Archeological Remote-Sensing Survey for Placement of an Artificial Reef in High Island Block A323

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Archeological Remote-Sensing Survey for Placement of an Artificial Reef in High Island Block A323

U.S. Army Corps of Engineers Permit Application No. SWG-2009-00930

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Contents

Figures

I. INTRODUCTION

In April 2010, Proserv Offshore, Inc., acting as agent for Apache Corporation, both of Houston, Texas, contracted PBS&J to conduct a marine remote-sensing archeological survey in offshore lease block High Island (HI) A323. This work was performed in support of U.S. Army Corps of Engineers (USACE) Permit Application No. SWG-2009-00930, filed by the Texas Parks and Wildlife Department (TPWD), Artificial Reef Program, requesting permission to create an artificial reef in the Gulf of Mexico. Apache Corporation intends to decommission petroleum platform HI A323 "A" adjacent to its existing location in order to establish an artificial reef habitat. The USACE, Galveston District, staff archeologist reviewed the permit area in accordance with 33 CFR Part 325, and, in consultation with the supervising Marine Archaeologist at Minerals Management Service (MMS), determined that Block HI A323 is a potential location for historic shipwrecks. According to the MMS Archaeological Resource Information database, a suspected shipwreck of unknown identity was located in an adjacent area during an industry lease block survey in 1995.

The survey covered a square area 8,000 feet (ft) (2,438 meters [m]) on a side (1,469 acres, total), which was centered on the proposed 40-acre reef location (Figure 1). The additional 1,429 acres of survey coverage was necessary to account for the anchor spreads of support vessels utilized during the decommissioning of Platform HI A323 "A" from its present location. The marine remote-sensing survey was conducted from April 18–21, 2010, by archeologists Bob Gearhart and Doug Jones of PBS&J, and survey equipment operators Justin Sandlin and Justin Naylor of Survey Equipment Services (SES). As a result, all but two targets were judged as insignificant. Magnetic anomalies (M1 and M2) and their associated sonar targets (S1 and S2) could not be ruled insignificant based on the survey data and thus have been recommended for avoidance by the proposed activities.

This study was conducted in order for TPWD to meet their requirements under Section 106 of the National Historic Preservation Act (NHPA). Section 106 requires federally funded or permitted projects to give due consideration to cultural resources. This investigation was conducted in compliance with the NHPA of 1966 (PL 89-665), as amended in 1974, 1976, 1980, and 1992; the National Environmental Policy Act of 1969 (PL 91-190, 83 Stat. 915 USC 4231, 1970); the Procedures for the Protection of Historic and Cultural Properties (36 CFR 800); the Federal Abandoned Shipwreck Act of 1987 (PL 100-298); and guidelines set forth by the MMS, the Texas Historical Commission (THC), the Council for Texas Archeologists, and the standards of the Register of Professional Archaeologists.

This report consists of six chapters. Chapter I is an introduction to the project and findings. Chapter II presents a brief description of the maritime history of the Gulf of Mexico, including the High Island area. Chapter III presents a description of the equipment and methods used for the remote-sensing data acquisition, processing, and analysis. Chapter IV provides the results of the magnetometer and sonar data analysis. Chapter V provides the conclusions and recommendations for the project. References cited in the report follow Chapter VI. A tabular description of potentially significant magnetic anomalies and sonar targets recorded in the survey area are included in an Appendix.

