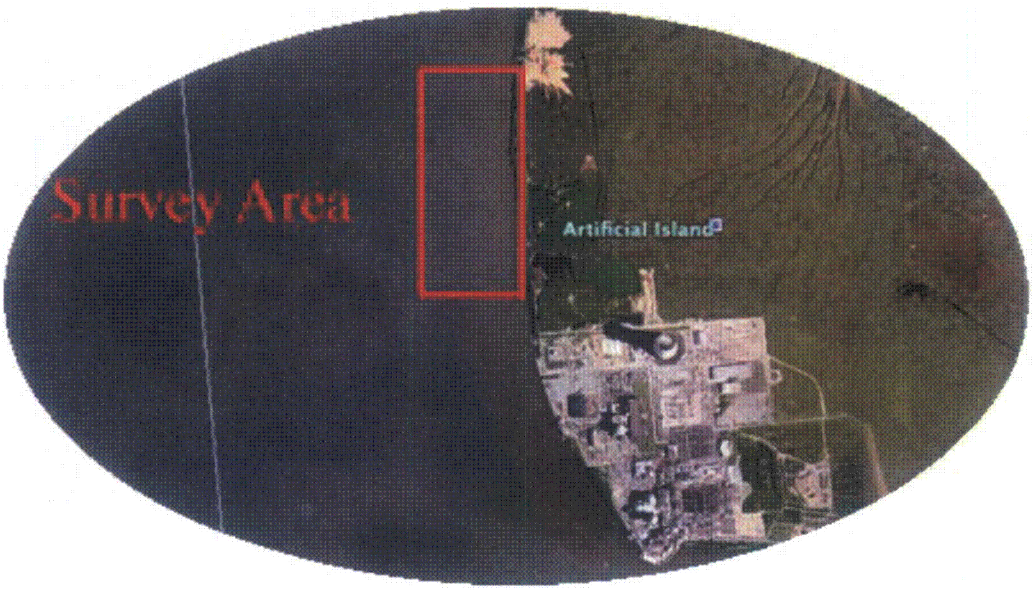
Enclosure 10

Submerged Cultural Resources Survey
of a Proposed Barge Facility and Water Intake
dated December 2009

SUBMERGED CULTURAL RESOURCES SURVEY OF A PROPOSED BARGE FACILITY AND WATER INTAKE PSEG EARLY SITE PERMIT ENVIRONMENTAL REVIEW DELAWARE RIVER, SALEM COUNTY, NEW JERSEY



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CONDUCTED UNDER:

MACTEC Work Order No. 200916573
MACTEC Project No. 3250085298/02

DRAFT REPORT ♦ DECEMBER 2009

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ABSTRACT

During October 2009, archaeologists with Panamerican Consultants, Inc. (Panamerican) of Memphis, Tennessee conducted an intensive submerged cultural resources remote sensing survey of a proposed dredging area, as part of work to support the PSEG Early Site Permit Application (ESPA). Situated on the Delaware River in Salem County, New Jersey, the survey area covers approximately 100 acres (ac) and is specifically located immediately adjacent to the western shore of Artificial Island, just north of the Hope Creek Generating Station. Performed under contract to MACTEC Engineering and Consultants, Inc. (MACTEC) of St. Louis, Missouri, the investigation was comprised of a magnetometer, sidescan sonar, and a subbottom profiler survey. The primary focus of the project was to determine the presence or absence of anomalies representative of potentially significant submerged cultural resources that are eligible for listing on the National Register of Historic Places (NRHP).

The results of the survey identified a total of 84 magnetic anomalies, 17 sidescan sonar targets, and no subbottom profiler impedance contrasts within the project area. Three clusters of magnetic anomalies and two associated acoustic images exhibit characteristics indicative of vessel remains. Target Cluster 1 is comprised of two magnetic anomalies that are associated with sonar image DR-14, which has characteristics suggestive of shipwreck remains. While it is possible that the image may be associated with bulkhead material, the image suggests the partially exposed remains of the lower hull of a vessel. It is recommended that the site be avoided. If avoidance is not possible, additional investigation should be conducted to identify material generating the signatures and to assess the NRHP significance of the site. Cluster 2 is comprised of five magnetic anomalies that are associated with sonar image DR-10, which is an area of small debris. The complex nature of the anomalies and debris on the bottom surface should be considered to have a potential association with vessel remains. Cluster 3 is composed of four magnetic anomalies. Although the anomalies have no corresponding sonar image, the complex nature of the magnetic signature should be considered as suggestive of an association with shipwreck remains. It is recommended that both Cluster 2 and 3 also be avoided. If avoidance is not possible, an additional investigation is recommended to identify material generating the signatures and to assess its NRHP significance.

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1. INTRODUCTION

During October 2009, under contract to MACTEC Engineering and Consultants, Inc. of St. Louis, Missouri, archaeologists from Panamerican Consultants, Inc. of Memphis, Tennessee conducted an intensive submerged cultural resources remote sensing survey of a proposed dredging area in support of the PSEG Early Site Permit Application (Figure 1). Situated on the Delaware River, in Salem County, New Jersey, the project area covers approximately 100 ac and is specifically located immediately adjacent to the western shore of Artificial Island, just north of the existing Salem and Hope Creek Generating Stations (Figures 2 and 3).

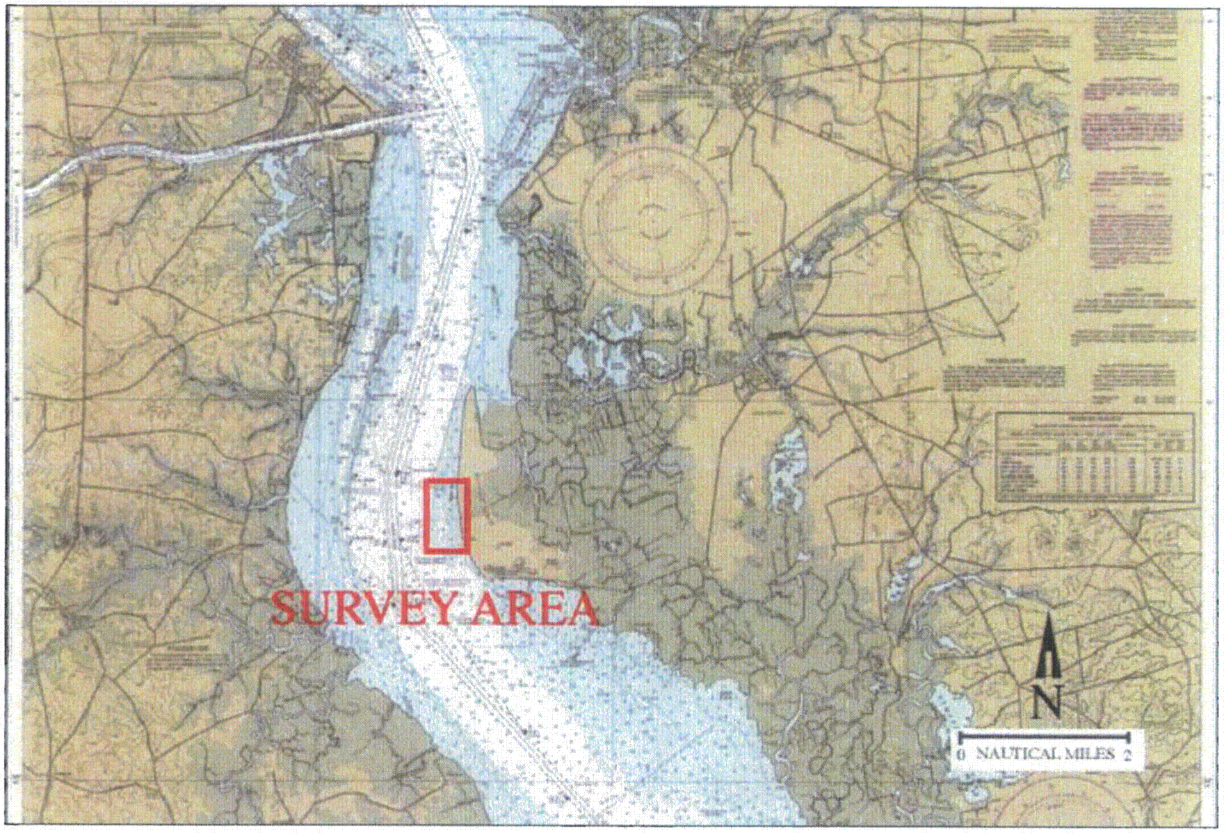

Figure 1. Project area location map (excerpt from NOAA Navigational Chart "Delaware River, Smyrna River to Wilmington," Chart No. 12311).

Comprised of a magnetometer, sidescan sonar, and a subbottom profiler survey, the primary focus of the investigation was to determine the presence or absence of anomalies representative of potentially significant submerged cultural resources eligible for listing on the National Register of Historic Places (NRHP). A secondary aspect of the survey was the identification of hazards to the proposed construction.

The project was conducted relative to responsibilities under various federal and state statutes and was performed in compliance with Section 106 of the National Historic Preservation Act (NHPA) of 1966, as amended (36 CFR 800, *Protection of Historic Properties*) and the Abandoned Shipwreck Act of 1987 (*Abandoned Shipwreck Act Guidelines*, National Park Service, *Federal Register*, Vol. 55, No. 3, December 4, 1990, pages 50116-50145).

Figure 2. General location of the survey area relative to Artificial Island and the nuclear plant (courtesy of Google Earth).

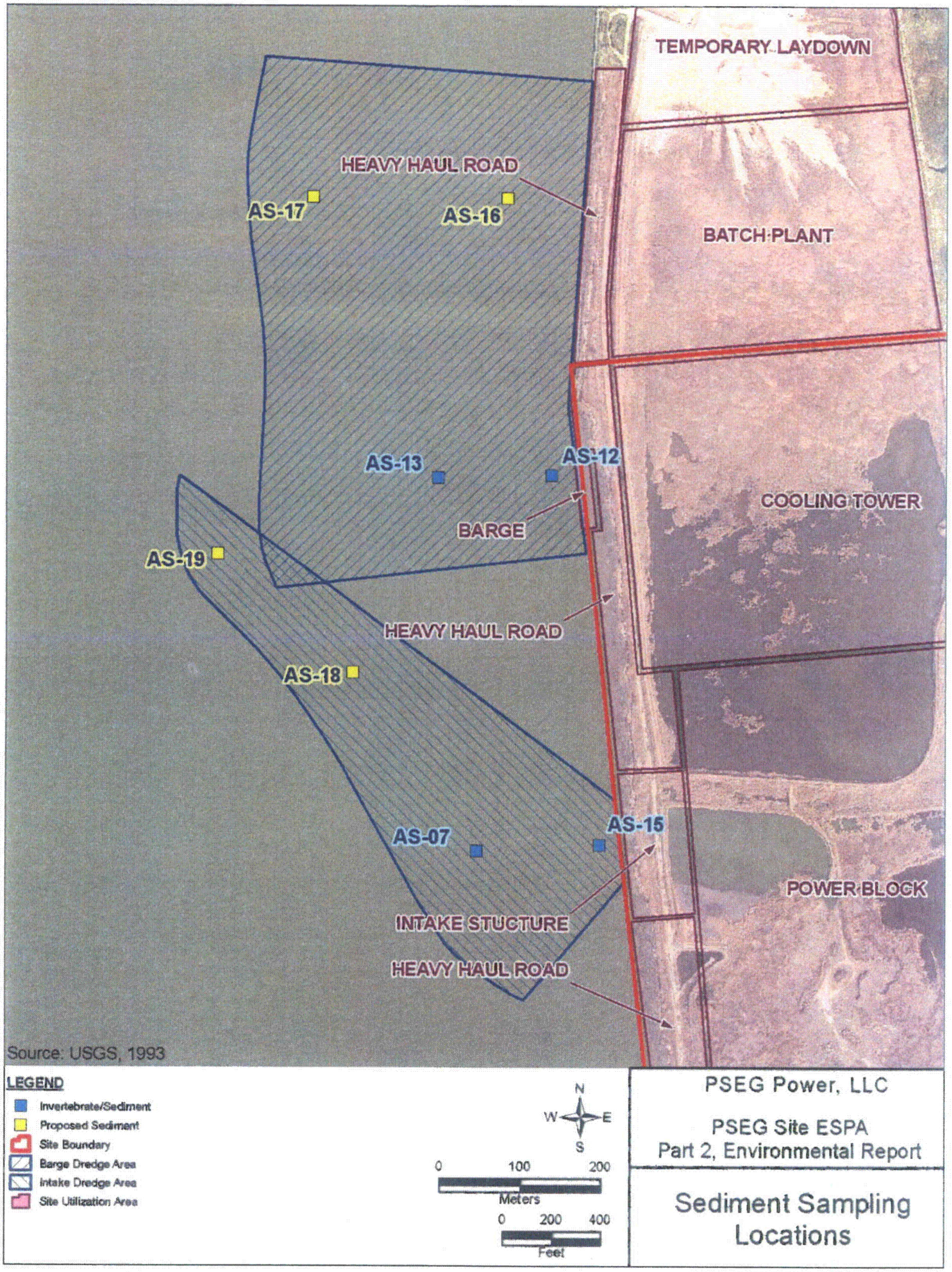

Figure 3. Survey area with proposed barge facility to the north and the proposed intake structure to the south outlined in blue (courtesy of MACTEC, Inc.).

2. HISTORICAL BACKGROUND

Research Methodology

An overview of the general history of the survey area, including Artificial Island, the Delaware River, and the Delaware Bay, accompany a discussion of specific research that investigated several maritime subjects. These subjects include: shipping, shipbuilding, naval activity, and navigation of the Delaware Bay and River and area shipwrecks. Both primary and secondary source information, including historic charts and maps were consulted to provide indicators for local and regional maritime historical developments and trends. Of particular importance was the discovery of any lists indicating ship losses or wrecks in and around the mouth of Delaware Bay. Research was conducted online and through local and regional sources, including: the U.S. Army Corps of Engineers, Philadelphia District, Philadelphia, Pennsylvania; Dover, Delaware; and the Salem Historical Society in Salem, New Jersey.

Research of the Delaware River and Bay area provided a context and basis by which submerged cultural resources, if identified, could be evaluated for possible NHPA, Section 106 eligibility. Particularly valuable sources aiding in this investigation included data contained within the two reports by Lee Cox, Jr., *Submerged Cultural Resources Investigations, Delaware River, Main Navigational Channel, Philadelphia, PA to Artificial Island, NJ* and *Phase I. and Phase II Underwater Archaeological Investigations Lewes Beach and Roosevelt Inlet Borrow Areas, Delaware Bay, Sussex County, Delaware;* and Frank E. Snyder and Brian Guss' *The District: A History of the Philadelphia District, U.S. Army Corps of Engineers 1866-1971.*

Overview of Colonial Maritime History of the Delaware River and Bay

Initial Contact Period

In 1609, Henry Hudson, under commission from the Dutch East India Company commanded the *Half Moon* on a mission to locate a safe northwest passage to the orient. In doing so, Hudson became the first documented European to discover the Delaware Bay and establish a foundation for colonization. Over the next thirty years, Dutch explorers from New Amsterdam (New York City) ventured up the bay in an effort to establish outposts for a fur-trading network with the Indians. Hendrick Christiaensen, Cornelius Jacobson May, and Cornelius Hendrickson were among the prominent Dutch sailors who explored the Delaware Bay and River during this initial contact period.

As the first settlers to the Delaware Valley, the Dutch built Fort Nassau in 1626 in the vicinity of the present Gloucester Point, New Jersey (Weslager 1988). It represents one of the first outposts constructed to support the developing trade network. However, a major developmental blow for Dutch colonization came in 1630 when Indians destroyed a whaling facility near the modern day Lewes, Delaware. Named Zwaanendael, the fledgling-whaling colony existed for only one year and never recovered. Furthermore, its demise allowed for other eager colonial competitors, such as the Swedes and English, to gain a lucrative foothold in the area.

In 1638, the Swedes, led by Peter Minuit, effectively ended the Dutch monopoly of Delaware Bay by establishing a Swedish stronghold known as Fort Christina. Located on the western shore of the river, near present day Wilmington, Delaware, the introduction of Swedish settlers initiated a twenty-year period of dual occupation of the Delaware Valley before the English assumed control of the region in 1664. Other early settlements or constructed fortifications include the Dutch-built Fort Beversrede and Casimir as well as the Swedish Fort New Gothenburg and Elfsborg (Weslager 1988). The Dutch and the Swedes, although in direct competition with each other for the lucrative fur trade with the Delaware and Schuylkill River

Indians, maintained a cooperative existence. Each country built and supplied several forts and outposts at various locations along the Delaware River and Bay area until 1664 when the English effectively took control of the region.

Figure 4. Nautical chart of "Zwaanendael" (1629) illustrating a land claim founded by Samuel Godyn and Godyn's Bay (Delaware Bay) in New Netherland. Approximate location of the survey area circled (courtesy of the Library of Congress).

English Settlement and Control

In 1663, the English began attacking Dutch holdings in the New World as part of the larger Anglo-Dutch Wars. In October of 1664, Sir Robert Carr, under orders from the Duke of York, captured the Dutch and Swedish settlements on the Delaware River (Weslager 1988). This marked the end of the Dutch/Swedish settlement period and ushered in the English era. Eighteen years later in 1862, the English solidified their control of the area when William Penn arrived in the Delaware Valley and formed his colony in Philadelphia.

The Quakers and English Occupation

In 1657, Stuyvesant, who did not tolerate full religious freedom in the colony, and especially the presence of Quakers, ordered the public torture of Robert Hodgson, a 23-year-old Quaker convert, who had become an influential preacher. Stuyvesant then made an ordinance, punishable by fine and imprisonment, against anyone found guilty of harboring Quakers (Weslager 1988). This action led to a strong protest from the citizens of the colony and perhaps paved the way for an easier occupation and transition to English control over Salem in 1664, where religious tolerances were more accepted.

ORIGIN OF SALEM

Fort Nya Elfsborg was established as a Swedish settlement in 1643 and became known as a significant part of the New Sweden colony for its strategic trade location near the mouth of the Delaware Bay. Representing one of the earliest European settlements in the state of New Jersey, the fort was named after the old Älvsborg Fortress offshore from Gothenburg, Sweden (Weslager 1988). The settlement is also situated near Alloway Creek, which is navigable by small watercraft that could easily deliver raw materials by trading with the Lenni-Lenap Indians from the New Jersey interior. In 1655, Peter Stuyvesant, on behalf of the Dutch West India Company, gained control of Fort Nya Elfsborg as well as other settlements in the region from the Swedes to secure this valuable trade location. Later, it was captured by the British in 1664, and then renamed Salem in 1675 by Quaker leader, John Fenwick.

SHIPPING ACTIVITIES IN DELAWARE RIVER AND BAY

The social and economic development of the Delaware Valley region flourished due to the vital transportation artery, which the bay and river conveniently provided for prospective settlers since the seventeenth century. European involvement in maritime trade in the Delaware Valley dates to the early 1600s when Dutch and Swedish fur traders sporadically ventured upstream to exchange goods with the Native American inhabitants. It was not until later in the same century that maritime trade began to proliferate and coalesce into an organized international exchange network. Delaware Valley merchants in the eighteenth Century shipped and imported goods with colonies through coastal trade and engaged in commerce overseas primarily with England, southern Europe, and the Caribbean (Cox 1988). Several key American ports, such as Philadelphia, serviced the network of trade routes within the colonies. Each colony contributed its local products for export, with eastern Pennsylvania, Delaware, and West Jersey primarily shipping lumber, staves, wheat, and flour (Brewington 1939).

Trade between Delaware and English ports was mostly a one-sided venture. The upstart colonies received a wide assortment of products from England, including: manufactured goods, textiles, metals, tea, shoes and tools. Meanwhile, the Delaware ports only exported lumber, foodstuffs, and furs to England (Cox 1988). Increasingly stringent regulations on manufacturing were imposed upon the colonies by the British Parliament in an effort to protect the interests and markets of British manufacturers. Regulatory control and a trade imbalance created by this unequal exchange was alleviated slightly by the development of a triangular trade route that moved items from Philadelphia to the West Indies before the ships crossed over to England. Another trade system involved the southern European nations of Spain and Portugal and delivered wine as a major import into the Delaware Valley.

At the start of the eighteenth century, Gabriel Thomas provides an indication of this trade network and the type of trade goods that came from ports, such as Philadelphia:

> Now the true reason why this flourishing city advance so considerably...is their great and extended traffique and commerce both by sea and land, to New York, New England, Maryland, Carolina, Jamaica, Barbados, Nevis, Montserrat, Antigo, St. Christopher's, Bermudas, New Foundland, Maderus, Saltetudeus, and old England...Their merchandise chiefly consists (of) horses, pipe stoves, pork and beef...bread and flour, all sorts of grain, peas, beans, skins, fur, tobacco and potashes; wax which bartered for rum, sugar, molasses, silver, negroes, salt, wine, linen, household goods ...." [Brandt 1929:87].

Around 1754, a more comprehensive description of trading activity in and out of Philadelphia is provided by Israel Acrelius, an eighteenth century Swedish clergyman, who wrote his *History of*

New Sweden in 1758. He listed articles, which were shipped to and from the port of Philadelphia mentioning that wheat, flour, bread and beef were all major exports to the West Indies in exchange for rum and sugar. Similar items were sent to Carolina, which in turn exported tar, pitch and turpentine. Philadelphia merchants sent rawhides, deerskins, and several items previously acquired from the West Indies to London, Bristol and Liverpool. In return, they "brought all kinds of English manufactures and even bottled liquors. But as this commerce is carried on with a very heavy balance against it, this must be made up by bills of exchange and by money..." (Brandt 1929:97). Acrelius went on to state that wheat, bread and wax were sent to Lisbon, whose merchants shipped wine, salt, olive oil, silk, satin, and tea back to the Delaware Valley (Brandt 1929). As a result, maritime commerce in the Delaware Valley increased throughout the eighteenth century. Port entrances and clearances in 1730 placed Philadelphia third in the colonies behind Boston and New York.

By 1772, Philadelphia's shipping activity had exceeded both of those ports, and in the immediate pre-Revolutionary War period, Philadelphia was indisputably the most active port in North America. The Revolutionary War completely disrupted commercial development in the Delaware River Valley, and the British Navy blockaded virtually all shipping that moved in and out of the Delaware Bay during most of the war. After the conflicts ended, Delaware Valley merchants sought to establish new trade routes to revitalize the local maritime economy, and a successful trade relationship was sponsored with the Far East (Cox 1988). Shortly thereafter, ships were also leaving Delaware Bay for Russian, Baltic and South American ports. Often the emergence of these new routes was necessitated by the tendency of each state to regulate its trade by levying stiff tariffs on shipped goods (Brewington 1939).

