INDEX OF TEXAS ARCHAEOLOGY

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Volume 2009

Article 11

2009

Cultural Resource Assessment and Archival Research for the Proposed Galveston-Bolivar Causeway Galveston County, Texas

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Cultural Resource Assessment and Archival Research for the Proposed Galveston-Bolivar Causeway Galveston County, Texas

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Document No. 090026
PBS&J Job No. 100005586

**CULTURAL RESOURCE ASSESSMENT AND
ARCHIVAL RESEARCH FOR THE PROPOSED
GALVESTON-BOLIVAR CAUSEWAY
GALVESTON COUNTY, TEXAS**

**TEXAS ANTIQUITIES PERMIT No. 4581
CONTRACT No. 577XXSA005
WORK AUTHORIZATION NOS. 577 18 SA005
AND 577 34 SA005, AND SUPPLEMENTAL WORK
AUTHORIZATION No. 1 TO WORK
AUTHORIZATION No. 577 34 SA005
CSJ No. 0367-05-042**

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TxDOT Archeological Studies Program Report No. 118

May 2009

ISBN: 1-930788-87-8

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jointly published by the

Texas Department of Transportation
Environment Affairs Division
Archeological Studies Program
Scott Pletka, Ph.D., Supervisor

Archeological Studies Program Report No. 118
A. McGraw, Series Editor

and

PBS&J
Austin, Texas

Document No. 090026

Printed by Ginny's Printing, Austin, Texas

ISBN: 1-930788-87-8

Abstract

In 2008, following a cultural resources remote-sensing survey for the Proposed Galveston-Bolivar Causeway Project, PBS&J was contracted by the Texas Department of Transportation to perform three studies as supplements to the original investigation. These studies comprised a hydraulic probing investigation at the Old Port Bolivar slip in the area of a charted historic shipwreck; a review of historic maps and aerial photography of the Area of Potential Effect (APE); and an assessment of a collection of abandoned hulks at the northwestern tip of Bolivar Peninsula. All three studies were completed between June and August 2008.

The hydraulic probing investigation at the Old Port Bolivar slip located the remains of a potential submerged shipwreck site measuring approximately 40 x 11 feet at a depth of 17–18 feet below the water surface. PBS&J also examined over 40 historic maps from the collections of the National Archives in Washington, D.C. The investigation of historic maps isolated at least 12 shipwrecks within the APE. Historic Tobin aerial photos of the APE acquired by PBS&J were limited to the sets available from 1930 and 1956. One shipwreck anomaly discovered during the 2007 Galveston-Bolivar Causeway remote-sensing survey was captured in the 1956 aerial. The incomplete coverage area of the 1930 photography prevented a review of other known targets. An investigation of the abandoned hulks at Bolivar Peninsula determined that 16 barges are arranged in three primary groups. These barges have either ferrous or wooden hulls; most of the hulks are submerged. Research did not discover parallels for the types of barges examined by PBS&J, but review of barge construction history indicates many of these hulks could likely predate World War II.

Contents

	Page
Abstract	iii
List of Figures	vi
List of Tables	vi
CHAPTER 1: INTRODUCTION	1
CHAPTER 2: HISTORIC BACKGROUND	5
PREVIOUS INVESTIGATIONS	8
CHAPTER 3: METHODS.....	15
HYDRAULIC PROBING SURVEY FOR POTENTIAL SHIPWRECK SITE	15
HISTORIC MAP RESEARCH AND AERIAL PHOTOGRAPHY	16
DERELICT HULKS INVESTIGATION.....	16
CHAPTER 4: RESULTS AND RECOMMENDATIONS	19
RESULTS	19
Hydraulic Probing Survey for Potential Shipwreck Site.....	19
Historic Map Research	20
Aerial Photography.....	28
Derelict Hulks Investigation	31
The History and Development of the Scow Barge	31
Hulks at Bolivar Peninsula	34
RECOMMENDATIONS	36
Hydraulic Probing.....	37
Historic Map Research and Aerial Photography	37
Derelict Hulk Documentation.....	37
REFERENCES CITED.....	39
Appendices:	
A	Interim Report: Hydraulic Probing of a Potential Shipwreck Site, Proposed Galveston-Bolivar Causeway Project, Galveston County, Texas
B	Interim Report: Aerial Photo and Historic Map Research of the Galveston-Bolivar Causeway Project Area, Galveston County, Texas
C	Interim Report: Documentation of Abandoned Vessel Hulks Near Port Bolivar Galveston-Bolivar Causeway Project, Galveston County, Texas
D	Glossary of Terms

Figures

		Page
1	Project Areas, Galveston Bay, Texas	2
2	The Bolivar Community of Gilchrest after Hurricane Ike	9
3	Composite Sonar Image of Site 41GV165	13
4	PBS&J Crew Probing Wreck	15
5	Orientation of Barge Hulks	17
6	Shipwrecks from Nautical Charts	26
7	Anomaly M5 (S4)	29
8	Historic Aerial Images of Port Bolivar	30
9	Configuration of Barge Hulks in March 1978	31
10	Scow Barge Used in the Construction of an 1870s Dock	32
11	Scow Sand Barge	33
12	Coal Tow Barges	35
13	Removable Deck on Barge M	35

Tables

		Page
1	Summary of Previous Investigations	10
2	Summary of Maps Inspected at the National Archives	21
3	Abandoned Hulks at Bolivar Peninsula	36

INTRODUCTION

The Galveston-Bolivar Causeway Project was designed by the Texas Department of Transportation (TxDOT) as a replacement for the State Highway (SH) 87 ferry service currently operating between Galveston Island and Bolivar Peninsula. TxDOT proposed to replace the existing ferry service with a series of bridges, approaches, and roadways, including a causeway, from Galveston Island, over to Pelican Island, and then terminating on Bolivar Peninsula. As part of this undertaking, TxDOT contracted with PBS&J in the spring of 2007 to conduct a marine remote-sensing survey for submerged cultural resources within the Area of Potential Effect (APE) for the Proposed Galveston-Bolivar Causeway Project, including the examination of potential landfall locations for the causeway on the southern shore of Bolivar Peninsula near Port Bolivar.

In April and May 2007, PBS&J surveyed 1,970 acres in Bolivar Roads, northeast of Pelican Island, and an additional 777 acres southwest of Pelican Island (Borgens et al. 2007). That survey identified 47 magnetic anomalies with 21 associated sonar targets that were indicative of potential historic locations. Additionally, an indeterminate number of derelict vessels were observed at the west end of Bolivar Peninsula, north of the Bolivar Ferry Terminal. The Texas Historical Commission's (THC) Historical Sites Atlas dated the derelicts to 1970–1971; however, inspection of coastal charts for Bolivar Roads identified wrecks in this area dating as far back as 1936 (Borgens et al. 2007). Several of these charts also identified a shipwreck southeast of the derelicts' location, in the easternmost abandoned commercial slip of Port Bolivar, adjacent to the Bolivar Ferry Terminal. A 1954 aerial photograph of Port Bolivar also appeared to show an unidentified feature in the same location as the charted wreck.

Following the 2007 remote-sensing survey for the Proposed Galveston-Bolivar Causeway Project, TxDOT approved a supplemental work authorization for additional investigations of submerged cultural resources within the APE. Those investigations, which are the subject of the current study, involved three separate tasks: (1) hydraulic probing of the suspected wreck location in the abandoned Port Bolivar slip; (2) examination of historic maps and aerial photography of the project area to identify possible magnetic anomaly and sonar target sources; and (3) documentation of the derelict vessels at the west end of Bolivar Peninsula. Figure 1 illustrates the overall Galveston-Bolivar Causeway project area and the locations of the hulk examination and probing (inset).

The objective of probing was to determine the presence or absence of potential historic shipwrecks within the Port Bolivar slip. If a potential submerged and buried wreck was located, then additional probes would be conducted as necessary to determine the orientation, material, and dimensions of the object.

Documentation of the derelict vessels was done in order to assess their potential for eligibility to the National Register of Historic Places (NRHP), with particular focus on the type, characteristics, construction details, and condition of the watercraft. These investigations adhered to the guidelines presented in National Register Bulletin 20 as they pertain to historic hulks, which the guidelines define as “substantially intact vessels that are not afloat, such as abandoned or laid up craft that are on a mudflat, beach or other shoreline” (Delgado 1992:2). The purpose of the aerial photo and historic map research was to determine possible sources of remote-sensing targets located during the initial survey. This research incorporated pre-1956 aerial photographs from the collection of Tobin International, in San Antonio, Texas, and maps housed at the National Archives and Records Administration (NARA) in College Park, Maryland. Prior to visiting the National Archives, PBS&J inventoried the State’s Texas Historic Overlay (THO) and related Houston Historic Overlay (HHO) map image databases to identify historic topographic maps, coastal charts, and other map types that depicted the project area from the mid-nineteenth century to the present day. Any maps fitting this description were visually assessed at the National Archives to determine whether they contained features, such as shipwrecks, that might explain some of the remote-sensing anomalies reported in the study area.

The above tasks were completed under Work Authorization 577 18 SA005, Contract No. 577XXSA005 and Texas Antiquities Permit No. 4581. Following completion of fieldwork, PBS&J submitted separate Interim Reports detailing methods, results, and conclusions for each of the hydraulic probing (Hudson and Borgens 2007), hulk documentation (Borgens 2007), and cartographic research (Jones and Borgens 2007) tasks. In order to fulfill the requirements of Texas Antiquities Permit 4581, these interim reports are synthesized and summarized in this document. The following chapters provide a brief historical outline of the project area, a description of field methods used for the hydraulic probing and hulk documentation tasks, a condensed summary of the results obtained for all three tasks, and conclusions presenting the authors’ recommendations of NRHP eligibility for historic sites within the project area and identifications of future research avenues to pursue. Each of the original interim reports submitted to TxDOT and the THC is included in its entirety as appendices A–C. Appendix D is a glossary of terms used in this report.

HISTORIC BACKGROUND

Expeditions to colonize and map the Texas coast were initiated in the early sixteenth century by the Spanish Crown and included the exploits of explorers such as Alonso Álvarez de Pineda (1519), Álvar Núñez Cabeza de Vaca (1527), Hernando de Soto (1539) and Luis de Moscoso Alvarado (1542). After the failure of the initial colonies, new exploration was not attempted until spurred by the French incursion into Spanish territory by René Robert Cavalier, Sieur de La Salle, in 1685. Another French expedition, by Jean Baptist Bénard de la Harpe in 1721, mapped the Texas coast and created a settlement at the location of Fort Point at Galveston Island (Taliaferro et al. 1988). Galveston derives its name from Bernardo de Gálvez, the Spanish governor of Louisiana from 1777 to 1783.

Galveston was utilized as a staging area for revolutionary activities in the early nineteenth century. Louis Michel Aury, a French privateer out of the West Indies, established Galveston as the capital of the Mexican Republic in 1816. Under the authority of José Manuel de Herrera, the official minister (of the Mexican junta) to the United States, Aury and his squadron were awarded letters of marque to attack Spanish shipping. The command of Galveston Island was quickly usurped by Jean Lafitte in September 1817, in the days after Aury's departure to transport a military expedition to the Mexican coast. Lafitte installed a new government at Galveston, which was sworn in by Luis Iturrigarria, a deputy to Herrera. He exploited his leadership at Galveston by both assisting filibuster factions out of New Orleans and by spying on these factions for Spain. Lafitte's tenure at Galveston was short-lived; his usefulness to the Spanish government diminished as Mexico neared its independence. The loss of Spanish monetary support for his enterprise and increased pressure from the United States collectively forced Lafitte to abandon his privateer establishment in 1821.

Concurrent with Lafitte's tenure at Galveston was the settlement of Bolivar Point by several families involved in Mexican filibustering enterprises. After Lafitte's abandonment of Galveston Island, and the departure of the other settlers, Jane Long remained at Bolivar Point with her daughter and a servant. Long was awaiting the return of her husband James Long, unaware that he had been killed accidentally in Mexico City after being captured during a failed filibuster attempt. She abandoned Bolivar Peninsula in 1822. Bolivar Peninsula remained largely uninhabited for the next several years, though it was a popular location for smuggling goods into the Texas interior. By 1830 the regularity of this activity caused the Mexican government to set up offices and living quarters on Bolivar Peninsula (Wiggins 1990:40).

The potential for Galveston to thrive as a port facility was officially recognized in the mid-1820s. The Mexican Congress established Galveston as a port of customs in 1825, though the city itself would not be incorporated until 1838, following the Texas Revolution (Francaviglia 1998:95).

Difficulties with the collection of customs revenues at both Galveston and Anahuac in 1835 prompted seizure of the customhouse by discontent colonists. Continued harassment and illegal seizures of Texas merchant vessels by the Mexican Navy exacerbated outstanding difficulties between the Mexican government and Texas settlers, and initiated the battles for Texas independence. After losses at San Antonio and Goliad, Texas successfully earned its independence with the defeat of the Mexican Army at the Battle of San Jacinto in April 1836. During this period, Galveston was the homeport of two naval fleets. The first fleet was purchased in January and February of 1836 but was all but lost by 1837. In April 1836 and in June 1837, the Mexican Navy engaged vessels of this initial fleet at Galveston Bay. During the second encounter, the Texas schooner *Invincible* became grounded and broke apart. The Texas government purchased new vessels in 1838, though the first would not arrive until 1839. By the time of Texas's annexation to the United States, the navy vessels were in a state of disrepair and were largely unusable. The serviceable vessels were sold to the U.S. government.

On July 4, 1845, Texans approved annexation to the United States by a vote of 4,254 to 267. Disputes between the Mexican and U.S. governments over the Texas and Mexican border would instigate the Mexican-American War in 1845. The capture of Mexico City by General Winfield Scott in late 1847 concluded the war. The subsequent Treaty of Hidalgo officially defined the Texas border as the Rio Grande and also included the U.S. purchase of California, most of New Mexico, Arizona, Nevada, and Utah, and parts of Colorado and Wyoming for \$15 million. Immigration into Texas increased dramatically after annexation. By 1850 the population of the state had increased to 212,295, an increase of over 70,000 residents in three years (Campbell 2003:207). The port of Galveston was a significant immigration gateway for the U.S., and by the time of the Civil War it was the second largest city in Texas.

During the Civil War, Galveston was one of several Gulf ports that became a focus of union blockading. The blockade of Galveston commenced in July 1862 with the arrival of the Union steamer *South Carolina*, a vessel that became one of the most successful Union blockaders (Cotham 1998:31). By September 24, 1862, Rear Admiral David Farragut ordered the invasion and capture of the city. In early October, Commander William Renshaw and his fleet of armed schooners and steam-powered warships captured Galveston without contest. Undeterred, Confederate forces attacked the USS *Harriet Lane* on January 1, 1863, and successfully forced the withdrawal of the Union naval vessels. The flagship USS *Westfield* was grounded early in the engagement, and the cottonclad CSS *Neptune* was intentionally beached and sunk after becoming damaged during the conflict. Following the Confederate victory at Galveston, the port was refortified and was not again the focus of a direct naval attack. A small Union fleet did, however, remain off Galveston and occasionally subjected the port to bombardment.

After the war, continued growth at Galveston made it the largest city in Texas by 1870. By the end of the century, however, Dallas-Fort Worth and San Antonio had exceeded the city in population, but Galveston remained second only to New Orleans as the largest port on the Gulf of Mexico (Campbell 2003:309; Cotham 1998:184). Parts of Texas were reachable through the railway, and several lines focused primarily on Galveston Island, including the Galveston and Houston Junction (1865); Galveston,

Harrisburg & San Antonio (1874); Galveston, Brazos & Colorado Narrow Gauge (1876); and North Galveston, Houston & Kansas City (1893) (Francaviglia 1998:236–237). By the end of the nineteenth century, Galveston was responsible for a quarter of the country's entire cotton exports and was considered the third largest cotton-shipping port in the U.S. (*Galveston Daily News* 1947; *Newark Daily Advocate* 1900).

An official ferry service was established between Galveston and Port Bolivar by L.P. Featherstone in 1896. At this time Bolivar Peninsula's population had swelled to 500. The community of Port Bolivar was established in 1893 with a townsite company purchase of 2,978 acres (Daniels 2007; Wiggins 1990:51). Initial community-level development at Port Bolivar included farming and the establishment of the Gulf and Interstate Railroad Company (G&I) between Port Bolivar and Beaumont in 1896. The newly established ferry service was used to transport iron ore from east Texas to Bolivar and to transport passengers and train cars between the two cities. The ferry service was composed of a barge capable of carrying 18 rail cars that was towed by a steam tug to the connecting railroad at Galveston. It was the first ferry service provided to Bolivar and the only one of its type in Texas capable of carrying train cars (Daniels 1985:29). The developments at Port Bolivar would be short-lived, as the Hurricane of 1900 leveled every building at the port and destroyed all the wharves, terminals, and tracks belonging to the G&I.

Commercial development of Galveston and Port Bolivar was quelled by this destructive hurricane. The infamous Galveston Hurricane of 1900 is the most deadly natural disaster in U.S. history. In the aftermath of the storm, roughly 6,000 people were believed dead in Galveston alone, a city whose population was 38,000. One-third of the city's total acreage was eliminated, resulting in a wreckage debris field spanning 4 miles and extending 1,200 feet (ft) behind the (nonextant) beachfront properties (Fay 1900). In a matter of hours, the winds and seas had leveled or destroyed over half the city's buildings. Property damage has been estimated to have ranged from \$20 to \$30 million (Campbell 2003:338–339). Prior to the devastating hurricane, Galveston was considered the fourth wealthiest city in the U.S. (Fay 1900). Galveston never fully recovered its former glory, though it did rebuild. In addition to constructing a 6-mile seawall rising 17 ft above low tide, the city of Galveston itself was elevated 17 ft. This tremendous task required raising more than 2,000 buildings in addition to water pipes and streetcar tracks (Campbell 2003:340–341).

After the hurricane, Galveston was never able to recapture its preeminence as Texas's Gulf port. Much of its capital had been invested in rebuilding the city following the hurricane, most of which was self-financed. This restructuring prevented Galveston from becoming involved in the industrial boom of the period, particularly within the oil industry. Houston quickly supplanted Galveston as the major Texas port due to its railroads and its connection to Beaumont oil. Galveston's economy stagnated, and the once-prosperous city degenerated into a haven for prostitution and rum-running. In spite of the illicit activities, Galveston was still a prominent cotton and grain shipping location and by the 1920s was a shipment locale for sulphur as well (McComb 1986:151, 156, 168).

