



Study to Conduct National Register of Historic Places Evaluations of Submerged Sites on the Gulf of Mexico Outer Continental Shelf



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Foreword

This report addresses issues related to the protection of historic shipwrecks on shallow portions of the Northern Gulf of Mexico Outer Continental Shelf. All aspects of this research and report were conducted under the supervision of the principal investigator, Robert Gearhart, who also directed the remote-sensing surveys and resulting analyses. Diving operations and historic research were directed by Jeffrey Enright. Site-specific portions of this report in Sections III and IV were principally authored by Jeffrey Enright, with the exception of Site 15170, the SS *Castine*, which was written in its entirety by Doug Jones. The introduction, discussion, and recommendations, Sections I, V and VI, were written principally by Robert Gearhart. Portions of this report were contributed by Jenna Enright.

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2004 Field Crew

Front Row (L-R): Terry Dempre (MMS), Marty Heaney (PBS&J), Bob Gearhart (PBS&J), Mark Henry (PBS&J);
Back Row (L-R): Chris Horrell (MMS), Dave Ball (MMS), Jenna Watts (PBS&J), Jeff Enright (PBS&J), Lisa Vitale (PBS&J), Doug Jones (PBS&J), Steve Hoyt (THC); Rail: Jeff Stroope (PBS&J)



2005 Field Crew

Front Row (L-R): Dr. Chris Horrell (MMS), Dave Ball (MMS), Jeff Enright (PBS&J), Amy Borgens (PBS&J), Jenna Enright (PBS&J); Back Row (L-R): Doug Jones (PBS&J), Jeff Stroope (PBS&J), Lisa Vitale (PBS&J), Bob Gearhart (PBS&J)

I. INTRODUCTION

The Minerals Management Service (MMS), a bureau of the United States (U.S.) Department of the Interior, has regulatory responsibility for mineral exploration and development on the Gulf of Mexico (GOM) Outer Continental Shelf (OCS). Part of that responsibility includes considering the effects of MMS-permitted undertakings on archaeological sites of the OCS. Legislative authority for oversight of cultural resources affected by OCS mineral development includes the National Historic Preservation Act of 1966 (as amended), the National Environmental Policy Act, and the Outer Continental Shelf Lands Act of 1953 (as amended). The National Park Service sponsored a study in 1977 of the Northern GOM OCS (Coastal Environments, Inc. 1977) in order to evaluate the potential for significant cultural resources. Based upon that study, the GOM OCS was divided into zones of high, medium and low probability for the presence of historic shipwrecks and intact prehistoric sites. The probability model for historic shipwrecks has been refined twice since then (Garrison, et al. 1989; Pearson, et al. 2003). Continued evaluation of the GOM OCS cultural resources has been tasked to MMS since its inception in 1982.

STUDY OBJECTIVES

Current Notices to Lessees (NTL) 98-20 and 2005-G07 require oil and gas operators to conduct geophysical survey of areas proposed for development, including drilling or pipeline construction. Archaeological survey and line-spacing requirements are stipulated by NTL 2005-G07 for each federal lease block based on its probability zone and water depth. Qualified archaeologists must analyze and report data from these surveys to MMS along with their archaeological recommendations for each potentially significant magnetic and/or acoustic anomaly. Industry operators typically avoid potential archaeological sites, since the alternative to avoidance is assessing their significance through diving or by remotely operated vehicle (ROV). While avoidance serves the purpose of protecting some cultural resources, historic and circumstantial evidence suggests that a substantial proportion of historic shipwrecks are missed by industry surveys. Currently there is no feedback procedure for systematically evaluating the MMS archaeological program's overall effectiveness at protecting sites. The present study was conceived as a partial remedy for that situation.

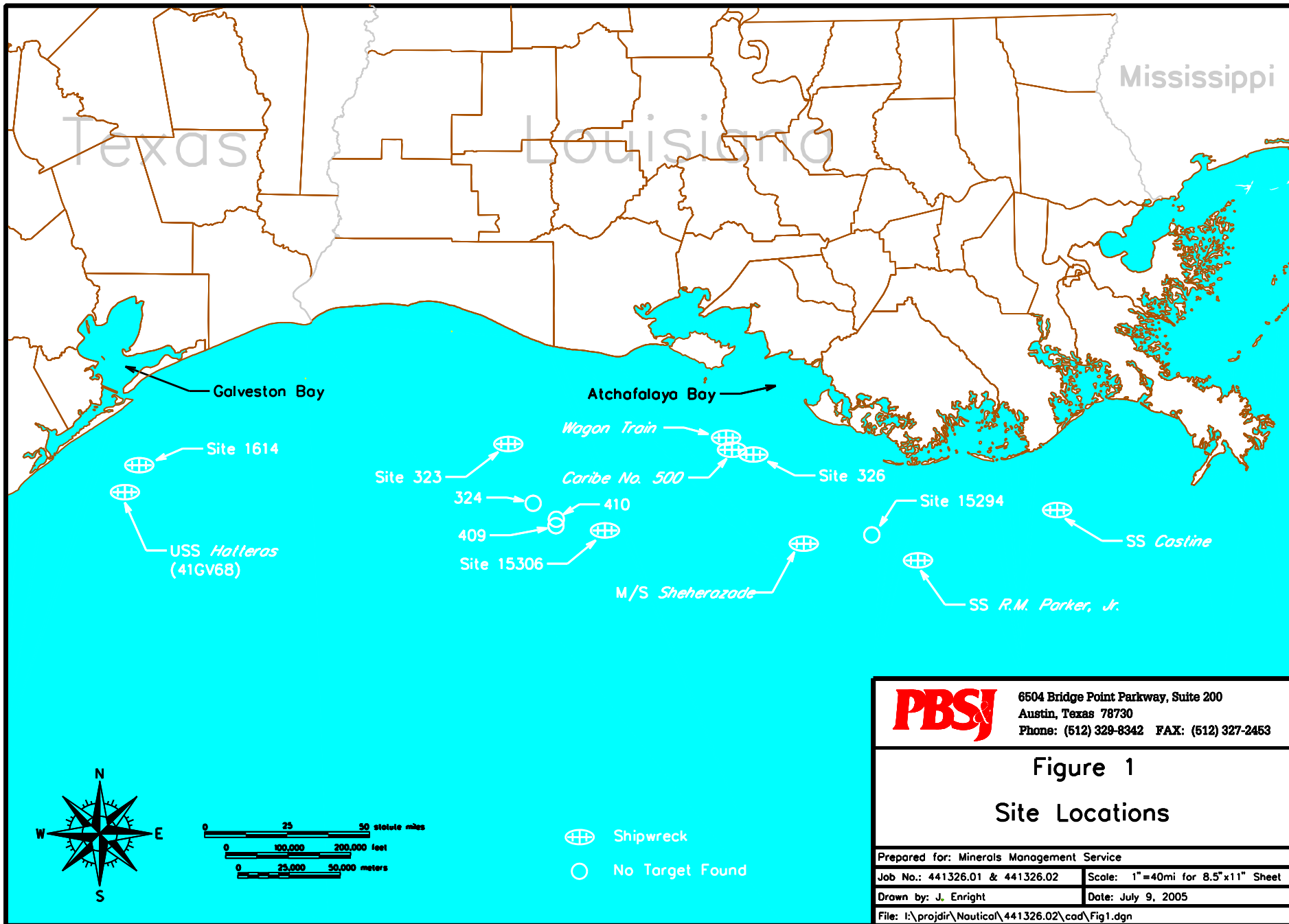
In November 2003 MMS contracted with PBS&J to conduct National Register of Historic Places (NRHP) evaluations of submerged sites on the GOM OCS. The study was designed to evaluate unidentified sidescan sonar targets detected by industry surveys and recommended for avoidance. In addition to evaluating the NRHP eligibility of each site several other research goals were addressed, including: assessing the adequacy of current MMS avoidance criteria; assessing industry compliance with government protective measures; applying lessons learned from this study to eliminate archaeologically insignificant sites from further concern; and refining analytical methods used for selecting sites for avoidance. An overarching goal of this study has been to provide feedback useful for evaluating the effectiveness of MMS's historic preservation program.

Eight sites were originally planned for study; however, a total of fourteen reported targets ultimately were investigated (Table 1 and Figure 1). Each of the sonar targets selected for this study displayed characteristics consistent with shipwrecks. The study was divided into two field trips. The first trip, conducted from May 4–10, 2004, investigated nine previously reported targets, including six shipwrecks and three locations where no targets remained. The second field season, from May 9–15, 2005, visited five reported targets, including three historic shipwrecks, one modern vessel, and one location where no target remained.

The remaining body of this report is organized into five sections, beginning in Section II with a summary of the remote-sensing instrumentation and methodology used for each of the fourteen investigated sonar targets. The results of site-specific research and field investigations are reported in Sections III and IV for the 2004 and 2005 field seasons, respectively. The discussion in Section V assesses the present level of protection afforded historic shipwrecks on the shallow (less than 200 meters [m] [656 feet (ft)]) GOM OCS. Finally, Section VI presents PBS&J’s archaeological recommendations, including site-specific NRHP eligibility assessments and general suggestions for improving the level of protection received by historic shipwrecks.

TABLE 1
SITES INVESTIGATED

Year	Site	Lease Block Area	Identity
2004	323	East Cameron	Unknown
	324	East Cameron	No site
	325	Eugene Island	Possible <i>Wagon Train</i>
	773	Eugene Island	<i>Caribe No. 500</i>
	236	Galveston	USS <i>Hatteras</i> (41GV68)
	1614	Galveston	Unknown
	409	Vermillion	No site
	410	Vermillion	No site
	15306	Vermillion	Unknown (modern)
2005	326	Eugene Island	Unknown (modern)
	328	Eugene Island	<i>M/S Sheherazade</i>
	15170	Grand Isle	<i>SS Castine</i>
	15294	Ship Shoal	No site
	432	South Timbalier	<i>SS R.M. Parker, Jr.</i>



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Figure 1
Site Locations

Prepared for: Minerals Management Service	
Job No.: 441326.01 & 441326.02	Scale: 1"=40mi for 8.5"x11" Sheet
Drawn by: J. Enright	Date: July 9, 2005
File: I:\projdir\Nautical\441326.02\cad\Fig1.dgn	

Figure 1. Site Locations.

II. REMOTE-SENSING METHODOLOGY

The remote-sensing survey and diving operations were conducted aboard the M/V *Fling*, a 100-foot (ft) aluminum-hulled crew boat converted to a charter dive boat by Gulf Diving, LLC. Instrumentation used for the survey portion of the project included a Marine Magnetics SeaSPY Overhauser Effect proton magnetometer; a CODA Technologies DA100 sidescan sonar data acquisition system; an Edgetech DF-1000 dual frequency (100 and 500 kHz) digital towfish; an Edgetech Digital Control Unit (DCU), which provides an interface between the digital towfish and the CODA topside unit; and a Trimble™ AgGPS® 132 differentially corrected Global Positioning System (DGPS) (advertised accuracy is sub-meter, 95 percent of the time) (Figures 2, 3, and 7). The DGPS receiver dome was positioned at the approximate centerpoint of the *Fling* on the sun deck. The 2004 field season utilized a VideoRay remotely operated vehicle (ROV) and the 2005 utilized a Seabatix LBV (Figures 4, 5, and 6).

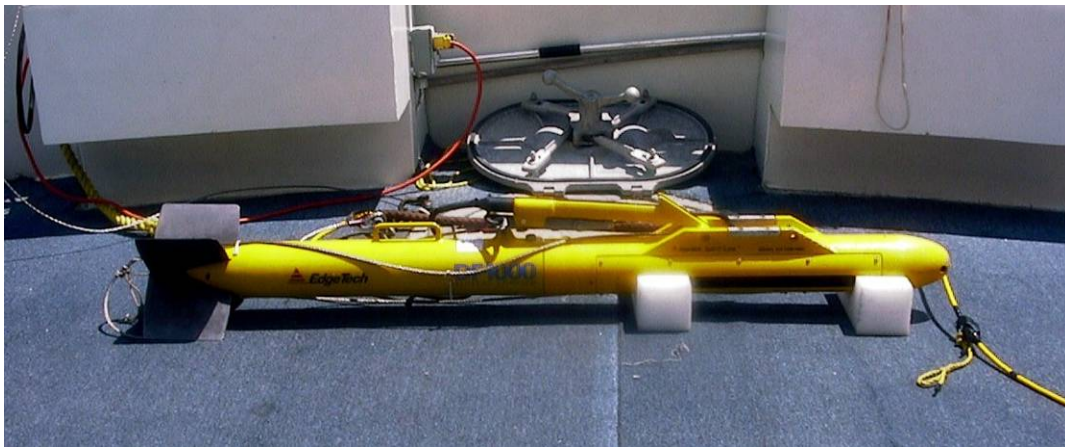


Figure 2. Digital Sidescan Sonar Sensor.



Figure 3. Magnetometer Sensor.



Figure 4. 2004 Remotely Operated Vehicle.



Figure 5. 2005 Remotely Operated Vehicle.



Figure 6. Operating the ROV.



Figure 7. Remote-Sensing Data Collection Center.

Trimble's *HydroPro* (version 2.1) software provided navigation guidance and position data logging. Horizontal positions were based on the Universal Transverse Mercator Coordinate System, Zone 15

North. Line spacing, sample rate, and vessel speed determined the resolution of the various data. The survey was recorded along transects spaced no more than 30 ft (9.1 m) apart and at speeds averaging from 4.0 to 5.0 knots (4.6–5.8 miles per hour [mph]/7.4-9.3 kilometers per hour [kmph]). Magnetometer and DGPS data were recorded at 1.0-second intervals, providing an in-line distance between sample points of 6.7–8.5 ft (2.0–2.6 m). DGPS positions also were exported to the CODA DA100 and integrated into sonar images.

HydroPro calculated and logged real-time offset position estimates for the DGPS and the sonar and magnetometer sensors. The magnetometer and sonar sensors were towed at various altitudes and distances aft of the DGPS antenna depending on site-by-site conditions (Table 2). Sensor altitude was determined by layback and speed. The sensors were towed as close as possible to the site in order to obtain the maximum resolution; however, altitude also was monitored to prevent either of the sensors from striking the bottom and/or the site. The altitudes provided for the magnetometer sensor in Table 2 are the average altitudes for the entire site survey and therefore include turns. Table 2 records sonar sensor height off bottom (altitude) directly over each site.

TABLE 2
SENSOR LAYBACKS AND ALTITUDES

Year	Site	Magnetometer				Sonar			
		Layback (ft/m)		Average Altitude (ft/m)		Layback (ft/m)		Altitude (ft/m)	
2004	236	250	76	23	7	100	30	33	10
	323	300	91	48	15	190	58	38	12
	324	250	76	47	14	190	58	66	20
	325	200	61	22	7	14	4	49	15
	409	395	120	40	12	190	58	57	18
	410	395	120	32	10	190	58	57	18
	773	200	61	22	7	14	4	16	5
	1614	200	61	28	9	100	30	41	13
	15306	395	120	46	14	190	58	74	23
2005	326	100	30	22	7	14	4	20	6
	328	200	61	55	17	97	30	18	6
	432	200	61	53	16	97	30	41	13
	15170	395	120	72	22	200	61	49	15
	15294	200	61	18	5	97	30	25	8

SIDESCAN SONAR DATA PROCESSING

Sidescan sonar was the primary remote-sensing tool utilized during the survey portion of this project. Sonar images were used to delineate the physical extent of each shipwreck site. The sidescan sonar was

set to image the bottom for a distance of 164 ft (50 m) to either side of the survey path. The CODA sonar acquisition software integrated UTM position data with the sonar graphics image, which was then stored automatically to electronic DVD media for processing and analysis. Sonar mosaics were created for each shipwreck site. Mosaic processing combines the individual streams of data recorded in the field into a composite image. This technique allows larger surface areas to be viewed as a single mosaic rather than as pieces of spatially isolated imagery. Larger objects that might span more than one stream of imagery, such as a shipwreck, are more readily viewed, interpreted, and mapped from a mosaic image. The sonar mosaic then was converted to a geotiff format and imported into Bentley Systems, Inc. MicroStation[®] CAD software (version 8). This allowed viewing of the mosaic in conjunction with other survey data such as magnetic contours and avoidance polygons. Unless otherwise stated, all figures depict sidescan sonar images to scale and properly oriented.

MAGNETIC DATA PROCESSING

Contouring of magnetic anomalies provide the best means to view three-dimensional data (x and y coordinates plus magnetic reading [z]) on a two-dimensional plane. Mapped anomaly locations additionally would allow MMS to determine whether avoidance criteria had been met following construction at a given lease block. 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. This spreadsheet was developed at PBS&J and has been used in place of a base station magnetometer for the past 5 years with great success. The algorithm recognizes any total magnetic field value (raw data) as part of an anomaly if it differs by greater than 0.5 gamma from the average of either the preceding three or following three values. The difference between anomalous values and the ambient magnetic field, which we refer to as the relative magnetic field, is then substituted for the raw (total field) value recorded by the magnetometer. Magnetic values not meeting this criterion are considered part of the magnetic background or ambient level. The difference between two adjacent readings (a number very close to zero) is substituted for the magnetic total field value in the latter case.

PBS&J's diurnal correction 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 as positive and negative values relative to the local (ambient) magnetic field as represented by the zero-gamma level in PBS&J's contour maps. 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. This method of diurnal correction allows data from multiple surveys, widely separated in time, to be combined and contoured seamlessly as if from a single survey. PBS&J combined and contoured data sets from Site 41NU291 (see Figure 39) collected more than a year apart without any problems. A side benefit of the zero-centered diurnal correction output file is that visual representations of the data can easily reflect the dipolar nature of the magnetic anomalies. PBS&J takes

advantage of this fact by representing polarity with an easily remembered hot/cold color scheme. Positive polarity is represented by red shades and negative polarity by blue shades.

Magnetometer data analysis involved construction of magnetic contour maps using Bentley's Geopak® digital terrain-modeling software. Using this mapping routine, a regularly spaced data grid or lattice was created from a triangulated model of irregularly spaced data by linearly interpolating values at each grid intersection based upon the values of the nearest triangle sides. A grid interval of 5.0 x 5.0 ft (1.5 x 1.5 m) was chosen to more than cover the collection distance between data points during the survey (6.7–8.5 ft [2.0–2.6 m]). The relative magnetic data set was contoured using a 5-gamma contour interval with 100-gamma index contours. The 0-gamma contour level was omitted to prevent a cluttered appearance in the magnetic contour maps resulting from the majority of relative magnetic values being near the ambient level. Instead, the first negative (blue) contour in the illustrations represents the –5-gamma level below ambient, and the first positive (red) contour represents the +5-gamma level above the ambient level. Every contour line thereafter represents a 5-gamma increment. An anomaly thus represented by a single contour line may vary between 5 and 10 gammas from the ambient level. An anomaly represented by two contour lines varies from the ambient level by 10–15 gammas, and so on. For illustrative purposes, in Sections III and IV only, the larger, steel-hulled vessels at Sites 432 and 328 were contoured at 25 gammas with 100-gamma index contours.

III. 2004 SITE INVESTIGATIONS

SITE 323

Site History

Three shipwreck databases and one shipwreck list were consulted in order to gather historic information regarding many of the sites in this study. These databases are some of the most complete, accurate, and detailed sources available for vessel losses in the GOM and include the MMS Archaeological Resource Information database (ARI), the National Oceanic and Atmospheric Administration's Automated Wreck and Obstruction Information System (AWOIS), and the Louisiana Division of Archaeology's Shipwreck List (LDA). The annual list of merchant vessels lost, published in the *Annual List of Merchant Vessels of the United States* (published 1878–1925) and the *Merchant Vessels of the United States* (published 1926–1989) (combined abbreviation – MVUS) by the U.S. Department of Commerce, was consulted for additional historic and modern information.

Site 323 was first discovered during a lease block survey for Apache Corporation (Trabant 1994). A previous version of the ARI database suggested a potential identification for Site 323 as that of the *Edgar F. Coney*, which was reported lost 18 miles (29 km) northwest of this location. Built in 1904, the 153 gross-ton tugboat measured 102 ft x 20 ft 9.5 inches x 10 ft 7 inches (31 m x 6.3 m x 3.2 m). The dimensions of the *Edgar F. Coney* do not match the dimensions of Site 323 as recorded by PBS&J (210–220 x 25–30 ft [64–67 x 7.6–9.1 m]) and it is not the identity of this shipwreck. The current version of the ARI database suggests Site 323 may be the modern vessel *Lafourche*, reported lost 2.7 miles (4.3 km) east-southeast of this location. Citing MVUS for the year 1973, the ARI database records the *Lafourche* as a 198-gross ton (180-metric ton), oil screw vessel constructed in 1956. MVUS lists this vessel as 130 ft 7.0 inches x 34 ft 1.0 inch x 10 ft (40 m x 10 m x 3.0 m). The dimensions of the *Lafourche* do not match the dimensions of Site 323 (210–220 x 25–30 ft [64–67 x 7.6–9.1 m]) and it is not the identity of this shipwreck. The LDA database lists a *Lafourche* wreck different from the 198-ton (180-metric ton) vessel listed in the ARI database. The LDA database entry, however, states that this vessel is a wooden-hulled stern-wheel steamboat constructed in 1888 and burned in the Mississippi River in 1907.

PBS&J consulted the ARI, AWOIS, and LDA databases to determine the identity of all shipwrecks reported within a 20-mile (32-km) radius of Site 323. The results then were correlated with various years of the MVUS list to identify those vessels within this radius that share similar characteristics with Site 323 as determined by PBS&J (metal construction, overall dimensions = 210–220 x 25–30 ft [64–67 x 7.6–9.1 m]). This research identified two reported wrecks that have potential to be the identity of Site 323. Unfortunately, no information other than their possible existence is known. PBS&J was unable to locate listings for the two vessels in the MVUS editions available at the time of writing. The identity of Site 323 remains unknown.

Remote-Sensing Investigation

The remote-sensing survey conducted for Apache Corporation identified a “sunken vessel” on sidescan sonar of “approximately 200 ft [61 m] long” and a magnetic anomaly “reading of 2,100 gammas” attributed to Site 323 (Trabant 1994:6, 7). PBS&J conducted a remote-sensing survey of Site 323 on May 4, 2004. The magnetic portion of the survey recorded a north-south dipolar anomaly with the main negative lobe oriented to the north, and a secondary positive lobe on the north side of the main anomaly (Figure 8). The anomaly’s maximum horizontal dimension measures approximately 970 ft (296 m). The relative amplitude of the anomaly ranges from +5,888 to -4,328 gammas. No additional anomalies were recorded within the area surveyed. The sidescan sonar image depicts an upside down vessel with twin screws approximately 210 ft (64 m) long, 30 ft (9.1 m) wide, and with a maximum vertical relief of approximately 7.0 ft (2.1 m) (see Figure 8). A few small, unidentified objects were imaged immediately adjacent to the bow of the vessel that likely are associated with Site 323. A geologic feature consisting of a 450-x-130-ft (137-x-40-m) patch of rock outcropping associated with a nearby salt dome was imaged approximately 900 ft (274 m) north-northeast of Site 323.

Diver Investigation

PBS&J, MMS, and THC divers spent a combined time of two and one-half hours on Site 323, and the ROV flew one-half hour on-site. The vessel rests in 85 ft (26 m) of water, with the top at about 70 ft (21 m), where visibility ranges from 5.0–10 ft (1.5–3.0 m) depending where on the site a diver was. The vessel is resting nearly upside down with a slight starboard list that exposes a portion of the deck on the port side. Archaeologists measured the vessel at 220 ft (67 m) long (difference from the sonar record likely is a result of current affecting the tape measure) and confirmed that the vessel had twin screws and is possibly constructed of steel or aluminum. The distance between the prop shaft tubes was measured at 14 ft (4.3 m), and each tube was supported against a skeg with a 10-inch (25-cm) wide cross-member (see Figure 8). Both three-bladed propellers were extant as were both rudder posts, but only the starboard rudder was still intact. The portion of deck exposed revealed a low, flat deck typical of offshore supply vessel design. The vessel is victim to a moderate degree of corrosion, and sections of the outer hull have disappeared creating a “honeycomb” effect around the internal framing members. A section of corrosion allowed a view inside the hull, and nautical archaeologists noted bulkheads cut with hatchways. An attempt was made to locate a name on the bow of the vessel but heavy marine growth prohibited this.

Mitigation Assessment

There has been no oil and gas industry development in the vicinity of Site 323; therefore, MMS has not formally stipulated an archaeological mitigation avoidance criterion. The nearest known pipeline is located approximately 1.2 miles (1.9 km) west of Site 323, and the nearest known well was drilled approximately 2,700 ft (823 m) to the northwest.

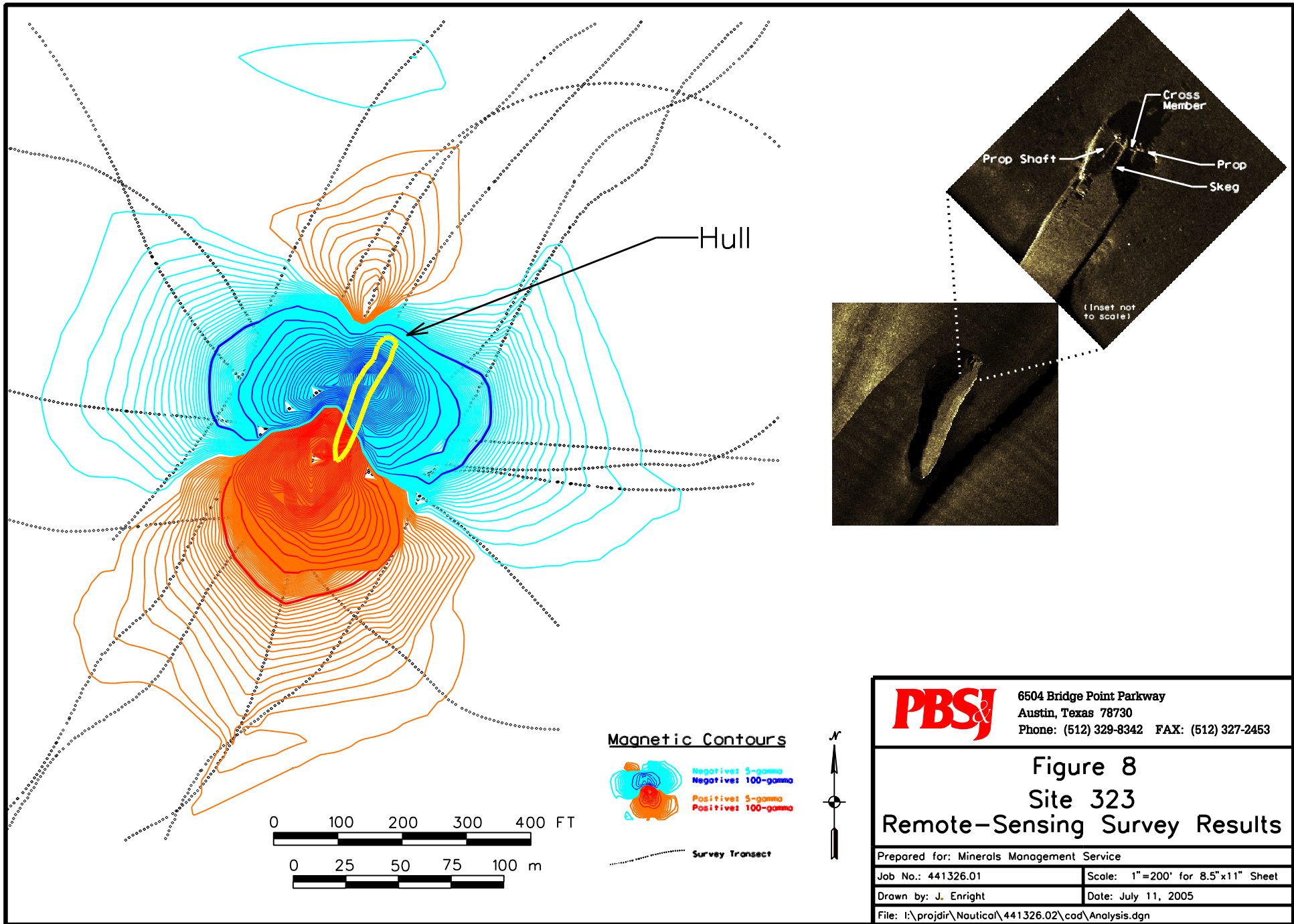



Figure 8. Site 323 Remote-Sensing Survey Results

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	<h3>Figure 8</h3> <h3>Site 323</h3> <h3>Remote-Sensing Survey Results</h3>	
Prepared for: Minerals Management Service		
Job No.: 441326.01	Scale: 1"=200' for 8.5"x11" Sheet	
Drawn by: J. Enright	Date: July 11, 2005	
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NRHP Assessment

The identity of Site 323 could not be determined through historical research, remote-sensing, and diver investigation. Sufficient information to allow a NRHP eligibility statement of Site 323 is not available. Therefore, Site 323's NRHP eligibility is deemed unknown at this time.

SITE 773

Site History

Site 773 corresponds closely with the ARI, AWOIS, and LDA charted location of the barge *Caribe No. 500*. It was for this reason that the original sidescan sonar target for Site 773 recorded in 1994 by John E. Chance & Associates, Inc. was first identified as the *Caribe No. 500* (Chance 1997). The remote-sensing survey was conducted in preparation for the laying of a pipeline by Burlington Offshore Resources, Inc. This identification was supported by Thales Geosolutions, Inc. in 2001 when they recorded Site 773 during a remote-sensing survey for ATP Oil & Gas Corporation (Floyd 2001b). AWOIS reports that the *Caribe No. 500* was lost in a marine casualty. The year of the event is not recorded, but it is noted that the barge was discovered late November 1954 and the notice to mariners was posted in December 1954.

PBS&J consulted the ARI, AWOIS, and LDA databases to determine the identity of all shipwrecks reported within a 20-mile (32-km) radius of Site 773. The results then were correlated with various years of the MVUS list to identify those vessels within this radius that share similar characteristics with Site 773 as determined by PBS&J (barge design, overall dimensions = 240–245 x 45–50 ft [73–75 x 22–23 m]). This research identified eight barges within the study area, including the *Caribe No. 500*. Five of these have dimensions too dissimilar to Site 773 to consider further. No information other than the possible existence of the remaining three barges, including the *Caribe No. 500*, is known. Based upon the close proximity for the reported loss of the *Caribe No. 500* to Site 773 (615 ft [187 m]), it is likely that this is the identity of the site.

A ninth barge was identified within the study area; however, its existence seems unlikely. The barge name is reported in AWOIS as *Caribe* and is located only 1.8 miles (2.9 km) southeast of Site 773. The year of sinking is unknown but the local notice to mariners was posted in 1954, just 11 months prior to the local notice to mariners for the *Caribe No. 500*. The position quality for the *Caribe*'s reported location is listed as poor, and an AWOIS survey failed to locate the barge. The odds of two barges named *Caribe* wrecking in separate events within 2.0 miles (3.2 km) of each other in the same year are remote. It is more likely that the barges *Caribe* and *Caribe No. 500* refer to the same vessel with two separate AWOIS records.

Remote-Sensing Investigation

The remote-sensing survey conducted for Burlington Offshore Resources, Inc. at Site 773 recorded “four magnetic anomalies” on three survey lines that ranged in amplitude from 27 to 730 gammas. The sidescan sonar portion of this survey identified a barge that “is mostly buried, with only a portion exposed at the seafloor” (Chance 1997). The 2001 survey for ATP Oil & Gas Corporation verified the existence of the barge in both sonar and magnetic data (Floyd 2001b). PBS&J conducted a remote-sensing survey of Site 773 on May 5, 2004. The magnetic portion of the survey recorded a north-south dipolar anomaly with the main negative lobe oriented to the north, and a secondary positive lobe on the north side of the main anomaly (Figure 9). The anomaly’s maximum horizontal dimension measures approximately 1,000 ft (305 m). The relative amplitude of the anomaly ranges from +10,264 to -4,691 gammas. The magnetic survey additionally verified the existence and location of three pipelines and two relatively smaller and weaker dipolar anomalies in the vicinity. The sidescan sonar image depicts a barge 245 ft (75 m) long by 50 ft (15 m) wide with a taper to 35 ft (11 m) wide at the ends (Figure 10). A 38-ft (12-m) wide break running athwartship through the entire hull and located approximately 50 ft (15 m) forward of the stern is a prominent feature in the sonar record. A 15-ft (4.6-m) wide debris field or sediment disturbance trails approximately 100 ft (30 m) off the stern of the barge.

Diver Investigation

PBS&J, MMS, and THC divers spent nearly a combined time of six hours on Site 773 and the ROV flew one hour on site. The vessel rests in 25 ft (7.6 m) of water, with the top at about 15 ft (4.6 m), where visibility ranges from 1.0–10 ft (0.3–3.0 m) depending where on the site a diver was. The vessel is resting upright, and archaeologists verified the break through the hull. The vessel has not been completely severed; rather, the lowest portion of the hull at the mud line is intact. Snagged and discarded shrimp nets were located on the jagged edges of this break (see Figure 10). This break currently is thought to be the result of collision with another vessel. The collision either was the cause of the shipwreck or occurred following deposition. Archaeologists measured the vessel at 240–245 ft (73–75 m) long, 45 ft (14 m) wide with a taper down to 35 ft (11 m) wide at the bow and stern, and 12 ft (3.7 m) depth of hold (the difference in width between this measurement and the sonar record derives from the location that the divers chose to obtain their measurement). Nautical archaeologists noted numerous features during the investigation, including three hatchways through the deck, multiple mooring bits and cleats along the gunwale, fairleads at the stern, and four vertical bumpers extending from above the deck at the stern down to the mud line (support for pushing the barge). At least one bumper is visible in the sonar image (see Figure 10).

A ledge is built into the bow that is topped with four square ridges each containing a circular hole through their top, possibly a means for attaching a second barge forward. Both the bow and stern are rounded between the deck and the lower hull, rather than straight-angled. A rope extending off the deck at the stern attaches to an anchor chain running to the sediment. The anchor is buried almost entirely in the sediment (only a portion of the shank was visible). This suggests that the anchor dropped off the deck

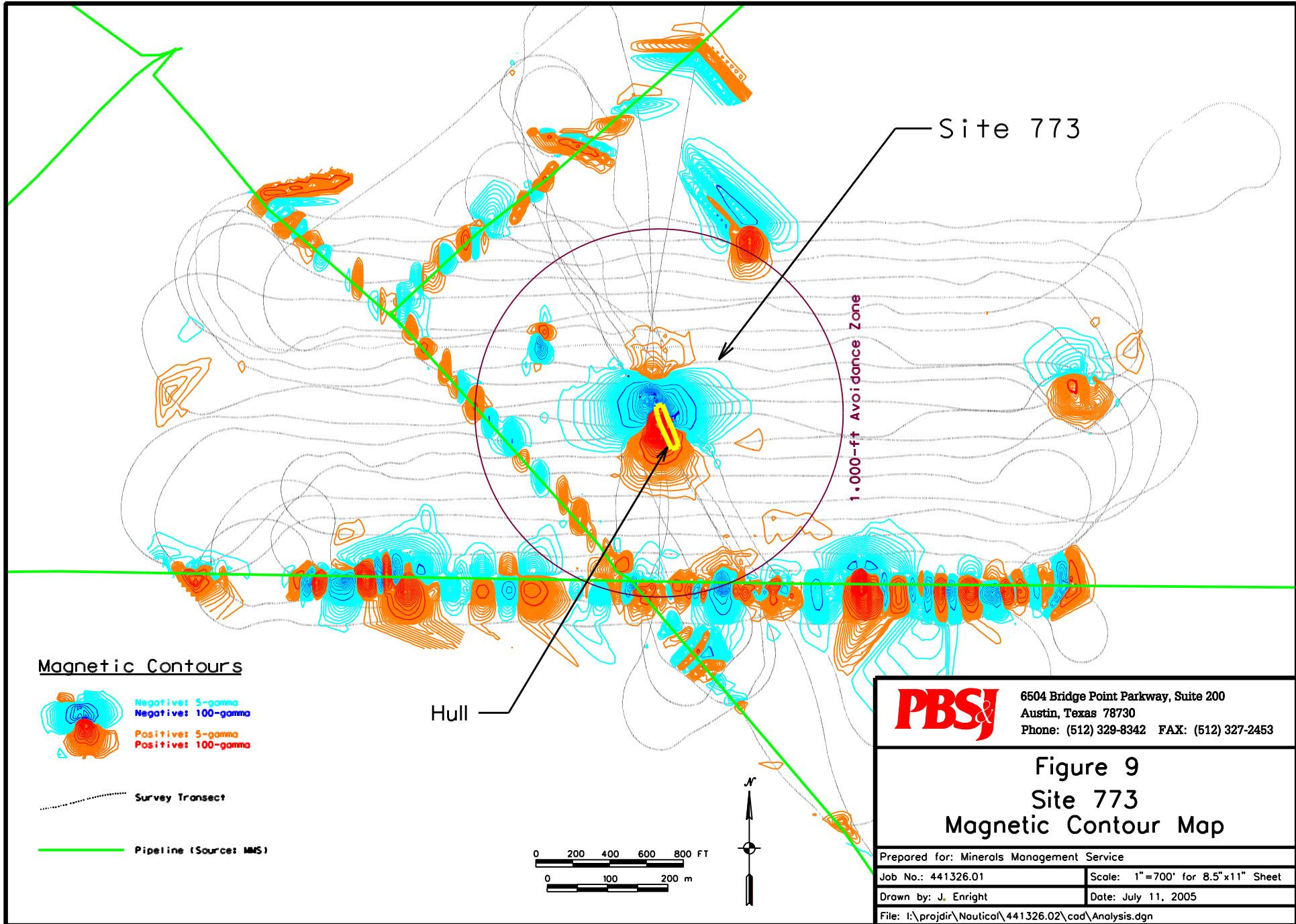
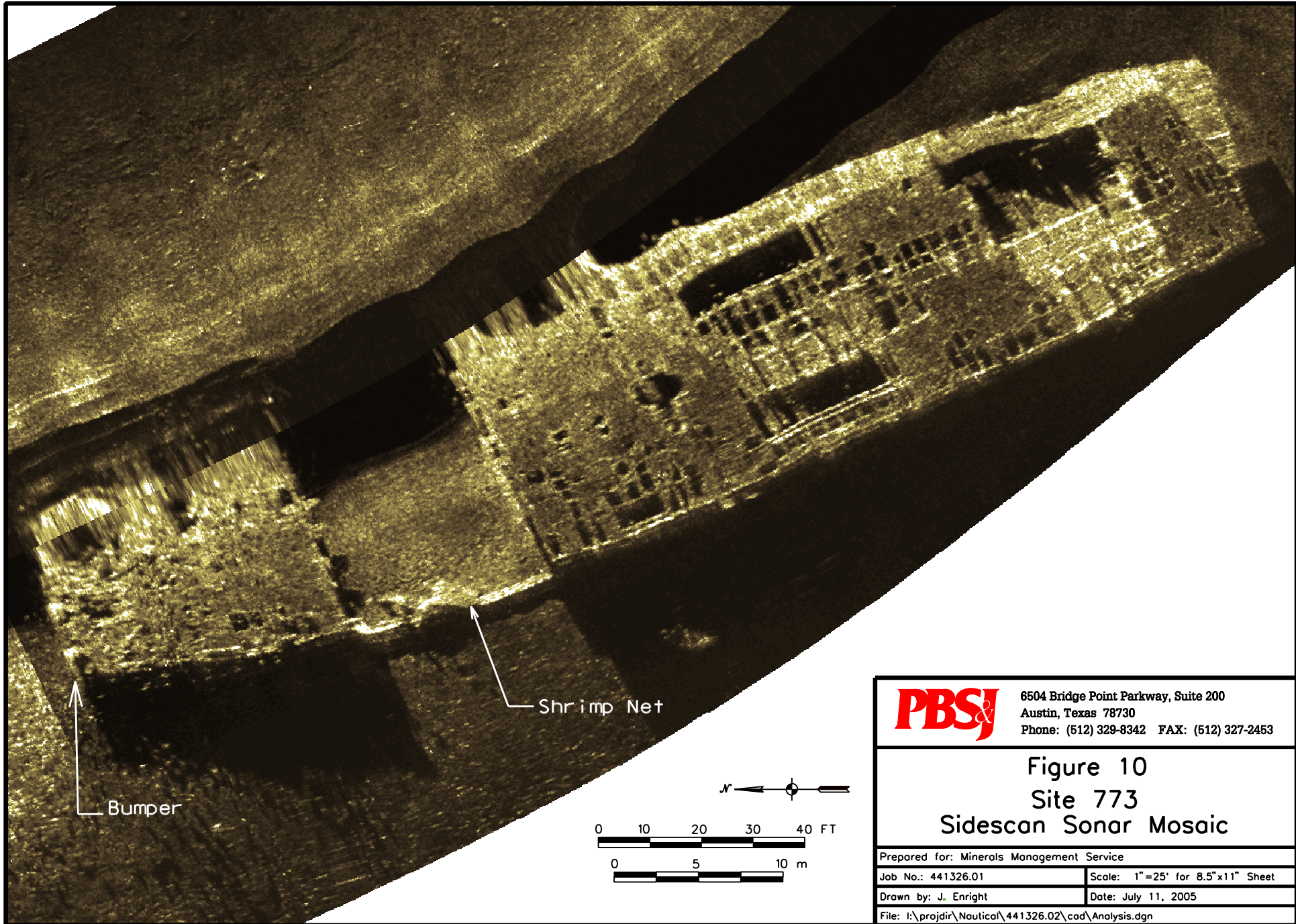


Figure 9. Site 773 Magnetic Contour Map.



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	Figure 10 Site 773 Sidescan Sonar Mosaic	
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Job No.: 441326.01	Scale: 1"=25' for 8.5"x11" Sheet	
Drawn by: J. Enright	Date: July 11, 2005	
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Figure 10. Site 773 Sidescan Sonar Mosaic.

during or after the site formation process, rather than purposely deployed prior to the event. It would be reasonable to assume that much more line would have been deployed with the anchor if the latter was true. The vessel has experienced extensive iron corrosion on the deck and the sides of the hull. Deck beams are exposed nearly the entire length and breadth of the vessel giving it a “honeycomb” appearance (evident in the sonar record in Figure 10).

Mitigation Assessment

MMS decreed in 1997 a minimum avoidance margin of 1,000 ft (305 m) around Site 773 in response to its location during the 1994 survey for Burlington Offshore Resources, Inc. Two of the pipelines located during PBS&J’s 2004 survey of Site 773 lie within this 1,000-ft (305-m) radius; however, both were constructed prior to the 1997 MMS mitigation requirement. PBS&J’s magnetic data have confirmed that the third pipeline, which was constructed by Burlington Offshore Resources, Inc., correlates precisely with the MMS plotted position (see Figure 9). This places the pipeline outside the avoidance zone as defined in MMS. Due to acceptable GPS accuracy (as defined in NTL 2005-G07) and layback, PBS&J’s survey places the center of Site 773 at a somewhat different position than the coordinate value used to define the avoidance zone. PBS&J imaged the shipwreck on 12 separate survey passes and averaged the position for the northwest corner of the site (closest to the pipeline location). The averaged location places the edge of the wreck site closer to the pipeline than the centerpoint but still more than 1,000 ft away. The farthest north and west coordinate values among the 12 place the site 120 ft (37 m) closer to the pipeline (within 120 ft [37 m]), but again more than 1,000 ft (305 m) away. Based upon PBS&J’s sonar survey, the pipeline lies approximately 1,390 ft (424 m) from the center of the wreck site and approximately 1,245 ft (379 m) from the average edge of Site 773.

There exist numerous wells within this lease block; all but one lie outside the 1,000-ft (305-m) avoidance margin. A single well was drilled approximately 695 ft (212 m) from Site 773 but was drilled in 1962 prior to the MMS mitigation requirement, as well as prior to the National Historic Preservation Act of 1966.

Prior sidescan sonar surveys of Site 773 are of insufficient resolution to determine whether or not the break in the hull was present prior to industry construction in the area. Likewise, documentation regarding the wrecking incident is lacking in detail. Collision with another vessel cannot be ruled out. Given the amount of industry activity adjacent to the wreck site, and the shallow water depth, it is just as possible that the break in the hull is a result of a modern accident. PBS&J cannot, however, state this with a high degree of certainty.

NRHP Assessment

Circumstantial evidence resulting from PBS&J’s historical research, remote-sensing survey, and diver investigation has identified Site 773 as the barge *Caribe No. 500* constructed prior to 1954. This vessel is historic under the definition of the U.S. Department of the Interior. The vessel additionally

maintains its historic integrity. The *Caribe No. 500*, however, does not meet any of the four criteria for historic significance and therefore is not eligible for listing in the NRHP.

SITE 325

Site History

Site 325 is located approximately 2,100 ft (640 m) north-northwest of the ARI and AWOIS charted location of the fishing vessel *Wagon Train*. It was for this reason that the original magnetic anomaly and sidescan sonar target recorded at Site 325 by Thales Geosolutions, Inc. was identified as the *Wagon Train* (Thales Geosolutions, Inc. 2001). ARI describes the *Wagon Train* as a fishing vessel 65 ft (20 m) long wrecked in 1984. This information is cited from the USCG electronic database of wrecks. PBS&J's 2004 investigation of Site 325 confirmed a steel-hulled vessel with dimensions of 60–65 x 15–20 ft (18–20 x 4.6–6.1 m). PBS&J consulted the ARI, AWOIS, and LDA databases to determine the identity of all shipwrecks reported within a 20-mile (32-km) radius of Site 325. The results then were correlated with various years of the MVUS list to identify those vessels within this radius that share similar characteristics with Site 325 as determined by PBS&J (steel construction, overall dimensions = 60–65 x 15–20 ft [18–20 x 4.6–6.1 m]). Six vessels with verified dimensions and hull material matching Site 325 were identified within the study area, the earliest constructed in 1946. Four vessels with no information other than their possible existence, including the *Wagon Train*, also are located within the 20-mile (32-km) study area. Despite best efforts, PBS&J was unable to locate a listing in the editions of the MVUS available at the time of writing for the *Wagon Train*. This list unfortunately was discontinued between the years 1981 and 1989. The 1989 edition attempts to fill this gap but it seems piecemeal at best. Based upon the circumstantial evidence of the reported location and the ARI database, the *Wagon Train* is the best fit for the identity of Site 325. It should be noted, however, that the age, hull material, and overall dimensions of the *Wagon Train* have not been verified and this hypothesis is considered tentative.