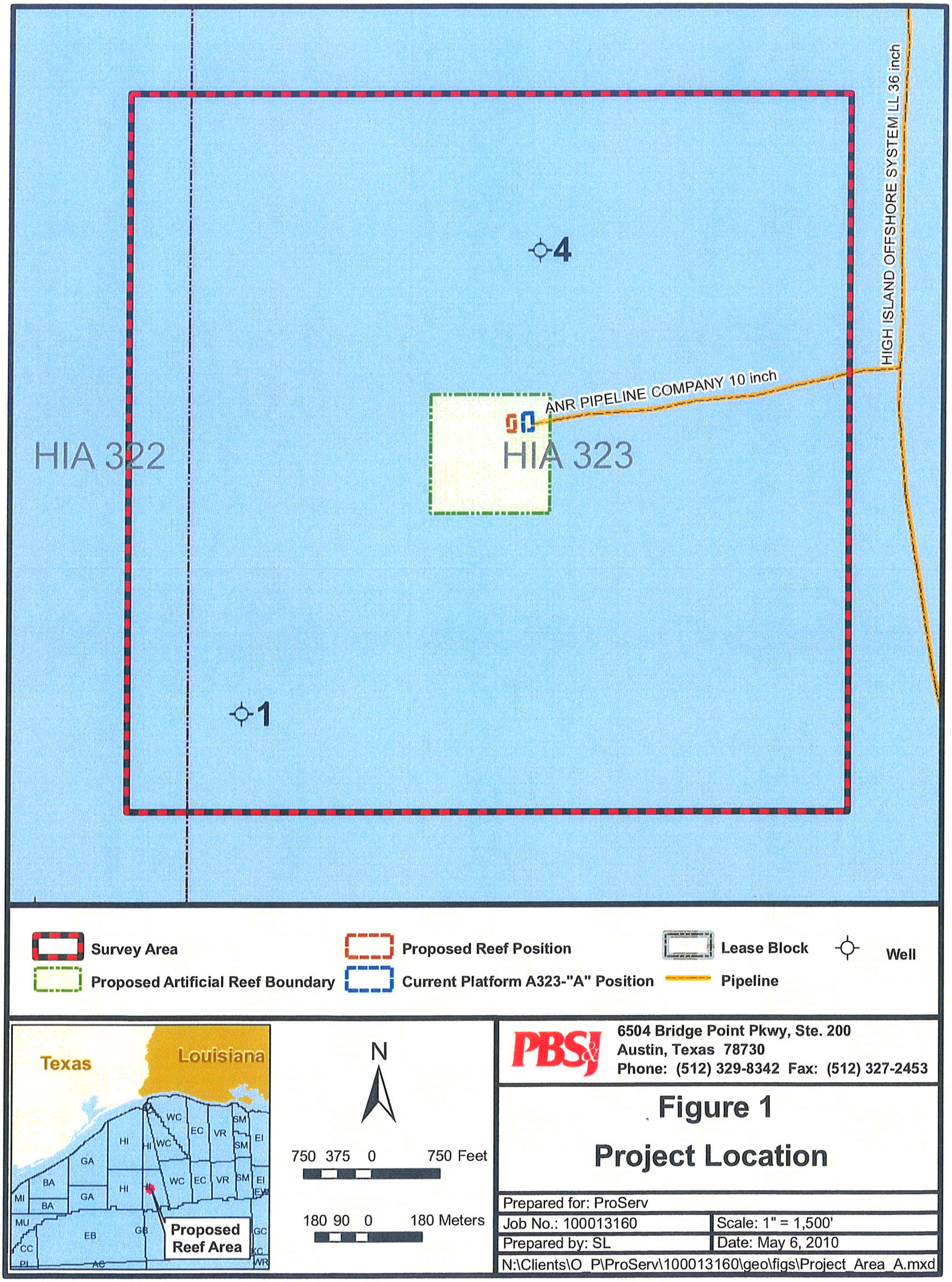

Figure 1

Project Location

II. MARITIME HISTORY OF THE GULF OF MEXICO

Historic navigation routes through the Gulf of Mexico, and, therefore, the potential for shipwrecks along those routes, date back more than five centuries, to the Pre-Columbian civilizations inhabiting the Mesoamerican coast. These native groups used large, oceangoing canoes in order to conduct coastal trade between the shallow coastlines and the Gulf islands (Garrison et al. 1989). European entry into the Gulf began when the Spanish explorer Sebastian De Ocampo circumnavigated Cuba in 1508 (Weddle 1985). Further exploration into the Gulf was realized in 1513, when Ponce de Leon, the Spanish Governor of Mexico, landed on the east coast of Florida and then explored its western coastline up to at least latitude 27° 30' (CEI 1978). De Leon is considered the first European to sail into the northern Gulf of Mexico.