However, disruption, and therefore, further development of shipping in the early nineteenth century was curtailed by several events. The Napoleonic Wars tied up the majority of the European fleets in an embargo, greatly reducing the volume of trans-Atlantic traffic. In 1812, the British blockaded the Delaware once again as a result of Anglo-American hostilities. However, several developments stimulated the revival of shipping that followed these restrictive actions. The emergence of the anthracite coal trade, the growth of packet lines, and the slow but steady conversion to steam propulsion helped to keep the Delaware ports active (Cox 1988). The first regular steamboat service on the Delaware River was in operation from 1809 to 1813. The steamers, *Phoenix* and *Philadelphia* carried passengers on the middle section of the Delaware River between Philadelphia and Bordentown, New Jersey. The *Phoenix* was then replaced by the *Eagle*, which ran between Philadelphia, Pennsylvania and Burlington, New Jersey three times a week. Seven steamboats were reported to be operating on the Delaware River by 1813 and their number continued to increase through the second half of the nineteenth century. The *Vesta* was the first steamboat to venture down the Delaware Bay from Philadelphia to Cape May, New Jersey in 1819 and completed the trip twice a week (Baker 1976). Since it took some time before mariners gained sufficient confidence in the operation of steam-propelled vessels, most of the initial steam craft were outfitted with a sail rig and limited to operation in a relatively protected environment. Other early steamboat lines that operated within Delaware Bay ran to the cities of Philadelphia, Wilmington, Smyrna, and Salem.

Steam service in rivers and harbors tended to outperform coastal lines due to their design, which was unseaworthy for offshore use. However, while steamboats were initially designed only for operation in calm waters, they were eventually modified for open-water transit (Cox 1988). Most of the initial changes in hull design and steam technology, however, did not produce much improvement in the seaworthiness of steamboats. In 1836, the 596-ton steamboat *Charlestown*, built at Philadelphia, ran to South Carolina. This service experienced many difficulties and was discontinued in 1839. It was not until 1849 that the steamship *Philadelphia*, a vessel designed specifically for the rigors of the open sea, was built for coastal service (Cox 1988). She was equipped with side paddle wheels and driven by two side-lever engines. Other coastal steamers were rapidly built as the early steamship lines began to thrive. The 227-foot paddle-wheel steamer *Quaker City* ran between Philadelphia and Havana in 1854. The Clyde Line to New York and Boston was started in 1842 (Baker 1976).

Wholesale transportation of cargo overseas was still utilized primarily by large sailing vessels during the first half of the nineteenth century. Shipping companies used the large, ship-rigged sailing vessels on established routes that became known as packet lines. Regularly scheduled packet lines were sailing out of Philadelphia by the 1820s. Thomas Cope, in 1822, initiated Philadelphia's first trans-Atlantic packet line to Liverpool with two ships, the 290-ton *Lancaster* and the 278-ton *Tobacco Plant* (Cox, 1988). Packet lines continued to thrive in Philadelphia until after the Civil War. Other lines that operated out of Delaware River ports included: the Welsh Line (1823-24), the New Line of Liverpool and Philadelphia Packets (1824-37), the Black Diamond Line (1823-24), the New Line (1847-55), the Line of Liverpool Packets (1850-61), and the Philadelphia-Liverpool Line (1852-54) (Baker, 1976).

Throughout the historic period, there were several small, yet active ports along the larger tributaries flowing into Delaware Bay through the coastal counties of New Jersey and Delaware. A strong regional trade network developed between various ports in New Jersey and Delaware and the regional port hub of Philadelphia. New Jersey farmers and merchants used docks and landings on the Salem, Maurice, and Cohansey rivers to transport their products to Philadelphia. Indeed, the town of Salem, near the project area on the Salem River, became an official port of entry as early as 1682 and was one of only three official ports of entry for the entire colony of New Jersey. As a result, Salem enjoyed extended periods of prosperity during the early eighteenth century (Sebold and Leach, 1991). However, the vast majority of shipping activity along New Jersey's rivers draining into the Delaware River ultimately revolved around the port of Philadelphia. By the end of the nineteenth century, Salem had 13 wharves on the waterfront, 12 of which were associated with the Pennsylvania Railroad. Steamers, sailing vessels, barges and canal boats carried glass, canned goods, iron and brass castings, agricultural products and fertilizer from the Salem River to Philadelphia (Snyder and Guss 1974).

The rise of Cape May as a summer resort destination caused steamboat companies to develop direct steamer routes from Philadelphia to the southern tip of New Jersey at the mouth of the Delaware Bay. Several steamboat companies conducted successful passenger excursion trips to the resort community of Cape May. As early as 1816, the steamboat *Baltimore* traveled between Philadelphia and Salem twice a week. From Salem, passengers continued to Bridgeton and Cape May via stagecoach. In 1824, the *Delaware*, under the command of Captain Whilldin, began shuttling vacationers from Philadelphia and Wilmington and New Castle, Delaware, to the southern New Jersey shore. As demand for this service increased, established excursion operators and new lines competed for riders, and the ticket prices fell from $5.00 to $.50 a head (Sebold and Leach 1991). Passengers and much of the commerce from Cumberland County was carried down the Maurice River by steamboats into the Delaware Bay and up to Philadelphia. The Maurice River Steamboat Company operated the *Thomas Salmond*, which offered excursions from its homeport of Maurice River to Philadelphia (Sebold and Leach 1991). Sand, for the glass industry, was the principal item shipped along the Maurice River. During the first half of the nineteenth century, bog iron was smelted and shipped down the Maurice River for export. Gravel, oysters, fish, and lumber were also transported down the river and up to Philadelphia, and to a lesser degree, to New York.

A steamboat line was also established on the Cohansey River, which connected Bridgeton with Philadelphia and other Delaware Valley ports. In 1844, the *Cohansey* began making three excursions a week from Bridgeton to Philadelphia with stops at Greenwich, Port Penn, Delaware City, New Castle, Marcus Hook and Chester, as well as occasional trips to Cape May (Cox 1988). Three other steamboats operated on the Cohansey: the *Arwames*, the *Patuxent,* and the *Express* (Sebold and Leach 1991). Fishing, oystering, and in recent years, crabbing were all major industries in southern New Jersey as well as building ships for these fleets. Shallops and sloops were typical vessels used for trade on the Delaware Bay and River during the colonial period. The use of shallops and sloops for fishing, oystering and trading, declined after the introduction of the more versatile schooner (Sebold and Leach 1991). In Delaware, Sussex and Kent County merchants used landings along most of the major streams (Appoquinimink Creek and the Murderkill, Broadkill, St. Jones, Smyrna, Mispillion, and Leipsic rivers) to ship agricultural products to Philadelphia. They then returned home with manufactured items for the local population. Settlers engaged local shipwrights to build various types of vessels, primarily sloops and schooners, at strategic locations along the riverbanks. By 1860, three-masted schooners carrying 400 tons of cargo were entering and clearing many of the rivers in Delaware.

Lebanon, Forest Landing, Barkers Landing, and Dover all served as ports for the shipment of produce from Delaware farms to Philadelphia. Lebanon, originally called Lisbon, quickly became the most active port in Kent County (Valle 1984). Lewes was an important base for Delaware River pilots who guided ships through the shoals up the navigational channel to upriver ports in Delaware, Pennsylvania, and New Jersey. In addition Lewes Harbor became a harbor of refuge for ships traversing the Atlantic Ocean and Delaware Bay. Steamboats were introduced to Delaware's trade network during the second half of the nineteenth century. At the end of the nineteenth century, large steamboats were involved in the trade between Delaware merchants and the port of Philadelphia. The steamers *Diamond State*, *Maid of Kent*, *City of Milford* and *Lamokin* carried passengers and cargo from various Delaware ports. Arrivals and departures of steamers were planned around favorable high tides. After 1887, when a dredge cleared a 6-foot channel as far inland as Drapers Wharf, steamboats were able to penetrate the St. Jones River all the way to Dover (Valle 1984). The Dover and Philadelphia Navigation Company commenced a regular service from the St. Jones River with two large steamers, *John P. Wilson* and the *City of Dover*. In addition to the steamers, freight boats and two- and three-masted schooners were actively engaged in transporting farm produce from Delaware to Philadelphia. Railroads and all weather highways offered strong competition to the steamboat lines, so that by the Depression era most of the lines had ceased to operate (Valle 1984).

The Chesapeake and Delaware Canal, connecting the Delaware River just above Reedy Island to the Chesapeake Bay via the Elk River, was opened on October 14, 1829. Originally, the canal was 36 feet wide at the bottom, 66 feet wide at the top, and ten feet deep (Cox 1988). A series of locks were required to allow navigation between the two waterways. Although the canal had little impact on shipping in the lower Delaware Bay, it forged a water link between Philadelphia and Baltimore. The advent of railroads throughout the region limited the initial success of the canal. However, the Federal Government took over control of the canal in 1919, widened it, deepened it, and removed the locks, allowing sea level navigation by 1923 (Cox 1988). Several decades later the canal was again enlarged to the present depth of 35 ft. with a width of 450 ft. and is ranked by the U.S. Army Corps of Engineers as the busiest canal in the United States (Bryant and Pennock 1988). Use of the canal did not have a direct impact on shipping in the lower Delaware Bay until after the canal was reopened without locks. Northbound ships leaving and calling on Baltimore used the shorter canal route to reach the Atlantic Ocean via Delaware Bay, instead of traveling down the Chesapeake Bay and passing around Cape Charles (Cox 1988).

Shipbuilding Activities in the Delaware River and Bay

Historically, the Delaware Valley has always had a strong and vibrant shipbuilding industry. From the early colonial period, even before William Penn founded Pennsylvania, up through World War II, Delaware Valley shipyards have been among the most productive in the country. With an advantageous combination of available resources, such as timber, iron, steel, and skilled labor, Delaware Valley shipyards rapidly established and maintained a strong shipbuilding tradition. The first documented shipbuilding activity by Europeans in the Delaware Valley region took place in the middle of the seventeenth century during the Dutch and Swedish occupation. Although references to shipbuilding during this period are sparse, records indicate that in 1644 the Swedes endeavored to build "two large, beautiful boats, one for use at Elfsborg, and the other at Fort Christina" (Brewington 1939:50). The Swedes remained active in shipbuilding for the next several years. Their carpenters finished a sloop, a barge, and a 200-ton ship by 1651. However, once the Dutch assumed control of the Lower Delaware Valley in 1655, Swedish shipbuilding activities ceased. There is no record of Dutch shipbuilding during this era, but it would not be unreasonable to assume that some boat construction took place in support of the several coastal forts and outposts that were built (Cox 1988).

Shipbuilding increased dramatically following the surge of English settlement in the Delaware Valley after 1664 (Cox 1988). One of the first vessels built by English settlers was the ship *Glob*, constructed in 1675. At least two other vessels were built that year along the Delaware River shoreline (Brewington 1939). In his designs for his colony, William Penn had intended to establish a strong tradition of shipbuilding. He recognized the potential of the hardwood forests that stretched along the upper sections of the Delaware River drainage. This vast source of timber suitable for shipbuilding was especially prized, since much of England's natural wood supply had been exhausted by the end of the seventeenth century. With these resources available, Penn advertised abroad for quality tradesman to come to Philadelphia. He wrote that shipwrights were among nine different types of craftsmen in Pennsylvania (Cox 1988). By 1685, there were shipwrights, boatwrights, ropemakers, sailmakers, and blockmakers all listed as residents of Philadelphia (Shipbuilding Research File, Philadelphia Maritime Museum n.d.).

With its ample supply of both raw materials and skilled labor, Delaware Valley shipyards rapidly became among the most active in all the colonies. In 1700, there were four commercial shipyards in operation along the Delaware River. Between 1682 and the beginning of maritime records in 1722 (ship registers started by the port authorities to collect customs), the average number of ships built is estimated to be slightly less than ten vessels per year, most of which were less than 50 tons in size (Crowther 1970). Several family shipyards were responsible for the majority of the early eighteenth century vessels built in the Delaware Valley. The West, Penrose, Humphries, Bowers, Eyre, Cramp, Lynn, and Vaughan facilities were some of the more prominent yards in the area (Cox 1988).

During the Colonial period, British Parliament enacted a ship register, whose purpose was to assist with enforcing certain provisions of the Navigation Acts of the late seventeenth century. In 1696, an Act required owners of vessels engaged in overseas plantation trade to swear an oath in writing that “no foreigner, directly or indirectly, hath any share, or part, or interest therein”. Registration of the oath was made before local customs officers and a certificate was issued to the master of the vessel. The certificate allowed Englishmen or colonists owning vessels to engage in overseas trade within the British Empire. Vessels solely conducting Intra-colonial commerce and fishing operations were exempt from the Act and therefore not required to register. After 1722, an estimation of the output of the shipyards in the Delaware Valley can be determined from the *Ship Registers of Pennsylvania, 1722-1775* (McCuster 1970). Simeon John Crowther conducted a detailed examination of the registry records for the Port of Philadelphia, which date from 1726-1776. This research was performed in connection with his dissertation entitled, *The Shipbuilding Industry and the Economic Development of the Delaware Valley: 1681-1776.* A total of 3,241 vessels were registered in Philadelphia over this period. A large percentage of that number was undoubtedly built in local yards. Between 1722 and 1776, Delaware Valley yards produced approximately 95,000 tons of shipping if one estimates the output of missing years in the registers and adds that number to the total recorded output of 87,346 tons (Crowther 1970). The average tonnage of individual vessels increased steadily throughout the entire 54-year period (Cox 1988). Six types of vessels were listed in the registers: square-rigged ships, sloops, brigantines, snows, schooners, and shallops. These were the vessel types predominantly used in the Delaware Bay and the Delaware River during the colonial period. Their basic distinguishing characteristics were the type of sails and rigging used, but they also varied in size as well (Cox 2005).

A series of tables compiled by Crowther are very useful for this current study. Tables 1 and 2, presented below, were generated using Crowther's findings. Table 1 lists the number of vessels, by type, that were registered within the Port of Philadelphia from 1745 to 1761. Table 2 lists the annual mean tonnage of vessels from 1745 to 1761, by vessel type. Since the archaeological remains of the Roosevelt Inlet Shipwreck suggest the vessel was likely classified as a Ship, Snow, Brigantine, or Schooner, only these types of vessels were included within Tables 1 and 2 (Cox 2005). In addition, since the artifacts from the wreck appear to date within the time period of 1760-1775, the Tables 1 and 2 focus on this era. An expanded timeline was utilized in the event that the date range of the artifacts should change, based on future analysis and findings.

Since records do not exist from 1762 to 1765, those years could not be included. The registry data shows that from 1745 to 1761, a total of 524 vessels of the types listed above were registered for overseas trade. Of this total, 10 were classified as Ships, 89 as Snows, 164 as Brigantines, and 91 as Schooners (Cox 2005). During this period, the mean average tonnage for Ships was 106; Snows, 74; Brigantines, 54.5; and Schooners 16. By 1770, Pennsylvania, New Jersey, and Delaware shipyards were among the most active colonies, in terms of tonnage of vessels built.

Table 1. Annual Number of Vessels Registered in Philadelphia by Type of Vessel, 1745-1761.

Year	Ships	Snows	Brigantines	Schooners	Totals
1745	5	2	5	3	**15**
1746	6	5	12	4	**27**
1747	4	4	12	3	**23**
1748	18	10	15	11	**54**
1749	10	7	5	2	**24**
1750	14	15	10	6	**44**
1751	15	8	13	3	**39**
1752	13	6	11	6	**36**
1753	11	4	5	3	**23**
1754	8	4	9	2	**23**
1755	9	3	3	4	**19**
1756	5	4	9	8	**26**
1757	9	2	8	4	**23**
1758	10	4	10	5	**29**
1759	13	5	12	7	**37**
1760	20	6	8	12	**46**
1761	10	1	17	8	**36**
Totals:	***180***	***89***	***164***	***91***	***524***

Source: Crowther 1970:157, Table III-7.

Technological innovations ushered in with the Industrial Revolution helped change the nature of shipping and shipbuilding on the Delaware Bay and the Delaware River during the nineteenth century. Iron-hulled steam vessels rapidly became the standard type of vessel operating on the waterway (Cox, 2005). Shipbuilding yards along the banks of the Delaware soon were producing more iron-hulled vessels than any other region in the country and quickly earned the reputation as the "Clyde" of American shipbuilding. The Harlan and Hollingsworth shipyard in Wilmington became one of the nation's leaders of producing quality iron-hulled and wooden-hulled steam vessels (Cox, 2005). Other regional leaders in the production of iron-hulled ships include: John Roach and Sons; Thomas Reaney, Son & Archbold; N.F. Palmer; Chester

Shipbuilding (Chester); William Cramp & Sons; Neafie, Reaney & Company; John Birely & Son and John Vaughan & Son (Philadelphia); and John Dialogue & Sons and Wood & Dialogue (Camden) (Cox, 2005). This strong regional shipbuilding tradition continued through World War I, when the Hog Island Shipyard in Philadelphia and the New York Shipyard in Camden had been mass-producing vessels for the war effort. Wooden-hull shipbuilding in South Jersey, specifically on the Maurice River, was also important in the historic period. From the beginning of the nineteenth century, expert local shipwrights produced sloops, schooners, shallops, and a variety of small vessels for local trade and the thriving fish/shellfish industry.

Table 2. Annual Mean Tonnage of Vessels Registered in Philadelphia by Type of Vessel, 1745-1761.

Year	Ships	Snows	Brigantines	Schooners
1745	142	85	53	10
1746	97	75	52.5	22.5
1747	124	71	61	6.5
1748	122	80	52	15.5
1749	87.5	79.5	44	16.5
1750	95.5	70	54.5	17.5
1751	86.5	66	49.5	13.5
1752	94	70	48	24
1753	92	67.5	49	16.5
1754	124.5	87	52	14
1755	88	70	70	19
1756	88	71	56	10.5
1757	112	55	62	20
1758	120.5	67.5	57.5	9.5
1759	119.5	80	50	15
1760	100	61.5	47.5	23
1761	108.5	100	65	22
Mean Average:	***106***	***74***	***54.5***	***16***

Source: Crowther 1970:159, Table III-9.

Occasionally, much larger vessels were constructed for overseas trade. The schooner rig, adapted from early-eighteenth-century English and European vessel types, became popular throughout the lower Delaware Bay. A small crew could effectively operate a schooner-rigged vessel. Various types of schooners were developed in the eastern United States: "Virginia Schooner," "Baltimore Clipper," and "Bay Schooner" versions were all developed by American shipwrights in the nineteenth century. A version of the *Bay Schooner*, referring to the Chesapeake Bay, was modified by New Jersey boat builders to adapt to Delaware's strong tides and shallow waters (Cox 2005). In reference to the characteristics of schooners, Witty states, "By the 1920s, Delaware Bay schooners had taken on their own unique characteristics. Increased length of the hull lines, a freeboard with a long sweeping shoreline, and smaller heart-shaped sterns with elliptical tops characterized New Jersey schooners" (1986:96). As schooners became more popular among watermen, Delaware Bay sloops were dismantled and refitted as schooners with their characteristic fore and aft sail rig. During the first half of the twentieth century wind-powered oyster schooners were eventually outfitted with motors and pilothouses. Most of the existing schooners on the Maurice River pre-date 1930, the last year they were built in the area (Sebold and Leach 1991). Researcher Alonza Bacon compiled a list of 618 ships launched in Cumberland County, New Jersey between 1870 and 1935. The list documented 153 vessels built in Bridgeton, three in Fairton, 38 in Greenwich, 16 in Cedarville, 17 in Newport, 35 in Dividing Creek, 55 in Millville, two in Port Elizabeth, 61 in Mauricetown, 100 in Dorchester, 71 in Leesburg, and 32 in Port Norris (Cox 2005).

Regional shipyards were also active along many of Delaware's tidal rivers. In 1859, there were three yards in Milton on the Broadkill River, three in Milford on the Mispillion River, three at Lebanon on the St. Jones River, and two in Frederica on the Murderkill River (Cox 2005). The majority of the vessels were wooden-hull schooners, sloops, and fishing boats that utilized local wood products, particularly white oak and pine. Occasionally, much larger vessels were constructed at some of these regional shipyards. Nathaniel Link's shipyard in Frederica, Kent County employed approximately 35 people at the height of the industry in the mid-nineteenth century (Cox 2005). Link's yard produced three-masted schooners, one at a time, each ship needing nearly a year and a half for completion. Because the Murderkill River was so shallow, the ships were launched without their masts and towed to Philadelphia for final outfitting. Productivity of the yards began to decline in the 1880s, when wooden sailing ships were gradually phased out of coastal shipping (Hoffecker 1977).

NAVAL ACTIVITY

During the War of Independence, there were many significant naval engagements waged on the Delaware River, including a battle for access to Philadelphia. In September 1777, the city fell to British forces, but the colonials remained in control of the Delaware River. An attempt to gain control of the only supply route available to them was made by the British when they sent a massive naval fleet of warships to destroy the colonial forces that controlled the river. The Americans attempted to counter the strength of the English warships with a defense system, including three forts, two tiers of river obstructions (known as Chevaux de Frise), and numerous assorted small crafts (Cox 1988). These were composed of rowed galleys, floating batteries, guard boats, sloops and schooners, and fire rafts. The colonial forces assembled approximately 57 vessels on the Delaware River at the time (Jackson 1974).

The initial encounter between the two forces took place in the spring of 1776, near Wilmington, but the major engagement was fought in the upper reaches of the Delaware River in the fall of 1777. In May 1776, a fleet of three English vessels, under the command of Captain Hammond, was ordered up the Delaware River to perform a reconnaissance mission and ascertain the strength of the colonial forces (Cox 1988). The Americans sent a portion of the small boat fleet down below the lower tier of obstructions to meet the English forces. The two sides met on two separate occasions between May 8 and 12. The first encounter was adjacent to the mouth of the Christina River, and the second skirmish was slightly downriver from the Christina. Neither side suffered a loss in either engagement, as both conflicts were rendered inconclusive.

However, a fierce, six-week long struggle ensued beginning in October 1777, when the two the forces met again. The battle was contested until the vastly superior English force of nine warships loaded with 295 long guns was able to capture two forts (Mifflin and Mercer) on November 16 (Cox 1988). The British lost two of their warships near the mouth of Mantua Creek during the course of the battle, including the sixty-four-gun frigate, *Augusta* and the eighteen-gun sloop of war, *Merlin.* Losses to the colonial naval forces were heavy as all of their boats became trapped once the forts were captured with most becoming destroyed in the process. This particular engagement in the Delaware River during the War of Independence is the last significant battle that took place in the region (Cox 1988).