Renewed efforts to redevelop Port Bolivar also emerged in the early twentieth century as the port was the focus of an ambitious plan to create a premiere iron-processing and exportation center. By the time of the devastating 1915 hurricane, over \$40,000 worth of construction had begun on ore industry facilities, and the port had also developed into a large lumber port, exceeding that of New York City. Two large slips, two or three wharfs, rail siding, and possibly a warehouse on the central wharf were created along the west shore of Bolivar Peninsula immediately north of the modern Bolivar Ferry Terminal (U.S. Coast and Geodetic Survey 1918). The hurricane destroyed the wharf facilities and G&I tracks. The iron ore industry never materialized, and the fear of German U-boat attacks during World War I crippled Port Bolivar's shipping industry (Wiggins 1990:82).

The current ferry service between Port Bolivar and Galveston was established by the Coastal States Transportation Service in 1930. This ferry service was sold to Galveston County, which, six months later, turned it over to the Texas State Highway Department in 1933 (Daniels 1992:15; Texas Highway Department 1963:12). Construction on the first of two ferry slips at the present location of the Bolivar Ferry Terminal was initiated in 1940; the second ferry slip was commenced in 1974 (Gearhart et al 2006:8). The G&I Railway continued until 1942 when the track between Port Bolivar and High Island was abandoned. In spite of the loss of both its industrial and shipping developments, Port Bolivar thrived as a vacation and tourist destination. By the mid-1990s, Bolivar Peninsula had an estimated 4,000 permanent residents, 1,200 of whom lived in Port Bolivar. Hurricane Ike struck the Galveston area in September 2008 and caused immense damage at Bolivar Peninsula. Many of the communities on Bolivar Peninsula, estimated to have a combined 30,000 residents and recently the focus of a booming resort development, were nearly or completely destroyed by the storm (Figure 2) (Bunn et al. 2008).

PREVIOUS INVESTIGATIONS

Several remote-sensing investigations have occurred in the vicinity of the APE. These surveys are discussed in detail Borgens et al. 2007. A summary of these investigations is produced in Table 1.

The probing, archival research, and hulk assessment detailed within this report were completed under TxDOT Contract No. 577XXSA005, Work Authorization no. 577 18 SA005. The principal survey to which this work was supplemental was completed under Contract No. 577XXSA005, Work Authorization No. 577 07 SA005. That remote-sensing investigation was conducted in May and April 2007 for the Proposed Galveston-Bolivar Causeway Project. The project included the construction of a series of bridges, approaches, roadways, and the causeway, which would extend from Galveston Island to and across Pelican Island and over to Bolivar Peninsula. PBS&J surveyed two locations as part of the remote-sensing investigations: a 777-acre region between west Pelican Island and Galveston Island, and 1,970 acres located east of Pelican Island and extending to Bolivar Peninsula. The remote-sensing survey located 47 magnetometer anomalies within the APE; 24 of the anomalies had associated sonar targets. Sonar targets S1 and S4 associated with magnetometer anomalies M5 and M13, respectively, demonstrated that these objects were submerged shipwreck sites. The recorded data, when manually

Figure 2. The Bolivar Community of Gilchrest after Hurricane Ike (Pool 2008)

TABLE 1. SUMMARY OF PREVIOUS INVESTIGATIONS

Date	Survey Group	Purpose	Location	Results	Reference
1980 June and July	Underwater Archaeological Research Section of the Texas Antiquities Committee	Examine areas with a high potential to yield shipwrecks and to possibly identify shipwrecks within these areas	16.9 acres in Galveston Bay	280 anomalies	Arnold 1987
1980 October	Archaeology Program of the Institute of Applied Sciences at North Texas State University	A cultural resources management survey in the Texas City Channel (TCC) conducted for the USACE	TCC, slightly west of the project area	11 magnetometer anomalies identified as characteristics suggestive of shipwreck sites; 2 anomalies were recommended for further review	Hays 1982
1991	Espey, Huston & Associates (EH&A, now PBS&I)	Archaeological survey along the Houston-Galveston Navigation Channel (HGNC) for the USACE to look for historic properties	Galveston area, survey area over 40 miles in length	Over 3,400 magnetometer targets and 570 sonar targets identified; 18 were recommended for ground-truthing	Hoyt 1992
1992	EH&A	Archival research for the USACE as a supplement to the 1991 EH&A survey	Galveston Bay area	103 previously recorded sites and 600 potential sites (terrestrial and underwater) reported within 1 mile of the HGNC; five additional locations were recommended for ground-truthing	Foster et al. 1992
1992 April-February	EH&A	Diver ground-truthing of 23 localities as a supplement to the 1991 EH&A survey and the 1992 archival study	Galveston Bay area	Metal debris discovered	Hoyt and Schmidt 1993
1992 October	EH&A	Cultural resources survey of the offshore portion of the HGNC for the USACE	Offshore portion of HGNC	211 magnetometer anomalies and 21 side-scan sonar targets identified; 10 were recommended for ground-truthing	Hoyt 1993
1994	EH&A	Cultural resources survey	Intersection of HGNC and Gulf Intracoastal Waterway (GIWW) and associated areas	13 anomalies were the focus of diver ground-truthing	Schmidt et al. 1995
1994	EH&A	Cultural resources survey; the survey also included a search for the suspected location of the USS <i>Westfield</i> and an examination of 10 anomalies recommended for evaluation in Hoyt 1993	Select areas along the HGNC between the Beltway 8 bridge and the outer end of the Galveston jetties	None of the anomalies were recommended for further study	Hoyt et al. 1998

Table 1 (Cont'd)

Date	Survey Group	Purpose	Location	Results	Reference
1996–1997	EH&A	Reconnaissance-level archival study for the USACE to identify potential historic properties along selected areas of the GIWW	77-mile section of the GIWW	194 historic properties identified	Hoyt et al. 1999
2000 February	PBS&J (formerly EH&A)	Oyster habitat remote-sensing survey for the city of Texas City in regard to the Shoal Point Container Terminal	5 areas: the northern flank of Shoal Point, the Shoal Point Turning Basin; a section on the west side of Pelican Island; a location near Dollar Point; and a portion of the TCC	Nine anomalies were recommended for avoidance or further investigation	Jones et al. 2002
2002	PBS&J	Cultural resources survey for select historic properties identified in Hoyt et al. 1999 and cartographic research for the USS <i>Westfield</i>	4 survey areas including the Texas City West Wye and Pelican Island marsh creation areas	Several targets identified, although after subsequent investigation none were recommended for avoidance. The cartographic research and remote-sensing survey indicated the <i>Westfield</i> was likely near the intersection of the HGNC and the TCC	Gearhart and Schmidt 2002
2003 April	PBS&J	Investigation of anomaly SP 2 from the Shoal Point survey area; conducted for Stevedoring Services of America	West Galveston Bay, near Texas City	Anomaly was not a historic property and was recommended for clearance	Watts et al. 2004
2004 May to June	PBS&J and Coastal Environments	Cultural resources survey for the Bolivar Terminal Expansion; conducted for TxDOT	Location adjacent to the ferry terminal at Bolivar Peninsula	Twelve anomalies were identified and investigated through ground-truthing (probing) of the sites; none of the anomalies were recommended for further investigation	Gearhart, Jones et al. 2006
2004 August to October	PBS&J	Close-order remote-sensing survey conducted in preparation for the deepening of the TCC; survey included the investigation of five anomalies recommended in Jones et al. 2002	TCC	Eight anomalies recommended as potential historic wreck sites; the USS <i>Westfield</i> believed to be either anomaly GV0031 or GV0032	Gearhart et al. 2005
2005 August	PBS&J	Diving assessment of GV0031 or GV0032	TCC	The source of GV0032 was a steel cable; GV0031 was identified as the site of the USS <i>Westfield</i>	Gearhart, Borgens et al. 2006
2006 June	PBS&J	NRHP assessment of USS <i>Westfield</i> (41GV151)	TCC	Site conclusively identified and recommended as eligible for listing in the NRHP	Gearhart, Borgens et al. 2006

georeferenced against historic navigational charts, also indicated these submerged sites were at the locations of shipwrecks illustrated on a 1936 coastal chart (U.S. Coast Survey 1853–1951). Anomaly M5 (S1) was described in the Automated Wreck and Obstruction Information System (AWOIS) database as two sunken barges, and anomaly M13 (S4) is unidentified. Additional magnetometer and sonar anomalies were discovered in the charted location of the now-submerged Civil War-era Fort Jackson. All the anomalies discovered during the survey were recommended for avoidance, or if unavoidable, investigation by ground-truthing.

As a consequence of the 2007 survey, anomaly M13 (S4) was recognized as a historic shipwreck and assigned the trinomial 41GV165 (Figure 3). On July 25, 2008, the THC conducted a reconnaissance evaluation of the site with State Marine Archeologist Steve Hoyt, marine stewards Andrew Hall and Russell Potocki, and PBS&J archeologist Amy Borgens. A total of eight dives were conducted on the site. Dive conditions, which were less than 1-ft visibility in a weak to moderate current, did not enable large-scale mapping of the site. The vessel was discovered to be wood-hulled with wood planking. A method of propulsion was not determined, though the hawsers and windlass for the anchor chain were located. The hull was buried in sand with only small portions of the framing protruding from the sediment. A collection of nondescript metal objects was “littered” about the hull, especially in proximity to tips of the frames.

Figure 3. Composite Sonar Image of Site 41GV165
(Image by Amy Borgens, revised from Figure 27 in Borgens et al. 2007)

METHODS

HYDRAULIC PROBING SURVEY FOR POTENTIAL SHIPWRECK SITE

Probing was performed primarily by wading, and from the deck of the 20-ft aluminum-hulled survey boat *PeeWee McKinney*. Equipment included a Honda 5.5-horsepower water pump, heavy-gauge rubber garden hose, and 14- and 20-ft lengths of ¾-inch-diameter steel pipe. The probing corridor covered a 65.6-ft (20-meter [m])-wide, 410-ft (125-m)-long area, beginning at the vegetation line on the beach and extending parallel to the north set of pilings demarcating the old Port Bolivar slip, Santa Fe Slip No. 3 (see Figure 1). Probes were spaced no more than 10 ft (3 m) apart. Probe depths were to a maximum of 22 ft (5.5 m) below the waterline, or to the depth of refusal due to impenetrable wood, clay, rock, or shell layers.

Positioning for each probe was provided with a Trimble Ag132 Differential Global Positioning System (DGPS), mounted to a floating platform (Figure 4). Each probe location was recorded using Trimble's HYDROpro® navigation software, and exported to a CAD program for mapping and analysis.

FIGURE 4. PBS&J CREW PROBING WRECK

HISTORIC MAP RESEARCH AND AERIAL PHOTOGRAPHY

The cartographic branch of NARA in College Park, Maryland, houses numerous collections of federally produced coastal maps and navigational charts. In June 2007, several of these collections were examined to identify historic maps illustrating the Galveston-Bolivar Causeway project area. Prior to commencing the archival research, a review of the State's THO map image database and the related HHO map inventory, identified historic topographic maps, coastal charts, and other maps that depict the project area in the 1860–1954 timeframe. The THO and HHO projects were completed in 2006 and included an inventory of historic maps that are housed in state and national repositories. Select maps from this inventory were digitized and geo-referenced for TxDOT as a means of predicting and avoiding historic-period sites during early stages of TxDOT project planning and design (Foster et al. 2006). For the current project, THO and HHO maps containing information on Bolivar Roads were selected for further assessment to determine whether they contain features, such as shipwrecks, that might explain some of the remote-sensing anomalies reported in the Galveston-Bolivar Causeway marine archeological survey (Borgens et al. 2007). This search yielded approximately 40 Bolivar-area map titles that were housed at the National Archives, but had not been acquired previously for digitization and geo-referencing. These 40 maps were then selected for visual inspection and, if necessary, reproduction by PBS&J.

Once at NARA, each of the selected maps was prioritized based on its limited index information and inspected in order of priority. Many of the selected maps were, in fact, series of maps, rather than individual sheets. As a result, substantially more than 40 maps were investigated during the project, including several map collections that had not been included in the THO and HHO inventories. Any maps showing potential shipwrecks within the survey area (or showing them for the first time, in cases where a wreck was charted on multiple maps) were photocopied and digitally scanned. Maps showing shoreline and/or development detail of the project area, but not shipwrecks, were photographed so that a decision on whether to purchase a copy could be made at a later date. Maps having no relevance to the current study were inspected and put aside with no further detail being recorded.

Following research at NARA, PBS&J contacted P2 Energy Solutions, Inc., to acquire an inventory of the Tobin aerial photographs of the project area taken between 1930 and 1960. These images were requested in an attempt to more accurately identify the vessel type and wreck date of several visible-above-water shipwrecks that were charted on some of the NARA maps.

DERELICT HULKS INVESTIGATION

The investigation of the derelict hulks was performed by Amy Borgens and Doug Jones from *PeeWee McKinney* on August 7 and 8, 2007. The examination of the vessels was completed through a visual assessment of the wrecks with photo-documentation of the visible features. A Humminbird 797c² SI Combo fathometer with side-scan sonar was used to review underwater components of the wrecks and to create screen-captures of the submerged hulks. GPS data were acquired using a Trimble Ag132 Differential Global Positioning System (DGPS); GPS fixes were taken at the corners of each vessel (when

feasible) or at the center point of each end of the hulks in the location of the coupling mechanism. Each GPS fix was recorded using Trimble's HYDROpro® navigation software and exported to a CAD program for geo-referenced mapping and analysis of each hulk's position (Figure 5).

FIGURE 5. ORIENTATION OF BARGE HULKS
GREEN HIGHLIGHTED AREAS ARE RECORDED GPS "FIX" POINTS (FIGURE BY AMY BORGENS)

RESULTS AND RECOMMENDATIONS

RESULTS

Hydraulic Probing Survey for Potential Shipwreck Site

PBS&J conducted a systematic hydraulic probing survey of a target at Bolivar Peninsula on June 25–29 and July 2–3, 2007. Probing was located within the remnants of a historic 1917 slip. The results of that survey were presented to TxDOT in a detailed interim report of findings (Hudson and Borgens 1997), which is included in its entirety as Appendix A to this report. Appendix A also includes a table listing the location, depth, and result of each probe. A brief synopsis of the probing results is presented here.

A total of 401 probes were placed within the project area. Water depths ranged from 0 to 5 ft (0 to 1.5 m), and depths of probe penetration ranged from 3 to 22 ft (0.9 to 6.7 m) below the water surface. The 20-ft hydroprobe was used whenever water depths and ease of sediment penetration allowed, which included the majority of the project area. On the beach and in extremely shallow water, the more densely consolidated sediments made it physically strenuous to manually manipulate, overhead, a 20-ft-long steel pipe connected to a heavy rubber hose funneling a pressurized water stream. In these areas, a shortened 14-ft probe was used.

Forty-four of the 401 probes were positive for buried wooden objects. Of these, 29 are clustered in a contiguous area of approximately 40 x 11 ft, and 250–300 ft offshore from the beach (Appendix A, Figure 4). This area matches closely with a shipwreck location charted in 1936 (U.S. Coast Survey 1853–1951). This cluster of positive probes averaged 17–18 ft in depth below the water surface, and the existence of a wood object (or objects) at this location was confirmed by the presence of wood fragments that lodged in the probe end. These fragments were collected, labeled, and remain in wet storage at PBS&J for further analysis, if necessary.

The remaining 15 positive probes were widely scattered and are believed to relate to debris or remnants of an old pier, rather than a shipwreck. A wooden pier bordered by a bulkhead had formerly been constructed at this location, but both had been allowed to fall into disrepair and collapse over time. Many of these probes released an odor and oily sheen in the water that was characteristic of the creosoted wood that would have been used to construct both the pier and bulkhead. None of the positive probes were located in the area that was identified in the 1954 aerial photograph as showing a possible emergent shipwreck.

The majority of the 357 negative probes encountered only sand, soft silt, or mud, and were able to penetrate the bottom until the probe handle was at or below the waterline. Other negative probes encountered an impenetrable clay or shell layer somewhere above maximum penetration depth.

Historic Map Research

Approximately 40 map titles were initially selected from the THO and HHO databases for further investigation at the National Archives. Upon inspection, most of these 40 maps were discovered to be of a series, or of file units containing multiple maps of similar attributes. As a result, substantially more than 40 maps were visually assessed. Maps identified from the THO and HHO inventories were primarily located in Record Group (RG) 77 (Fortifications Map File and Civil Works Map File) and RG 23 (Library and Archives Map Collection). Additional maps relevant to the study but not included in the THO and HHO databases were identified in RG 23 and RG 370 (National Oceanic and Atmospheric Administration [NOAA] Records). These maps included Chart 520 (RG 23), a U.S. Coast Survey chart of the Galveston Entrance produced from 1853 to 1951, and Chart 11324 (RG 370), a map of the same area produced by NOAA from 1974 to the present (though 2004 was the last year available at NARA).

A detailed discussion of specific maps and map types inspected is presented in an interim report submitted to TxDOT upon completion of the field research (Jones and Borgens 2007). That interim report is reproduced in its entirety as Appendix B of this report. A summary of maps inspected is presented in Table 2 below, including the map date, archives Record Group and File Unit, map description, and whether photocopies or photographs were taken. Table 2 is not intended to be a complete list of every map assessed at the archives, but is an abbreviated list of map titles that had some relevance to the present study. Maps having no relevance or appearing unchanged over multiple years were omitted from the table. Maps of the same series or chart number are grouped together and listed chronologically.

Based on examination of these maps, at least 12 shipwrecks may be present within the survey area (Figure 6). Brief summaries of each wreck location keyed to the numbers on Figure 6 are presented below. Unless otherwise noted, these summaries are based only on information gleaned from the maps studied at the National Archives and should not be considered a definitive account of the charted history of each wreck or a complete list of potential shipwrecks in the project area. It is likely that further historic map research will provide a clearer picture of when each of the charted wrecks first and last appeared on navigational charts.

