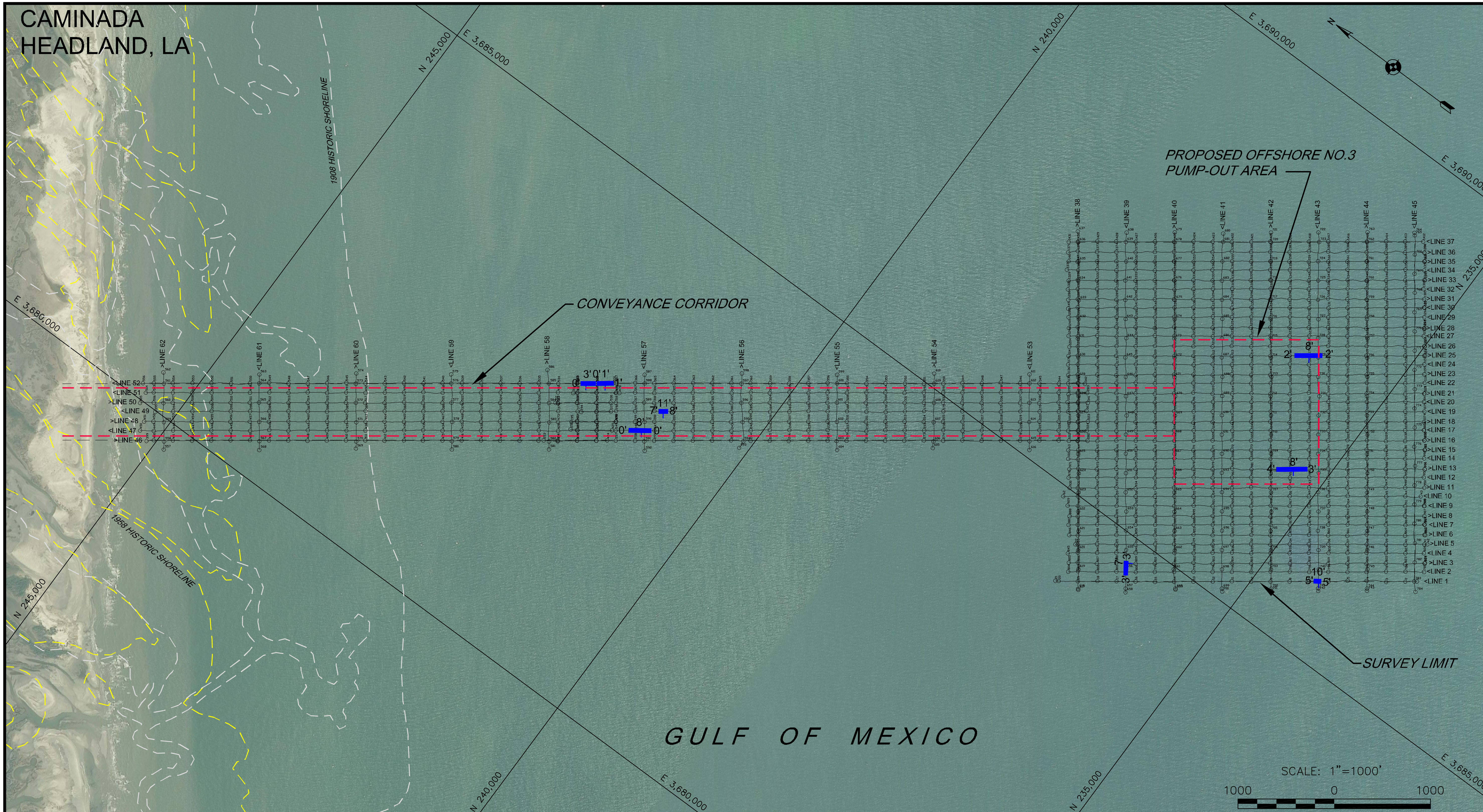


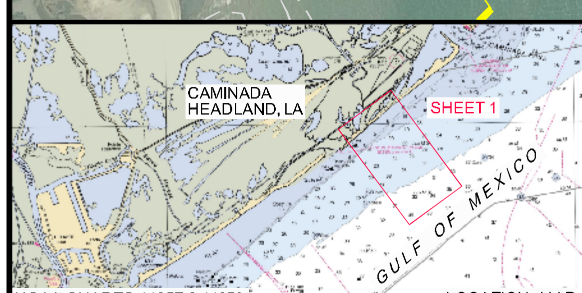
SS39
(X) 3684928 (Y) 237917

Dimensions
Target Height: 1.8 US Feet
Target Length: 2.1 US Feet
Target Width: 1.2 US Feet
Mag Anomaly:
Description: Oblong target