DELAWARE BAY AND RIVER NAVIGATION

Although Henry Hudson visited the Delaware Bay in 1609, which was explored by others within the next decade, the first comprehensive navigational chart of the Delaware Coast vicinity was not completed until 1756. In that year, Joshua Fisher charted the waters of the Delaware Bay and provided the first bottom contours, based on soundings. In the first half of the nineteenth century, several other maps and charts of the vicinity were privately published. The first standardized charting of the bay/river was not provided until the first United States Coast Survey was finished in 1848 (Cox 2005). In 1878, this agency was reconstituted as the United States Coast and Geodetic Survey, and from this time on, the agency has periodically updated the chart of the vicinity with increasingly detailed, more accurate hydrographic information.

As the Delaware Bay affords the only suitable deepwater inlet along the 295-mi. stretch of the Atlantic Coast between Chesapeake Bay and New York Bay, mariners frequently sought refuge in the mouth of the bay during periods of inclement weather. Lewes became a harbor of refuge for ships heading along the Atlantic Coast and up the Delaware Bay, alike (Cox, 2005). The earliest known aid to navigation in Delaware was the Cape Henlopen Light, which was erected in 1767. The light helped to guide vessels into the bay and also served as a warning that the cape was nearby. The lighthouse continued to aid vessels entering and exiting Delaware Bay until it was destroyed by erosion in 1926. A second lighthouse was constructed on Fenwick Island in 1858 to further aid mariners who traversed the Delaware coastal waters (Cox 2005).

A major aid to navigation in the area was the construction of a pair of breakwaters inside Cape Henlopen and the creation of a Harbor of Refuge, which provided protection to vessels from storms and ice at the mouth of the Delaware Bay (Cox 2005). Before the construction of these breakwaters, conditions at the mouth of the Delaware Bay were often more perilous than in the open ocean. Mariners, shipping companies, port officials, and insurers all raised the issue of the need for a protective breakwater near the mouth of the Delaware Bay to protect shipping (Cox 2005). In a plea made to Washington, D.C. in 1826, Alex Stewart encouraged officials to:

> ... place a shelter at the entrance of the bay [because] the commerce of the Delaware will not alone be protected and preserved by it, but that of the whole coast, daily passing and repassing its capes, together with foreign vessels who resort there when overtaken by accident at sea. All will find a haven where their crews can be recruited; damages repaired, and their wants fully supplied secure from mishap or danger; thereby the interests of merchants, and the lives of hundreds of individuals will be saved from jeopardy or untimely death [cited in Hazard 1828:70].

Delaware River Navigation

The first organized efforts to overcome the navigational hazards facing mariners who traversed up the Delaware River was established in 1766, when the port of Philadelphia was placed under control of the "Wardens of the Port of Philadelphia" (Snyder and Guss 1974). The office was created by, "An Act for Appointing Wardens for the Port of Philadelphia and for Regulating Pilots Plying the River and Bay to and from Said Port" (Slaski n.d.). The wardens were issued the responsibility of licensing pilots, placing buoys, alleviating the problem of winter icing, the erection of lighthouses, and the dredging of wharves and piers. However, in terms of physical improvements or installation of navigational aids, little was done until the nineteenth century. A set of 1796 sailing instructions for the bay mentions that buoys were located on Brown, Brandywine, and Cross Ledge Shoals. By 1827, additional buoys were placed on Joe Flogger, Fourteen Bank, and Upper Middle Shoals.

Ice was a serious threat to navigation on the Delaware River. Each winter, almost without exception until the middle of the nineteenth century, the Delaware River froze over. This phenomenon not only closed the port for a significant period of time each winter, sometimes lasting over a month, but it also posed a serious threat to any unfortunate vessel that became entrapped in its ice floes. The first attempt to manage this problem was in 1803 when the first of a series of ice piers was constructed off New Castle, Delaware (Cox 1988). A total of seven piers were built at New Castle and served to break up ice floes as they came down the river. The intention of these constructions was to provide a safe anchorage for ships behind the piers. Other piers were built later at Marcus Hook, Pennsylvania and Lewes, Delaware.

Another navigational hazard present in the Delaware River was the placement of the Chevaux de Frise during the Revolutionary War, mentioned earlier in the "Naval Activity" section. These frames, designed to defend the river, became serious threats to commercial shipping at the conclusion of the war. In 1783, the Port Wardens determined the location of buoys to mark the obstructions. Arthur Donaldson and Levi Hollingsworth were contracted by the Port Wardens in 1784 to remove the frames (Snyder and Guss 1974). After six months of work, they succeeded in removing 54 of the obstructions (Slaski n.d.). It is difficult to determine how thorough their effort was, because the number of frames the British had removed in 1777 cannot be determined. A report from the Port Wardens mentioned that during the year following the removal, only one incident concerning an obstruction was reported. Dredges working in the river during the 1930s and 1940s periodically struck a frame while dredging the main channel in the river (Cox 1988).

However, in the Delaware River, the most significant danger to mariners was, and still remains to this day, the hazard of running aground due to shoaling. Additionally, these shoals accumulate and shift unpredictably from sediment carried downstream, which further challenges the safety of navigating through the shoals. Today, there are eighteen major shoals or bars near the main shipping channel of the Delaware River and Bay (Cox 1988). Historically, mariners had to navigate through these shoals in a winding channel that was not improved until the last quarter of the nineteenth century. The average depth of the unimproved bay and river of the early nineteenth century was slightly more than 20 ft. in the main channel (Snyder and Guss 1974). This provided adequate draft for most vessels plying the river at that time. However, by the 1870s, a normal ocean-going vessel typically drew 20 to 24 ft. (Snyder and Guss 1974) and could easily run aground without the benefit of a full high tide. The major natural obstruction in the Delaware River was a rock shoal, located between Chester and Marcus Hook, Pennsylvania, known as Schooner Ledge (Snyder and Guss 1974).

Rock excavations at Schooner Ledge were started in 1879. The rock face was drilled with a rack and pinion device, and blasting charges were inserted into the rock. After exploding, the dispersed rock material was removed with a dipper dredge, and most of the material was placed behind Chester Island. Other major obstructions during this initial period were the shoals at Petty Island and near Fort Mifflin. Spoil from these two areas was deposited on government land at Fort Mifflin and League Island (Snyder and Guss 1974). Work at these locations was conducted between 1877 and 1882.

Finally, in 1885, legislation was approved, which authorized the permanent improvement of the Delaware River. The U.S. Army Corp of Engineers supervised all improvements on the waterway, including dredging and the construction and maintenance of anchorages, dikes, and harbors. A 30-foot channel from Bombay Hook Point to Philadelphia was authorized by the River and Harbor Act of 1896, which shortly thereafter, led to the creation of Artificial Island, just south of Salem, immediately adjacent to the survey area.

DREDGING IN THE DELAWARE RIVER

Up until the Industrial Revolution, the social and economic development of the Delaware River Valley could not advance appreciably without advancements in dredging technology. As noted earlier, the average natural depth of the Delaware River was only 20 ft. and did not allow for larger, more heavily laden, deeper drafted vessels to reach the major port of Philadelphia. Noteworthy activity in pursuit of channel dredging in the Delaware River coincided with the advent of steam-powered equipment (Snyder and Guss 1974). The establishment and maintenance of reliable Delaware River channels for navigation was first made possible in 1804 by Oliver Evans' "carriage," equipped with a steam engine and a stern paddle wheel (Figure 5).

The "*Orukter Amphibolos*" was probably the first mechanically functioning dredge to operate in the Delaware River. Evans described it as, "a large flat, or scow, with a steam engine of the power of five horses on board to work machinery to raise into flats" (Snyder and Guss 1974). With steam dredges such as the "Orukter," it became possible to retain and transport a higher percentage of the heavier material to create designated dredge spoil deposits. However, while this capability existed, without the use of a hydraulic pipeline dredge, deposition of this material was somewhat inefficient and prohibitively expensive. Attempts at avoiding this problem in the early nineteenth century involved inducing a measure of self-maintenance through harnessing the natural scouring force of the tide and current. However, a program for construction of channel training dikes was curtailed in 1885 after some effective diking had been done through the invention of another steam dredging machine, the *Ocracock Apparatus*. According to Snyder and Guss (1974), this apparatus was a form of a ladder dredge, which successfully provided a channel through a sand bar to a depth of approximately 10 feet. A hired machine worked the Delaware harbors and river in the summer of 1830. Operations continued through 1832, with Port Penn added to the harbor-dredging schedule.

In 1853, a system for improving navigation through dredging was recommended within the context of helping secure a greater national defense. Major Delafield, who was the superintendent of projects involving bolstering Atlantic Coast defenses, proposed a combination of dredging with ladders and diking the stream banks (Snyder and Guss 1974). The dredge spoil was to be dumped behind stone-filled timber dikes and represents a practice that continued long after ladder dredges disappeared from the Delaware River.

Dredging operations understandably came to a near standstill during the Civil War, but the post-war decade witnessed a phenomenal expansion of trade and industry, which accompanied a marked increase in maritime traffic for Philadelphia. Harbor planners ambitiously envisioned a ship channel in the Delaware River with fixed dimensions and permanent maintenance facilities. As mentioned previously, late 1800s commercial vessels had an average draft of 20 to 24 feet.

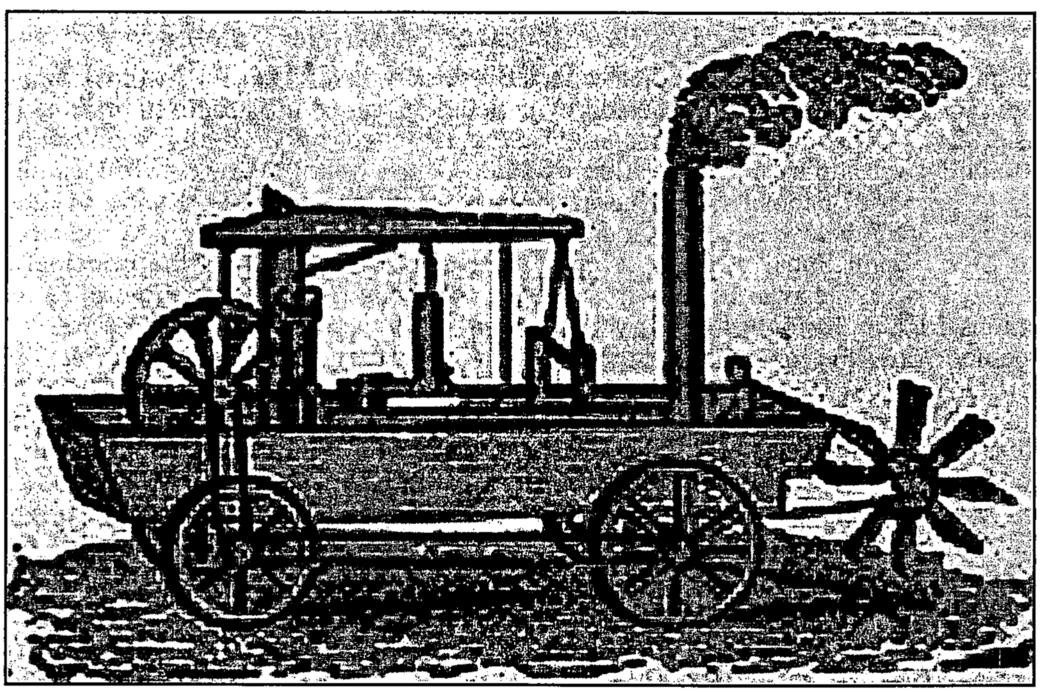

Figure 5. The Amphibious Digger, built by Oliver Evans for the Philadelphia Board of Health in 1804, was the first wheeled vehicle to move under its own power in the U.S. It was also the first mechanically powered dredge to operate in the Delaware River (courtesy of U.S. Army Corp of Engineers, Philadelphia District).

There were places in the Delaware River where ships could run aground easily, even at high tide, and the goal was to dredge the river to an average depth of 27 ft. (Snyder and Guss 1974). The most feared hazard and obstacle to this was at Schooner Ledge, 18 mi. below Philadelphia. It was a rock reef, in which according to Captain Ludlow of the U.S. Army Corp of Engineers, "could be regarded as the most serious obstruction in the river" (Snyder and Guss 1974). Rock excavation of Schooner Ledge took place in 1879, in the costliest single project undertaken yet for the improvement of the Delaware River for navigation.

DESIGNATED SPOIL SITES ON THE DELAWARE RIVER

When the challenge at Schooner Ledge was overcome, an experiment seeking an alternative to the overboard disposal of dredge material was proposed by Colonel Macomb at Fort Mifflin in 1879. Material was deposited in basins dug adjacent to a land-based dike enclosure, and then re-dredged into dump cars that moved on tracks along the top of the dikes, where they were then redeposited on land (Snyder and Guss 1974). This extensive effort was done, because it was observed that the "fluid and yielding material" tended to be redistributed and returned to the channel by natural forces (Snyder and Guss 1974). Seen as a success, dredge spoil sites were prospected for along the river, but by 1890, the scarcity of disposal areas was acute. Major Raymond, who started a 10-year tour of duty as the Philadelphia District Engineer, took charge of navigation improvement and the challenge of spoil disposal. A partial solution was achieved by making spoil disposal a responsibility of the dredging contractors. However, a tremendous volume of material had to be excavated from the Philadelphia harbor area. Government lands at Fort Mifflin and League Island were capable of receiving nearly half of the dredged material. However, in 1895, the Navy Department blocked a proposed extension of authority to continue the depositing of spoil at the League Island Navy Yard site (Synder and Guss 1974). In the six years following Major Raymond's appointment, approximately 10.7 million cubic yards of dredged materials were dumped on the river at nine different locations (Figure 6).

ARTIFICIAL ISLAND, SHIP BREAKWATER, AND HOPE CREEK

The River and Harbor Act of 1896 authorized a survey for the creation of a 30-foot channel from Philadelphia to the Delaware Bay. The survey covered 56 mi. of the proposed channel (Snyder and Guss 1974). The amount of material to be removed by dredging was estimated at 34,953,000 cubic yards plus the excavation of 24,000 cubic yards of rock. Six locations were earmarked as places of deposit with specific authority providing for the creation of one of the largest disposal areas below Reedy Island, on the eastern side of the river. At the site, Baker Shoal and Stony Point Shoal were to be enclosed by bulkheads to form the principal deposit basin in the Lower Delaware, known since as Artificial Island (see Figure 6). Initial appropriations for the 30-foot channel were designated for removal of the shoal below Reedy Island, deemed "now the most troublesome obstruction to the navigation of the river" (Snyder and Guss 1974) and for construction of bulk heading for the proposed artificial island disposal area. This work began with pile driving for the bulkhead on April 4, 1900 (Snyder and Guss 1974), but it was not until 1908 that the Artificial Island was finally completed. According to Josephine Jaquette, in a letter to the Salem Historical Society (see Appendix B), oral accounts from local fishermen, trappers, and people who helped construct Artificial Island, substantiated that the island was created on Stony Point and Baker Shoals as a means of keeping the channel open at the mouth of Alloway Creek. Furthermore, the intention was to create an island approximately 3 miles long and 1 mile wide for this to effectively occur.

After World War I, the government also had needed to dispose various wooden vessels (mostly freighters and oilers) particularly for World War I that had become obsolete. The World War I wooden vessels were sunken at the southern end of the Artificial Island (Figure 7). As this was all open water before the island was blown in (permitting the use of shad nets that would have caught on any obstruction below water), it is not believed that any ancient boats or wrecks are in this vicinity, according to the letter to the Salem Historical Society (see Appendix B).

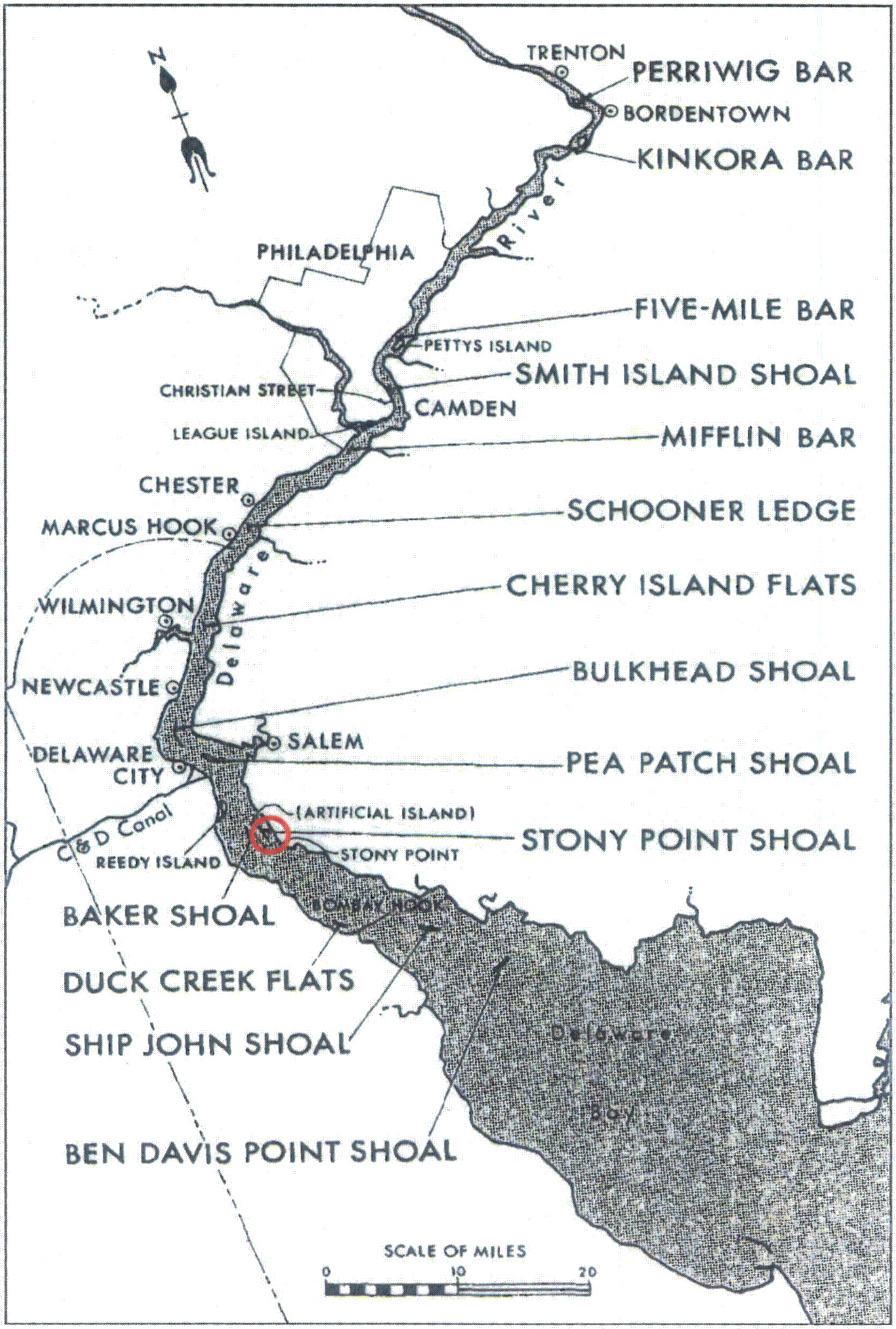

Figure 6. Showing the location of designated dredge spoil sites including Artificial Island and the approximate location of the survey area circled in red (courtesy of the U.S. Army Corp of Engineers, Philadelphia District).

Figure 7. Breakwater just south of Artificial Island composed of obsolete wooden World War I era vessels (courtesy of Google Earth™).

Referred to as "working on the Jetty" by locals employed during its construction in the early 1900s, the island was built in three sections on what was historically Stony Point Shoal, extending out to Baker Shoal (Figures 8a to 8c). The lower third of the island was built first, and then the upper third was built near the old cove of Alloway Creek. The east side connection was made next, leaving the west side of the middle section open so that tugboats could move the loaded scows inside for dumping mud. The gap was later filled in with clay from the nearby Hamburg Cove, and then topped with stone. There is also a stone bank that runs across the northern end of the lower third section and the southern end of the upper third section (*The Island Paper* 1991).

The U.S. Army Corp of Engineers owned Artificial Island until a 200 ac tract of land on the southern part of the island was exchanged with PSE&G for property the utility had owned in other locations along the Delaware River. Additional property was acquired from the State of New Jersey in 1974 to become what is now a 734 ac site for the Salem and Hope Creek Generating Stations. In 1968, a contractor for PSE&G built an access road to the Artificial Island across the marshland. Workmen in 1968 had to first cross Fishing Creek, and then bridge Hope Creek to make the island accessible to motor vehicle traffic (*The Island Paper* 1991).