Remote-Sensing Investigation

Thales Geosolutions, Inc. first recorded Site 325 in a pipeline right-of-way remote-sensing survey performed for ATP Oil and Gas Corporation. The initial survey did not record the site; however Thales chased a scattering of magnetic anomalies that led to Site 325 (Thales Geosolutions, Inc. 2001:16). Thales estimated the dimensions of the vessel at 60 x 20 ft (18 x 6.1 m), based upon the sidescan sonar image recorded, and identified a 200-gamma anomaly in the magnetic data associated with Site 325.

PBS&J conducted a remote-sensing survey at Site 325 on May 6, 2004. The magnetic data recorded in 2004 is dominated by a pipeline located to the west of Site 325 (Figure 11). The magnetic signature of the vessel is skewed due to the close proximity of the pipeline and a heavy current at the time of survey. The Site 325 anomaly begins to resemble a north-south dipolar anomaly with the negative lobe oriented to the north; however, it does not have the characteristic shape of what is expected from a shipwreck (see *Discussion: Protection of Historic Shipwrecks on the Shallow OCS* section below). The line spacing achieved in PBS&J's survey was sufficient to record an isolated shipwreck anomaly; however, the data

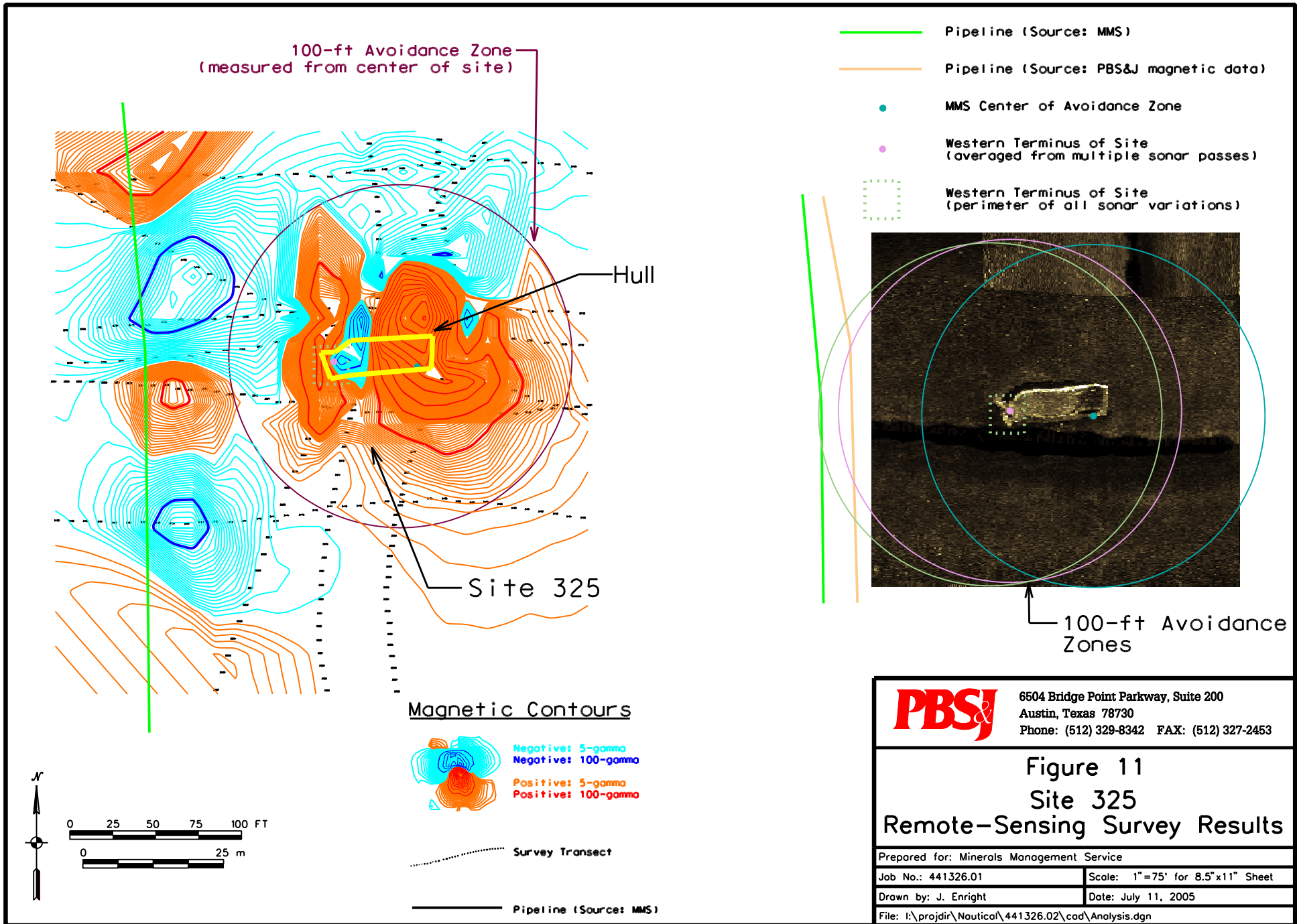


Figure 11. Site 325 Remote-Sensing Survey Results.

density was not sufficient to accurately characterize the anomaly separate from the pipeline anomaly. Moreover, the heavy current combined with the long layback of the magnetometer towfish compromised the position estimate for the sensor. The result was the infiltration of pipeline readings into the Site 325 dataset. As it stands, the Site 325 anomaly encompasses an area defined by a circle with a radius of approximately 100 ft (30 m). Relative magnetic amplitudes range between +1010 and -500 gammas. As stated previously, however, the size and amplitude of the anomaly are not an accurate representation. PBS&J predicts that if the pipeline and well platform were not in place, the anomaly recorded over Site 325 would resemble others recorded over known shipwreck sites.

The sidescan sonar data imaged a vessel 60–65 x 15–20 ft (see Figure 11). The stern is nearly flush with the sediment with a vertical relief of approximately 1.0 ft (0.3 m) and gradually rises towards the bow to a maximum height of approximately 4.5 ft (1.4 m). The vessel has a round bow, square stern, and there exists an unknown feature extending athwartships in the stern, as evident by a dark sonar return visible in some survey passes. The sonar image appears to illustrate a lack of deck structures extant on Site 325 and coupled with the low vertical relief of the site, indicates that only the lowest portion of the hull has survived. There is no evidence of a debris field within the area surveyed to suggest that any deck structure became separated from the vessel either during or following the site formation process. One hypothesis is the vessel is a derelict and the deck was cleared prior to deposition. Earlier sonar images from the Thales Geosolutions Survey support this hypothesis as they also illustrate a lack of deck structures on Site 325. No additional sonar contacts were recorded within the area surveyed.

Diver Investigation

Divers were prevented from fully investigating Site 325 due to environmental and site conditions. Black water and heavy current resulted in divers becoming separated; inadvertently penetrating deck hatches; and being drug across jagged, broken metal and discarded shrimp netting. In total, divers spent a combined time of 22 minutes in 25 ft (7.6 m) of water on Site 325. The sole data that divers were able to obtain was a confirmation that the hull was constructed of iron or steel. The current prevented the ROV from flying on the site.

Mitigation Assessment

Aviara Energy Corporation applied with MMS in 2001 to lay a pipeline west of Site 325. MMS stipulated that the pipeline and its associated construction impacts avoid the magnetic anomaly and sidescan sonar target identified in the Thales Geosolutions survey by a minimum distance of 100 ft (30 m). PBS&J's 2004 magnetic remote-sensing survey data have plotted the potential position of this pipeline between 12 and 20 ft (3.7 and 6.1 m) to the east of the MMS plotted position (see Figure 11). The difference could be a combination of acceptable GPS accuracy (as defined in NTL 2005-G07) between the two surveys and the magnetometer layback. As discussed above, current was a factor when recording the Site 325 anomaly. However, PBS&J crossed perpendicular to the pipeline on six separate transects, and it is the contoured results of these transects upon which PBS&J based the potential pipeline

location. The perpendicular orientation of the pipeline data effectively eliminated any heading error introduced by the current (the Site 325 anomaly was surveyed in multiple directions allowing current to become a factor).

Both the plotted pipeline position and the position based upon magnetometer data fall outside the 100-ft (30-m) avoidance zone as placed around the coordinate value provided by Thales Geosolutions, Inc. (2001). However, this coordinate value does not match the coordinate for the center of the shipwreck based upon PBS&J's sidescan sonar data. Again, this could be a result of acceptable GPS accuracy and sonar sensor layback in the Thales survey. PBS&J imaged the shipwreck on eight separate survey transects and believes that the position illustrated on Figure 11 is accurate within the allotted GPS accuracy. Current was not a factor in the collection of sonar data as the sensor was towed directly off the survey vessel's side, owing to the shallow water. Both the plotted pipeline position and the position based upon magnetometer data fall outside a 100-ft avoidance zone defined by PBS&J's coordinate value for the center of Site 325. However, Site 325 measures 60–65-ft- (18–20-m-) long and is oriented in an east-west direction. As such, the westerly terminus of the site is approximately 30 ft (9.1 m) closer to the pipeline. To account for GPS accuracy, PBS&J determined, from the Site 325 mosaic, the position of the western terminus in each of the eight survey passes over the wreck site. Figure 11 illustrates the average of these eight positions. Based upon PBS&J's survey results, the pipeline position plotted using magnetic data falls within a 100-ft (30-m) avoidance zone placed around the averaged position for the western terminus of Site 325. The square on Figure 11 represents the extreme values for the location of the Site 325 western terminus (i.e., all eight positions fall within this polygon). Both the plotted pipeline position and the position based upon magnetometer data fall within a 100-ft (30-m) avoidance zone placed around the west side of this polygon.

NRHP Assessment

Historical research, remote-sensing survey, and diver investigation tentatively have identified Site 325 as the fishing vessel *Wagon Train*. The age of this vessel is unknown; however, the fishing vessel design does not qualify as eligible for listing on the NRHP under the definitions of Criteria C or D. It does not seem that the *Wagon Train* meets the qualifications for listing under the definitions of Criteria A or B either. Historical research has not located mention of this vessel being associated with an important event or person in American history. Four historic shipwrecks reported within the 20-mile (32-km) study area around Site 325 pose alternate identities. Without further information regarding the design and history of these vessels, an NRHP eligibility recommendation cannot be made. It seems likely though that they would not be eligible for similar reasons that the *Wagon Train* is not eligible.

SITE 15306

Site History

The identity and age of Site 15306 was unknown to PBS&J and MMS prior to the 2004 remote-sensing and diver investigations. Diver investigations described below ascertained that Site 15306 is a

modern, steel-hulled vessel, but its identity has not been determined beyond doubt. PBS&J consulted the ARI, AWOIS, and LDA databases to determine the identity of all shipwrecks reported within a 20-mile (32-km) radius of Site 15306. The results then were correlated with various years of the MVUS list to identify those vessels within this radius that share similar characteristics with Site 15306 as determined by PBS&J (steel construction, overall dimensions = 60–65 x 15 ft [18–20 x 4.6 m]). Several vessels were identified with similar dimensions but constructed of wood, and information for one vessel, aside from its possible existence, could not be located. One steel vessel with similar dimensions was located within the study area; however, at 69.2 x 22 ft, this vessel is too dissimilar to consider. The identity of Site 15306 remains unknown.

Remote-Sensing Investigation

Magnetic data collected during a lease block archaeological and hazard survey for Shell Deepwater Development Systems, Inc. did not record Site 15306 (Monier et al. 1998:17) due to the line spacing of this survey. The sidescan sonar record, however, imaged an 82-x-25-ft (25-x-7.6-m) target described as “an oval shaped high density object” (Monier et al. 1998:7) at Site 15306. The survey interpretation concluded that this target could represent a shipwreck despite the lack of a magnetic signature as it lays “well in between survey lines” (Monier et al. 1998:19–20). Remote-sensing survey data collected for McMoRan Oil & Gas, LLC in preparation for laying a pipeline in the vicinity verified the presence of Site 15306, which MMS then labeled a shipwreck (el Darragi and Saltus 2001:11). Magnetic data collected in this survey recorded three anomalies at Site 15306 of 15, 114, and 203 gammas, while the sidescan sonar imaged a target 72 ft (22 m) long.

PBS&J performed a remote-sensing survey at Site 15306 on May 7, 2004. The signatures of the nearby well and pipeline dominate the magnetic data collected; however, Site 15306 does exhibit a dipolar anomaly (Figure 12). The anomaly has a north-south orientation, with the negative pole situated on the north side. However, as with Site 325, the Site 15306 anomaly is skewed by the nearby pipeline and well. The line spacing achieved in PBS&J’s survey was sufficient to record an isolated shipwreck anomaly; however, the data density was not sufficient to accurately characterize the anomaly separate from the pipeline anomaly. As it stands, the anomaly’s maximum horizontal dimension measures approximately 240 ft (73 m). Relative amplitudes range from +525 to -250 gammas. As stated previously, however, the size and amplitude of the anomaly are not an accurate representation.

The sidescan sonar imaged a shipwreck upside-down in 121 ft (37 m) of water (see Figure 12). The vessel is 65 x 15 ft (20 x 4.6 m), has twin screws, and has a relatively deep keel. The maximum vertical relief of Site 15306 is approximately 10 ft (3.0 m). A debris field or sediment disturbance was imaged off the starboard bow encompassing a radius of approximately 40 ft (12 m). A nearby well platform was recorded in the sonar record and lies approximately 550 ft (168 m) to the east-northeast of Site 15306. A 15-x-10-ft (4.6-x-3.0-m) unidentified object with a maximum vertical relief of less than 3.0 ft is located approximately 930 ft (282 m) to the northeast. A 290-ft (88-m) linear depression in the sediment is visible approximately 360 ft (110 m) to the southeast of Site 15306. This likely is a portion of the

pipeline trench dug for the McMoRan Oil & Gas, LLC pipeline. Four circular depressions are associated in an area approximately 40 ft (12 m) in diameter 480 ft (146 m) north-northeast of Site 15306. This likely represents a temporary set-down of the platform rig prior to its permanent jack-up 490 ft (149 m) to the southeast.

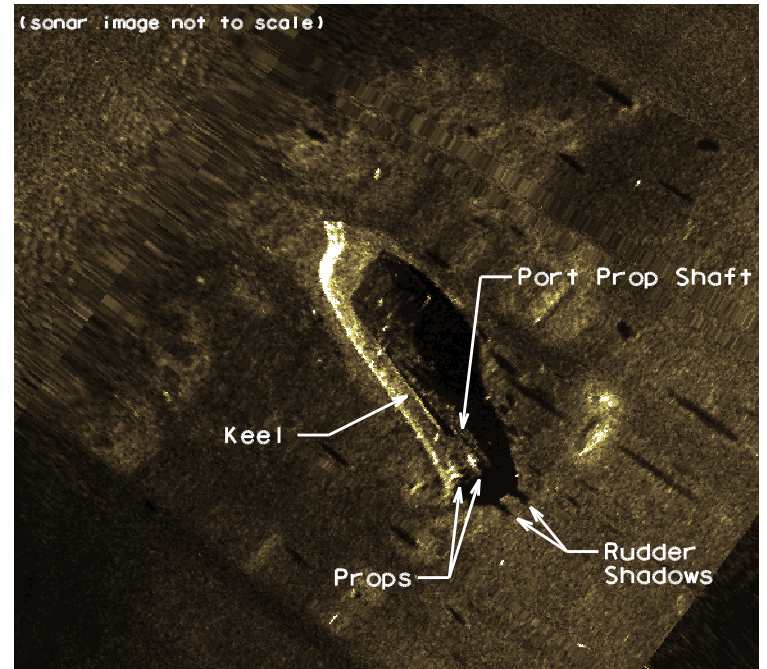
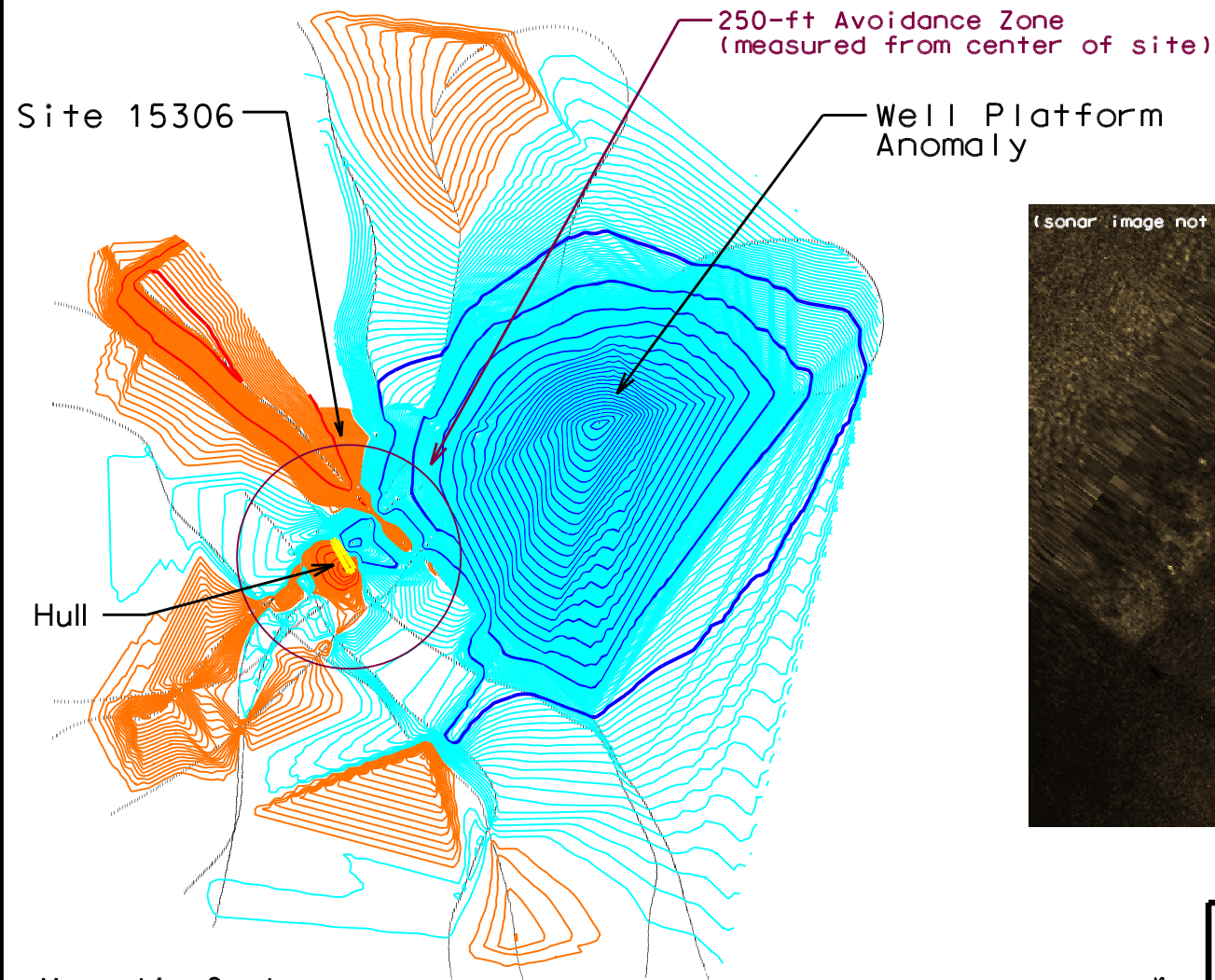
Diver Investigation

PBS&J, MMS, and THC divers spent a combined time of nearly two hours on Site 15306, and the ROV flew 30 minutes on-site. The vessel rests in 121 ft (37 m) of water, with the top at about 114 ft (35 m), where visibility ranges from 2.0–20 ft (0.6–6.1 m) depending where on the site a diver was. Divers verified a steel, V-hulled vessel 60–65 ft (18–20 m) long (variation due to the sharp bow of the V-hull design and the orientation of the vessel upside-down) with a 6.0-inch (15-cm) deep keel. Both prop shafts, props, and rudders are extant. Snagged and discarded shrimp nets completely cover these elements of the wreck site. Divers additionally identified sacrificial anodes lining both prop shafts and a through-hull mount for an echo-sounder transducer approximately amidships adjacent to the keel on the starboard side.

Mitigation Assessment

McMoRan Oil & Gas, LLC applied with MMS in 2001 to drill a well east-northeast of Site 15306 and to lay a pipeline to this well that would cross close to the site. MMS stipulated that the well and its associated construction impacts avoid the magnetic anomalies and sidescan sonar targets identified in the previous surveys by a minimum distance of 200 ft (61 m). The pipeline right-of-way and its construction impacts needed to avoid the same features by a distance of 250 ft (76 m). Magnetic data have verified the location of the well and the well platform, while the sidescan sonar imagery has recorded the location of the well platform. PBS&J's magnetic survey was unable to record the location of the pipeline due to the dominance of the well platform anomaly. The sidescan sonar survey on the other hand imaged what appears to be a section of the pipeline trench approximately 16 ft (4.9 m) to the southeast of the MMS plotted position (Figure 13).

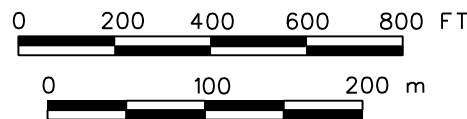
PBS&J plotted the five sonar target and magnetic anomaly locations (based upon C&C and Cochrane surveys) for which mitigation criteria were applied. PBS&J imaged Site 15306 on six separate survey passes. Figure 13 also depicts the average location for the southeast edge of the wreck site (closest to the pipeline and platform) based upon PBS&J's survey. The locations of the platform and the pipeline fall outside the avoidance zones no matter which of the six coordinate values are used; however, Figure 13 clearly demonstrates the variations in data. The differing locations are the result of a relatively longer layback, due to deeper water; accepted GPS accuracy (as defined in NTL 2005-G07); and survey transect interval (PBS&J surveyed at close order, Cochrane at 50 m [164 ft], and C&C employed 300 m [984 ft]).



Magnetic Contours



Survey Transect

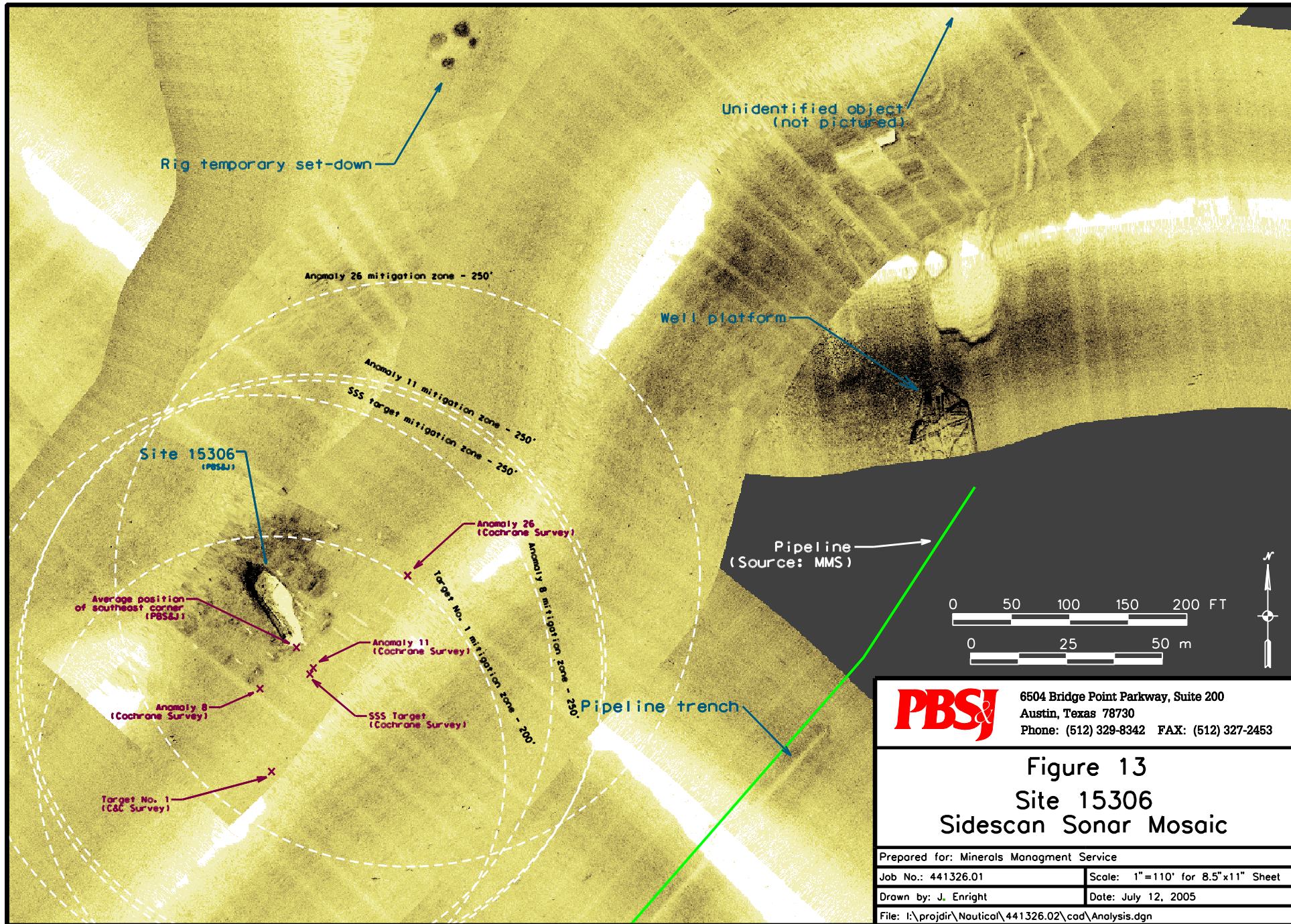


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Figure 12
Site 15306
Remote-Sensing Survey Results

Prepared for: Minerals Management Service	
Job No.: 441326.01	Scale: 1"=400' for 8.5"x11" Sheet
Drawn by: J. Enright	Date: July 12, 2005
File: I:\projdir\Nautical\441326.02\cad\Analysis.dgn	

Figure 12. Site 15306 Remote-Sensing Survey Results.



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Figure 13
Site 15306
Sidescan Sonar Mosaic

Prepared for: Minerals Management Service

Job No.: 441326.01	Scale: 1"=110' for 8.5"x11" Sheet
Drawn by: J. Enright	Date: July 12, 2005
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Figure 13. Site 15306 Sidescan Sonar Mosaic.

NRHP Assessment

Historical research, remote-sensing survey, and diver investigation were not successful in identifying Site 15306. Despite this, PBS&J's work has determined that the vessel is not historic and therefore not eligible for listing on the NRHP.

SITE 409

Site 409 was located in a lease block remote-sensing survey conducted for Diamond Shamrock and Amerada Hess Corporation by John E. Chance & Associates, Inc. (Thomas et al. 1994). Sonar Contact No. 8 is described as a possible shipwreck approximately 105 ft (32 m) long by 25 ft (7.6 m) wide with a vertical relief of 10 ft (3.0 m) (Thomas et al. 1994:37). No magnetic anomaly was recorded associated with this contact. PBS&J conducted a close-order remote-sensing survey of Site 409 on May 8, 2004. No sidescan sonar targets or magnetic anomalies were recorded in this survey. No archaeological diving was performed. Following fieldwork, it was determined that the charted position of Site 409 was incorrect and that the sonar contact recorded during the Chance survey actually resides approximately 4.0 miles (6.4 km) southwest.

SITE 410

Site 410 was located in a lease block remote-sensing survey conducted for Shell Offshore, Inc. by John E. Chance & Associates (Samson et al. 1994). The sidescan sonar target imaged at Site 410 is described as a previously recorded obstruction approximately 35 m (115 ft) long by 4.0 m (13 ft) wide with a vertical relief of 4.5 m (15 ft) (Samson et al. 1994:31). A 2,000+ gamma magnetic anomaly was recorded associated with the sonar target. Site 410 was recorded again in a lease block remote-sensing survey conducted for Diamond Shamrock and Amerada Hess Corporation by John E. Chance & Associates, Inc. (Thomas et al. 1994). Sonar Contact No. 1 is described as a possible shipwreck approximately 140 ft (43 m) long by 35 ft (11 m) wide with a vertical relief of 22 ft (6.7 m) (Thomas et al. 1994:29). No magnetic anomaly was recorded associated with this sonar target; however, Thomas et al. (1994:36–37) state that this may be the result of the magnetometer being shut down at the end of a line. PBS&J conducted a close-order remote-sensing survey of Site 410 on May 8, 2004. No sidescan sonar targets or magnetic anomalies were recorded in this survey. No archaeological diving was performed. Following fieldwork, it was determined that the charted position of Site 410 was incorrect and that the sonar contact recorded during the Chance surveys actually resides approximately 3,200 ft (975 m) northwest.

SITE 324

Site 409 was located in a lease block remote-sensing survey conducted for Seagull Energy E. & P., Inc. by Gulf Ocean Services, Inc. (Antoine and Saltus 1997a). A sonar target recorded at Site 324 is described as “a possible unknown feature ... which is boat-shaped” (Saltus 1997). Saltus, the contracting archaeologist for Gulf Ocean Services, states (1997:4) that “this feature could represent a vessel upside

down some 30 ft [9.1 m] wide and 65 or more ft [20 m] long.” No magnetic anomaly was recorded associated with this target; however, Saltus states (Saltus 1997:4) that this “is not surprising as the sonar feature lies over 300 ft [91 m] west of the survey line.” This sonar contact is quite faint and is described in the ARI database as “very tenuous.” PBS&J conducted a close-order remote-sensing survey of Site 324 on May 8, 2004. No sidescan sonar targets or magnetic anomalies were recorded in this survey. No archaeological diving was performed.

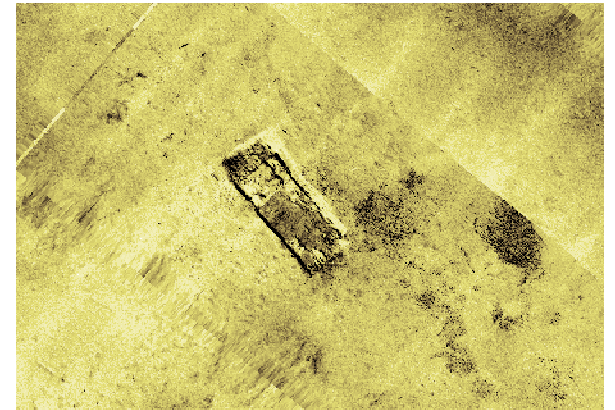
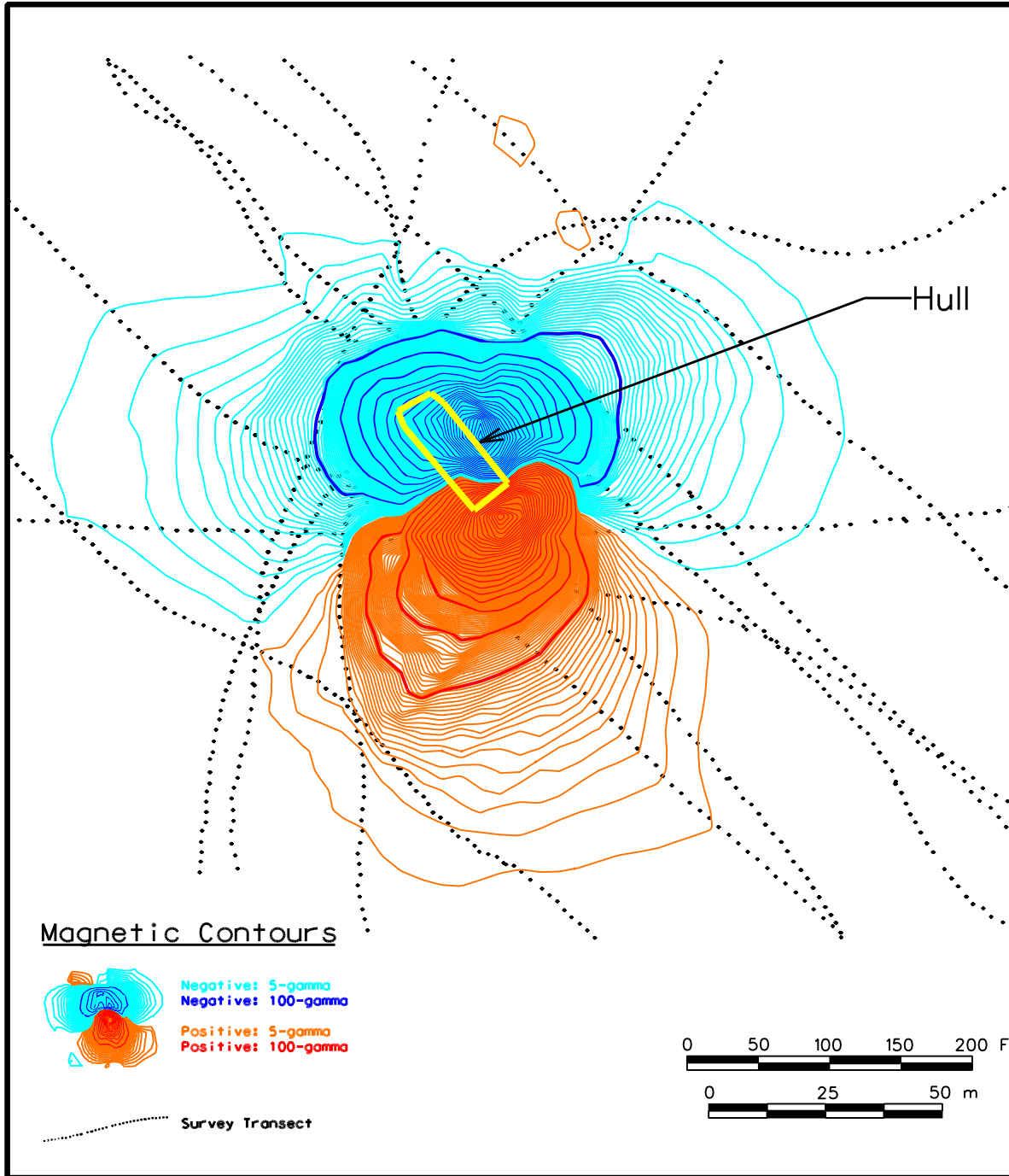
SITE 1614

Site History

The identity of Site 1614 was unknown prior to PBS&J’s 2004 field season. AWOIS plots a wreck at Site 1614, which is described as “a probable sunken barge” in at least 56 ft (17 m) of water. The 2004 remote-sensing survey (described below) confirmed that the site is a barge approximately 87–89 ft (27 m) long and 28–30 ft (8.5–9.1 m) wide. PBS&J consulted the ARI, AWOIS, and LDA databases to determine the identity of all shipwrecks reported within a 20-mile (32-km) radius of Site 1614. The results then were correlated with various years of the MVUS list to identify those vessels within this radius that share similar characteristics with Site 1614 as determined by PBS&J (barge design, overall dimensions = ca. 87–89 x 28–30 ft [27 x 8.5–9.1 m]). Two barges, *Patton* and *Margate*, were identified within the search area. The 1943 MVUS lists the *Margate*’s dimensions as 100.5 x 32.1 x 6.9 ft (31 x 9.8 x 2.1 m). PBS&J researched the MVUS editions available at the time of writing and did not locate an entry for the *Patton* (U.S. Department of Commerce, various). The position for the loss of the *Patton*, 15 miles (24 km) east-northeast, is described in the ARI database as “moderate to good.” Based upon this, it is unlikely that Site 1614 is the *Patton*. The identity of Site 1614 currently remains unknown.

Remote-Sensing Investigation

Site 1614 was first recorded by Gulf Ocean Services, Inc. (Antoine and Saltus 1997b) as a cluster of magnetic anomalies and a “very faint boat-shaped feature” on the sidescan sonar record. PBS&J conducted a remote-sensing survey of Site 1614 on May 9, 2004. The magnetic signature of the vessel exhibits a north-south dipolar anomaly with the negative lobe oriented to the north (Figure 14). The anomaly’s maximum horizontal dimension measures approximately 470 ft (143 m). Relative magnetic amplitudes range between +2,562 and –2,698 gammas. The sidescan sonar imaged a shipwrecked barge approximately 87–89 x 28–30 ft (27 x 8.5–9.1 m) with a maximum vertical relief of approximately 3.0 ft (0.9 m) (see Figure 14). Numerous large holes are evident in the deck, which are attributed to hatchways and/or corrosion. Deck beams are evident inside some of these holes. It appears as if the southeast corner of the barge has collapsed. An 18-ft (5.5-m) gap exists across the entire width of the barge approximately 17 ft (5.2 m) from the north end. This gap does not cut the barge entirely in half as a portion of the lower hull is still intact. It is unknown if this damage was the cause of the sinking or occurred postdepositionally. No additional targets were identified in the sonar record.



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Figure 14
Site 1614
Remote-Sensing Survey Results

Prepared for: Minerals Management Service	
Job No.: 441326.01	Scale: 1"=115' for 8.5"x11" Sheet
Drawn by: J. Enright	Date: July 12, 2005
File: I:\projdir\Nautical\441326.02\cad\Analysis.dgn	

Figure 14. Site 1614 Remote-Sensing Survey Results.

Diver Investigation

Divers were prevented from fully investigating Site 1614 due to environmental and site conditions. Divers were in danger of entanglement amongst discarded shrimp nets, and black water conditions led to the inadvertent penetration of an open deck hatch. In all, PBS&J divers spent a combined time of 25 minutes on Site 1614, which rests in 65 ft (20 m) of water. Divers verified an iron- or steel-hulled vessel. The ROV flew one hour on-site.

Mitigation Assessment

There presently is no oil and gas industry development in the immediate vicinity of Site 1614. Therefore, the MMS have not stipulated an avoidance zone around this site. The nearest well was drilled approximately 1.8 miles (2.9 km) west-northwest of Site 1614 in 2002 and two pipelines are located to the south of the site approximately 1.4 miles (2.3 km) distance.

NRHP Assessment

Historical research, remote-sensing survey, and diver investigation were not successful in identifying Site 1614. Despite this, the barge design does not qualify as eligible for listing on the NRHP under the definitions of Criteria C or D. It does not seem that Site 1614 meets the qualifications for listing under the definitions of Criteria A or B either. Historical research has not located mention of a barge in the area of Site 1614 being associated with an important event or person in American history.

SITE 236 – USS *HATTERAS* (41GV68)

Site History

The USS *Hatteras* began as the merchant ship *St. Mary*. Harlan and Hollingsworth Company of Wilmington, Delaware, completed the iron-hulled, side-wheel steamer *St. Mary* in 1861 for the Charles Morgan Line of GOM coast steamers. The vessel measured 210 x 34 x 18 ft (64 x 10 x 5.5 m), was schooner-rigged with three masts, and propelled its paddlewheels with a steam-condensing, walking-beam engine. The U.S. Navy acquired the *St. Mary* in September 1861, renamed her USS *Hatteras*, and assigned her to the South Atlantic Blockading Squadron. She was armed and fitted out at the Philadelphia Navy Yard with an armament of four 32-pounders, two 30-pounders, one 20-pounder, and one 8-pounder (Arnold n.d.). After a successful tour in the South Atlantic Blockading Squadron, the *Hatteras* was transferred to the Western Gulf Blockading Squadron in January 1862 where she captured seven Confederate blockade-runners.

Rear Admiral David Farragut of the Union navy was poised to retake the town of Galveston, Texas, in January 1863 after a successful Confederate raid captured the town that New Year's Eve. The USS *Hatteras* was assigned to Farragut's command offshore of Galveston when, on January 11th, a set of sails was sighted approaching the Union position. The *Hatteras* was ordered to pursue, which she did for

several hours. The two ships came within hailing distance after sunset at which time the prey was revealed as the successful Confederate raider *CSS Alabama*. The former merchant ship *Hatteras* stood no chance against the warship *Alabama*, and she went down after a brief exchange lasting only minutes (Figure 15). The *Hatteras* suffered two losses, and the remaining crew was rescued by the *Alabama* and paroled at Port Royal, Jamaica (Arnold and Anuskiewicz 1995:83–85).

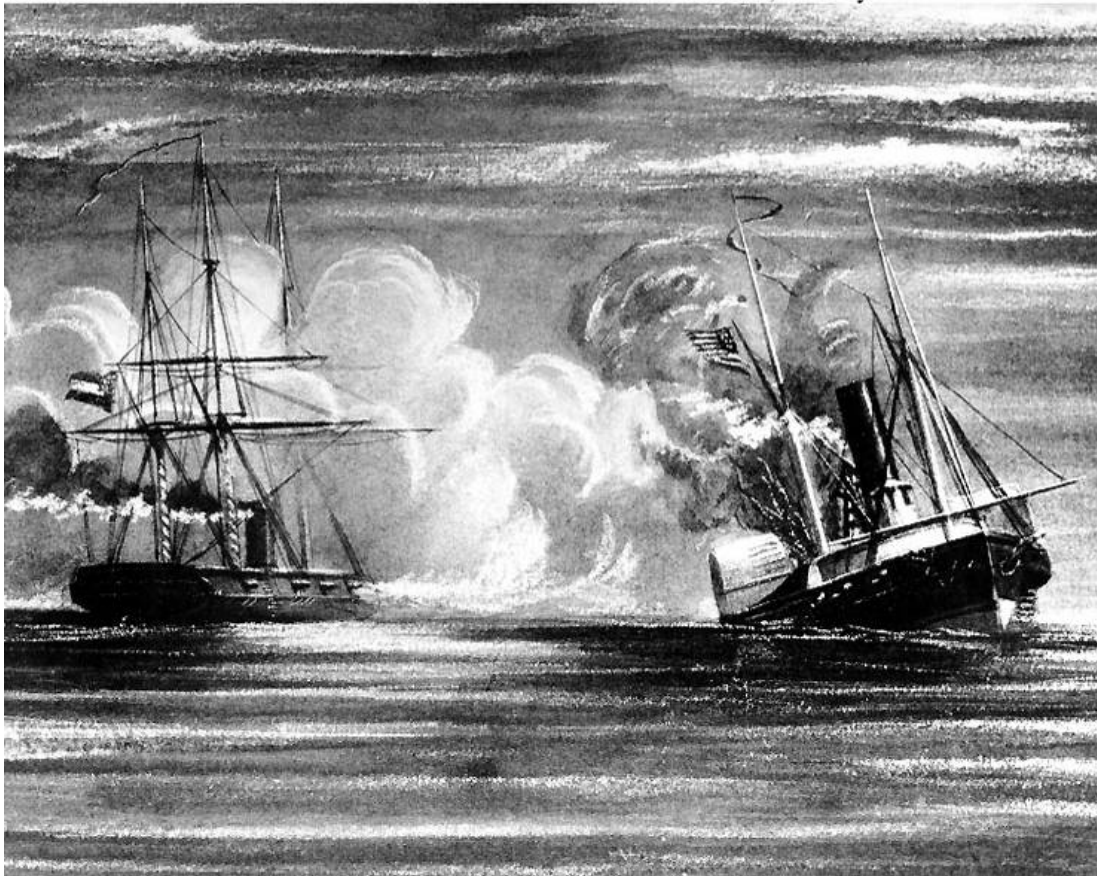


Figure 15. USS *Hatteras* vs. CSS *Alabama*. (Source: Naval Historical Center 2005a)

The USS *Hatteras* sank in 60 ft (18 m) of water approximately 20 miles (32 km) off Galveston. The wreck site had been known to modern divers and historians for some time before a group of treasure hunters attempted to claim rights to the site in the mid-1970s. An admiralty suit followed that the U.S. Navy won as it retains ownership of all its vessels, floating or not (U.S. District Court n.d.). An effort among the Bureau of Land Management (precursor to the MMS), the THC, and Texas A&M University surveyed the site and firmly fixed its position following the legal battle (Arnold and Anuskiewicz 1995:85). The MMS and THC renewed their interest in the site in the early 1990s under the impetus of oil and gas development in the area. The two organizations have since initiated a program of periodic monitoring of the site. Currently, the USS *Hatteras* is a Texas State Archeological Landmark and is listed on the NRHP. The vessel represents a comparatively intact representative example of an iron-hulled, side-wheeled steamship from a period of transition between the wooden sailing ship and the modern steamship (Arnold n.d.).

Remote-Sensing Investigation

PBS&J conducted a close-order remote-sensing survey of the USS *Hatteras* on May 9, 2004. The main body of the anomaly consists of a north-south-oriented dipole with the negative pole to the north (Figure 16). The anomaly's maximum horizontal dimension measures approximately 950 ft (290 m). The relative amplitude ranges between +3,170 and -2,425 gammas. The sidescan sonar image of the wreck site depicts few exposed features (see Figure 16). The tops of both paddlewheel hubs are visible, one more than the other; a portion of the paddlewheel shaft is exposed; and two sections of unknown elements also are visible, one midway between the hubs and the other forward/aft of the more exposed hub. The distance between the hubs constitutes the total width of the site exposed and equals approximately 40–45 ft (12–14 m). Two members of the 2004 field crew had the benefit of diving previously on the wreck site. They were able to verify that the exposed portions of the site, visible on the sonar record, are approximately the same as the previous visit with perhaps more burial.