APPENDIX 4

PROJECT DRAWINGS





NOTES

1. GRID SYSTEM IS IN FEET AND IS THE LOUISIANA STATE PLANE COORDINATE SYSTEM, ZONE 1702, NAD 83.
2. LAND IMAGERY ARE PORTIONS OF DIGITAL ORTHOPHOTO QUADRANGLES OBTAINED FROM THE UNITED STATES GEOLOGICAL SURVEY (USGS).
3. 1908 AND 1958 HISTORIC SHORELINES ARE BASED ON NOAA CHART NUMBER 196 (DATED SEPTEMBER 1908) AND 1050 (DATED OCTOBER 1958).
4. THE INFORMATION PRESENTED ON THIS DRAWING REPRESENTS THE RESULTS OF A SURVEY PERFORMED BY OCEAN SURVEYS, INC. DURING THE PERIOD OF 24–25 AND 29 APRIL 2012 AND CAN ONLY BE CONSIDERED AS INDICATING THE CONDITIONS EXISTING DURING THAT TIME. REUSE OF THIS INFORMATION BY CLIENT OR OTHERS BEYOND THE SPECIFIC SCOPE OF WORK FOR WHICH IT WAS ACQUIRED SHALL BE AT THE SOLE RISK OF THE USER AND WITHOUT LIABILITY TO OSI.

LEGEND

<LINE 59 — SURVEY VESSEL TRACKLINE WITH LINE NUMBER & DIRECTION

0' 3'0'1' 1' — POSSIBLE PALEO CHANNEL (DEPTH BELOW SURFACE)

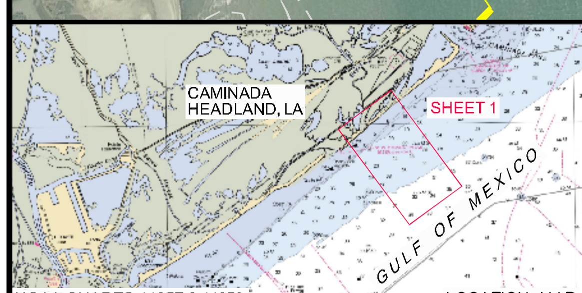
OCEAN SURVEYS, INC.
OLD SAYBROOK, CONNECTICUT

PREPARED FOR: COASTAL ENGINEERING CONSULTANTS, INC.

TRACKLINES

PROPOSED OFFSHORE NO.3 PUMP-OUT AREA &
CONVEYANCE CORRIDOR
GULF OF MEXICO
CAMINADA HEADLAND, LOUISIANA

DRAWING 1 SHEET 1 OF 1
OSI JOB NO. 12ES018



NOTES

1. GRID SYSTEM IS IN FEET AND IS THE LOUISIANA STATE PLANE COORDINATE SYSTEM, ZONE 1702, NAD 83.
2. DEPTHS ARE IN FEET AND ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88). WATER DEPTHS WERE ADJUSTED TO THE PROJECT DATUM BASED ON NOAA PREDICTED TIDES AT PORT FOURCHON (STATION ID 8762075). CEC PROVIDED THE CONVERSION TO NAVD88 BASED ON AN INSTALLED TIDE GAUGE AT PORT FOURCHON: 0 FEET MLLW = +0.48 FEET NAVD88.
3. CONTOUR INTERVAL IS 1 FOOT. CONTOURS WERE COMPUTER GENERATED USING "QUICKSURF" VERSION 5.1 (SCHREIBER INSTRUMENTS, INC.) OPERATING WITHIN "AUTOCAD" VERSION 2004 (AUTODESK).
4. LAND IMAGERY ARE PORTIONS OF DIGITAL ORTHOPHOTO QUADRANGLES OBTAINED FROM THE UNITED STATES GEOLOGICAL SURVEY (USGS).
5. 1908 AND 1958 HISTORIC SHORELINES ARE BASED ON NOAA CHART NUMBER 196 (DATED SEPTEMBER 1908) AND 1050 (DATED OCTOBER 1958).
6. THE INFORMATION PRESENTED ON THIS DRAWING REPRESENTS THE RESULTS OF A SURVEY PERFORMED BY OCEAN SURVEYS, INC. DURING THE PERIOD OF 24–25 AND 29 APRIL 2012 AND CAN ONLY BE CONSIDERED AS INDICATING THE CONDITIONS EXISTING DURING THAT TIME. REUSE OF THIS INFORMATION BY CLIENT OR OTHERS BEYOND THE SPECIFIC SCOPE OF WORK FOR WHICH IT WAS ACQUIRED SHALL BE AT THE SOLE RISK OF THE USER AND WITHOUT LIABILITY TO OSI.