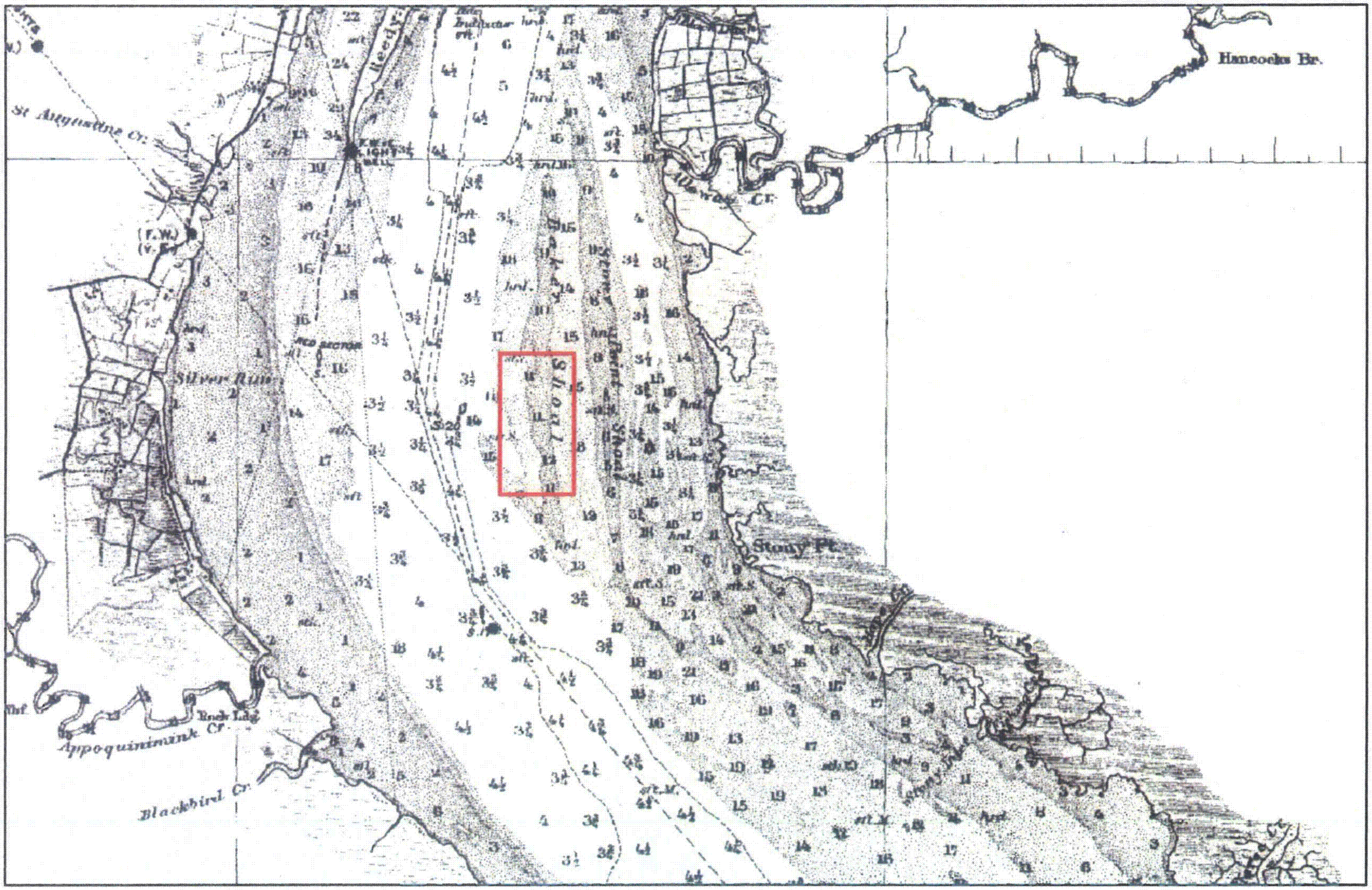

Figure 8a. 1896 chart, just prior to construction, shows Stony Point Shoal; project survey area outlined in red (courtesy of National Historic Chart Center).

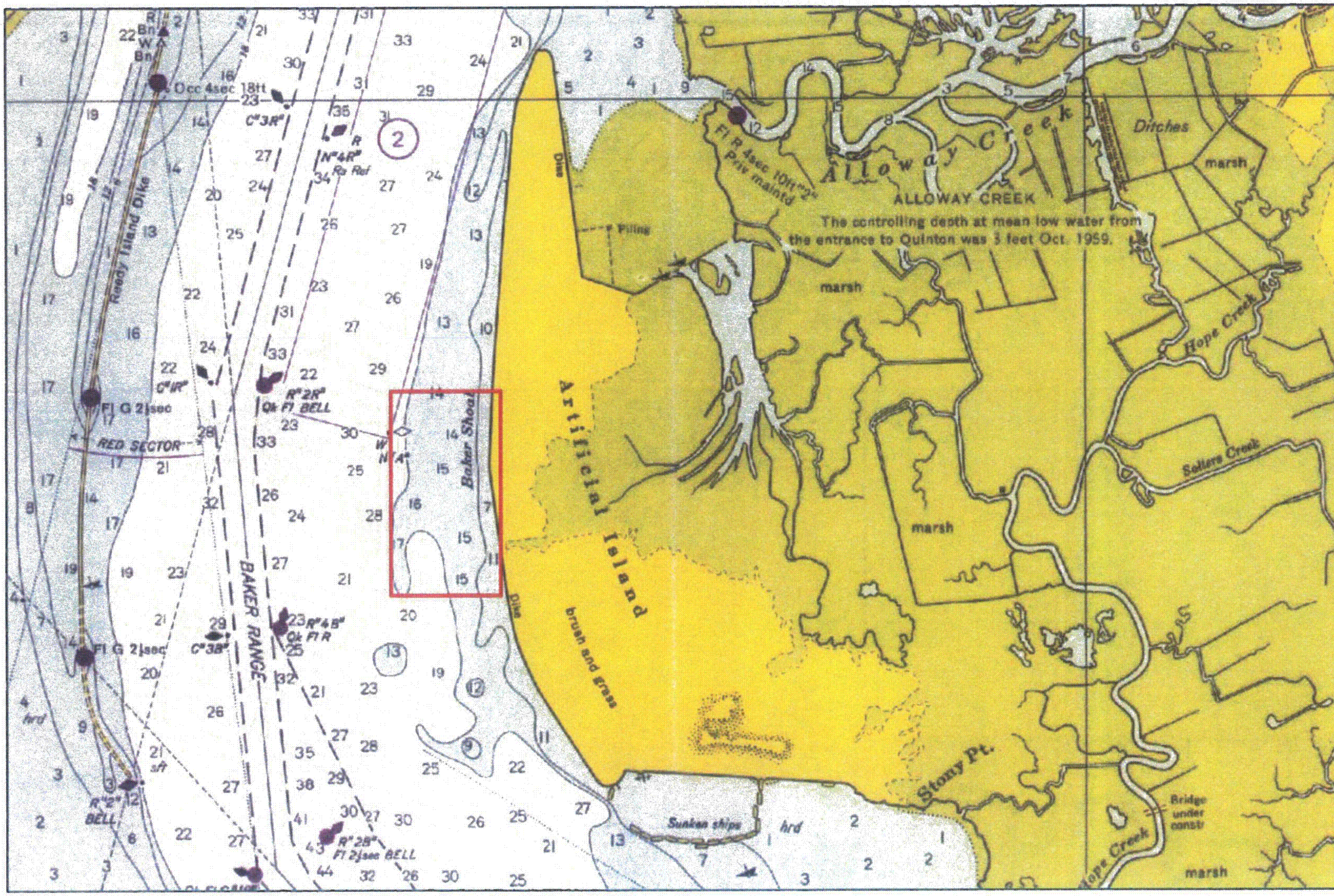

Figure 8b. 1968 chart just prior to the establishment of the nuclear plant; project survey area outlined in red (courtesy of National Historic Chart Center).

Hope Creek was the center of the fishing industry on the Delaware River, and for many years, fishermen made their headquarters along the creek due to its accessibility to the bay. The mouth of Hope Creek is still marked by a beacon and jetty. Also nearby, a tall granite obelisk marks the mouth of the Delaware River and the head of Delaware Bay (*The Island Paper* 1991). Today, three nuclear power plants constructed by PSE&G from 1968 to 1986 are on the southern portion of Artificial Island. The nuclear plant consists of three reactors, just southeast of the survey area. It is shown best in a nautical chart from 2000 (Figure 8c).

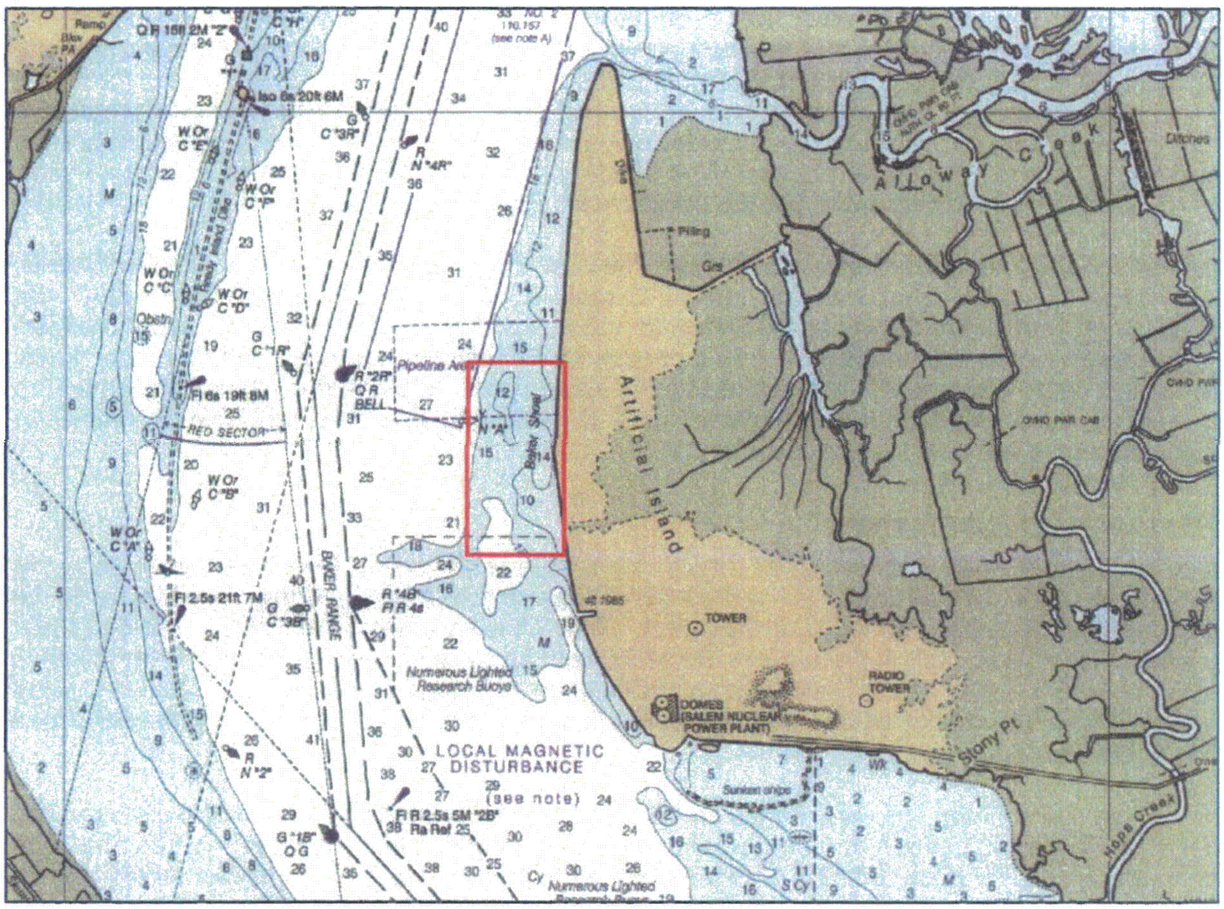

Figure 8c. 2000 chart showing nuclear plant facility; project survey area outlined in red (courtesy of National Historic Chart Center).

SHIPWRECKS IN THE DELAWARE RIVER

Two historic shipwreck sites were encountered during dredge operations on the Delaware River in the 1940s. The first site had been encountered while a new 34-foot channel off Hog Island, Philadelphia, was dug in January of 1941. The Atlantic Refining Company had been building a large wharf on the island and received permission to have the access channel cleared. The oil company built a dike on Hog Island that was eventually filled with more than 100,000 square yards of dirt and fill. Three suction dredges were then floated out over the spots where the channel was to be cleared. The bottom material was brought up through a cutterhead and was sent through a large pipeline to the shore disposal site (Cox 2005).

Among the items discovered in the disposal area, were various artifacts dating to different periods. An iron anchor, hand forged and weighing approximately 40 lbs., was found with one fluke missing. It was in a good state of preservation. Some 280 lbs. of copper sheathing, handmade nails, a hand forged brass spike, an iron cannon ball, a brass collar marked, "USNYN, 1871", and a copper spoon were among the recovered items (Cox 2005).

A second shipwreck site was discovered in 1948 on the New Jersey side of the river. In actuality, two separate sites were encountered by a dredge removing bottom sediment for the Mantua Creek Anchorage. The wrecks, one west of the mouth of Woodbury Creek and the other near the mouth of Mantua Creek, were reported to be imbedded in 6 ft. of mud under 36 ft. of water. Divers estimated the wreck near Woodbury Creek to be 200 ft. long and reported that the cutterhead had clipped off part of the deck, revealing a vast number of "kegs of nails". Among the items that were drawn up from the bottom and survived the mile and a half journey through a 27 in. dredge pipe to the disposal area on a farm near Thorofare, New Jersey, included: a harpoon, table knives, hand scythes, brass locks and keys, pewter plates, hoes, hinges, silver shoe buckles, copper tea kettles, and bottles (Cox 2005). Materials from the sites were dated as early as 1700, and debates ensued whether the vessels were English or Dutch.

Additionally, a *New York Times* article from June 29, 1902, entitled, *Treasure in River Shoals,* also states the local belief was that one of Captain Kidd's "treasure laden pirate ships" was wrecked on Dan Baker Shoals in the Delaware River, and the article also reveals that "dredgers at the mouth of the Schuylkill turned up a portion of the hull of a schooner, which no one knew anything about. The vessel's name could not be ascertained. In the part of the wreck brought to the surface were found a number of shovels and picks of antique pattern and several watches of unknown make and date" (see Appendix C).

PREVIOUS INVESTIGATIONS

Numerous underwater archaeological surveys have been conducted in Lower Delaware Bay over the last 25 years. In addition to the underwater archaeological investigations, one shipwreck, the *DeBraak,* has also been salvaged at the mouth of the Delaware Bay (Cox 2005). Most of these underwater projects included a cursory literature search. A few projects entailed more detailed archival study, while others involved a combination of historic research and remote sensing survey. A small number of these investigations included diving to examine targets established by remote sensing.

The Phase I and Phase II Lewes Beach and Roosevelt Inlet project area was originally surveyed during a 1995 investigation of two borrow areas (Area #1 and Borrow Area # 2 (where the 2004 dredging occurred) (Cox 2005). A submerged and shoreline cultural resources survey project was jointly undertaken by Hunter Research and Dolan Research at those two offshore borrow areas and a portion of the shoreline at Beach Plum Island (Cox 2005). Hunter Research conducted the shoreline survey and documented the remains of a derelict shipwreck site referred to as the Beach Plum Island wreck site. This wreck, a four-masted schooner converted to use later as a barge, was considered preliminarily eligible for inclusion in the National Register of Historic Places. A Phase II level study to confirm such a status was recommended, if avoidance was not feasible. Dolan Research was responsible for the submerged portion of the project and listed two targets in Borrow Area #1 and three targets in Borrow Area #2 (Cox 2005). However, no additional investigation was recommended at any of the five target locations.

Prior to the project described above and offshore of Lewes Beach and Broadkill Beach, numerous submerged cultural resources studies were conducted in the Delaware Bay, beginning in the early 1980s. In 1982, Historic Sites Research, under contract to the U.S. Corps of Engineers, conducted a Phase II level cultural resources survey for a proposed offshore borrow area off Cape May, New Jersey (Cox 2005). Nine magnetic anomalies were noted, three of which were deemed to be potentially significant enough to avoid in any future activities (Cox 2005). In 1985, Tidewater Atlantic Research performed an offshore cultural resources survey for the section of the Delaware Bay between Pickering Beach and Broadkill Beach, Delaware for the Delaware Department of Natural Resources and Environmental Control (DNREC). A magnetometer survey was conducted in four areas, all located west (i.e., on the Delaware side) of the main shipping channel—Pickering Beach, Bowers Beach, Broadkill Beach and Kitts Hummock resulted in the detection of 11 anomalies (four off Broadkill Beach, three off Pickering Beach, three off Kitts Hummock, and one off Bowers Beach). Seven of these anomalies were considered potentially significant, and avoidance was recommended (Cox, 2005).

Karell Archaeological Services performed two other offshore studies around the same time for DNREC. One of these studies was carried out in connection with the Slaughter Beach (South) Beach Nourishment Project, Sussex County Delaware. No anomalies were detected during the remote sensing component of this survey (Koski-Karell 1984a). The second investigation consisted of a background research study and field survey of the Delaware Inner Continental Shelf. This included remote sensing work at two offshore locations near Indian River Inlet, both offshore and south of the current study area (Koski-Karell 1984b).

In 1984, Dolan Research conducted a broad survey for the Pennsylvania Bureau for Historic Preservation, which was designed to assist the state in developing a strategy for managing submerged cultural resources in the Delaware and Susquehanna Rivers. The survey included magnetometer and diving work in selected portions of the Delaware River between Essington, Pennsylvania and Trenton, New Jersey. The remote sensing portion of the survey identified 39 targets in nine different work areas. In addition, 13 derelict vessels, one visible shipwreck and one submerged shipwreck were documented. The submerged wreck, discovered in a dredged portion of the Mantua Creek anchorage, lay in 40 ft. of water, and had been severely impacted by past dredging activities. Although highly disarticulated by dredging activity, it was still possible to date the remains on structural evidence to the early nineteenth century (Cox 1984).

In 1987, Dolan Research conducted a remote sensing survey of 14 locations in the Delaware River between Artificial Island, Salem County, New Jersey and League Island, Philadelphia in conjunction with the proposed modification of the federally-maintained and administered shipping channel. A total of 66 targets were identified, of which six were considered potentially significant and in need of additional archaeological investigation (Cox 1988). Two related studies were also conducted by Dolan Research, concurrently with the Delaware River main channel project: one at the mouth of the Maurice River, on the New Jersey side of the Delaware Bay (Cox 1988); and the other at the mouth of the Salem River, straddling both sides of the Delaware River (Cox 1988).

In the 1990s, Dolan Research conducted several additional magnetic and acoustic investigations in the Delaware Bay and Lower Delaware River, including: a remote sensing survey at the proposed site of a coal pier adjacent to the New Jersey shoreline, north of Oldman's Creek, where 11 targets, none of which were considered significant, were identified (Cox 1992); another remote sensing survey in conjunction with the planned improvement of the Salem River, where six targets were identified, one of which was considered potentially significant (Cox 1992); and a survey of a 200-foot wide proposed pipeline corridor across the Delaware River, just north of Tinicum Island, in which three remote sensing targets were identified, none of which was considered to be historically significant (Cox 1995).

In 1993, further underwater archaeological investigations were conducted by Dolan Research for the U.S. Corps of Engineers at various locations along the Delaware Bay and Delaware River, again in conjunction with the planned improvement of the main navigation channel. A total of 48 survey areas were examined as part of this project, comprising 12 locations where channel deepening was proposed, three locations where widening of bends in the channel was planned, and 33 locations where the side slope of the channel was to be altered. The survey included an intensive magnetic, acoustic, seismic, and bathymetric remote sensing investigation as well as target analysis to determine the presence or absence of submerged cultural resources, which might be affected by the proposed improvements. A total of 154 remote sensing targets were identified in the 48 different survey locations, 11 of which were designated as high probability targets, because they possessed signature characteristics suggestive of submerged cultural resources (Cox 2005). This program of underwater investigation also included ground-truthing of five other targets that had been identified during the earlier 1987 underwater survey carried out by Dolan Research. Two of these targets were considered eligible for listing in the NRHP—a late-nineteenth-century side paddlewheel steamboat and a mid-nineteenth century, intact sectional canal boat (Cox 2005). The extensive amount of underwater survey work performed to date in the Delaware Bay and Lower Delaware River has focused on the identification and evaluation of submerged cultural resources that might be affected by various project actions, such as dredging work, navigation improvements, and shoreline erosion control. Only one known historic resource has actually been physically removed from the floor of the Delaware Bay during the period that professional surveys have been undertaken. The specific project that was not designed or executed by professional underwater archaeologists, involved the salvage in 1986 of *DeBraak*, a late-eighteenth-century British naval vessel, which sank off Cape Henlopen, Delaware in 1798, approximately 50 mi. from the current study area. The salvage work entailed raising the wrecked vessel from a depth of 70 ft. in an area of strong currents. The entire operation produced a rich collection of late-eighteenth-century artifacts, consisting of well over 20,000 items, and it is important in demonstrating that historically significant material may still survive intact in a dynamic, high-energy environment, such as that encountered around the mouth of the bay (Cox 2005).

SUBMERGED CULTURAL RESOURCES POTENTIAL

CRITERIA OF EVALUATION

The information generated by these investigations was considered in terms of the criteria for evaluation outlined by the U.S. Department of the Interior, National Register Program. Nautical vessels and shipwreck sites, with the exception of reconstructions and reproductions, are considered historic if they are eligible for listing in the NRHP at a local, regional, national, or international level of significance (Cox 2005). To be eligible for the NRHP, a vessel or site "must be significant in American history, architecture, archaeology, engineering, or culture, and possess integrity of location, design, setting, materials, workmanship, feeling, and association". The vessel or site must meet one or more of the following four National Register criteria to be considered significant:

A. Association with events that have made a significant contribution to the broad patterns of our history; or

B. Association with the lives of persons significant in our past; or

C. Embodiment of the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

D. Sites that have yielded, or may be likely to yield, information important in prehistory or history.

National Register of Historic Places Bulletin 20 clarifies the National Register review process with regard to shipwrecks and other submerged cultural resources. Shipwrecks must meet at least one of the above criteria and retain integrity of location, design, settings, materials, workmanship, feelings, and association. Determining the significance of a historic vessel depends on establishing whether the vessel is:

1. the sole, best, or a good representative of a specific vessel type; or
2. is associated with a significant designer or builder; or
3. was involved in important maritime trade, naval, recreational, government, or commercial activities.

Properties which qualify for the National Register, must have significance in one or more "Areas of Significance" that are listed in *National Register Bulletin 16A*. Although 29 specific categories are listed, only some are relevant to the submerged cultural resources in the Lower Delaware Bay. Architecture, commerce, engineering, industry, invention, maritime history, and transportation are potentially applicable data categories for the type of submerged cultural resources, which may be expected in the Lower Delaware Bay study area.

POTENTIAL UNDERWATER RESOURCE TYPES

The effect of coastal geomorphic processes may either erode or bury underwater resources, and the processes may occur rapidly or slowly over time. In many cases, the remains of shipwrecks may be submerged but not buried beneath sediment. Shipwreck material deposited in even the shallowest environment can settle rapidly into the bottom with its associated archaeological record intact. The wreck of the *DeBraak* (1798), discovered near the Delaware Breakwater 50 miles from the study area, provides a classic example. A good portion of the lower hull survived intact, along with an extensive associated artifact assemblage (Cox 2005). Even in extremely high-energy environments, evidence of the ship structure frequently survives. Numerous other underwater archaeological investigations along the eastern seaboard of the United States—off Massachusetts, North Carolina, South Carolina, Florida, and Texas—and in the waters off other countries around the world (such as England, Israel, and Turkey) offer examples where ship remains have survived largely intact with valuable archaeological data.

At many shipwreck sites sand and light mud similar to the bottom sediments found in the study area provide an excellent environment for preservation. Given the level of maritime activity throughout Delaware Bay, the extent of vessel losses in the vicinity of the study area, and the level of preservation at shipwreck sites in other similar environments, it is highly possible that well-preserved shipwreck sites could exist in the project vicinity.