Diver Investigation

Archaeologists spent a combined time of nearly four hours investigating the site while the ROV flew close to one hour collecting footage. Visibility was approximately 5.0 ft (1.5 m). A small section of a snagged and discarded shrimp net was found on the exposed portion of the wreck site. Both paddlewheel hubs were investigated and found to be approximately 41 ft (12 m) apart (outer edge to outer edge). The north, more-buried hub is exposed approximately 1.5–2.0 ft (0.5–0.6 m) while the south hub is exposed approximately 4.5 ft (1.4 m), where the depth of burial equals the approximate center of the hub. The distance between the two circular elements comprising the north hub was measured at 3.0 ft (0.9 m). At the north hub approximately 3.0–4.0 ft (0.9–1.2 m) of the 10–12-inch (25–30-cm) diameter shaft is exposed. The element seen on the sonar image midway between the hubs was identified as a partially exposed knuckle joining two rods that are laying flat in the sand.

The unknown element visible on the sonar image just inboard and forward/aft of the north hub was identified as three open-ended iron cylinders approximately 3.0 ft (0.9 m) long and 1.0 ft (0.3 m) in diameter. At one end of the series was a larger cylinder open on one side revealing a shaft that extended its internal length. Near one end of the shaft, two brass or bronze rings or bearings approximately 6.0–8.0 inches (15–20 cm) in diameter were loosely attached. These elements have not been identified but a likely candidate for the larger cylinder is a steam chest with an internal poppet valve.

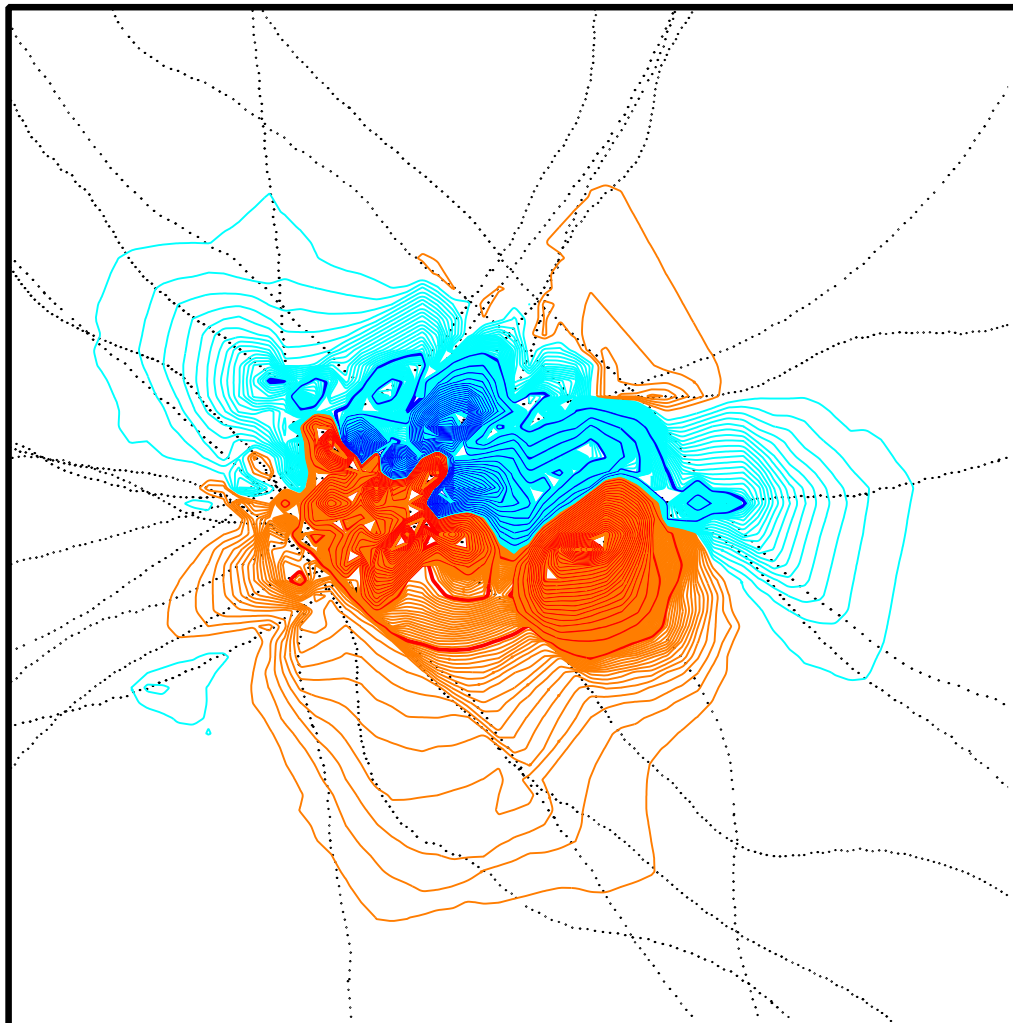
Mitigation Assessment

The current MMS recommended avoidance zone around the USS *Hatteras* is 2,000 ft (610 m). The nearest pipeline is located approximately 1.3 miles (2.1 km) to the south and the nearest well was drilled approximately 1.7 miles (2.7 km) to the east-southeast. PBS&J surveyed a 1,500-ft (457-m) radius around the wreck site and identified no oil and gas construction inside this zone. Diver investigations likewise did not identify industry activity near the wreck site. The maximum areal extent of the site anomaly is approximately 984 ft (300 m). Using a circle with a radius of 2,000 ft (610 m) centered over

the site, the minimum distance between the anomaly margin and the avoidance perimeter is approximately 1,508 ft (460 m). PBS&J believes that the MMS avoidance margin of 2,000 ft (610 m) is sufficient.

NRHP Assessment

The wreck site of the USS *Hatteras* currently is a Texas State Archeological Landmark and is listed on the NRHP as site number 41GV68.



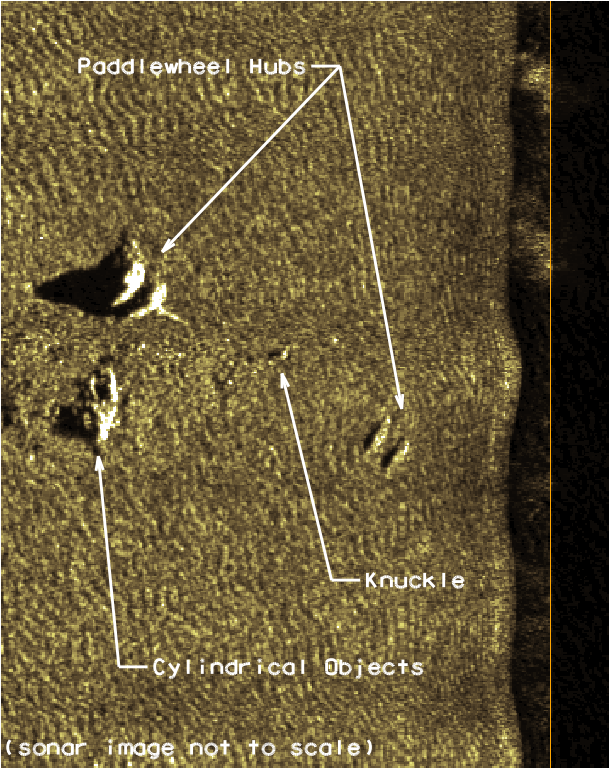
Magnetic Contours



Survey Transect



Note: avoidance zone not visible due to scale.



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Figure 16

USS *Hatteras* (Site 236)

Remote-Sensing Survey Results

Prepared for: Minerals Management Service	
Job No.: 441326.01	Scale: 1"=220' for 8.5"x11" Sheet
Drawn by: J. Enright	Date: July 12, 2005
File: I:\projdir\Nautical\441326.02\cad\Analysis.dgn	

Figure 16. USS *Hatteras* (Site 236) Remote-Sensing Survey Results.

IV. 2005 SITE INVESTIGATIONS

SITE 432 – SS *R.M. PARKER, JR.*

PBS&J investigated Site 432 in May 2005 to determine its identity, its eligibility for listing on the NRHP, and to assess the current MMS avoidance criteria. A previous hypothesis suggested that Site 432 is the *R.M. Parker, Jr.* This vessel was launched as the *Imlay* for the U.S. Shipping Board (USSB) in 1919 and ended her career in 1942 as the *R.M. Parker, Jr.* when the German submarine U-171 sank her in the GOM. Historical research, remote-sensing survey, and diver investigation (all described below) conducted in 2005 supports this hypothesis. PBS&J has confirmed that Site 432 is the *R.M. Parker, Jr.* and recommends that it is eligible for listing on the NRHP.

Site History

On September 7, 1916, the U.S. Congress adopted the U.S. Shipping Act and followed up with the Emergency Shipping Fund Provision of the Urgent Deficiencies Appropriations Act (approved on June 15, 1917) (USSB 1917). These acts effectively boosted America's shipping industry against foreign competition and provided for the acquisition and construction of much-needed vessel tonnage during World War I. The Shipping Act established the USSB "for the general purpose of regulating shipping and promoting the development of a naval auxiliary and naval reserve, and the American Merchant Marine" (Public-No. 260, 64th Congress, USSB 1917). President Woodrow Wilson's Executive Order 2664 (July 11, 1917) delegated the authority in the Emergency Shipping Fund to construct, purchase, requisition, seize, and operate ships without limitations or conditions to the USSB and the Emergency Fleet Corporation. The Emergency Shipping Fund provided financial support for the construction of shipping in the amount of \$250,000,000 (USSB 1917).

The combined effect of the Emergency Fleet Corporation's push to increase the U.S. maritime fleet and the end of World War I resulted in a surplus of vessels owned by, and vessels under construction for, the USSB in 1919. The latter included 1,300 vessels as of June 30, 1919, not yet launched (Baughman 1972:263). The Moore Shipbuilding Company of Oakland, California, built numerous standard design cargo ships and tankers for the USSB during World War I, including a dozen oil-powered 425-x-57-x-33-ft (130-x-17-x-10-m), 7,000 gross-ton (6,350 metric-ton) tankers (registered at 6,779 tons [6,150 metric tons]). One tanker, Hull #139, was under construction for the USSB in 1919, and the remaining 11 were completed in 1920 and 1921. Hull #139 was the first of the Moore Shipbuilding Company's 7,000 gross-ton (6,350 metric-ton) tankers to be launched. She was christened *Imlay*, possibly after the title of a Persian prince (Jarrell 1977), and delivered to the USSB on September 26, 1919, where she was designated USSB #1025 (Colton Company n.d.). The *Imlay* later was described as having one deck, two masts, a plain head, and an elliptical stern (Bureau of Marine Inspection and Navigation 1941).

Several of Moore's incomplete vessels initially were considered for U.S. Navy acquisition in 1919 but ultimately were left with the USSB due to the rapidly shrinking navy at the time (U.S. Naval Historical Center n.d.). The USSB was forced to find alternate uses for its surplus of ships following World War I. The USSB retained ownership of its 88-ship tanker fleet. Eighteen ships from this fleet were let to private managing agents as part of the USSB profit-sharing consignment program, and the remaining 70, including the *Imlay*, were laid-up (Baughman 1972:307). Laid-up tankers were offered for charter, and the *Imlay* was operated in this way on a limited basis for New England Oil.

The USSB Emergency Fleet Corporation assistant director of operations, Clifford Day Mallory, resigned his position in 1919 and founded the C.D. Mallory & Company Inc. (CDM&C) shipping firm (Mystic Seaport Museum, Inc. n.d.). CDM&C was one of several American companies created to take advantage of the USSB cargo ship consignment program following World War I. CDM&C operated 49 ships as transoceanic tramps and liners for the USSB between late 1919 and early 1921 before it was cancelled as a managing agent for the USSB (Baughman 1972:290–293). Mallory followed his partnership with the USSB in 1921 by securing two important contracts for CDM&C: 1) exclusive broker for a tanker fleet, and 2) chartering agent for New England Oil. It was in this new triangle that Mallory witnessed a changing market requiring a supply of American-flag tankers for coastal and intercoastal delivery of oil (Baughman 1972:299–306).

Meanwhile, late in 1922 as the American petroleum industry began to rise, the USSB also recognized a new demand for tanker tonnage, which caused it to reevaluate its policy concerning its 88-ship tanker fleet. The USSB seized on the opportunity and in March 1923 offered any or all of the fleet for sale (Baughman 1972:308). Mallory's first response was the formation of the Dover, Delaware, subsidiary of CDM&C, Malston Company, Inc., in March 1923. "The company's purpose was to capitalize on a sudden upward shift in the private demand for American-flag tankers and the Shipping Board's [USSB] consequent decision to meet that demand by dumping some of its excess capacity on the public ship market at bargain prices" (*Marine News* 1923; *New York Times* 1923). The Malston Company struck a nine-tanker purchase deal with the USSB, of which the *Imlay* was a part. The *Imlay* fit the Malston Company requirements for tanker purchase and was a known quantity thanks to a previous CDM&C charter of this vessel for New England Oil.

Malston Company placed the *Imlay* on a series of 6-month and 12-month charters to the General Petroleum Company and the Standard Oil Company between late 1923 and 1930. The stock market crash in 1929 brought an economic downturn in the U.S., and one result was that Malston's tanker contract with Standard Oil was not renewed when it lapsed on January 1, 1931. Malston Company moved each tanker to Mobile, Alabama, as her charter expired, painted her with crude-oil preservative, and laid her up in fresh water (Baughman 1972:325). The *Imlay* sat in this state until 1934 when prosperity returned and the need for tankers once again boomed. Thanks to government subsidies available for ship construction, however, Standard Oil began a major shipbuilding program in 1936 and no longer required the Malston charters. Despite this setback, the Malston tankers continued charter service for other companies, and the *Imlay* was contracted to the Texas Company in 1936 and 1938 and the Atlanta Refining Company in 1937

and 1938 (*Port Arthur News*, 1936–1938). To take advantage of new tax laws in the Revenue Act of 1939, CDM&C acquired the operating plants of the textile firm Farr Alpaca Company and sold one of these plants to the newly formed Mallory company, Farr Spinning & Operating Company, in March 1940 (Baughman 1972:337). Ownership of 10 tankers from the Malston fleet, including the *Imlay*, then was transferred to Farr, which legally eliminated the income tax due on the tankers' earnings.

Clifford Day Mallory died in April 1941. Faced with high estate taxes, the Mallory family liquidated Clifford Day's assets. This sent the *Imlay* with the Farr tanker fleet to the Marine Transport Lines, Inc., a company formed by Mallory's partners after his death. The *Imlay* sold for \$1,200,000 (Anonymous n.d.). Not long after, in July 1941, she was traded to the Hartol Oil Company, a subsidiary of Continental Steamship Company, in exchange for their vessel *Malay* (Crawford 1941; Helmbold 1941). The new owners changed her name from *Imlay* to *R.M. Parker, Jr.*, enrolled her in the coasting trade, and placed her operation out of Baltimore under Master L.L. Hamwood (Figure 17). America's involvement at this time in World War II set the stage to bring the *Imlay* full circle back to her initial construction purpose.

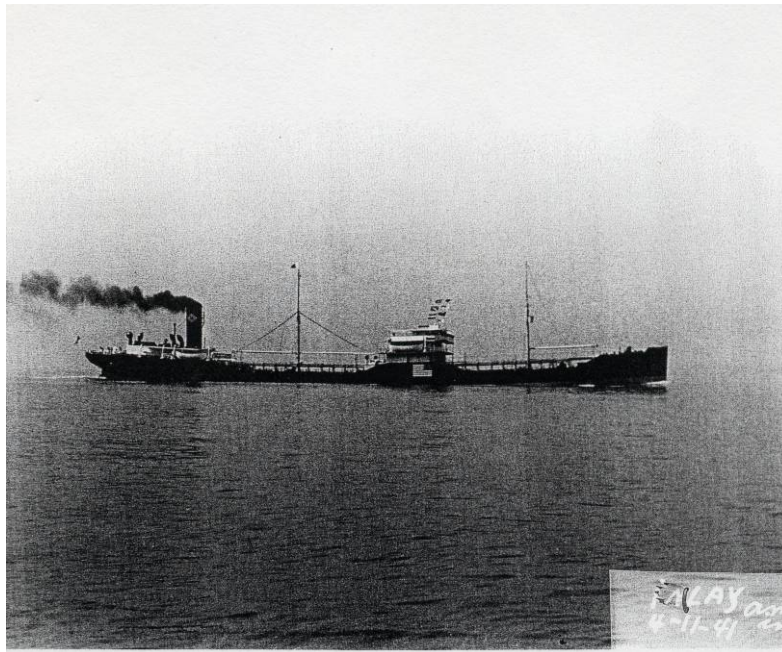


Figure 17. *Imlay*, April 1941. (Source: National Archives, RG26)

The *Imlay* transported oil and operated mostly out of Texas ports (*Gulf Daily Shipping Guide* 1930–1941). Her career between the new boom in 1934 and the onset of World War II was relatively uneventful except for an oil salvage operation that occurred in February and March of 1934. According to the *Oakland Tribune* (1934a), the *Imlay* was dispatched from New York on February 24th to attempt a salvage of the oil cargo from the CDM&C tanker *Swifteagle*. The *Swifteagle* had stranded ashore at San Benito Island (450 miles [724 kilometers (km)] south of Los Angeles Harbor) during a rainstorm. After a six-day unsuccessful battle to transfer the oil in heavy seas, the effort was abandoned. The *Swifteagle* was declared a total loss (*Oakland Tribune* 1934b) and her crew was rescued by the U.S. Coast Guard (USCG) cutter *Shoshone*.

The Merchant Marine Act of June 29, 1936, established the independent agency U.S. Maritime Commission “to further develop and maintain a merchant marine for the promotion of U.S. commerce and defense” (Maritime Administration n.d.). The Commission took over the duties and responsibilities of the USSB, resulting in its dissolution. U.S. involvement in World War II (following the attack on Pearl Harbor on December 7, 1941) prompted President Franklin Delano Roosevelt to establish the War Shipping Administration (WSA) in February 1942 “in order to assure the most effective utilization of the shipping of the U.S. for the successful prosecution of the war” (Roosevelt 1942). Many duties of the Maritime Commission were transferred to the WSA between February 1942 and September 1946. These duties included “the operation, purchase, charter, insurance, repair, maintenance, and requisition of vessels, and the issuance of warrants with respect thereto” (Roosevelt 1942). The WSA requisitioned Hartol Oil Company’s tanker *R.M. Parker, Jr.* in 1942. The WSA allocated back to the civilian managing agent Continental Steamship Company the duty of operating the *R.M. Parker, Jr.* She was fitted with one 5-inch and two 50-caliber guns, and a complement of seven armed guards joined her crew.

The GOM was organized into the Gulf Sea Frontier during World War II and fell under the command of the Eastern Sea Frontier. The Gulf Sea Frontier encompassed the waters from the Duval-Saint Johns County Line near St. Augustine, Florida, around the Florida Keys, past the Mississippi River, and down the coasts of Texas and Mexico to Belize and included the entire GOM (Gannon 1990:347). Grand Admiral Karl Dönitz, commander of the U-boat arm of the German *Kriegsmarine*, opened an unanticipated offensive on the Gulf Sea Frontier when U-507 entered the GOM on May 4, 1942, and sank the American freighter *Norlindo*. This was the vanguard of the Dönitz offensive that eventually included five U-boats operating in the GOM by the end of May, seven in the month of June, and 10 by July (Kelshall 1988:79; Wiggins 1995:237). U-boat targets mainly included tankers traveling off the passes of the Mississippi River. Casualties drastically increased during the month of May to a rate approaching one vessel sunk per day (Gannon 1990:348). According to Gannon (1990:174), “the Gulf of Mexico, and the Caribbean Frontier would for six months of 1942 become the most intense continuous theater of German naval operations.” Sixty-five vessels were sunk in the Gulf Sea Frontier during May and June; combined with losses in the Caribbean Frontier, more ships went down in the area than anywhere else in the world in any previous two-month period (Gannon 1990:349).

On July 23, 1942, U-171, a member of the German 10th Flotilla and under command of Günther Pfeffer, entered the GOM and took up its position between Galveston and New Orleans. U-171 was one of 54 Type IXC U-boats in the German *Kriegsmarine* and was commissioned October 25, 1941. The IXC class U-boat measured 252 x 22 ft (77 x 6.7 m) overall with a height of 31 ft (9.4 m) including the conning tower. U-171 had a cruising range of 13,450 miles (21,646 km), could reach speeds of 18 knots (21 mph/33 kmph), and submerge to 755 ft (230 m). She carried 22 torpedoes, which could be launched through four bow tubes or two stern tubes; 44 mines; and two deck guns of 105 and 45 millimeters (mm). Just three days after her arrival in the GOM, July 26th, U-171 sank her first vessel offshore of Matagorda Bay, Texas, the Mexican freighter *Oaxaca* traveling along the U.S. coastline from New Orleans to Veracruz. Despite his quick initial success, Pfeffer entered the GOM campaign towards the end of U-boat successes and would end up with only three kills. Following the heavy losses in shipping during the

previous months, the U.S. responded with heavy air patrols and vigilant convoy escorts. The GOM was no longer favorable for the U-boats during much of the time that U-171 was cruising in the area (Kelshall 1988:325). U-171 in fact was the sole U-boat operating in the GOM by the end of August 1942.

The *R.M. Parker, Jr.* was traveling alone in ballast from Baltimore bound for Port Arthur at a time when U-boat casualties or damage dropped from an average of nearly five vessels torpedoed a week between the beginning of May 1942 and the third week in July to just four in the two and a half weeks prior to August 12, 1942 (Wiggins 1995:233–237). On August 12, the *R.M. Parker, Jr.* was traveling westbound along the northern GOM coastline. She was blacked-out and under radio silence, but was traveling in a straight line (as opposed to zigzagging to avoid detection). As evening turned to August 13, the *R.M. Parker, Jr.* was approximately 25 miles (40 km) south of Isles Dernieres, Louisiana, traveling at a speed of 10 knots (12 mph/19 kmph). Three engineers were on watch below deck and six lookouts were stationed on deck as the crew slept under a cloudy sky and calm sea (USCG 1944). The following description of the next several minutes comes from the official USCG Report on U.S. Merchant Tanker War Action Casualty (USCG 1944) (Figure 18) and the summary of statements by the survivors reported in Wiggins (1995:111–112). The lookouts spotted a phosphorescent wake astern of their vessel and two points of light approaching at 0050 Eastern War Time (EWT). No alarm was sounded as the approaching torpedoes were only 25 yards (75 ft/23 m) off when they were spotted. Deck plates ruptured when the torpedoes struck the *R.M. Parker, Jr.* on the port side, approximately amidships, and a large hole was opened, flooding tanks #5 and #6 (see Figure 18). The initial impacts destroyed one of the four lifeboats and additionally toppled the mainmast, which took out the radio antennae. No distress signal could be sent. The heavy list to port prevented a response from the vessel's deck guns and forced the crew to abandon ship at 0053 EWT. As the *R.M. Parker, Jr.* continued her plunge into the GOM, U-171 surfaced 250 yards (750 ft/ 229 m) off and fired six shells from her deck guns at the crippled vessel. The first round exploded the stern deck gun magazine, and the remaining five pierced the amidships deckhouse and bridge.

All 44 crew and guards managed to abandon ship and reach three lifeboats. Injuries to Sergeant 2nd class Steven Joseph Gangl, Sergeant 2nd class Harry Garfinkel, and one officer from the ship's crew were reported (American Merchant Marine at War 1998; USCG 1944). The armed guards removed their dog tags and weapons in order to claim that they were merchant seamen and avoid becoming prisoners of war, but U-171 did not return. The crew had a breakfast of water and hardtack while they watched as the bow of their ship came into view with the rising sun. The stern of the vessel had sunk; however, since the compartments were empty when she was torpedoed, the forward section back to the bridge remained afloat and listing to port. Shortly after breakfast, the survivors spotted a PBY patrol plane overhead. A message was dropped with news of impending rescue. Eight and one-half hours after the torpedoes struck, at 0920 EWT, the *R.M. Parker, Jr.* sunk completely from view and the survivors were picked up by a shrimp boat. The 44 men were brought ashore at Morgan City, Louisiana, that same day. The WSA agreed in November 1942 to pay the Hartol Steamship Corporation (Hartol Oil Company) a hull insurance claim of \$813,000 due to the total loss of the *R.M. Parker, Jr.* by enemy action (WSA 1942a).

After sinking one more freighter on September 4, 1942, U-171 headed home. She never made land as she struck a mine in the Bay of Biscay on October 9, 1942, and sank to the bottom in 125 ft (38 m) of water. Twenty-two crewmen out of 52 died in the incident. Following U-171's withdrawal from the GOM, six months went by before another Allied vessel was sunk in the region, and then only four losses occurred throughout 1943. Rampant U-boat hunting in the GOM was finally checked after the loss of 56 Allied vessels and the damaging of 14 (Wiggins 1995:238).

Shipwreck Correlation

PBS&J consulted several shipwreck sources in order to surmise various locations for the loss of the *R.M. Parker, Jr.* as well as other shipwrecks of similar size in the area of Site 432 that could pose an alternate identity. This exercise was performed to provide additional circumstantial evidence that Site 432 indeed is the *R.M. Parker, Jr.* Sources were limited to those providing the most comprehensive list of shipwrecks for this particular area of the GOM and those concerned with World War II casualties, and included three shipwreck databases, two secondary sources, and one index.

The ARI, AWOIS, and LDA databases were consulted; however, these three databases come with the caveat that position accuracy can range from precise to vague due to the sources from which such information originates. Moreover, the databases oftentimes rely upon one another for information and therefore share some of the same data. Jordan (1999) researched the world's merchant fleet for the year 1939 and provides the "particulars" for 6,000 ships. This is a good secondary source for vessels similar to the size and age of the *R.M. Parker, Jr.* A large portion of Jordan's work consists of the "wartime fate" of every vessel from the 1939 fleet that was sunk, whether by war causes or marine casualty, and provides the catalyst of and approximate positions for the losses. Supplied data for losses were compiled from the *Casualty Returns* and *Lloyd's War Losses* published by Lloyd's of London. Wiggins (1995:114–117), while not providing coordinate accuracy, does provide a list of merchant vessels that were attacked and/or sunk in the GOM during World War II. From this list, databases were searched to provide approximate positions for these losses. The "U.S. Coast Guard Index to U.S. Merchant Ship Losses during the Second World War" is a list compiled from official reports and survivor accounts. The USCG states that coordinates provided in this list were recorded "after the end of World War II and [are] therefore subject to error" (USCG 1999). The MVUS perhaps is the most comprehensive list of U.S. historic vessel losses (aside from wartime years when losses were confidential) and was thought an excellent source for this endeavor. However, positions provided in this list are limited to bodies of water or positions in relation to landmarks. Rarely are coordinate values for a vessel loss provided, making a search of this list fruitless.

First, PBS&J examined the positional data provided by each source for the location of the wreck of the *R.M. Parker, Jr.* If the locations differed from Site 432 by great distances, the identity of the site must be questioned. The following table summarizes the results of this research. It should be noted that the MMS selected this site as the possible location for the *R.M. Parker, Jr.* Therefore, Site 432 coordinates and ARI coordinates for the location of *R.M. Parker, Jr.* are the same and not noted in Table 3.

REC-200-2
210-202

CONFIDENTIAL

UNITED STATES COAST GUARD

REPORT ON U. S. MERCHANT TANKER WAR ACTION CASUALTY

Ten Commodore, U. S. Coast Guard, Washington, D. C.

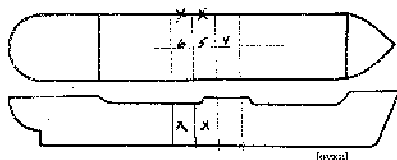
Ship: R. M. PARKER, JR. Service: ROBERT WISE TANKER

Owner: HOBBS S. S. Co. Operator: CONTINENTAL S.S. Co.

Information furnished by: MASTER + CREW + ONI REPORT Date: 7 DECEMBER, 1944

DECLASSIFIED
Authority: AND 98008
By: NAVA UNCL 1946

No.	DESCRIPTION	ANSWERS
1	Type built and propulsion	Built <u>1919</u> Propulsion <u>STEAM</u>
2	Tonnage	Gross <u>4,779</u> Net <u>4,003</u>
3	Draft loaded (maximum allowed)	Prod. <u>22'00" (M)</u> aft
4	Draft when attacked	Prod. <u>15'00" (M)</u> aft
5	D. W. T. (Emergency (maximum L. W.))	<u>4,000</u>
6	Capacity cargo capacity and carried	Capacity <u>80,000 BBL.</u> Carried <u>NO BARR.</u>
7	Kind of cargo or use in ballast	<u>WATER BALLAST - RIPTIDE SIBL. RE. TANKS. 250000-7.</u>
8	Where ship chartered (Specify)	<u>YES</u>
9	Voyage	From <u>BALTIMORE, MD.</u> To <u>PORT ARTHUR, TEXAS.</u>
10	Were routing orders followed	<u>YES</u>
11	Any violation of orders	<u>NO</u>
12	Weather at time of attack	Weather <u>CLOUDY</u> Sea <u>CALM</u>
13	Was enemy sighted? When	<u>YES, AFTER ATTACK.</u>
14	Any friendly ships in sight	<u>NO</u>
15	Were navigation lights on	<u>NO</u>
16	Date and time of attack	Date <u>11-12-44</u> Time <u>08:30</u>
17	Position	Latitude <u> </u> Longitude <u> </u>
18	Nature of attack (Give date)	<u>TORPEDOES AND SHALLS</u>
19	Number of hits	<u>2 TORPEDOES; 6 SHALLS.</u>
20	Location of hits (Deck, forward)	<u>2 TORP. HIT (1/2 FORWARD) & ALL OVER.</u>
21	Effect of hits	<u>SMALL HOLE</u>
22	Was ship set off? What type	<u>YES, 1.5" 2-STEP SWL</u>
23	Was equipment used? (State result)	<u>NO</u>
24	Was oil engaged over ship	<u>NO</u>
25	Did enemy fire (Mark explosion)	<u>NO</u>
26	Did enemy explode (Mark direction)	<u>NO</u>
27	Was deck ruptured	<u>YES</u>
28	Did ship break in two	<u>NO</u>
29	Was BOD used	<u>NO</u>
30	Ship's speed	Normal <u>12.0</u> When attacked <u>12.0</u> When abandoned <u>5.0</u>
31	Time abandoned, (mark)	Abandoned <u>00:53 (2 min)</u> Sunk <u>00:20 (8 hrs 30 min)</u>
32	Was ship abandoned	By whom <u>NO</u> When <u> </u>
33	Was ship brought in	How <u>NO</u> Approximate damage <u>SMALL</u>



Fill in this diagram to show
attack hits, fires, explosions, etc.

Indicate by asterisk (*) hits, blasts, or other aid in emergency refuge in water before rescue by lifeboats.

No.	DESCRIPTION	ANSWERS
34	Lifeboats	Number carried <u>2</u> Which most used <u> </u>
35	Life rafts	Number lost <u>1</u> How <u>TARRERA HELMSTON</u>
36	Life rafts	Number carried <u>1</u> Which used <u> </u>
37	Life rafts	Number lost <u>1</u> How <u>NOT NEEDED</u>
38	Life rafts	Number carried <u>0</u> Which used <u> </u>
39	Life rafts	Number lost <u>0</u> How <u> </u>
40	Life-saving suits	Number carried <u>0</u> Number used <u> </u>
41	Work boats, etc., attached	Detached <u>NO</u> Casalties <u> </u>
42	Time in each boat, raft, etc.	<u>3 - 8 hrs. Boat <u> </u> Raft <u> </u> Float <u> </u></u>
43	Rescued by and where	<u>SB</u> By <u>ALLIED SUBS.</u> Where <u>NEAR SCENE</u>
44	Number of gun order carried (ammunition)	Officers <u>0</u> Enlisted men <u>2</u>
45	Number of ship's crew carried	Officers <u>8</u> Enlisted men <u>28</u>
46	Number of persons rescued	<u>0</u>
47	Explosion heard	<u>YES</u>
48	Number of gun crew injured (military)	Officers <u>0</u> Enlisted men <u>1</u>
49	Number of ship's crew injured	Officers <u>1</u> Enlisted men <u>0</u> Uninjured <u>1</u>
50	Number of wounds injured	<u>0</u>
51	Number of gun crew lost (military)	Officers <u>0</u> Enlisted men <u>0</u>
52	Number of ship's crew lost	Officers <u>0</u> Enlisted men <u>0</u>
53	Number of others lost	<u>0</u>
54	Total casualties	Injured <u>1</u> Total <u>0</u>
55	Persons lost by (specify)	Drowning <u>0</u> Fire <u>0</u> Sunk or trapped <u>0</u>
56	Other causes	<u>0</u>
57	Total rescued	Officers <u>8</u> Enlisted men <u>28</u>
58	Persons saved by	Boats <u>1</u> Rafts <u>0</u> Floats <u>0</u> Suits <u>0</u>
59	Engineering work below	Number on watch below <u>0</u> Number lost below <u>0</u>
60	Number of lockets	<u>NO</u>
61	Any defective material	<u>NO</u>

COMMENTS, CRITICISMS, AND RECOMMENDATIONS

The report and recommendations are prepared for the safety of common and ships personnel in war and are currently submitted by Headquarters to the Bureau of Naval Operations for their use.

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Austin, Texas 78730
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Figure 18
War Action Casualty Report,
R.M. Parker, Jr.

Prepared for: Minerals Management Service	
Job No.: 441326.01 & 441326.02	Scale: N/A
Drawn by: J. Enright	Date: July 10, 2005
File: I:\projdir\Nautical\441326.02\cod\Analysis.dgn	

Figure 18. War Action Casualty Report, R.M. Parker, Jr.

TABLE 3

VARYING LOCATIONS FOR THE *R.M. PARKER, JR.*

	AWOIS	LDA	USCG	Jordan (1999)
Distance from Site 432	3 miles (4.8 km)	3 miles (4.8 km)	9 miles (14 km)	9 miles (14 km)
Bearing	NNW	NNW	SSW	SSW

The positions provided in the AWOIS and LDA databases are the same because the LDA relied upon the AWOIS data for this particular wreck. The AWOIS *R.M. Parker, Jr.* record notes that the position accuracy for this wreck is 1.0–3.0 miles (1.6–4.8 km), the source for the coordinates is unknown, and the quality of the position is categorized as questionable or unverified. An AWOIS 3,000-m (9,843-ft) radius sidescan sonar survey in 1995, moreover, failed to locate the wreck site. Given this information, a 3.0-mile (4.8-km) difference does not warrant seeking an alternate identity to Site 432. The coordinates obtained by Jordan, through Lloyd’s of London, seem to have originated from the USCG, as they correlate precisely with the USCG coordinates for the sinking of the *R.M. Parker, Jr.* Given that the USCG coordinates likely relied upon the approximate position of loss provided in the survivor accounts, 9.0 miles (14 km) is acceptable.

Second, PBS&J reviewed the data to determine whether a vessel of similar dimensions wrecked in the vicinity of Site 432 and could be an alternate identification for the site (Table 4). Two results are tabulated in Table 4. First, the results for those shipwrecks located within a 20-mile (32-km) radius of Site 432 and that measure within 50 ft (15 m) of the *R.M. Parker, Jr.*’s overall length, without consideration of date or cause of sinking. Second is the same data for vessels torpedoed in the GOM during World War II that measure within 50 ft (15 m) of Site 432. The latter was compiled from Wiggins (1995) and the USCG Index with help identifying coordinate values from the databases. Some of these shipwrecks are listed more than once as different sources list different positions for the same wreck.

TABLE 4

LOCATIONS OF VESSELS SIMILAR TO THE *R.M. PARKER, JR.*

Wreck	Distance from Site 432 (miles/km)	Bearing	Length (ft/m)	Source
<i>Benjamin Brewster</i> *	42/68	NE	427/130	ARI/AWOIS/LDA
<i>Cities Services Toledo</i> *	82/132	WNW	465/142	ARI/LDA
<i>David McKelvy</i>	16/26	NE	445/135	AWOIS/LDA
<i>Gulf Penn</i> *	89/143	ESE	480/146	MMS
<i>Gulf Penn</i> *	96/154	ESE	480/146	AWOIS/LDA
<i>Gulfoil</i> *	73/117	SE	383/117	ARI/LDA
<i>R.W. Gallagher</i> *	19/31	SW	413/126	ARI/AWOIS/LDA

*Torpedoed in the GOM during World War II.

Seven unknown shipwrecks are identified in the databases within 20 miles (32 km) of Site 432. No information other than their possible existence is known. Two shipwrecks, the *Betsey* and the *Helen Buck*, also are located within 20 miles (32 km), but dimensions for these two vessels are not provided. The *Betsey* was reported lost in 1750, which excludes her from being a 425-ft (130-m) steel-hulled, oil-driven, screw-propelled cargo ship. The *Helen Buck* was reported lost in 1902, but research has been unable to locate further information. ARI notes a vessel with the questionable name of *Hello* located within the 20-mile (32-km) radius. It additionally notes that this vessel was documented using USCG records and might refer to the *Halo*, which was sunk by a German U-boat during World War II. If so, the *Halo* measures 534 ft (163 m) long, and according to the ARI database her location was confirmed in August 2004, 37 miles (60 km) to the east of Site 432. The *Gulf Penn's* location also was confirmed in August 2004, 89 miles (143 km) to the east-southeast of Site 432.

The closest matches to the size of the *R.M. Parker, Jr.* and reported lost within a reasonable distance are the *David McKelvy* and the *R.W. Gallagher*. The location of the *R.W. Gallagher* wreck site has been investigated and verified. Therefore, the 19-mile (31-km) distance listed in Table 4 is accurate. The historic record reports that the survivors of the *David McKelvy* were rescued from the water by a USCG cutter (Helgason 1995). It can be assumed that the coordinates recorded in the USCG records therefore are accurate. AWOIS notes that a search for the *David McKelvy* at this recorded location was unsuccessful. However, the vessel reportedly was salvaged following the sinking, towed towards the coastline of Louisiana until she became beached, and abandoned (Helgason 1995). It is possible that the AWOIS coordinates for the location of the *David McKelvy* are those of the sinking and not the final resting place for the vessel. There appears to be no correlation between Site 432 and the *David McKelvy*. Remote-sensing investigations (discussed below), diver investigations (discussed below), and historical research have provided solid evidence that the identity of Site 432 is that of the *R.M. Parker, Jr.*

Remote-Sensing Investigation

Cochrane Technologies, Inc. documented Site 432 in a lease block remote-sensing survey conducted for Spinnaker Exploration Company, LLC in 2003 (el Darragi and Saltus 2003). The sidescan sonar imaged the wreck (Target No. 1) on three separate survey transects, with a fourth imaging a possible debris field several hundred feet away that may be associated with the wreck site. The wreck is described as rising 24 ft (7.3 m) above the seafloor with what “appears to be a berm built up by the accumulating of sediments” on the southwest side of the wreck (el Darragi and Saltus 2003:15). Eight magnetic anomalies were recorded associated with Site 432, the most intense reaching 6,290 gammas for a distance of 2,000 ft (610 m) (el Darragi and Saltus 2003:19, 22). Additionally, “a number of other anomalies within a 1,000-ft [305-m] radius around the wreck could represent debris from this event” (el Darragi and Saltus 2003:19).

PBS&J conducted a remote-sensing survey of Site 432 on May 10, 2005. The magnetic portion of the survey recorded a north-south dipolar anomaly with the main negative lobe oriented to the north (Figure 19). The anomaly’s maximum horizontal dimension measures approximately 960 ft (293 m) edge

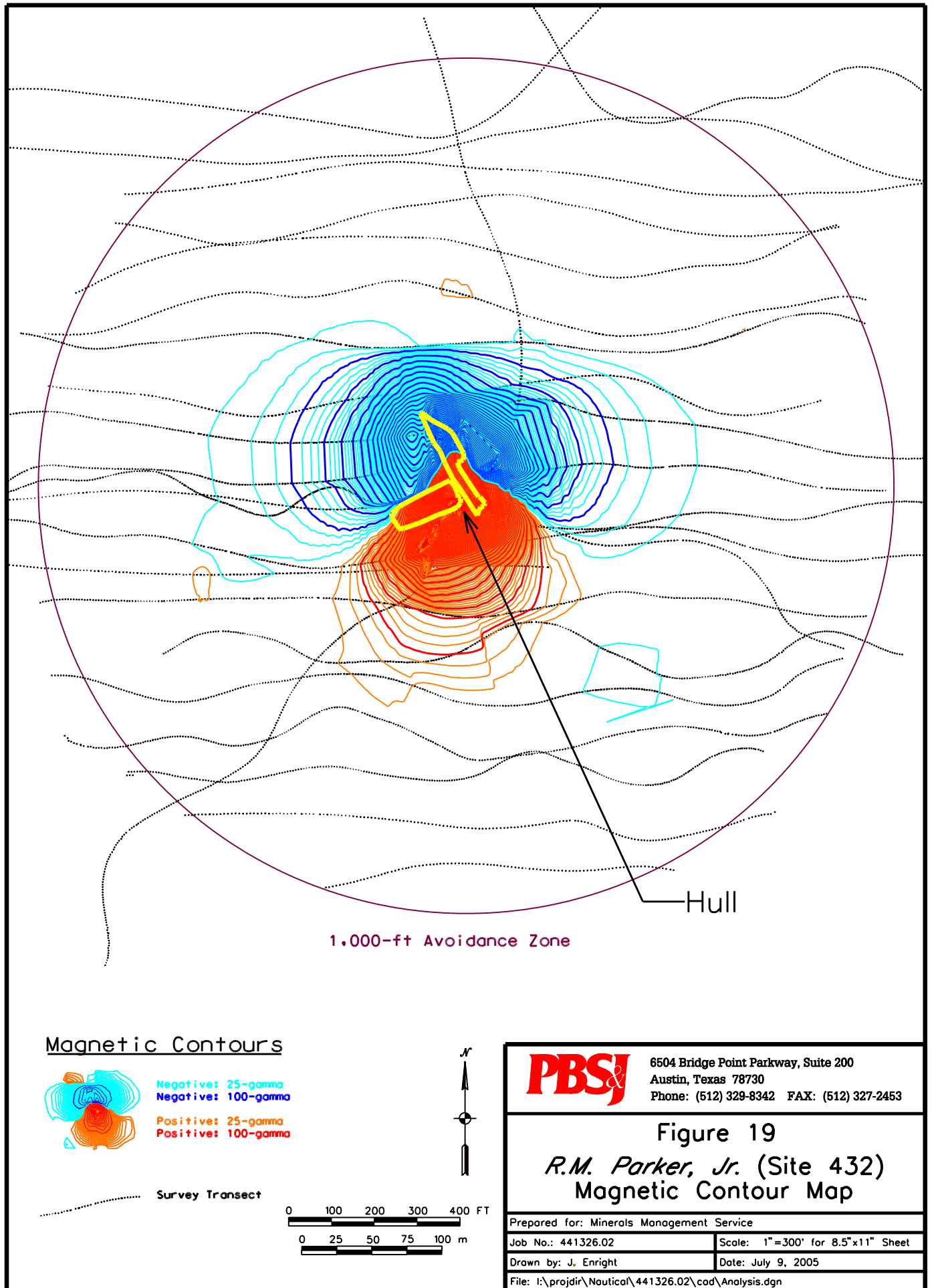


Figure 19. *R.M. Parker, Jr. (Site 432)* Magnetic Contour Map.

to edge. The size of the Site 432 anomaly is comparatively small for the size of the *R.M. Parker, Jr.* However, as discussed with the sidescan sonar interpretation below, the vessel is in two pieces perpendicular to each other. This presents a smaller site radius than if the vessel were in one piece. The relative amplitude of the anomaly ranges from +11,675 to -4,100 gammas. No additional anomalies were recorded within the area surveyed.

It was determined from the sidescan sonar imagery that the *R.M. Parker, Jr.* is broken in two with the aft portion lying upright and the forward portion (the larger of the two) lying on its starboard side nearly perpendicular to the aft section (Figure 20). This is in conflict with the official USCG report of the sinking (USCG 1944) that states that the vessel did not break in two (see Figure 18). However, it may be that the survivors watched the vessel sink completely eight hours after the initial attack and were unaware that this was the result of the break. An unconfirmed account states that the wreck site of the *R.M. Parker, Jr.* was demolished following World War II, either to clear it as a navigation hazard or during navy exercises. If this is corroborated, an alternate hypothesis is that the vessel broke in two as a result of this activity. The vessel appears to have broken apart near the middle of the bridge deck, possibly corresponding to where one torpedo struck tank #5 (see Figure 18). Sediment has built up on the forward portion of the wreck providing only a partial image of the bow. Combined with the angle that the sonar recorded this section, Figure 20 is a skewed representation of the vessel's bow.

The sonar image of the aft section depicts a full poop deck raised above the aft portion of the main deck (Figure 21). The transom portion of the poop deck, which hangs over the rudder and prop creating an elliptical stern, is no longer extant. The transom could have been crushed under the vessel's weight if she hit bottom stern first, could have collapsed under its own weight following the sinking, or could have been destroyed as a result of the first shot from U-171's deck gun. The answer also could include a combination of all three. The transom line in Figure 21 was drawn to follow the curvature of the extant hull and is a relatively accurate representation of the original. Forward, the demarcation between the main deck and the bridge deck clearly is evident in Figure 21. The enclosed bridge house is not visible in the sonar record, and it is unknown if it now resides beneath the wreck site, has collapsed onto the deck, or if during the site formation process it separated from the wreck and subsequently sunk some distance away. Several deck features are visible in the sonar record including hatchways, stairways, and catwalks. The smokestack is no longer intact. The aft section, as measured on the sonar image, is approximately 175 ft (53 m) long, taking into account the missing portion of the transom, and approximately 55 ft (17 m) wide. The maximum vertical relief of this portion is approximately 23 ft (7.0 m).