1. This wreck was first observed on an 1888 Corps of Engineers map of Galveston Harbor (U.S. Army Corps of Engineers [USACE] 1888). A wreck appears again in a virtually identical location on U.S. Coast Survey Chart 520 from 1936 to 1951 (U.S. Coast Survey 1853-1951), but is uncharted by 1974 (1951–1974 maps for this geographic area were produced by a different federal agency and were, therefore, located in a different NARA record group. They were not investigated due to time constraints). In 1988 a “submerged obstruction” appears in

TABLE 2. SUMMARY OF MAPS INSPECTED AT THE NATIONAL ARCHIVES

Map Title	Date	RG	Series	File Unit	Description	Copied (C) or Photographed (P)
Copied from Chart of Galveston Bay and Harbor	1841	77	Fortifications Map File	Drawer 148, Sheet 4	U.S. Coast Survey map showing depths of the harbor and a mark showing the wreck of <i>Cuba</i>	P
Sketch of Galveston Bay for Placing Lighthouses	1851	23	Library and Archives Map Collection	877-1851	U.S. Coast Survey map showing approximate ship channel location from Galveston to Morgan's Point	P
Preliminary Sketch of Galveston Bay	1852	77	Fortifications Map File	Drawer 148, Sheet 25	U.S. Coast Survey map showing shoreline of entire Galveston Bay with soundings from the entrance up to Redfish Bar	P
Sketch showing the Locality of Half Moon Shoal in Galveston Bay, Texas	1852	23	Library and Archives Map Collection	877-1852	Shows the location of Half Moon Shoal in relation to Shoal Point and Pelican Island	P
Galveston Entrance, Texas	1858	77	Fortifications Map File	Drawer 91, Sheet 4	Ranges of casemate and barbette fire from fort on Pelican Spit	P
Fort on Pelican Spit, Galveston Harbor	ca. 1865	77	Civil Works Map File	Z53-6	Layout of the fort showing armaments and dimensions	C
Galveston, Texas and vicinity	ca. 1865	77	Civil Works Map File	Z53-2	Detailed map of Galveston showing location of forts, including one on Pelican Spit	C
Chart of Galveston Harbor & Vicinity	1868	23	Library and Archives Map Collection	877-1877	U.S. Coast Survey map showing changes in the shoreline for Pelican Spit and Fort Point since an 1867 survey	P
Outer and Inner Bars and Vicinity of Bolivar Gabionnade, Galveston Harbor, Texas	1877	23	Library and Archives Map Collection	877-1877	Soundings around the inner and outer bar, and the proposed line of a gabionnade	P
Galveston Harbor, Texas	1884	77	Civil Works Map File	Q519	Harbor depths starting at the west end of the jetties	P
Galveston Harbor	1885	77	Civil Works Map File	Q568	A colored-pencil sketch of Galveston Bay and Gulf of Mexico, with a proposed plan for improvements	NA

Table 2 (Cont'd)

Map Title	Date	RG	Series	File Unit	Description	Copied (C) or Photographed (P)
Galveston Harbor, Texas	1886	77	Civil Works Map File	Q564-1	Shows soundings from an 1884 survey of the entrance to Galveston harbor between the jetties	P
Galveston Harbor, Comparative Chart	1886	77	Civil Works Map File	Q564-2	Comparative map of harbor entrance depth contours from 1851, 1872-73, 1875-76, and 1884 surveys	P
Sketch Showing location of proposed Tide Gauge at Entrance to Galveston Harbor	1887	77	Civil Works Map File	Q591	Depths and ranges from a proposed tide gauge house to Fort Point and Bolivar lighthouses	NA
Map of Ship Channel through Galveston Bay	1887	77	Civil Works Map File	Q592	Survey depths within the channel including a depth profile	P
Galveston Harbor, Texas	1888	23	Library and Archives Map Collection	877-1888	Corps of Engineers map from May to August 1888; shows depth contours and two wrecks: one north of Port Bolivar, the other southwest of Pelican Island, near the mainland	C, P
Galveston Harbor Improvement	1891	77	Civil Works Map File	Q736	Sketch showing location of the proposed north jetty; good detail on Bolivar Point development at that time, including the "Old wharf" location	P
Galveston Bay, Texas	1905	77	Civil Works Map File	Q536, Roll 82	Navigation chart for entire bay; also shows the railroad dock at Bolivar	P
Survey of Galveston Harbor	1908	77	Civil Works Map File	Q536, Roll 143	A depth survey of Bolivar Roads	P
Galveston Entrance	1910	23	Library and Archives Map Collection	877-1910	USGS chart with hand-written note around Port Bolivar saying "see sketch of wharf attached to chart No. 204"; Chart No. 204 could not be located; another written note pointing to the south Port Bolivar slip says "This slip is dredged and is used by steamship (illegible)"	P

Table 2 (Cont'd)

Map Title	Date	RG	Series	File Unit	Description	Copied (C) or Photographed (P)
Galveston Bay, Texas, Showing Positions of Vessels Which Were Driven from Their Moorings During the Hurricane of August 16 and 17, 1915	1916	77	Civil Works Map File	Q536, Roll 203	Shows schooner <i>Edna V. Picles</i> and SS <i>Wallace</i> driven ashore on Pelican Island near 41GV165; these were the only wrecks on the map within the survey area	P
Upper End of Bolivar Roads	1915	77	Civil Works Map File	Q536, Roll 201	A depth survey of Bolivar roads	NA
Port Bolivar	1920	77	Fortifications Map File	Drawer 148, Sheet 63-4	Blueprint of Port Bolivar, showing city blocks and pier numbers; a photo-negative of the ship yards is inset	P
Galveston Entrance, Texas	1853	23	Library and Archives Map Collection	Chart 520	Shows several wrecks in Galveston Channel, adjacent to the city docks; these wrecks are gone on the 1867 map	C
Galveston Entrance, Texas	1856	23	Library and Archives Map Collection	Chart 520	Same as above	P
Galveston Entrance, Texas	1867	23	Library and Archives Map Collection	Chart 520	Shows "Westfield Beacon" Wrecks in Galveston Channel from 1853 chart are no longer present	P
Galveston Entrance, Texas	1867	23	Library and Archives Map Collection	Chart 520	"Boiler" charted in Bolivar Roads	P
Galveston Entrance, Texas	1888	23	Library and Archives Map Collection	Chart 520	Wreck north of Port Bolivar shows up for first time, although port itself is not present yet	C, P
Galveston Entrance, Texas	1899	23	Library and Archives Map Collection	Chart 520	A single railroad trestle is present at Port Bolivar	P
Galveston Entrance, Texas	1909	23	Library and Archives Map Collection	Chart 520	Shows progress of 1908 dredging at Port Bolivar	P

Table 2 (Cont'd)

Map Title	Date	RG	Series	File Unit	Description	Copied (C) or Photographed (P)
Galveston Entrance, Texas	1910	23	Library and Archives Map Collection	Chart 520	Shows progress of 1909 dredging at Port Bolivar and more development at the port	P
Galveston Entrance, Texas	1910	23	Library and Archives Map Collection	Chart 520	Shows slightly more detail of Port Bolivar than previous 1910 map	P
Galveston Entrance, Texas	1912	23	Library and Archives Map Collection	Chart 520	Shows further development of Port Bolivar	P
Galveston Entrance, Texas	1915	23	Library and Archives Map Collection	Chart 520	Shoreline near the wreck at Port Bolivar has migrated westward	NA
Galveston Entrance, Texas	1924	23	Library and Archives Map Collection	Chart 520	Shoreline near the wreck at Port Bolivar has eroded back eastward to the 1914 position	P
Galveston Entrance, Texas	1934	23	Library and Archives Map Collection	Chart 520	Last available year in the series before multiple wrecks are illustrated (see 1936 version)	C, P
Galveston Entrance, Texas	1936	23	Library and Archives Map Collection	Chart 520	Beginning this year the map series has a slightly smaller scale and is more detailed. Multiple wrecks in the survey area show up for the first time including 41GV165, <i>Selma</i> , two wrecks in the Port Bolivar slips, and two wrecks on the west side of Pelican Island. The wreck at Port Bolivar dating to 1888 is no longer charted.	C
Galveston Entrance, Texas	1944	23	Library and Archives Map Collection	Chart 520	Shows new dredging depth at Bolivar to be 20 ft	NA
Galveston Entrance, Texas	1945 (Feb)	23	Library and Archives Map Collection	Chart 520	41GV165 is shown as exposed, as is the southern of two Port Bolivar wrecks	C, P
Galveston Entrance, Texas	1951	23	Library and Archives Map Collection	Chart 520	Two more wrecks are charted on the west side of Pelican Island, north of the Old Dike	C, P

Table 2 (Cont'd)

Map Title	Date	RG	Series	File Unit	Description	Copied (C) or Photographed (P)
Galveston Bay Entrance	1974	370	NOAA Records	Chart 11324	Two wrecks charted on the east side of Pelican Island, <i>Selma</i> and one near 41GV165. Three wrecks charted within the slips at Port Bolivar	NA
Galveston Bay Entrance	1979	370	NOAA Records	Chart 11324	A third wreck appears on the east side of Pelican Island, and actually appears to be on the island due to migrating sediments	P
Galveston Bay Entrance	1982	370	NOAA Records	Chart 11324	Several wrecks appear in the Galveston Channel, in vicinity of wrecks charted on 1853 map	NA
Galveston Bay Entrance	1988	370	NOAA Records	Chart 11324	A wreck appears on the west side of Pelican Island, south of the GIWW. May be associated with wreck plotted on 1888 USACE chart	NA
Galveston Bay Entrance	1990	370	NOAA Records	Chart 11324	Wreck in vicinity of 41GV165 is no longer charted	NA
Galveston Bay Entrance	1994	370	NOAA Records	Chart 11324	Wreck north of Bolivar Point that dates to 1888 USACE chart is once again charted	NA
Galveston Bay Entrance	1997	370	NOAA Records	Chart 11324	A fourth wreck appears west of Pelican Island approximately in the middle of the Bolivar Causeway survey area, north of the GIWW. Also the 1888 wreck north of the Port Bolivar slips is recharted, and there is a wreck between Bolivar and the HGNC, immediately south of the GIWW	C, P
Galveston Bay Entrance	1998	370	NOAA Records	Chart 11324	Several wrecks have been removed from the chart including the one west of Pelican Island and south of GIWW, one adjacent to the <i>Selma</i> , and wrecks in Galveston Channel	NA
Galveston Bay Entrance	2004	370	NOAA Records	Chart 11324	Last available map in this series; details are the same as previous years	P

FIGURE 6. SHIPWRECKS FROM NAUTICAL CHARTS

- this area on NOAA Chart 11324 (NOAA 1974–2004). It is unknown whether the submerged obstruction or the wreck charted from 1936 to 1951 are related to the original 1888 wreck, or if each is separate. A magnetic anomaly (M2) was also recorded in the vicinity of this wreck during PBS&J’s remote-sensing survey of the Galveston-Bolivar Causeway project area (Borgens et al. 2007). Since the above-listed historic maps have not been geo-referenced, it is also unknown how closely the anomaly is located to the charted wreck position.
2. This wreck first appears in 1988 and appears until 1998 (NOAA 1974–2004). NOAA’s AWOIS identifies this wreck as *Mr. Wick*, a 34-ft fishing vessel that sunk in 1987. The wreck’s location was “disproved by local knowledge of salvage . . . and echo sounder investigation” in 1995–1996 (AWOIS 2008). PBS&J, however, did record a potential shipwreck anomaly (M3) in the vicinity of this charted wreck (Borgens et al. 2007).
 3. Wreck No. 3 appears on the 1997 version of Chart 11324 and appears through 2004, the last year available at NARA (NOAA 1974–2004).
 4. A wreck first appears at this location in 1936 (U.S. Coast Survey 1853–1951). In 1951 a second wreck appears in the same location. Both wrecks continue to be charted through 2004, although by 1986 Chart 11324 illustrates only a single location for “wrecks,” rather than two separate wreck symbols (NOAA 1974–2004). AWOIS identifies these wrecks as two unknown barges. PBS&J recorded a magnetic anomaly (M5) with an associated sonar target (S1) at this location during its Galveston-Bolivar Causeway remote-sensing survey (Borgens et al. 2007).
 5. This wreck also first appears on the 1951 U.S. Coast Survey Chart 520 (U.S. Coast Survey 1836–1951), but was removed by 1986 (NOAA 1974–2004). AWOIS does not currently list any wreck at this location; however, PBS&J did record a magnetic anomaly (M4) at the same approximate location (Borgens et al. 1997).
 6. This wreck is charted by at least 1979. Due to the migrating shoreline of Pelican Island, later maps show the wreck as being on dry land (NOAA 1974–2004). The wreck was removed from the NOAA charts prior to 1997, and there is no current AWOIS entry for the site.
 7. This wreck first appears in 1936, and is visible on Chart 520 through 1951 (U.S. Coast Survey 1836–1951). It does not appear on NOAA Chart 11324 until 1988, but is removed again by 1997 (NOAA 1974–2004). In 2007 PBS&J recorded a magnetic anomaly with a corresponding shipwreck sonar target at this location (Borgens et al. 2007). The site has been given archeological site trinomial 41GV165 (see Figure 3). Principal Investigator Amy Borgens accompanied the THC on a field investigation of 41GV165 in the summer of 2008; however, the site has not yet been identified.
 8. There may be at least three and as many as four wrecks at this location. One is *Selma*, a World War I-era concrete-hulled tanker that is still visible today. *Selma* was scrapped at its current location in 1922, but did not show on U.S. Coast Survey charts until 1936. Sometime after 1979, at least two additional wrecks began to be charted in this same vicinity. By 1997, two separate notes marking “wrecks” appear within approximately 100 ft of *Selma*. AWOIS lists two unidentified visible wrecks due south of *Selma* in 1980, which were reported as disproved by diver investigation in 1995–1996. AWOIS lists another wreck off the bow of *Selma* (to the west) that was first reported in 1988 and was salvaged the same year. PBS&J

- recorded multiple anomalies and sonar targets in the vicinity in 2007 that may correlate to one or more of these charted wrecks (Borgens et al. 2007).
9. Two charts from 1867 separately identify the “Westfield Beacon” and a “Boiler” in Bolivar Roads. These locations refer to the wreck of the USS *Westfield*, a Union gunboat that was blown up during the Battle of Galveston Bay in January 1863. In 2005 PBS&J identified the remains of the *Westfield* (Gearhart, Borgens, et al. 2006), which also appear in the Galveston-Bolivar Causeway remote-sensing survey as anomaly M17 and sonar target S6 (Borgens et al. 2007).
 10. This wreck first appeared on Chart 11324 in 1990 (NOAA 1974–2004) and is listed in AWOIS as a 27-ft pleasure craft. A NOAA search for the wreck was unsuccessful, and its exact location is unknown. No anomalies or sonar targets were located in the same general area during the 2007 survey.
 11. Three twentieth-century wrecks are charted in or near the Port Bolivar slips. Two are charted beginning in 1936—one each in the north and south slips. Each continues to be charted through the 1990s. Beginning in the 1970s, a third wreck appears immediately west of the two slips. By 2004 Chart 11324 had replaced individual wreck symbols with the note “foul with wrecks,” referring to the general area of the slips (NOAA 1974–2004). In 2007, the southern slip was probed by PBS&J to confirm that wreck’s location (see above).
 12. This wreck first appears in an Army Corps of Engineers map from 1888, and on U.S. Coast Survey Chart 520 from the same year (USACE 1888; U.S. Coast Survey 1853–1951). Chart 520 continues to map the wreck through 1934, but it is removed in the 1936 edition of the chart. A wreck in the same approximate location shows up on NOAA Chart 11324 in 1994 continuous through 2004 (NOAA 1974–2004). It is unknown if this is meant to signify the same wreck that was mapped from 1888 to 1934, or a new wreck. PBS&J recorded multiple magnetic anomalies in the vicinity of this wreck (Borgens et al. 2007).

Aerial Photography

PBS&J contacted P2 Energy Solutions, Inc., to request an inventory of Tobin aerial photographs of the project area between the years 1930 and 1960. This was done in an attempt to more accurately identify the type and/or wrecking date of any wrecks discovered through the historic map research task or during the 2007 remote-sensing survey. Only two image sets were available: one from 1930, showing incomplete coverage, and one from 1956 showing complete coverage of the project area (Tobin International Ltd. 1930, 1956). The results of the aerial photograph analysis were presented to TxDOT in an interim report (Jones and Borgens 2007) that is attached as Appendix B to this report.

The selection of available Tobin aerial photographs precluded an examination of the wreck site, anomaly M13 (S4), east of Pelican Island. The location of this wreck, designated site 41GV165, was not part of the coverage area photo-documented in 1930. There is not a visible wreck anomaly at the position of 41GV165 in 1956 (Figure 7). One remote-sensing anomaly recorded on the west side of Pelican Island during the 2007 survey was recognizable from the Tobin photography. Anomaly M5 (S4) was not visible in the 1930 aerial images, though a wreck, or series of wrecks, is charted at this location on a 1936 U.S.

Coast Survey chart (1853–1951). Anomaly M5 (S4) is, however, evident in the aerial photography from 1956. Comparisons between the 1930 and 1956 images demonstrate that water levels had greatly receded in 1956 enabling the source of the anomaly to become visible. The characteristics and orientation of the feature from the 1956 aerial are identical to the sonar anomaly recorded by PBS&J in 2007.

FIGURE 7. ANOMALY M5 (S4). (A) COMPOSITE SONAR MOSAIC; (B) DETAIL OF 1956 AERIAL PHOTOGRAPHY (IMAGE BY AMY BORGENS, REVISED FROM JONES AND BORGENS 2008)

In a 1954 aerial, an object of interest was examined at the location of a 1936 charted wreck near the Bolivar Ferry Terminal (Texas Natural Resources Information Service [TNRIS] 1954). This same feature was not apparent in the 1956 photography of the same location, dismissing this object as a potential historic shipwreck site (TNRIS 1956). The object is possibly a series of floating pontoons like those utilized in dredging activities.

PBS&J contacted TNRIS in January 2009 to request a review of historic aerial photography for the project area. Available photography was incomplete for the survey area prior to 1952; however, PBS&J requested geo-referenced files of Port Bolivar from 1969 and 1978 to review the hulks that were reported to have been deposited in 1970 (Figure 8). These were the only sets to include coverage of the port prior to the 1980s. These images demonstrate the barges were arranged in their current configuration after May 10, 1969, and that there are a total of 16 hulks (Figure 9). Review of the 1978 aerial image also indicated that the now-submerged hulk, indicated by letter L on Figure 9, evident in 1995 aerial photography is not a barge but is instead likely a displaced ferrous deck. This feature was not evident in 1978 at its current location. The semisubmerged condition of barges B–F may also suggest that these hulls were intentionally used to form a breakwater as is suggested in an account of the barge histories (Anthamattan 2007).

FIGURE 8. HISTORIC AERIAL IMAGES OF PORT BOLIVAR (IMAGE BY TNRIS
(A) 1969, (B) 1978, AND (C) 1995)

FIGURE 9. CONFIGURATION OF BARGE HULKS IN MARCH 1978

Derelict Hulks Investigation

PBS&J conducted a visual assessment of a collection of abandoned hulks located at the northwest end of Bolivar Peninsula. Visual assessment of the wrecks and examination of 1996 aerial photographs demonstrated that 16 barges are located in the study area and that over half of these vessels are submerged. These derelict vessels are double-ended and are of two general types: wooden-hulled with wooden decks and ferrous-hulled with ferrous decks. The dimensions were recorded using the GPS coordinates for each corner, on two of the more intact vessels. These vessels measured approximately 98 x 39 ft (33 x 12 m). A more detailed account of the derelict hulks and their investigation is provided in the interim report (Appendix C).

The barges are believed to have been towed to their current location in the 1970s for use as docks for a seafood processing plant (Swafford 2007). At least one of the hulks, letter Q, is still recognizable as a dock, though it is greatly dilapidated. Other sources suggest that the barges were brought from Buffalo Bayou in 1970 and filled with sand to serve as a breakwater (Anthamatten 2007; Ellis 2007).