As a major conduit for exploration, colonization, and expanding coastal commerce, Delaware Bay is an obvious and natural repository for underwater resources. Strong coastal storms, often with a lethal combination of treacherous northeast winds and swift tidal currents, coupled with the presence of shallow water and historically heavy bay and coastal traffic, have conspired to make the Delaware Bay the final resting place for dozens of documented sailing vessels, steamships, barges, tugs, and large modern ships over the last three centuries. A wide variety of ship types have wrecked while passing up or down the Delaware Bay. Many vessels attempting to reach the Harbor of Refuge at Lewes in the lee of Cape Henlopen have instead been wrecked in the mouth of the bay. A Bureau of Land Management study of the Continental Shelf from the Bay of Fundy to Cape Hatteras has characterized the Delaware Coastal Zone as an area of "moderately heavy" predicted shipwreck density (Bourque et al. 1979). An inventory of eighteenth-century shipwrecks and all types of ship losses near the mouth of the Delaware Bay was compiled during the background research phase of this study and confirms this predicted density (see Appendix A). Numerous shipwrecks and ship losses can be documented in the Lower Delaware Bay and near the mouth of the bay since the first reported loss in 1741. Drawn from a range of available primary and secondary sources, this extensive shipwreck list, while far from comprehensive, nonetheless gives an indication of the variety of shipwrecks that have occurred in the project vicinity during the eighteenth century. Furthermore, secondary and primary historical sources show that vessels have wrecked in the general vicinity of the project area throughout the eighteenth, nineteenth, and twentieth centuries (Cox 2005). The study area is therefore considered, based on background research, to hold a high potential for yielding underwater resources of a caliber suitable for inclusion in the National Register of Historic Places. Based on the information in Appendix A, numerous shipwreck episodes occurred at the mouth of Delaware Bay during the eighteenth century. These documented ship losses involved most of the common eighteenth-century ship types, including: ships, brigantines, snows, and schooners (see Appendix A). Other undocumented shipwreck sites involving smaller ships and boats must be considered likely in the Lewes offshore vicinity. These would include small fishing sloops and shallops. Any of the above mentioned vessel types would potentially lend historic insights into a wide range of maritime topics, including the contexts of international trading patterns, shipbuilding and regional shipping, and general patterns of local trade and industry.

3. METHODS

Project Personnel

The personnel assigned to this project met training and qualification requirements outlined in the U.S. Army Corps of Engineers Safety and Health Requirements Manual (EM 385-1-1). All team members are current in their Red Cross training certifications for first aid and Cardio-Pulmonary Resuscitation (CPR). Dr. Gordon P. Watts of Tidewater Atlantic Research directed and conducted the remote sensing survey. With extensive experience in remote sensing surveys, Dr. Watts was assisted by remote sensing technician, Joshua Daniel.

Safety and security was of paramount concern during the remote sensing phase of this project. Survey personnel registered with the PSEG security forces and remained in direct contact prior to and during the survey.

Remote Sensing Survey Equipment

The remote sensing survey was conducted with equipment and procedures intended to facilitate the effective and efficient search for magnetic and/or sidescan sonar anomalies and to determine their exact location. The positioning system used was a Trimble DSM12/212, Integrated 12-channel Global Positioning System (DGPS). Remote sensing instruments included an EG&G Geometrics cesium vapor magnetometer, a Klein System 3900 digital sidescan sonar, and an EdgeTech 3100P subbottom profiler with an SB-216S tow vehicle.

Differential Global Positioning System

A primary consideration in the search for magnetic anomalies is positioning. Accurate positioning is essential during the running of survey tracklines and for returning to recorded locations for supplemental remote sensing operations or ground-truthing activities. These positioning functions were accomplished on this project through the use of a Trimble Navigation DSM12/212 global-based positioning system (Figure 9).

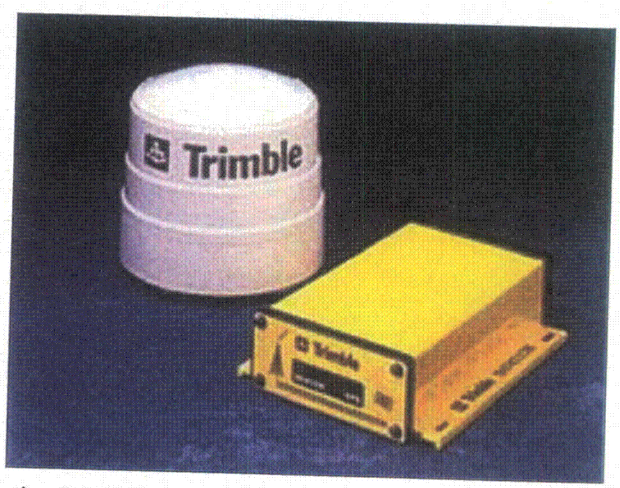

Figure 9. Trimble Navigation DSM 12/212 global-based positioning system used during the investigation.

The DSM12/212 is a global positioning system that attains differential capabilities by internal integration with a Dual-channel MSK Beacon receiver. This electronic device interprets transmissions both from satellites in Earth's orbit and from a shore-based station, to provide

SIDESCAN SONAR

The remote sensing instrument used to search for physical features on or above the ocean floor was a Klein 3900 digital sidescan sonar system (Figure 12). The sidescan sonar is an instrument that, through the transmission of dual fan-shaped pulses of sound and reception of reflected sound pulses, produces an acoustic image of the bottom. Under ideal circumstances, the sidescan sonar is capable of providing a near-photographic representation of the bottom on either side of the trackline of a survey vessel. This range was set at 20 m during the Survey.

The Klein 3900 digital sidescan sonar unit utilized on this project was operated with an integrated single frequency 445/900 kHz towfish. The sidescan has internal capability for removal of the water column from the instrument's video printout, as well as correction for slant range distortion. This sidescan sonar was utilized with the navigation system to provide manual marking of positioning fix points on the digital printout. Sidescan sonar data are useful in searching for the physical features indicative of submerged cultural resources. Specifically, the record is examined for features showing characteristics such as height above bottom, linearity, and structural form. Additionally, potential acoustic targets are checked for any locational match with the data derived from the magnetometer and the subbottom profiler.

A 445/900 kHz Klein 3900 digital sidescan sonar was interfaced with SonarPro data acquisition software to collect acoustic data in the survey area. The sidescan sonar transducer was deployed and maintained 10 ft. below the water surface. Acoustic data was collected using a range scale of 50 m to provide a combination of 300 percent coverage and high target signature definition. Acoustic data was recorded as a digital file with SonarPro and tied to the magnetic and positioning data by the computer navigation system. This data was then imported into the Chesapeake Technology SonarWiz.MAP for additional review and to create a mosaic.

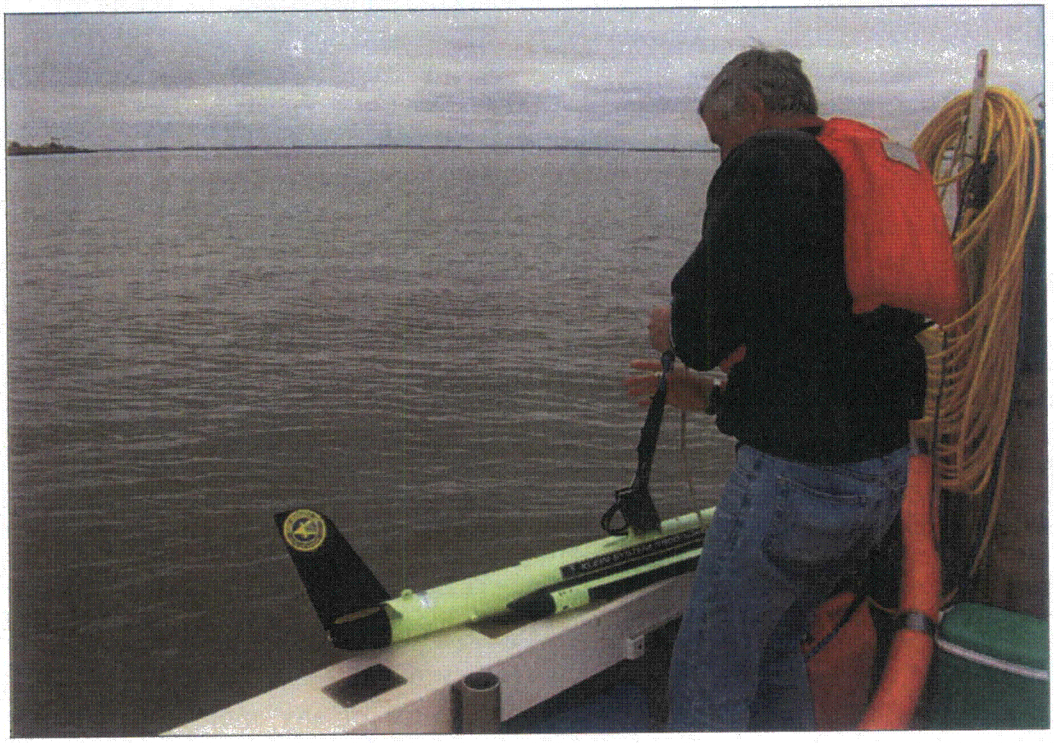

Figure 12. Launching the Klein System 3900 digital sidescan sonar.

SUBBOTTOM PROFILER

Acoustic subbottom data was collected using an EdgeTech 3100P Portable subbottom profiler with an SB-216S tow vehicle (Figure 13). The SB-216S provides three frequency spectrums between 2 and 15 kHz with a pulse length of 20 m/s. Penetration in coarse and calcareous sand is factory rated at 6 m with between 2 and 10 cm of vertical resolution. During the survey, the subbottom transducer was deployed and maintained between 4 to 5 ft. below the water surface. To facilitate target identification, subbottom sonar records were electronically tied to DGPS coordinates and recorded as a digital file using EdgeTech's Discover® software.

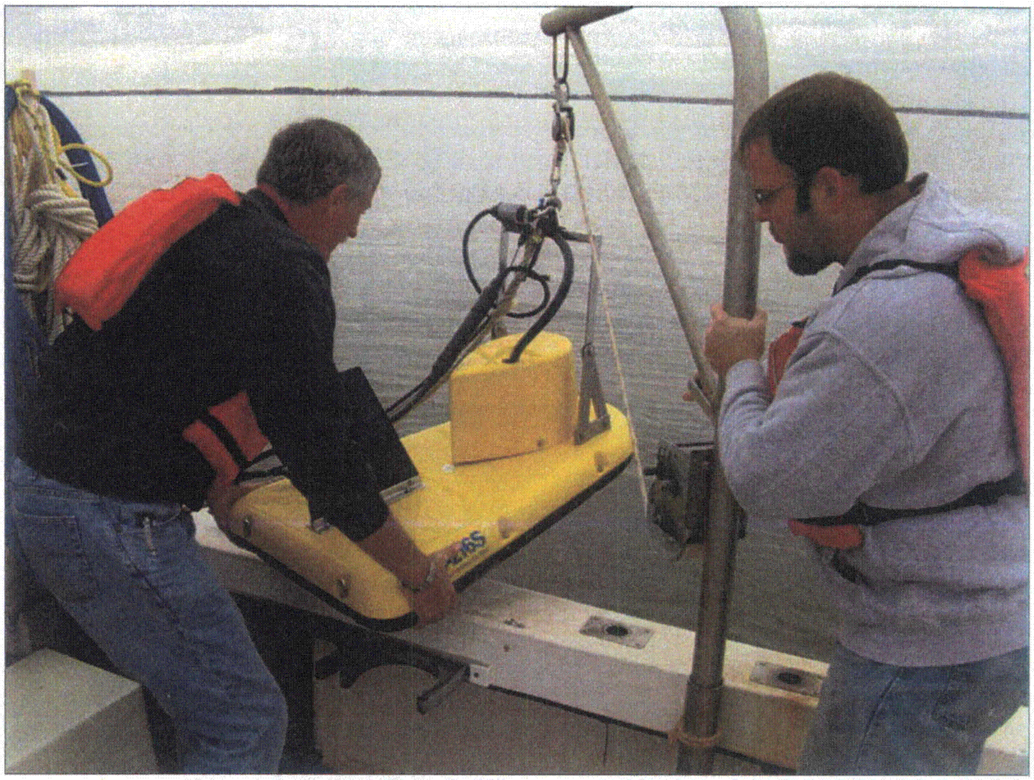

Figure 13. Launching the EdgeTech SB-216S tow vehicle.

Subbottom profilers generate low frequency acoustic waves that are capable of penetrating the seabed, and then reflect off boundaries or objects within the subsurface. These returns are received by hydrophone or hydrophone array operated in close proximity to the source. The data is then processed and reproduced as a cross section scaled in two-way travel time (the time taken for the pulse to travel from the source to the reflector and back to the receiver). This travel time can then be interpolated to depth in the sediment column by reference to the travel time of the sound (averaging 1,500 m/s).

These seismic cross sections can be studied visually as well as the shapes and extent of reflectors used to identify bottom and subbottom profile characteristics.

There are several types of subbottom profilers: sparkers, pingers, boomers, and CHIRP systems. Sparkers operate at the lowest frequencies and afford deep penetration but low resolution. Boomers operate from 0.5 to 5 kHz and can penetrate to between 30 and 100 m with resolution of 0.3 to 1.0 meter. Pingers operate from 3.5 and 7 kHz and penetrate seabeds from a few meters to more than 50 m depending on sediment consolidation, with resolution to about 0.3 m. CHIRP systems operate around a central frequency that is swept electronically across a range of frequencies between 3 to 40 kHz, and resolution can be on the order of 0.1 m in suitable near-seabed sediments.

Unconformities and other stratal contacts can be determined by seismic remote sensing, because these surfaces make acoustic impedance contrasts when printed (or projected). In general, high and low amplitude reflectors (light and dark returns) distinguish between stratigraphic beds; parabolic returns indicate point source objects of sufficient size to be sensed by the wavelength and frequency of the power source. Erosional or non-depositional contacts can be identified by discontinuities in extent, slope angle, and shape of the reflector returns. This latter fact is important when identifying drowned channel systems and other relict and buried fluvial system features (e.g., estuarine, tidal, lowland, upland areas around drainage features).

There are five types of spurious signals that may cause confusion in the two dimensional records: direct arrivals from the sound source, water surface reflection, side echoes, reflection multiples, and point source reflections. Judicious analysis is required to inspect them.

SURVEY VESSEL

The survey vessel, the *Tidewater Surveyor,* a 25-foot Parker, was used for the survey (Figure 14). There was abundant covered deck space for the electronic gear, generator, and towfish.

Figure 14. Project support vessel *Tidewater Surveyor*. Project area is the opposite shoreline in line with the pier and to the left of the nuclear plant's cooling tower.

SURVEY PROCEDURES

Provided by MACTEC, Inc., coordinates for the proposed survey area were entered into the navigation program Hypack®, and pre-plotted tracklines were produced using the New Jersey State Plane, NAD 83, U.S. Survey Foot coordinate system (see Appendix D). The border of the survey area was an irregular polygon approximately 3,758 ft. in length (along the shoreline), 1,593 ft. in width (from shore out), covering an area of 90.38 acres. Thirty-five pre-plotted tracklines with 50-foot offsets were programmed for full survey coverage and ran parallel to the shoreline (Figure 15). As indicated in Figure 15A, the sidescan mosaic of the project area, over 100 acres were surveyed and full coverage of the area was obtained.

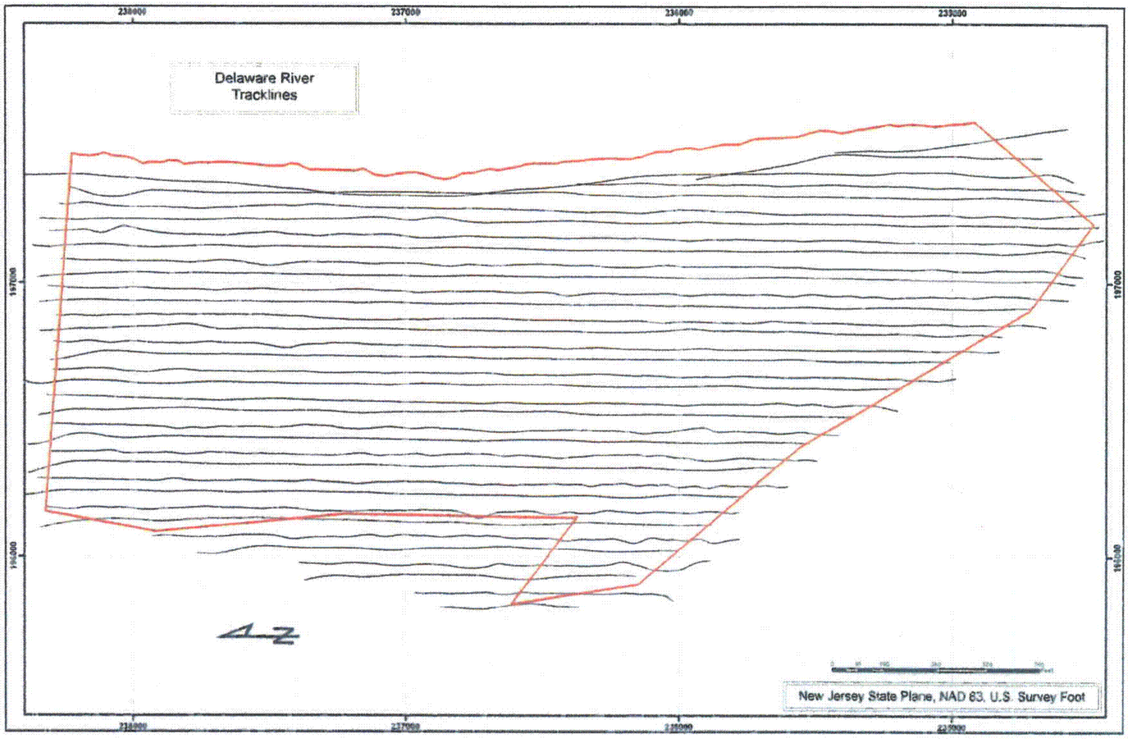

Figure 15. Survey transect lines relative to the survey area.

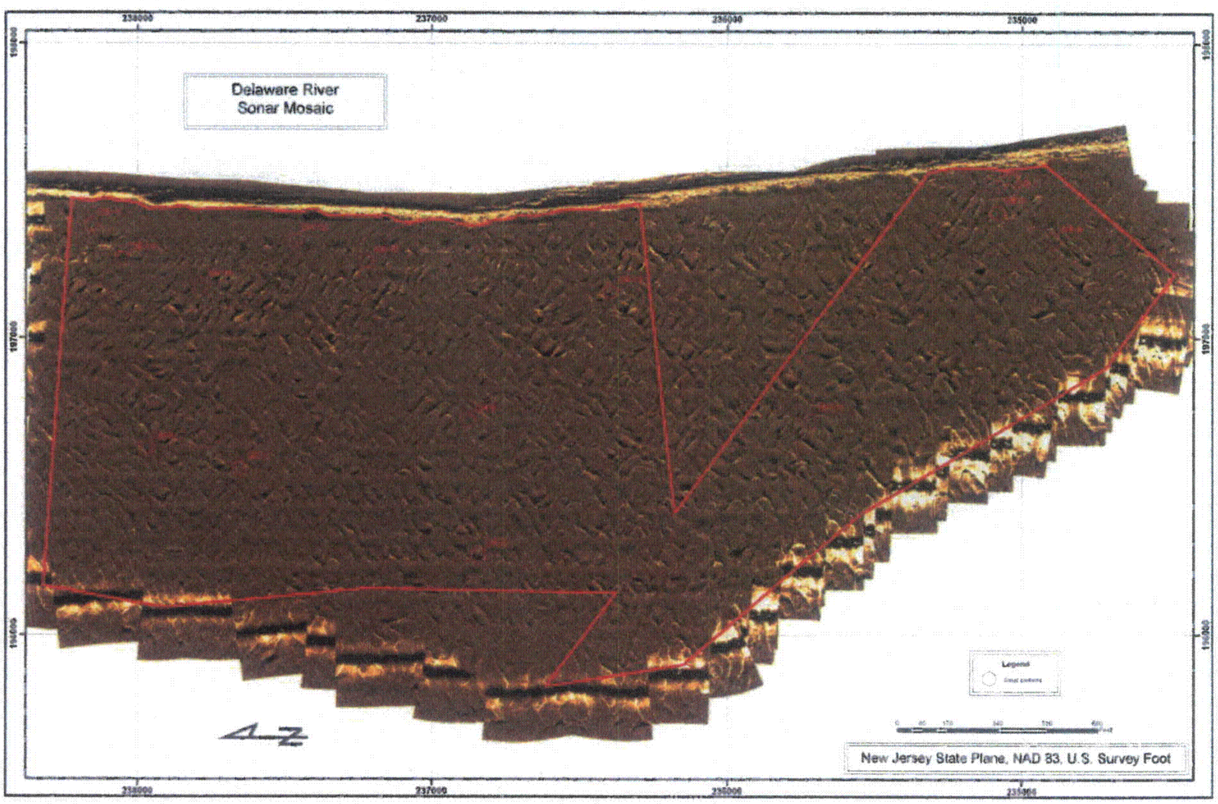

Figure 15A. Sidescan mosaic shows complete coverage of the survey area.

The magnetometer, sidescan sonar, and DGPS were mobilized and tested, and the running of pre-plotted tracklines began. The helmsman viewed a video monitor, linked to the DGPS and navigational computer, to aid in directing the course of the vessel relative to the individual survey tracklines. The monitor displayed the real-time position of the path of the survey vessel along the trackline (Figure 16).

As the survey vessel maneuvered down each trackline, the navigation system determined vessel position along the actual line of travel every second. One computer recorded positioning and magnetometer data every second, while a separate computer recorded all sidescan sonar returns during the survey. Vessel speed was between 3 to 4 ft. per second, acquiring magnetic readings every second. The positioning points along the line traveled were recorded on the computer hard drive, and the magnetic data were also stored digitally.

Each trackline was run until completed. Any navigation errors, problems with the remote sensing instruments, or with the positioning system during the running of a line resulted in the termination of that run. Significant off-line errors in navigation resulted in the immediate repetition of that line. Problems with remote sensing instruments were resolved before repeating the run of an aborted line.

Figure 16. Dr. Watts at the helm viewing the survey computer directing the course of the vessel along a transect line.

Upon completion of the magnetometer survey, the raw positioning and magnetometer data were edited within the Hypack® computer program. The edited file was inputted into the system's contouring program to produce magnetic contour maps. The maps, field notes, and magnetometer digital strip charts were then analyzed to create a list of magnetic anomalies that were indicative of potentially significant cultural resources. Afterwards, the sidescan sonar data was reviewed for any evidence of submerged cultural resources.