For the next several years, Spanish activity in the Gulf was based out of Cuba, which was used as a staging point for the various exploratory expeditions to the Yucatan and other areas of the Mexican coast. These expeditions, highlighted by Hernando Cortez's 1519 landing at Vera Cruz, eventually led to the conquering of Mexico and the establishment of New Spain. At this same time, Alonso Alvarez de Piñeda, under orders of the governor of Jamaica, entered the Gulf of Mexico to search for a strait to India. After leaving Jamaica, Alvarez de Piñeda was the first to explore the northwestern Gulf, sailing from Vera Cruz up the coast to northeastern Mexico and present-day Texas, and as far east as Apalachee Bay, in Florida (CEI 1978). Alvarez de Piñeda produced the first maps of the area, and also brought back the first detailed information on the wind and current patterns that would dictate navigation routes from New Spain back to the Caribbean Islands and on to Europe. These trade routes, which remained consistent for centuries, sent merchant and naval vessels alike through the waters surrounding the present-day High Island area.

The Gulf of Mexico essentially became the sole province of the Spanish Crown over the next century and a half. The waterway was used primarily as a transport route for the precious metals and other treasures acquired in Mexico and Peru, which were sent back to Spain on large armed merchant vessels travelling in convoys. Both the French and English attempted to encroach on Spain's new-found riches, by means of piracy (France) and by trading African slaves for Spanish treasures (England), but Spain rebuffed these efforts and maintained its monopoly on the Gulf. The first serious competition in the area did not materialize until the late seventeenth century, when Robert Cavelier Sieur de LaSalle claimed the entire Mississippi River drainage basin and Louisiana for France in 1682 (CEI 1978). After LaSalle's later failed attempt to establish a colony at the mouth of the Mississippi, France was able to successfully establish a presence at Ship Island, near present-day Biloxi, in 1699, and another settlement at the mouth of the river in Louisiana the following year. With their presence in the region firmly established, the French subsequently produced the first detailed maps and navigation charts of the northern Gulf of Mexico (Atauz et al. 2006).

France gradually strengthened its position along the Mississippi by establishing New Orleans as its commercial and military headquarters by 1718, and maintaining regular coastal trading routes between that port and the other commercial centers at Biloxi and Mobile. Coastal trading in the area increased following the British victory in the French and Indian war, which returned the island of New Orleans and Louisiana territory west of the Mississippi to Spain, and gave England possession of the Louisiana territory east of the Mississippi and formerly Spanish Florida.

The American presence in the region began in earnest following the American Revolution, when citizens in the Ohio River Valley opened up regular commerce to New Orleans via the Mississippi. After completing the purchase of the Louisiana territory from Napoleon Bonaparte in 1803, the United States doubled its size, and gained control of the Mississippi River and New Orleans, the most significant Gulf port. The western Gulf, however, remained a lawless no-man's-land, frequented by smugglers, privateers, and pirates. U.S. legislation outlawing the importation of slaves, and an embargo on any European goods into U.S. ports, created a market for contraband cargos in the Gulf. Slaves in particular were a valuable commodity for the burgeoning sugar and cotton plantations in lower Louisiana. As a result, the Barataria area became a haven for piracy and illegal slave trade, most notably by the infamous Lafitte brothers (Ford et al. 2008). The U.S. mounted its first real opposition to these activities in the second decade of the nineteenth century. A concerted U.S. naval presence eradicated the Barataria pirates, and drove the Lafitte's to Galveston. Continued naval patrols throughout the Gulf effectively ended the threat of piracy in the region by the early 1820s.

Following Texas' independence from Mexico and later entry into the Union in 1845, regular trade routes opened up between New Orleans, and the Texas ports of Galveston and Matagorda. These passages were conducted by so-called packet-steamers — sidewheel steamboats carrying manufactured goods, mail, and passengers. Regular coastal trade in the Gulf was interrupted during the Civil War when the U.S. blockade of Southern ports closed off commerce to all but the Confederate-supporting blockade runners. The area was slow to recover from the ravages of war and Reconstruction; however, economic growth and Gulf shipping eventually resumed. Along with the antebellum staple of cotton, new industries developed along the Texas coast, around the shipment of lumber, salt, fish, and cattle, among other products.