The History and Development of the Scow Barge

Modern barge design is derived from the scow, a flat-bottomed, flat-sided vessel of shallow draft that was used in the Great Lakes for over a century. Scows were utilized to serve ports, bays, and rivers in the Great Lakes beginning in the early nineteenth century, during the War of 1812. This vessel type proliferated in use and was eventually manufactured in other regions of the United States. Early scows were rigged variably as barks, schooners, or sloops, though some versions were unrigged. Towards the end of the nineteenth century, the rigged scow was becoming obsolete yet the hull form was becoming widely used for unrigged barges (Pike 2006). An example of a late nineteenth-century scow barge unearthed at Southampton in 2001 (Barrick 2001) illustrates the typical scow hull design that is still evident in modern barge forms (Figure 10).

FIGURE 10. SCOW BARGE USED IN THE CONSTRUCTION OF AN 1870S DOCK (BARRICK 2001)

The use of barges increased after the introduction of steam-powered vessels (towboats were developed in the 1850s); it was at this time that vessels were manufactured in more-standardized sizes. For example, in the early twentieth century, scow barges utilized in the Upper Mississippi Improvement were of two standard sizes: 100 x 20 x 4.5 ft and 110 x 24 x 5 ft. The use period for the Mississippi barges, dependent upon wood type and quality, ranged from 8 to 18 years (Dana 1921:57, 65). Earlier deep-water barges (to transport oil) used on the Allegheny and Ohio rivers during the 1880s were larger than those of the Upper Mississippi and measured, on average, 130 x 22 x 16 ft (Pees 2004a).

Advances in shipbuilding technologies enabled towboats to handle barges of larger capacities and weight; at this juncture, steel-hulled barges were introduced. The construction of steel barges appears to have been introduced towards the end of the nineteenth century. Some of the earliest steel barges may have been manufactured for specialized cargos or for government use. Steel tank barges for transporting oil were introduced in 1892 by Standard Oil for use on the Great Lakes (Pees 2004a). Fourteen steel barges were constructed for use in government work on the Mississippi River in 1912. These latter vessels measured 120 x 30 x 7.3 ft (Dana 1921:65). The use of steel barges was increasing at this time, with the life span of a steel barge perceived to be generally triple that of a wood barge (Prelini 1911:238). An example of an early steel barge is pictured on Figure 11. The manufacture of wood-hulled barges declined in the early twentieth century as the use of steel barges gained prominence. By World War II, the sight of wooden barges was rare, even given an unusual resurgence in wooden barge manufacture that occurred in 1943. Two hundred sixty-nine wooden barges were built by October of that year, though 77 of the barges were never used (Pees 2004b). By World War II, the majority of barges were made of steel (Pees 2004b).

FIGURE 11. SCOW SAND BARGE
HISTORIC AERIAL (TOP) AND CURRENT VIEW OF THE STEEL BARGE THAT HAS BEEN
STUCK AT NIAGARA FALLS SINCE 1918 (BERKETA N.D.)

There are many varieties of barges that are represented by four general types. The most common form of barge (in the 1960s) was the hopper barge. This watercraft was essentially a deep-hulled, large, uncovered floating box. A dry cargo barge was generally a hopper barge with a covering. The tank barge was used for carrying liquid cargos, and the deck barge had a closed-in, hollow (but shallow) hold and carried the cargo on its deck (Osborne 1929:21–23). A publication from 1911 (Prelini) additionally discusses the types of scow barges used for the transport of dredge materials. According to this source, there were three types of barges used for this purpose: open-hold scows, deck scows or floats (likely the deck barge), and dumping scows. An open-hold scow had a platform that laid atop the keelson. This platform was removed by a lifting machine and was generally only used for transporting dredged material to another location without it scattering. Deck scows were subdivided into three additional categories: deck scows proper, railroad floats, and deck scows with open boxes. The deck scows proper had skips (or skip boxes) that were loaded and then later removed by derricks or cranes. The skips could be loaded into railroad cars for continued transport. This method of barge shipment was not as commonly employed as it was easier to load materials into railroad cars located on the deck of a scow (railroad float). The deck scow with open boxes was equipped with a cargo box that would be emptied by clamshell buckets or orange-peel buckets. The third major type of scow barge, the dumping scow, was utilized for moving materials into deeper waters for deposit. The bottom of the hull was fitted with trap doors, which were opened to empty the contents of the hold (Prelini 1911:191–192).

A coupling mechanism evident at both ends of each hulk at Bolivar Peninsula indicates they were consort barges, or tow-barges, wherein the individual barges could be connected to form one unit. The consort system of shipping was developed during the late 1850s, though the early barges were frequently modified sailing vessels (Rodgers and Green 2003:4). Some rectangular scow barges were fashioned to have vertical sides instead of the raked bow and stern that was characteristic of the barge (Figure 12). In some of the consort barge “chains,” these vertical-sided scow barges were placed in the center of the tow sequence with the typical scow barges comprising the first and last vessels.

Hulks at Bolivar Peninsula

Aerial photography and archeological reconnaissance of the hulks indicates there are 16 barges that are abandoned at the northwest end of Bolivar Peninsula. These hulks appear to be the remnants of open-deck scow barges whose hulls were manufactured of either wood or steel. One hulk, letter M, was wood hulled with a detachable ferrous deck (Figure 13). Hulk L also appears to be the displaced ferrous deck from either K or M. This feature could be a type of skip or skip box. Due to the condition of the remaining exposed wood-hulled barges, letters G, I, and Q, it is difficult to determine whether these watercraft were also equipped with removable ferrous decks. The barge hulks appear to be of a standardized size. The two barges for which dimensions were recorded (98 x 39 ft [33 x 12 m]) were roughly similar, albeit of slightly larger breadth to examples used on the Upper Mississippi and Ohio rivers in the early twentieth century. The barge wrecks are summarized in Table 3.

FIGURE 12. COAL TOW BARGES
A GROUP OF BARGES AT ELIZABETH, PENNSYLVANIA, IN THE EARLY 1900S (MOHNEY 2001)

FIGURE 13. REMOVABLE DECK ON BARGE M
(PHOTO BY AMY BORGENS)

TABLE 3. ABANDONED HULKS AT BOLIVAR PENINSULA

Barge Letter	Disposition	Hull Type	Deck type
A	submerged	unknown	unknown
B	submerged	unknown	unknown
C	submerged	unknown	unknown
D	submerged	unknown	unknown
E	semisubmerged	ferrous	ferrous
F	semisubmerged	ferrous	ferrous
G	semisubmerged	wood	wood
H	submerged	unknown	unknown
I	semisubmerged	wood	wood
J	submerged	unknown	unknown
K	submerged	unknown	unknown
L	submerged	none	unknown
M	semisubmerged	wood	wood with detachable ferrous deck
N	submerged	unknown	unknown
O	submerged	unknown	unknown
P	submerged	unknown	unknown
Q	semi-submerged	wood	Wood

Cursory research into barge history and construction indicates wood-hulled barges, like those at Bolivar Peninsula, were produced in standardized sizes by the mid-nineteenth century. The use of steel as a construction material began to supplant the use of wood towards the end of the nineteenth century, and by the 1940s the wood-hulled barge was all but obsolete. Though the movement of the barge hulks to Bolivar Peninsula occurred in the 1970s, the age of the vessels may greatly predate their deposition at their current location.

RECOMMENDATIONS

The following sections detail recommendations for each investigation conducted under WA 577 18 SA005. There are many man-made and environmental factors that can affect the potential for finding sites, in general, and impact site integrity. Due to the nature of marine remote-sensing surveys, wherein anomalies are located most often without an indication of their historical significance, many potential historic sites are unknown and unidentified—they are simply anomalies that bear similarities to historic wreck sites. It is therefore difficult to define existing impacts that are site-specific. A list of possible existing impacts to known and unknown shipwrecks within the project area is provided below.

Storm damage

Vessel traffic

Harbor improvements

- Dredging
- Bridge construction or maintenance
- Hurricane debris removal
- Burial
- Natural hull degradation
- Commercial fishing/shrimping

Hydraulic Probing

Hydraulic probing at the abandoned Port Bolivar slip, Santa Fe Slip No. 3, discovered the potential remains of a submerged and buried wooden-hulled vessel measuring approximately 40 x 11 ft and located 250–300 ft offshore from the beach. The target is at the position of a shipwreck that appears on a 1936 U.S. Coast Survey nautical chart. The inclusion of the wreck on the 1936 chart, in combination with the construction date of Santa Fe Slip No. 3, indicates the vessel likely sank between 1917 and 1936. Due to the historic nature of the site, PBS&J recommends avoidance of this area by a minimum of 50 m (164 ft) as stipulated by the THC. If avoidance is not feasible, ground-truthing of the site should be performed to assess the condition of the wreck and to determine NRHP eligibility.

Historic Map Research and Aerial Photography

As a result of the 2007 remote-sensing survey for the proposed causeway, PBS&J recorded 46 potential shipwreck magnetometer anomalies within the Galveston-Bolivar Causeway project area. As many as 12 of these anomalies are in the vicinity of charted wrecks identified during the National Archives map research. PBS&J recommends that those maps listed in Table 2, which show historic and modern wreck locations and for which a photocopy has been made, be geo-referenced due to their ability to clarify the remote-sensing data. In this manner, potentially historic shipwreck anomalies can be isolated from anomalies more likely to be associated with modern wrecks. This information can then be used to prioritize future diver ground-truthing of selected targets.

Derelict Hulk Documentation

Visual assessment and acoustic underwater examination of a collection of hulks at the northwest tip of Bolivar Peninsula have identified 16 abandoned barges. The barges were moved to their present location in 1970, but their construction materials indicate they could bear historic significance. The hulls are fabricated from either wood or metal. Based on the deterioration of the vessels, it appears the larger portion had wooden hulls. The symmetrical grouping of the vessels agrees with the suggestion the barges were used as a dock facility. The use of steel barges began to supplant those of wood by the turn of the twentieth century. Wooden hulled barges were all but obsolete by the early 1940s. There is a high probability that many of these barges were constructed prior to the mid-twentieth century, therefore classifying them as historic. PBS&J recommends continued archival research into methods of barge

construction and a history of the barge assemblage itself as a means to ascertain a more exact period of construction and use. The frequency of these specific types of barge wrecks is also unknown within the archeological community; several barges are still relatively intact and could merit thorough documentation. A more in-depth examination of these barges, their history, and construction might determine whether they warrant NRHP assessment.

REFERENCES CITED

Anthamatten, Fred L.

2007 Fred Anthamatten to Janelle Stokes. Email correspondence, August 20, 2007.

Arnold, J. Barto III

1987 *Marine Magnetometer Survey of Archeological Materials Found Near Galveston, Texas*. Texas Antiquities Committee, Publication No. 10. Texas Historical Commission, Austin.

Automated Wreck and Obstruction Information System (AWOIS)

2008 Available online: http://www.nauticalcharts.noaa.gov/hsd/AWOIS_download.html

Barrick, Frances

2001 Marine History Discovered in 2001 Finally Raised Out of Southampton's Sand. TheRecord.com. <http://www.chantryisland.com/barge%20article.pdf> (accessed December 23, 2008).

Berketa, Rick

n.d. Niagara Falls: The Scow (Sand Barge) & The Subchaser – A History. <http://www.iaw.com/~falls/scow.html> (accessed December 26, 2008).

Borgens, Amy

2007 *Interim Report: Documentation of Abandoned Vessel Hulks Near Port Bolivar, Galveston-Bolivar Causeway Project, Galveston County, Texas*. Document No. 070194. PBS&J, Austin.

Borgens, Amy A., Sara G. Hoskins, Robert L. Gearhart II, Dan Hudson, and Doug Jones

2007 *Marine Remote-Sensing Survey of the Proposed Galveston-Bolivar Causeway, Galveston County, Texas*. Document No. 070173. PBS&J, Austin.

Bunn, Jim, Ashley Phillips, Ryan Owens, and Shayrn Alfonsi

2008 Ike's Wrath: Entire Towns Disappear. ABC News. <http://abcnews.go.com/US/story?id=5803468&page=1> (accessed December 20, 2008).

Campbell, Randolph B.

2003 *Gone to Texas: A History of the Lone Star State*. Oxford University Press, New York.

Cotham, Edward T., Jr.

1998 *Battle on the Bay: The Civil War Struggle for Galveston*. University of Texas Press, Austin

Dana, Richard T.

1921 *Handbook of Construction Equipment, Its Cost and Use*. McGraw-Hill Book Company Inc., New York.

Daniels, A. Pat

- 1985 *Bolivar! Gulf Coast Peninsula*. Peninsula Press of Texas, Crystal Beach, Texas.
- 1992 *A Fascinating Voyage on the Bolivar Ferry*. Peninsula Press of Texas, Crystal Beach, Texas.
- 2007 *Handbook of Texas Online*, s.v. "Port Bolivar, Texas," <http://www.tsha.utexas.edu/handbook/online/articles/PP/hgp8.html> (accessed July 12, 2007).

Delgado, James P. (and a National Park Service Maritime Task Force)

- 1992 *National Register Bulletin: Nominating Historic Vessels and Shipwrecks to the National Register of Historic Places*. National Register Bulletin 20. U.S. Department of the Interior, National Park Service, National Register, History and Education, Washington, D.C.

Ellis, Lain

- 2007 Lain Ellis to Janelle Stokes. Email correspondence, August 20, 2007.

Fay, John

- 1900 The Galveston Tragedy. *Cosmopolitan* 33-42 (November 1900).

Foster, Eugene R., John Gilvar, and Steven D. Hoyt

- 1993 *Archival Research, Houston-Galveston Navigation Channels, Texas Project, Galveston, Harris, Liberty and Chambers Counties, Texas*. Document No. 920918. Submitted to the U.S. Army Corps of Engineers, Galveston District by Espy, Huston & Associates, Inc., Austin, Texas.

Foster, Eugene R., Jr., Ty Summerville, and Thomas Brown

- 2006 *The Texas Historical Overlay: A Geographic Information System of Historic Map Images for Planning Transportation Projects in Texas*. Document No. 060206. PBS&J, Austin.

Francaviglia, Richard V.

- 1998 *From Sail to Steam: Four Centuries of Texas Maritime History, 1500–1900*. University of Texas Press, Austin.

Galveston Daily News, The

- 1947 Monday Morning Notebook. *Galveston Daily News*, November 17, 1947, p. 4.

Gearhart Robert L., Amy Borgens, Sara Hoskins, Doug Jones, Jenna Enright, and Jeff Enright

- 2006 *Diving Assessment of Two Anomalies for Historic Properties Investigations and National Register Assessment of Site 41GV151 (USS Westfield), Texas City Channel Improvement Project, Galveston County, Galveston Bay, Texas*. Draft report submitted to the U.S. Army Corps of Engineers, Galveston District. Document No. 060313. PBS&J, Austin.

Gearhart, Robert L. II, Doug S. Jones, James T. Abbott, Lain Ellis, and Charles E. Pearson

- 2006 *Archeological Survey of the Bolivar Ferry Terminal Expansion and Underwater Evaluation of One Unidentified Magnetic Anomaly, Bolivar Peninsula, Galveston*

County, Texas. Texas Department of Transportation, Austin, Texas, and Coastal Environments, Inc., Baton Rouge, Louisiana.

Gearhart, Robert L., Douglas S. Jones, Jeffrey M. Enright, Jenna Enright, and Ty Summerville

- 2005 *Close-Order Remote-Sensing Survey of Five Anomalies and Proposed Channel Modifications for Historic Properties Investigations, Texas City Channel Improvements, Galveston Bay, Texas.* Document No. 040322. Prepared for the U.S. Army Corps of Engineers, Galveston District, by PBS&J, Austin.

Gearhart, Robert L., and James S. Schmidt

- 2002 *Underwater Remote-Sensing Survey of Selected Areas, GIWW, High Island to Brazos River, Brazoria and Galveston Counties, Texas.* Document No. 990817. Prepared for the Department of the Army, Galveston District, Corps of Engineers by PBS&J, Austin.

Hays, T.R.

- 1982 *Cultural Resource Survey, Texas City Channel, Galveston Bay, Texas.* Prepared for the U.S. Army Corps of Engineers, Galveston District, by the Archaeology Program, Institute of Applied Sciences, North Texas State University.

Hedderwick, Peter

- 1830 *Treatise on Marine Architecture.* Edinburgh.

Hoyt, Steven D.

- 1992 *Underwater Investigations, Houston-Galveston Navigation Channels, Texas Project, Galveston, Harris, Liberty and Chambers Counties, Texas.* Document No. 920111. Prepared for the U.S. Army Corps of Engineers, Galveston District, by Espey, Huston & Associates, Inc., Austin, Texas.
- 1993 *Offshore Underwater Investigations, Houston-Galveston Navigation Channels, Texas Project, Galveston, Harris, Liberty and Chambers Counties, Texas.* Document No. 930196. Submitted to the U.S. Army Corps of Engineers, Galveston District by PBS&J, Austin.

Hoyt, Steven D., Eugene R. Foster, Victor Galan, and James S. Schmidt

- 1999 *Reconnaissance Level Study of Historic Period Resources, Selected Areas Along the GIWW, High Island to Brazos River Floodgate, Brazoria, Chambers and Galveston Counties, Texas.* Document No. 970729. Prepared for Department of the Army, Galveston District, Corps of Engineers, by PBS&J, Austin.

Hoyt, Steven D., Eugene R. Foster, and James S. Schmidt

- 1998 *Intensive Archival Research, Close-Order Magnetometer Survey, Dating, and Offshore Diving, Houston-Galveston Navigation Channels, Texas Project, Galveston, Harris, Liberty, and Chambers Counties, Texas Offshore, Galveston Bay, and Houston Ship Channel.* Document No. 970571. Prepared for Department of the Army, Galveston District, Corps of Engineers, by Espey, Huston & Associates, Austin, Texas.

Hoyt, Steven D., and James S. Schmidt

- 1993 *Bay Ground Truthing: Phase I and Phase II Houston-Galveston Navigational Channels Texas Project, Galveston, Harris, Liberty, and Chamber Counties, Texas.* Document No. 930440. Espey Huston & Associates, Inc., Austin, Texas.

Hudson, Dan, and Amy Borgens

- 2007 *Interim Report, Hydraulic Probing Survey for Abandoned Vessels, Proposed Galveston-Bolivar Causeway Project, Galveston County, Texas.* Document No. 070189. PBS&J, Austin.

Jones, Doug, and Amy Borgens

- 2007 *Interim Report, Aerial Photo and Historic Map Research of the Galveston-Bolivar Causeway Project Area, Galveston County, Texas.* Document No. 070192. PBS&J, Austin.