Prior to contour map production, a review of each survey tract line is conducted in Hypack®. Magnetic anomalies present on each survey trackline are labeled at this time, and locational information (Easting, Northing), as well as gamma deviations, are taken from the electronic strip-chart data and tabulated, the data table that appears in the report. Once all survey tracklines have been analyzed and all anomalies along each line have been labeled and tabulated, the contour map is then produced.

DATA ANALYSIS PROCEDURES

Upon completion of the remote sensing survey, the data was reviewed. This task essentially required the archaeologist and remote sensing specialist to analyze the previously acquired and processed data. Sidescan and subbottom features and magnetic anomalies were tabulated and prioritized for possible significance by employing signal characteristics (e.g., spatial extent, structural features, etc.). Magnetic data was presented in a magnetic contour map(s) with trackline format. Specific sidescan targets are also located on the map and are illustrated and discussed individually. The magnetic anomalies and/or sidescan targets shown on the map(s) are sequentially numbered and tabulated by location (Northing and Easting), as well as magnetic deviation. The contoured/labeled targets are then compared with strip chart records and attendant sidescan data. Each magnetic anomaly or sidescan target, described with the proper terminology and locational and positional information, is included. If any of the remote sensing targets correlated with any documentary evidence, it was noted.

The evaluation of the potential cultural significance of targets was then conducted, which was dependent on a variety of factors. These include: the detected characteristics of the individual targets (e.g., magnetic anomaly strength and duration and sidescan image configuration); association with other sidescan or magnetic targets on the same or adjacent lines; relationships to observable target sources, such as channel buoys or pipeline crossings; as well as correlation to the historic record. Magnetic anomalies were evaluated and prioritized based on amplitude or deflection intensity in concert with duration or spatial extent. Targets such as isolated sections of pipe can normally be immediately discarded as non-significant. Targets that were likely to represent potential historical shipwrecks or other potentially historic submerged resources were identified, and recommendations for subsequent avoidance or assessment were made.

MAGNETOMETER ANALYSIS

Data collected by the magnetometer is perhaps the most problematic to analyze. Magnetic anomalies are evaluated and prioritized based on magnetic amplitude or deflection of gamma intensity in concert with duration or spatial extent; they are also correlated with sidescan targets. The problems of differentiating between modern debris and shipwrecks, based on remote sensing data, have been discussed by a number of authors. This difficulty is particularly true in the case of magnetic data, and therefore, it has received the most attention in the current body of literature dealing with the subject. Pearson and Saltus state, "even though a considerable body of magnetic signature data for shipwrecks is now available, it is impossible to positively associate any specific signature with a shipwreck or any other feature" (1990:32). There is no doubt that the only positive way to verify a magnetic source object is through physical examination. With that said, however, the size and complexity of a magnetic signature does provide a usable key for distinguishing between modern debris and shipwreck remains (see Garrison et al. 1989; Irion et al. 1995; Pearson et al. 1993). Specifically, the magnetic signatures of most shipwrecks tend to be large in area and tend to display multiple magnetic peaks of differing amplitude.

The state of technology of iron-hulled or steam vessels may also be considered a factor in their potential for being detected by modern remote sensing techniques. The magnetometer detects ferrous objects that create deviations in the Earth's natural magnetic field. The greater the weight of iron in the remains of a shipwreck, the greater the likelihood the remains will be observed, at least theoretically. The mass of metal on iron-hulled or steam vessels is made up of the hull and/or boilers, pipes, valves, steam engines, hogging trusses and straps, deck gear, auxiliary engines, pumps, hoists, winches, and other pieces of equipment. As the state of steam technology advanced, boilers and engines became larger and/or more were used for larger vessels. Larger locomotion systems contained more iron, and therefore, are more likely to have a detectable magnetic signature.

In a study of magnetic anomalies in the northern Gulf of Mexico, Garrison et al. (1989) indicate that a shipwreck signature will cover an area between 10,000 and 50,000 square meters. Applicable to the Gulf Coast and based on large vessel types, the study's findings are not entirely relevant to wooden sailing vessels in the pre-steam era. However, criteria from the Garrison et al. (1989) study and others, developed to identify that the signatures of larger vessel types are applicable. Using the Garrison et al. (1989) study as well as years of "practical experience," in an effort to assess potential significance of remote sensing targets, Pearson et al. (1991) developed general characteristics of magnetometer signatures that most likely represent shipwrecks. The report states, "the amplitude of magnetic anomalies associated with shipwrecks vary [*sic*] considerably, but, in general, the signature of large watercraft, or portions of watercraft, range from moderate to high intensity (> 50 gamma) when the sensor is at distances of 20 feet or so" (1991:70). Using a table of magnetic data from various sources as a base, the report goes on to state, "data suggests that at a distance of 20 ft. or less, watercraft of moderate size are likely to produce a magnetic anomaly (this would be a complex signature, i.e., a cluster of dipoles and/or monopoles) greater than 80 or 90 ft. across the smallest dimension..." (Pearson et al. 1991:70).

While establishing baseline amounts of amplitude and duration reflective of the magnetic characteristics for a shipwreck site, the authors recognize, "that a considerable amount of variability does occur" (Pearson et al. 1991:70). Generated in an effort to test the 50-gamma/80-foot criteria and to determine amount of variability, Table 3 lists numerous shipwrecks as well as single- and multiple-source objects located by magnetic survey and verified by divers. All shipwrecks meet and surpass the 50-gamma/80-foot criteria, while all single-source object readings, with the exception of the pipeline, fall below the criteria. However, the signature of the pipeline should be portrayed as a linear feature on a magnetic contour map, and it should not be confused with a single-source object. While the shipwrecks and single-source objects adhere to the 50-gamma/80-foot criteria, the multiple-source objects do not. If all targets listed on the table had to be prioritized as to potentially significant, based on the 50-gamma/80-foot criteria, then the two multiple-source object targets would be classified as potentially significant.

Although data indicates the validity of employing the 50-gamma/80-foot criteria, when assessing magnetic anomalies other factors must be taken into account. Pearson and Hudson (1990) have argued that the past and recent use of a water body must be an important consideration in the interpretation of remote sensing data; in many cases, it is the most important criterion. Unless the remote sensing data, historical record, or specific environment (e.g., harbor entrance channel) provide compelling and overriding evidence to the contrary, it is believed that the history of use should be a primary consideration in interpretation. What constitutes "compelling evidence" is to some extent left to the discretion of the researcher; however, in settings where modern commercial traffic and historic use are intensive, the presence of a large quantity of modern debris must be anticipated. In harbor, bay, or riverine situations with heavy traffic, this debris will be scattered along the channel right-of-way (ROW), although it may be concentrated at areas where traffic would slow or halt; it will appear on remote sensing surveys as small, discrete objects.

Table 3. Magnetic Data from Shipwrecks and Non-Significant Sources.

Vessel (object)	Type & Size	Magnetic deviation	Duration (ft.)	Reference
Shipwrecks				
Tug	wooden tug with machinery	-30257	176	Tuttle and Mitchell 1998
Mexico	288 ton wooden bark	1260	454	Tuttle and Mitchell 1998
J.D. Hinde	129-ft. wooden sternwheeler	573	110	Gearhart and Hoyt 1990
Utina	267-ft., 238-ton wooden freighter	690	150	James and Pearson 1991; Pearson and Simmons 1995
King Phillip	182-ft., 1,194-ton clipper	300	200	Gearhart 1991
Reporter	141-ft., 350-ton schooner	165	160	Gearhart 1991
Mary Somers	967-ton iron-hulled sidewheeler	5000	400	Pearson et al. 1993
Gen. C.B. Comstock	177-ft. wooden hopper dredge	200	200	James et al. 1991
Mary	234-ft. iron sidewheeler	1180	200	Hoyt 1990
Columbus	138-ft., 416-ton wooden-hulled Chesapeake sidewheeler	366	300+	Morrison et al. 1992
El Nuevo Constante	126-ft. wooden collier	65	250	Pearson et al. 1991
James Stockton	55-ft. wooden schooner	80	130	Pearson et al. 1991
Homer	148-ft. wooden sidewheeler	810	200	Pearson and Saltus 1993
Modern shrimp boat	27 × 5 ft. segment	350	90	Pearson et al. 1991
Confederate obstructions	various wooden vessels w/ machinery removed, filled w/ construction rubble	110	long duration	Irion and Bond 1984
Single-source Objects				
pipeline	18-in. diameter	1570	200	Duff 1996
anchor	6-ft. shaft	30	270	Pearson et al. 1991
iron anvil	150 lbs.	598	26	Pearson et al. 1991
engine block	modern gasoline	357	60	Rogers et al. 1990
steel drum	55 gallon	191	35	Rogers et al. 1990
pipe	8 ft. long × 3 in. diameter	121	40	Rogers et al. 1990
railroad rail segment	4-ft. section	216	40	Rogers et al. 1990
Vessel (object)	**Type & Size**	**Magnetic deviation**	**Duration (ft.)**	**Reference**
Multiple-source Objects				
anchor/wire rope	8-ft. modern stockless/large coil	910	140	Rogers et al. 1990
cable and chain	5 ft.	30	50	Pearson et al. 1991
scattered ferrous metal	14 × ft.	100	110	Pearson et al. 1991

After Pearson et al. 1991.

SIDESCAN ANALYSIS

By contrast, sidescan analysis is less problematic. The chief factors considered in analyzing sidescan data include: linearity, height off bottom, size, associated magnetics, and environmental context. Since historic resources in the form of shipwrecks usually contain large amounts of ferrous compounds, sidescan targets with associated magnetic anomalies are of top importance. The results of targets with no associated magnetics are usually items such as rocks, trees, and other non-historic debris that are of no interest to the archaeologist. In addition, since historic shipwrecks tend to be larger in size, smaller targets tend to be less important during data evaluation. In addition, the area in which the target is located can have a strong bearing on whether or not the target is selected for further work. If a target is found in an area with other known wreck sites or an area determined to be high probability for the location of historic resources, it may be given more consideration than it would be given otherwise. However, every situation and every target located is different, and all sidescan targets are evaluated on a case-by-case basis.

SUBBOTTOM PROFILER ANALYSIS

Subbottom profilers generate low frequency acoustic waves capable of penetrating the seabed and then reflect off boundaries or objects within the subsurface. These returns are received by hydrophone or hydrophone array operated in close proximity to the source. The data are then processed and reproduced as a cross section scaled in two-way travel time (the time taken for the pulse to travel from the source to the reflector and back to the receiver). This travel time can then be interpolated to depth in the sediment column by reference to the travel time of the sound down (averaging 1,500 m/s) and forward (speed of the vessel).

These seismic cross sections can be studied visually and the shapes and extent of reflectors used to identify bottom and subbottom profile characteristics. In general, high and low amplitude reflectors (light and dark returns) distinguish between stratigraphic beds; parabolic returns indicate point source objects of sufficient size to be sensed by the wavelength and frequency of the power source. Erosional or non-depositional contacts can be identified by discontinuities in extent, slope angle, and shape of the reflector returns. This latter fact is important when identifying drowned channel systems and other relict and buried fluvial system features (e.g., estuarine, tidal, lowland, upland areas around drainage features).

Seismic stratigraphy is a form of stratigraphic correlation. The reflection characteristics (e.g., as amplitude, continuity, wipeout [erosion] and bedform geometry) of regional unconformities and strata surfaces are used to estimate rock or sediment properties, facie relationships, and some stratigraphic details to infer structural evolution and paleo-environmental histories (Mitchum et al. 1977, Vail et al. 1977).

There are five types of spurious signals that may cause confusion in the two dimensional records: direct arrivals from the sound source, water surface reflection, side echoes, reflection multiples, and point source reflections. Judicious analysis is required to suspect them. This is particularly true when the bottom or subbottom being traversed has considerable deformation or point source anomalies.

Subbottom in the Identification of Shipwreck Sites

Previous research (Quinn et al. 1997, 1998) has shown that wooden wreckage can be recognized, depending on the type of wood (hard woods are better), size of the remains, and the context (sand or silt, etc.). The strategy for identifying historic wrecks was to identify seismic features in the strata that might be coincident with magnetometer fluctuations, and thus indicate buried wreckage. In addition, the subbottom profiler record includes data on precise depth to bottom, and so can be used to reconstruct bathymetry.

This output record is a visual representation of density differences in the geologic bed and sound wave velocity of the device. In general, high and low amplitude reflectors (light and dark returns) distinguish between stratigraphic beds; parabolic and "spot" returns indicate point source objects of sufficient size to be sensed by the wavelength and frequency of the power source. Erosional or non-depositional contacts can be identified by discontinuities in extent, slope angle, and shape of the reflector returns. This latter fact is important when identifying drowned channels systems and other relict and buried fluvial system features (e.g., estuarine, tidal, lowland, upland areas around drainage features) but not necessarily of value with respect to shipwreck remains.

Wood objects of sufficient density and size can be sensed with CHIRP systems, but the image is dependent on "the orientation of the incident compression wave relative to the axis of the woods elastic symmetry cellular structure" (Quinn et al. 1997:27). In other words, the ability of the sensor to detect buried shipwreck remains is dependent on which angle the wood is approached with the sound waves, the character of the burial sediment, and the size of the remains (Quinn et al. 1997:33).

GIS MAPPING LOCATIONAL CONTROL AND ANALYSES

To ensure reliable target identification and assessment, analysis of the magnetic and acoustic data was carried out as it was generated. Using QuickSurf contouring software, magnetic data generated during the survey were contour plotted at 5-gamma intervals for analysis and accurate location of magnetic anomalies. The magnetic data was examined for anomalies that were isolated and analyzed in accordance with intensity, duration, areal extent, and signature characteristics. Sonar records were mosaiced in EdgeTech's Discover® software and analyzed to identify targets based on configuration, areal extent, target intensity and contrast with background, and elevation and shadow image. The records were also reviewed for possible association with identified magnetic anomalies. The subbottom profiler data was mined for bathymetric data, and a bathymetric map was produced for inclusion in the results section of this report. All data was translated from decimal minutes latitude longitude (from the subbottom profile software from Edgetech) to New Jersey State Plane Coordinates in feet, by the U.S. Army Corps of Engineers. These conversions allowed all locational data from the magnetometer, sidescan sonar, and subbottom profiler to be compared in GIS format.

Data generated by the remote sensing equipment was developed to support an assessment of each magnetic and acoustic signature. Analysis of each target signature included consideration of magnetic and sonar signature characteristics previously demonstrated to be reliable indicators of historically significant submerged cultural resources. Assessment of each target includes avoidance options and possible adjustments to avoid potential cultural resources. Where avoidance is not possible, the assessment will include recommendations for additional investigation to determine the exact nature of the cultural material generating the signature and its potential NRHP significance. Historical evidence was developed into a background context and an inventory of shipwreck sites that identified possible correlations with magnetic signatures. A magnetic contour map of the survey area was produced to aid in the analysis of each target.

4. RESULTS

Conducted the last week of October, survey conditions were excellent. No wind or waves were present which allowed the collection of excellent sidescan sonar and magnetometer data. Figure 17 illustrates the conditions at the time of the survey as well as the environment.

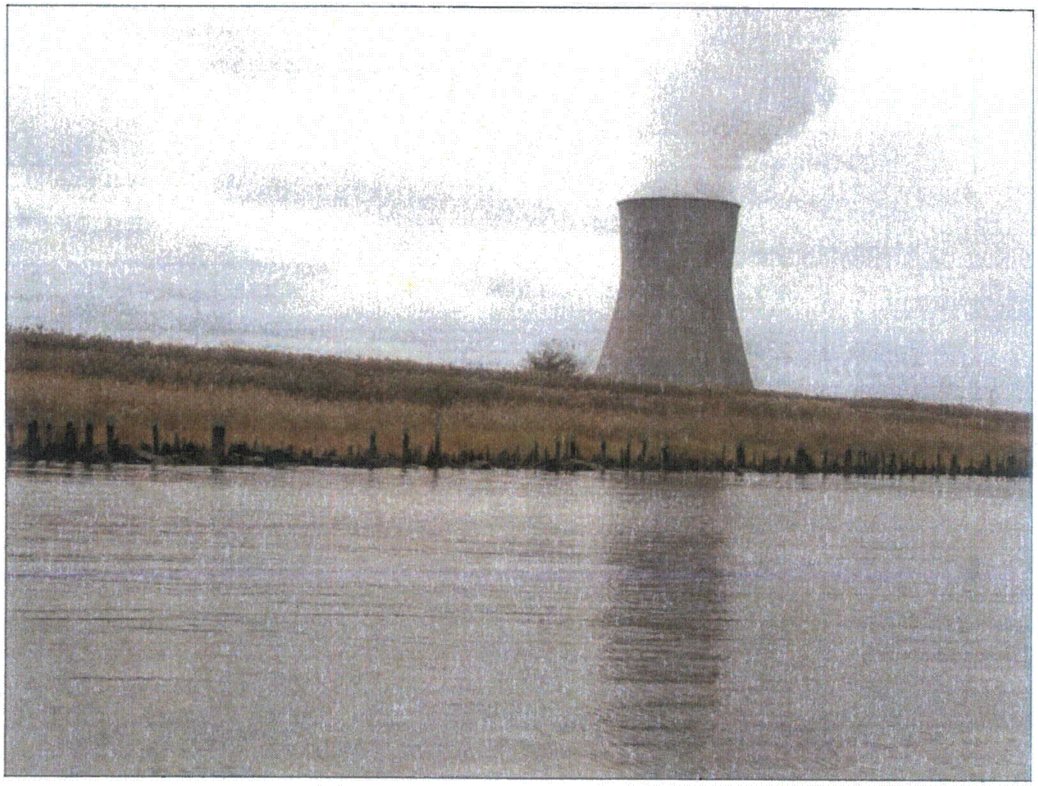

Figure 17. Looking eastward toward the Artificial Island shoreline. Note wooden bulkhead wall and the excellent working conditions at time of survey (i.e., no wind or waves).

MAGNETOMETER RESULTS

Examination of the sonar record revealed that 16 anomalies have an associated acoustic image (Figure 18, see Appendix E). Sonar images confirm that at least 14 anomalies are associated with small single objects or modern debris exposed on the bottom surface possibly associated with the deteriorating bulkhead that defines the eastern perimeter of the survey area. Analysis of the remote sensing data revealed 84 magnetic targets within the area surveyed (Table 4, Figure 19). Relative to the analysis section above, the vast majority of the magnetic anomalies do not have signature characteristics that are considered suggestive of historic vessel remains.

Three clusters of magnetic anomalies and two associated acoustic images exhibit characteristics indicative of vessel remains (Table 5, Figure 18). Target Cluster 1 is comprised of two magnetic anomalies that are associated with sonar image DR-14. That sonar image has characteristics suggestive of shipwreck remains (Figure 20). While it is possible that the image is associated with bulkhead material, the image suggests the partially exposed remains of the lower hull of a vessel. That site should be avoided. If avoidance is not possible, additional investigations should be carried out to identify material generating the signatures and to assess its NRHP significance. Cluster 2 is comprised of five magnetic anomalies that are associated with sonar image DR-10, which is an area of small debris (Figure 21). The complex nature of the anomalies and debris on the bottom surface should also be considered to have a potential association with vessel remains. Cluster 3 is composed of four magnetic anomalies. Although the anomalies have no corresponding sonar image, the complex nature of the magnetic signature should be considered as suggestive of an association with shipwreck remains. Like Cluster 1, both Cluster 2 and 3 should also be avoided, and if avoidance is not possible, additional investigations should conducted to identify material generating the signatures and to assess its NRHP significance.

Table 4. Magnetic Anomalies from the Delaware Artificial Island Remote Sensing Survey.

Anomaly	Northing	Easting	Type* and Deviation	Duration (ft.)	Sonar Association
3-1	197483.0	235317.6	Nm 40g	180	No
3-2	197502.3	235012.4	Mc 30g	390	DR-1 and DR-2
4-1	197463.6	235057.7	Mc 29g	700	DR-1 and DR-2
5-1	197402.7	238513.2	Pm 1486g	250	No
5-2	197394.7	238159.4	Mc 4g	170	DR-4
5-3	197392.2	234891.3	Pm 72g	180	No
6-1	197345.0	234892.2	Dp 5g	100	No
6-2	197345.0	234892.2	Pm 9g	310	DR-5
7-1	197328.2	237421.0	Mc 10g	1400	DR-12
7-2	197321.0	236295.0	Pm 5g	50	No
7-3	197308.8	235107.3	Mc 13g	275	No
8-3	197264.0	236033.3	Mc 12g	420	No
8-4	197248.0	235103.1	Mc 5g	190	No
8-5	197240.2	234680.0	Pm 213g	90	No
9-2	197210.7	235186.0	Mc 16g	350	DR-17
9-4	197210.7	235186.0	Dp 5g	300	No
9-5	197206.4	234685.6	Nm 80g	110	No
10-1	197176.4	237786.6	Dp 12g	90	DR-11
10-3	197164.5	236387.4	Dp 6g	100	DR-13
10-4	197147.8	235056.9	Mc 6g	900	No
11-2	197135.7	238014.1	Dp 5g	80	No
11-3	197133.3	237595.9	Dp 4g	100	No
11-5	197121.0	236400.8	Pm 4g	70	No
11-7	197113.4	235098.8	Mc 6g	470	No
12-1	197081.1	238021.5	Dp 5g	120	No
12-3	197073.2	237036.2	Dp 16g	100	No
12-4	197069.1	236778.8	Dp 3g	100	No
12-5	197051.1	235091.8	Mc 7g	250	No
13-1	197036.9	238083.5	Pm 5g	110	No
13-2	197037.0	237784.7	Pm 3g	40	No
13-3	197028.0	237180.8	Mc 10g	520	No
13-4	197021.2	235551.4	Mc 7g	175	No
14-1	196977.1	237650.9	Pm 5g	90	No
14-2	196958.3	235754.4	Dp 47g	140	No
14-3	196951.7	235078.6	Mc 6g	850	No
15-1	196937.3	238249.5	Pm 8g	100	No
15-2	196911.6	235702.9	Mc 6g	240	No
15-3	196911.7	235142.2	Mc 16g	350	No
16-1	196867.4	237008.9	Dp 9g	90	No

Anomaly	Northing	Easting	Type* and Deviation	Duration (ft.)	Sonar Association
16-2	196860.7	235676.0	Pm 6g	90	No
16-3	196858.3	235566.3	Nm 5g	100	No
17-1	196824.1	235579.8	Mc 13g	160	No
17-2	196815.1	235257.3	Mc 6g	475	No
18-1	196758.9	235712.3	Dp 15g	110	No
19-1	196731.0	236878.0	Dp 7g	180	DR-9
19-2	196719.8	235712.4	Dp 26g	120	DR-15
20-1	196680.7	237771.3	Mc 12g	160	No
21-1	196635.0	237975.1	Dp 6g	70	DR-8
21-2	196637.3	237783.1	Nm 6g	100	No
21-3	196627.5	236382.6	Dp 4g	60	No
21-5	196615.5	235320.5	Dp 10g	190	No
22-1	196570.9	237155.3	Dp 3g	180	No
22-2	196557.8	235325.2	Dp 104g	170	No
23-1	196543.9	237930.8	Dp 4g	80	No
23-2	196537.6	237642.5	Dp 8g	160	DR-7
24-2	196461.0	235810.7	Dp 4g	100	No
25-1	196437.1	237602.1	Pm 5g	50	No
25-3	196417.2	235890.0	Dp 4g	80	No
26-2	196371.4	236069.6	Pm 5g	100	No
26-3	196361.3	235964.3	Dp 7g	80	No
27-2	196325.4	236097.2	Nm 5g	110	No
27-3	196317.5	235893.7	Dp 3g	65	No
28-1	196269.3	237204.4	Nm 5g	130	No
28-2	196270.4	236866.4	Mc 9g	440	DR-6
28-3	196265.0	236528.3	Nm 4g	110	No
28-4	196260.2	235950.3	Pm 3g	40	No
29-1	196236.4	237205.1	Nm 7g	200	No
29-2	196223.2	236535.2	Nm 4g	150	No
30-1	196169.0	236570.0	Nm 3g	120	No
31-2	196138.0	237772.3	Dp 5g	200	No
31-3	196124.9	236247.3	Dp 6g	75	No
31-4	196118.1	236006.9	Mc 4g	100	No
32-1	196051.1	236165.4	Nm 4g	60	No
35-3	195930.3	236345.4	Pm 3g	75	No

*D = dipole, M = monopole, C = complex, N = negative, P = positive

SUBBOTTOM PROFILE RECORD

Employed to penetrate sediment beds with the possibility that buried hazards or paleochannels, paleo-landscape settings, or mounded midden features might be sensed, review of the seismic data suggests that the bottom consists of winnowed sand deposits over a uniform clay substrate. No evidence of tidal estuaries, alluvial terraces, stream channels, shell middens, or other relic landforms considered to be associated with prehistoric habitation was recorded in the survey area (Figure 22).