Coastal trade within the Gulf continued to expand through the turn of the twentieth century, as Texas ports in Galveston, Freeport, Rockport, and Corpus Christi developed and maintained shipping lanes to the established ports of New Orleans, Mobile, and Tampa. Tanker traffic increased in the Gulf during World War I, as oil became a principal export of the area, along with agricultural products. This traffic continued to increase until World War II, when merchant shipping of all kinds became imperiled by the arrival of German U-boats. In 1942, Hitler launched Operation Drumbeat, which authorized a naval offensive against supply lines along the U.S. coasts. Using shipping lanes and navigational beacons as hunting guides, U-boats inflicted casualties along both the Atlantic and Gulf coasts, targeting, in particular, tankers carrying petroleum products that were vital to the Allied war effort (Church et al. 2007). Shipping casualties reached their peak during the spring of 1942, and within the first 12 months of the U-boat presence in the Gulf, 56 tankers were sunk and an additional 14 damaged. Only one U-boat, *U-166*, was lost in the Gulf. Beginning in July 1942, establishment of shipping convoys and other countermeasures drastically reduced the effectiveness of the U-boat attacks.

After the end of World War II, shipping traffic returned to pre-war levels. Petroleum-related and agrarian cargos continued to dominate exports from the western Gulf, while grains and manufactured goods supplied the principal shipments from central and eastern Gulf ports (Garrison et al. 1989). The bulk of shipping traffic shifted to western ports, a pattern which continues to this day.

III. METHODS

MARINE REMOTE-SENSING SURVEY

The marine remote-sensing survey was conducted from April 18 – 21, 2010. Work was carried out aboard the *Chantise G*, a 120-ft offshore utility/supply boat (Figure 2). Survey equipment (Figure 3) included an Edgetech 4200 side-scan sonar with an integrated data acquisition system, a Marine Magnetics SeaSPY magnetometer, and a Trimble *Ag*132 differentially corrected Global Positioning System (DGPS). Both the sonar and magnetometer were towed in tandem on a single, double-armored tow cable. The sonar was towed 756-ft aft of a davit welded to the center point of the survey vessel's stern rail. The magnetometer was towed on an extension cable, 28-ft aft of the sonar. Survey transects were run along a north/south orientation and spaced an average of 100 ft (30 m) apart. A total of 81 transects were surveyed, totaling approximately 123 linear miles. Two-person survey crews worked in rotating 6-hour shifts for continuous 24-hour operations.