The sonar record provides a profile view of the forward section and clearly illustrates the forward portion of the bridge deck, the forward portion of the main deck, and the topgallant forecastle. Because the bow is partially covered with sediment and the angle at which it was recorded is skewed, a length measurement of this section is difficult. However, it likely measures between 234 and 275 ft (71 and 84m) providing a total length to Site 432 between 409 and 450 ft (125 and 137 m). The depth of hold, obtainable from the sonar image thanks to the orientation of this portion, measures approximately 27–30 ft (8.2–9.1 m) at the main deck and approximately 48–50 ft (15 m) at the forecastle level. The

maximum vertical relief of this section is approximately 20 ft (6.1 m). A 13-x-10-ft (4.0-x3.0-m) unidentified object is located approximately 435 ft (133 m) west-southwest off the stern of the vessel (see Figure 20). This debris may be the same described in el Darragi and Saltus (2003) several hundred feet away from the wreck site. There is a light scatter of small debris items trailing off the vessel's stern to this larger object. The debris scatter becomes more dense immediately adjacent to the wreck site off the collapsed stern and port quarter. There is an additional light debris scatter around the bow and forecastle deck.

Diver Investigation

PBS&J and MMS nautical archaeologists spent one day, May 10th, investigating Site 432. Six dives totaling nearly a combined three hours were conducted in depths of 60–76 ft (18–23 m) and visibility of less than 10 ft (3.0 m). All dives were conducted on the upright aft portion of the vessel. The investigative goals for Site 432 were established to positively identify this site as that of the *R.M. Parker, Jr.* Goals included investigating design characteristics that could be correlated to the extant photograph of the *R.M. Parker, Jr.* (see Figure 17), search for deck guns, and identify any potential torpedo damage.

Nautical archaeologists noted that the design of the aft section of the wreck matched the available image of the *R.M. Parker, Jr.* (see Figure 17) in that a portion of the extant aft section of the hull consists of a full poop deck raised above the main deck. Nautical archaeologists additionally noted numerous portholes on both the port and starboard side of the poop deck, matching those visible along the forward half of the poop deck in Figure 17. Both the aft section of the main deck and the poop deck appear to be relatively intact, and many features normally located at this level are still extant. Nautical archaeologists identified, for example, an anchor adjacent to a pair of mooring bits on the starboard stern quarter; a second pair of bits opposite on the port stern quarter; two hatchways, each with a ladder attached to the adjacent forward bulkhead; and possibly two chain lockers. No definitive evidence of torpedo damage was located; however, it seems that the vessel broke apart at or near the location of both torpedo impacts. No deck guns were located.

Mitigation Assessment

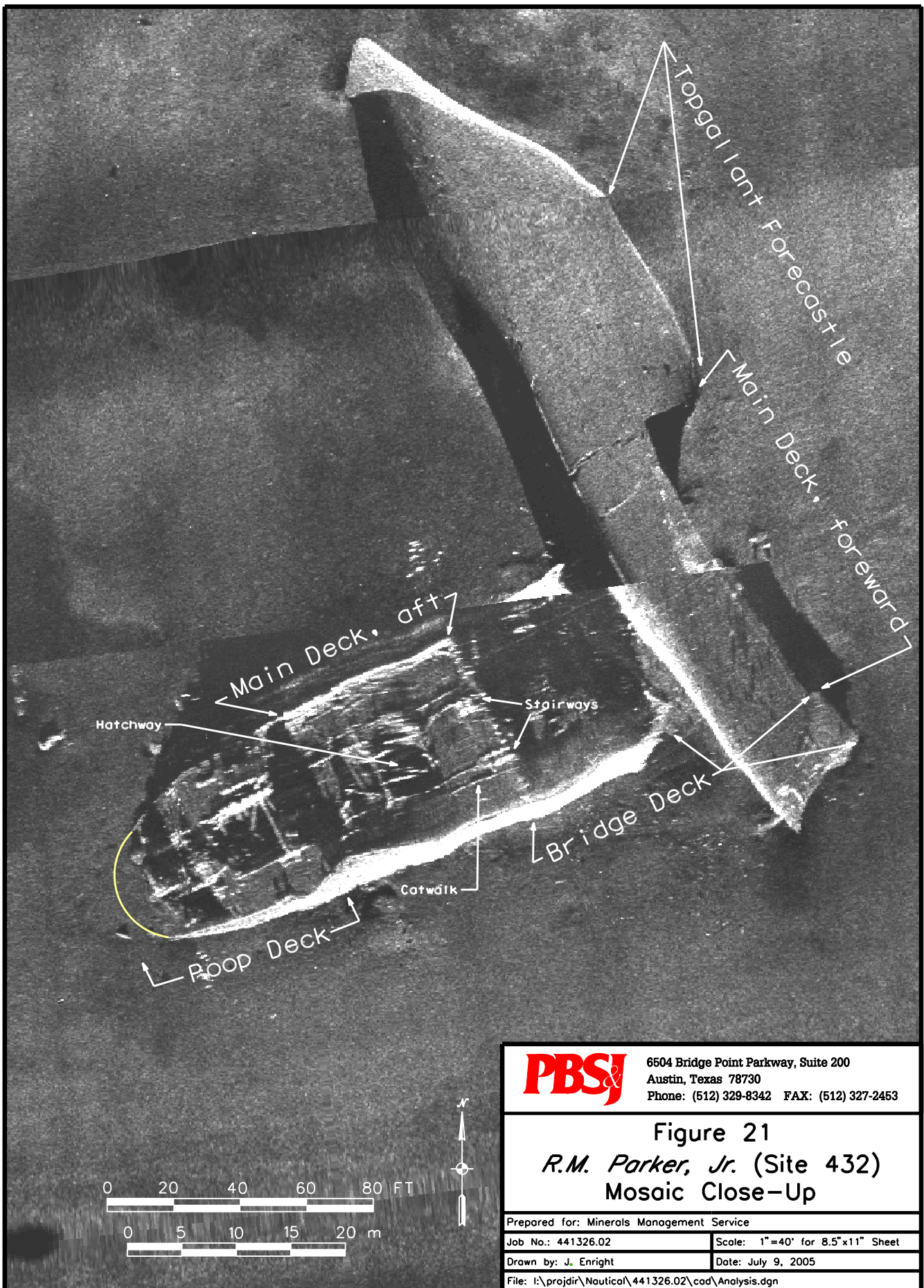
el Darragi and Saltus (2003:17) recommended a minimum 1,000-ft (305-m) avoidance zone around Site 432 and the MMS concurred. The nearest construction to Site 432 is a well located approximately 1,250 ft (381 m) to the southwest and a pipeline approximately 4,600 ft (1,402 m) to the east. PBS&J's remote-sensing survey and diver investigation of the *R.M. Parker, Jr.* found no evidence of oil and gas industry impacts within the 1,000-ft (305-m) avoidance zone.

NRHP Assessment

Historical research, remote-sensing survey, and diver investigation have determined that Site 432 is the *R.M. Parker, Jr.* PBS&J applied the U.S. Department of Interior guidelines for nominating historic sites to the NRHP (U.S. Department of the Interior 1997) to Site 432. Three key concepts help determine



Figure 20. *R.M. Parker, Jr.* (Site 432) Sidescan Sonar Mosaic.



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Figure 21
R.M. Parker, Jr. (Site 432)
Mosaic Close-Up

Prepared for: Minerals Management Service	
Job No.: 441326.02	Scale: 1"=40' for 8.5"x11" Sheet
Drawn by: J. Enright	Date: July 9, 2005
File: I:\projdir\Nautical\441326.02\cad\Analysis.dgn	

Figure 21. *R.M. Parker, Jr. (Site 432)* Mosaic Close-Up.

whether a site qualifies for listing on the NRHP—**historic significance**, **historic integrity**, and **historic context**. To establish **historic significance** of a site, four criteria are applied. At least one of the four criteria must be applicable to the site in order for it to be historically significant and potentially eligible for listing on the NRHP. These criteria are:

- A. be associated with events that have made a significant contribution to the broad patterns of our history; or
- B. be associated with the lives of persons significant in our past; or
- C. embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic value, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
- D. have yielded, or may be likely to yield, information important in prehistory or history (U.S. Department of the Interior 1985:5–6).

“**Historic integrity** is the authenticity of a property’s historic identity, evidenced by the survival of physical characteristics that existed during the property’s prehistoric or historic period” (U.S. Department of the Interior 1997:4). “Sufficient diagnostic attributes must be present to permit identification of the vessel type and historical context or discussion of significant construction details, marine engineering, or other technological aspects; or discussion of the spatial relationship with significant remains; and a discussion of eligibility or significance” (U.S. Department of the Interior 1985:17). “**Historic context** is information about historic trends and properties grouped by an important theme in the prehistory or history of a community, State, or the nation during a particular period of time” (U.S. Department of the Interior 1997:4). Historic context provides the link between the shipwreck and unique, representative, and/or pivotal historic trends.

The *R.M. Parker, Jr.* qualifies as historic under the definition of the U.S. Department of the Interior in that she is more than 50 years old. Despite being broken in two, the vessel holds her historic integrity. Her design, physical characteristics, and aspects of construction have survived the 63 years of submersion as evidenced in the remote-sensing survey data and diver investigations of the site. The U-boat war in the GOM was a unique aspect of World War II and provides a historic context for the *R.M. Parker, Jr.* For a brief period in 1942, the GOM became an active theater for German U-boat operations and witnessed dozens of Allied casualties. One U-boat, U-158 discussed below, reportedly was operating so close to the American coastline in the GOM that she was unable to submerge. This front was a pivotal period for the U.S. in World War II, and many more vessels likely would have gone to the bottom of the GOM had the problem not been dealt with swiftly. The participation of the *R.M. Parker, Jr.* in these events and her demise as a result, provide the historic context necessary for listing in the NRHP.

The *R.M. Parker, Jr.* maintains historic significance under Criterion A to two separate events in American history. First, her construction was the result of World War I and the U.S. attempt to boost America’s shipping industry against foreign competition. The *R.M. Parker, Jr.* was a direct result of the U.S. Shipping Act of 1916 and the Emergency Shipping Fund Provision of the Urgent Deficiencies

Appropriations Act (1917) (USSB 1917). These acts allowed for America's successful push to overcome Atlantic shipping casualties during World War I and established the pattern in U.S. history of America's participation in worldwide trade and the expansion of its shipping industry. Second, World War II and the Allied victory was a pivotal twentieth-century event that determined the future of the global society. No single event determined the outcome of World War II. Rather, many unique, significant events combined to result in the Axis defeat. The U-boat war in the GOM is one such significant event for reasons discussed above and is little known amongst the public. The *R.M. Parker, Jr.*'s participation in this front connects the vessel to an important event in U.S. history.

SITE 15170 – SS *CASTINE*

On May 11, 2005, PBS&J investigated a known sonar target in the Grand Isle Area. This target was originally recorded in 2001 by Thales Geosolutions, whose analysis of the sonar image indicated that the target was likely a modern shipwreck, approximately 170 ft (52 m) long by 30 ft (9 m) wide and laying in 105 ft (32 m) of water (Floyd 2001a). PBS&J conducted a sonar and magnetometer survey over the site to confirm its location, and subsequently conducted multiple diver investigations in order to determine its identity. Those investigations, combined with in-field examination of the ARI database to identify reported shipwrecks in the vicinity, and simultaneous records research by PBS&J staff in Austin, led to the identification of Site 15170 as the SS *Castine*, a merchant steam vessel that foundered in 1924. At the time of her sinking the *Castine* was in service to the low-grade fish meal suppliers, New Orleans Menhaden Company; however, her historical significance derives from her preceding career as a navy gunboat during the end of the nineteenth century and first quarter of the twentieth century—a period defined by significant developments in U.S. naval ship design, combat strategy, and international diplomacy. PBS&J has confirmed that site 15170 is the SS *Castine* and recommends that it be considered eligible for listing in the NRHP.

Site History

The *Castine* (also known as Gunboat No. 6 [Figure 22]) was built in 1892 at Bath Iron Works in Bath, Maine, along with her sister ship, *Machias* (Gunboat No. 5). Both vessels were named after Maine towns, and they represented the first steel-hulled vessels built in Maine, as well as the first ships built by Bath Iron Works—one of the most prolific naval ship builders of the last century (during World War II Bath Iron Works built one-quarter of the U.S. Navy's destroyer fleet, and more destroyers than the entire Japanese Navy built during the same time [Toppan 2002]). The construction of these twin gunboats was evidence of a progressive shift in naval ship design and technology being developed at the end of the nineteenth century. After the Civil War, the U.S. Navy went into a prolonged period of purposeful neglect. By 1879 the navy had only 49 vessels available for immediate service, and all of these were obsolete wooden and ironclad warships, lacking a single long-range rifled gun among them (Crawford et al. 1998). Expansion of overseas markets and a corresponding shift in American foreign policy, however, led to the Navy Act of 1883, which authorized the construction of several new steel cruisers and a dispatch vessel. The steel warships USS *Texas* and USS *Maine* were soon added to the vastly improved

fleet, now known as the New Navy. The following decades were defined by the expansion of the navy, and its conversion from a primarily defensive fleet to a force capable of initiating offensive operations overseas. This conversion was inspired in part by naval captain Alfred Thayer Mahan, whose prolific writings on naval strategy and the impacts of sea power on world history were used by governments around the world to promote the development of their own navies (Crawford et al. 1998).

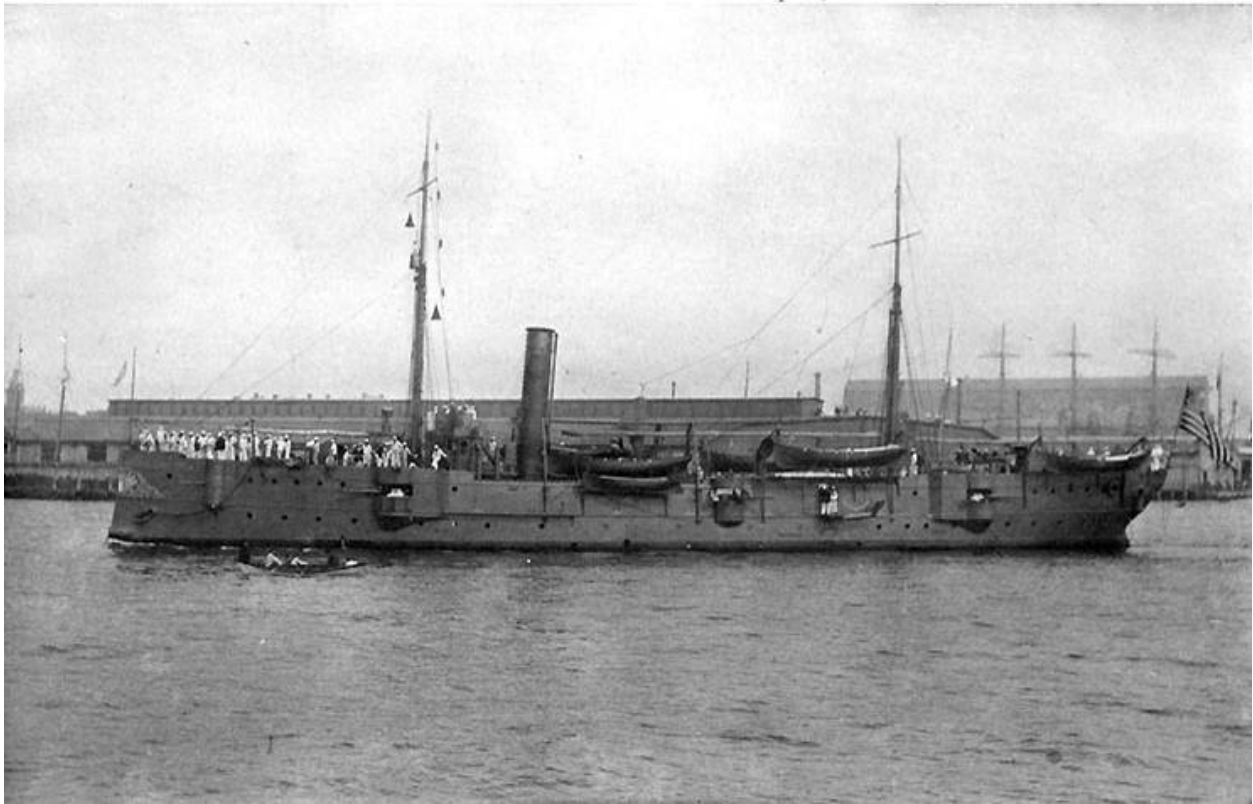


Figure 22. USS *Castine* in Port, 1898. (Source: U.S. Naval Historical Center 2005b)

Within this New Navy, gunboats and torpedo boats were the smallest rated warships. Gunboats in particular had limited capabilities, lacking the speed, armor, and firepower of larger ships rated as “cruisers”; however, as peacetime exhibits of American military potential, they were very effective. In times of war, these vessels were used in blockade and patrol operations in areas where powerful enemy forces were unlikely to be encountered. They were generally designed to be sturdy vessels with good endurance and relatively light draft. Many retained sails to supplement their light coal supplies and enhance operating range. At the close of the 1890s there were 17 active gunboats in the navy—10 of these, including the *Castine* and *Machias*, were relatively small, displacing between 800 and 1,200 tons (726 and 1,089 metric tons), while the other 7 displaced over 1,300 tons (1,179 metric tons) (U.S. Naval Historical Center 1998a).

The keel for the 1,177-ton (1,068-metric ton) *Castine* was laid on February 4, 1891, and the completed vessel was launched on May 11, 1892. Initially the *Castine* measured 190 ft (58 m) long with a 32-ft (10-m) beam and a draft of 12 ft. She was schooner rigged with fore- and mainmasts capable of

flying a total sail area of 6,083 square ft (565 m²) (Barton and Denig 1893:847). Additionally, the vessel had a poop and forecastle deck, with an open gun deck in between. The main battery consisted of eight 4-inch rapid-fire rifles. Six of these were mounted in armored sponsons projecting from each side of the gun deck, and the remaining two were pivot-mounted on the topgallant forecastle and poop deck. The secondary battery was comprised of four 6-pounders; two in sponsons under the topgallant forecastle and two on the poop deck over the after sponsons. There were also two 1-pounders firing directly aft from the after cabin, a Colt .30-caliber automatic amidships, and a Howell torpedo tube fitted through the stem and discharging above the waterline (Barton and Denig 1893:847; Bureau of Construction and Repair n.d.).

Bath Iron Works's first foray into naval shipbuilding appeared to be a successful one, as speed trials for both gunboats in September 1893 yielded results far surpassing the navy's performance requirements. Running a course laid out over 30 nautical miles (56 km) in Long Island Sound, the *Castine*'s twin vertical, inverted, direct-acting, triple-expansion steam engines powered the vessel at a four-hour average of 16.032 knots (18 mph/30 kmph) and an official speed of 15.61 knots (18 mph/29 kmph). This speed was 2.1 knots (2.4 mph/3.9 kmph) above the contract requirements, earning Bath Iron Works a \$50,000 bonus. The speed trial for the *Machias* produced similar results (Barton and Denig 1893:848, 862–864). Subsequent tests by the Naval Stability Board, however, revealed a top-heavy condition with the gunboats, resulting from the heavy guns and masts. To remedy this, 14 ft (4.3 m) were added to the hulls of both the *Machias* and *Castine* (increasing their total length to 204 ft [62 m]) (Figure 23), with the extra space occupied by additional coal bunkers and a water tank (*New York Times* 1894).

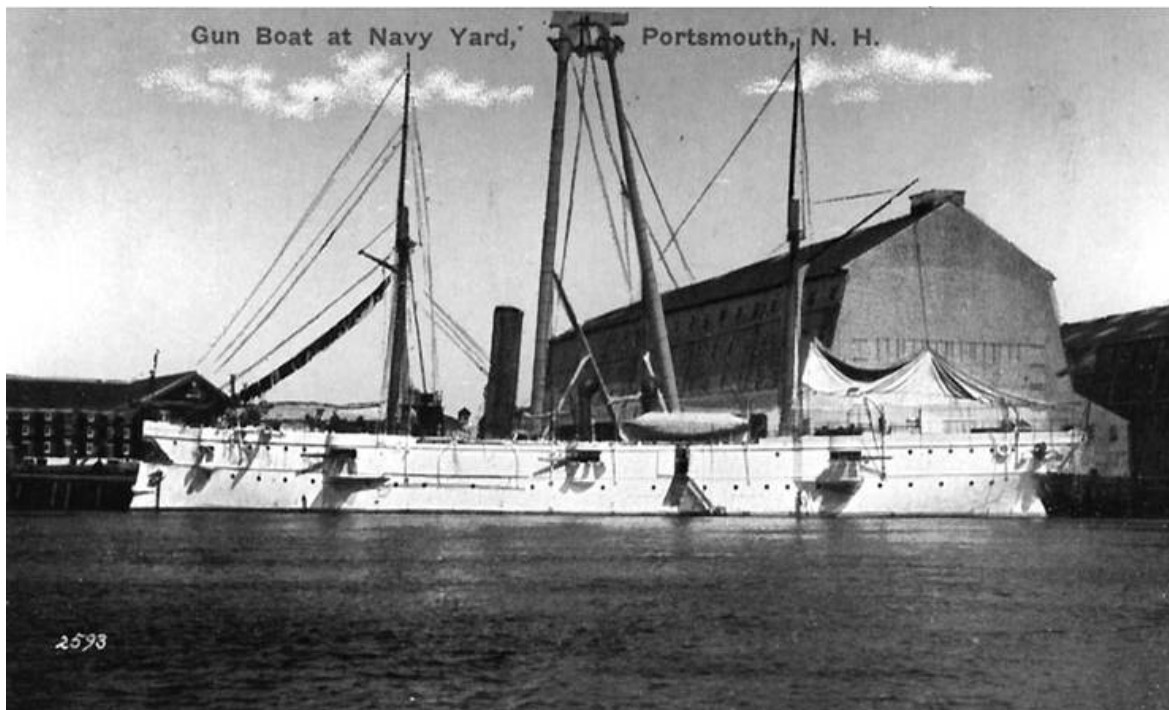


Figure 23. USS *Castine*, Prior to Hull Lengthening. (Source: U.S. Naval Historical Center 2005c)

With her repairs finally completed, the *Castine* was commissioned on October 22, 1894, and joined the Atlantic Fleet under the command of Commander T. Perry. With a complement of 153 (130 crew, 12 marines, and 11 officers), the small gunboat was assigned to duty in the South Atlantic, and after a short cruise off the New England coast was dispatched to international waters. The *Castine* departed in February 1895, traveling successively to the Azores, Gibraltar, through the Suez Canal to Aden, Zanzibar, and Mozambique, then around the Cape of Good Hope and back across the South Atlantic to Pernambuco, Brazil (Lawrence 1921). During this time, the primary objective of the South Atlantic fleet was not to engage in combat, but rather to maintain a military presence in politically unstable countries where American interests were potentially at risk. This intention was illustrated in an 1893 New York newspaper article reporting on the completion and readiness for service of several vessels of the “new navy,” including the Bath Iron Works gunboats:

During the past six months calls for cruising vessels have been many and urgent. [T]here have been revolutions calling for vessels to protect American interests in Nicaragua, Guatemala, Costa Rica, Honduras, Argentina and Brazil while he [*sic*] conditions of affairs in Honolulu has required the constant presence of one or more ships (Hornsville Weekly Tribune 1893).

Except for a brief return to port in Norfolk, Virginia, the *Castine* remained on patrol off South America and the West Indies until March 1898. At that time, the gunboat was called to duty in Key West and Cuba, the Spanish colony that was the focus of escalating hostilities between the U.S. and Spain. Diplomatic relations between America and Spain had been strained since the First Cuban Insurrection from 1868 to 1878, when groups of Americans supported filibusters running military supplies to Cuban insurrectionists (Crawford et al. 1998). Though a treaty was eventually reached, American support remained with the independence-seeking Cubans. In 1893 Cuba plunged into a deep depression following a raise on tariffs for sugar imported into the U.S. (which the U.S. Congress enacted in response to America’s own concurrent economic depression). Cuban citizens blamed this depression on Spanish and American competition, and once again the call for independence was sounded. Revolutionaries began offensive operations in 1895, and Spain responded quickly and cruelly with military action and forced reconcentration of Cuban civilians (Crawford et al. 1998). Diplomatic negotiations eventually resumed; however, an impasse was reached and rioting erupted in the streets of Havana in January 1898. Concerned for the safety of its citizens, the U.S. administration (under President William McKinley) sent the battleship USS *Maine* to Havana harbor in order to provide protection for Americans and to not-so-subtly remind the Spanish crown that a quick end to the conflict was in everyone’s best interest. After three weeks in Havana without incident, a massive explosion on the night of February 15 ripped through the *Maine*’s powder magazines, sinking the ship and killing 266 sailors. Without assigning blame, a U.S. Navy board of inquiry concluded that the explosion was caused by a mine that detonated under the ship. Spain denied these claims and no U.S. officials could prove them (many felt that the explosion originated from inside the ship) but, regardless, the tragedy set in motion a chain of events that led McKinley to order a blockade of Cuba on April 21, followed by a mutual declaration of war a few days later (U.S. Naval Historical Center 2003).

Shortly before war was declared, President McKinley formally organized the Naval War Board, which initially included Assistant Secretary Theodore Roosevelt and Captain Mahan, among others. The board soon implemented a war plan (drawn up with considerable foresight in 1894), which called for engaging Spanish forces in both its Atlantic (Cuba, Puerto Rico) and Pacific (the Philippines, Guam) colonies (Crawford et al. 1998). Following through on this plan, the U.S. began naval operations in both theaters in advance of Army deployment. In the Philippines this led to Commodore George Dewey's career-making victory at Manila Bay, whereas in the Atlantic, direct combat was initially avoided in favor of a blockade of Cuban ports—the second primary objective of the War Board's plan (Crawford et al. 1998; DiGiantomasso n.d.).

The *Castine*, already cruising between Key West and Cuba, was an active member of these early blockade operations and was credited with at least one prize. On May 3, 1898, the *Castine* captured the merchant schooner *Paco* and brought her into Key West (*Newark Daily Advocate* 1898). Later newspaper articles credit the *Castine* with firing the first shots of the war and also taking the first Spanish prize, though this is debated and it is unclear if the *Paco* is the prize being referred to (*New Orleans States* 1924; *Times Picayune* 1924).

On May 20, the *Castine*, along with the *Iowa* and *Merrimac*, joined Commodore Winfield Scott Schley's Flying Squadron off the coast of Cienfuegos (U.S. Naval Historical Center 1998b). The Flying Squadron was a division of Rear Admiral William T. Sampson's North Atlantic Fleet based in Key West, and it was presently involved in a cat-and-mouse hunt with the Spanish fleet. Admiral Pascual Cervera y Topete's token fleet of four armored cruisers and three torpedo boats was ill-equipped to defend itself against the American navy. Obsolete and dilapidated, with short supplies of ammunition and coal, the Spanish vessels were intended only to aid in suppressing colonial uprisings, not to engage in ship-to-ship combat (Crawford et al. 1998). Knowing this, and with few options, Cervera hid his fleet in the harbor at Santiago. After learning of Cervera's whereabouts Schley's Flying Squadron arrived off Santiago on May 29, and Sampson ordered the port blockaded. Shortly thereafter the *Castine*, along with the USS *Prairie* and USS *Marietta*, was dispatched to Havana Bay to maintain a blockade off of the capital city (USS *Castine* 1898). The blockade of both Havana and Santiago continued until July 3, when Cervera attempted to break through Schley's line and the Battle of Santiago de Cuba was begun. The U.S. fleet's performance was less than stellar; strategic miscues, mechanical failures, and visibility-limiting smoke from the weapons' brown powder led to only 1.29 percent of shots hitting their target (Crawford et al. 1998). The Spanish ships could not defend themselves even under these conditions, however, and Cervera's entire fleet was either destroyed or run aground. After the war, a study of the U.S.'s poor performance at Santiago led directly to a search for new technologies and techniques for naval gunnery (Crawford et al. 1998).

The sweeping victories at Santiago and Manila freed the naval fleets to participate in other strategic options during the remainder of the war, specifically with escorting and supporting the successful infantry invasions of Puerto Rico and Manila. The war was won within five months and representatives of Spain and the U.S. finally signed the Treaty of Peace in Paris on December 10, 1898. Cuba was granted its

independence and Spain ceded possession of the Philippines, Guam, and Puerto Rico to the U.S. With newly imperial aspirations, the U.S. also acquired, through treaty or purchase, the Hawaiian Islands, Guantánamo Bay, the Virgin Islands, and part of the Samoan Archipelago (Crawford et al. 1998).

Following the end of the war with Spain, the *Castine* returned stateside for a short time before being dispatched to suppress the Philippine Insurrection. Insurgents who had fought for their independence along with U.S. forces in the Spanish-American War were now upset at having their country simply transferred from one foreign government to another. The insurgents took up arms against their U.S. liberators and a three-year struggle ensued. What had been a globally fought but short-lived war with Spain spun off into a localized but far bloodier and drawn-out engagement within the Philippine Islands (Plante 2000).

The navy's role in this engagement was primarily to support army operations with gunfire and deployment of troops. In addition to these duties, the *Castine* participated in blockade and patrol operations throughout the archipelago (Anonymous 1925). The *Castine* achieved her largest measure of fame during the conflict when her commanding officer, Commander Very, accepted the surrender of the province of Zamboanga. Zamboanga was located on Mindanao, the second largest island in the Philippines, and many of its residents had no measure of alliance with the insurgents. In November 1899, one of the province's mayors orchestrated the assassination of the local rebel leader, and immediately surrendered control of Zamboanga to Commander Very, who was conducting blockade duties aboard the *Castine*. Very accepted the surrender, took into custody the remaining insurgents, and set up a provisional government, with the opportunistic mayor installed as the provincial President (*Davenport Daily Republican* 1899; *Steubenville Herald-Star* 1899).

While on station in the Philippines, the *Castine* was briefly dispatched to aid in operations against the Chinese Boxer Rebellion, which was a response to foreign occupation of Chinese territory. The U.S. Navy had maintained a presence in East Asia since 1835, protecting lives and property during numerous incidents of instability in Imperial China. Other Colonial powers such as Britain, Germany, Russia, and Japan had also secured territorial and commercial concessions from the Chinese Empire. By the end of the nineteenth century, this foreign presence had led to strong resentment within the Chinese community. In 1899 a centuries-old secret society called the *I Ho Ch'uan* (Righteous Harmonious Fists), but referred to by Westerners as "Boxers," began a series of violent attacks on foreign missionaries and Chinese Christians. These attacks gradually grew more severe and were virtually ignored by Chinese authorities, forcing the western governments to take action. In June 1900 the start of a two-month siege of foreign legations in Peking brought an international force, including American sailors and marines, to the defense of that city. Once the Boxers were driven from Peking, western forces pursued the rebel group throughout northern China until September 1901 when the Peace Protocol of Peking was signed and the Chinese authorities agreed to abolish the Boxer Society (U.S. Naval Historical Center 2000). For her part, the *Castine* conducted patrolling operations off the Chinese coast from January 24 to September 19, 1900, specifically in Shanghai and Amoy (Anonymous 1925). The *Castine* then returned to patrol duties in the Philippines until June 29, 1901, when she began a return cruise to the U.S. with sick and short-time

men. In October 1901 she was decommissioned at League Island Navy Yard in Philadelphia, Pennsylvania.

In 1903 the *Castine* returned to commission in the South Atlantic Station and began two and a half years of cruising missions off Florida, Cuba, Puerto Rico, the Dominican Republic, Haiti, and along the west coast of Africa and east coast of South America (Anonymous 1925; Lawrence 1921). After this extended tour, the 12-year old gunboat was exhausted and once again in need of repair. The North Atlantic Fleet, Third Squadron Commander reported in July 1905 that “the *Castine* is fifteen months out of dry dock and needs a thorough renovating in all departments. She has, however, done a great deal of work and been a very useful little cruiser. Unless overhauled soon I fear she may collapse generally” (Navy Department 1905). Two months later the commander’s suggestion was implemented, and the *Castine* began a three-year decommissioning at Portsmouth Navy Yard in New Hampshire.

The *Castine* returned to duty in October 1908 as a submarine tender in the Atlantic Submarine Flotilla, and spent the next five years stationed between several east coast bases. From 1912 to 1913, a young lieutenant named Chester W. Nimitz was the commanding officer of the Atlantic Submarine Flotilla, of which the *Castine* was the principal sub tender. Nimitz would go on to become one of the most accomplished naval officers in U.S. history, serving as Commander in Chief of the Pacific Fleet during World War II, and achieving the newly created top rank of 5-Star Fleet Admiral in 1944. Incidentally, Nimitz was the second of the four original 5-Star Fleet Admirals with a connection to the USS *Castine*. William D. Leahy, an ensign at the time, served aboard the *Castine* as one of his first post-Annapolis assignments during the Philippine Insurrection and the Boxer Rebellion. Promoted to 5-Star Fleet Admiral, along with Nimitz, Ernest King, and William Halsey, in 1944, Leahy also served during his career as Chief of Naval Operations, Governor of Puerto Rico, and Chief of Staff for President Franklin D. Roosevelt (Henriott 2005).

In 1914, following a short decommission period, the *Castine* returned to international cruising duties in Haiti and the Dominican Republic in order to protect American interests during a local revolution. The *Castine* remained at this station until 1916, during which time she was involved in one of the worst peacetime tragedies in U.S. naval history. On August 29, 1916, the *Castine* and the cruiser-force flagship, *Memphis*, were at anchor off the Dominican capitol city, Santo Domingo, on a calm afternoon. Suddenly, breakers began forming in the ships’ anchorage, and shortly thereafter a massive tsunami was seen approaching the harbor. Both ships attempted to fire their boilers and gather steam in order to flee the building seas. Only the *Castine* was successful, though it still endured extensive damage. Waves in excess of 40 ft (12 m) flooded the engine room, cabin, and magazine, swept the deck clean of several of the ships’ boats, and drove the vessel to within yards of a rocky destruction before the *Castine* was finally able to escape the breakers (Bennett 1916). The *Memphis* was not so fortunate. Broadside to the waves, the *Memphis* was rolling to such an exaggerated degree that water was washing down the stacks and extinguishing the boiler flames (*Frederick Post* 1916). The cruiser could not gather steam in time, and was driven against the rocks—a total loss—where it remained for many years. Over 40 of the *Memphis*’s crew died in the disaster, 25 of whom were in a recreation party returning from shore in a motor launch

that capsized. Eight more died in ship's boats that were sent out to sea, and another 10 died aboard the *Memphis*, either from being washed overboard or from burns and steam inhalation suffered in the ship's power plant (U.S. Naval Historical Center 2005d).

Following repairs to the battered gunboat, the *Castine* was dispatched to the Mexican Patrol in Tampico and Vera Cruz, Mexico. In addition to the *Castine*, the Mexican Patrol consisted of the USS *Tacoma*, the USS *Wheeling*, and the USS *Nashville*. These vessels were once again charged with protecting American interests, this time during strained relations with Mexico as a result of the on-going Mexican Revolution. The *Castine* remained on patrol in Mexico from March 3 to July 4, 1917, at which time she was called back to the U.S. and ordered to "fit out for distant service," joining the Allied response to German U-boat dominance in the Atlantic during World War I (Anonymous 1925). A month later, at Hampton Roads, the *Castine* rejoined her sister ship, *Machias*, and departed for Gibraltar.

For the first three years of the Great War, Germany had been wary of provoking the U.S. into action. Not confident in its own relatively weak navy, Germany feared that American involvement would bring about a quick Allied victory, and it was correspondingly attentive to America's diplomatic overtures and rights on the sea (Knox 2003). As a result of Germany's conciliatory stance towards American interests, the U.S. remained officially neutral. By 1917, however, Germany had developed what they believed was an invincible U-boat fleet, and they no longer feared American retaliation. Germany declared unrestricted submarine warfare in February 1917, and quickly decimated Allied shipping in the eastern Atlantic. This submarine offensive was designed to destroy Allied supply and communication lines to both civilian and military fronts, and in the first few months of the campaign it was devastatingly effective. By April 1917, U-boats were sinking 900,000 tons (816,466 metric tons) of shipping per month, out of a total available 34,000,000 tons (30,844,281 metric tons) of Allied and neutral shipping, with only about 177,000 tons (160,572 metric tons) of new construction being produced per month (Knox 2003). Furthermore, an official dispatch from a British Ambassador revealed that "there is only food enough here to last the civil population not more than six weeks or two months" (Knox 2003). On the brink of defeat, the Allied forces made a desperate plea for immediate U.S. assistance in the way of destroyers, antisubmarine craft, and merchant tonnage. Recognizing the consequences of this new German threat, the U.S. obliged and joined a naval counteroffensive that helped change the tide of the war.

The American naval involvement in the war primarily took the form of utilizing light, fast, and highly seaworthy vessels for patrol and convoy escort duties in U-boat-threatened areas. Destroyers were the optimal vessels of this type; however, a shortage in their supply necessitated supplementing the fleets with converted yachts, gunboats, revenue cutters, small cruisers, and other similar vessels. Initially, these vessels were used to patrol shipping lanes, whereby each destroyer was assigned a specific area to patrol in order to force any submarines in the area to stay submerged, hampering their ability to attack a passing supply ship. This method proved to be inefficient, however, owing to the large areas to patrol and the shortage of available destroyers (Knox 2003).

As the number of antisubmarine vessels in-theater increased, however, the convoy system was able to be implemented. Under this approach, merchant vessels were formed into large groups and escorted through the war zone by one or more antisubmarine craft. This was an “offensive-defensive” tactic in that it was primarily a defensive measure but allowed for an immediate offensive response in the event of a submarine attack (Knox 2003). The tactic had immediate results, drastically reducing the amount of shipping casualties; by July 17, 1917, only one-half of 1 percent of the 10,000 convoyed ships had been lost (Knox 2003).

The principal bases for the American antisubmarine fleets were necessarily located near the primary shipping lanes, specifically at Queenstown, Brest, and Gibraltar, along with smaller bases on the west coast of France. The detachments at Queenstown and Brest were the primary defenders of the sea transportation of the U.S. Army in Europe; however, the base at Gibraltar was the gateway for more shipping traffic than in any other part of the world, and it comprised the largest contingent of U.S. antisubmarine forces (Knox 2003). Gibraltar was the key to maintaining communication lines for the armies in Italy, Saloniki, Egypt, Palestine, and Mesopotamia, and it was defended by British, American, French, Japanese, and Italian vessels. The American contingent was comprised of nearly 5,000 personnel and 41 vessels, including the *Castine* (Knox 2003).

The *Castine* and the other escort vessels maintained an arduous and redundant routine. Their normal cycle of operations involved first steaming to a European port where empty ships were waiting, scouting the approaches to the port, organizing the ships into a convoy, then leading the convoy westward through the war zone until the vessels dispersed towards their respective ports. The escort vessels would then pick up an inbound convoy of loaded supply ships (often as far as 300 miles [483 km] off the European coast), transport it east, and guard the ships as they dispersed to various ports. This process required three to four days, after which the crews would return to their home port to wait for the next outbound convoy (Knox 2003).

The *Castine* participated in these vital escort duties until the armistice was signed in November 1918. The success of the U.S. Navy convoy escorts no doubt played a significant role in the overall Allied victory; during the 18 months of U.S. involvement, a total of 18,653 ships were escorted through the war zone, and at least 24 U-boats were damaged and 2 are known to have been destroyed (Knox 2003).

A month after the armistice, the *Castine* left Gibraltar along with U.S. ships *Hannibal*, *Lydonia*, *Algonquin*, *Ossippee*, *Cytheria*, and *Venetia*, convoying 18 submarine chasers to the Azores (Anonymous 1925). By the end of January 1919, the *Castine* had reached New Orleans, where she remained until being laid up for the final time on August 28 of that year, her illustrious naval career coming to an end.

The *Castine* remained seaworthy, however, and she was eventually sold into private ownership, though to whom and for what purpose remains somewhat unclear. Naval records indicate the *Castine* was sold for \$12,500 to A. Marx & Sons of New Orleans on August 5, 1921 (Bureau of Construction and

Repair n.d.). Alternately, correspondence from August 1923 between the Department of Commerce Steamboat Inspection Service and the Equitable Equipment Company of New Orleans indicate that the latter company had recently purchased the *Castine* from the navy, and was attempting to get it approved for merchant service (Equitable Equipment Company 1923; Steamboat Inspection Service 1923). The Equitable Equipment Company was a New Orleans–based shipbuilder that frequently built or converted vessels for use in the banana trade. Many of the vessels Equitable Equipment converted to banana boats were former navy warships, including the destroyers *Masaya*, *Worden*, and *Putnam*, among others (Fetterly n.d.). This may account for the frequent reporting of the *Castine* having been used as a banana boat; however, no other evidence of this service was presently discovered, and the *Castine* was not listed as such in the 1923 MVUS (U.S. Department of Commerce, various). In fact, the *Castine* does not show up in the MVUS at all until 1924, when it was owned by the New Orleans Menhaden Company, a fish meal producer. A Bureau of Navigation Application for Official Number dated August 16, 1923—the same month as the Equitable Equipment Company correspondence with the Steamboat Inspection Service—also lists the New Orleans Menhaden Company as the vessel’s owner at that time. It is possible that Equitable Equipment Company sold the *Castine* to the New Orleans Menhaden Company in August 1923, or perhaps the Steamboat Inspection Service had a misunderstanding of the vessel’s ownership, and the Equitable Equipment Company was only under contract to repair the ship.

In any case, the *Castine* was not employed in the fish meal industry long, for on December 12, 1924, the vessel reached her final port. Having been stripped of her armament and while being towed to the Sabine River to be used as a barge, an explosion forced the seven-man crew to cut loose of their tow, abandon ship, and take to the lifeboats. The crew were picked up by the Bisso Company towboat, *Barranca*, and the old gunboat sank to the bottom of the Gulf of Mexico within about 20 minutes (*New Orleans Item* 1924; *New Orleans States* 1924). A subsequent investigation was unable to determine either the cause or the source of the explosion, but did conclude that the source could not have been the boilers since crewmen were able to get into the engine room and fire room immediately after the explosion (Steamboat Inspection Service 1924).

Shipwreck Correlation

PBS&J consulted shipwreck sources in order to surmise various locations for the loss of the *Castine* as well as other shipwrecks of similar size in the area of Site 15170 that could pose an alternate identity. This exercise was performed to provide additional circumstantial evidence that Site 15170 indeed is the *Castine*. Sources were limited to the ARI, AWOIS, and LDA shipwreck databases, and a 1924 *Port Arthur News* account of the *Castine*’s sinking (*Port Arthur News* 1924). The sources used and the methodology employed are discussed under the *R.M. Parker, Jr. Shipwreck Correlation* section. Table 5 lists the differences in positional data provided by each source for the location of the wreck of the *Castine*. The ARI entry in Table 5 is due to the fact that site 15170 was initially listed as a separate wreck from the *Castine* (listed elsewhere in the ARI as Site 562). MMS’s initial position for the *Castine* was interpreted from the 1925 MVUS, and is listed as “unreliable or vague” (U.S. Department of Commerce, various). LDA’s position for *Castine* is identical to the one from ARI. The *Port Arthur News* listed the

Castine as sinking in 10 fathoms of water and provided approximate latitude and longitude coordinates. AWOIS does not list a location for the *Castine*.