Table 5. Potentially Significant Clusters.

Cluster	Anomaly	Northing	Easting	Sonar
Cluster 1	8-1	197279.7	238055.8	DR-14
Cluster 1	9-1	197234.4	238044.2	DR-14
Cluster 2	8-2	197279.3	237196.8	DR-10
Cluster 2	9-2	197235.7	237208.1	DR-10
Cluster 2	10-2	197172.2	237307.2	No
Cluster 2	11-4	197133.6	237361.0	No
Cluster 2	12-2	197076.3	237390.7	No
Cluster 3	24-1	196472.5	237113.0	No
Cluster 3	25-2	196430.2	237010.0	No
Cluster 3	26-1	196372.1	237027.0	No
Cluster 3	27-1	196331.6	237013.8	No

POTENTIAL HAZARDS

All of the located targets may be construed as potential hazards; that is, magnetic targets are composed of metal, and sidescan targets can also be composed of metal and/or wood. These materials may be hazardous to the proposed construction activities, depending on the type of activity that is conducted (i.e., pile driving, etc.).

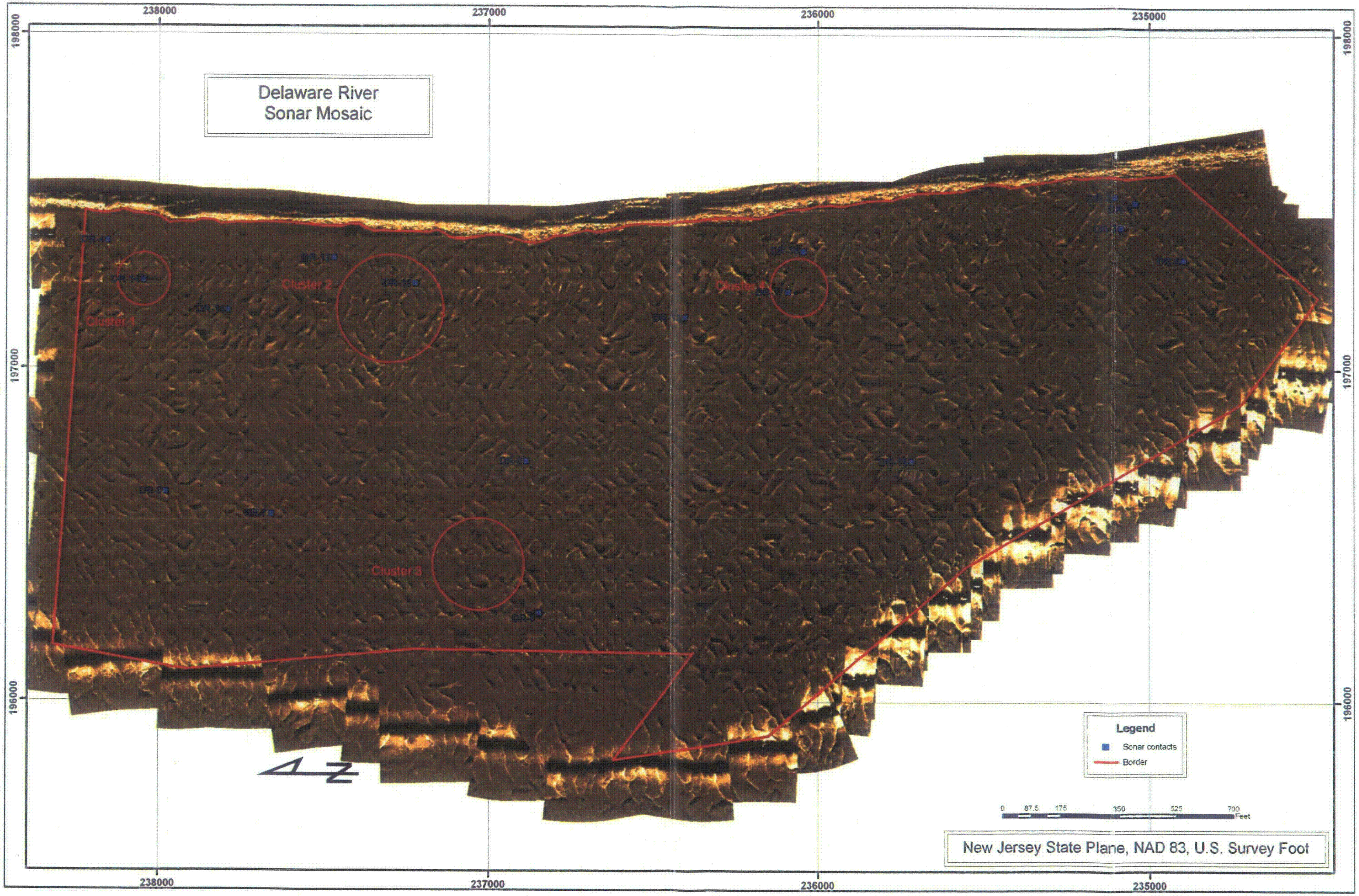

Figure 18. Sonar mosaic with acoustic target locations.

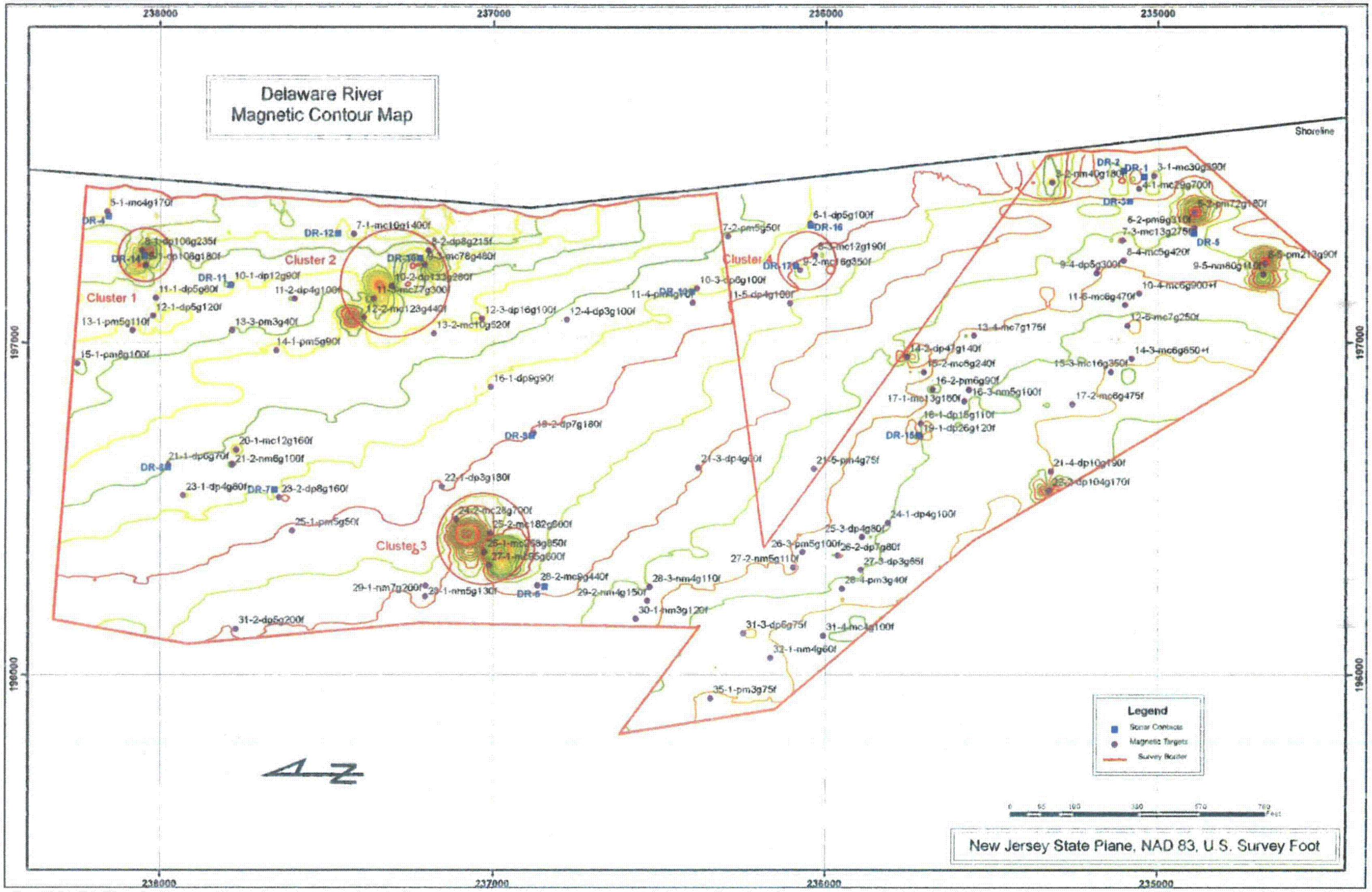

Figure 19. Magnetic contour map with anomaly, anomaly cluster and sonar target locations.

Figure 20. Acoustic image of DR-14 associated with Target Cluster 1. Approximately 40 ft. long and 50 ft. wide, this target has the characteristics of the remains of a wooden hull.

Figure 21. Acoustic image of DR-10 associated with Target Cluster 2. It is a 50 foot-wide area of small debris. Note the winnowed sand bottom.

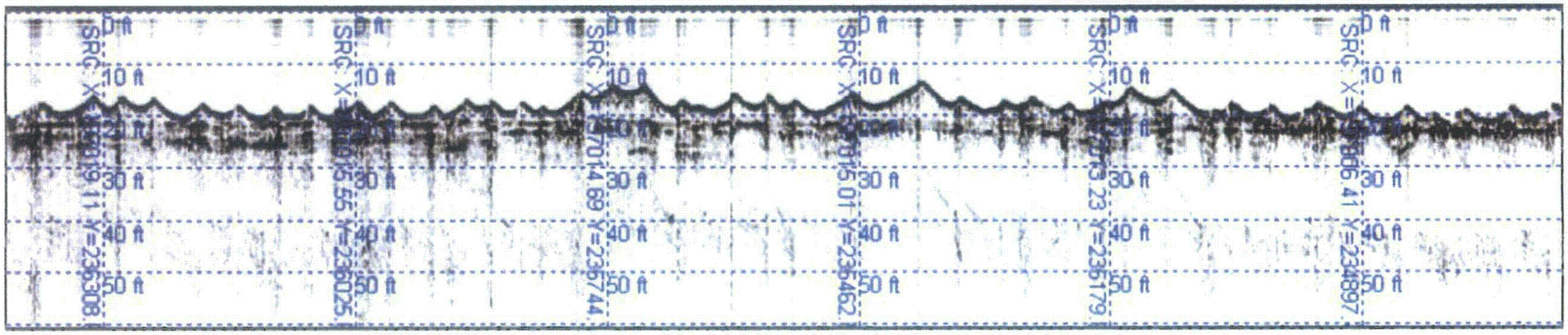

Figure 22. A sample of the subbottom data showing a featureless landscape. The upper surface reflects the winnowed sand waves seen in the sidescan mosaic. Note this image is a center line segment that runs parallel to the shore.

5. CONCLUSIONS AND RECOMMENDATIONS

Panamerican Consultants, Inc. of Memphis, Tennessee conducted an intensive submerged cultural resources remote sensing survey of a proposed dredging area, as part of work to support the PSEG Early Site Permit Application (ESPA), immediately adjacent to the western shore of Artificial Island on the Delaware River in Salem County, New Jersey. Comprised of a magnetometer, sidescan sonar, and a subbottom profiler survey, the primary focus of the investigation was to determine the presence or absence of anomalies representative of potentially significant submerged cultural resources that are eligible for listing on the NRHP, and if present, which resources subsequently, might require additional investigations. A secondary aspect of the project was to identify hazards to the proposed construction.

Results of the survey identified a total of 84 magnetic anomalies, 17 sidescan sonar targets, and no subbottom profiler impedance contrasts within the project area. Three clusters of magnetic anomalies and two associated acoustic images exhibit characteristics indicative of vessel remains. Target Cluster 1 is comprised of two magnetic anomalies that are associated with sonar image DR-14. That sonar image has characteristics suggestive of shipwreck remains. While it is possible that the image is associated with bulkhead material, the image suggests the partially exposed remains of the lower hull of a vessel. It is recommended that the site be avoided. If avoidance is not possible, additional investigations should be conducted to identify material generating the signatures and to assess its NRHP significance. Cluster 2 is comprised of five magnetic anomalies that are associated with sonar image DR-10, which is an area of small debris. The complex nature of the anomalies and debris on the bottom surface should also be considered to have a potential association with vessel remains. Cluster 3 is composed of four magnetic anomalies. Although the anomalies have no corresponding sonar image, the complex nature of the magnetic signature should be considered as suggestive of an association with shipwreck remains. Like Cluster 1, it is recommended that both Cluster 2 and 3 also be avoided. If avoidance is not possible, additional investigations are recommended to be conducted to identify material generating the signatures and to assess its NRHP significance.

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APPENDIX A: EIGHTEENTH CENTURY DELAWARE BAY SHIPWRECK LIST

A list of shipwrecks and marine accidents in Delaware Bay/River was compiled from numerous primary and secondary sources. Among the sources used during the compilation of this list include: *Pennsylvania Gazette*, Philadelphia Chamber of Commerce Study, 1826; *Encyclopedia of American Shipwrecks* (Berman 1972); *Shipwrecks off the New Jersey Coast* (Krotee and Krotee 1965); "A Preliminary Survey to Analyze The Potential Presence of Submerged Cultural Resources In the Delaware and Susquehanna Rivers" (Cox, 1984); *Shipwrecks in the Americas* (Marx, 1971); *Shipwrecks of Delaware and Maryland* (Gentile 1990); *Shipwrecks of New Jersey* (Gentile 1988); *The Pennsylvania Navy, 1775-1781: The Defense of the Delaware* (Jackson, 1974); *Automated Wreck and Obstruction Information System - AWOIS*, (National Oceanographic and Atmospheric Administration); *Wreck Chart of the North American Coast of America*, General Records of the Hydrographic Office, National Archives; *Philadelphia, Port of History*, 1609 -1837 (Chandler, et. al. 1976); *Hazard Annuals of Pennsylvania 1609 -1682* (Hazard 1850); and *The Majestic Delaware* (Brandt 1929).

Name	Year Lost	Comments
Mercury	1741	English merchantman, Captain Hogg, sailing from Philadelphia to Lisbon, lost near the Delaware River.
Molly	1754	Captain Francis Blair, bound to Jamaica, struck on the Brandywine and sprung leak. Got off and was intentionally run ashore about the mouth of Lewes-Town Creek, where she was entirely lost. Little of the cargo saved.
Beaufort	1754	Captain Ferguson, bound to St. Christophers from Philadelphia, was drove ashore at Cape Henlopen in a violent gale of wind.
Sally	1757	Captain Saze, sailing from Philadelphia to Antigua, lost at Brandy Wine on the Delaware.
Pusey	1757	Captain Good, arriving from Jamaica wrecked on Reedy Island in the Delaware River.
Cornelia	1757	Captain Smith, sailing from Philadelphia to Gibraltar, lost her rudder and received other damage on Reedy Island. Came ashore on the Cross Ledge full of water. Eventually sank in the Delaware Bay somewhere between Cape Henlopen and Cape May.

Molly	1760	Captain Stewart, overset off of Cape Henlopen, in a violent gale of wind.
Vaughan (Vaughn)	1763	English merchantman, under Captain Foster, sailing from Bristol to Philadelphia, ran ashore on the Shears in Delaware Bay.
Pitt Packet	1763	English merchantman, under Captain Montgomery sailing from Belfast to Philadelphia with a large number of passengers, foundered in the Delaware Bay with a total loss of life.
Charlestown	1766	American merchantman, under Captain Simpson, sailing from Hamburg to Philadelphia wrecked on January 25 on Brandywine Bank in the Delaware Bay.
Kildare	1768	Captain Nicholson, sailing from Barbados to Philadelphia, lost at the mouth of the Delaware River.
Commerce	1771	English merchantman, under Captain Addis, sailing from England to New York, wrecked at Cape Henlopen.
Severn	1774	English merchantman, under Captain Hathorn sailing from Bristol to Philadelphia, wrecked in the Delaware Bay, but all of her crew was saved.
Endeavor	1775	English merchantman, under Captain Caldwell, sailing from Philadelphia to Londonderry, caught fire and sank off Reedy Island in the Delaware River but most of her cargo was saved.
Washington	1777	Continental frigate, 32 guns, was scuttled along with Effingham near Bordentown to prevent capture by British.
Effingham	1777	Continental frigate, 28 guns, was scuttled along with Washington near Bordentown to prevent capture by British.
Andrea Doria	1777	Warship, 14 guns, was scuttled near Philadelphia to prevent capture by British.
Sachem	1777	Warship, ten guns, lost in the Delaware River during naval battle with British.
Independence	1777	Warship, ten guns, lost in the Delaware River during naval battle with British.

Wasp	1777	Warship, eight guns, lost in the Delaware River during naval battle with British.
Mosquito	1777	Warship, four guns, lost in the Delaware River during naval battle with British.
Xebecks	1777	Brig, lost in the Delaware River during naval engagement with British warships.
Repulse	1777	Brig, lost in the Delaware River during naval engagement with British warships.
Champion	1777	Brig, lost in the Delaware River during naval engagement with British warships.
Augusta	1777	British Frigate, 64 guns, grounded and exploded off mouth of Mantua Creek.
Merlin	1777	British Sloop of War, 18 guns, grounded and later scuttled by British off of Mantua Creek, south of Augusta.
20 unidentified	1777	Small sloops and other vessels of the Pennsylvania Navy were burned after attempting to pass above Philadelphia after the surrender of Forts Mifflin and Mercer.
Montgomery	1777	Pennsylvania Navy brig, 20 guns, was scuttled after attempting to pass above Philadelphia after the surrender of Forts Mifflin and Mercer.
2 unidentified	1777	Two floating batteries were burned after attempting to pass above Philadelphia after the surrender of Forts Mifflin and Mercer.
2 unidentified	1778	Two ships were part of a 44-vessel fleet destroyed by British in and around Crosswicks Creek during a two day raid to destroy colonial vessels that hid upriver after the surrender of Forts Mifflin and Mercer.
Unidentified	1778	Privateer sloop, part of the colonial fleet destroyed by the British near Bordentown.
18 unidentified	1778	Brigs, schooners and sloops, part of the colonial fleet destroyed by the British near Bordentown.
Sturdy Beggar	1778	Privateer, 18 guns, part of the colonial fleet destroyed by the British near Bordentown.
2 unidentified	1778	Schooners, 14 and 10 guns each, part of the colonial fleet destroyed by the British near Biles Island Creek.

4 unidentified	1778	Sloops, 16 guns each, part of the colonial fleet destroyed by the British near Biles Island Creek.
6 unidentified	1778	Brigs and Schooners, part of the colonial fleet destroyed by the British near Bristol.
2 unidentified	1778	Sloops, part of the colonial fleet destroyed by the British at ferry above Bristol.
9 unidentified ships	1783	Wrecked at Cape Henlopen during a severe gale in the fall.
Peace	1784	Captain Star, sailing vessel from London to Virginia wrecked on Hog Island in the Delaware Bay.
Faithful Steward	1785	Scottish immigrant ship, under Captain McCausland, sailing from Londonderry to Philadelphia sank near Cape Henlopen, over 200 persons perished.
Santa Rosalea	1788	Spanish merchantman, under Captain Pardenus sailing from Baltimore to Havana, wrecked near Cape Henlopen.
Pomona	1789	English ship, under Captain Hopkins arriving from Quebec, sank in the Delaware Bay in October.
John	1790	English merchantman, under Captain Staples, arriving from England, wrecked on December 5, in the Delaware Bay.
Alliance	1790	Continental Navy frigate was abandoned and broken up behind Pettys Island.
Perseverance	1790	John Fitch's experimental steamboat abandoned behind Pettys Island.
Industry	1793	American merchantman, under Captain Carson, sailing from France to Philadelphia sank in the Delaware Bay, near Cape May.
San Joseph	1794	Spanish merchantman, sailing from Philadelphia to Cuba, was lost in the Delaware Bay when ice crushed her hull.
Peggy	1794	American merchantman, sailing from Philadelphia for Savannah, was lost in the Delaware Bay.
Lively	1795	Sailing from Amsterdam to New York, under Captain Lawrence, ship sank near Lewes.