Figure 2: Survey Vessel *Chantise G*

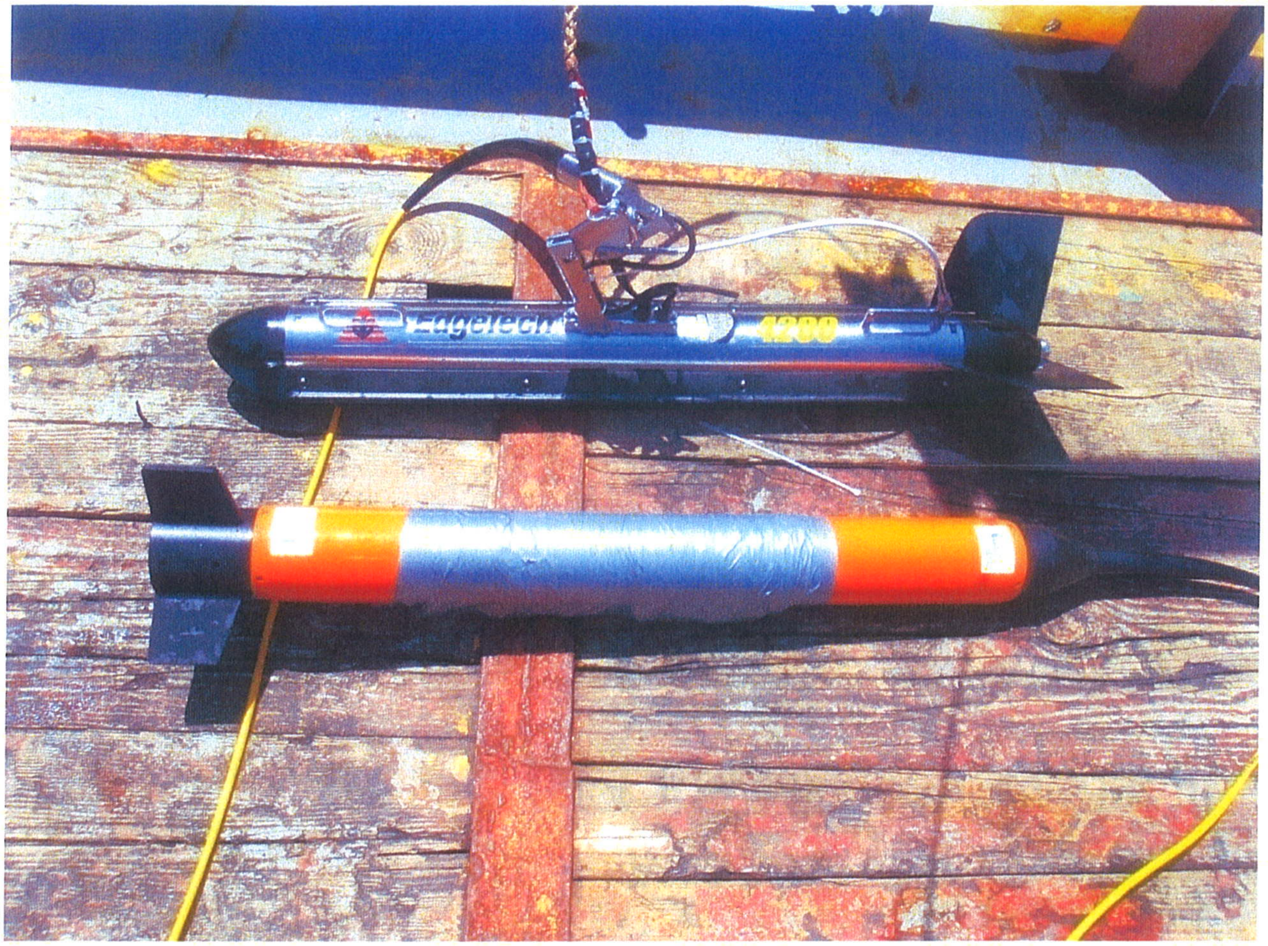

Figure 3: Edgetech 4200 Sonar and Marine Magnetics SeaSPY Magnetometer

Horizontal positioning was based on the State Plane coordinate system, Texas South Central projection, NAD27 datum. Trimble's HydroPro hydrographic surveying software provided navigation guidance and data logging. HydroPro calculated and recorded position estimates for the magnetometer and sonar sensors in real time.

The survey was conducted at vessel speeds averaging 5.2 knots (6.0 miles per hour). Magnetometer and DGPS data were recorded at 1-second intervals, providing average an in-line distance between sample points of 8.8 ft (2.7 m). The side-scan sonar was set to image the bottom at a range of 246 ft (75 m), ensuring at least double coverage of the center line of each transect. Magnetometer sensor height averaged 17.9 ft off the seafloor.

DATA PROCESSING

Upon completion of the survey, the raw magnetometer data were exported from the navigation software as text files and imported into a Microsoft EXCEL® spreadsheet containing a mathematical algorithm that removes diurnal fluctuations. Any total field value differing by greater than 0.3 gamma from the average of either the preceding three or following three recorded values was considered part of a magnetic anomaly. The difference between anomalous values and the ambient magnetic field was then substituted for the actual total-field value recorded by the magnetometer. Magnetic values not meeting this criterion were considered part of the magnetic background or ambient level. The difference between two adjacent readings (a number very close to zero) was substituted for the magnetic total field value in the latter case. This algorithm results in a data set in which abnormally high and low magnetic values (anomalies) center around a zero background level. The resulting data set represents the magnetic total-field amplitude relative to the ambient magnetic field. One result of the above process is that relatively long-term trends in the magnetic data amplitude, such as those caused by diurnal variation, geologic gradients, or gradual changes in water depth, are filtered out of the data set, leaving only local magnetic anomalies. A side benefit of this process is that visual representations of the data can easily reflect the dipolar nature of the magnetic anomalies.

A magnetic contour map was prepared following the application of the filter to remove low-frequency diurnal variations. Bentley's Geopak® digital terrain-modeling software was used to contour the data. A triangulated model of the irregularly spaced magnetometer data was created using Geopak by linearly interpolating values at each grid intersection based upon the values of the nearest triangle sides. The data set was contoured using a 5-nanoTesla (nT) contour interval with 100-nT index contours. The 0-nT contour level was omitted to prevent a cluttered appearance in the contour maps resulting from the concentration of relative magnetic values near the ambient (zero) level.