LEGEND

——10—— HYDROGRAPHIC CONTOURS (CONTOUR INTERVAL = 1 FOOT)

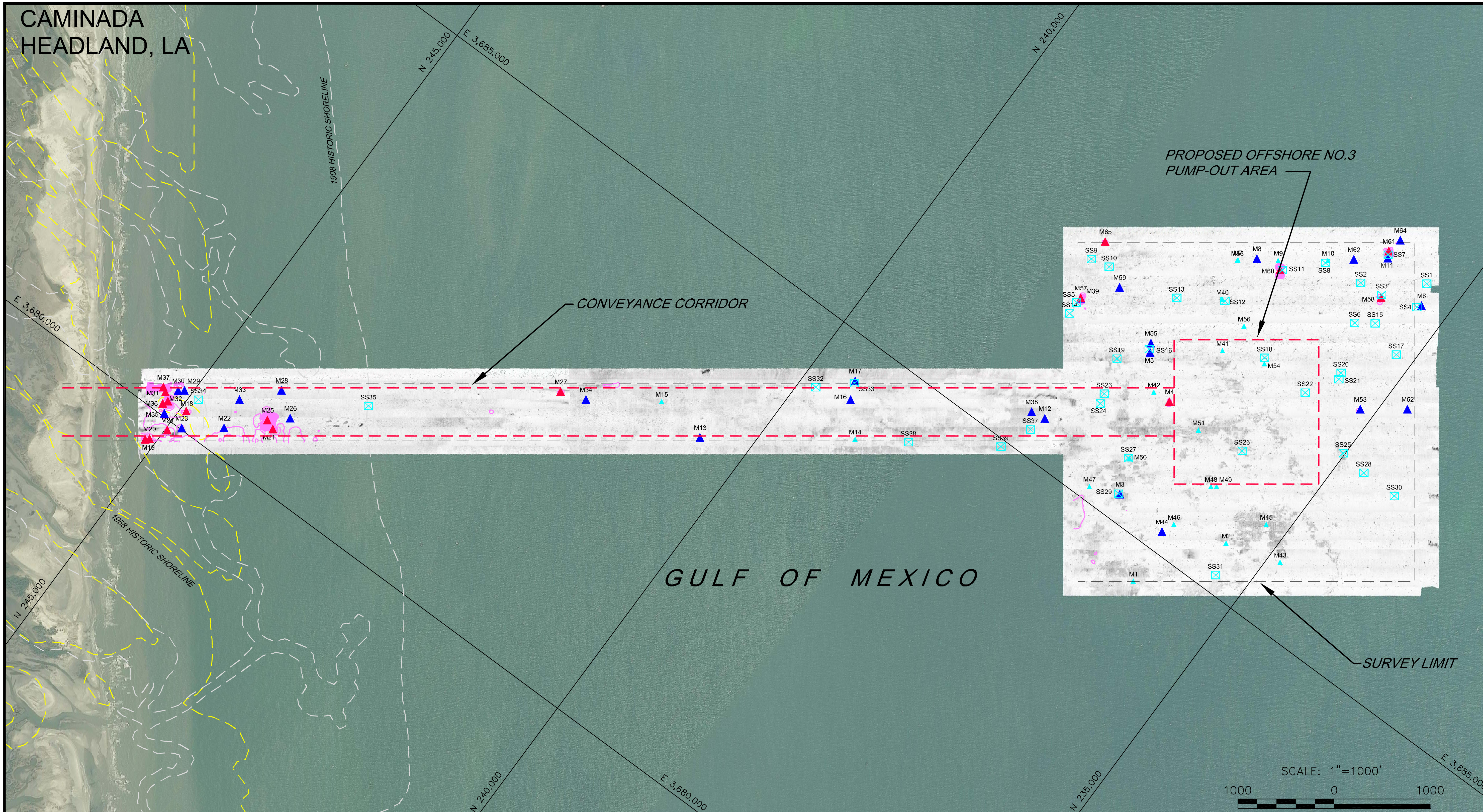
OCEAN SURVEYS, INC.
OLD SAYBROOK, CONNECTICUT

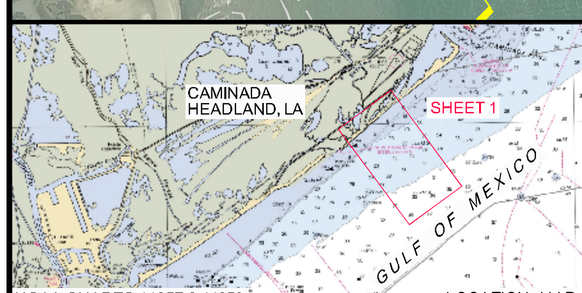
PREPARED FOR: COASTAL ENGINEERING CONSULTANTS, INC.

HYDROGRAPHY

PROPOSED OFFSHORE NO.3 PUMP-OUT AREA &
CONVEYANCE CORRIDOR
GULF OF MEXICO
CAMINADA HEADLAND, LOUISIANA

DRAWING 2 SHEET 1 OF 1
OSI JOB NO. 12ES018





NOTES

1. GRID SYSTEM IS IN FEET AND IS THE LOUISIANA STATE PLANE COORDINATE SYSTEM, ZONE 1702, NAD 83.
2. GEOLOGICAL INTERPRETATIONS ARE BASED ON THE ANALYSIS OF HYDROGRAPHIC, SIDE SCAN SONAR, MAGNETOMETER AND SUBBOTTOM PROFILE DATA. FOR ADDITIONAL INFORMATION REGARDING THE INTERPRETATION PRESENTED REFER TO OSI FINAL REPORT NO. 12ES018.
3. CONTOUR INTERVAL IS 5 GAMMAS. MAGNETIC FIELD CONTOURS WERE COMPUTER GENERATED USING MAGPICK VERSION 3.2 GEOMETRICS.
4. LAND IMAGERY ARE PORTIONS OF DIGITAL ORTHOPHOTO QUADRANGLES OBTAINED FROM THE UNITED STATES GEOLOGICAL SURVEY (USGS).