TABLE 5
VARYING LOCATIONS FOR THE *CASTINE*

	ARI	LDA	<i>Port Arthur News</i>
Distance from Site 15170	13 miles (21 km)	13 miles (21 km)	4.2 miles (6.7 km)
Bearing	NW	NW	SE

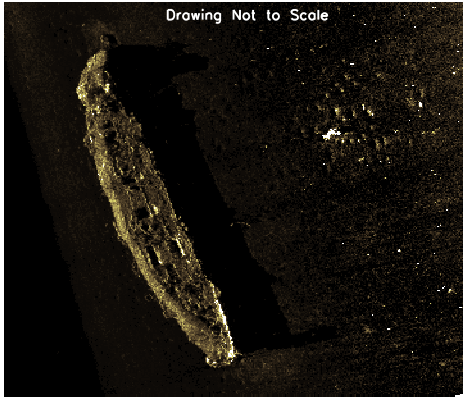
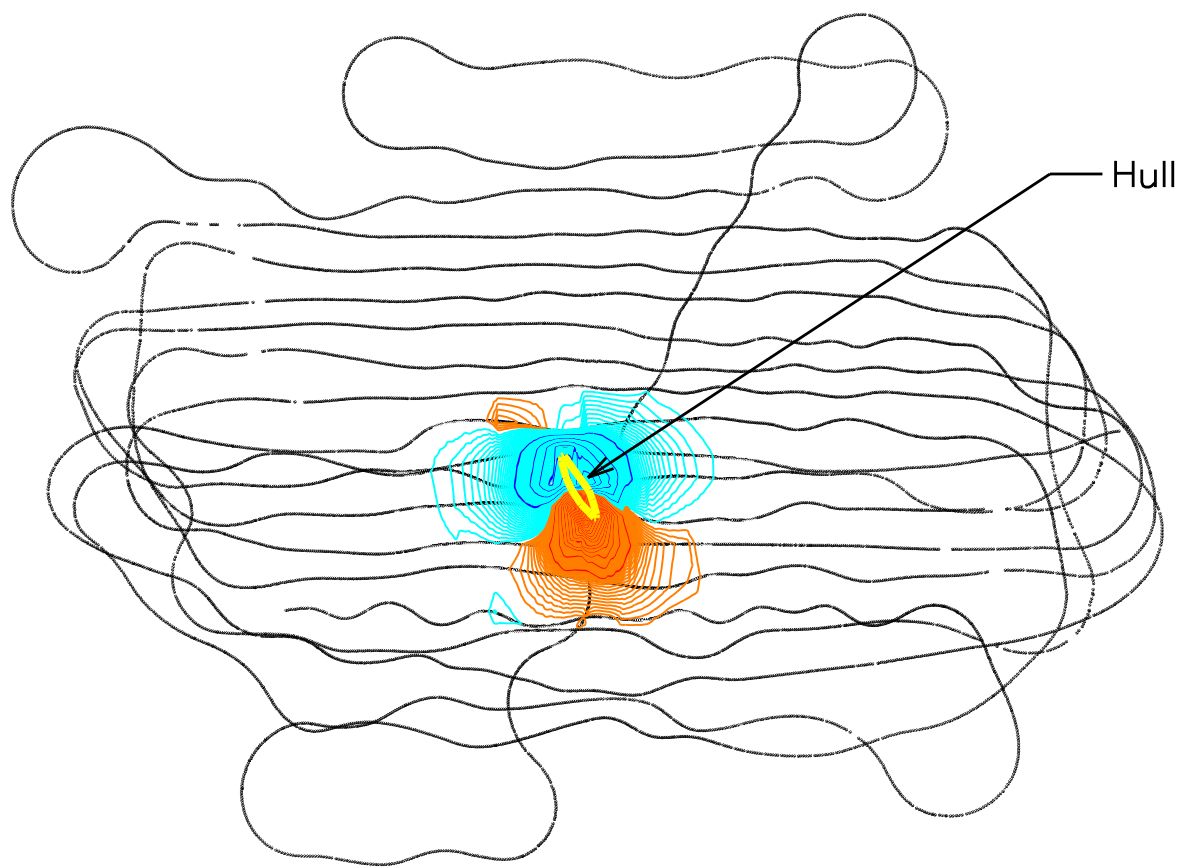
PBS&J also researched vessels wrecked in the GOM that measure within 50 ft of the *Castine*'s length and were reported lost within a 20-mile radius of Site 15170. No vessels reported in the ARI, LDA, or AWOIS databases fit both criteria. Two barges are listed in ARI as reportedly sunk within a 20-mile radius (32 km) of Site 15170; however, their dimensions are unknown. The *Murmanill* (Site 795) reportedly sank in 1957 approximately 17 miles (28 km) from Site 15170. The *Trans-Gulf No. 10* (Site 813) foundered in 1959 approximately 19 miles (31 km) from Site 15170. Though the length of *Trans-Gulf No. 10* is unknown, it is listed at 2,690 gross tons (2,440 metric tons), much larger than the *Castine*. Three other vessels (*William C. McTarnahan*, *Nola*, and *Rachel Emery*) are listed in LDA within a 20-mile radius of Site 15170; however, nothing is known about the wrecks except the dates of their sinking (1942, 1922, and 1911, respectively). Twenty-five unknown shipwrecks have been identified within 20 miles (32 km) of Site 15170. No information other than their possible existence is known.

Remote-Sensing Investigation

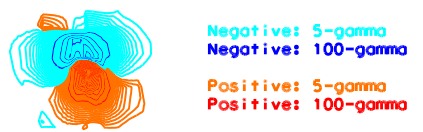
Site 15170 was first brought to MMS's attention in 2001 following a sonar survey conducted by Thales Geosolutions (Floyd 2001a). Their analysis of the sonar data indicated the wreck was approximately 170 ft (52 m) long, 35 ft (11 m) wide, and lying flush with the mudline in 105 ft (32 m) of water.

PBS&J conducted a remote-sensing survey of Site 15170 on May 11, 2005. The magnetic portion of the survey recorded a north-south dipolar anomaly with the main negative lobe oriented to the north, and the primary positive lobe oriented to the south (Figure 24). A small secondary positive lobe is also present to the northwest of the main negative lobe. The anomaly measures approximately 700 x 900 ft (2,213 x 274 m). The relative amplitude of the anomaly ranges from +1,845 to -615 gammas. No additional anomalies were recorded within the area surveyed.

The sonar record shows an intact vessel oriented northwest to southeast (Figure 25). The wreck measures approximately 223 ft (68 m) long by 33 ft (10 m) wide at its widest point, and with a maximum vertical relief of 20 ft (6 m). The bow and stern were not immediately distinguishable from the sonar image as the wreck appears to be double-ended. The sonar image exposes only a single deck, but also



Magnetic Contours



Survey Transect

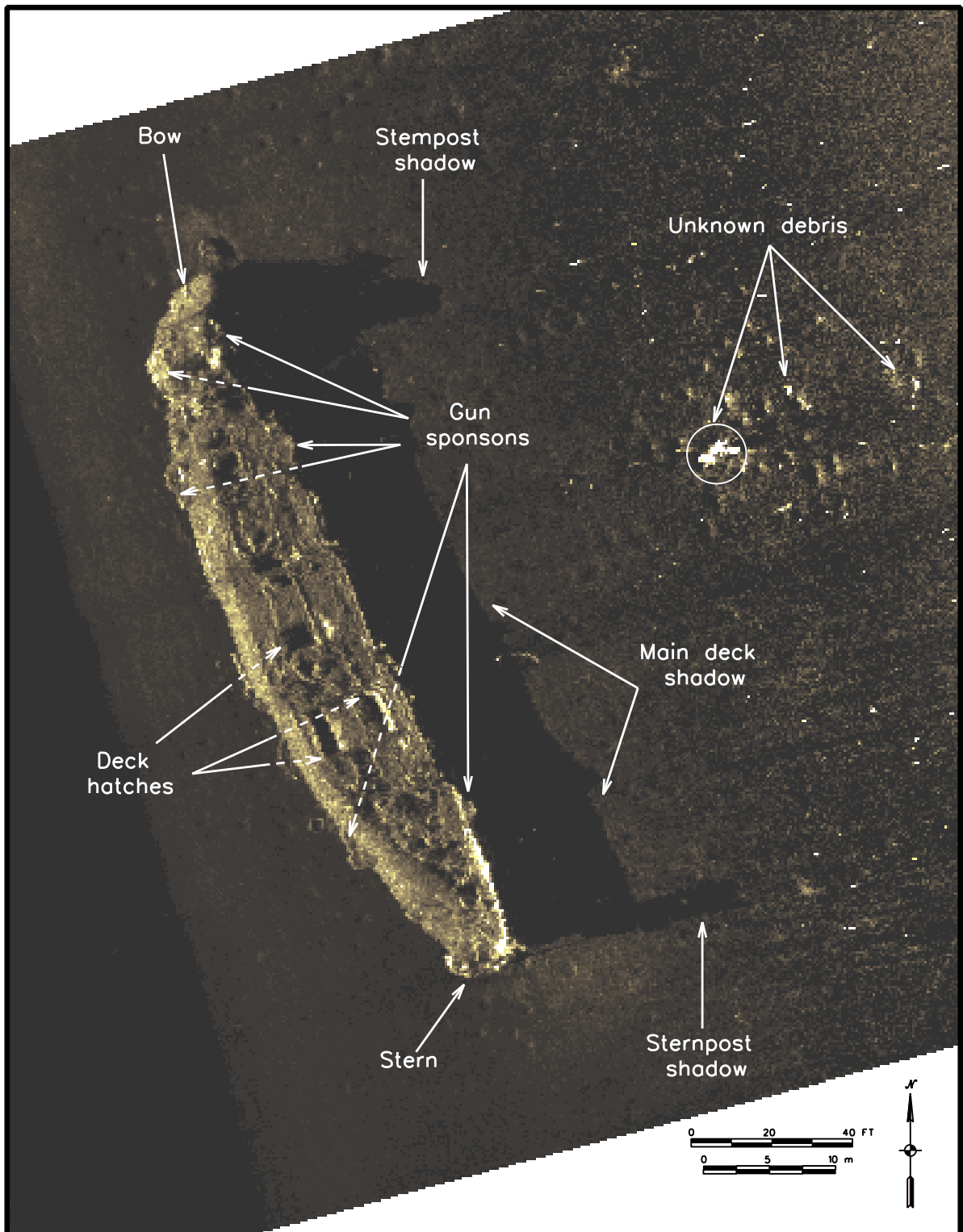


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Figure 24
Castine (Site 15170)
Magnetic Contour Map

Prepared for: U.S. Minerals Management Service	
Job No.: 441326.01 & 441326.02	Scale: 1"=600' for 8.5"x11" Sheet
Drawn by: Doug Jones	Date: July 11, 2005
File: I:\projdir\Nautical\441326.02\cod\castine_analysis.dgn	

Figure 24. *Castine* (Site 15170) Magnetic Contour Map.



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Figure 25
Castine (Site 15170)
 Sidescan Sonar Image

Prepared for: U.S. Minerals Management Service
 Job No.: 441326.01 and 441326.02 Scale: 1"=50' for 8.5"x11" Sheet

Drawn by: Doug Jones Date: July 12, 2005
 File: I:\Nautical\441326.02\cad\castine_analysis

Figure 25. *Castine* (Site 15170) Sidescan Sonar Image.

reveals acoustic shadows from the stem and stern posts that show there is approximately a 6.5-ft (2.0-m) vertical distance between the deck and the tops of each post. Several open deck hatches can be seen, along with other unidentified thru-deck openings. Numerous narrow, linear features are running parallel athwartships, indicating possible exposed deck beams. A second, 11-x-11-ft (3.4-x-3.4-m) sonar target lies 72 ft (22 m) northeast of the midship point of the main wreck site.

Diver Investigation

PBS&J and MMS archaeologists spent three days, May 11–13, investigating Site 15170. Twenty-six dives totaling 11 hours, 34 minutes were conducted at depths ranging from 102 to 118 ft (31 to 36 m), and 3 hours, 36 minutes of ROV footage were collected. Conditions on the site were less than optimal. Visibility was generally less than 5 ft (1.5 m) and frequently less than 2 ft (0.6 m), particularly once bottom sediments were disturbed by diver activity. Copious amounts of shrimp netting covered both ends of the wreck, further complicating the diving conditions. Because of the depth, maximum bottom times were kept under 25 minutes which, combined with the low visibility and divers' rate of air consumption, limited the area of the wreck that could be investigated in any one dive. In order to assist diver navigation throughout the site, tape measures were used to establish a baseline from bow to stern, running along what was believed to be the port side gunwale and tied into the buoy line, which was secured in an open deck hatch along the port side of the vessel. A subsequent dive stretched a crossline, marked at 1-m (3.3-ft) increments, from the buoy line to the opposite (starboard) gunwale. Using these baselines, divers conducted visual inspections of the exposed deck and the upper portions of the outer hull.

As the identity of Site 15170 was not previously known or suspected, investigative goals of the diving operations were initially focused on determining the vessel type, function, general date of construction, cause of sinking, and locating diagnostic features that might lead to the vessel's identification. Initial dives on the site confirmed that the vessel was steel-hulled and in good condition; the deck and outer-hull plates were solid and still retained most of their metal. The vessel appeared to have a "double-ended" construction; however, the south end was slightly wider and rounded, leading to the conclusion that this was the stern and the north end was the bow. At both ends of the wreck there was a considerable amount of relief between the main deck and the tops of the stem and stern posts. This is confirmed in the sonar record, which shows the stem and stern extending approximately 6.5 ft (2.0 m) above the main deck (see Figure 25). A large gash in the hull was extant on the port side of the bow and appeared to be caused from an external force, as the surrounding metal was pushed inward. Though not measured, the vertical height of the gash was considerably larger than the body length of the divers present. It could not be determined whether the gash was a factor in the vessel's sinking or whether it occurred after the wrecking process. One possible explanation is that, before settling into its current attitude, the vessel hit the sea floor nose-down causing the hull to rupture.

On top of the deck were several large hatches of various dimensions, as well as at least three smaller, manhole-sized hatches—two with a cover and one without (Figure 26). Based on a later comparison with an 1894 deck plan of the *Castine* (Figure 27), these smaller hatches were likely coal scuttles (Bureau of



Figure 26. ROV Image of a *Castine* Hatch Cover.

Ships 1894). A row of portholes ran along both sides of the outer hull, and a smaller, circular, green glass lens was observed mounted in a frame, flush with the main deck, possibly used as a skylight. A 1923 Consolidated Certificate of Enrollment and License (Bureau of Marine Inspection and Navigation 1923) describes the *Castine* as having skylights built into the deck. A 1914 inboard profile of the *Castine* identifies these skylights as several large glass prisms protruding from the raised forecastle and poop decks (Bureau of Ships 1914); however, the same 1894 deck plan mentioned above also illustrates numerous small, porthole-sized circular objects spaced throughout both the raised decks and the gun deck (Bureau of Ships 1894). The objects are not labeled in the drawing, but are within the vicinity of the diver-located glass object mentioned above, and are possibly illustrations of another type of through-deck skylight. On the main deck towards the bow, divers also identified a small piece of ceramic, copper wiring, protruding steam tubes, a possible engine block, several electrical junction boxes, and three large, parallel, cylindrical objects, approximately 10–12 inches (25–30 cm) in diameter, that were tentatively identified as pipes or possibly industrial-sized drill bits used for dredging operations. Much of this material appeared to be intrusive, dumped onto the vessel sometime after the wrecking process. Ken Bush, the M/V *Fling*'s captain, explained that once a shipwreck or other obstruction becomes a known shrimp-net hazard, local captains will frequently dump old machinery and similar refuse on the site rather than dumping it in an area where it might create a new obstruction. This is one possible explanation for the debris on Site 15170.

At several different locations divers also noted semicircular bulges of at least two different diameters protruding from the outer hull at the deck level. These features turned out to be one of the key diagnostic elements used to identify the wreck. After the first day's diving, MMS nautical archaeologist Dave Ball searched the ARI database for other reported wrecks within the vicinity of Grand Isle, in order to determine a possible identity for Site 15170. One likely candidate was the *Castine* (ARI Site 562), reportedly sunk approximately 13 miles (21 km) from Site 15170.

The following day, PBS&J nautical archaeologist Sara Hoskins began a library and internet search for information on the *Castine*, revealing its identity as a former U.S. Navy gunboat. Pictures of the vessel, described by Ms. Hoskins over the telephone, showed eight gun sponsons along the outer hull of the boat. Six of these were uniform in size and located at the aft third, amidships, and forward third of the hull. The remaining two sponsons were noticeably smaller and located on either side of the bow (see Figure 27). This description matched the features already observed by the divers.

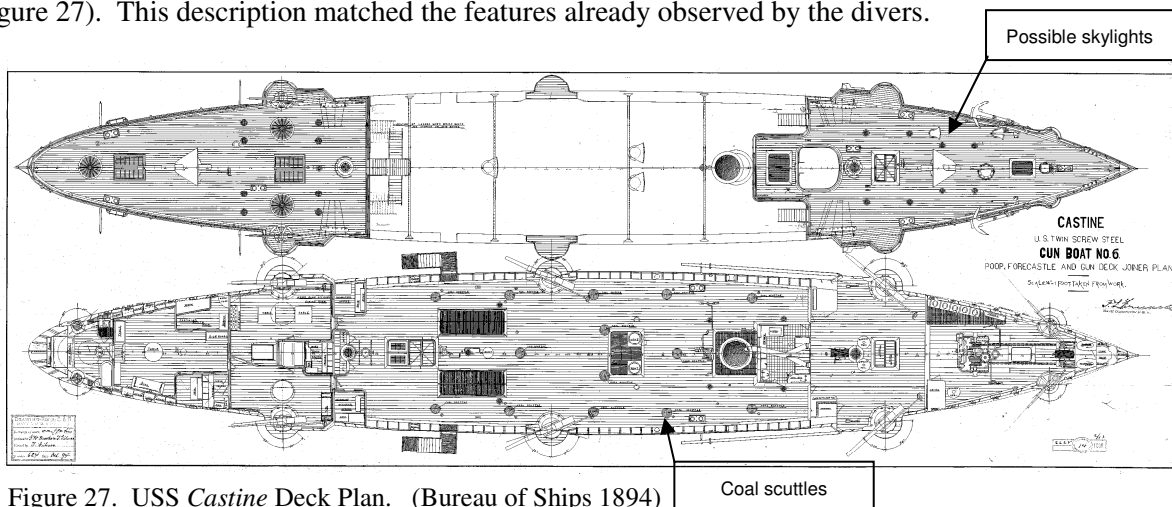


Figure 27. USS *Castine* Deck Plan. (Bureau of Ships 1894)

A subsequent dive located the starboard midships sponson (initially housing the 4-inch rapid-fire rifles) and its approximate dimensions were recorded. The sponson measured approximately 5 ft (1.5 m) along the length of the hull, and at its apex protruded approximately 2 ft (0.6 m) outboard from the hull (Figure 28). A roughly 2-inch-wide (5-centimeter [cm]) rub rail ran along the top edge of the sponson and, in fact, ran the entire length of the hull. The total depth of the sponson was approximately 2 ft (0.6 m), where it then curved back to the hull, resembling a soup bowl cut in half vertically. This shape and the 2-inch (5-cm) rub rail can clearly be seen in photographs of the *Castine*; however, these photographs show a much longer vertical component to the sponsons (Figure 29). Based on this observation, it appears that the riveted steel side-shell that would have protected and extended above the main gun deck (to a point level with the raised forecastle and poop decks) has been removed from a substantial portion at the vessel's midsection.

The sonar and diver-corroborated evidence further suggests that the poop deck and at least part of the forecastle decks have themselves been removed. Towards the stern there is only a single deck with no vertical change in the wreck structure until the outer-hull plates of the rounded stern (known as a cruiser stern) are reached. The raised poop deck and the associated staircases and catwalks that would have connected it to the other decks are not present (see Figure 27). Towards the bow, however, at least a

portion of the forecastle deck may remain. Divers investigating one of the forwardmost gun sponsons documented a vertical height of that sponson that was much larger than the one observed amidships and, in fact, more accurately reflected the size of the sponsons as they appear in historic photos (see Figure 29). In this same area divers also observed two rows of portholes—one above and paralleling the other—indicating that the upper portion of the outer hull remains extant near the bow. The sonar record does not evince a completely intact forecastle deck (which would have covered almost a third of the gun deck) and, as with the aft end of the wreck, there was no indication of staircases or catwalks leading to an upper deck. There is, however, a definite vertical rise at the bow, in the vicinity of the forwardmost sponsons. This can be seen in the sonar record and was observed by divers. A dense overhead covering of shrimp netting engulfed this area so few of the deck details could be safely observed; however, one dive team reported seeing wooden deck planks on the raised portion of the bow. This suggests that the outer side-shell and upper decks were removed aft of this point, but kept partially or completely intact at the bow. Jerry Steiner, a naval architect at Bath Iron Works who is exceedingly familiar with the design and history of the *Castine* and with ship construction techniques of that time period, explained that such alterations to the hull would not have been unconventional for a vessel being converted to a barge (personal communications 2005–2006). Mr. Steiner pointed out that throughout its career the *Castine* had several reported problems with top-heaviness, a condition that would have only been exacerbated by the presence of raised decks. Mr. Steiner further explained that these decks served no significant purpose on a commercial vessel and that, since they did not contribute to the structural integrity of the hull, could safely be removed. He also speculated that the side-shell was left intact at the bow in order to maximize the vessel's ability to cut through rough seas. A National Archives records search did not locate documentation of the *Castine*'s hull alterations after it was sold by the navy.

Immediately aft of the buoy line, along the port gunwale, divers also located a small pile of bricks that were each stamped with a maker's mark. Two of these bricks were brought to the surface and photographed, as were the ceramic fragment located at the bow, and one of the electrical junction boxes. The bricks and junction box were returned to the site after they were photographed; the ceramic fragment is currently being curated at PBS&J.

The bricks were each stamped with one of at least three observed maker's marks. One mark showed a five-pointed star underscored by the word LIVERMORE (Figure 30); the second read ST. LOUIS V&F B.CO. STANDARD (Figure 31); and the third (not photographed) read ST. LOUIS V&F B. CO. STAR. No information has yet been obtained on the V&F Brick Company; however, the California-based Livermore Brick Company was in operation intermittently between 1910 and 1949, establishing an earliest wreck date of 1910 for Site 15170. This is consistent with PBS&J's determination of Site 15170 as the *Castine*.

The ceramic piece (Figure 32) was identified by PBS&J's Archaeological Laboratory Director, Meg Cruse, as ironstone, a heavily vitrified, molded, and undecorated type of ceramic. It was common beginning in the mid to late nineteenth century, particularly as restaurant dinnerware, and was designed as an inexpensive imitation of Chinese porcelain. It is also commonly referred to as Hotel China (Stelle



Figure 28. ROV Image of a *Castine* Gun Sponson at Deck Level.

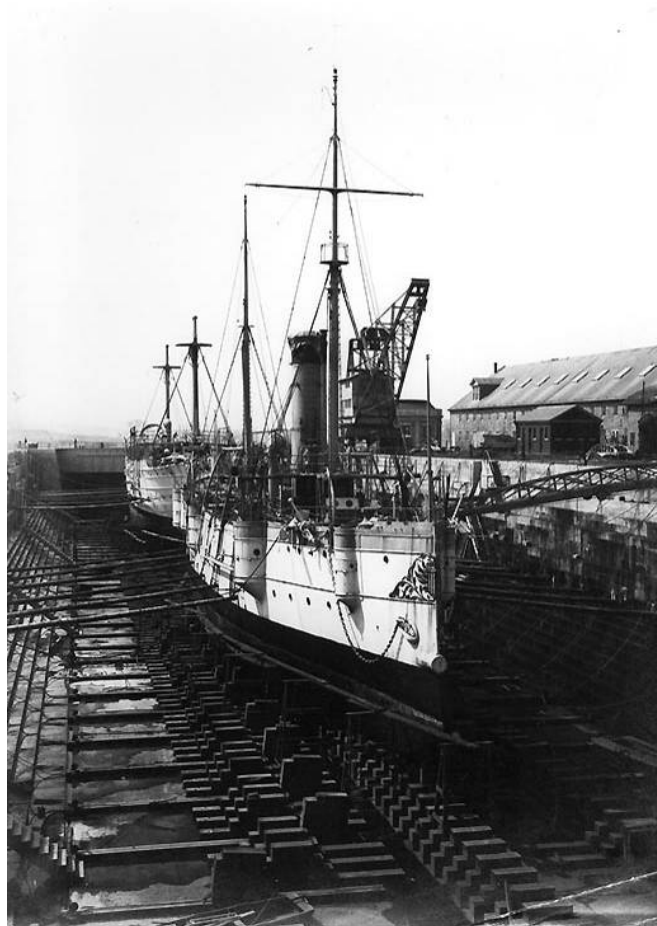


Figure 29. USS *Castine* in Dry Dock. (Source: U.S. Naval Historical Center 2005e)



Figure 30. Livermore Brick.



Figure 31. V&F Brick Company Brick.



Figure 32. Ironstone Fragment.

2001). This type of ceramic was widely used in the early twentieth century and would not have been uncommon in ships' galleys.

The electrical junction box was cleaned of corrosion, and its back cover removed. Inside the cover was stamped a serial number and the date 1958. This artifact obviously does not conform to the dates of operation of the *Castine*; however, the discrepancy does support the hypothesis that much of the machinery and debris on the wreck's deck is intrusive.

Finally, a single attempt was made to locate and identify the sonar target located to the northeast of the main wreck site. Unfortunately, owing to the water depth and the relatively small size of the target, the buoy drop was inaccurate and divers were unable to locate the object.

Mitigation Assessment

There has been no oil and gas industry development in the vicinity of Site 15170; therefore, MMS has not formally stipulated an archaeological mitigation avoidance criterion. The nearest known pipeline is located approximately 4,419 ft (1,347 m) southwest of Site 15170, and the nearest known well was drilled approximately 1.1 mile (1.8 km) to the east.

NRHP Assessment

Historical research, remote-sensing survey, and diver investigation have determined that Site 15170 is the *Castine*. PBS&J applied the U.S. Department of Interior guidelines for nominating historic sites to the NRHP (U.S. Department of the Interior 1997) to Site 15170 (see *R.M. Parker, Jr. NRHP Assessment* section).

The wreck site of the *Castine* qualifies as historic under the definition of the U.S. Department of the Interior in that it is more than 50 years old. It additionally holds its historic integrity. Its design, physical characteristics, and aspects of construction have survived the 81 years of submersion as evidenced in the remote-sensing survey data and diver investigations of the site. There are several significant events and associations that provide a historic context for the *Castine*. The vessel was constructed in the early years of the development of the “New Navy,” which signaled a shift in American naval design from a primarily defensive and commerce-protecting function to offensive fleet action. Beginning with dramatic victories during the Spanish-American War, the modern, armored U.S. Navy was born, and by the end of World War I had developed into one of the most powerful military forces in the world, able to project American diplomacy to all corners of the globe. Furthermore, the antisubmarine operations waged by Allied forces against the German U-boat fleet in World War I were largely responsible for the eventual Allied victory. Prior to U.S. involvement in the war, unconditional U-boat warfare had decimated Allied shipping and perched Germany on the brink of victory—an outcome that would have changed the course of world history. Once America’s antisubmarine fleet joined the Allied navies, Germany’s stranglehold on European shipping lanes came to an immediate end, shifting the balance of power in the war. The contributions of the *Castine* to these events provide the historic context necessary for listing in the NRHP.

The *Castine* maintains historic significance under both Criteria A and C of the NRHP eligibility criteria. The *Castine*’s construction itself marked the beginning of an American shipbuilding institution. *Castine* and her sister ship, *Machias*, were the first ships built at Bath Iron Works, a company that, in addition to its commercial and private productions (including America’s Cup-winning yachts), is renowned for its contributions to the U.S. Navy, which include 212 destroyers and over 300 ships total during the company’s history. The *Castine* was representative of the New Navy vessels first developed at the end of the nineteenth century, characterized by steel construction and improved armament, and designed for offensive engagements around the world. Furthermore, the *Castine* is the only known surviving remnant of the *Machias* class of gunboats, initiated with the construction of the two sister ships. The *Castine*, therefore, represents the work of a master and embodies the distinctive characteristics of a type and period of construction, as defined in NRHP Criterion C.

The New Navy of the United States was successfully put to the test during the short-lived but consequential Spanish-American War. The U.S.’s vastly superior fleet was able to soundly defeat the Spanish Navy, leading to a quick American victory in the war. The subsequent Spanish concessions granted the U.S. territories outside of its continental boundaries and initiated a period of American imperialism designed, in part, to establish overseas bases for the support of its Armed Forces. The *Castine* was an active combatant in this war, aiding in the successful pursuit of the Spanish fleet, blockading Cuban ports, and possibly firing the first shots and taking the first prize of the war. Furthermore, the *Castine* was a participant in suppressing the subsequent Philippine Insurrection and Boxer Rebellion—the two other notable U.S. military engagements at the turn of the century.

Finally, the *Castine* was one of the 41 American antisubmarine vessels stationed at Gibraltar during World War I. This was the largest contingent of U.S. naval vessels in the war, responsible for escorting

many of the 18,000 supply and troop ships convoyed into the European theater. These operations were pivotal in defeating the German forces, and helped establish naval strategy for antisubmarine warfare during World War II. The *Castine*'s active involvement in these early-twentieth-century military conflicts puts it in close association with "events that have made a significant contribution to the broad patterns of our history," and, therefore, establishes its NRHP eligibility under Criterion A.

SITE 328 – M/S *SHEHERAZADE*

PBS&J investigated Site 328 in May 2005 to determine its identity, its eligibility for listing on the NRHP, and to assess the current MMS avoidance criteria. A previous hypothesis suggested that Site 328 is the *Sheherazade*. The *Sheherazade* was launched in France in 1935 and ended her career under U.S. requisition for the transportation of petroleum products during World War II. The German submarine U-158 sank the vessel in the GOM in 1942. Historical research, remote-sensing survey, and diver investigation (all described below) conducted in 2005 support this hypothesis. PBS&J has confirmed that Site 328 is the *Sheherazade* and recommends that she is eligible for listing on the NRHP.

Site History

The name Sheherazade is derived from the medieval Arabic story told in *The Book of One Thousand and One Nights* (English translation published as *The Arabian Nights*). The Arabian king Shahrayar, believing in the infidelity of women, weds and beheads a woman every night. The story's heroine, Sheherazade, agrees to be the next in line. But instead of beheading Sheherazade, Shahrayar listens for 1,001 nights to his bride's amazing stories (e.g., Aladdin's Lamp, Sinbad the Sailor, and Ali Baba and the Forty Thieves). Over the 1,001 nights Sheherazade not only saves her life and the lives of the brides that would have followed her death, but bears three children and convinces the king of her faithfulness, effectively ending his brutal practice (al-Jahshiyari n.d.).

The Compagnie Auxiliaire de Navigation (Auxiliary Company of Navigation), located in Paris, France, contracted for a petroleum tanker that would be christened with the name of the Arabian heroine Sheherazade. The shipyard Ateliers et Chantiers de la Seine Maritime Worms & Company (roughly translated, Worms and Company Seine Maritime Workshops and Building Sites [SMW]) launched the *Sheherazade* at Le Trait in the province of Seine-Maritime in 1935 (the town of Le Trait, France, is located in Upper Normandy northwest of Paris on the lower Seine River) (Figure 33). SMW constructed the 13,467-gross ton (12,217-metric ton) tanker with overall dimensions of 574 ft (175 m) in length, 71 ft 11 inches (22 m 28 cm) in breadth, and 30 ft 11 inches (9.1 m 28 cm) in draught (Jordan 1999:36). The *Sheherazade* was propelled with twin screws driven by diesel engines. Following World War II, a race ensued among world nations to launch the biggest tanker. Prior to this effort, the *Sheherazade* reportedly was the largest tanker in the world (*Dothan Eagle* 1950) at 18,530 maximum deadweight tons (16,810 metric tons). Transport Maritimes DuMoroc out of Vichie, France, chartered the *Sheherazade* and put her into service bringing American petroleum products, mostly from Texas, to French North Africa in the late 1930s and into early 1941 (*Gulf Daily Shipping Guide* 1930–1940; USCG 1940–1942, 1941b, 1941k).



Figure 33. M/S *Sheherazade*. (Source: National Archives, RG26)

The German army invaded and occupied France as far as Paris in May 1940, forcing the French government to flee to Vichy. Henri Philippe Pétain subsequently was appointed prime minister of unoccupied Vichy, France, and in June 1940 signed an armistice with Germany and suspended the French constitution. In May 1941 the Vichy government was accused of collaboration with Germany. Great Britain leveled several charges including that Pétain was planning to allow Nazi forces “through unoccupied [Vichy] France and into Spain for an assault upon the key fortress of Gibraltar” (*Nebraska State Journal* 1941); was allowing German planes to use airfields in the French mandate of Syria in support of Iraq’s pro-Nazi coup d’etat (*Iowa City Press-Citizen* 1941); and was “allowing German torpedo boats to go down the lower Rhone river into the Mediterranean” (*Nebraska State Journal* 1941). Great Britain vowed to strike “the enemy wherever he may be found” on French territory—occupied or unoccupied (*Iowa City Press-Citizen* 1941; *Nebraska State Journal* 1941). Many viewed this as an undeclared war against the Vichy government of France. The Master of the *Sheherazade* received orders while in port in the U.S. in December 1940 to be prepared to scuttle his vessel should it be attacked by the British (USCG 1940–1942). In response to the allegations, the U.S. began placing coast guardsmen aboard French vessels lying idle in American ports (USCG 1940–1942). Because of this the USCG was able to determine that the crew of the *Sheherazade* at this time consisted of two factions, “one pro-Nazi and the other free-French” (Peeler 1941).

The *Sheherazade* in May 1941 had loaded oil into her holds at Houston, Texas, and was bound for Casablanca in French North Africa with British permission to navigate (*Nebraska State Journal* 1941). The U.S. Vice Consul assigned to Casablanca was onboard the vessel at the time (USCG 1940–1942). USCG dispatch reported that the *Sheherazade* cleared Bolivar Roads at Galveston, Texas, on May 12, 1941 (USCG 1941a). On the 15th, Coast Guard Headquarters issued orders to the commanders of Jacksonville, Florida, and New Orleans to detain the *Sheherazade* if found within U.S. territorial waters and to trail her if found outside territorial waters (USCG 1941c) (Figure 34). A second dispatch on the

U. S. COAST GUARD
 OFFICIAL DISPATCH
TRANSMIT

DATE 15 MAY, 1941.

FROM	COAST GUARD HEADQUARTERS	CODE	
TO (FOR ACTION)	COMMANDERS, JACKSONVILLE AND NEW ORLEANS DISTRICTS (PRIORITY)	CIPHER	
UNLESS DESIGNATED OTHERWISE TRANSMIT THIS DISPATCH AS NITE.		ACKNOWLEDGE	<input checked="" type="checkbox"/>
TO (FOR INFORMATION)		PRIORITY	<input checked="" type="checkbox"/>
		ROUTINE	
MAIL TO		ACKNOWLEDGE	
TELEPHONE TO		PRIORITY	
MESSENGER TO		ROUTINE	

OUTGOING HEADING

TWX #8 SN Z QUAH 152126 QUAG QUAV P

TEXT

FRENCH TANKER SHEHERAZADE DEPARTED GALVESTON TEXAS 1620 ZONE PLUS
 SIX TIME MAY 12 1941 X DESTINATION CASA BLANCA MOROCCO X REPORTED SPEED
 X TWELVE TO THIRTEEN KNOTS X IF THIS VESSEL IS FOUND WITHIN TERRITORIAL
 WATERS OF THE UNITED STATES DETAIN X IF FOUND OUTSIDE TERRITORIAL
 WATERS OF UNITED STATES TRAIL X IN EITHER CASE REPORT THE MATTER TO
 HEADQUARTERS FOR INSTRUCTIONS X

CONFIDENTIAL

ALL DISPATCHES IN REPLY OR IN REFERENCE TO THIS
 DISPATCH MUST BE SENT TO THE CODING BOARD, ROOM 316

V.I.A. TWX

[Handwritten signature]

OPERATIONS.
 L.T.C.

TOD 2127 SN 15 MAY 41 TWX # 8 SENT
 RV QUAG SA 2129
 R V QUAY CY 2128

OPERATOR'S RECORD

OFFICIAL BUSINESS

INITIALS OF "RELAYING" OFFICER

U. S. GOVERNMENT PRINTING OFFICE 2-16457



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 Austin, Texas 78730
 Phone: (512) 329-8342 FAX: (512) 327-2453

Figure 34
 USCG Dispatch

Prepared for: Minerals Management Service

Job No.: 441326.01 & 441326.02 Scale: N/A

Drawn by: J. Enright Date: July 10, 2005

File: I:\projdir\Nautical\441326.02\cod\Analysis.dgn

Figure 34. USCG Dispatch.

same day to Jacksonville ordered that the district “shall make every reasonable effort to locate Sheherazade” (USCG 1941d). Jacksonville responded by dispatching one plane and the USCG vessel *Nemesis* to locate the vessel. The *Sheherazade* was located and trailed the following day; however, the trail was discontinued because contact could not be maintained (USCG 1941e, 1941f, 1941g, 1941h, 1941i). On the 17th, an official dispatch was transmitted to two Atlantic weather stations from the Coast Guard Commandant to “be on the lookout for her” and to report her position if sighted (USCG 1941j).

Shortly thereafter, the British seized the *Sheherazade* in the Atlantic. The seizure had the consent of the U.S. government and likely was accomplished with the assistance of the USCG dispatches. Reports stated that the seizure was in response to the Vichy government actions, particularly in Syria, which “had a keen sharpening effect not only in London but in Washington” (*Gettysburg Times* 1941; *Iowa City Press-Citizen* 1941; *Nebraska State Journal* 1941). The *Sheherazade* was held at Bermuda for several weeks temporarily cutting the trade route between the U.S. and French North Africa (*Oakland Tribune* 1941a). France’s official protest over the seizure was delivered to Great Britain through the American State Department (USCG 1940–1942). The two nations eventually worked out an agreement and trade resumed, allowing the *Sheherazade* to reach Morocco on July 19, 1941, with 15,000 tons (13,608 metric tons) of American oil (*Oakland Tribune* 1941b).

President Franklin Roosevelt arranged for the still-neutral U.S. to supply countries fighting the Axis powers, particularly Great Britain, with weapons and equipment, as well as convoy support from the U.S. Navy, in early 1941 under the Lend-Lease system (Rahn 1994:7–8). At the same time, the German *Kriegsmarine*, including Dönitz’s U-boats, and the *Luftwaffe* were operating on a limited basis in the Atlantic in an attempt to cut off this arm of Great Britain’s supply route. Hitler, focused on the eastern front and the Soviet Union, was not yet ready to provoke the U.S. into war. Germany therefore focused on the British and other Allied shipping in the Atlantic theater. Allied shipping tonnage lost in 1941 to the combination of Nazi U-boats, aircraft, and warships averaged over 301,000 (273,061 metric tons) per month with U-boats accounting for 60 percent of the total (Roskill 1954:615–618, reported in Steury 1994:85). This was an increase of 171,500 tons (155,581 metric tons) more per month than in the months that saw losses in 1940 and 180,000 tons (163,292 metric tons) more per month than in the months that saw losses in 1939. Such heavy losses in the Atlantic stranded many foreign vessels in U.S. ports for fear of falling victim to the U-boat wolf packs and *Luftwaffe* air strikes. The *Sheherazade* found herself in just this situation when she dry-docked at Mobile, Alabama, on November 18, 1941. The *Sheherazade* had arrived from Fort-de-France, Martinique, where she had transported a shipment of U.S. oil (USCG 1941k).

The increase in German *Kriegsmarine* and *Luftwaffe* operations in the Atlantic prompted President Franklin Roosevelt to write to Congress on April 10, 1941, “in view of the growing shortage of available tonnage suited to our national needs, I am satisfied, after consultation with the heads of the interested departments and agencies of the Government, that we should have statutory authority to take over any such [foreign-owned] vessels as our needs may require, subject, of course, to the payment of just compensation” (Roosevelt 1941). Roosevelt’s request was in response to foreign shipping losses in the

Atlantic but also to the immobilization of U.S. harbors and shipping facilities and the accumulation of materials at ports that he feared “can only result in stoppage of production with attendant unemployment and suspension of production contracts” (Roosevelt 1941). Roosevelt approved an act on June 6, 1941, “to authorize the acquisition by the U.S. of title to or the use of domestic or foreign merchant vessels for urgent needs of commerce and national defense, and for other purposes” (U.S. Congress 1941). Section 3 of this act authorized the U.S. Maritime Commission, during the national emergency declared by President Roosevelt on September 8, 1939, to charter any vessel, foreign or domestic, “in addition to those otherwise available... for the transportation of foreign commerce of the U.S. or of commodities essential to the national defense.” Chartering was to be on a time-charter or bare-boat basis for the time deemed necessary by the Maritime Commission and at a rate of hire deemed “fair and reasonable in view of the attendant circumstances.”

The USCG was authorized on that day to seize 84 voluntarily inactive ships of foreign registry in U.S. ports (American Merchant Marine at War 1998). Great Britain also transferred vessels to the U.S. as well as Brazil, which had seized vessels in its ports. The *Sheherazade* arrived at Mobile, Alabama, on November 18, 1941, and was taken into custody by the USCG on December 12, 1941 (USCG 1942a). She sat idle until early 1942 when she officially was requisitioned from the French government. The Coast Guard seizure of the *Sheherazade* occurred shortly after the Japanese attack on Pearl Harbor (December 7, 1941) brought the U.S. into World War II. Japan drew U.S. focus to the Pacific, but the Atlantic remained an important bridge to Great Britain. “[Great Britain] held the key positions in the eastern Atlantic that were to become the starting bases for successful allied offensives against the Axis Powers in Europe” (Rahn 1994:21). This meant that the supply line to Great Britain must continue to operate at a high level in order to hold back the Nazi war machine until U.S. troops arrived. To counteract the U-boat successes along this supply line, the U.S. needed to increase its construction and requisition of cargo and tanker vessels.

The U.S. Maritime Commission announced on February 4, 1942, that it would requisition eight French ships laid up in U.S. ports, including the *Sheherazade*, to use on a charter basis by American companies (*Times Recorder* 1942). The *Times Recorder* (February 5, 1942) also reported that the charter fees would be impounded, since the U.S. had frozen French funds (likely due to Pétain’s accused corroboration with Germany), and turned over to shipowners at a later date. The French government released the *Sheherazade* to the WSA at Mobile on February 7, 1942, the same day that the WSA was established by executive order. Section 2 of Executive Order Number 9054 authorized the WSA to “represent the United States Government in dealing with... shipping agencies of Nations allied with the United States in the prosecution of the war, in matters related to the use of shipping.” The *Sheherazade* was moved to the Newport News Shipyard in Norfolk, Virginia, and using its powers decreed under Executive Order Number 9054 and Public Law 101, the WSA readied the vessel for use. The *Sheherazade* was armed with one 4-inch breech-loaded .50-caliber gun on the poop deck with 97 rounds of ammunition; two Browning .50-caliber machine guns on the wings of the bridge deck with 2,000 rounds of ammunition; and took onboard 15 U.S. Navy armed guards, including a gun crew of six (USCG 1942c). The vessel first was bare-boat chartered to the American shipping company Marine Transport

Lines, Inc. for coastwise trade and later reallocated to the Marine Operating Company, Inc. in February 1942 (WSA 1942a). The *Sheherazade's* registry was changed to Panamanian on March 18, 1942 (USCG 1942b).

The *Sheherazade* remained docked until April 1942 when she began service along the gulf and eastern coastlines of the U.S. transporting fuel and heating oil (USCG 1942a). Ports of call included Baytown, Texas; Charleston, South Carolina; New York; Norfolk, Virginia; and Ft. Lauderdale, Florida. On April 16, 1942, the *Sheherazade* was outbound from Baytown, Texas, en route to New York with a cargo of heating oil (U.S. Maritime Commission 1942a). Shortly before lunch she ran aground broadside to the beach south of Ft. Lauderdale (U.S. Maritime Commission 1942a, 1942b). Rescue attempts failed until the afternoon of April 20th when the *Sheherazade* was floated and hauled into Port Everglades (U.S. Maritime Commission 1942c). She limped to New York to discharge her cargo and then to Newport News for three weeks of “temporary repairs” (Brierley 1942a). She sustained extensive damage and it was determined that main engine revolutions had “dropped from 105-107 prior to grounding to 99 on the stbd [starboard] engine and 96 on [the] port engine” (Brierley 1942b). The Newport News Shipbuilding and Dry Dock Company surveyed the *Sheherazade* from May 8 through 11 to determine the extent of permanent repairs necessary and the amount of temporary repairs deemed satisfactory for a seaworthy condition. This inspection notes that the vessel is equipped with 214-ft (65-m) long bilge keels and that the port keel had been “flattened against [the] ship’s side, setup and distorted” (Price 1942). The port bilge keel was a necessary temporary repair and was burned off and replaced with “a temporary bilge keel ...welded in place” (Price 1942). As discussed later, the knowledge of bilge keels became an important diagnostic feature supporting the wreck site’s identification. Following repair, the *Sheherazade* was anchored off Wolf Trap lighthouse (Chesapeake Bay) in June 1942 awaiting orders (USCG 1942a). After several days she received her orders and on June 4, 1942, started her first voyage to a port outside the U.S. (while under U.S. requisition)—Australia (USCG 1942a). The *Sheherazade* rounded Key West on June 9, 1942, en route to Australia via Houston (perhaps to take on a shipment of oil).

The same day that the French government released the *Sheherazade* to the WSA, February 7, 1942, U-158 left Helgoland (an island in the North Sea off Germany’s northwest coast). U-158 was on her second sailing bound for Lorient (a town on the Atlantic coast of western France) under the command of Erwin Rostin. U-158 was a Type IXC U-boat commissioned by the *Kriegsmarine* on September 25, 1941, and a member of the German 10th Flotilla (see *R.M. Parker, Jr. Site History* section for a description of Type IXC U-boat). Rostin departed from Lorient on his third sailing after sinking or damaging seven allied ships. Rostin’s new orders directed him to take his U-boat into the Gulf Sea Frontier. En route U-158 sank two ships and another two upon arrival. On June 5, 1942, Rostin moved up the Yucatan Channel into the GOM (Kelshall 1988:96), sinking one American ship in the process (ubootwaffe.net 2005). Less than a month prior to Rostin’s movement into the GOM, on May 16, 1942, orders from Germany came advising the U-boats “that they were now free to attack all South American shipping without warning” (Kelshall 1988:83).

The *Sheherazade*, flying the flag of Panama, was 20 miles (32 km) west of Ship Shoals, just 30 miles (48 km) from the Mississippi Delta, on June 11, 1942. On this date, U-158 was operating close to the Mississippi Delta in water too shallow to dive and at a time when U-boat hunting in the GOM was just beginning. The previous month witnessed 25 Allied ships sunk or damaged in the GOM, and June had already seen two victims (Wiggins 1995:233–235). The following description of the events leading up to, during, and following the *Sheherazade*'s encounter with U-158 is taken from the Summary of Statements by survivors, written by Lieutenant M.J. Smith on June 26, 1942, and received at the Navy Department on July 1, 1942 (Smith 1942).