Overlapping side-scan sonar coverage provided a complete "visual" record of the seafloor in the survey area. The CODA sonar acquisition software integrated survey coordinates with the sonar graphic image, which was stored automatically to electronic media. A mosaic map was created from the original stream of data recorded in the field. The sonar mosaic was then converted to a geotiff format, with a resolution of 3 pixels per meter, and imported into ArcGIS software. This allowed viewing the mosaic in juxtaposition with other survey data such as magnetic contours. Sonar data were analyzed to locate and map potential shipwrecks.

DATA INTERPRETATION

Analysis of unidentified magnetic anomalies recorded in the survey area was based upon a resemblance to anomalies recorded over documented sources. PBS&J has assembled a database of magnetic anomalies (Gearhart 2004 and 2010) for use in comparison with data from remote-sensing surveys similar to the present study. This database is most useful for interpreting magnetic survey data recorded at a close-order (maximum 33-ft [10-m]) transect interval, but it also sets important limits on the parameters of a potential shipwreck anomaly from surveys conducted at wider transect intervals. This reference database contains high-resolution, contoured examples of 29 verified shipwrecks and numerous ground-truthed objects (or object clusters) of modern ferrous debris.

The shipwrecks incorporated in PBS&J's anomaly database include a wide variety of types, ages, compositions, and depositional environments. Vessel types include wooden-hulled sailing vessels, wooden-hulled steamboats, iron-hulled steamboats, wooden-hulled steam screw (converted to a barge), and steel-hulled diesel screw. These vessels range in age from the late eighteenth century to the mid-twentieth century. Wreck environments range from high-energy to low-energy conditions, including harbor entrances, barrier island surf zones, beaches, marsh, oyster reefs, open bay, and the Gulf of Mexico. In addition, a variety of wreck and post-depositional events are represented, including vessels that stranded, foundered, exploded, burned, were partially demolished, and/or were partially salvaged. Most of the vessels are presumed to have relatively intact lower hulls. Three beached vessels in the database were stripped of their most valuable fittings by salvers of the period.

The most significant conclusion to be drawn from a comparative analysis of these wrecks is that all of the shipwreck anomalies in the database are essentially simple dipoles whose magnetic moments are aligned nearly parallel with the earth's magnetic axis. In northern magnetic mid-latitudes, the negative portion of each shipwreck anomaly is located toward magnetic north, while the positive pole is located toward the magnetic South Pole. All of the shipwreck anomalies in PBS&J's database for which measurements are possible have declinations that vary less than 30 degrees from magnetic north. The average variation is 10 degrees. On the other hand, the declinations of debris anomalies tend to follow the orientations of the debris; thus, debris anomalies might be aligned along any azimuth. Seventy-one percent of all the debris anomalies in PBS&J's database (n = 2 of 17 total) have declinations that vary from magnetic north by greater than 36 degrees. The average variation of debris anomalies from magnetic north in the sample (n = 17) is 66.4 degrees. The range of variation is from 3 to 175 degrees, and the median value is 55 degrees. The methodology for measuring anomaly declination is documented in Gearhart (2004).

The reason for the difference in declination between shipwreck anomalies and most debris anomalies is that individual magnetic fields produced by each of the numerous ferromagnetic components in a typical vessel largely cancel one another, leaving primarily the earth-induced portion of the anomaly to be observed. On the other hand, the remnant portion of the magnetic field dominates anomalies associated with debris. This single significance criterion (orientation of the dipole axis, otherwise known as declination) is believed to offer the potential, given adequate survey resolution and sufficient empirical corroboration, for elimination of over 80 percent of debris anomalies from consideration as shipwrecks.

Analysis of the magnetic data collected in the survey area entailed a careful examination of all isolated anomalies to determine whether any might be associated with a historic shipwreck. The primary means of assessing anomalies was by comparison with contoured examples of verified shipwreck anomalies as discussed above and described by Gearhart (2004 and 2010). A direct visual comparison was conducted between each contoured anomaly from this survey and the smallest verified shipwreck anomaly from PBS&J's database. Any survey anomaly closely resembling this database wreck anomaly was considered a potential shipwreck.