5. 1908 AND 1958 HISTORIC SHORELINES ARE BASED ON NOAA CHART NUMBER 196 (DATED SEPTEMBER 1908) AND 1050 (DATED OCTOBER 1958).
6. THE INFORMATION PRESENTED ON THIS DRAWING REPRESENTS THE RESULTS OF A SURVEY PERFORMED BY OCEAN SURVEYS, INC. DURING THE PERIOD OF 24–25 AND 29 APRIL 2012 AND CAN ONLY BE CONSIDERED AS INDICATING THE CONDITIONS EXISTING DURING THAT TIME. REUSE OF THIS INFORMATION BY CLIENT OR OTHERS BEYOND THE SPECIFIC SCOPE OF WORK FOR WHICH IT WAS ACQUIRED SHALL BE AT THE SOLE RISK OF THE USER AND WITHOUT LIABILITY TO OSI.

LEGEND

SS93 — SIDE SCAN SONAR TARGET

MAGNETIC ANOMALY CLASSIFICATIONS

M207 — < 5 GAMMAS
M191 — 5 - 25 GAMMAS
M168 — > 25 GAMMAS
MAGNETIC FIELD CONTOURS (CONTOUR INTERVAL = 5 GAMMAS)

OCEAN SURVEYS, INC.
OLD SAYBROOK, CONNECTICUT

PREPARED FOR: COASTAL ENGINEERING CONSULTANTS, INC.

SIDE SCAN SONAR MOSAIC & RESIDUAL MAGNETIC FIELD CONTOURS
PROPOSED OFFSHORE NO.3 PUMP-OUT AREA & CONVEYANCE CORRIDOR
GULF OF MEXICO
CAMINADA HEADLAND, LOUISIANA

DRAWING 3 SHEET 1 OF 1
OSI JOB NO. 12ES018