Jones, Douglas S., Jeffrey M. Enright, Jenna Watts, and Robert L. Gearhart II

- 2002 *Side-Scan Sonar, Magnetometer, and Bathymetric Survey to Map Oyster Habitat and Submerged Cultural Resources for the Proposed Shoal Point Container Terminal, Galveston Bay, Texas.* Document No. 020349. Prepared for the City of Texas City, by PBS&J, Austin.

McComb, David G.

- 1986 *Galveston: A History.* University of Texas Press, Austin.

Mohney, Jay

- 2001 *Steamboat Building in Elizabeth PA: A Journal of Daily Activities at the Elizabeth Marine Ways 1898 to 1925.* Updated December 6, 2008. http://images.google.com/imgres?imgurl=http://freepages.history.rootsweb.ancestry.com/~jmohney/Resolute_wharfboat_a.jpg&imgrefurl=http://freepages.history.rootsweb.ancestry.com/~jmohney/toc.htm&usg=__5zIsY3-Jn-ZsQyIPsUvCXZIWizs=&h=495&w=750&sz=142&hl=en&start=7&um=1&tbnid=rYgjO765Rph3kM:&tbnh=93&tbnw=141&prev=/images%3Fq%3Dwharfboat%26um%3D1%26hl%3Den%26rlz%3D1T4GPEA_enUS292US305 (accessed December 23, 2008).

National Oceanic and Atmospheric Administration (NOAA)

- 1974–2004 Chart No. 11324, “Galveston Entrance.” National Archives and Records Administration, Record Group 370. College Park, Maryland.

Newark Daily Advocate (Newark, Ohio)

- 1900 Galveston: Second Largest Texas City Has a Population of 37,789. September 10, 1900.

Osborne, Walter

- 1969 *Tug, Tow, and Barge.* Van Nostrand Reinhold Company, New York.

Pees, Samuel T.

- 2004a Growth of Barges. <http://www.petroleumhistory.org/OilHistory/pages/barges/growth.html> (accessed December 23, 2008).

- 2004b The Demise of Wooden Barges. <http://www.petroleumhistory.org/OilHistory/pages/barges/demise.html> (accessed December 23, 2008).
- Pike, John
- 2006 Barge History. <http://www.globalsecurity.org/military/systems/ship/barge-hist.htm> (accessed December 23, 2008).
- Pool, Sniley N.
- 2008 The Storm This Time. Image printed in "Pictures that Mattered." *Time* 172 (no. 26):125.
- Prelini, Charles
- 1911 *Dredges and Dredging*. D. Van Nostrand Company, New York.
- Rodgers, Bradley A., and Russell T. Green
- 2003 *Of Limestone and Labor Shipwrecks of the Stone Trade: The 1999 Bullhead Point Stone Barge Investigation*. Research Report No. 11. East Carolina University, Program in Maritime History and Nautical Archaeology, Greenville, North Carolina.
- Schmidt, James S., Steven D. Hoyt, and Robert L. Gearhart
- 1995 *Magnetometer Survey and Diving, Gulf Intracoastal Waterway and Houston Ship Channel Intersection, Galveston County, Texas*. Document No. 950777. Prepared for the U.S. Army Corps of Engineers, Galveston District, by PBS&J, Austin, Texas.
- Sulakowski, Valery
- ca. 1865 *Pelican Spit No. 107*. Collection of the National Archives, Washington, D.C.
- Swafford, Rusty
- 2007 Rusty Swafford to Carolyn Murphy. Email correspondence, August 21, 2007.
- Taliaferro, Henry G., Jane A. Kenamore, and Uli Haller
- 1988 *Cartographic Sources in the Rosenberg Library*. Texas A&M University Press, College Station.
- Texas Highway Department
- 1963 *A Ferry Tale*. Texas Highways. TxDOT Public Information Office, Austin.
- Tobin International Ltd.
- 1930 *Port Bolivar and Galveston Quads*. Exposures 794-03-072, 070, 068, 066 and 794-02-059, 061.
- 1956 *Port Bolivar and Galveston Quads*. Exposures 5711-22-207, 205 and 5711-16-174, 176.
- Texas Natural Resources Information Service (TNRIS)
- 1954 Galveston County Aerial Photograph.
- 1969 Galveston County Aerial Photograph.
- 1978 Galveston County Aerial Photograph.

U.S. Army Corps of Engineers (USACE)

- 1888 *Galveston Harbor, Texas*. National Archives and Records Administration, Record Group 23, Library and Archives Map Collection, File Unit 877-1888. College Park, Maryland.

U.S. Coast and Geodetic Survey

- 1918 *Galveston Bay, Texas*. Chart 204. Galveston Bay and entrance from surveys by Corps of Engineers, U.S.A. to 1917. U.S. Coast and Geodetic Survey, Washington, D.C.

U.S. Coast Survey

- 1853–1951 *Galveston Entrance, Texas*. Chart 520, National Archives and Records Administration, Record Group 23, Library and Archives Map Collection. College Park, Maryland.

Watts, Jenna, Douglas S. Jones, Robert L. Gearhart II, and Jeffrey M. Enright

- 2004 *Marine Cultural Resources Close-Order, Remote-Sensing, and Hydroprobing Surveys of Anomaly SP2 for the Proposed Shoal Point Container Terminal, Galveston Bay, Texas*. Document No. 030193. Prepared for Stevedoring Services of America by PBS&J, Austin, Texas.

Wiggins, Melanie

- 1990 *They Made Their Own Law: Stories of Bolivar Peninsula*. Rice University Press, Houston, Texas.

Appendix A

Interim Report: Hydraulic Probing of a Potential Shipwreck Site, Proposed Galveston-Bolivar Causeway Project Galveston County, Texas

Document No. 070189
PBS&J Job No. 441759.18

INTERIM REPORT
HYDRAULIC PROBING OF A
POTENTIAL SHIPWRECK SITE, PROPOSED
GALVESTON-BOLIVAR CAUSEWAY PROJECT
GALVESTON COUNTY, TEXAS

TEXAS ANTIQUITIES PERMIT No. 4581
CONTRACT No. 577XXSA005
WORK AUTHORIZATION No. 577 18 SA005
CSJ No. 0367-05-042

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August 2007

Contents

	Page
List of Figures	A-iv
List of Tables	A-iv
METHODS.....	A-1
RESULTS OF THE HYDRAULIC PROBING.....	A-4
RECOMMENDATIONS.....	A-6
REFERENCES CITED	A-18

Figures

		Page
1	Bolivar Peninsula Probing Survey Area.....	A-2
2	Abandoned Vessel in Survey Area with Masts Exposed	A-3
3	1954 Aerial Photograph.....	A-4
4	Bolivar Probe Survey Distribution	A-5

Tables

		Page
1	Probe Results.....	A-7

INTERIM REPORT: BOLIVAR HYDRAULIC PROBING SURVEY

PBS&J has completed a hydraulic probing survey to investigate potential historic remains in the abandoned Santa Fe Slip No. 3 of Port Bolivar adjacent to the northern breakwater of the Bolivar ferry terminal (Figure 1) in Galveston County, Texas, for the Texas Department of Transportation (TxDOT). The present study is part of a larger effort to survey and identify historic resources in the Area of Potential Effect (APE) of the proposed Galveston-Bolivar Causeway Project, which would replace the State Highway (SH) 87 ferry service between Galveston Island and Bolivar Peninsula. One aspect of this study involves examination of potential landfall locations for the causeway on the southern shore of Bolivar Peninsula. Of particular concern is the vicinity of Port Bolivar, a commercial port facility that was heavily used during the first half of the twentieth century, including the period of World War I. In addition to the port facility remains, there is a high potential for abandoned historic vessels to be present in and around Port Bolivar. Historic-period aerial photography, as well as historic charts and maps, appear to show several wrecked vessels concentrated at Port Bolivar, including a 1936 historic chart that indicates a visible wreck within the current study area (Figure 2). A 1954 aerial photograph depicts an unknown feature in the study area (Figure 3). Evidence from historic sources concerning vessel losses combined with the overall historic context of this port facility during the early 1900s required a thorough probing of the area to confirm the presence or absence of potentially significant historical remains.

METHODS

On June 25 through 29 and July 2 and 3, 2007, PBS&J conducted a systematic hydraulic probe survey utilizing a small-diameter steel pipe and water pump at the charted location of a historic wreck. The procedures and parameters of the hydraulic probing survey were determined through consultation with the State of Texas Marine Archeologist, Steve Hoyt. Probing was conducted from the deck of the 20-foot (ft) aluminum-hulled *PeeWee McKinney* as well as by wading in the bay. The positions of probes were provided by a Trimble Ag132 DGPS system and recorded using HYDROpro® software. Probing was done manually utilizing a 5.5-horsepower Honda water pump and ¾-inch-diameter (1.9-centimeter) steel pipes that were 14 feet (ft) (4.3 meters [m]) and 20 ft (6.1 m) in length. Probe depths were to a maximum of 22 ft (5.5 m) below the water line, or to the depth of a refusal due to impenetrable wood, clay, rock, or shell layers. In the majority of instances, the entire probe length penetrated to a depth such that the top of the probe was even with the water surface or ground level for beach probes. Exceptions occurred only where an impenetrable wood, clay, or shell layer was encountered at a relatively shallow depth.

Figure 1: Bolivar Peninsula Probing Survey Area

Figure 2: Abandoned vessel in survey area with masts exposed.
U.S. Coast Survey Chart 520 (1936) (Figure by Amy Borgens)

Figure 3: 1954 Aerial Photograph
(Figure by Amy Borgens)

In the event that material (e.g., clay or shell) was encountered that could not be reasonably penetrated by two persons manually operating a hydraulic probe, then penetration beyond the level of that material was not required. The objective of the probing was to determine the presence or absence of potential historic shipwrecks. The horizontal extent of probing is a 20-m-wide strip adjacent to pilings remaining from Port Bolivar and extending into the water from the vegetation line on the beach for a distance of 125 m. The probes were spaced at 3-m intervals, and all probe locations were mapped using differential GPS with submeter accuracy (Figure 4).

RESULTS OF THE HYDRAULIC PROBING

Water depths in the project area ranged from 0 to 5 ft (0 to 1.5 m), and the depths of probe penetration ranged from 3 to 22 ft (0.9 to 6.7 m) below the water surface. While using only a 20-foot hydraulic probe, the sediment occasionally gave way and allowed the probe to be pushed 2 ft beneath the water surface. In these instances, the maximum depth is reflected as 22 ft in the data table.

Figure 4: Bolivar Probe Survey Distribution
(Image by Dan Hudson and Amy Borgens)

A total of 401 probes were completed (Table 1). All but 44 of the 401 probes were negative. Of the 44 positive probes where wood is believed to be present, 29 are tightly clustered roughly 250–300 ft from the shoreline. A historic chart dating from 1936 provides evidence of an exposed wreck in this approximate location (U.S. Coast Survey 1936). Because of that fact, particular attention was given to this area in order to determine the approximate dimensions of the submerged object. The dimensions of this suspected wrecked vessel are approximately 40 ft by 11 ft. These clustered probes average 17–18 ft in depth below the water surface. Several wood samples were collected from the end of the probe during the probing of this object and are available for analysis.

Of the other 15 positive probes, they are more randomly spaced and likely relate to fallen sections of the old pier structure or debris and not to any submerged watercraft. Many of these 15 probe locations released an oily sheen on the water along with a pungent smell that is characteristic of creosoted wood. Creosote has long been used as a wood preservative, especially for pilings and other structures in marine environments to protect against wood-eating marine organisms. This reinforces the theory that these features are part of the old slip bulkhead rather than part of any submerged wreckage.

Aerial photographs have been useful in determining the position of the former shoreline and configuration of the old slip. A 1954 aerial photo originally thought to have shown an unknown feature in the slip is now believed to possibly be floating pontoons (see Figure 3). This determination was made as a result of the probing data plus a more thorough analysis of the photograph, which reveals an object that is asymmetrical and lacks the uniformity of shape characteristic of watercraft. This conclusion is supported by the absence of any positive probes in this area.

As determined from the probing, the bottom sediments in the survey area were comprised mainly of varying combinations of soft mud, shell hash, sand, and clay. The density of the shell is highest along the edge of the old bulkhead and thins out the farther south one probes. The pier behind the former bulkhead was created from fill consisting of shell and bricks, but over time the importance and usefulness of the pier structure waned. As a result, the bulkhead fell into disrepair and collapsed, allowing the fill material to slide south into the slip.

RECOMMENDATIONS

The suspected shipwreck in the APE is potentially at least 71 years old. The pre-1936 date of this vessel indicates the potential for historical significance. Therefore, should the proposed Galveston-Bolivar Causeway Project proceed, it is recommended that any work carried out in this area avoid the area by at least 50 m as stipulated by the Texas Historical Commission.

Table 1: Probe Results

Probe #	Easting	Northing	Method	Total Depth of Penetration (Feet)	Material Encountered at Total Depth
1	327237.8	3249638.8	20-foot Hydraulic Probe	18	Silt
2	327174.8	3249632.7	20-foot Hydraulic Probe	18	Silt
3	327170.8	3249637.7	20-foot Hydraulic Probe	18	Silt
4	327171.9	3249631.1	20-foot Hydraulic Probe	18	Silt
5	327174.6	3249635.9	20-foot Hydraulic Probe	18	Silt
6	327171.5	3249641.6	20-foot Hydraulic Probe	18	Silt
7	327174.9	3249638.1	20-foot Hydraulic Probe	18	Silt
8	327172.3	3249641.5	20-foot Hydraulic Probe	18	Silt
9	327171.3	3249644.6	20-foot Hydraulic Probe	18	Silt
10	327177.9	3249638.5	20-foot Hydraulic Probe	18	Silt
11	327177.9	3249641.2	20-foot Hydraulic Probe	18	Silt
12	327175.6	3249643.9	20-foot Hydraulic Probe	18	Silt
13	327177.2	3249631.1	20-foot Hydraulic Probe	18	Silt
14	327178.5	3249644.4	20-foot Hydraulic Probe	18	Silt
15	327181.1	3249641.4	20-foot Hydraulic Probe	18	Silt
16	327180.3	3249637.1	20-foot Hydraulic Probe	18	Silt
17	327179.0	3249634.8	20-foot Hydraulic Probe	18	Silt
18	327179.9	3249647.1	20-foot Hydraulic Probe	18	Silt
19	327183.7	3249643.1	20-foot Hydraulic Probe	18	Silt
20	327183.0	3249639.9	20-foot Hydraulic Probe	18	Silt
21	327182.5	3249642.7	20-foot Hydraulic Probe	18	Silt
22	327226.3	3249660.4	14-foot Hydraulic Probe	13	Clay
23	327228.3	3249656.5	14-foot Hydraulic Probe	12.5	Clay
24	327227.6	3249659.4	14-foot Hydraulic Probe	14	Silt
25	327230.8	3249654.5	14-foot Hydraulic Probe	14	Silt
26	327233.1	3249652.9	14-foot Hydraulic Probe	14	Silt
27	327235.0	3249650.2	14-foot Hydraulic Probe	14	Silt
28	327237.4	3249648.6	14-foot Hydraulic Probe	14	Silt
29	327239.8	3249650.4	14-foot Hydraulic Probe	14	Silt
30	327236.0	3249651.6	14-foot Hydraulic Probe	14	Silt
31	327234.3	3249654.7	14-foot Hydraulic Probe	14	Silt
32	327232.4	3249657.3	14-foot Hydraulic Probe	13	Wood
33	327232.8	3249656.1	14-foot Hydraulic Probe	14	Silt
34	327230.2	3249657.9	14-foot Hydraulic Probe	14	Silt
35	327230.4	3249658.4	14-foot Hydraulic Probe	not used	
36	327231.0	3249657.5	14-foot Hydraulic Probe	14	Silt

Table 1 (Cont'd)

Probe #	Easting	Northing	Method	Total Depth of Penetration (Feet)	Material Encountered at Total Depth
37	327228.9	3249661.0	14-foot Hydraulic Probe	14	Silt
38	327227.9	3249663.7	14-foot Hydraulic Probe	14	Clay
39	327226.7	3249666.3	14-foot Hydraulic Probe	14	Clay
40	327229.3	3249667.8	14-foot Hydraulic Probe	14	Silt
41	327229.0	3249670.9	14-foot Hydraulic Probe	3	Wood
42	327227.5	3249673.6	14-foot Hydraulic Probe	14	Silt
43	327226.3	3249675.5	14-foot Hydraulic Probe	3	Wood
44	327228.8	3249676.8	14-foot Hydraulic Probe	14	Silt
45	327229.2	3249674.0	14-foot Hydraulic Probe	14	Silt
46	327231.1	3249671.4	14-foot Hydraulic Probe	14	Silt
47	327232.1	3249668.9	14-foot Hydraulic Probe	14	Shell
48	327233.6	3249665.9	14-foot Hydraulic Probe	14	Silt
49	327235.1	3249663.1	14-foot Hydraulic Probe	14	Silt
50	327236.0	3249660.5	14-foot Hydraulic Probe	14	Silt
51	327236.9	3249657.5	14-foot Hydraulic Probe	14	Silt
52	327235.1	3249656.7	14-foot Hydraulic Probe	14	Silt
53	327233.3	3249658.7	14-foot Hydraulic Probe	14	Silt
54	327231.2	3249661.3	14-foot Hydraulic Probe	14	Clay
55	327229.9	3249664.2	14-foot Hydraulic Probe	14	Silt
56	327229.5	3249666.1	14-foot Hydraulic Probe	14	Shell
57	327231.5	3249666.9	14-foot Hydraulic Probe	14	Shell
58	327231.8	3249664.2	14-foot Hydraulic Probe	14	Silt
59	327233.2	3249661.8	14-foot Hydraulic Probe	14	Silt
60	327239.1	3249658.3	14-foot Hydraulic Probe	14	Silt
61	327238.4	3249661.1	14-foot Hydraulic Probe	14	Silt
62	327237.1	3249663.9	14-foot Hydraulic Probe	14	Silt
63	327235.8	3249666.6	14-foot Hydraulic Probe	14	Silt
64	327234.7	3249668.7	14-foot Hydraulic Probe	14	Silt
65	327233.7	3249671.6	14-foot Hydraulic Probe	14	Shell
66	327231.4	3249673.7	14-foot Hydraulic Probe	14	Shell
67	327230.3	3249676.2	14-foot Hydraulic Probe	7	Shell
68	327232.2	3249676.6	14-foot Hydraulic Probe	7	Shell
69	327234.3	3249675.4	14-foot Hydraulic Probe	9	Shell
70	327235.0	3249672.7	14-foot Hydraulic Probe	14	Silt
71	327236.5	3249669.9	14-foot Hydraulic Probe	13	Clay
72	327237.7	3249667.1	14-foot Hydraulic Probe	14	Silt
73	327239.6	3249664.4	14-foot Hydraulic Probe	14	Silt

Table 1 (Cont'd)