IV. RESULTS

Approximately 123 linear miles were surveyed, including 1,345 acres of HI A323 and 124 acres of HI A322. Twenty-four magnetic anomalies were recorded within the survey area (Figure 4 [see map insert 1]); however, 22 of those anomalies are associated either with modern ferrous debris — visible on sonar and likely related to petroleum industry operations — or with the known locations of Platform HI A323 "A", capped wells HI A323-1 and HI A323-4, and ANR Pipeline Company's 10-inch gas pipeline. The remaining two anomalies (M1 and M2) retain characteristics consistent with verified shipwreck anomalies, based on the evaluation criteria described in the previous chapter (i.e. a dipolar or complex signature with a north-oriented negative pole and a south-oriented positive pole). Though these anomalies may also be associated with modern debris related to petroleum industry operations, their potential to be associated with historic shipwrecks cannot be ruled out based on the data. These locations should be avoided by any bottom disturbance activities. Figure 4 illustrates the magnetic signatures at M1 and M2, along with a recommended 500-ft radius (150 m) avoidance boundary beyond the anomaly margins. This recommendation is consistent with avoidance boundaries required by the THC, State Marine Archeologist, for archeological sites in Texas state waters outside of 3 nautical miles. The center-point locations and descriptive information of the recommended anomalies are presented in tabular format in an Appendix to this report.

Anomalies M1 and M2 also each have an associated sonar target (S1 and S2). S1/M1 (Figure 5) is a roughly circular, non-descript object measuring approximately 20-ft diameter. S2/M2 (Figure 6) consists of two objects in close proximity. The first measures approximately 70 ft long by 20 ft wide and has linear features resembling a partial outline of a vessel hull. Approximately 40 ft northeast of this object, and still within the margins of M2, is an object or group of objects measuring approximately 25 ft diameter.

The results of the entire sonar survey are illustrated in Figure 7 (see map insert 2). Numerous other small sonar targets are located within the radius (ca. 1,700 ft) of the magnetic anomaly associated with Platform A323 "A", such that the density of the platform anomaly is obscuring any smaller-amplitude anomalies that may be associated with these other sonar targets. Therefore, comparison with shipwreck anomalies in PBS&J's anomaly database is impossible, and analysis of these objects can only be based on the sonar data. Accordingly, none of these objects in proximity to Platform A323 "A" can be visually identified as potential shipwreck locations. Several other sonar targets are visible throughout the survey area (see Figure 7), but do not have associated magnetic anomalies and, therefore, are unlikely to indicate the presence of a shipwreck. Many of these targets represent depressions or scours in the seafloor (rather than manmade objects protruding above the seabed), which are often caused by drilling rigs dragging their spuds or jacking up.