In the early morning hours of June 11, 1942, the *Sheherazade* was cruising at 13 knots (15 mph/ 24 kmph), in 10 fathoms (60 ft/18 m) of water, on a course of 282°, with seawater ballast in tanks 3, 5, and 8. The tanker's zigzag pattern called for a course change of 30° every 10 minutes under blacked-out conditions and radio silence. Six lookouts were on watch under fair conditions, a moderate easterly wind, and a choppy sea. No ships were in sight on the moonless morning. At 0455 EWT without warning, the *Sheherazade* was hit with one torpedo on her starboard side near amidships, followed immediately by a second torpedo in the starboard bunker. The second torpedo destroyed the power facilities, preventing a distress signal, and stopped the engines setting the tanker adrift. No counter offensive was offered and at 0503 EWT, without direct orders, the crew commenced abandoning ship. Sometime during this evacuation, the captain threw the secret and confidential codes overboard. The *Sheherazade* was listing 45° to starboard when at 0505 EWT a third torpedo struck the starboard engine room. “[The] tanker capsized immediately, bottom up.” U-158 fired eight rounds from its deck gun into the capsized *Sheherazade* in bursts of two. The U-boat was close enough to the *Sheherazade* that American crewmen reported hearing the U-boat crew speaking German amongst themselves. Rostin circled the tanker, fired his deck gun again, and fled south from the scene on the surface.

Twenty-six survivors made it to the tanker's launch, 23 managed to board a lifeboat, and 9 men were forced to jump overboard. Thomas Chapman, the tanker's 2nd Cook from Windsor, Ontario, did not survive the sinking. Nearly three and a half hours after the abandonment of the *Sheherazade*, at 0830 EWT, the fishing boat *40 Fathoms #6* picked up the 23 survivors in the lifeboat. At an unreported time, the shrimp boat *Midshipman* rescued the 26 survivors in the launch and pulled the 9 men out of the water who had jumped overboard. The fishing boat landed the men at Morgan City, Louisiana, that same day at 1640 EWT while the *Midshipman* followed at 2300 EWT. The body of Thomas Chapman was recovered later by a fishing boat and taken to Morgan City. The WSA cancelled Marine Operating Company's bare-boat charter of the *Sheherazade* on July 15, 1942 (WSA 1942b).

U-158 sank four more Allied ships in the GOM before heading home to Germany to resupply on June 23, 1942. Rostin had sunk 17 vessels, including 6 in the GOM, and damaged 2 additional since leaving Helgoland. U-158's total Allied tonnage sunk in the Gulf Sea Frontier was second on the list for the area and included “the largest vessel sunk during the war in the west”—the *Sheherazade* (Kelshall 1988:100). Unfortunately for U-158, Rostin enjoyed relaying his successes to command in Germany. Most U-boats allowed many days between reports within which they may have sunk multiple ships.

Rostin, on the other hand, reported every day, and the U.S. Navy had been listening to him since the sinking of the *Sheherazade* on June 11, 1942 (Kelshall 1988:110). U.S. Navy plotting of Rostin’s reports provided his course, rate of progress, and projected future position. The navy caught up with U-158 at the end of June 1942 in the Atlantic. U.S. Navy Patrol Squadron 74, one of the first squadrons to fly the Martin Mariner flying boat and later the second-highest-scoring U.S. Navy antisubmarine unit, was dispatched to the locale predicted for Rostin’s broadcast on June 30, 1942 (Kelshall 1988:111, 247). Right on cue, U-158 surfaced, not to broadcast the day’s report, but rather the report from the day before. The flying boat homed in on the signal and dropped four depth charges while Rostin’s report was underway. The first three charges exploded without hitting their mark. The fourth charge stuck to U-158’s deck planking and detonated as the U-boat submerged to avoid a second attack. There were no survivors.

Shipwreck Correlation

PBS&J consulted several shipwreck sources in order to surmise various locations for the loss of the *Sheherazade* as well as other shipwrecks of similar size in the area of Site 328 that could pose an alternate identity. This exercise was performed to provide additional circumstantial evidence that Site 328 indeed is the *Sheherazade*. Sources were limited to those providing the most comprehensive list of shipwrecks for this particular area of the GOM and those concerned with World War II casualties, and included three shipwreck databases, two secondary sources, and one index. The sources used and the methodology employed are discussed under the *R.M. Parker, Jr. Shipwreck Correlation* section. One exception is the absence of USCG coordinates for the loss of the *Sheherazade*. The USCG Index does not list casualties of vessels flying non-U.S. flags. The location provided in the official summary of survivor statements to the Navy Department (Smith 1942) instead is listed in Table 6. Table 6 lists the differences in positional data provided by each source for the location of the wreck of the *Sheherazade*. LDA obtained its position listed in Table 6 from AWOIS, and the Jordan position originates from Lloyd’s Register of Shipping, which likely used the Navy Department summary of survivors’ statements.

TABLE 6

VARYING LOCATIONS FOR THE *SHEHERAZADE*

	AWOIS	LDA	Navy Dept.	Jordan (1999)
Distance from Site 328	1 mile (1.6 km)	1 mile (1.6 km)	2.4 mile (3.9 km)	2.4 mile (3.9 km)
Bearing	NW	NW	SSE	SE

PBS&J researched vessels torpedoed in the GOM that measure within 50 ft (15 m) of *Sheherazade*’s length and found that none exist. Two vessels were sunk in the GOM that measure between 495 and 545 ft (length within 50 ft [15 m] of the Site 328 measurement based upon sidescan sonar data—see *Remote-Sensing Investigation* below). Both have been physically verified elsewhere in the GOM. PBS&J also researched vessels that measure within 50 ft (15 m) of the *Sheherazade*’s length and were

reported lost within a 20-mile (32-km) radius, regardless of age or cause of sinking. Again, no vessels fitting these criteria were located. Five unknown shipwrecks have been identified within 20 miles (32 km) of Site 328. No information other than their possible existence is known.

Remote-Sensing Investigation

Site 328 was first noted in a survey for Forest Oil Corporation in 1979 (Hole 1979). This survey recorded a sidescan sonar contact and a magnetic anomaly of 500+ gammas lasting for 1,000 ft (305 m) (Hole 1979:Appendix A). Hole (1979) notes that “MMS records do show that a tanker, by the name of ‘Sheherozada’ was sunk by a German submarine in 1942, it is located . . .” The report identified the sidescan sonar contact as the “shipwreck of the Sheherozada” and recommended an avoidance zone of 1,000 ft (305 m) (Hole 1979:Appendix A). John E. Chance & Associates, Inc. later recorded Site 328 in a pipeline right-of-way remote-sensing survey performed for Shell Pipe Line Corporation (DuVal et al. 1996). Site 328 was located outside this survey area but registered on the two outside survey transects. Sidescan sonar Target 2 reportedly measured “approximately 575 ft [175 m] by 75 ft [23 m] with a relief of 10 ft [3.0 m] above the seafloor” (DuVal et al. 1996:17). A 1,000-gamma, 1,800-ft (549-m) duration magnetic anomaly was recorded at Site 328 on the outside survey transect, and a 20-gamma, 2,200-ft (671-m) duration anomaly was recorded on the adjacent line (DuVal et al. 1996:34). DuVal et al. (1996:33) identified this target as the *Sheherazade*.

PBS&J conducted a remote-sensing investigation of Site 328 on May 14, 2005. The magnetic portion of the survey recorded a north-south dipolar anomaly with the main negative lobe oriented to the north, and a secondary, less-intensive positive lobe on the north side of the main anomaly (Figure 35). A second smaller, less-intensive dipole is oriented on the south side of the main anomaly. The anomaly’s maximum horizontal dimension measures approximately 1,650 ft (503 m) and the relative amplitude ranges from +30,425 to -5,625 gammas. No additional anomalies were recorded within the area surveyed. The sidescan sonar image of Site 328 depicts a vessel lying upside-down, a result of the *Sheherazade* capsizing during the site formation process (Figure 36). The sonar image of the *Sheherazade* measures approximately 545 ft (166 m) by 60 ft (18 m) and has a vertical relief of 30 ft (9.1 m). The inconsistency with the registered dimensions of the *Sheherazade* (574 ft [175 m] x 71 ft [22 m] 11 inches [28 cm]) likely results from the orientation of the vessel. The sonar imaged the bottom of the hull rather than the top of the deck where the registered dimensions were calculated. The most prominent features visible in the sonar imagery are two large holes in the starboard side of the vessel (see Figure 36), resulting from two torpedo impacts. Measured from the sonar record, these holes are approximately 30 ft (9.1 m) wide. Also visible in the sonar record is the port prop shaft and prop, the rudder, and the starboard bilge keel (see Figure 36). Three objects resembling pieces of cable are visible in the sonar record that likely are related to the wreck site (these objects are not visible on Figure 36 due to the scale of this illustration). All three are located off the stern of the vessel. Object 1 is approximately 800 ft (244 m) northwest of the wreck site and is coiled within an area approximately 110 x 14 ft (34 x 4.3 m). Object 2 is approximately 360 ft (110 m) north-northeast and is coiled within an area

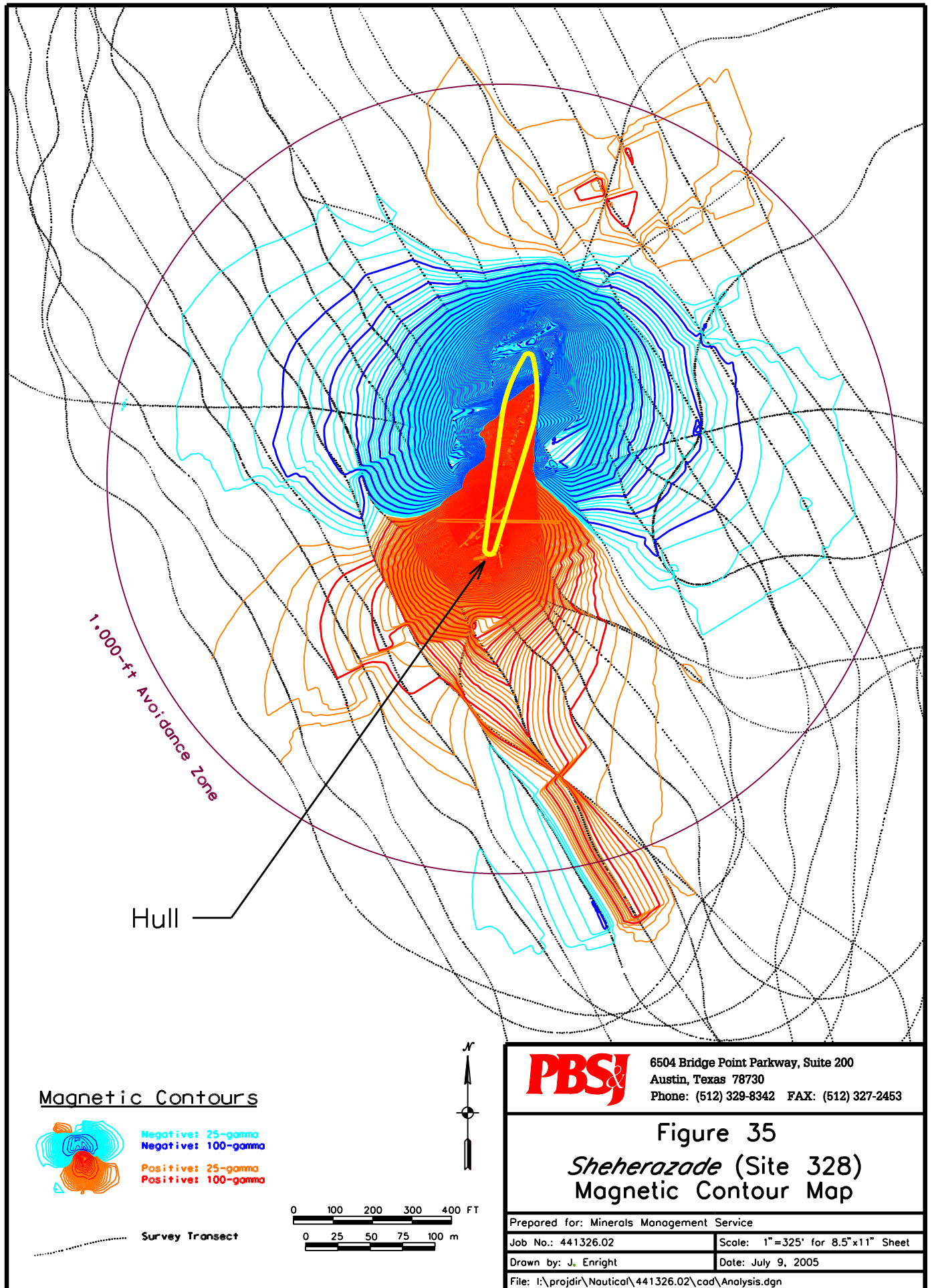
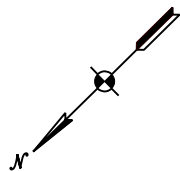
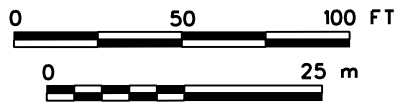
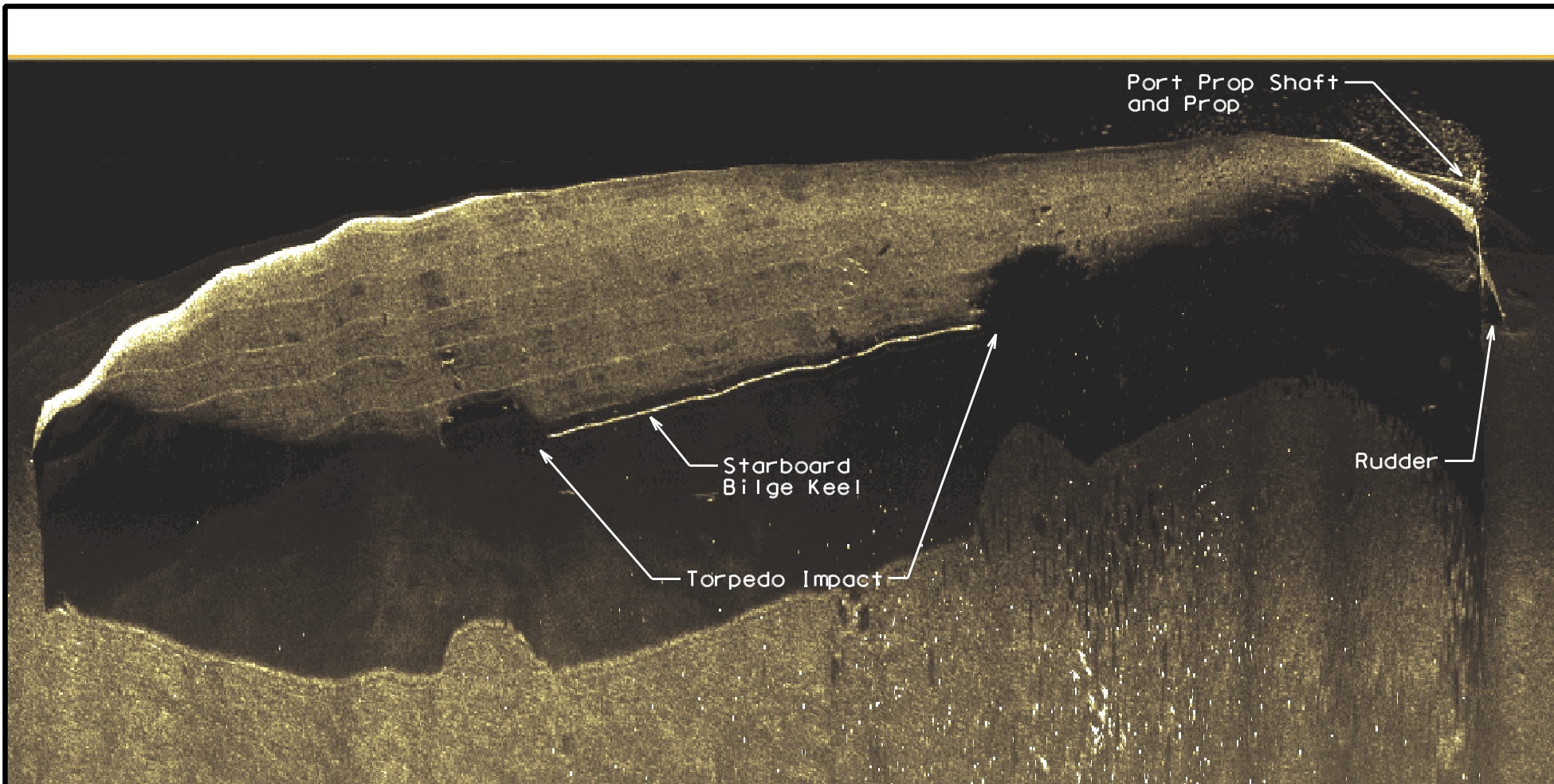


Figure 35. *Sheherazade* (Site 328) Magnetic Contour Map.



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Figure 36
Sheherazade (Site 328)
 Sidescan Sonar Image

Prepared for: Minerals Management Service	
Job No.: 441326.02	Scale: 1"=60' for 8.5"x11" Sheet
Drawn by: J. Enright	Date: July 11, 2005
File: I:\projdir\Nautical\441326.02\cad\Analysis.dgn	

Figure 36. *Sheherazade* (Site 328) Sidescan Sonar Image.

approximately 85 x 4.0 ft (26 x 1.2 m). Object 3 is approximately 1,030 ft (314 m) north and is coiled within an area approximately 90 x 3.0 ft (27 x 0.9 m).

Diver Investigation

PBS&J and MMS nautical archaeologists spent one day, May 14th, investigating Site 328. Eight dives totaling a combined three and one-half hours were conducted in depths of 55–85 ft (17–26 m) and visibility of less than 1.0 ft (0.3 m) on bottom and better than 15 ft (4.6 m) at the top of the site. The ROV flew one hour and 40 minutes on Site 328. The investigative goals for Site 328 were established to positively identify this site as that of the *Sheherazade*. Due to the orientation of the vessel, these could only include verifying the torpedo damage and searching for damage resulting from U-158's deck gun. At the time of investigation, no design characteristics of the *Sheherazade* were known. Therefore, investigation focused on gathering all the data possible in order to provide a comparison to later research. This meant focusing on the most prominent design characteristics of the site, the stern features. Results of archaeological diving and remote-sensing investigations were later corroborated in the historic record.

Little additional information was gained from the diver investigations due to fact that the vessel is positioned upside-down revealing only the outer hull. The bottom of the hull is teardrop-shaped, decreasing in beam toward the stern, and relatively flat with a hard chine, likely to maximize its cargo-carrying capacity. Located at the turn of the bilge on either side is a 12-inch (30-cm) bilge keel for added stability (Figure 37g), a design characteristic supported by subsequent historical research (see above). Both prop shafts are extant, but only the starboard prop is intact and in place (see Figure 37a–c). The external portions of the shaft tubes are supported against the hull with cross-members. The prop appears to be a controllable pitch prop (see Figure 37a,b). Controllable pitch propellers have their blades set into sockets in the hub. Gear arrangements allow the pitch of the blade to be altered while underway. Rotational speeds on larger marine diesel engines are limited, so controllable pitch propellers allow the screw “to propel a ship with a wider range of speeds” (Wikipedia.org 2006). An added feature of this propeller type is that the screw can achieve ahead, astern, or neutral thrust, with the main engine only required to run in a constant direction. Each blade of the three-bladed prop measures 7.0 ft (2.1 m) from the center out. The rudder measures 11 ft (3.4 m) wide and approximately 20–25 ft (6.1–7.6 m) tall and is attached to the stern of the vessel with three gudgeon straps and three pintels (see Figure 37d, e). The rudder is turned at an angle approximately 45° to starboard (see Figure 37f).

The torpedo damage visible on the sidescan sonar image (see Figure 36) was located and each entry point verified at approximately 30 ft (9.1 m) wide. No evidence of the third torpedo impact was discovered; however, the *Sheherazade* was listing heavily to starboard when this torpedo struck. It is likely that the entry point is located higher up the side of the hull (i.e., lower on the wreck site), an area not investigated thoroughly by divers. Archaeologists noted a fracture approximately amidships in the bottom hull plates, crossing the starboard bilge keel, and traveling approximately 15 ft (4.6 m) up the side of the hull (i.e., down the wreck site). This damage could have resulted from either a torpedo impact or the final impact of the vessel on the seafloor. Several small-diameter holes were located along the hull,

more than one measure approximately 9–10 inches (23–25 cm) in diameter. It is possible that some of these are damage resulting from the rounds fired from U-158's deck gun, but it could not be guaranteed.

An additional reason that *Sheherazade* was chosen for investigation is that the MMS had received reports that the site is leaking a petroleum substance. Immediately upon anchoring at the site, it was evident that the reports were correct. Small rainbow slicks were noticed on the water's surface throughout the day that emanated from various locations of the site. Divers were unable to determine on-site precisely where the oil is leaking from the *Sheherazade*. Following her grounding on April 16, 1942, the *Sheherazade* discharged her cargo in New York on April 29. All of her tanks, with the exception of the after main fuel oil tanks, were drained (Price 1942). A representative of the U.S. Maritime Commission noted at this time leaks in six cargo tanks, one cofferdam, and two diesel fuel oil tanks (Brierley 1942b). Temporary repairs ordered at Newport News included mending these leaks and testing the tanks so that they were "proven tight to the satisfaction of the classification and owner's surveyors" (Price 1942). Between the grounding on April 16, 1942, and her sinking on June 11, 1942, the *Sheherazade* had discharged her last shipment, undergone repairs, and was en route to Houston to take on a new cargo. Smith (1942) notes that seawater ballast was present in three tanks when the *Sheherazade* sank and it can be assumed that this was the only "cargo" at the time. Therefore, the substance leaking from the wreck site of the *Sheherazade* can only be diesel fuel oil and confined to this supply.

Mitigation Assessment

The 1979 remote-sensing survey recommended an avoidance zone of 1,000 ft (305 m) around Site 328, with which the MMS concurred. Two pipelines have been laid in the vicinity of Site 328, one approximately 2,000 ft (610 m) to the east and one approximately 2,000 ft (610 m) to the west. The nearest well was drilled approximately 1,250 ft (381 m) to the southwest. PBS&J's remote-sensing survey and diver investigation did not locate any apparent impacts from the oil and gas industry within a 1,000-ft (305-m) radius around Site 328.

NRHP Assessment

Historical research, remote-sensing survey, and diver investigation have determined that Site 328 is the *Sheherazade*. PBS&J applied the U.S. Department of Interior guidelines for nominating historic sites to the NRHP (U.S. Department of the Interior 1997) to Site 328 (see *R.M. Parker, Jr. NRHP Assessment* section).

The *Sheherazade* qualifies as historic under the definition of the U.S. Department of the Interior in that she is more than 50 years old. She additionally holds her historic integrity. Her design, physical characteristics, and aspects of construction have survived the 63 years of submersion as evidenced in the remote-sensing survey data and diver investigations of the site. The U-boat war in the GOM was a unique aspect of World War II and provides a historic context for the *Sheherazade*. For a brief period in 1942, the GOM became an active theater for German U-boat operations and witnessed dozens of Allied casualties. U-158, the vessel that sunk the *Sheherazade*, reportedly was operating so close to the



A. Port Prop Shaft Tube and Prop



B. Port Prop



C. Port Prop



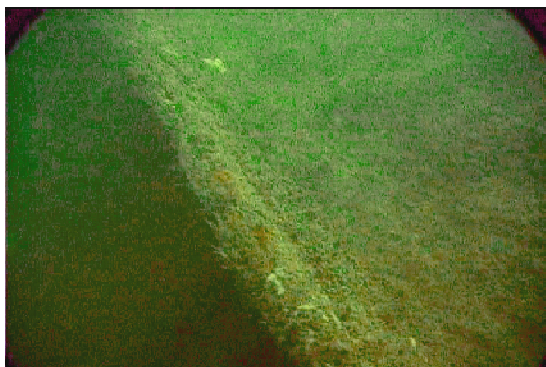
D. Sternpost and Rudder



E. Pintel and Gudgeon



F. Sternpost and Rudder



G. Starboard Side Bilge Keel



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Figure 37
Sheherazade
 ROV Screen Captures

Prepared for: Minerals Management Service

Job No.: 441326.01 & 441326.02 Scale: NOT TO SCALE

Drawn by: J. Enright Date: July 10, 2005

File: I:\projdir\Nautical\441326.02\cad\Analysis.dgn

Figure 37. *Sheherazade* ROV Screen Captures.

American coastline in the GOM that it was unable to submerge. This front was a pivotal period for the U.S. in World War II, and many more vessels likely would have gone to the bottom of the GOM had the problem not been dealt with swiftly. The participation of the *Sheherazade* in these events and her demise as a result provide the historic context necessary for listing in the NRHP.

The race for large tankers and cargo carriers in the early twentieth century adds a second historic context for the *Sheherazade*. The *Sheherazade* was, for a time, reportedly the largest merchant tanker sailing the world's oceans. This vessel participated in carrying cargo during a time of struggle amongst world powers to become the dominant force in worldwide trade. This was a pivotal period in world history and the expansion of free trade.

The *Sheherazade* maintains historic significance under Criterion A to events in American history. World War II and the Allied victory was a pivotal twentieth-century event that determined the future of the global society. No single event determined the outcome of World War II. Rather, many unique, significant events combined to result in the Axis defeat. The U-boat war in the GOM is one such significant event for reasons discussed above and is little known amongst the public. The *Sheherazade's* participation in this front connects the vessel to an important event in U.S. history. Moreover, the vessel reportedly was the largest maritime casualty not only in this front but in the entire west during the war. The *Sheherazade* also maintains historic significance under Criteria C and D. At the time of her launch, the *Sheherazade* was reportedly the largest merchant vessel sailing the world's oceans. The design and construction of this vessel is unique as the first vessel of its size and important to understanding the evolution of large merchant tankers in the early twentieth century. The wreck of the *Sheherazade* has potential to yield information through archaeological investigation important to understanding this design and construction.

SITE 15294

Site 15294 was located in a lease block remote-sensing survey conducted for Tana Exploration Company, L.L.C. by Thales Geosolutions, Inc. in 2003 (Thales Geosolutions, Inc. 2003). The sidescan sonar contact at Site 15294 is described as "a possible modern 50-ft [15-m] wreck" (Thales Geosolutions, Inc. 2003:19). No associated magnetic anomaly was recorded in the survey. PBS&J conducted a remote-sensing survey of Site 15294 on May 14, 2005. No sidescan sonar target or magnetic anomaly was recorded at the location provided for Site 15294. PBS&J did, however, verify Thales Sonar Target No. 1 approximately 1,250 ft (381 m) northwest of Site 15294. This target is an unidentified debris object with maximum dimensions of approximately 28 x 16 ft (8.5 x 4.9 m) and a maximum vertical relief of approximately 1.5 ft (0.5 m). A relatively small, weak dipolar anomaly is associated with this target that varies in intensity between +15 and -30 gammas. No archaeological diving was performed.

SITE 326

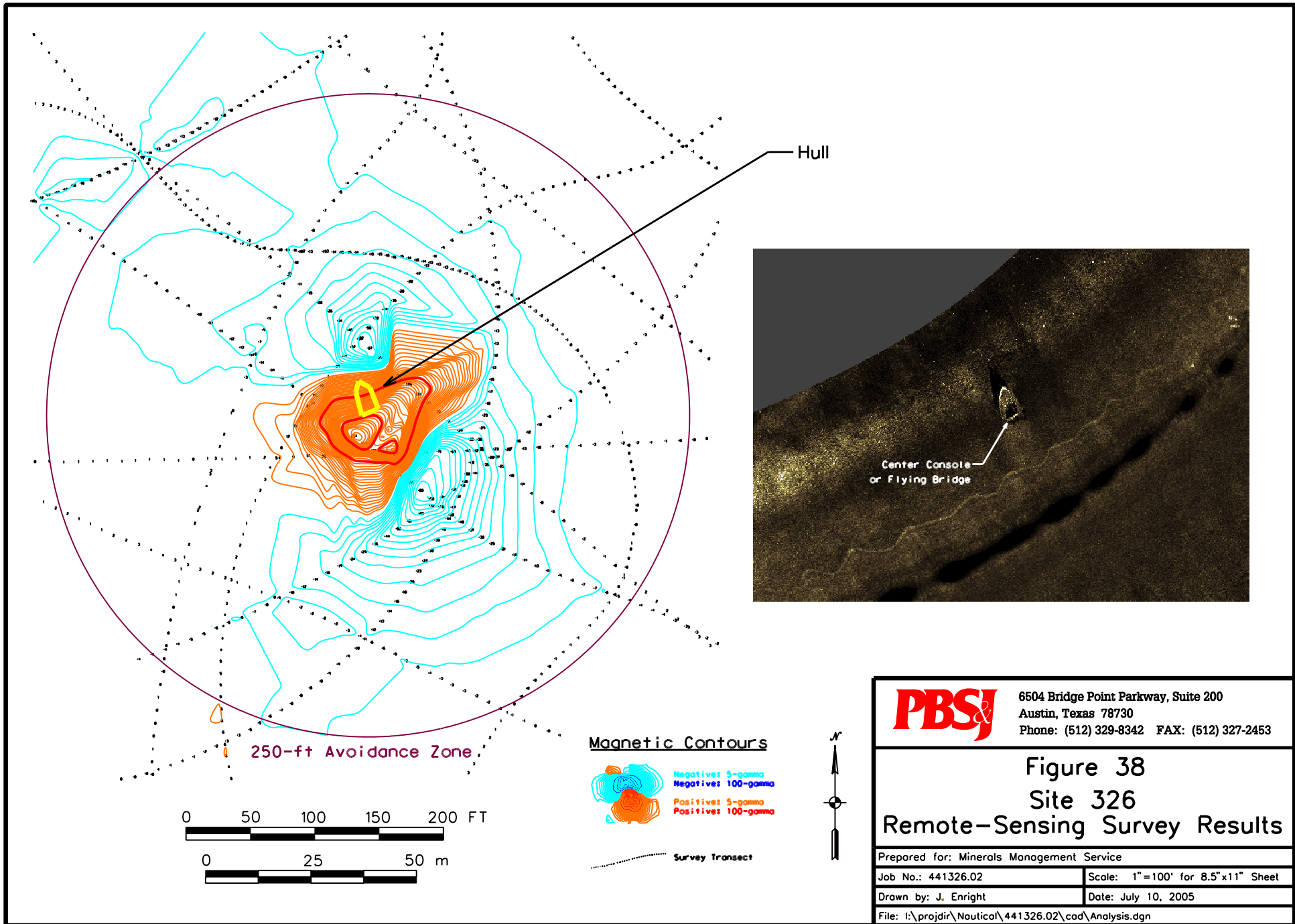
Site History

John E. Chance & Associates first discovered Site 326 during a lease block survey for Chevron U.S.A., Inc. in 1989. Thomas et al. (1989:26) state that “the vessel design is relatively modern” and that it “is 80 ft [24 m] long with two decks or a flying bridge.” The identity of this vessel was unknown prior to PBS&J’s 2005 investigations. PBS&J consulted the ARI, AWOIS, and LDA databases to determine the identity of all shipwrecks reported within a 20-mile (32-km) radius of Site 326. The results then were correlated with various years of the MVUS list to identify those vessels within this radius that share similar characteristics with Site 326 based upon PBS&J’s investigations (fishing or speed boat design, fiberglass, overall dimensions = 30–35 x 15 ft [9.1–11 x 4.6 m]). Five vessels were identified, but information other than their possible existence is unknown. All five were constructed prior to the commercial use of fiberglass in hull design. A 32-ft (9.6-m) vessel is located 3.0 miles (4.8 km) to the west; however, this vessel is a tugboat and does not match the design of Site 326. AWOIS reports the 33-ft (10-m) pleasure craft *Kamikaze 2* wrecked 1.2 miles (1.9 km) northwest of Site 326. The *Kamikaze 2* matches closely with Site 326 in location, size, and design and is the likely identity for the site.

Remote-Sensing Investigation

The John E. Chance and Associates survey recorded a 1,000+ gamma anomaly lasting 600 ft (183 m) at Site 326 (Thomas et al. 1989:15). The sidescan sonar image of Site 326 did not present an acoustic shadow, which led to the interpretation that “the vessel has deteriorated and collapsed into the surficial sands” (Thomas et al. 1989:26). PBS&J conducted a remote-sensing survey of Site 326 on May 14, 2005 (Figure 38). Site 326 is located approximately 500 ft (152 m) south of the provided coordinates. The magnetic anomaly recorded at Site 326 does not exhibit the characteristics expected for an iron-, steel-, or wooden-hulled vessel (see *Discussion: Protection of Historic Shipwrecks on the Shallow OCS* section below). It is dominated by the positive pole of a dipole that is oriented with this positive component to the northwest. There exists a secondary, relatively smaller negative component to the northwest of the positive pole. The anomaly’s maximum horizontal dimension measures approximately 280 ft (85 m). The relative amplitude of the anomaly ranges from +245 to –85 gammas. The relatively small area, low amplitude, and uncharacteristic orientation of this shipwreck anomaly suggest that the vessel is fiberglass. The anomaly likely does not represent the sum of individual parts of the shipwreck as is normal (see *Discussion: Protection of Historic Shipwrecks on the Shallow OCS* section below), but rather a single ferrous object located on the wreck site. The anomaly therefore is oriented in line with this object and not with the earth’s induced field as is the norm with shipwreck anomalies.

The sidescan sonar image of Site 326 (see Figure 38) depicts a vessel 30–35 x 15 ft (9.1–11 x 4.6 m) with a square stern and sharp bow, a design used for modern recreational fishing and speed boats. The resolution of PBS&J’s close-order survey recorded a distinct acoustic shadow that allowed the maximum vertical relief to be measured at 3.0 ft (0.9 m). There appears to be a center console or flying bridge near



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Figure 38
Site 326
Remote-Sensing Survey Results

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Job No.: 441326.02	Scale: 1"=100' for 8.5"x11" Sheet
Drawn by: J. Enright	Date: July 10, 2005
File: I:\projdir\Nautical\441326.02\cad\Analysis.dgn	

Figure 38. Site 326 Remote-Sensing Survey Results.

the stern of the vessel, again a feature of modern recreational fishing or speed boats, which measures approximately 8.0 ft (2.4 m) wide.

Diver Investigation

Based upon the remote-sensing data, it was determined that Site 326 is a modern vessel. Diver investigation of this site was not performed because of this fact and a lack of available time.

Mitigation Assessment

The MMS recommended an avoidance zone around Site 326 of 250 ft (76 m). PBS&J's remote-sensing survey did not record any impacts from the oil and gas industry within this zone. The nearest construction is a pipeline located approximately 1,150 ft (351 m) to the northeast of Site 326.

NRHP Assessment

Site 326 is neither historic nor eligible for listing in the NRHP.

V. DISCUSSION: PROTECTION OF HISTORIC SHIPWRECKS ON THE SHALLOW OCS

The protection of historically significant shipwrecks is an implicit objective of all archaeological assessments and government-sponsored archaeological studies on the OCS. It, therefore, seems appropriate in the context of this study to address the issue of protection along with a few related topics. Much of this discussion centers around the following question: Are historically significant shipwrecks on the OCS receiving an adequate level of protection? We believe that some sites receive a high level of protection, while others go completely unprotected. Those shipwrecks receiving the highest level of protection tend to be those that are the most noticeable. They include exposed vessels having metal hulls and/or machinery, such as those selected for this study, as well as deep-water wooden ships that are less affected by degradation from wood-boring organisms, shallow-water environmental factors, and shrimp trawlers, than are shallower shipwrecks.

There exists another large subset of OCS shipwrecks that tend to evade discovery. We believe that many such wrecks might exist within previously surveyed lease blocks, yet remain completely unprotected due to their lack of discovery. They are wooden-hulled sailing ships occurring within the depth range of wood-boring organisms (above 650 ft [198 m] according to Gonor et al. 1988), shallow water environmental factors, and shrimp trawlers. These sailing ships tend to be smaller, older, and less intact (above the mud line) than machine-powered and/or metal-hulled vessels. They also lack machinery, which might otherwise remain visible above the mud line after decomposition of exposed wooden elements has occurred.

Wooden-hulled sailing vessels are more difficult to discover than other vessels because they tend to have smaller, lower-amplitude magnetic anomalies and ambiguous or nonexistent sidescan sonar targets. Yet wooden-hulled sailing vessels comprised the majority of merchant vessels built in the U.S. until 1879 and were the largest class (by type of propulsion) of U.S. merchant vessels lost up until 1890 (Gearhart et al. 1990: IV-34 to IV-35). We believe this class of vessel comprises a significant archaeological data gap on the OCS.

This archaeological data gap can be filled only by discovering *at least* a representative sample of wooden-hulled, sail-powered shipwrecks on the OCS. Leaving aside the question of whether or not a sample would constitute adequate protection of OCS historic resources, we believe it is technologically feasible to protect all historically significant shipwrecks on the OCS. The process of protecting the data-gap wrecks necessarily begins with their detection. Detection of all wooden-hulled sailing vessels would require a reduction of survey line-spacing. Their protection would require a mandate to avoid all unidentified magnetic anomalies and sonar targets. The following discussion establishes the existence of an archaeological data gap, characterizes the nature of remote-sensing signatures of shipwrecks comprising the data gap, and develops a strategy for the detection of those wrecks.

Shipwrecks that are never detected by remote-sensing surveys are not protected in any way and are emergency site discoveries waiting to happen. Thus, any evaluation of how well we succeed at protecting historic shipwrecks must begin with an evaluation of how good we are at detecting shipwrecks. The next logical step in protecting historic shipwrecks is the selection of potential wreck sites from among all the remote-sensing signatures (sidescan sonar targets and magnetic anomalies) detected by each industry survey. Notice the reference to “potential” sites. This is to emphasize the point that a significant percentage of historic shipwrecks in the GOM are marked only by ambiguous magnetic anomalies. If each historic shipwreck detected by a remote-sensing survey were recognized as such, then undoubtedly each would be selected by an archaeologist for protection. Realistically though, we believe that many *potential* shipwrecks must be selected for avoidance in order to achieve protection of all *historic* shipwrecks.

Once a remote-sensing signature has been detected and selected as a potential shipwreck, it can be protected by recommending an appropriate level of avoidance. In the process of protecting historic shipwrecks, many nonhistoric shipwrecks and potential wreck sites must also be selected for protection. This is unavoidable because buried anomaly sources cannot be positively identified as wrecks, nor can shipwrecks be positively identified as historic, in the absence of diver or ROV assessments.

The purpose of this analysis is to assess and improve upon the level of protection received by historically significant shipwrecks on the GOM OCS. We begin the discussion below by illuminating a significant gap in the historic archaeological record. This gap is comprised largely of wooden-hulled sailing ships. The physical parameters of remote-sensing signatures distinguish data-gap wrecks from the subset of shipwrecks already discovered on the OCS. This fact is demonstrated below based on magnetic anomalies recorded over 20 verified shipwrecks. If this data gap were to be filled, methodologies for detection of potential shipwreck anomalies and criteria for selection of potential shipwreck anomalies would require revision.

The scope of services for this project lists six objectives: They include 1) determining potential NRHP eligibility of selected sites, 2) assessing the adequacy of current avoidance criteria, 3) assessing industry compliance with government protective measures, and 4) preparation of related documentation. The scope of services also expresses optimism that site assessments performed under this contract would 5) help eliminate archaeologically insignificant sites from further concern and would 6) aid refinement of analytical methods used for selecting sites for avoidance. Objectives 1, 3, and 4, and aspects of Objective 2, pertaining specifically to the sites visited during these field investigations, have been addressed under the respective results section for each site earlier in this report.

Objectives 2, 5, and 6 include loftier goals of applying lessons learned from this study to all federally permitted activities on the OCS. In addition to the topics for discussion outlined above, this analysis addresses those broader aspects of Objectives 2, 5, and 6. Objective 6 is covered by the discussion of selection criteria for potential shipwreck anomalies. Assessment of avoidance criteria (Objective 2) is discussed below as it pertains to magnetic anomalies selected as potential shipwrecks. Ideas for

elimination of archaeologically insignificant remote-sensing anomalies from further concern (Objective 5), other than the obvious diver and ROV investigations, are based primarily on remote-sensing analyses. Finally, an industry hazard survey is simulated by randomly placing magnetic anomalies from various identified sources in a model lease block. This exercise highlights many salient points concerning the archaeological data gap, detection methodology, selection and avoidance criteria, and elimination of archaeologically insignificant sites.

A GAP IN THE ARCHAEOLOGICAL RECORD

In order to protect a historic shipwreck one must be aware of its existence. Yet a large proportion of shipwrecks in shallow waters of the GOM are known only through historic records. Wooden-hulled vessels are underrepresented in the archaeological record, and few examples of wooden-hulled sailing vessels, in particular, have been discovered in shallow waters of the GOM OCS. This point was brought home recently by discoveries of three historic, wooden-hulled sailing vessels in deep water (MMS Vessel ID Nos. 337, 15169, and 15321). The level of preservation and corresponding historic potential of these wrecks are striking, leading this author to reflect upon just why that is so. It became apparent that these three wrecks stand out from their peers precisely because they are among the first discoveries of this caliber in the GOM. They owe their level of preservation above the mud line, and likely their very discovery, to the limited activity of wood-boring organisms at such great depths; to the lack of shallow water environmental factors such as sediment flow, surf, and storm surge; and to the absence of shrimp trawling at these depths.

Could these deep-water discoveries be unique? Surely there are substantial numbers of wooden-hulled sailing vessels preserved beneath the mud line in shallow waters of the GOM. Evidence suggests that a sizable gap exists in the archaeological record of the shallow OCS. The existence and persistence of this data gap is attributable to the fact that wooden-hulled sailing vessels are the most difficult class of vessel to detect in shallow-water remote-sensing surveys. Their absence of machinery results in magnetic anomalies that are significantly smaller in size and amplitude than those of machine-powered vessels, while the effect of wood-boring organisms, shallow water environmental factors, and shrimp trawlers on their hulls removes most sizable elements of these wrecks down to the level of the mud line, making their detection by sonar problematic.

A review of relevant shipwreck statistics from various sources should provide an appreciation for the potential size of the archaeological data gap represented by wooden-hulled vessels and in particular by wooden-hulled sailing vessels. One valuable source of shipwreck statistics for the U.S. Merchant Fleet, including yachts and government vessels, is the MVUS casualty tables published from 1906 through 1947 (U.S. Department of Commerce, various). A summary of annual losses by vessel type for most years is printed at the end of each table. Based on those lists for the period 1908 through 1939, excluding 1909 and 1918, a total of 9,066 U.S. merchant vessels were reported as lost. Of that number, 2,218 were sailing vessels. Of the sailing vessels lost during that period, 2,180 (98 percent) had wooden hulls.

According to this source, 24 percent of all U.S. registered vessels officially reported as lost from 1908 through 1939 were wooden-hulled sailing vessels.

This represents a large proportion of total shipwrecks considering this was during the decline of the sailing era. Earlier statistics suggest that the proportion of sailing vessels for the historic period is significantly greater than 24 percent. For example, Gearhart et al. (1990) summarized West Coast data published by the U.S. Life-Saving Service. During 1876, the first publication year of their *Annual Reports*, 86 percent of all reported shipping losses were sailing vessels. Although the percentage of sailing losses was already in decline by 1876, the number of sailing losses exceeded machine-powered losses until 1890. Forty three percent (43 percent) of all losses for the period 1876 through 1914 were sailing vessels (U.S. Treasury Department 1876–1914).

By 1908, the first year of the U.S. merchant vessel statistics cited above, the proportion of sailing vessel losses was in a steady decline. For the decade from 1910–1919, sailing vessel losses comprised 39.7 percent of all U.S. merchant shipping losses. For the decade of 1920–1929 that figure had dropped to 20.1 percent, and over the period 1930–1939 sailing losses averaged only 5.4 percent of the total (U.S. Department of Commerce, various). The average loss rate of sailing vessels as compared to total merchant vessel losses for the 63-year period from 1876 to 1939 is 33.8 percent. Adjusting for the proportion of wooden-hulled sailing vessels, this number lowers slightly to 33.3 percent. In other words, at least one-third of all U.S. merchant vessel losses from the period 1876–1939 were wooden-hulled sailing vessels.

From 1940 through the present, the percentage of sailing vessel losses can safely be assumed to be less than the 5.4 percent averaged over the decade of the 1930s, since by 1939, only 2.3 percent of losses were reported to be sailing vessels. Going back in time, however, one can assume that the proportion of sailing vessel losses climbed from 86 percent in 1876 to 100 percent prior to the introduction of steam propulsion. We must conclude that the proportion of wooden-hulled sailing vessel losses prior to World War II actually exceeded 33.3 percent. So for every three pre-1940 wrecks on the OCS, one might reasonably assume that at least one is a historic sailing vessel.

In fact, the MMS shipwreck database for the GOM shows that 61 percent (n = 141), more than half, of pre-1940 shipwrecks, from a sample of 233 vessels for which the date of the wreck event is known, are sailing ships, ranging in age (i.e., date of wreck event) from 1625 to 1927. If we only consider wrecks of known age for which propulsion is also known, then sailing vessels represent 79 percent of the pre-1940 total in the MMS shipwreck database. If we extend the age range up through 1955, the present 50-year cutoff date for NRHP eligibility, then sailing vessels represent 45 percent of shipwrecks for which both the date of the wreck event and the system of propulsion are known.

Three other shipwreck databases were consulted in an effort to further document the archaeological data gap represented largely by wooden-hulled sailing vessels. Arnold (1991) reported that 45 percent of shipwrecks lost in Texas waters, from all time periods, were merchant sailing ships. The total size of

Arnold's sample was 1,540 shipwrecks, 36 percent of which went down in the GOM. Gearhart et al. (1990: IV-37 to IV-43) reported that 44 percent of shipwrecks, from all time periods, in a West Coast database of 3,850 shipwrecks were sailing vessels. Finally, PBS&J maintains an in-house database of shipwrecks from all time periods for Texas coastal waters, which lists 233 sailing vessels (40 percent) out of 580 total losses for which vessel type is known. The numbers from these three databases corroborate the conclusion, based on historic government publications and on the MMS shipwreck database, that wooden-hulled sailing vessels represent a high proportion of historic shipwrecks. The actual percentage is less important than the realization that we are talking about roughly half of all the shipwrecks in the GOM, which meet the 50-year age criterion for NRHP eligibility.