Probe #	Easting	Northing	Method	Total Depth of Penetration (Feet)	Material Encountered at Total Depth
74	327240.8	3249661.2	14-foot Hydraulic Probe	14	Silt
75	327241.6	3249658.6	14-foot Hydraulic Probe	14	Silt
76	327244.4	3249659.6	14-foot Hydraulic Probe	14	Silt
77	327243.7	3249662.5	14-foot Hydraulic Probe	14	Silt
78	327242.4	3249664.3	14-foot Hydraulic Probe	14	Silt
79	327240.9	3249667.1	14-foot Hydraulic Probe	14	Silt
80	327238.8	3249669.6	14-foot Hydraulic Probe	14	Shell
81	327237.6	3249672.6	14-foot Hydraulic Probe	11	Wood
82	327236.9	3249675.5	14-foot Hydraulic Probe	14	Shell
83	327235.5	3249677.5	14-foot Hydraulic Probe	14	Clay
84	327238.3	3249678.9	14-foot Hydraulic Probe	14	Silt
85	327239.4	3249675.9	14-foot Hydraulic Probe	6	Shell
86	327241.4	3249672.6	14-foot Hydraulic Probe	9	Clay
87	327242.7	3249669.2	14-foot Hydraulic Probe	13.5	Clay
88	327244.8	3249666.6	14-foot Hydraulic Probe	14	Silt
89	327246.0	3249664.0	14-foot Hydraulic Probe	14	Silt
90	327247.4	3249660.8	14-foot Hydraulic Probe	14	Silt
91	327250.3	3249662.0	14-foot Hydraulic Probe	14	Silt
92	327249.1	3249664.9	14-foot Hydraulic Probe	14	Silt
93	327247.6	3249667.2	14-foot Hydraulic Probe	14	Silt
94	327246.3	3249669.6	14-foot Hydraulic Probe	14	Silt
95	327245.1	3249673.0	14-foot Hydraulic Probe	14	Shell
96	327242.9	3249675.9	14-foot Hydraulic Probe	14	Shell
97	327241.6	3249678.6	14-foot Hydraulic Probe	14	Shell
98	327241.1	3249680.5	14-foot Hydraulic Probe	14	Shell
99	327244.0	3249681.7	14-foot Hydraulic Probe	14	Shell
100	327245.6	3249678.6	14-foot Hydraulic Probe	14	Shell
101	327246.9	3249675.6	14-foot Hydraulic Probe	14	Silt
102	327248.5	3249671.8	14-foot Hydraulic Probe	14	Shell
103	327250.0	3249669.5	14-foot Hydraulic Probe	14	Shell
104	327251.5	3249665.8	14-foot Hydraulic Probe	14	Shell
105	327253.0	3249663.0	14-foot Hydraulic Probe	14	Silt
106	327226.3	3249669.6	14-foot Hydraulic Probe	3	Wood
107	327224.6	3249672.2	14-foot Hydraulic Probe	14	Silt
108	327223.2	3249674.4	14-foot Hydraulic Probe	12	Shell
109	327222.8	3249668.3	14-foot Hydraulic Probe	14	Silt
110	327224.5	3249664.8	14-foot Hydraulic Probe	14	Clay

Table 1 (Cont'd)

Probe #	Easting	Northing	Method	Total Depth of Penetration (Feet)	Material Encountered at Total Depth
111	327224.3	3249662.3	14-foot Hydraulic Probe	14	Silt
112	327224.6	3249659.9	14-foot Hydraulic Probe	14	Silt
113	327226.1	3249655.7	20-foot Hydraulic Probe	20	Silt
114	327226.5	3249658.2	20-foot Hydraulic Probe	20	Silt
115	327224.7	3249657.3	20-foot Hydraulic Probe	not used	
116	327222.3	3249657.0	20-foot Hydraulic Probe	20	Silt
117	327224.4	3249654.6	20-foot Hydraulic Probe	20	Silt
118	327221.9	3249654.7	20-foot Hydraulic Probe	20	Silt
119	327222.5	3249659.8	20-foot Hydraulic Probe	18	Silt
120	327221.4	3249663.3	20-foot Hydraulic Probe	14	Shell
121	327221.7	3249667.6	20-foot Hydraulic Probe	10	Wood
122	327220.9	3249670.2	20-foot Hydraulic Probe	18	Silt
123	327222.9	3249665.6	20-foot Hydraulic Probe	10	Shell
124	327219.2	3249661.9	20-foot Hydraulic Probe	12	Shell
125	327208.1	3249654.6	20-foot Hydraulic Probe	20	Silt
126	327209.0	3249651.7	20-foot Hydraulic Probe	20	Silt
127	327210.2	3249648.5	20-foot Hydraulic Probe	20	Silt
128	327213.2	3249649.8	20-foot Hydraulic Probe	20	Silt
129	327216.3	3249651.0	20-foot Hydraulic Probe	20	Silt
130	327219.9	3249652.9	20-foot Hydraulic Probe	20	Silt
131	327219.6	3249656.9	20-foot Hydraulic Probe	20	Silt
132	327217.5	3249654.5	20-foot Hydraulic Probe	20	Silt
133	327215.5	3249653.2	20-foot Hydraulic Probe	20	Silt
134	327212.3	3249651.9	20-foot Hydraulic Probe	20	Silt
135	327206.8	3249650.5	20-foot Hydraulic Probe	20	Silt
136	327206.8	3249650.5	20-foot Hydraulic Probe	20	Silt
137	327206.1	3249652.6	20-foot Hydraulic Probe	20	Silt
138	327210.4	3249654.2	20-foot Hydraulic Probe	20	Silt
139	327213.3	3249654.2	20-foot Hydraulic Probe	20	Silt
140	327215.8	3249655.9	20-foot Hydraulic Probe	19	Silt
141	327219.3	3249660.1	20-foot Hydraulic Probe	20	Silt
142	327217.2	3249657.9	20-foot Hydraulic Probe	20	Silt
143	327213.4	3249658.0	20-foot Hydraulic Probe	12	Shell
144	327211.4	3249655.5	20-foot Hydraulic Probe	19	Shell
145	327208.4	3249656.5	20-foot Hydraulic Probe	20	Silt
146	327208.4	3249656.5	20-foot Hydraulic Probe	20	Silt
147	327210.4	3249659.3	20-foot Hydraulic Probe	14	Shell

Table 1 (Cont'd)

Probe #	Easting	Northing	Method	Total Depth of Penetration (Feet)	Material Encountered at Total Depth
148	327207.8	3249658.9	20-foot Hydraulic Probe	13	Shell
149	327213.2	3249660.4	20-foot Hydraulic Probe	18	Shell
150	327216.3	3249661.1	20-foot Hydraulic Probe	18	Shell
151	327221.5	3249665.6	20-foot Hydraulic Probe	17	Shell
152	327219.2	3249664.8	20-foot Hydraulic Probe	15	Shell
153	327216.4	3249663.5	20-foot Hydraulic Probe	20	Silt
154	327213.6	3249662.2	20-foot Hydraulic Probe	17	Wood
155	327209.6	3249662.5	20-foot Hydraulic Probe	not used	
156	327210.9	3249662.0	20-foot Hydraulic Probe	18	Shell
157	327208.8	3249662.6	20-foot Hydraulic Probe	15	Shell
158	327206.5	3249661.0	20-foot Hydraulic Probe	18	Shell
159	327206.4	3249663.9	20-foot Hydraulic Probe	18	Silt
160	327209.2	3249665.5	20-foot Hydraulic Probe	18	Silt
161	327210.9	3249664.4	20-foot Hydraulic Probe	10	Shell
162	327213.4	3249664.9	20-foot Hydraulic Probe	18	Silt
163	327216.8	3249666.3	20-foot Hydraulic Probe	7	Wood
164	327219.0	3249668.5	20-foot Hydraulic Probe	18	Silt
165	327217.6	3249671.6	20-foot Hydraulic Probe	9	Shell
166	327216.7	3249668.9	20-foot Hydraulic Probe	17	Shell
167	327214.7	3249667.2	20-foot Hydraulic Probe	9	Wood
168	327204.9	3249656.0	20-foot Hydraulic Probe	17	Shell
169	327208.0	3249647.7	20-foot Hydraulic Probe	20	Silt
170	327208.1	3249647.7	20-foot Hydraulic Probe	19	Silt
171	327204.6	3249647.3	20-foot Hydraulic Probe	19	Silt
172	327200.7	3249645.5	20-foot Hydraulic Probe	20	Silt
173	327196.1	3249642.6	20-foot Hydraulic Probe	20	Silt
174	327192.4	3249640.9	20-foot Hydraulic Probe	20	Silt
175	327190.4	3249641.6	20-foot Hydraulic Probe	20	Silt
176	327198.2	3249644.4	20-foot Hydraulic Probe	20	Silt
177	327195.8	3249644.7	20-foot Hydraulic Probe	20	Silt
178	327194.7	3249647.2	20-foot Hydraulic Probe	20	Silt
179	327196.6	3249649.1	20-foot Hydraulic Probe	20	Silt
180	327199.0	3249647.4	20-foot Hydraulic Probe	20	Silt
181	327201.5	3249649.8	20-foot Hydraulic Probe	20	Silt
182	327202.5	3249646.9	20-foot Hydraulic Probe	20	Silt
183	327204.3	3249649.2	20-foot Hydraulic Probe	20	Silt
184	327202.8	3249653.1	20-foot Hydraulic Probe	20	Silt

Table 1 (Cont'd)

Probe #	Easting	Northing	Method	Total Depth of Penetration (Feet)	Material Encountered at Total Depth
185	327201.2	3249652.3	20-foot Hydraulic Probe	19	Silt
186	327199.8	3249651.7	20-foot Hydraulic Probe	20	Silt
187	327197.9	3249650.8	20-foot Hydraulic Probe	20	Silt
188	327193.8	3249649.1	20-foot Hydraulic Probe	20	Silt
189	327191.5	3249648.0	20-foot Hydraulic Probe	18	Silt
190	327188.7	3249646.0	20-foot Hydraulic Probe	20	Silt
191	327189.7	3249643.6	20-foot Hydraulic Probe	20	Silt
192	327193.1	3249644.8	20-foot Hydraulic Probe	20	Silt
193	327192.6	3249642.6	20-foot Hydraulic Probe	20	Silt
194	327191.4	3249645.5	20-foot Hydraulic Probe	20	Silt
195	327188.4	3249649.4	20-foot Hydraulic Probe	20	Silt
196	327190.9	3249650.9	20-foot Hydraulic Probe	20	Silt
197	327193.0	3249651.6	20-foot Hydraulic Probe	20	Silt
198	327195.9	3249653.0	20-foot Hydraulic Probe	20	Silt
199	327199.3	3249654.2	20-foot Hydraulic Probe	20	Silt
200	327202.0	3249655.3	20-foot Hydraulic Probe	20	Silt
201	327203.9	3249658.9	20-foot Hydraulic Probe	15	Silt
202	327201.4	3249658.6	20-foot Hydraulic Probe	20	Shell
203	327198.3	3249655.9	20-foot Hydraulic Probe	20	Shell
204	327194.8	3249656.2	20-foot Hydraulic Probe	20	Silt
205	327186.0	3249645.4	20-foot Hydraulic Probe	20	Silt
206	327187.5	3249642.2	20-foot Hydraulic Probe	20	Silt
207	327186.1	3249639.9	20-foot Hydraulic Probe	20	Silt
208	327184.0	3249641.5	20-foot Hydraulic Probe	20	Silt
209	327181.4	3249644.6	20-foot Hydraulic Probe	20	Shell
210	327183.4	3249648.9	20-foot Hydraulic Probe	18	Silt
211	327186.5	3249649.9	20-foot Hydraulic Probe	19	Clay
212	327186.7	3249647.4	20-foot Hydraulic Probe	20	Shell
213	327182.8	3249646.4	20-foot Hydraulic Probe	20	Silt
214	327171.3	3249633.9	20-foot Hydraulic Probe	19	Silt
215	327171.9	3249635.9	20-foot Hydraulic Probe	20	Silt
216	327169.2	3249640.2	20-foot Hydraulic Probe	20	Silt
217	327172.7	3249638.8	20-foot Hydraulic Probe	20	Silt
218	327175.1	3249641.5	20-foot Hydraulic Probe	20	Silt
219	327176.6	3249636.1	20-foot Hydraulic Probe	20	Silt
220	327168.3	3249632.8	20-foot Hydraulic Probe	20	Silt
221	327167.8	3249636.0	20-foot Hydraulic Probe	20	Silt

Table 1 (Cont'd)

Probe #	Easting	Northing	Method	Total Depth of Penetration (Feet)	Material Encountered at Total Depth
222	327167.1	3249638.7	20-foot Hydraulic Probe	20	Silt
223	327169.4	3249643.0	20-foot Hydraulic Probe	20	Silt
224	327169.1	3249645.8	20-foot Hydraulic Probe	17	Clay
225	327167.4	3249649.0	20-foot Hydraulic Probe	19	Silt
226	327164.8	3249648.1	20-foot Hydraulic Probe	20	Silt
227	327166.3	3249645.8	20-foot Hydraulic Probe	17	Wood
228	327166.4	3249643.5	20-foot Hydraulic Probe	19	Silt
229	327166.5	3249641.0	20-foot Hydraulic Probe	20	Silt
230	327176.8	3249633.9	20-foot Hydraulic Probe	20	Silt
231	327164.7	3249637.5	20-foot Hydraulic Probe	20	Silt
232	327164.2	3249639.7	20-foot Hydraulic Probe	20	Silt
233	327164.2	3249642.3	20-foot Hydraulic Probe	19	Silt
234	327163.8	3249645.5	20-foot Hydraulic Probe	19	Wood
235	327162.5	3249647.3	20-foot Hydraulic Probe	19	Shell
236	327160.4	3249646.0	20-foot Hydraulic Probe	16	Shell
237	327161.7	3249644.0	20-foot Hydraulic Probe	19	Wood
238	327162.0	3249641.3	20-foot Hydraulic Probe	20	Silt
239	327159.1	3249640.3	20-foot Hydraulic Probe	20	Silt
240	327157.2	3249643.5	20-foot Hydraulic Probe	7	Wood
241	327159.6	3249643.6	20-foot Hydraulic Probe	17	Wood
242	327161.7	3249638.4	20-foot Hydraulic Probe	20	Silt
243	327159.5	3249637.2	20-foot Hydraulic Probe	20	Silt
244	327158.6	3249633.7	20-foot Hydraulic Probe	10	Wood
245	327157.0	3249636.4	20-foot Hydraulic Probe	18	Silt
246	327155.8	3249639.4	20-foot Hydraulic Probe	19	Silt
247	327154.9	3249642.0	20-foot Hydraulic Probe	20	Silt
248	327162.4	3249636.0	20-foot Hydraulic Probe	18	Silt
249	327167.1	3249634.8	20-foot Hydraulic Probe	18	Silt
250	327165.2	3249633.7	20-foot Hydraulic Probe	20	Silt
251	327169.0	3249630.4	20-foot Hydraulic Probe	20	Silt
252	327165.9	3249629.7	20-foot Hydraulic Probe	19	Silt
253	327165.9	3249631.5	20-foot Hydraulic Probe	19	Silt
254	327165.1	3249635.6	20-foot Hydraulic Probe	19	Silt
255	327160.5	3249634.6	20-foot Hydraulic Probe	19	Silt
256	327162.6	3249633.6	20-foot Hydraulic Probe	20	Silt
257	327163.4	3249631.4	20-foot Hydraulic Probe	20	Silt
258	327160.4	3249631.6	20-foot Hydraulic Probe	20	Silt

Table 1 (Cont'd)

Probe #	Easting	Northing	Method	Total Depth of Penetration (Feet)	Material Encountered at Total Depth
259	327162.9	3249628.6	20-foot Hydraulic Probe	20	Silt
260	327160.3	3249627.7	20-foot Hydraulic Probe	20	Silt
261	327158.5	3249629.6	20-foot Hydraulic Probe	19	Silt
262	327157.6	3249626.6	20-foot Hydraulic Probe	20	Silt
263	327155.9	3249629.4	20-foot Hydraulic Probe	20	Silt
264	327155.9	3249632.1	20-foot Hydraulic Probe	20	Silt
265	327154.4	3249634.9	20-foot Hydraulic Probe	10	Clay
266	327151.8	3249633.8	20-foot Hydraulic Probe	20	Silt
267	327153.1	3249631.1	20-foot Hydraulic Probe	20	Silt
268	327153.9	3249628.8	20-foot Hydraulic Probe	20	Silt
269	327154.9	3249626.3	20-foot Hydraulic Probe	20	Silt
270	327151.4	3249627.7	20-foot Hydraulic Probe	20	Silt
271	327150.1	3249630.5	20-foot Hydraulic Probe	20	Silt
272	327148.7	3249633.1	20-foot Hydraulic Probe	20	Silt
273	327152.3	3249624.9	20-foot Hydraulic Probe	20	Silt
274	327149.5	3249624.1	20-foot Hydraulic Probe	20	Silt
275	327148.4	3249626.9	20-foot Hydraulic Probe	19	Silt
276	327148.0	3249629.7	20-foot Hydraulic Probe	11	Wood
277	327146.3	3249632.1	20-foot Hydraulic Probe	20	Silt
278	327143.8	3249630.8	20-foot Hydraulic Probe	10	Wood
279	327145.0	3249628.7	20-foot Hydraulic Probe	10	Shell
280	327145.9	3249626.3	20-foot Hydraulic Probe	20	Silt
281	327147.5	3249624.6	20-foot Hydraulic Probe	20	Silt
282	327147.5	3249622.0	20-foot Hydraulic Probe	20	Silt
283	327144.6	3249622.1	20-foot Hydraulic Probe	20	Silt
284	327143.6	3249624.9	20-foot Hydraulic Probe	20	Silt
285	327142.3	3249627.1	20-foot Hydraulic Probe	20	Silt
286	327141.4	3249629.4	20-foot Hydraulic Probe	13	Shell
287	327138.6	3249629.2	20-foot Hydraulic Probe	20	Silt
288	327139.5	3249626.3	20-foot Hydraulic Probe	20	Silt
289	327141.1	3249623.8	20-foot Hydraulic Probe	18	Silt
290	327142.0	3249621.1	20-foot Hydraulic Probe	20	Silt
291	327139.3	3249620.0	20-foot Hydraulic Probe	20	Silt
292	327139.0	3249622.6	20-foot Hydraulic Probe	20	Silt
293	327137.6	3249625.3	20-foot Hydraulic Probe	20	Silt
294	327136.1	3249627.4	20-foot Hydraulic Probe	20	Silt
295	327137.3	3249619.0	20-foot Hydraulic Probe	20	Silt

Table 1 (Cont'd)