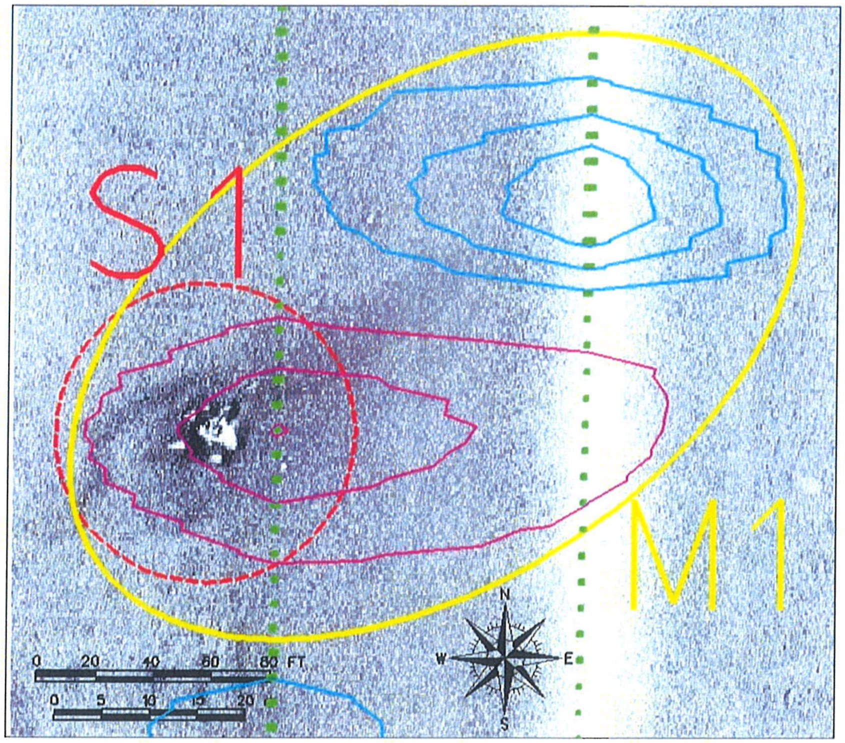

Figure 5: Sonar Target S1 and Anomaly M1

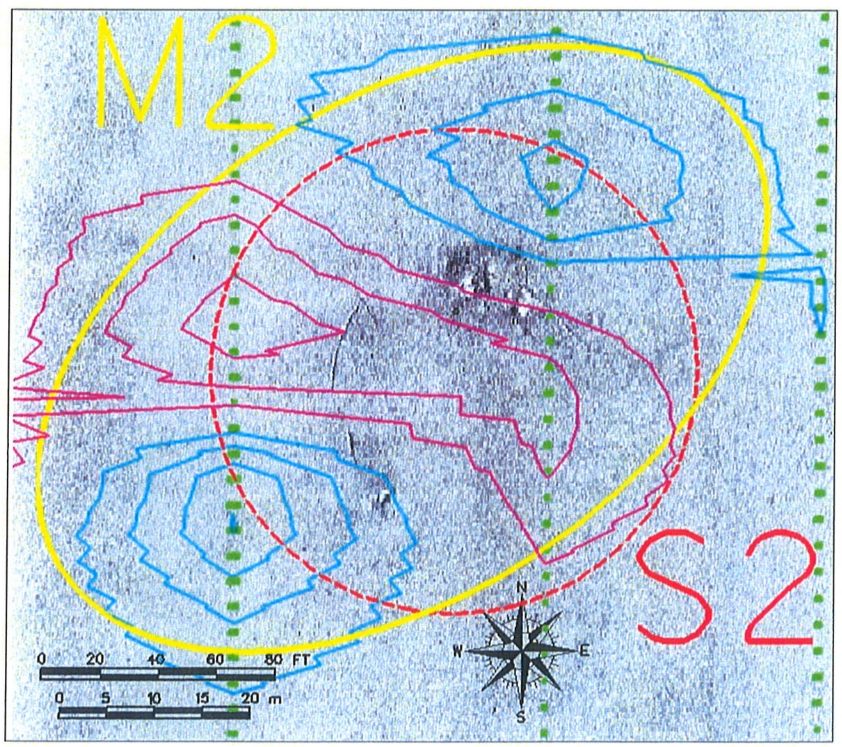

Figure 6: Sonar Target S2 and Anomaly M2

V. CONCLUSIONS AND RECOMMENDATIONS

PBS&J recorded 24 magnetic anomalies and numerous small sonar targets within the project area. The majority of these anomalies and sonar targets are likely associated with modern ferrous debris related to petroleum industry activities in the immediate area.

Two of the magnetic anomalies (M1 and M2), each with a corresponding sonar target (S1 and S2, respectively), retain characteristics consistent with verified shipwreck anomalies. PBS&J recommends that these anomaly locations be avoided by anchor spreads or any other bottom disturbance activities associated with the proposed platform decommissioning or artificial reef placement. PBS&J further recommends that the avoidance areas include a 500-ft-radius (150-m) buffer zone around the margins of each anomaly as illustrated in figures 4 and 7. PBS&J recommends that all other portions of the survey area be cleared from any further cultural resources consideration.

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Appendix

Potentially Significant Magnetic Anomalies and Sonar Targets

Appendix
Potentially Significant Magnetic Anomalies and Sonar Targets

Anomaly	Easting, NAD27 State Plane Texas South Central (ft)	Northing, NAD27 State Plane Texas South Central (ft)	Latitude (NAD27)	Longitude (NAD27)	Amplitude (nT)	Associated Sonar Target	Recommended Avoidance Radius (ft/m)*
M1	3681500.0	158777.5	–93.78009102	28.16680293	30	S1	500/150
M2	3683369.0	159117.0	–93.77436619	28.16743032	30	S2	500/150

* Avoidance distance is calculated from the 5 nT anomaly contour.