How does the perception of an archaeological data gap compare with the archaeological record? To date, 206 shipwreck discoveries have been confirmed on the GOM OCS, according to the most recent ARI database. Of that number, the hull composition is known for 44 vessels. Mode of propulsion is known or can be presumed for 39 of those vessels, including 11 (28 percent) having wooden hulls. Of those 11, six (15 percent of $n = 39$) are known to be wooden-hulled sailing vessels. Of those six, two (5 percent of $n = 39$) are located at depths where they would be affected significantly by wood boring organisms, shallow-water environmental factors, and shrimp trawlers. These include the *El Nuevo Constante* (Pearson and Hoffman 1998) in Louisiana state waters, and *El Cazador* (*New York Times* 1993; Summers 1996), in an unleased Federal block, both discovered by fishermen and worked by salvors. At least one other example of a wooden-hulled sailing vessel has been discovered in shallow waters of the GOM, the *303 Hang Wreck* reported by James et al. (1991a), but no other examples are known from federal waters.

We must conclude, based on the evidence, that the archaeological data gap on the shallow OCS, comprised primarily of wooden-hulled sailing vessels, is very real and rather large. Whereas we would expect approximately half of all wrecks on the shallow OCS to be wooden-hulled sailing vessels, the total archaeological sample to date in the ARI database is a single vessel. Furthermore, *El Nuevo Constante* was discovered by a shrimp trawler, so not even one proven example of a wooden-hulled sailing vessel has been discovered to date by an MMS-mandated oil and gas industry survey in the shallow portion of the GOM. By contrast, all of the deep-water wooden-hulled vessels ($n = 6$) were discovered through federal regulation or oversight of oil and gas industry activities. Historic evidence strongly suggests that wooden-hulled sailing vessels should be present in roughly equal proportion to all other combined classes of historic shipwrecks; therefore, the only conclusion we can draw is that these wrecks are not being recognized by industry surveys in shallow waters of the OCS. One implication of this conclusion is that if wooden-hulled sailing vessels are not being recognized as potential shipwrecks, then they might not be successfully avoided by bottom disturbing activities. In other words, they represent emergency discovery situations waiting to happen. The *303 Hang Wreck*, although located in state waters, is a prime example of an emergency discovery. Originally known only as a shrimp net hang to fishermen, this 100-ft sailing ship (Site 41BO173) was discovered in good condition, but completely buried, during construction of a pipeline (James et al. 1991a).

MAGNETIC ANOMALIES OF 20 SHIPWRECKS

Protection of historically significant shipwrecks will remain incomplete as long as the archaeological data gap exists. The chance of emergency discovery and/or damage to historically significant sites remains high due to the discrepancy between types and numbers of shipwrecks listed in historic records and the population of known shipwrecks on the OCS. Improvement of survey and analysis methodologies is necessary if archaeologists hope to fill this data gap. It is with such methodological improvements in mind that we provide illustrated examples of magnetic surveys over 20 verified shipwrecks.

The combined shipwreck anomaly data set is illustrated on Figures 39–44. Twelve of the illustrated wreck anomalies come from a collection of magnetic anomalies recorded over shipwrecks by PBS&J in the past five years (e.g., Gearhart 2004). All 12 of these shipwrecks were surveyed in at least two crossing directions at line intervals ranging from 2.0 to 10 m (6.6 to 33 ft) using a cesium vapor magnetometer. Also included in this data set is the *San Esteban* anomaly, reported by Arnold and Weddle (1978:197), and seven wreck anomalies recorded as part of this project.

This data set allows one to accurately establish the parameters of what constitutes a potential shipwreck anomaly from surveys conducted at various line intervals. The shipwrecks represented on Figures 39–44 include a wide variety of types, ages, compositions, and depositional environments. Vessel types include four wooden-hulled sailing vessels, three wooden-hulled paddlewheel steamboats, three wooden-hulled steamboats of unknown propulsion style (i.e., paddlewheel or screw), one wooden-hulled steam screw (converted to a barge), two iron-hulled steamboats, one steel-hulled steam screw (converted to a barge), four steel-hulled diesel screws, and two steel-hulled barges. These vessels range in age from the mid-sixteenth to the mid-twentieth century. Wreck environments for this data set range from high-energy to low-energy conditions, including harbor entrances, barrier-island surf zones, beaches, marsh, oyster reefs, open bay, and open GOM. A variety of wreck and postdepositional events are represented, including vessels that stranded, foundered, experienced boiler explosions, burned, were partially demolished, and/or were salvaged.

The most striking feature of this data set is the wide range in size of magnetic anomalies. All of their magnetic contour maps are reproduced here at the same scale, contour interval, and orientation, so visual comparisons are easy to make. Notice that the smallest eight wreck anomalies, including all four wooden-hulled sailing vessels, fit easily onto a single page, while the largest seven wrecks, including six of the seven wreck anomalies contributed by this project, fit only one or two to a page. One can quickly appreciate how a small sailing ship anomaly might be overlooked in the absence of a prominent sidescan sonar target.

We know the hull size for only one sailing vessel from this data set. The wreck at 41CF125 measures 88 ft (27 m) long by 20 ft (6.1 m) wide. It was found exposed in a beach along the Texas coast. Salvors stripped the hull following the wreck event, so the size of the anomaly is smaller than would

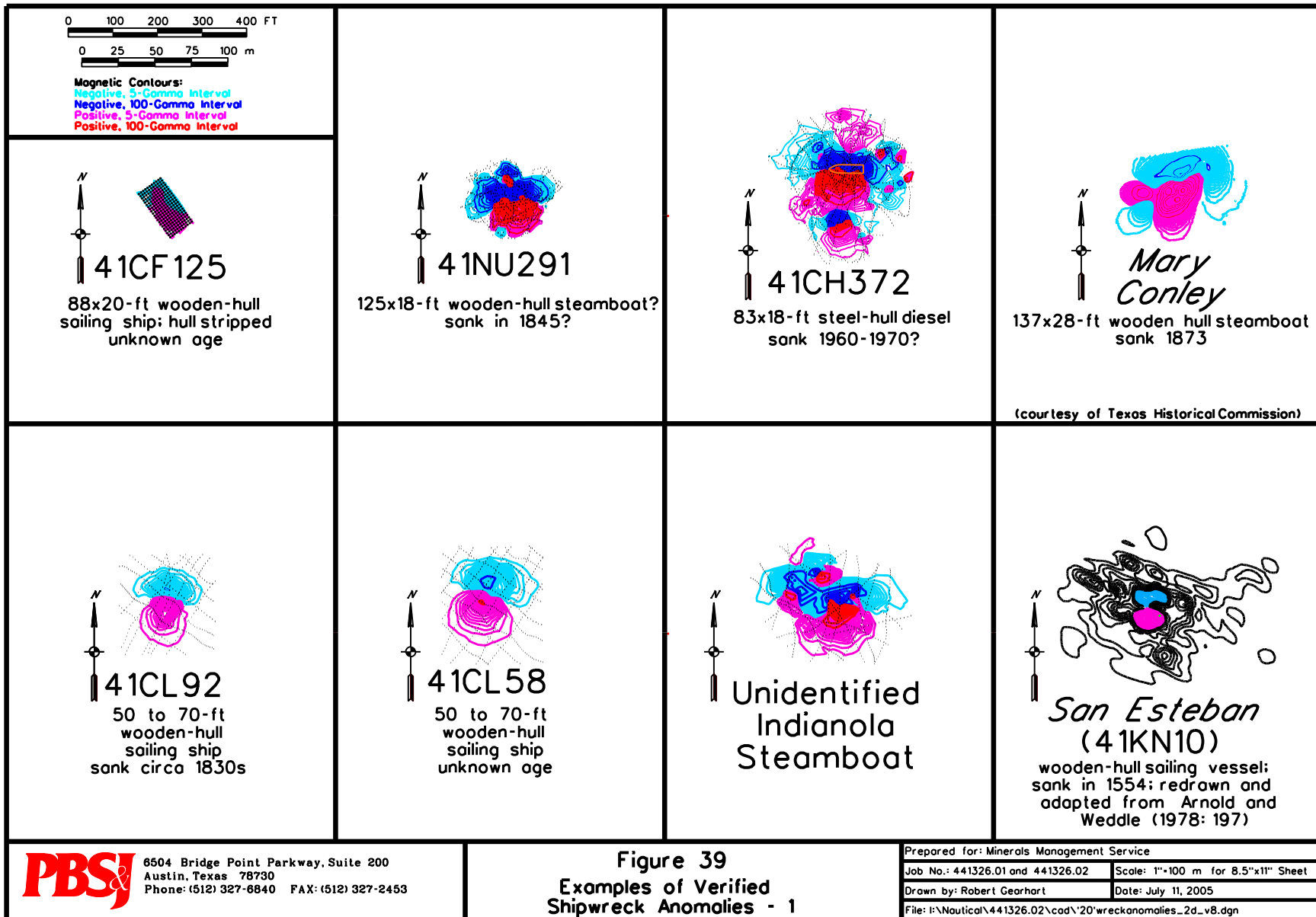


Figure 39. Examples of Verified Shipwreck Anomalies - 1.

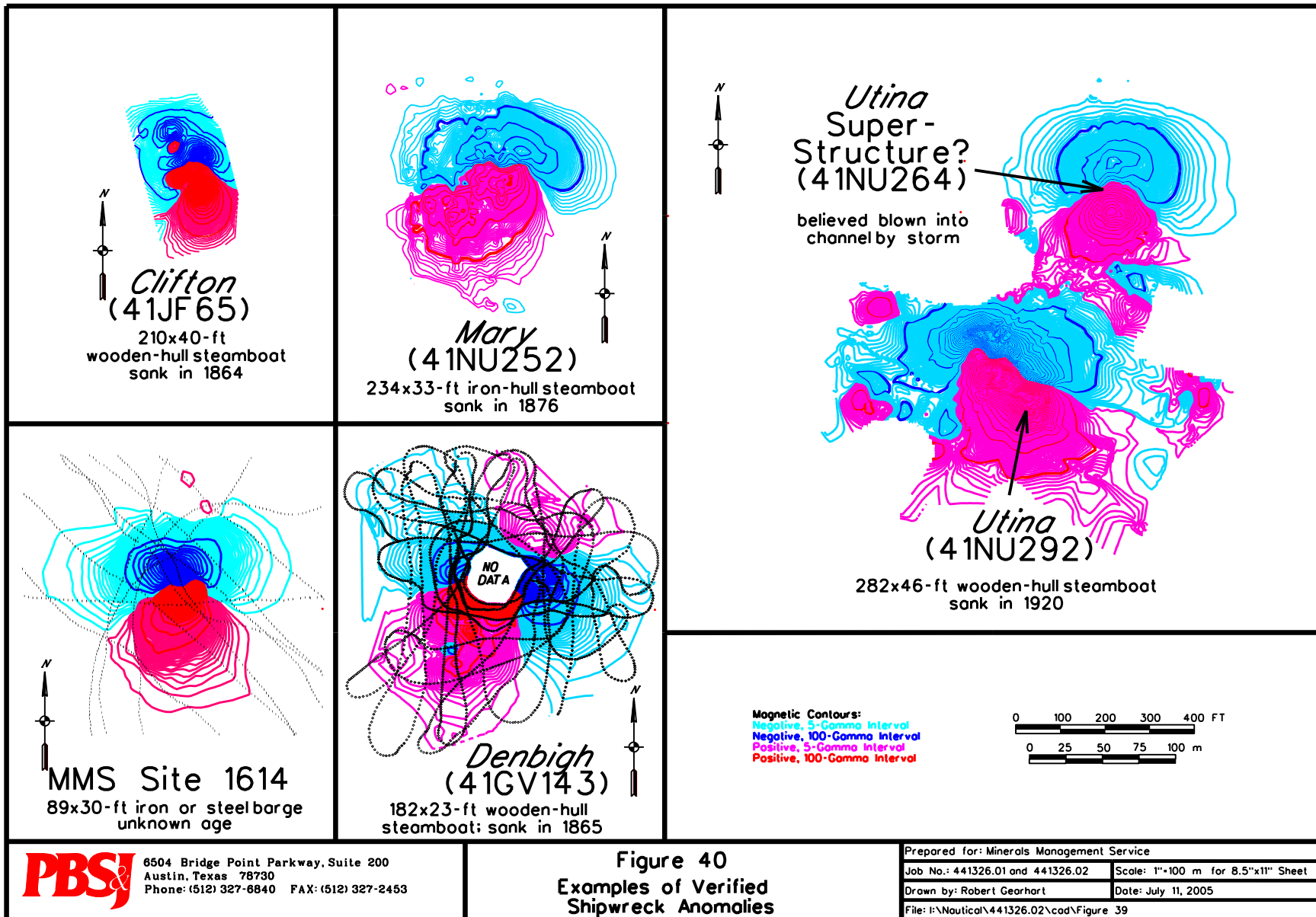


Figure 40. Examples of Verified Shipwreck Anomalies - 2.



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Figure 40
Examples of Verified
Shipwreck Anomalies

Prepared for: Minerals Management Service	
Job No.: 441326.01 and 441326.02	Scale: 1"=100 m for 8.5"x11" Sheet
Drawn by: Robert Gearhart	Date: July 11, 2005
File: I:\Nautical\441326.02\cad\Figure 39	

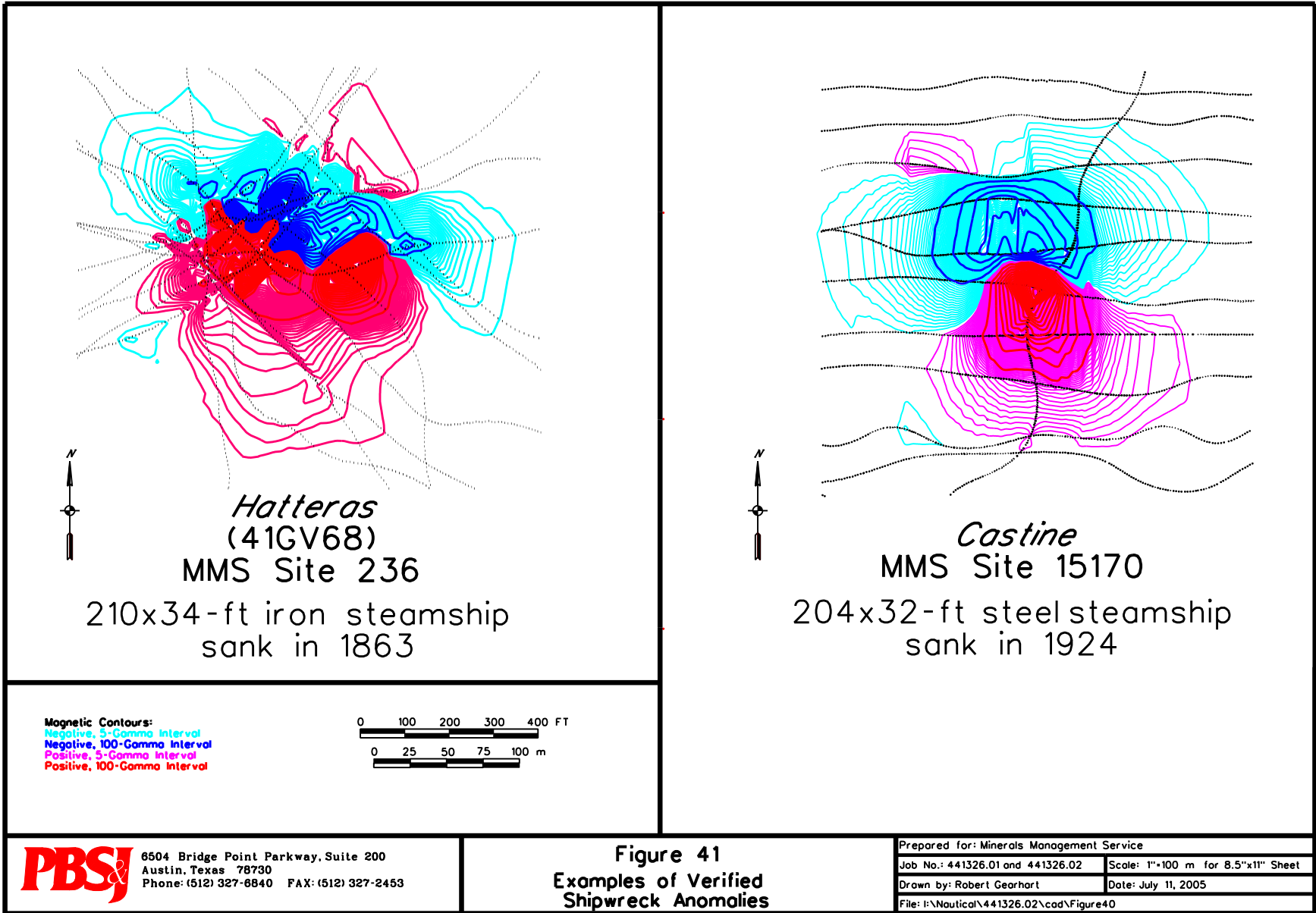


Figure 41. Examples of Verified Shipwreck Anomalies - 3.

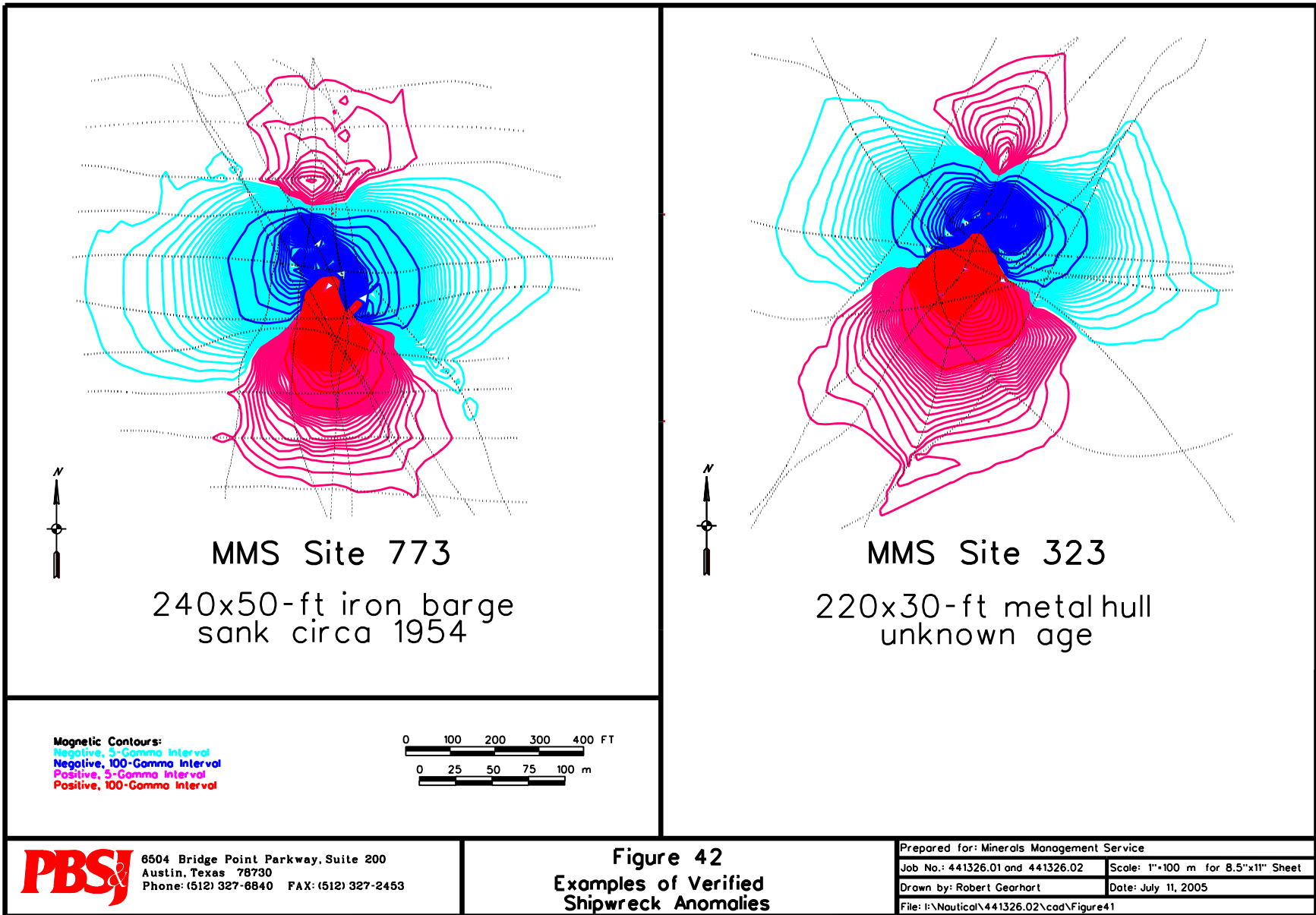


Figure 42. Examples of Verified Shipwreck Anomalies - 4.

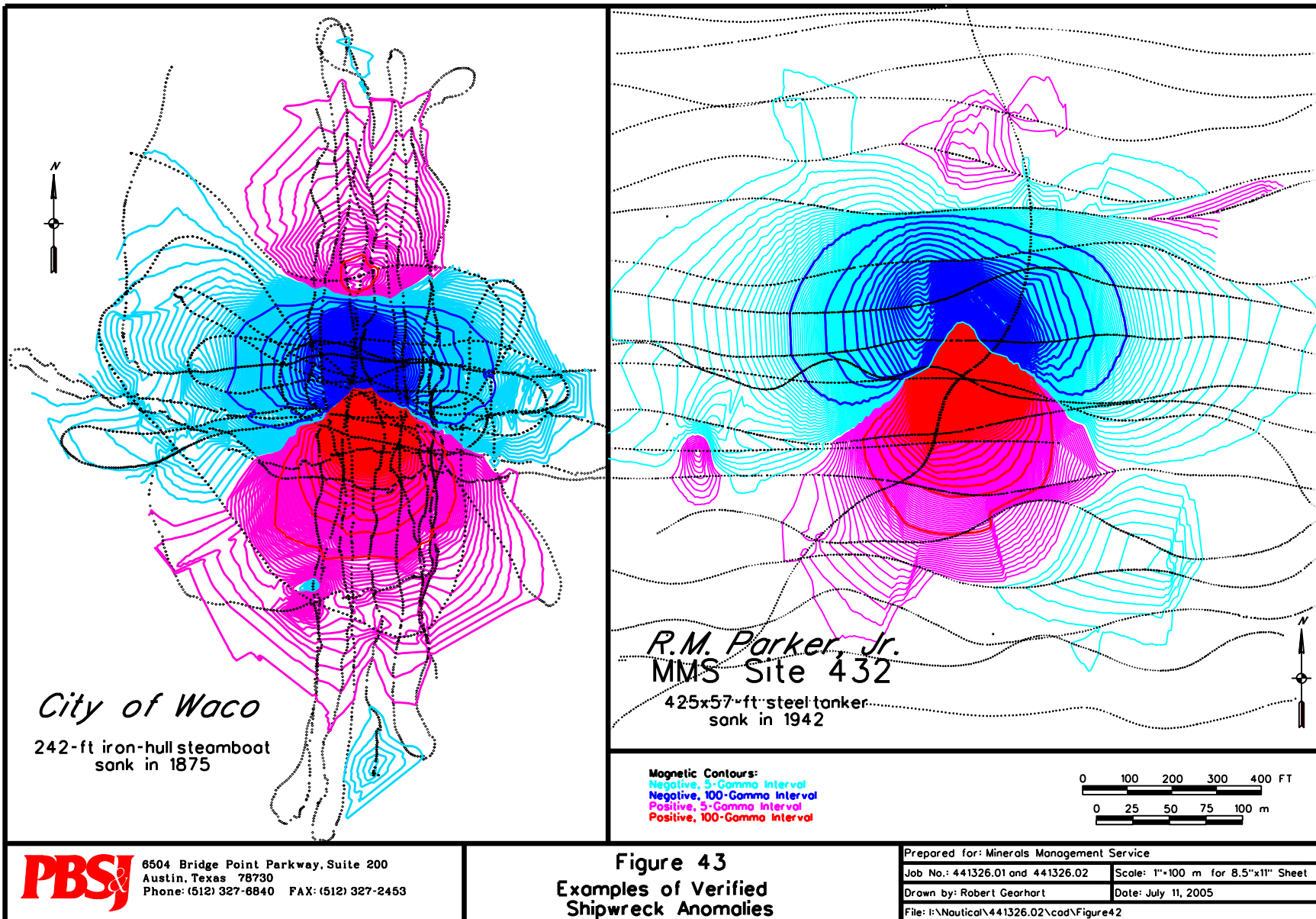


Figure 43
Examples of Verified
Shipwreck Anomalies

Figure 43. Examples of Verified Shipwreck Anomalies - 5.



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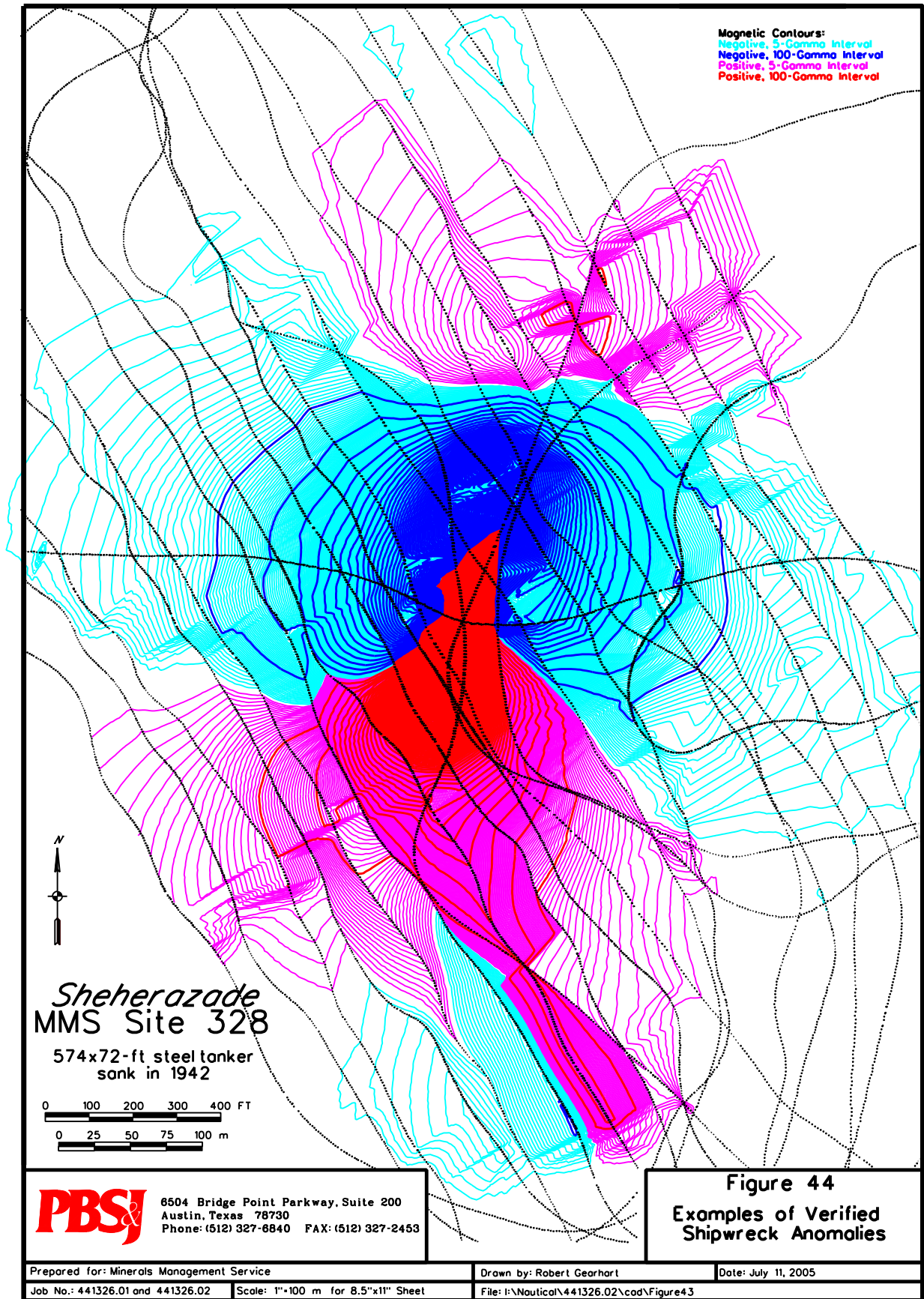


Figure 44. Examples of Verified Shipwreck Anomalies - 6.

otherwise be expected for a vessel of this size. The other three wooden-hulled sailing vessels (41CL92, 41CL58, and 41KN10) occurred in shallow, high-energy environments in the open GOM. Their hull sizes are unknown; however, we presume because of their age and/or artifact assemblages that all were large enough to engage in extended trans-Atlantic voyages. Based on comparisons with the anomaly recorded over La Salle's ship *La Belle* (Arnold 1996), we believe that the shipwreck associated with 41CL92 is close in size to *La Belle* (51 ft [16 m]). As other such vessels are discovered, a more complete picture will develop concerning the size range of anomalies represented within the OCS archaeological data gap. Until that time, these four wreck anomalies might serve as a ruler by which detection methodologies and selection criteria are measured. Their anomalies are expected to be fairly representative of many wrecks on the OCS, although their hulls are probably less intact than most OCS wrecks in federal lease blocks, the latter having sunk in deeper waters. Their amplitudes range from +80/-50 gammas for 41KN10 to +108/-158 for 41CL58, while their sizes (out to the 5-gamma contour) range from 44 x 54 m (144 x 77 ft) for 41CL92 to 91 x 145 m (299 x 476 ft) for 41KN10. The anomaly margins for 41CF125 were not mapped so its width could not be determined.

DETECTION OF POTENTIAL SHIPWRECK ANOMALIES

Compromises between economics and preservation are implicit, but unstated, in the design of most surveys yet even a small number of unanticipated discoveries during construction can have enormous economic consequences. The authors address two important questions concerning those compromises: What might be missed by typical magnetometer surveys, and what could be done to improve the situation?

The magnetometer and the sidescan sonar are the two instruments most commonly relied upon for recognizing submerged shipwrecks. The magnetometer is the primary instrument for this purpose, as historic shipwrecks typically contain sufficient ferromagnetic material to produce a magnetic anomaly. The magnetometer also can detect wrecks that are buried and are, therefore, invisible to sidescan sonar. Sidescan sonar imagery is used secondarily as a means of visualizing magnetic anomaly sources where they exist above the mud line. Wrecks falling into the archaeological data gap are marked by relatively small magnetic anomalies and by ambiguous to nonexistent sonar targets. The largest class of shipwrecks, wooden-hulled sailing vessels, is represented by the smallest size of magnetic anomalies.

Current MMS archaeological resource survey requirements (NTL 2005-G07) for lease blocks having a high probability for historic resources call for a line spacing of no greater than 50 m (164 ft) in water depths up to 200 m (65 ft) or a line spacing of no more than 300 m (984 ft) in water depths exceeding 200 m (65 ft). A magnetometer is required for all surveys in water depths less than 200 m (65 ft). Sidescan sonar is required on all such surveys regardless of their depth. MMS does not define the parameters constituting a magnetic anomaly; however, Garrison et al. (1989:II-129) state that, "In practice, archaeologists preparing cultural resource reports for lease block surveys consider anomalies over five nanoteslas [gammas] with a period of three or more counts as a possible target." For the purposes of this discussion, we will restate Garrison et al.'s statement in terms of anomaly width rather than duration, such

that an anomaly has successfully been detected (though not necessarily recognized as a potential shipwreck) if it registers at least 5 gammas amplitude over a distance of at least 6.0 m (20 ft). This distance is equivalent to traveling for 3 seconds at a survey speed of 3.9 knots or 4 seconds at 2.9 knots.

One can gauge the performance of the present survey methodology in the detection of shipwreck anomalies from the data set illustrated above. Table 7 lists the maximum survey line interval to ensure detection of each wreck anomaly by the magnetometer on at least one survey line. The shipwreck anomalies on Figures 39–44, with the addition of *La Belle* anomaly from Arnold (1996), are arranged from smallest to largest in Table 7. As one can see from this table, the smallest four shipwreck anomalies (19 percent) would not be guaranteed of detection by the magnetometer on a single 50-m (164-ft) survey line. In order to ensure detection of all wooden-hulled sailing vessel anomalies from this sample on at least a single line, one would need to reduce the survey line spacing to 40 m (131 ft). When surveying at 300-m (984 ft) line spacing, only the three largest wreck anomalies are guaranteed of detection by a magnetometer on a single survey line.

TABLE 7
MAXIMUM SURVEY LINE INTERVALS TO GUARANTEE
DETECTION OF SHIPWRECK MAGNETIC ANOMALIES ON A SINGLE SURVEY LINE

Confirmed Shipwreck Anomalies	Maximum Line Interval (m) to Guarantee Detection on a Single Survey Line
41CF125*	est. 40
41CL92*	44
41MG86 (<i>La Belle</i>)*	est. 45 (Arnold 1996)
41NU291*	46
41CL58	56
41CH372	62
unidentified steamer	64
<i>Mary Conley</i>	est. 82
41KN10 (<i>San Esteban</i>)	90
41JF65 (<i>Clifton</i>)	est. 114
Site 1614	138
41NU252 (<i>Mary</i>)	144
41NU292 (<i>Utina</i>)	180
41GV143 (<i>Denbigh</i>)	194
41GV68 (<i>Hatteras</i>)	218
<i>Castine</i>	220
Site 773	270
Site 323	284
<i>City of Waco</i>	340
<i>R.M. Parker Jr.</i>	360
<i>Sheherazade</i>	660

* Indicates site could go undetected on a single line at a 50-m line interval
Shipwrecks in bold type were surveyed as part of this study

The results of this exercise suggest room for much optimism. It is likely, based on current practices described by Garrison et al. (1989) above, that a sizable portion of data-gap wrecks are already being detected in high-probability survey areas. Reduction of the high-probability survey line spacing to 40 m (131 ft) would take this one step further ensuring that nearly 100 percent of all shipwrecks in high-probability lease blocks would be detected on a single survey line. Even reducing the high-probability line spacing to 40 m (131 ft), however, still would require selection of every single-line anomaly as a potential shipwreck to ensure protection of most wooden-hulled sailing vessels.

As one might expect, 300-m (984-ft) survey line spacing detects a very small sample of magnetic anomalies such that very large vessels might go completely undetected by the magnetometer. Fortunately, at least those with metal hulls should be detected as sidescan sonar targets. Small wooden-hulled vessels, whether machine- or sail-powered, are unlikely to be detected by 300-m (984-ft) surveys in most instances. In order to maximize the effectiveness of 300-m (984-ft) surveys for detecting shipwrecks, all single-line anomalies should be selected as potential shipwrecks.

SELECTION OF POTENTIAL SHIPWRECK ANOMALIES

Current guidelines (NTL 2005-G07) require that all unidentified magnetic anomalies be reported to MMS, but they do not specify criteria for selection of anomalies having potential for historic significance (i.e., potential shipwrecks). By far the single most common criterion for selecting potential shipwrecks for avoidance on the GOM OCS is the presence of a suspicious sidescan target. Out of 141 known or suspected shipwrecks on the GOM OCS (including state waters) for which target type is reported, 98 percent (n = 138) have sidescan targets associated. Only 2 percent (n = 3) are represented by magnetic anomalies alone, and the latter occur on multiple adjacent lines in each case.

Arguably, the most common criterion used by archaeologists for selecting potential shipwrecks from the larger set of unidentified magnetic anomalies is to look for patterns of paired anomalies on adjacent survey lines. This criterion is not universally applied, as some archaeologists recommend every unidentified anomaly, whether detected on a single line or on multiple adjacent lines, as potential shipwrecks. Nevertheless, for the purposes of this discussion we will define selection of a potential shipwreck anomaly as detection of an unidentified anomaly (as defined above) on at least two adjacent survey lines.

Table 8 lists the maximum survey line interval to ensure selection of each confirmed wreck anomaly based on the two-line selection criterion described above. The results indicate that the smallest nine shipwreck anomalies (43 percent) would not be guaranteed of selection (i.e., detection on two adjacent survey lines spaced 50 m [64 ft] apart). The nine smallest wreck anomalies in the data set include all of the wooden-hulled sailing ships, plus three steamboats and a steel-hulled, diesel-powered 83-ft (25-m) workboat. Historic sources and wreck databases have shown (above) that roughly half of all historic wrecks on the OCS should be sailing ships, 98 percent of which should have wooden hulls. It is conceivable then that half of all historic shipwreck anomalies might go unselected, and therefore

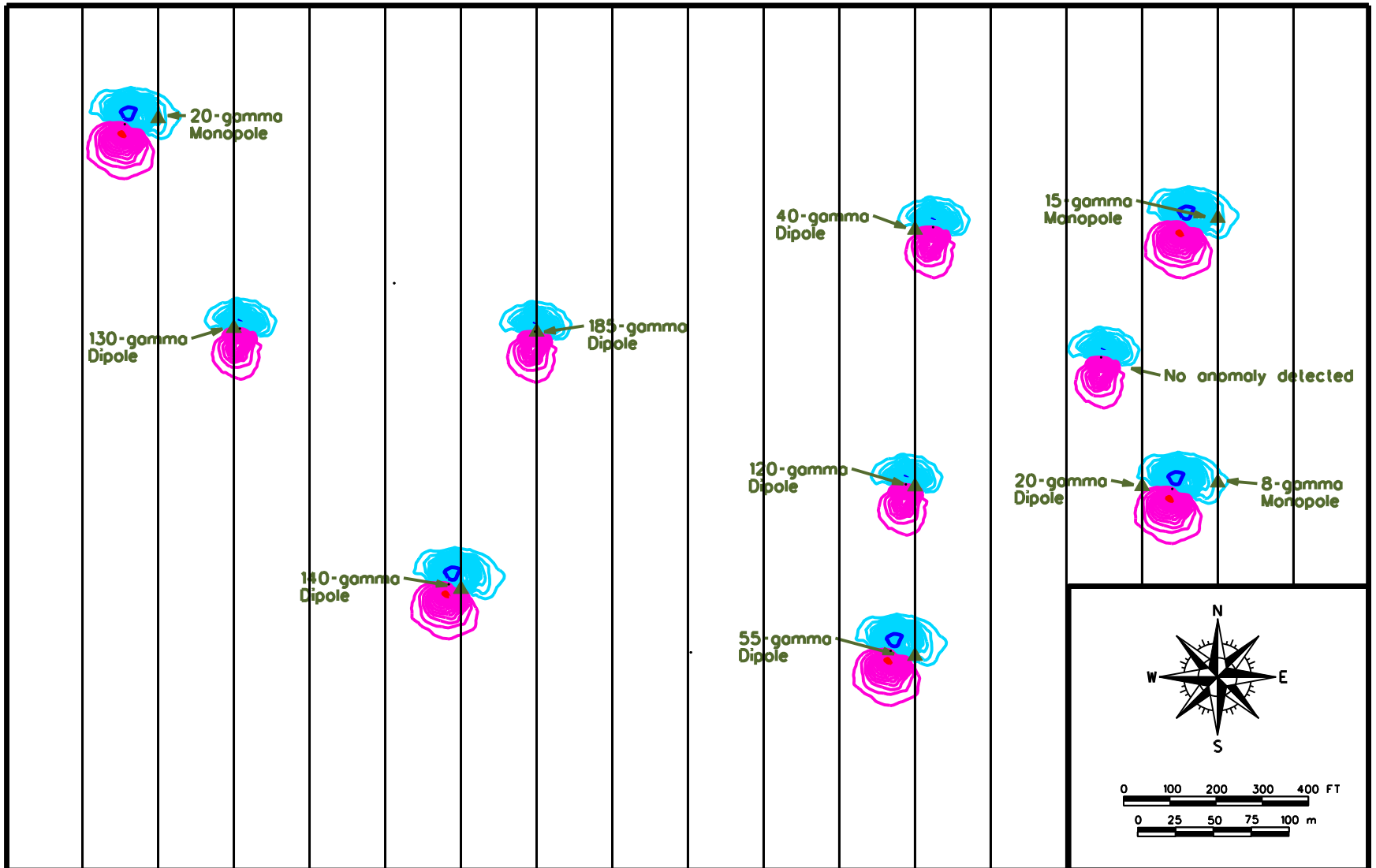
unprotected, using the two-line selection criterion. Table 8 and Figures 39–44 demonstrate that a significant proportion of the OCS archaeological data gap could result from the two-line selection criterion. Table 8 also demonstrates that reliance on the two-line selection criterion would not only miss wooden-hulled sailing ships but other vessel types as well. For example, three steamship anomalies and one steel-hulled vessel anomaly from Table 8 would remain unselected as potential shipwrecks using the two-line selection criterion in the absence of sonar targets.

TABLE 8
MAXIMUM SURVEY LINE INTERVALS TO
GUARANTEE SELECTION OF SHIPWRECK MAGNETIC ANOMALIES

Confirmed Shipwreck Anomalies	Maximum Line Interval (m) to Guarantee Detection on Two Adjacent Survey Lines
41CF125**	est. 20
41CL92**	22
41MG86 (<i>La Belle</i>)**	est. 23 (Arnold 1996)
41NU291**	23
41CL58**	28
41CH372**	31
unidentified steamer**	32
<i>Mary Conley</i> **	est. 41
41KN10 (<i>San Esteban</i>)**	45
41JF65 (<i>Clifton</i>)	est. 57
Site 1614	69
41NU252 (<i>Mary</i>)	72
41NU292 (<i>Utina</i>)	90
41GV143 (<i>Denbigh</i>)	97
Hatteras	109
Castine	110
Site 773	135
Site 323	142
<i>City of Waco</i>	170
R.M. Parker Jr.	180
Sheherazade	330

**Site could go undetected on two adjacent lines at a 50-m line interval
Shipwrecks in bold type were surveyed as part of this study

Figure 45 shows a simulated magnetometer survey over 10 randomly placed wooden-hulled sailing ships in order to estimate the proportion of that large population of shipwrecks that might be missed by a 50-m (164-ft) survey. The anomalies for 41CL58 and 41CL92 (see Figure 39) were each copied five times at random points into a simulated survey block (see Figure 45). Recall that the smaller of these two wreck anomalies, 41CL92, is very close in size to the anomaly reported by Arnold (1996) over La Salle’s



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Figure 45
Magnetic Detection of Ten Randomly
Placed Wooden-Hulled Sailing Ships
Surveyed on 50-meter Line Spacing

Prepared for: Minerals Management Survey
 Job No.: 441326.01 and 441326.02 Scale: 1"=100 m for 8.5"x11" Sheet
 Drawn by: Robert Gearhart Date: July 11, 2005
 File: I:\Nautical\441326.02\cad\Figure44.dgn

Figure 45. Magnetic Detection of Ten Randomly Placed Wooden-Hulled Sailing Ships Surveyed on 50-meter Line Spacing.

51-ft-long (16-m) ship *La Belle* excavated in Matagorda Bay, Texas (Bruseh and Turner 2005:69–70). Triangular symbols, labeled with total peak-to-peak amplitude, were placed at the center of each anomaly wherever it was crossed by a survey line, indicating how each of these wrecks would appear in a high-probability lease block survey as conducted and mapped under present practices.

This simple exercise nicely illustrates how wooden-hulled sailing ships might easily be overlooked. One of the 10 wreck anomalies (10 percent) went completely undetected at the 5-gamma level using 50-m (164-ft) line spacing. Eight wreck anomalies (80 percent) were detected on single lines at amplitudes ranging from 8 to 185 gammas. Only one wreck (10 percent) was detected on two adjacent lines, qualifying it for selection as a potential shipwreck at the discretion of the archaeologist. The only way for the latter wreck, which was the larger of the two examples, to appear on adjacent lines was for the hull to be located midway between the survey lines. As a result, the wreck was detected at low amplitude consisting of an 8-gamma monopole on one line and a 20-gamma dipole on the adjacent line. If we assume, for the sake of argument, that these two anomalies are representative of all wooden-hulled sailing vessel anomalies and that 50 percent of all historic shipwrecks on the OCS are wooden-hulled sailing vessels, then we could estimate that 45 percent of all historic shipwrecks on the OCS (90 percent of 50 percent) either are not recommended for avoidance because they only appear on a single line or are missed entirely.

There seem to be at least three ways in which the data-gap half of the OCS historic shipwreck population might be guaranteed of selection for protection. The first option, already recommended above, would be to reduce the historic high-probability zone survey-line spacing to 40 m (131 ft), and select every single-line unidentified anomaly as a potential shipwreck. The second method would be to reduce the historic high-probability zone survey-line spacing to 20 m (66 ft), and select every double-line unidentified anomaly as a potential shipwreck. The latter option would somewhat improve archaeologists' ability to eliminate archaeologically insignificant anomalies from further consideration but at a higher survey cost. A hybrid of these two scenarios would involve surveying lease blocks at 40-m (131-ft) line intervals and selecting every unidentified anomaly as a potential shipwreck, while surveying pipeline corridors and well pads at 20-m (66-ft) intervals and selecting all double-line unidentified anomalies as potential shipwrecks. The reason for a higher level of scrutiny on pipelines and wells might be justified given the higher density of bottom-disturbing activities in such areas.