Probe #	Easting	Northing	Method	Total Depth of Penetration (Feet)	Material Encountered at Total Depth
296	327136.9	3249621.5	20-foot Hydraulic Probe	20	Silt
297	327135.7	3249623.9	20-foot Hydraulic Probe	20	Silt
298	327134.2	3249626.1	20-foot Hydraulic Probe	20	Silt
299	327140.6	3249632.1	20-foot Hydraulic Probe	20	Silt
300	327140.2	3249634.8	20-foot Hydraulic Probe	20	Silt
301	327139.3	3249637.2	20-foot Hydraulic Probe	20	Silt
302	327141.9	3249638.3	20-foot Hydraulic Probe	20	Silt
303	327143.0	3249635.1	20-foot Hydraulic Probe	20	Silt
304	327143.5	3249632.9	20-foot Hydraulic Probe	20	Silt
305	327145.6	3249634.4	20-foot Hydraulic Probe	20	Silt
306	327144.9	3249636.7	20-foot Hydraulic Probe	19	Shell
307	327144.2	3249639.6	20-foot Hydraulic Probe	20	Silt
308	327147.2	3249640.9	20-foot Hydraulic Probe	20	Silt
309	327147.5	3249638.3	20-foot Hydraulic Probe	20	Shell
310	327148.3	3249635.9	20-foot Hydraulic Probe	20	Silt
311	327153.5	3249637.6	20-foot Hydraulic Probe	13	Wood
312	327153.2	3249640.2	20-foot Hydraulic Probe	20	Silt
313	327151.8	3249642.7	20-foot Hydraulic Probe	10	Shell
314	327154.0	3249644.9	20-foot Hydraulic Probe	22	Shell
315	327149.3	3249641.7	20-foot Hydraulic Probe	20	Silt
316	327150.2	3249639.2	20-foot Hydraulic Probe	14	Shell
317	327150.8	3249636.3	20-foot Hydraulic Probe	8	Wood
318	327159.7	3249642.4	20-foot Hydraulic Probe	22	Silt
319	327162.2	3249643.1	20-foot Hydraulic Probe	19	Wood
320	327165.7	3249644.7	20-foot Hydraulic Probe	18	Wood
321	327163.9	3249644.1	20-foot Hydraulic Probe	18	Wood
322	327164.9	3249643.4	20-foot Hydraulic Probe	22	Silt
323	327163.1	3249642.4	20-foot Hydraulic Probe	22	Silt
324	327163.8	3249643.3	20-foot Hydraulic Probe	17	Wood
325	327164.4	3249646.9	20-foot Hydraulic Probe	16	Wood
326	327163.5	3249646.6	20-foot Hydraulic Probe	16	Wood
327	327161.6	3249645.2	20-foot Hydraulic Probe	19	Wood
328	327160.2	3249644.7	20-foot Hydraulic Probe	17	Wood
329	327158.0	3249644.4	20-foot Hydraulic Probe	6	Wood
330	327157.7	3249645.4	20-foot Hydraulic Probe	20	Silt
331	327158.8	3249643.2	20-foot Hydraulic Probe	17	Wood
332	327157.8	3249642.4	20-foot Hydraulic Probe	17	Wood

Table 1 (Cont'd)

Probe #	Easting	Northing	Method	Total Depth of Penetration (Feet)	Material Encountered at Total Depth
333	327157.0	3249642.9	20-foot Hydraulic Probe	20	Silt
334	327133.6	3249629.2	20-foot Hydraulic Probe	20	Silt
335	327132.8	3249632.1	20-foot Hydraulic Probe	15	Shell
336	327132.3	3249634.7	20-foot Hydraulic Probe	18	Silt
337	327135.1	3249636.0	20-foot Hydraulic Probe	20	Silt
338	327134.6	3249633.1	20-foot Hydraulic Probe	20	Silt
339	327136.1	3249630.4	20-foot Hydraulic Probe	20	Silt
340	327137.8	3249631.9	20-foot Hydraulic Probe	20	Silt
341	327137.2	3249634.5	20-foot Hydraulic Probe	20	Silt
342	327136.9	3249636.4	20-foot Hydraulic Probe	20	Silt
343	327203.6	3249663.0	20-foot Hydraulic Probe	20	Silt
344	327202.3	3249661.0	20-foot Hydraulic Probe	20	Silt
345	327200.0	3249662.2	20-foot Hydraulic Probe	19	Shell
346	327197.3	3249660.6	20-foot Hydraulic Probe	20	Shell
347	327198.8	3249658.8	20-foot Hydraulic Probe	20	Silt
348	327196.9	3249657.7	20-foot Hydraulic Probe	20	Shell
349	327194.2	3249658.8	20-foot Hydraulic Probe	20	Shell
350	327191.1	3249658.0	20-foot Hydraulic Probe	20	Shell
351	327192.4	3249654.9	20-foot Hydraulic Probe	20	Silt
352	327188.3	3249657.2	20-foot Hydraulic Probe	20	Shell
353	327189.5	3249653.6	20-foot Hydraulic Probe	20	Shell
354	327187.7	3249651.9	20-foot Hydraulic Probe	20	Silt
355	327186.8	3249654.9	20-foot Hydraulic Probe	20	Silt
356	327185.8	3249656.7	20-foot Hydraulic Probe	12	Wood
357	327183.9	3249655.9	20-foot Hydraulic Probe	10	Clay
358	327184.8	3249652.8	20-foot Hydraulic Probe	20	Silt
359	327182.9	3249651.5	20-foot Hydraulic Probe	20	Silt
360	327181.8	3249654.4	20-foot Hydraulic Probe	10	Clay
361	327178.9	3249653.6	20-foot Hydraulic Probe	15	Shell
362	327180.2	3249650.7	20-foot Hydraulic Probe	20	Silt
363	327177.6	3249648.7	20-foot Hydraulic Probe	20	Silt
364	327177.7	3249651.2	20-foot Hydraulic Probe	20	Silt
365	327176.0	3249653.5	20-foot Hydraulic Probe	20	Silt
366	327174.2	3249651.4	20-foot Hydraulic Probe	20	Silt
367	327175.3	3249648.6	20-foot Hydraulic Probe	20	Silt
368	327177.3	3249646.5	20-foot Hydraulic Probe	20	Silt
369	327174.1	3249646.5	20-foot Hydraulic Probe	20	Silt

Table 1 (Cont'd)

Probe #	Easting	Northing	Method	Total Depth of Penetration (Feet)	Material Encountered at Total Depth
370	327172.7	3249648.7	20-foot Hydraulic Probe	20	Silt
371	327170.4	3249648.1	20-foot Hydraulic Probe	20	Silt
372	327171.6	3249650.8	20-foot Hydraulic Probe	16	Shell
373	327169.6	3249650.4	20-foot Hydraulic Probe	12	Shell
374	327173.7	3249643.1	20-foot Hydraulic Probe	20	Silt
375	327182.5	3249636.6	20-foot Hydraulic Probe	20	Silt
376	327185.0	3249637.3	20-foot Hydraulic Probe	20	Silt
377	327188.4	3249638.9	20-foot Hydraulic Probe	20	Silt
378	327167.3	3249647.4	20-foot Hydraulic Probe	16	Wood
379	327168.4	3249647.9	20-foot Hydraulic Probe	20	Clay
380	327167.9	3249646.3	20-foot Hydraulic Probe	17	Wood
381	327168.5	3249646.7	20-foot Hydraulic Probe	17	Wood
382	327168.5	3249645.9	20-foot Hydraulic Probe	16	Wood
383	327166.7	3249644.4	20-foot Hydraulic Probe	18	Wood
384	327167.8	3249643.8	20-foot Hydraulic Probe	22	Silt
385	327166.9	3249648.1	20-foot Hydraulic Probe	22	Silt
386	327167.4	3249648.1	20-foot Hydraulic Probe	22	Silt
387	327167.9	3249647.6	20-foot Hydraulic Probe	16	Wood
388	327168.1	3249644.4	20-foot Hydraulic Probe	22	Silt
389	327168.9	3249645.4	20-foot Hydraulic Probe	17	Wood
390	327170.2	3249644.3	20-foot Hydraulic Probe	22	Silt
391	327169.6	3249645.2	20-foot Hydraulic Probe	17	Wood
392	327170.2	3249645.0	20-foot Hydraulic Probe	22	Silt
393	327170.3	3249644.6	20-foot Hydraulic Probe	22	Silt
394	327169.3	3249646.8	20-foot Hydraulic Probe	16	Wood
395	327170.0	3249647.1	20-foot Hydraulic Probe	17	Wood
396	327171.1	3249646.8	20-foot Hydraulic Probe	22	Silt
397	327169.3	3249647.4	20-foot Hydraulic Probe	16	Wood
398	327169.5	3249647.2	20-foot Hydraulic Probe	17	Wood
399	327170.3	3249646.5	20-foot Hydraulic Probe	17	Wood
400	327168.9	3249648.2	20-foot Hydraulic Probe	22	Silt
401	327169.6	3249647.8	20-foot Hydraulic Probe	22	Silt

REFERENCES CITED

U.S. Coast Survey

1936 *Galveston Entrance, Texas*. Chart 520. National Archives and Records Administration, Record Group 23, Library and Archives Map Collection, College Park, Maryland.

Appendix B

Interim Report: Aerial Photo and Historic Map Research of the Galveston-Bolivar Causeway Project Area, Galveston County, Texas

Document No. 070192
PBS&J Job No. 441759.18

INTERIM REPORT
AERIAL PHOTO AND HISTORIC MAP RESEARCH OF THE
GALVESTON-BOLIVAR CAUSEWAY PROJECT AREA
GALVESTON COUNTY, TEXAS

CONTRACT No. 577XXSA005
WORK AUTHORIZATION No. 577 18 SA005
CSJ No. 0367-05-042

Prepared for:

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August 2007

Interim Report
Aerial Photo and Historic Map Research
of the Galveston-Bolivar Causeway Project Area
Galveston County, Texas

In June 2007, a PBS&J researcher spent 2 days at the National Archives and Records Administration (NARA) in College Park, Maryland, examining historic maps of Galveston Bay. This work was done under Work Authorization No. 577 18 SA005 of Scientific Services Contract No. 577XXSA005 between the Texas Department of Transportation (TxDOT) and PBS&J. The purpose of the historical map research was to seek explanations for remote-sensing targets recorded during PBS&J's March 2007 marine survey, and to help identify or refute potential hulks and wrecks, with particular emphasis on the area of historic Port Bolivar.

Prior to commencing the archives research, a review of the State's Texas Historic Overlay (THO) map image database, and the related Houston Historic Overlay (HHO) map inventory records, identified historic topographic maps, coastal charts, and other maps that depict the project area in the 1860–1954 time frame. Maps identified by the THO and HHO studies and relevant to Bolivar Roads were selected for further assessment to determine whether they contain features, such as shipwrecks, that might explain some of the remote-sensing anomalies reported in the study area. Approximately 40 such maps residing at the National Archives were identified at the index level. Of that number, those that had not previously been scanned by PBS&J were selected for further examination as part of the present Work Authorization. When relevant, portions of those maps were photographed using a hand-held digital camera in order to capture details to aid in assessment of each map.

Once the archival research began, it became apparent that there were far more than 40 historic maps at NARA that depicted Bolivar Roads. Many of the 40 entries identified by the index-level search of the THO and HHO studies were actually a series of maps listed under the same file designation rather than one individual map. These file designations were organized by various criteria including time period, government agency, navigation-improvement project, and geographic area, though there was often no obvious rationale for grouping certain maps in the same file designation.

The map series were prioritized based on their limited index information, and as many of these collections as possible were searched in the allotted time, with the result being that substantially more than 40 individual maps were visually assessed. These maps were primarily from Record Group (RG) 77 (Fortifications Map File, and Civil Works Map File) and RG 23 (Library and Archives Map Collection). Depending on their relevance to the present study, maps were either photocopied and scanned (those showing potential shipwrecks within the survey area), or digitally photographed so that a decision on whether to purchase a copy could be made at a later date (maps showing some shoreline or development

detail of the project area, if not shipwreck locations). Maps having no relevance to the current study were inspected and put aside, with no further detail being recorded.

Unfortunately, the majority of maps identified from the THO and HHO searches fell into the latter category. Recurring map types included engineering drawings of various harbor improvements and depth-sounding charts. In many of these cases, the maps were either of insufficient detail or showed areas of Galveston Bay outside the current survey area. Most of these also did not provide a coordinate system or distinguishing landmarks, and therefore would be difficult or impossible to georeference, even if they had contained relevant detail.

There were several notable exceptions, however. An 1888 U.S. Army Corps of Engineers (USACE) map of Galveston Harbor shows depth contours and two shipwrecks within the survey area: one slightly north of Port Bolivar, and the other southwest of Pelican Island, near Galveston Island (Figure 1). Several Civil War-era maps illustrated various details of Galveston fortifications, including a Confederate map of Fort Jackson that was captured after the war (Figure 2). Subsequent research by PBS&J has further determined that this map was created by General J.B. Magruder's chief engineer. Both of the above-mentioned maps were photocopied and digitally scanned at PBS&J. Other maps photographed but not copied include, but are not limited to, late nineteenth- to early twentieth-century navigation charts, a map showing changes in the Pelican Spit shoreline, a similar map comparing harbor depths over time, one showing ranges of fire from the casemate on Pelican Spit, and several maps that illustrate, in varying detail, the development of Port Bolivar.

Apart from the THO- and HHO-identified maps, the archives also house a nearly complete collection of federally produced coastal charts of the entrance to Galveston Bay and Bolivar Roads. From at least the years 1853–1951, the U.S. Coast Survey produced Chart 520, “Galveston Entrance, Texas” (RG 23), which encompasses all of PBS&J's survey area. National Oceanic and Atmospheric Administration (NOAA) charts of this same area exist for 1974–2004 (RG 370, NOAA Chart 11324, “Galveston Entrance”). This map series proved to be the most useful of those inspected by PBS&J, and showed at least 12 potential shipwrecks that may be present in the project area. Two of these are the wrecks recorded on the 1888 USACE map described above. The 1888 wreck north of Port Bolivar first shows on Chart 520 that same year and continues to show through 1934. It is gone from the chart in 1936 (no chart for 1935 was available), but a wreck in the same location begins to be charted again on NOAA Chart 11324 in 1994 continuous through 2004 (the last charted year available at NARA). It is unknown if this is meant to be signifying the 1888 wreck again, or marking the location of a new wreck in the same vicinity.

The other wreck from the 1888 USACE map — southwest of Pelican Island, near the Galveston railroad yards — is not initially present on Chart 520, but a wreck begins to be charted in an almost identical location beginning in 1936 and continuing through at least 1951 (Figure 3). This wreck is absent by 1974 but shows up again in 1988 (from 1951–1974, maps for this geographic area were produced by a

Figure 1: 1888 Chart Showing Two Shipwreck Locations (USACE 1888)

Figure 2: Confederate Map of Fort Jackson (Sulakowski ca. 1865)

PBS

The appearance of the above-mentioned wrecks between 1934 and 1936 should not necessarily be taken as evidence of their sinking during that time, however. There is a slight but noticeable change in scale and level of detail between the 1934 and 1936 charts, which suggests that the charting of particular wrecks before and after those dates may have simply been a mapmaker's decision. The USS *Selma*, for instance, was present in its current location (visible well above the waterline) beginning in 1922, but was not charted until 1936.

Figure 4: Wrecks Shown on 1936 Chart of Galveston Entrance
(U.S. Coast Survey 1936)

In 1951, two more wrecks are charted west of Pelican Island and north of the old dike (Figure 5), in addition to the 1936 wreck in this same location. In 1988 a wreck is charted west of Pelican Island and south of the Gulf Intracoastal Waterway (GIWW). The 1936 wreck east of Pelican Island (northwest of the *Selma*) also was charted in 1988 but is no longer charted, though it is known to still be present (Borgens et al. 2007). Finally, a sixth wreck west of Pelican Island — this one slightly north of the GIWW — is first charted in 1997 and continues through the 2004 chart (Figure 6).

Historic Aerial Photography

PBS&J contacted P2 Energy Solutions, Inc., to request an inventory of the Tobin aerial photographs for the project area between 1930 and 1960. Only two sets of images were available for this period; a set of 1 inch = 1,500-foot scaled images showing incomplete coverage from 1930 (Tobin International Ltd. 1930) and a set of 1 inch = 2,000-foot scaled images showing complete coverage of the project area from 1956 (Tobin International Ltd. 1956). PBS&J acquired both sets of aerial photographs. The 1930

Figure 5: Wrecks West of Pelican Island in 1951 (U.S. Coast Survey 1951)

Figure 6: Wrecks West of Pelican Island in 1997 (NOAA 1997)

photographs include the southernmost section of the project area in the vicinity of Pelican Island. Bolivar Peninsula is not pictured in this group of images.

One of the principal interests in these early sets of images was to gauge the appearance of two wrecks charted at the east and west side of Pelican Island in 1936. Both wrecks are first depicted on the 1936 chart (U.S. Coast Survey 1936). Unfortunately the area of the wreck on the east side of Pelican Island is just outside the 1930 photographic coverage and therefore cannot be viewed. The wreck on the west side of Pelican Island does not appear to be visible in the 1930 aerial photography, suggesting that the wreck postdates November 17, 1930, the date of the aerial photograph (Figure 7). A feature does appear at the approximate location of the 1936 charted wreck (see Figure 3) off west Pelican Island in the 1956 aerial photograph. This feature is nearly identical to a sonar target discovered at that location by PBS&J during the remote-sensing survey in March and April 2007 (Figure 8). It is possible that the 1936 charted wreck could still have been visible (as denoted in the 1951 chart, see Figure 5) in 1956, or that this feature is new wreckage related to the ongoing dredging occurring in the immediate area.

PBS&J also viewed the historic aerial photographs to correlate these images to a wreck depicted on the 1936 chart, and the location of a feature captured in a 1954 aerial photograph. The 1954 feature does not appear in the 1956 aerial photograph (Figure 9), indicating it was removed or moved during the 2-year period. It is not likely that this feature is related to the 1936 charted wreck (Hudson and Borgens 2007).

Recommendations

As a result of a March 2007 remote-sensing survey for the proposed causeway, PBS&J recorded 46 potential shipwreck magnetometer anomalies within the project area. Seven of these anomalies are in the vicinity of charted wrecks identified during the National Archives map research. PBS&J recommends that the eight photocopied NARA maps discussed above and listed in Table 1 (see Appendix), showing historic and modern wreck locations, be georeferenced due to their ability to clarify the remote-sensing data. In this manner, potentially historic shipwreck anomalies can be isolated from anomalies likely associated with modern wrecks. This information can then be used to prioritize future diver ground-truthing of selected targets.

Figure 7. West Pelican Island Wreck Feature.
(a) Area of wreck; (b) enlarged view of the inset from 1930; and (c) from 1956.

Figure 8. West Pelican Island Wreck Feature.
(a) Sonar Target S1; (b) enlarged detail from the 1930 aerial photograph.

Figure 9. 1954 and 1956 Aerial Photographs of Bolivar Marina.

REFERENCES

Borgens, Amy, Sara Hoskins, Robert Gearhart II, Dan Hudson, and Doug Jones

- 2007 *Marine Remote-Sensing Survey of the Proposed Galveston-Bolivar Causeway, Galveston County, Texas*. Prepared for Texas Department of Transportation. Document No. 070173. PBS&J, Austin, Texas.

Hudson, Dan

- 2007 *Interim Report: Hydraulic Probing Survey for Abandoned Vessels, Proposed Galveston-Bolivar Causeway Project, Galveston County, Texas*. Prepared for Texas Department of Transportation. Document No. 070189. PBS&J, Austin, Texas.

Hudson, Dan, and Amy Borgens

- 2007 *Interim Report: Hydraulic Probing Survey for Abandoned Vessels, Proposed Galveston-Bolivar Causeway Project, Galveston County, Texas*. Document No. 070189. PBS&J, Austin.

National Oceanic and Atmospheric Administration

- 1997 *Galveston Entrance*. Record Group 370, Chart 11324. National Archives, College Park, Maryland.
- 1974–2004 *Galveston Entrance*. Chart No. 11324. National Archives and Records Administration, Record Group 370. College Park, Maryland.

Sulakowski, Valery

- ca. 1865 *Fort on Pelican Spit*. Record Group 77, Civil Works Map File, Z53-6. National Archives, College Park, Maryland.

Tobin International Ltd.

- 1930 *Port Bolivar and Galveston Quads*. Exposures 794-03-072,070, 068, 066 and 794-02-059, 061.
- 1956 *Port Bolivar and Galveston Quads*. Exposures 5711-22-207, 205 and 5711-16-174, 176.

U.S. Army Corps of Engineers (USACE)

- 1888 *Galveston Harbor, Texas*. National Archives and Records Administration, Record Group 23, Library and Archives Map Collection, File Unit 877-1888. College Park, Maryland.

U.S. Coast Survey

- 1936 *Galveston Entrance*. Chart 520. National Archives and Records Administration, Record Group 23, College Park, Maryland.
- 1951 *Galveston Entrance*. Chart 520. National Archives and Records Administration, Record Group 23, College Park, Maryland.

APPENDIX

Table 1: Maps Photocopied and Scanned

Title	Date	Record Group	Series	File Unit
Chart 520, Galveston Entrance	1853	23		
Fort on Pelican Spit, Galveston Harbor	Ca. 1865	77	Civil Works Map File	Z53-6
Galveston, Texas and Vicinity	Ca. 1865	77	Civil Works Map File	Z53-2
Galveston Harbor, Texas	1888	23	Library & Archives Col.	877-1888
Chart 520, Galveston Entrance	1888	23		
Chart 520, Galveston Entrance	1934	23		
Chart 520, Galveston Entrance	1936	23		
Chart 520, Galveston Entrance	1945-1950	23		
Chart 520, Galveston Entrance	1951	23		
Chart 11324, Galveston Entrance	1997	370		

Table 2: Maps Photographed

Title	Date	Record Group	Series	File Unit
Copied from Chart of Galveston Bay and Harbor	1841	77	Fortifications Map File	Drawer 148, Sheet 4
Sketch of Galveston Bay for Placing Lighthouses	1851	23	Library & Archives Map Collection	877-1851
Preliminary Sketch of Galveston Bay	1852	77	Fortifications Map File	Drawer 148, Sheet 25
Sketch Showing the Locality of Half Moon Island in Galveston Bay	1852	23	Library & Archives Map Collection	877-1852
Chart 520*, Galveston Entrance	1856, 1867, 1899, 1909, 1910, 1912, 1914, 1922, 1924	23	U.S. Coast Survey	
Galveston Entrance, Texas	1858	77	Fortifications Map File	Drawer 91, Sheet 4
U.S. Coast Survey, Chart of Galveston Harbor and Vicinity	1868	23	Library & Archives Map Collection	877-1877

Table 2: Maps Photographed (concluded)

Title	Date	Record Group	Series	File Unit
Outer & Inner Bars and Vicinity of Bolivar Gabionnade, Galveston Harbor	1877	23	Library & Archives Map Collection	877-1877
Galveston Harbor, Texas	1884	77	Civil Works Map File	Q519
Galveston Harbor, Texas	1884-1885	77	Civil Works Map File	Q564-1
Galveston Harbor, Comparative Chart	1884-1885	77	Civil Works Map File	Q564-2
Galveston Harbor	1885	77	Civil Works Map File	Q568
Sketch Showing Location of Proposed Tide Gauge at Entrance to Galveston Harbor	1887	77	Civil Works Map File	Q591
Galveston Bay, Texas	1887	77	Civil Works Map File	Q592
Galveston Harbor Improvement	1891	77	Civil Works Map File	Q736
Galveston Bay, Texas	1905	77	Civil Works Map File	Q536, Roll 82
Survey of Galveston Harbor	1908	77	Civil Works Map File	Q536, Roll 143
Galveston Entrance	1910	23	Library & Archives Map Collection	877-1910
Upper End of Bolivar Roads	1915	77	Civil Works Map File	Q536, Roll 201
Port Bolivar	1920	77	Fortifications Map File	Drawer 148, Sheet 63
Chart 11324*, Galveston Entrance	1979, 1986, 2004	370	National Oceanic and Atmospheric Administration	
Galveston Bay, Texas	?	77	Civil Works Map File	Q536, Roll 203

* All maps for U.S. Coast Survey Chart 520 (1853 - 1951 [RG23]) and NOAA Chart 11324 (1974 - 2004 [RG370]) were inspected. Photographs were only taken of those years where a notable geographic or cultural feature was illustrated.

Table 3: Maps Inspected but Determined Irrelevant to the Current Project

Title	Date	Record Group	Series	File Unit
Galveston, Texas and Vicinity, Showing Fortifications, etc.	1864?	77	Civil Works Map File	Q102 roll
Misc. Galveston Maps	Ca. 1864	77	Civil Works Map File	Z53 roll
Galveston Harbor, Texas	1884	77	Civil Works Map File	Q519 roll
Galveston Harbor, Texas	1885	77	Civil Works Map File	Q536
Galveston Harbor, Texas.	1888	77	Civil Works Map File	Q629

Appendix C

Interim Report: Documentation of Abandoned Vessel Hulks Near Port Bolivar, Galveston-Bolivar Causeway Project, Galveston County, Texas

Document No. 070194
PBS&J Job No. 441759.18

INTERIM REPORT
DOCUMENTATION OF ABANDONED VESSEL
HULKS NEAR PORT BOLIVAR
GALVESTON-BOLIVAR CAUSEWAY PROJECT
GALVESTON COUNTY, TEXAS

TEXAS ANTIQUITIES PERMIT No. 4581
CONTRACT No. 577XXSA005
WORK AUTHORIZATION No. 577 18 SA005
CSJ No. 0367-05-042

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August 2007

Interim Report
Documentation of Abandoned Vessel
Hulks Near Port Bolivar
Galveston-Bolivar Causeway Project
Galveston County, Texas

PBS&J was contracted by the Texas Department of Transportation (TxDOT) to conduct a survey of several wrecks located off Bolivar Peninsula as part of the proposed Bolivar-Galveston Causeway Project. The survey work was completed under Work Authorization 577 18 SA005 of Scientific Services Contract No. 577XXSA005 between TxDOT and PBS&J. PBS&J conducted the visual assessment of a collection of submerged and semisubmerged hulks to ascertain their condition, the number of vessels, features of the wrecks, and the size of the affected area. An appraisal of the wrecks has concluded the hulks are the remains of 14 to 17 barges of at least two major categories of construction. The survey was conducted from the *PeeWee McKinney* by Amy Borgens and Doug Jones on August 7 and 8, 2007.

The condition and placement of the hulks did not allow for perimeter measurements to be physically acquired by the archeologists. Instead, GPS coordinates were taken at specific locations at each vessel. The researchers focused on attaining, if possible, coordinates at the corners of each hulk and at the center-point of the “bow” and “stern” end of the barges. The center-points of each end of the barge were used for a coupling mechanism that allowed the barges to be affixed together during transport (Figure 1). Positional data recorded in HydroPro were imported into Bentley MicroStation. The coordinate-based positions of key features of the wrecks, in combination with estimations of the approximate barge size, allowed PBS&J staff to reconstruct the arrangement of the hulks (Figure 2).

Figure 1. Coupling Mechanism

Figure 2. Bolivar Hulks. (a) 1996 (b) 2004

Photo-documentation of the hulks was acquired with a Canon EOS Digital Rebel XT, and for the underwater portions of the wreck, a Humminbird 797c² SI Combo. The Humminbird is a depth sounder with a side-imaging sonar device and an internal WAAS GPS Receiver. While maneuvering the survey vessel amidst the wrecks, jpeg screen captures of the submerged hulks were taken. Use of the Humminbird was limited by the shallow depths of the submerged hulks. Images could only be taken around the perimeter of the wrecks as the survey vessel could not drive directly over the sites. The Humminbird produced a real-time sonar image as the survey was conducted. These images enabled the archeologists to determine location and orientation for some of the vessels whose hulls could not be visually detected above the water surface.

The barges were deposited at their current location in the early 1970s. Patrick Henry used the derelict barges as docks for his seafood processing plant, though it is not known if he was the original owner of the vessels. It has also been suggested that the barges were purchased in 1970 and brought from Buffalo Bayou, filled with sand, and used as breakwaters (Anthamatten 2007; Ellis 2007; Swafford 2007). The Automated Wreck and Obstruction Information System (AWOIS) database describes the collection of wrecks (Table 1) as consisting in 1994, of two visible wrecks, one partially exposed wreck, and one submerged wreck, though it is acknowledged that there are as many as three to five wrecks in the vicinity. The AWOIS database correlates the locations of the wrecks to the position of three wrecks charted on Chart 11324 (NOAA 1974–2004), though the deposition of the barges postdates the positions of the charted wrecks by as much as 34 years (Borgens et al. 2007).

Table 1. NOAA-documented AWOIS Obstructions

Name of Vessel	PBS&J No.	AWOIS No.	THC No.	Identity	Locality
Unknown	465	9092	1321	Submerged wreck near pier, approximately 10 meters (m) long	Bolivar Peninsula, Galveston Bay, Texas
Unknown	464	9093	1300	Partially exposed wreck, approximately 25 x 5 m	Bolivar Peninsula, Galveston Bay, Texas
Unknown	466	9094	1318	Two visible wrecks; steel and wood barges approximately 15 x 5 m	Bolivar Peninsula, Galveston Bay, Texas

There are three main groups of submerged hulks. All of the hulks appear to be the remains of rectangular barges. These barges were similar in size and seemed to be of two different types: a wood hull with either a ferrous or wood deck (Type 1) and a ferrous hull with a ferrous deck (Type 2). Six of the barge wrecks were visible and at least 11 are submerged. Two of the hulks visible in a 1996 aerial could instead be ferrous decks that were separated from the hull or related wreck debris. These wrecks, H, K, and L on Figure 2, did not have vertically protruding ferrous features associated with the deck (Figure 3) or the coupling mechanisms that are evident in the adjacent wrecks. For simplicity, these hulks were designated by A–G (Group 1), H–M (Group 2), and N–P (Group 3) (see Figure 2). Group 1 contained two hulks wherein the entirety of the decks was visible above the surface of the water; the remainder of this group was submerged. These were the only two hulks for which GPS coordinates could be acquired for each

Figure 3. Vertical Ferrous Deck Features

corner of the barge. The barge wrecks from Group 2 were partially submerged, and those from Group 3 were completely submerged.

HULL CONSTRUCTION FEATURES

Type 1 Wood Hull and Wood Deck/Ferrous Deck

At least six extant vessels have construction features indicating each barge may have had a wood hull with a detachable ferrous deck. Hulks G (Figure 4), I (Figure 5), and Q (Figure 8) do not have the ferrous decks that are evident on hulks J and M (figures 6 and 7). All five vessels have at least one of a series of similar attributes suggesting they are of the same construction: vertical iron deck protrusions (see Figure 3); “bow” and “stern” coupling mechanisms; “bow” and “stern” rails; a series of ferrous deck fittings (Figure 4c); and a portion of the deck (at each end) that is devoid of deck planking. Hulks G and I also have a series of longitudinal deck beams that mortise into the side of the barge (see Figure 1). This particular type of barge appears to have been constructed with a wood deck (Figures 4a–e) that could receive a separately constructed ferrous deck that could possibly be used for the transport of specific cargoes, such as sand. The ferrous deck appears to have been attached to the hull through a locking mechanism directly beneath the deck. This is best illustrated on Figures 6 and 7.

Figure 4. Hulk G. (a) Deck view; (b) central deck; (c) deck equipment; (d) and (e) coupling mechanisms

Figure 5. Hulk I

Figure 6. Hulk M

Figure 7. Hulk M. Detail of Deck Clasps

One barge, hulk Q (Figure 8), appears to have been towed to its present location and converted into a dock. Aerial photography from 1996 and 2004 indicates that the wreck conforms to the size and shape of the neighboring hulks. Though much of the vessel appears to now be ashore and perhaps buried, certain deck features allude to its former use (Figure 8b).

Figure 8. Hulk Q. Deck feature (a) from G and (b) from Q

The type of submerged hulks in Group 3, though not visible, can be deduced by the presence of the vertical ferrous deck and the coupling mechanism visible at the east end of each vessel (Figure 9). The vessels have some of the same features as the extant hulks G, I, J, and M and are therefore likely of Type 1 construction. A digital Humminbird screen capture of submerged barges O and P (Figure 10) indicates that they are still positioned staggered from one another as they are depicted in the 1996 aerial photograph.

Figure 9. Hulks N, O, and P in Group 3

Figure 10. East Ends of Hulks O and P

Type 2 Ferrous Hull/Ferrous Deck

Hulk F from Group 1 has both a ferrous hull and deck (Figure 11). Despite its different construction material, it is roughly the same size as the exposed wood-hulled barge, hulk G. The adjacent semisubmerged barge, hulk E, appears to be of similar construction.

Figure 11. Hulk F

HULK ORIENTATION

Group 1

Seven hulks comprise Group 1. They align roughly east to west and abut one another. Two of these are visible, one is partially exposed, and the remainder of the hulks are submerged. Unlike the submerged barges in groups 2 and 3, there are not any visible traces of the submerged hulks to indicate their location. Digital images of submerged hulks A and D illustrate the current condition of the hulks (figures 12 and 13). GPS coordinates could be attained for almost all four corners of hulks K and J. The Hydropro/GPS measurement for each barge was approximately 33 x 11.6 m (98 x 38 feet)

Figure 12. Image in area of Hulk A

Figure 13. Area of Hulk D

Group 2

The semisubmerged barges in Group 2 are oriented east to west. The remnants of only three barges in this group, hulks I, J, and M, are still evident. The aerial photograph produced in 1996 demonstrates that, at that time, six hulks/hulk features were apparent. The absence of the protruding vertical ferrous features for hulks H, I, and K that are characteristic of neighboring hulks, I, J, and M may suggest these are components of the barges and not necessarily hulks. The objects at the locations of H and K could likely be displaced ferrous decks. Additionally, a Humminbird digital image of the submerged portion of hulk L is inconclusive as to the object submerged at that position (Figure 14).

Group 3

Group 3 contains three submerged barges whose number and orientation were determined by the placement of the coupling mechanisms that are still evident. These three barges are arranged roughly east to west and are adjacent to one another. Imagery of the submerged portion of the barges demonstrates the hulks were staggered with hulk P lying the farthest east of the vessels.

Figure 14. Wreckage in vicinity of Hulk L

CONCLUSION

The remnants of as many as 17 derelict barges are located northeast of the new Bolivar Ferry Landing at Bolivar Peninsula. These vessels are of two major construction types, with both wood and ferrous hulls. The wood-hulled barges appear to have also been able to incorporate a ferrous deck that could be attached through a locking/clasping mechanism. Only six of the hulks are still visible; the remainder are submerged or semisubmerged. The vessels have degraded remarkably in the last decade, as 14 of the barges are pictured in the 1996 aerial photograph. Though the appearance of the hulks off Bolivar Peninsula date to the early 1970s, the construction of these vessels could well predate their purchase and movement north of the new ferry terminal. PBS&J recommends additional research be conducted in order

to ascertain a more concise determination of age or construction for these barges. Such data would determine whether these vessels fulfill any of the criteria for eligibility to the National Register of Historic Place or if they are modern vessels.

REFERENCES

Anthamatten, Fred L.

2007 Fred Anthamatten to Janelle Stokes. Email correspondence, August 20, 2007.

Borgens, Amy, Sara Hoskins, Robert Gearhart II, Dan Hudson, and Doug Jones

2007 *Marine Remote-Sensing of the Proposed-Bolivar Causeway, Galveston County, Texas*. Document No. 070173. PBS&J, Austin, Texas.

Ellis, Lain

2007 Lain Ellis to Janelle Stokes. Email correspondence, August 20, 2007.

National Oceanic and Atmospheric Administration (NOAA)

1974–2004 *Galveston Entrance*. Chart No. 11324. National Archives and Records Administration, Record Group 370. College Park, Maryland.

Swafford, Rusty

2007 Rusty Swafford to Carolyn Murphy. Email correspondence, August 21, 2007.

Appendix D

Glossary of Terms

Glossary of Terms

Ship construction terminology is from a *Treatise on Marine Architecture* by Peter Hedderwick, Edinburgh, 1830.

Anomaly: In a remote-sensing investigation, the term is used interchangeably to describe an unidentifiable source of a magnetometer or side-scan sonar target.

Beams: Large pieces of timber extending from the one side of a vessel to the other, for binding her together and supporting the deck.

Bow: Forward part of a vessel.

Bulkhead: a partition. Bulkhead is the name given to the boards or planks that separate one part or cabin from another.

Decks: The flats that are formed by covering the beams with plank; these run in the fore-and-aft direction and constitute the deck of the ship.

Dredging: Excavation activity or operation usually carried out at least partly underwater, in shallow seas or fresh water areas with the purpose of gathering up bottom sediments and disposing of them at a different location.

Frame: Signifies a number of pieces of timber bolted together, in order to form the bottom and sides of a vessel. The frames are placed at right angles to the keel.

Hold: That part of a ship in which the cargo is placed.

Hull: The sides, bottom, and deck of a ship.

Keelson: An internal keel, placed immediately above the floor timbers, and bolted down through every other floor and the keel.

Magnetometer: An instrument for detecting the presence of ferrous or magnetic materials.

Plank: Wood much less in thickness than in breadth is called plank; the act of covering the timbers of a ship with is called planking.

Side-scan sonar: Mechanical device that produces an acoustic signal that is reflected from the seafloor. This signal is used to create a real-time photographiclike image of the seafloor.

Stern: The after part of a ship above the counter and in which windows are made to give light and air to a ship.