Repeating the exercise from Figure 45, but using a 40-m (131-ft) line spacing, none of the shipwrecks were missed; however, six wrecks still appeared on just one survey transect. Four of the wrecks were detected on two adjacent survey lines. These results suggest that 40-m (131-ft) line spacing would be sufficient to guarantee single-line detection of most wrecks, including vessels as small as *La Belle*. Repeating the exercise for a 20-m (66-ft) line spacing resulted in all 10 shipwrecks being detected on multiple adjacent lines, including seven triple-line detections. Of course, decreasing the line interval to 20 m (66-ft) likely also would result in detection of significantly more debris anomalies. This problem turns out not to be insurmountable because the higher data density provided by a 20-m (66-ft) line spacing

also increases our ability to differentiate between debris anomalies and potential shipwreck anomalies as discussed in the next section.

ELIMINATION OF ARCHAEOLOGICALLY INSIGNIFICANT SITES AND REMOTE-SENSING SIGNATURES

Elimination of historically insignificant archaeological sites and remote-sensing signatures can be accomplished either through fieldwork or through analysis of remote-sensing data. Diving has been the primary method of accomplishing this task since the beginning of nautical archaeology as a discipline, and direct archaeological inspection by divers or ROV cameras remains the only procedure capable of distinguishing a historically significant shipwreck from either a non-NRHP-eligible shipwreck of historic age or a non-historic shipwreck. It is also the most common procedure used in the GOM and elsewhere to distinguish non-shipwreck remote-sensing targets from potential shipwreck targets (i.e., ground truthing).

Diving and ROV inspection are both expensive undertakings, especially on the OCS. Fortunately, analysis of remote-sensing signatures, in particular magnetic anomalies, has begun to replace the need for physical inspection of every unidentified target or anomaly. Some remote-sensing signatures can be eliminated during the archaeological selection process (remote-sensing interpretation) following a survey, provided the density of magnetometer data is sufficient. The shape and orientation of magnetic anomalies can provide clues as to their possible source allowing the possibility of differentiating potential shipwreck anomalies from non-shipwreck anomalies. Given an adequate density of magnetometer data, it is possible to differentiate up to 80 percent of magnetic anomalies caused by solitary items of ferromagnetic debris from potential shipwreck anomalies. The remaining 20 percent or so of magnetic anomalies must either be avoided or inspected, as the nature of their sources remains ambiguous. Although one cannot determine in this manner whether an anomaly is caused by a shipwreck, the number of potential shipwrecks can be significantly and safely reduced by this methodology.

Garrison et al. wrote in 1989 that “The present survey methodology [on the OCS, at that time requiring 150-m (492-ft) line spacing] is not developed enough to differentiate, at a high confidence level, between modern ferromagnetic debris and potential cultural resources. It represents a compromise between scientific and economic goals.” Their statement is as true today using 50-m (164-ft) line spacing as it was 14 years ago. Even reducing the line spacing requirement to 40 m (131 ft) would only ensure *detection* of most shipwrecks. It would provide insufficient information to differentiate reliably between debris and shipwreck anomalies. It is that very shortcoming that necessitates selection of every unidentified anomaly as potentially significant (assuming use of a 40-m [131 ft] line spacing) in order to approach a 100 percent level of protection for historic shipwrecks on the shallow OCS.

A number of investigators have contributed over the years to the body of literature regarding what we refer to here as “significance criteria.” Garrison et al. (1989) nicely summarized various points of view on the subject in a report completed for MMS 16 years ago. They state that, “In practice, archaeologists preparing cultural resource reports for lease block surveys consider anomalies over five [gammas]... with

a period of three or more counts as a possible target.” They add, however, that further characterization of those anomalies is inhibited by insufficient data and that current OCS survey requirements cannot provide a level of data adequate to reasonably evaluate anomalies.

One objective of Garrison et al.’s study (1989) was an attempt to present empirical data that demonstrated specific causes for a variety of anomaly types, including shipwrecks and modern debris. They summarized shipwreck anomalies as follows, “Common to most ... examples is the pattern articulated by Arnold, Arnold and Clausen, Mistovich, and others that a shipwreck as an archaeomagnetic feature can be defined as *a cluster of multiple anomalies...*”. The authors continued by explaining that “...a shipwreck ...typically demonstrates more *irregularity* in its multiple anomaly peaks. *Uniformity of amplitudes* point away from an interpretation of a multiple anomaly feature as a shipwreck.” Garrison et al.’s (1989) summary of anomaly patterns characteristic of historic shipwrecks includes: 1. *multiple peak* anomalies; 2. differential amplitude anomalies; and 3. areal distribution exceeding 10,000 square m (equivalent to a 113-m (370-ft) diameter circle).

Some investigators have used the term multi-component to describe “typical” wreck anomalies, meaning that they have multiple poles. Pearson et al. (1991:70) characterized shipwreck anomalies for moderate-sized watercraft at a distance of 20 ft or less as “a complex signature, i.e., a cluster of dipoles and/or monopoles greater than 80 or 90 ft across the smallest dimension...” Arnold and Weddle’s (1978:197) contour map of a sixteenth-century Spanish wreck site off Padre Island (Figure 46) is perhaps the quintessential example of the so-called complex, multi-component wreck anomaly. Many early impressions and characterizations of shipwreck anomalies were influenced by this often-cited example of the *San Esteban* anomaly.

Nineteen of the 20 shipwreck anomalies illustrated on Figures 39–44 (excluding the *San Esteban* anomaly) contradict the above characterizations of shipwreck anomalies as a cluster of multiple anomalies having irregular amplitude peaks, which we refer to as the “complex, multi-component” model of shipwreck anomalies. In fact, we have found shipwreck anomalies as a rule are dominated by very predictable dipolar shapes. Based upon this author’s work compiling a magnetic anomaly database (e.g., Gearhart 2004), it is clear that shipwreck anomalies do not resemble their descriptions as found in many cultural resource reports. Their hallmark feature is not complexity. Rather they tend toward simple dipolar shapes. This pattern conforms nicely with that observed on all of the shipwreck anomalies recorded previously by PBS&J (Gearhart 2004) and by the seven wreck anomalies added by this study.

Although the *San Esteban* anomaly was an early source of many previous conceptions regarding shipwreck anomalies, in fact, it is very consistent with the simple pattern observed in the other 19 wreck anomalies illustrated on Figures 39–44. Gearhart (2004) overlaid the anomalies for 41CL92 and 41CL58 to scale on the *San Esteban* anomaly for comparison. The results demonstrated that the three anomalies are quite similar in size, shape, amplitude, and orientation. The principal difference between the *San Esteban* anomaly and the other two is the presence of several low-amplitude peaks around the margins of the *San Esteban* anomaly giving it “complexity” that distracts one’s attention from the simplicity of its

central dipole. These outlying peaks might be due to site formation processes. We know, for example, that the *San Esteban* was driven aground during a severe storm, was salvaged extensively by the Spanish shortly after the event, and was partially excavated by treasure salvagers prior to being surveyed with a magnetometer.



Figure 46. “Complex Multi-Component Anomaly” (5-gamma contours) Recorded Over the 16th-Century Wreck of the *San Esteban*. (Source: Arnold and Weddle 1978:197)

The most useful conclusion to be drawn from PBS&J’s research on shipwreck anomalies is confirmation that they are characterized by simple dipoles whose polar axes (declination) are aligned nearly parallel with the earth’s magnetic axis. In northern magnetic latitudes, the negative portion of each shipwreck anomaly is located toward magnetic north, and the positive pole is located toward the magnetic South Pole. All of the shipwreck anomalies reported by Gearhart (2004), for which measurements are possible ($n = 12$), have declinations that vary less than 31 degrees from magnetic north. The average variation is 12.6 degrees. The range in variation is from 1 to 31 degrees, and the median value is 9.4 degrees.

The declinations of debris anomalies, on the other hand, 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 ($n = 12$ of 17 total) reported by Gearhart (2004) 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 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.

The fact that debris anomaly orientation tends to follow the orientation of the debris is illustrated by the results of a simple experiment (Figure 47). All five of the anomalies contoured in this illustration are generated by the same piece of braided steel cable, 12 ft (3.7 m) in length. Each of the five surveys that generated these data was conducted on the same 2.0-x-2.0-m (6.6-x-6.6-m) grid. Prior to each survey, the segment of steel cable was realigned in a new direction at the center of the grid, always keeping track of which end was which. The plus and minus signs at either end of the cable in each image always refer to the same ends of the cable. Magnetic north is toward the top of the illustration.

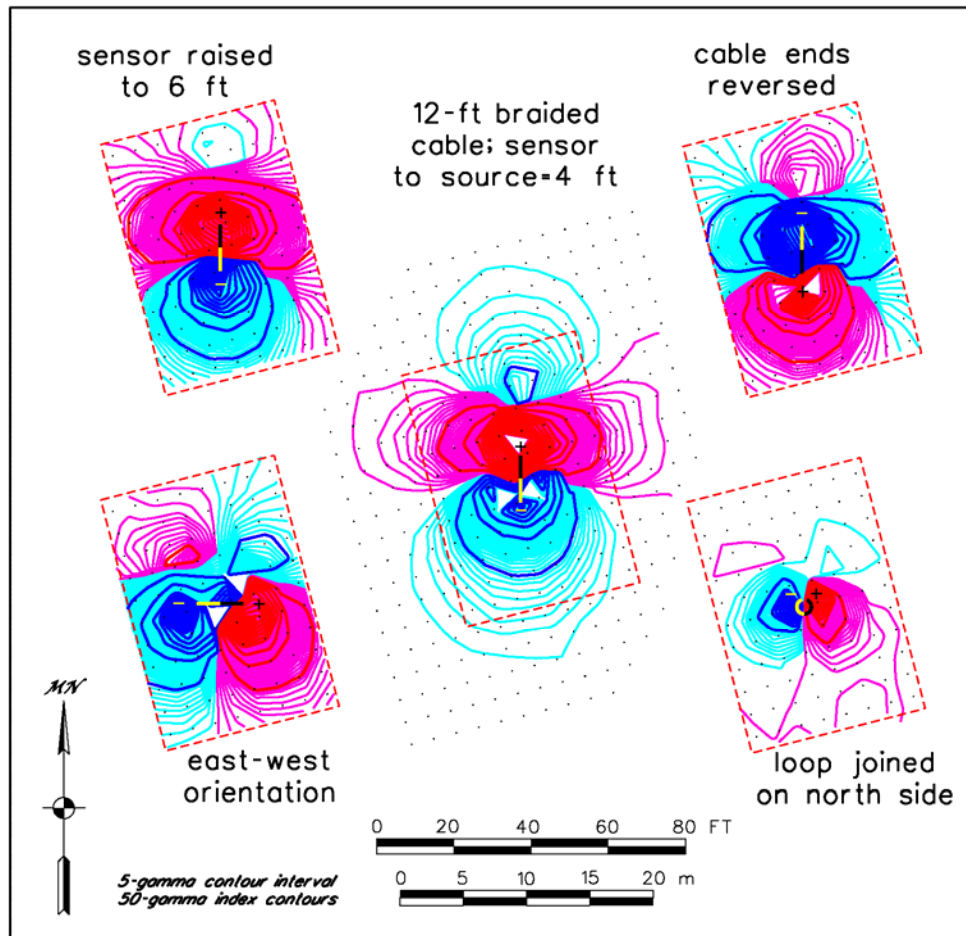


Figure 47. Debris Anomaly Declination Experiment.

Notice that the primary positive peak of each anomaly (red contours) always aligns with the end of the cable marked with the plus sign. Likewise the negative pole of each anomaly (blue contours) always aligns with the opposite end of the cable. Even when the cable is looped into a closed circle (lower right)

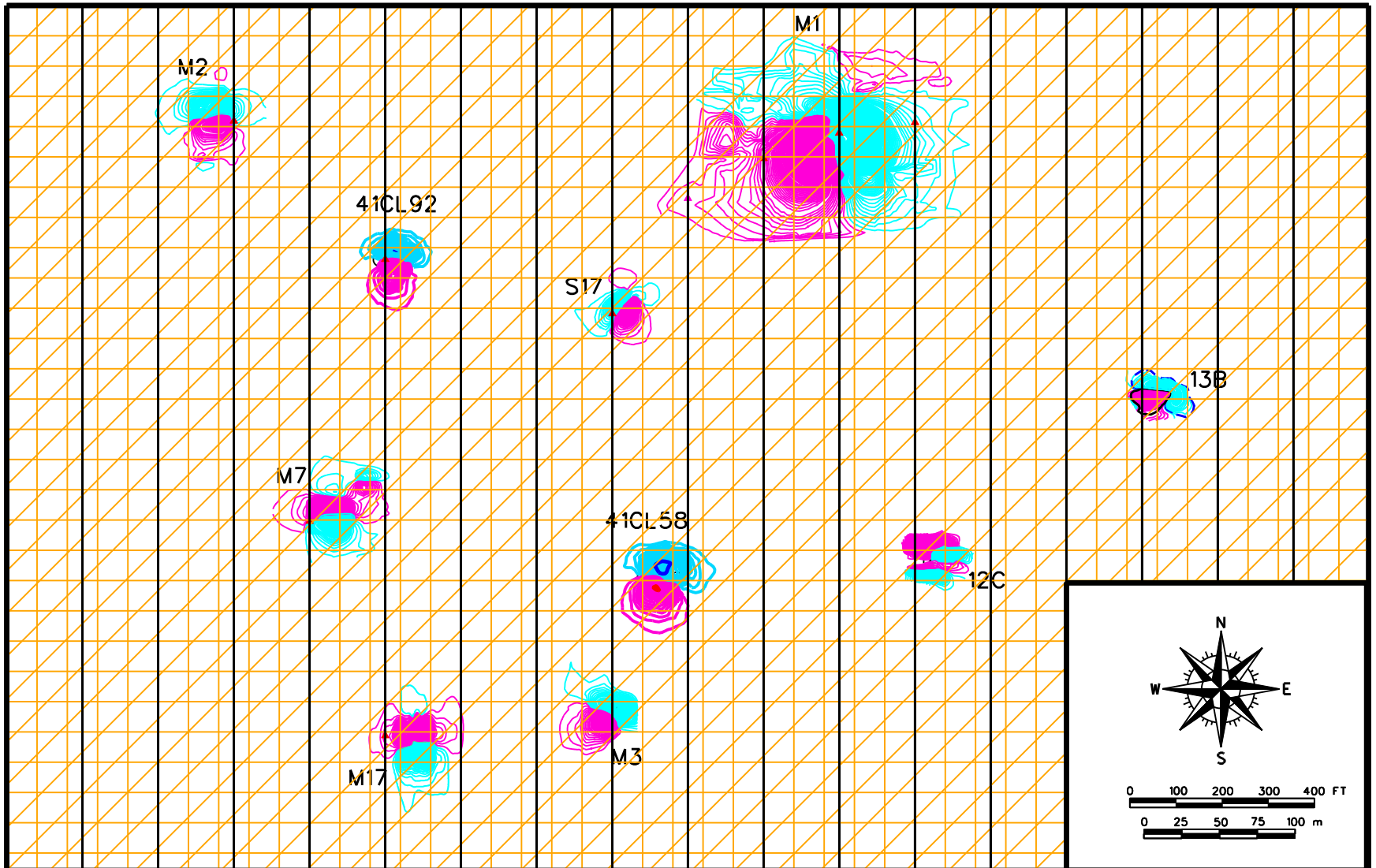
with the two ends joined on the north side of the circle, the polarity of the anomaly aligns with the polarity of the cable.

Garrison et al. (1989:II-224) suggested the potential usefulness of this anomaly trait, stating that:

...one may be able to characterize anomalies as to their inductive magnetization. This component of an anomaly has a strong dependence on declination and inclination characteristics of the geomagnetic field (Von Frese 1986). The argument here would rely on the structural complexity of a shipwreck having a large or detectable inductive magnetization. Anomalies without this component could be classified as exclusively ferromagnetic features and by logical extension, debris. ...this is an analytical approach that could improve the detection of and discrimination between classes of ferromagnetic materials and be used within the current methodology.

PBS&J has been successfully applying this knowledge to archaeological analyses of marine magnetic survey data for the past five years. The orientation of the dipole axis (declination) is believed to have potential as a significance criterion, given adequate survey resolution, to eliminate roughly 80 percent of debris anomalies from consideration as potential shipwrecks. The most efficient means of assessing anomalies, based on our experience, is by direct comparison of unidentified magnetic anomalies with contoured examples of verified shipwreck anomalies as described by Gearhart (2004). This is done easily in computer-aided-drafting software using a side-by-side visual comparison between each contoured anomaly from a survey and the smallest complete shipwreck anomaly (41CL92) from Figure 39. Anomalies are compared at the same orientation (with respect to magnetic north) and scale. Any unidentified anomaly that is of equal or greater horizontal dimensions as the 41CL92 wreck anomaly and has similar declination is considered a potential shipwreck.

We believe this methodology can be adapted to oil and gas surveys by reducing the magnetometer line spacing on pipeline and well pad surveys to 20 m (66 ft). While this would more than double the linear mileage of survey required for such undertakings, we believe it is justified by the higher level of data analysis possible, by the size of the shallow OCS archaeological data gap, and by the insurance this would provide against emergency discovery of shipwrecks during or following construction projects. Figure 48 demonstrates the effectiveness of 20-m (66-ft) line spacing for determining anomaly size and declination. Magnetic anomalies from eight verified debris sources (Table 9) were randomly placed on a 50-m (164-ft) survey grid (vertical dark lines) along with the shipwreck anomalies for two wooden-hulled sailing vessels (41CL58 and 41CL92). Three different orientations of 20-m (66-ft) lines were overlaid so one could easily visualize the effect of survey orientation on data density. The results clearly show that surveying 20-m (66-ft) lines in any direction should provide adequate density of magnetometer data to reasonably estimate the horizontal shape, amplitude, and declination (polar orientation) of anomalies over many debris objects as well as over shipwrecks as small as these two wooden-hulled sailing vessels. The results suggest that contouring magnetic data collected on 20-m (66-ft) lines would be a suitable method of presenting the data from pipeline and well pad surveys. Although magnetic contours from a 20-m (66-ft) survey would not completely represent the shape of these anomalies, they should allow elimination



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Figure 48
Magnetic Declination of Debris
and Shipwreck Anomalies Simulated
for 20-Meter Survey Line Spacing

Prepared for: Minerals Management Service	
Job No.: 441326.01 and 441326.02	Scale: 1"=100 m for 8.5"x11" Sheet
Drawn by: Robert Gearhart	Date: July 11, 2005
File: I:\Nautical\441326.02\cad\Figure46	

Figure 48. Magnetic Declination of Debris and Shipwreck Anomalies Simulated for 20-Meter Survey Line Spacing.

of many debris anomalies from further consideration based on the analytical technique described above, while greatly decreasing the chances of missing historically significant shipwrecks. The effectiveness of this technique for eliminating insignificant targets would be greatly enhanced by the addition of even a couple lines crossing unidentified anomalies at right angles to the primary 20-m (66-ft) survey lines. The full benefit of this technique, eliminating up to 80 percent of insignificant targets, could be realized by completing a close-order survey of unidentified anomalies using multiple lines crossing from various directions at less than a 10-m (30-ft) interval.

TABLE 9
MAGNETIC ANOMALY SOURCES
CORRESPONDING TO FIGURE 48 MAGNETIC CONTOURS

Anomaly	Source Description
M1	Seven large dredge pipes dropped from barge
M2	Pipe measuring 10.1 m (33 ft) long by 0.6 m (2 ft)
M3	Pipe; 0.2 m (0.5 ft) diameter; length unknown
M7	Pipe measuring 9.6 m (31.5 ft) long by .2 m (0.6 ft)
M17	Braided steel cable; greater than 6 m (20 ft) long
S17	Pipe measuring 5.2 m (17 ft) long
12C	Pipe measuring 7.3 m (20 ft) by 2.5 cm (1 in)
13B	Pipe 0.6x12.8 m (2x42 ft); steel cable 21.3 m (70 ft); angle iron 0.9 m (3 ft)
CL58	Wooden-hulled sailing vessel; length unknown
CL92	Wooden-hulled sailing vessel; anomaly comparable in size to <i>La Belle</i>

PROTECTION: ASSESSING ADEQUACY OF CURRENT AVOIDANCE CRITERIA

Avoidance criteria determine the types and level of protective measures required to prevent adverse effects to shipwrecks. The goal of avoidance should be protection of shipwrecks and their associated debris fields from any kind of adverse effect by federally permitted activities on the OCS. Adverse effects would include, but not necessarily be limited to, anchoring boats or work barges, dropping or dragging spuds, jacking up or anchoring rigs, drilling wells, clearing well pad debris, and laying or removing pipelines.

MMS has not generally mandated specific avoidance criteria for all archaeological sites in the GOM. Avoidance distances are recommended at the discretion of each archaeologist responsible for assessing industry surveys. Site specific avoidance recommendations are reviewed by MMS archaeologists for each project and occasionally revised as they deem appropriate. An assessment of site-specific avoidance criteria for the shipwrecks investigated by this study are addressed under the respective investigation results for each site. The discussion of avoidance in this section focuses instead on what has been the

common thread of this analysis, which is extending protection to all shipwrecks, including those comprising a gap in OCS archaeological data.

It is common practice for archaeologists to recommend only a small proportion of unidentified anomalies from any given survey as potential shipwrecks. The vast majority of unidentified anomalies are assumed to be debris. This is especially true in the vicinity of existing petroleum developments, which are often surrounded by an increased density of unidentified anomalies. Circumstantial evidence suggests that oilfield debris comprises the majority of anomaly sources in such settings, but to assume that anomalies near existing development are attributable to oilfield debris because of their location leads one down a slippery slope. In fact, data collected according to present OCS survey practices provide little empirical evidence to support categorizing unidentified anomalies as either debris or shipwrecks. While the probability that any particular anomaly is associated with a shipwreck is extremely low, the locations of most shipwrecks within a particular lease block are unknown and unpredictable. They might just as likely occur amid a dense scatter of debris surrounding an oil well as in an undeveloped area a mile from the nearest well. Several examples of emergency shipwreck discoveries are known from projects in the GOM (e.g., Arnold and Weddle 1978; James et al. 1991a and 1991b). While these particular examples occurred in state waters, they serve to illustrate the point that no matter how unlikely that one might encounter a historic shipwreck, occasionally it happens, and the consequences can be expensive.

The reality of protecting shipwrecks, as demonstrated by earlier discussion, means that potential shipwreck anomalies must be avoided in precisely the manner we would treat a confirmed shipwreck. Unless we extend the practice of avoidance to all potential shipwreck anomalies, we might deny protection to roughly half of all historic shipwrecks in shallow portions of the GOM.

VI. RECOMMENDATIONS

The MMS OCS archaeological program currently has no systematic procedure in place for evaluating its effectiveness at protecting sites. This study was designed to partially remedy that situation by providing feedback about unidentified sidescan sonar targets detected by industry surveys and recommended for avoidance. MMS had a number of diverse goals in mind for this study, including 1) assessing the NRHP eligibility of the sites selected for this study; 2) assessing the adequacy of current MMS avoidance criteria; 3) assessing industry compliance with government protective measures; 4) eliminating archaeologically insignificant remote-sensing targets from further consideration; and 5) refining analytical methods used for selecting sites for avoidance. All of these objectives can be subsumed under a single broad goal of evaluating the effectiveness of historic site protection on the GOM OCS. Recommendations relevant to the stated project objectives are organized by topic below as indicated by subheadings. The topic of each group of recommendations should be self-explanatory. Topic titles are not necessarily the same as project objectives, since some recommendations are relevant to more than one objective.

NRHP ELIGIBILITY

PBS&J used historical research, remote-sensing survey, and diver investigation to assess the NRHP eligibility status of all the sites visited for this project. The USS *Hatteras* is already listed on the NRHP; PBS&J's visit was part of an ongoing monitoring effort. Three sites, SS *R.M. Parker, Jr.*; SS *Castine* and M/S *Sheherazade*, are recommended as eligible for listing on the NRHP. Standard NRHP forms for these vessels have been submitted with this report. The eligibility status of Sites 323 and 325 remain unknown at this time. All other targets visited by this study are recommended as ineligible for listing on the NRHP.

AVOIDANCE CRITERIA AND INDUSTRY COMPLIANCE

Although 10 shipwrecks were visited during this study, the adequacy of current MMS avoidance criteria could be assessed for only three sites (325, 773, and 15306), which have had oil and gas industry construction in their vicinity since the date when their avoidance criteria were instituted. We are somewhat limited by this fact in drawing meaningful conclusions regarding either the adequacy of avoidance criteria or industry's level of compliance with government protective measures. In the three cases mentioned above, it appears that the avoidance zones established around each site were adequate in protecting the sites and that industry complied with the mandated protective measures. The outcome for these three sites was good, but the results are specific to each site, and such a small sample tells us little about the bigger picture of site protection on the GOM OCS. Having said that, addressing avoidance criteria and industry compliance for the three sites listed above led us to an awareness of several issues related to avoidance criteria, which are worth repeating here, at the risk of stating the obvious. These issues include a) tailoring of avoidance zones for magnetic anomalies versus sidescan sonar targets; b)

considering water depth when recommending avoidance zones; and c) avoiding potential shipwrecks with lay barge anchor cables.

Magnetic Anomalies versus Sidescan Sonar Targets: Avoidance of potential shipwrecks that are expressed only as magnetic anomalies must take into consideration the facts that magnetic source locations often are not precisely known to an accuracy greater than about half the survey line spacing in the cross-track direction and that locations of anomaly margins in the along-track direction are not currently mapped (although duration is reported). Ideally anomalies would be avoided by a specified distance from their margins rather than from an apparent center point or amplitude peak. Avoidance from an anomaly's margins virtually guarantees that its source is encompassed by the avoidance zone. But avoidance by a fixed distance either from an anomaly's margins, peaks, or center point currently is not possible, because we cannot accurately map any of these landmarks based on the data density attained by 50-m (164-ft) survey lines. A variable-sized avoidance zone, tailored to each magnetic anomaly, might prove most effective for the time being. For example, magnetic anomaly avoidance zones should take into account line spacing and apparent anomaly width (in along-track direction).

It is clear that representation of a potential shipwreck location by a single point does not factor in the size of a magnetic anomaly. The same is true of sidescan sonar targets. Avoidance zones should factor in the size and shape of sonar targets if the goal is to avoid a potential site by a specified distance. The *Mitigation Assessment* sections for Sites 325 and 773 and Figures 11 and 9, respectively, clearly demonstrate this issue. While it appears that a nearby pipeline was constructed outside Site 325's avoidance zone, defined by a 100-ft (30-m) radius around a point, the pipeline might have been built closer than 100 ft (30 m) from the bow of the shipwreck. In the case of Site 773, the edge of the wreck is located approximately 145 ft (44 m) closer to a nearby pipeline than is the center of the wreck. This distance equates to 14.5 percent of the minimum 1,000-ft (305-m) avoidance margin. We suggest using polygonal avoidance zones, defined relative to the edges of potential wreck sites observed on sidescan sonar images, rather than circular avoidance zones centered on a point.

Consideration of Water Depth in Establishing Avoidance Zones: As cable laybacks of geophysical sensors increase due to water depth, the margin of error grows for estimating sensor offset positions. Unless sensors are tracked using acoustic beacons, position estimates for sites located in deeper water typically would be less accurate than for sites in shallower water. Other factors affecting position accuracy include lateral movement of geophysical sensors with respect to survey vessel paths due to tidal currents. This effect is amplified when surveying in directions perpendicular to the current and when adjacent survey lines have opposite headings. The *Mitigation Assessment* section for each site illustrates examples of variations in target positions obtained from multiple surveys. Error in position estimates is especially pronounced for Site 15306 (see Figure 13), the deepest site that PBS&J investigated. We suggest that avoidance zones increase with sensor layback due to depth in order to compensate for systematic errors in target position estimation unless sensors are equipped with tracking beacons. Water depth also is a key factor for industry vessel traffic to consider when conducting work adjacent to avoidance zones around shallow sites. Although it cannot be stated with certainty, it is possible that the

break in the hull of Site 773 is a result of shallow water and vessel traffic in the area. The potential exists for shallow-water sites to be impacted by vessel collisions, and the errant loss of equipment threatens all sites no matter how deep.

Lay Barge Anchorage: One final avoidance issue can be addressed using Site 325 as an example. This shipwreck lies within a lay barge anchorage area. An as-built survey illustrates numerous lay barge anchor lines crisscrossing the avoidance zone. The fact that no superstructure was observed on this vessel, either on sonar or by divers, led investigators to question whether anchor cables could have sheared away the upper portions of this wreck. A careful comparison of pre- and postconstruction sonar records demonstrated in this case that the superstructure was missing before the pipeline was built. Nevertheless, the question remains valid for other wrecks occurring in similar situations. Is there a potential for wrecks to be affected by anchor cables dragging over them even though lay barge anchors are placed outside recommended avoidance zones? Avoidance zones around potential shipwrecks should be honored by lay barge anchor spreads in order to prevent anchor lines from crossing shipwrecks, whether exposed or shallowly buried.

PROTECTION OF HISTORIC SHIPWRECKS

Three decades of extensive archaeological exploration, mainly in the form of oil and gas industry surveys, has led to the discovery of 267 suspected or known shipwrecks on the GOM OCS (including state GOM waters), yet this part of the ocean is poorly known with respect to shipwrecks of *historic age*. It is estimated that roughly half of all historic shipwrecks on the OCS are wooden-hulled sailing ships, yet no wooden-hulled sailing ships have been discovered by federally mandated surveys in shallow (less than 200 m deep) portions of the GOM OCS. By contrast industry surveys in poorly explored deeper waters of the GOM OCS have discovered 4 wooden-hulled sailing ships in the last 7 years alone. The lack of such discoveries in shallow water is due largely to burial of wrecks by a sediment cover, which is frequently reworked by tropical storms, combined with degradation of exposed hull by wood-boring organisms and snagging of exposed elements by shrimp trawlers. Thus the remains of most wooden-hulled sailing ships on the shallow GOM OCS are expected to be nearly or completely buried. Detection of buried wrecks is currently practical only with a magnetometer making their discovery problematic, because for every shipwreck anomaly in the GOM there are many more magnetic anomalies associated with discarded ferrous debris. Unfortunately industry survey practices provide insufficient resolution to allow differentiation between debris anomalies and potential shipwrecks.

The discussion section of this report focused at length on documenting a gap in the OCS archaeological record comprised largely of wooden-hulled shipwrecks and, in particular, of wooden-hulled sailing vessels. The existence of this gap was reflected by the types of vessels investigated for this study. Although metal-hulled vessels were not specifically sought for these investigations, none of the unidentified shipwrecks from this study had wooden hulls. This fact simply reflects the present bias of remote-sensing target selection toward metal hulls, as suggested by ARI statistics. The ARI presently reports remote-sensing target type for 141 (of a total 267) known or suspected shipwrecks. Of that

number, 71 (50 percent) are represented only by sidescan sonar targets; 67 (48 percent) are represented by both sidescan targets and magnetic anomalies; and 3 (2 percent) are reported as clusters of magnetic anomalies. These numbers suggest a reticence to recommend magnetic anomalies for avoidance as potential shipwrecks in the absence of associated sidescan targets, even when anomalies occur on multiple adjacent lines.

There is no technological limitation to detection of nearly every historic shipwreck on the OCS; however, current survey and analytical practices are believed insufficient to discover most wooden-hulled sailing vessels. Evidence presented in this report suggests that up to 50 percent of all shipwrecks on the shallow GOM OCS might go unprotected using present survey methods, not necessarily because they would not be detected but because they might not be selected as potential shipwreck anomalies to be avoided. For example, GOM archaeologists often recommend avoidance of unidentified magnetic anomalies as potential shipwrecks only if they register on at least two adjacent lines spaced 50 m apart; however, earlier discussion demonstrated that a “two-line” significance criterion for magnetic anomalies might miss 90 percent of wooden-hulled sailing ship anomalies. Using 50-m line spacing, 9 shipwrecks (43%) from our sample of 21 wreck anomalies were not guaranteed of detection on two adjacent survey lines. This number included all 5 of the wooden-hulled sailing ships in the sample, plus 3 steamboats and a 25-m steel-hulled workboat. Three of the 5 wooden-hulled sailing ship anomalies in the sample were not guaranteed of detection on even a single survey line.

We recommend that MMS develop and implement a strategy to eventually protect 100 percent of all historic shipwrecks within the GOM OCS historic high-probability zone. Until steps are taken to ensure 100 percent protection, emergency discovery of a shipwreck in this zone will loom as a rare but costly possibility for industry operators. This problem might best be addressed by further research, testing and refining survey and analysis methodologies for the dual purposes of a) determining the optimal effective strategy for detecting a near-100-percent sample of historic shipwrecks, and b) distinguishing between potential shipwreck anomalies and debris anomalies. Such a study should have several well-defined objectives in support of these goals including 1) to characterize measurable differences between magnetic anomalies caused by debris and those caused by shipwrecks; 2) to determine the minimal survey parameters necessary to detect those differences; 3) to develop an efficient methodology, reasonably consistent with existing industry survey procedures, for collecting and analyzing data to differentiate debris anomalies from potential shipwreck anomalies; and 4) to assess the potential for sub-bottom acoustic technologies to help distinguish between buried shipwrecks and debris.

SURVEY METHODOLOGY

The remains of most wooden-hulled sailing vessels on the shallow GOM OCS are expected to be nearly or completely buried. As the upper portions of wooden hulls age, periodic exposure to the elements might eventually degrade wood to the point where shrimp nets could remove most or all visible evidence of a shipwreck. At that point, detection would be possible only with a magnetometer. James et

al. (1991a), for example, reported an example of a wooden-hulled schooner from state OCS waters in 10 m (30 ft) of water for which wreckage was exposed only intermittently.

Improving upon the detection of buried wrecks will require tighter line spacing for magnetometer surveys. Pearson et al. (2003:7–18) recommended a reduction in line spacing from 50 m (164 ft) to 30 m (98 ft) for high-probability areas. Gearhart (2004), and in the discussion above, demonstrated that 20-m (66-ft) line spacing is necessary for detection of a near-100-percent sample of small wooden-hulled sailing vessel anomalies on two adjacent lines, which is a common archaeological significance criterion used on the GOM OCS. PBS&J believes that a near-100-percent sample of historic shipwrecks in shallow OCS high-probability areas could be avoided by a reduction in magnetometer line spacing from 50 m (164 ft) to 40 m (131 ft), coupled with a requirement that all unidentified, single-line magnetic anomalies be considered potential shipwrecks.

Reduction to 40-m (131-ft) line spacing is achievable without reducing the actual interval of survey lines below 50 m (164 ft) and without increasing line miles surveyed. This is possible by the addition of a second magnetometer on a survey vessel. If two magnetometers are boomed 10 m (33 ft) apart and towed simultaneously on 50-m (164-ft) line spacing, the result would be a 40-m (131-ft) maximum line spacing capable of detecting virtually every historic shipwreck on at least one survey line. Such a plan could be implemented with only the added expense of one additional magnetometer, a minimal amount of additional data processing time, and a one-time setup cost for survey vessels to fabricate short outrigger booms for towing dual magnetometers.

ANALYTICAL METHODOLOGY

Interpretation of marine remote-sensing data is arguably one of the most important aspects of what we, as archaeologists, do in the context of submerged cultural resource management. If a shipwreck is missed at this stage of investigations, it likely would remain unprotected by avoidance measures. It then becomes a hidden liability both to industry operators and to the government agency responsible for its protection. Detection of wreck anomalies is largely a question of following a methodology. If one succeeds in deploying a magnetometer sensor to the proper height above the seabed on the specified line interval, then the magnetometer does the detection for us. But even if every shipwreck were detected by geophysical instruments, wreck anomalies could easily be misinterpreted by archaeologists. The importance of the interpretative process justifies development of a highly standardized and objective approach to this work. We offer several suggestions for consideration below.

Archaeologists working on the GOM OCS are required to choose potential shipwrecks based upon remote-sensing signatures and recommend an appropriate level of avoidance for each. At present, the methods employed to those ends are left largely to the discretion of each archaeologist. We recommend that MMS formulate a set of guidelines for assessing significance and assigning avoidance criteria, based on interpretation of remote-sensing data. Long-term benefits of establishing such guidelines would

include a greater consistency in the archaeological data interpretations received by MMS and a uniform level of protection for historic shipwrecks on the OCS.

Among the features of the interpretive guidelines proposed above, we suggest they include standard definitions for phrases denoting significance. Some examples are proposed below. For example, for survey lines spaced greater than 20 m (66 ft) apart, we recommend that “potential shipwreck anomaly” be defined as any unidentified magnetic anomaly detected on at least one line at 5-gamma or greater amplitude for a distance of at least 6.0 m (20 ft). For survey lines spaced 10 to 20 m (33 to 66 ft) apart, we recommend that “potential shipwreck anomaly” be defined as any unidentified magnetic anomaly detected on at least two adjacent lines at 5-gamma or greater amplitude for a distance of at least 6.0 m (20 ft). We recommend that “potential shipwreck target” be defined, regardless of line spacing, as any sidescan sonar target that cannot be reasonably attributable to a non-historic source. The intent of this definition is to ensure that even the smallest sonar target be considered as a potential buried shipwreck.

In the absence of standardized interpretative guidelines, analytical criteria for defining potential shipwreck anomalies should be clearly stated in each report. If the goal is to minimize potential for emergency discoveries, then all unidentified anomalies should be recommended for avoidance unless empirical evidence exists to demonstrate that they are not associated with shipwrecks. Any anomaly exhibiting a dipolar shape consistent with an earth-induced anomaly, with the negative pole oriented toward magnetic north, certainly should be considered for avoidance.

Contouring of magnetic data offers several advantages with potential to improve archaeological interpretations including the ability to automatically display polarity and width of anomalies. The orientation of an anomaly’s polarity (i.e., declination) has proven to be a valuable interpretive tool. Because of the importance of declination, denoting polarity of each anomaly should be a requirement, regardless of the method chosen to accomplish this. For example, the use of color to differentially represent positive and negative poles greatly facilitates visual interpretation of the data. Contouring of magnetometer data would necessitate collection of data in a digital format and diurnal correction of the data.

Pearson et al. (2003:7–19) experimented with a marine base station magnetometer for purposes of diurnal correction and stated correctly that contouring of data collected during extended surveys without the use of diurnal correction would be “problematic at best.” They recommended that if diurnal corrections are not made then contouring of offshore data should be limited to surveys where data are collected over the course of an uninterrupted block of time. Fortunately, effective diurnal correction can be accomplished using a mathematical algorithm to filter low-frequency diurnal fluctuations from data. PBS&J has 5 years of experience with this methodology, which does not require the use of a base station magnetometer and which allows data collected at widely separated times to be combined and contoured as if they were from a single survey. For example, the contour map of site 41NU291 (see Figure 39) includes data collected on two occasions separated by more than a year. All magnetic anomalies contoured for this report were diurnally corrected in this fashion.

We recommend that the use of symbols marking anomaly center points be phased out and eventually replaced entirely by digital data collection, diurnal correction, and contouring of all magnetic data collected on the OCS. When magnetic contours are used, descriptions of diurnal correction procedures and contouring parameters should be clearly stated in each report. The contour interval should not exceed the minimal amplitude defined as a potentially significant anomaly. Exclusion of the zero-gamma contour greatly improves the legibility of contour maps without sacrificing any meaningful data. It is also important to illustrate the estimated location of each magnetometer reading used as the basis for the contours.

SUMMARY

This study was designed to provide MMS with feedback about unidentified sidescan sonar targets detected by industry surveys and recommended for avoidance. PBS&J was asked to assess the NRHP eligibility of sidescan targets selected for this study, to assess the adequacy of current MMS avoidance criteria, and to assess industry compliance with government protective measures. Secondary objectives included eliminating archaeologically insignificant remote-sensing targets from further consideration and refining analytical methods used for selecting sites for avoidance. The authors have attempted to frame these project objectives in the broader context of effective historic site protection on the GOM OCS.

The original plan for this study called for investigating 8 unidentified sidescan sonar targets. By the project's end a total of 13 unidentified sidescan targets had been assessed. All of these targets were initially suspected of being shipwrecks. Nine of the 13 targets investigated turned out to be submerged watercraft. In addition, the remains of a fourteenth target, the USS *Hatteras* were visited for the purpose of monitoring site preservation. Not counting the *Hatteras*, which was a known site and was already listed on the NRHP, this study recommended 3 sites, SS *R.M. Parker, Jr.*, SS *Castine*, and M/S *Sheherazade*, as eligible for listing on the NRHP. The eligibility status of Sites 323 and 325 remains undetermined. The other 4 wrecks were recommended as ineligible for the NRHP, and 4 reported targets were cleared as archaeologically insignificant because no wrecks were present.

Only three sites (Sites 325, 773, and 15306) could be assessed regarding the adequacy of their avoidance criteria or the level of industry compliance with government protective measures. These are the only sites from the study that have had oil and gas industry construction in their vicinity since the establishment of their avoidance criteria. In each case, it appears that the avoidance zone established around the site provided adequate protection and that industry complied with the mandated protective measures. Other issues raised concerning avoidance of potential sites include a) tailoring of avoidance zones for magnetic anomalies versus sidescan sonar targets, b) considering water depth when recommending avoidance zones; and c) avoiding potential shipwrecks with lay barge anchor cables. Avoidance of magnetic anomalies should consider the fact that magnetic source locations often are not precisely known. Avoidance of sidescan sonar targets should take account of target size and shape. The relative sizes of avoidance zones should increase with sensor layback in order to compensate for systematic errors in target position estimation unless sensors are equipped with tracking beacons.

Avoidance of potential shipwrecks in pipeline construction corridors should apply to lay barge anchor patterns in order to prevent anchor lines from crossing shipwrecks.

Historic shipwrecks are underrepresented on the GOM OCS. Wooden-hulled vessels arguably comprise at least 50 percent of all historic shipwrecks on the OCS, yet the only wooden-hulled shipwrecks discovered to date by federally mandated surveys have been in deep-water (greater than 200 m) portions of the GOM. This imbalance exists despite a sample size of at least 267 known or suspected shipwrecks for which positions have been reported in the GOM (including state waters). There is no technological limitation to detection of historic shipwrecks; however, we must acknowledge that most wooden-hulled shipwrecks are not likely to be recognized as such based on sidescan sonar imagery alone. Unfortunately, current survey and analytical practices on the OCS inhibit selection of magnetic anomalies as potential shipwrecks to be avoided.

Interpretation of marine remote-sensing data is vitally important to protection of submerged historic resources on the OCS. Development of MMS guidelines for assessing significance and assigning avoidance criteria based on interpretation of remote-sensing data should minimize the potential for emergency discovery of shipwrecks by industry operators. The importance of magnetic declination to the interpretative process has been emphasized only recently in archaeological literature; however, we believe its importance warrants denoting anomaly polarity in some manner when illustrating remote-sensing survey results. Contouring of magnetic data, for example, offers the ability to automatically display anomaly polarity and width (in along-track direction).

Improving upon the detection of buried wrecks will require tighter line spacing for magnetometer surveys. Nearly 100 percent of historic shipwrecks in shallow OCS high-probability areas could be detected and avoided if the magnetometer line spacing for those areas were reduced from 50 m (164 ft) to 40 m (131 ft), coupled with a requirement that all unidentified single-line magnetic anomalies be considered potential shipwrecks. Avoidance of potential shipwrecks, whether they are unidentified sonar targets or magnetic anomalies, ensures their protection regardless of their historic significance or confirmation as shipwrecks; however, recommendation of a large number of unidentified remote-sensing signatures for avoidance might restrict industry activities on broad areas of the sea floor where pipelines and wells are planned. There is an apparent contradiction between the goal of eliminating archaeologically insignificant remote-sensing targets from further consideration and the goal of protecting historically significant shipwrecks. We recommend resolving this contradiction through further refinement and testing of survey and analytical methodologies to determine the optimal effective and acceptable strategy for distinguishing between potential historic shipwreck anomalies and debris anomalies. In the future we hope to see implementation of a systematic procedure for evaluating the effectiveness of archaeological protection on the OCS.

The authors of this study have no illusion of having completely accomplished all of the ambitious goals listed above. But it is our sincere hope that the issues discussed in these pages will stimulate further discussion among our peers regarding the present effectiveness of historic site protection and how it

might be improved upon, not only in the GOM, but on the OCS in general. Our intent has not been to critique the past but to offer our combined perspectives going forward. We realize that some of our recommendations might not be embraced as practical solutions by professionals working in the complex business of developing and regulating offshore minerals. However, we feel it important to firmly ground our recommendations in objectivity, leaving real-world compromises to be worked out in the future. The authors offer these recommendations in the best interest of the OCS historic sites we all strive to protect.

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The Department of the Interior Mission

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.



The Minerals Management Service Mission

As a bureau of the Department of the Interior, the Minerals Management Service's (MMS) primary responsibilities are to manage the mineral resources located on the Nation's Outer Continental Shelf (OCS), collect revenue from the Federal OCS and onshore Federal and Indian lands, and distribute those revenues.

Moreover, in working to meet its responsibilities, the **Offshore Minerals Management Program** administers the OCS competitive leasing program and oversees the safe and environmentally sound exploration and production of our Nation's offshore natural gas, oil and other mineral resources. The MMS **Minerals Revenue Management** meets its responsibilities by ensuring the efficient, timely and accurate collection and disbursement of revenue from mineral leasing and production due to Indian tribes and allottees, States and the U.S. Treasury.

The MMS strives to fulfill its responsibilities through the general guiding principles of: (1) being responsive to the public's concerns and interests by maintaining a dialogue with all potentially affected parties and (2) carrying out its programs with an emphasis on working to enhance the quality of life for all Americans by lending MMS assistance and expertise to economic development and environmental protection.