Henry & Charles	1796	American merchantman, sailing from Hamburg to Philadelphia, wrecked near Cape Henlopen.
Favorite	1796	American merchantman, sailing from Cadiz to Philadelphia sank in the Delaware Bay.
Minerva	1796	American merchantman, sailing from Lisbon to Philadelphia wrecked near the mouth of the Delaware River.
John	1797	American ship sailing from Hamburg to Philadelphia with 300 immigrants under Captain Folger wrecked at what is now know at Ship John Shoal in the Delaware Bay.
DeBraak	1798	A British Sloop of War, capsized approximately one mile off Cape Henlopen.
New Jersey	1799	American merchantman, under Captain Clay sailing from Puerto Rico to Philadelphia, wrecked on the west side of the Delaware Bay.
George	1800	English merchantman preparing to sail for England, sank at Philadelphia.
Susannah	1800	Merchantman, sailing from Hamburg to Philadelphia under Captain Medlin wrecked in the Delaware Bay.

APPENDIX B: SALEM HISTORICAL SOCIETY LETTER

Artificial Island

450 East Broadway,
Salem, N. J.,
May 20, 1961.

Mr. H. B. Marshall,
309 Nichols Ave.,
Wilmington 3, Del.

Dear Sir:

Replying to your letter of May 6th, I have made a search thru our records and our many scrap-books regarding Artificial Island and the ships sunk there, but could find no printed matter regarding same. However, I have been in touch with several of our local elder men who have fished and trapped in that vicinity for years - one of them, in fact, since 1888. They all tell me the same thing, so I feel sure it is correct.

Mr. Billy Baker father of Mrs. Zey Parkell Born 1874 owned his 1st boat at 14.

Artificial Island was blown in on the Dan Baker Shoals (local name) by the Government in the decade 1895 to 1905, as a means of keeping the channel open at the mouth of Alloway Creek. The Island is approximately three miles long and maybe one mile wide, and runs from one-half mile below the mouth of Alloway Creek to Hope Creek.

After World War I, the Government had need to dispose of various wooden vessels, mostly freighters and oilers which had been built particularly for that war period and were obsolete. They were sunk at the southern end of the Island.

As this was all open water before the Island was blown in, an d thus permitted the use of shad nets, which would have caught on any obstruction below water, it is not believed any ancient boats or wrecks are in this vicinity.

I trust this will be of some help to you.

Yours very truly,

SALEM COUNTY HISTORICAL SOCIETY

Josephine Jaquett, Historian

Figure B-1. Letter sent from Historian of Salem Historical Society discussing creation of Artificial Island, according to local oral historical accounts.

APPENDIX C: *NEW YORK TIMES* ARTICLE

TREASURE IN RIVER SHOALS.

Uncle Sam Wants It If Picked Up by Dredgers in the Delaware.

Special to The New York Times.

PHILADELPHIA, June 28.—At last some one has been found who thinks there "might be something in" the old sailors' yarns to the effect that wealth beyond the dreams of avarice lie buried in the treacherous sands of Dan Baker Shoals, in the Delaware River, and that some one is no less a personage than credulous old Uncle Sam.

Veteran seadogs believe in the old story that one of Capt. Kidd's treasure-laden pirate ships was wrecked on the shoals, and to bear out their stories, they point triumphantly to the fact that a few years ago dredgers at work at the mouth of the Schuylkill turned up a portion of the hull of a schooner which no one knew anything about. The vessel's name could not be ascertained. In the part of the wreck brought to the surface were found a number of shovels and picks of antique pattern, and several watches of unknown make and date.

Dan Baker Shoals are several miles from the mouth of the Schuylkill. Uncle Sam may have had these discoveries in mind when he inserted a clause in the contract for dredging these shoals, and for which bids have been opened, to the effect that any coin or valuables discovered in the work of dredging must revert to the National Government.

The New York Times

Published: June 29, 1902

Figure C-1. Article in *New York Times* stating local belief that a schooner found in Baker Shoal near the project area was sailed by the pirate, Captain Kidd.

APPENDIX D: SURVEY AREA COORDINATES

Point	X	Y
A	196165.95	238319.16
B	197471.99	238223.00
C	197454.20	236300.10
D	196411.43	236179.88
E	197564.11	235318.03
F	197588.66	234919.18
G	197216.77	234484.10
H	196901.34	234715.24
I	196406.44	235552.76
J	195897.94	236151.00
K	195824.52	236618.71
L	196143.89	236379.92
M	196156.49	237222.34
N	196093.46	237915.73

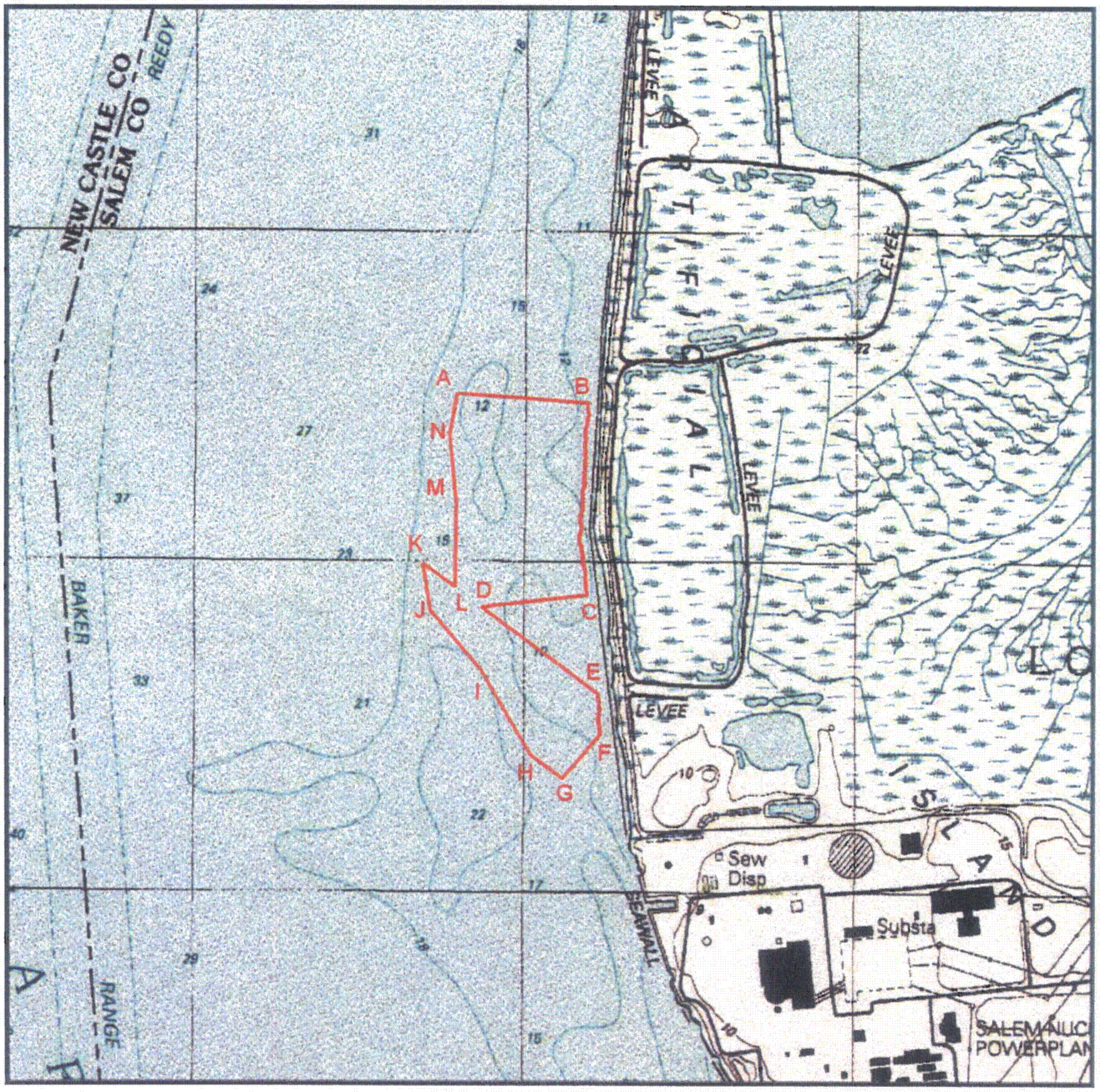
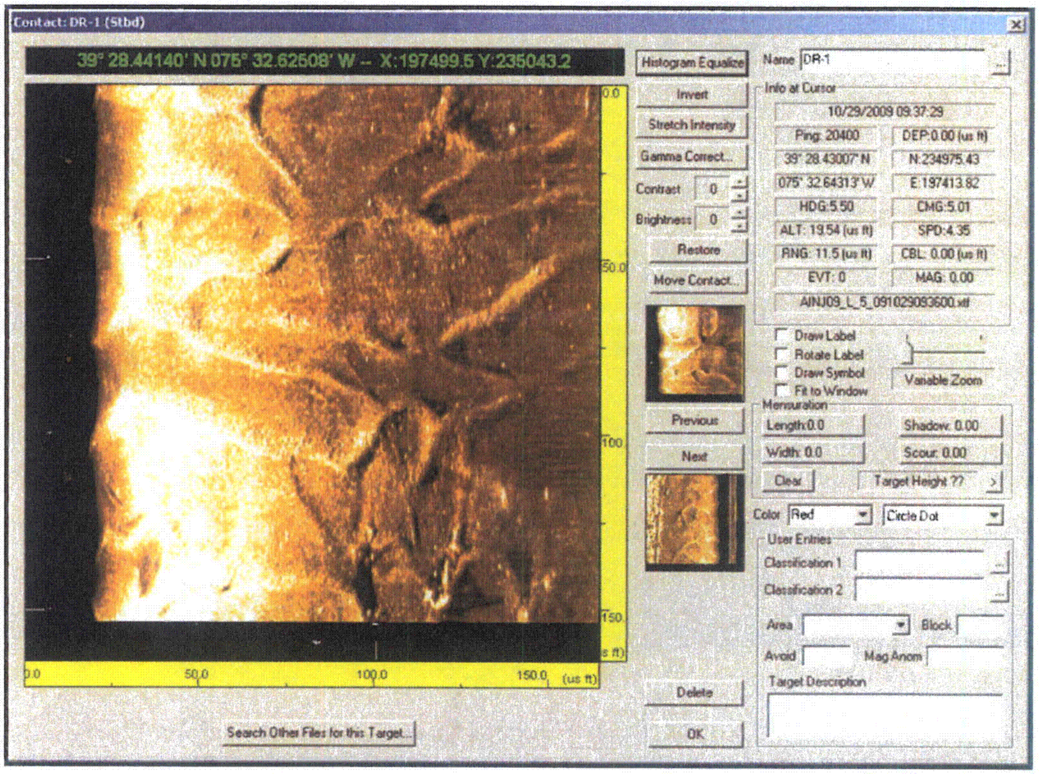


Figure D-1. Coordinate location map (USGS 7.5' Quadrangle: Taylors Bridge (DE), 1981).

APPENDIX E: SIDESCAN SONAR TARGET IMAGES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Brightness 0
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Move Contact...
Previous
Next
Delete
OK
Search Other Files for this Target...
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Rotate Label
Draw Symbol
Fit to Window
Variable Zoom
Mensuration
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Scour: 0.00
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Target Height ??
Color Red
Circle Dot
User Entries
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Classification 2
Area
Block
Avoid
Mag Anom
Target Description
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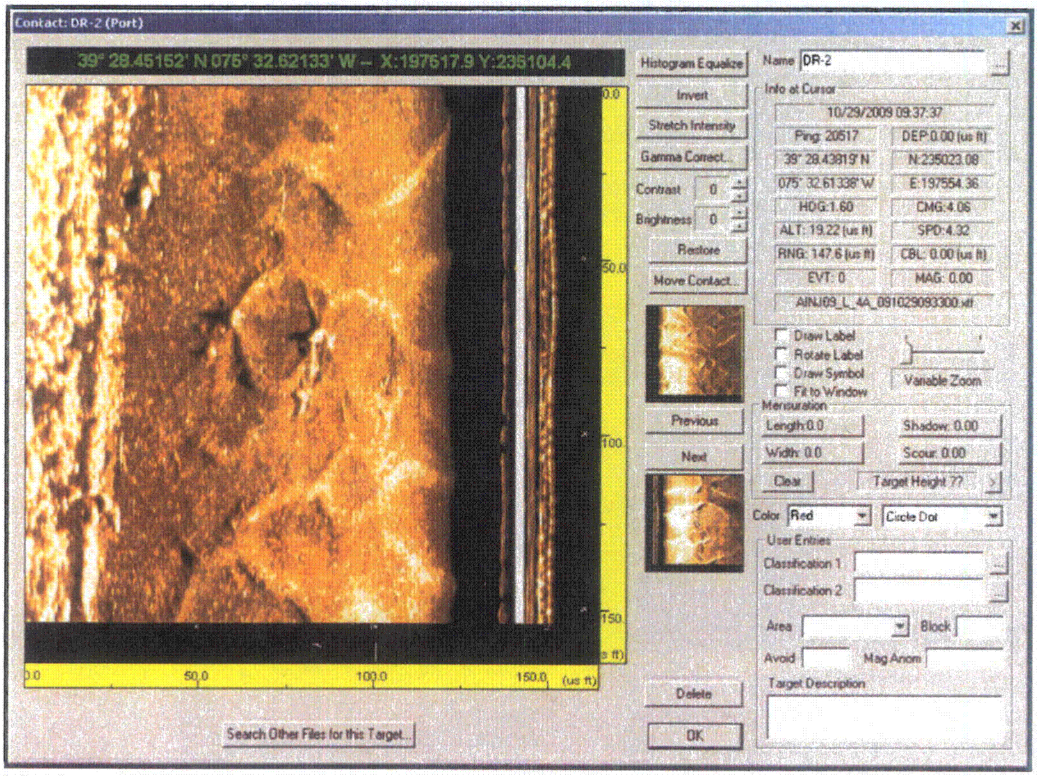
150.0
(us ft)

DR-1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Stretch Intensity
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Brightness 0
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Next
Delete
OK
Search Other Files for this Target...
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075° 32.61338' W
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CMG:4.06
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Circle Dot
User Entries
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Classification 2
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Block
Avoid
Mag Anom
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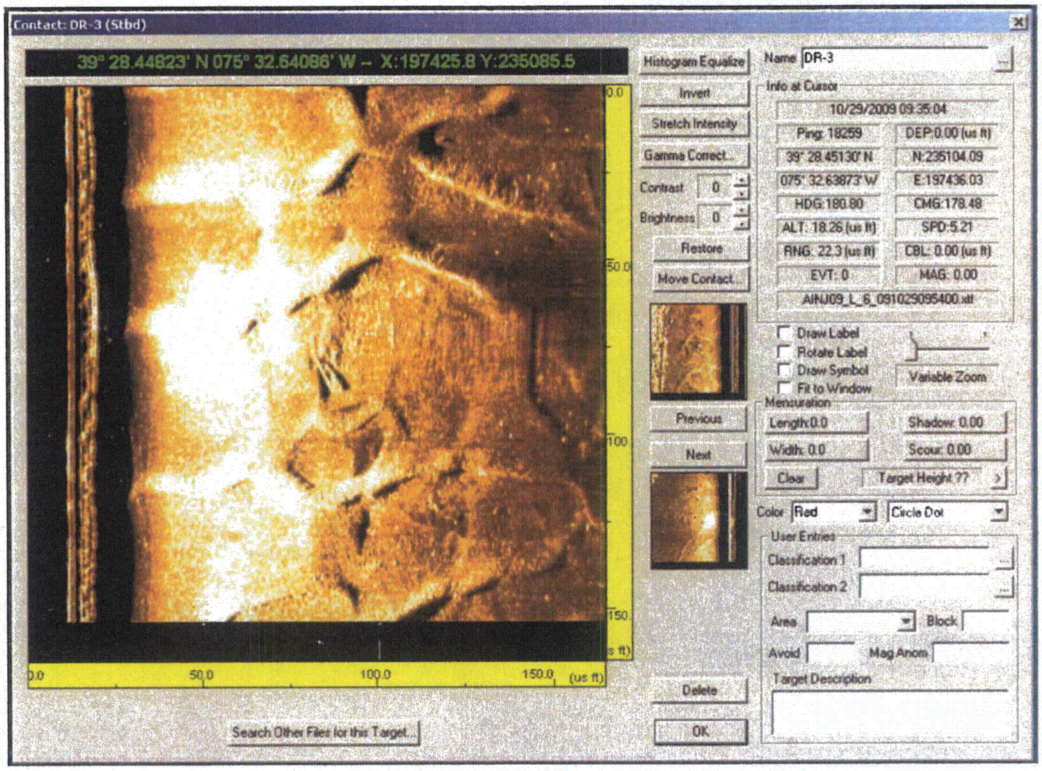
150.0
(us ft)

DR-2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Next
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CMG:178.48
ALT: 18.26 (us ft)
SPD:5.21
RNG: 22.3 (us ft)
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Color Red
Circle Dot
User Entries
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Classification 2
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Avoid
Mag Anom
Target Description
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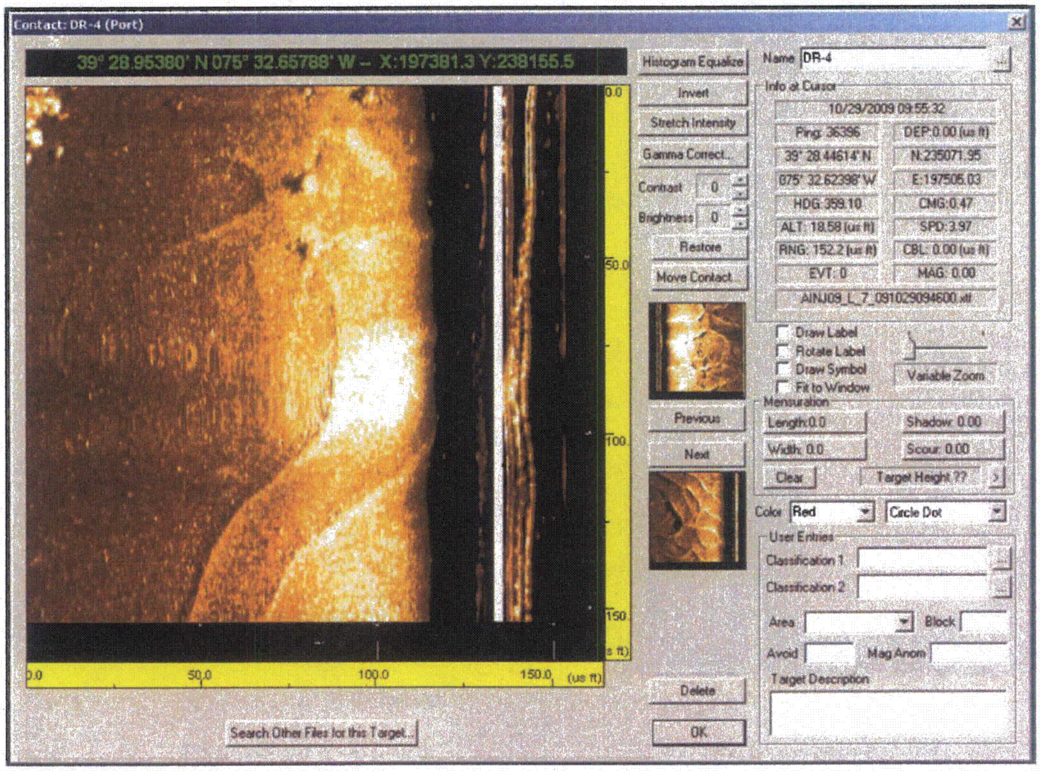
150.0
(us ft)

DR-3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Next
Delete
OK
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ALT: 18.58 (us ft)
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Color Red
Circle Dot
User Entries
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Block
Avoid
Mag Anom
Target Description
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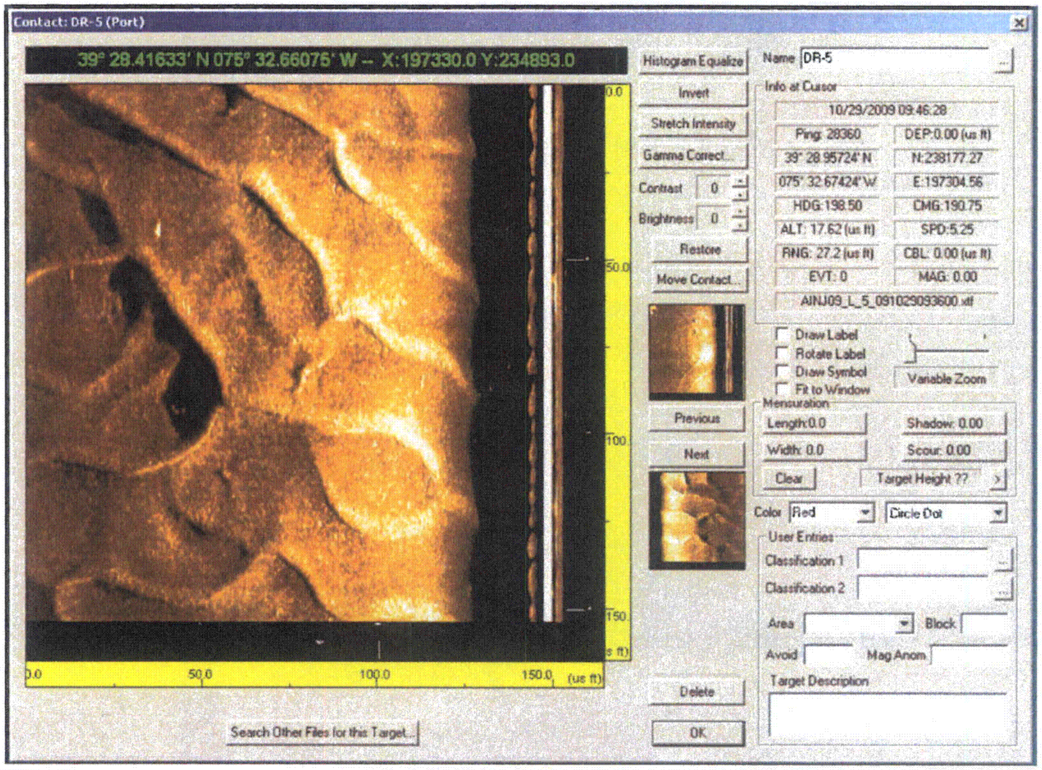
100.0
150.0
(us ft)

DR-4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Stretch Intensity
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Move Contact...
Previous
Next
Delete
OK
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CMG:190.75
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Mensuration
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Avoid
Mag Anom
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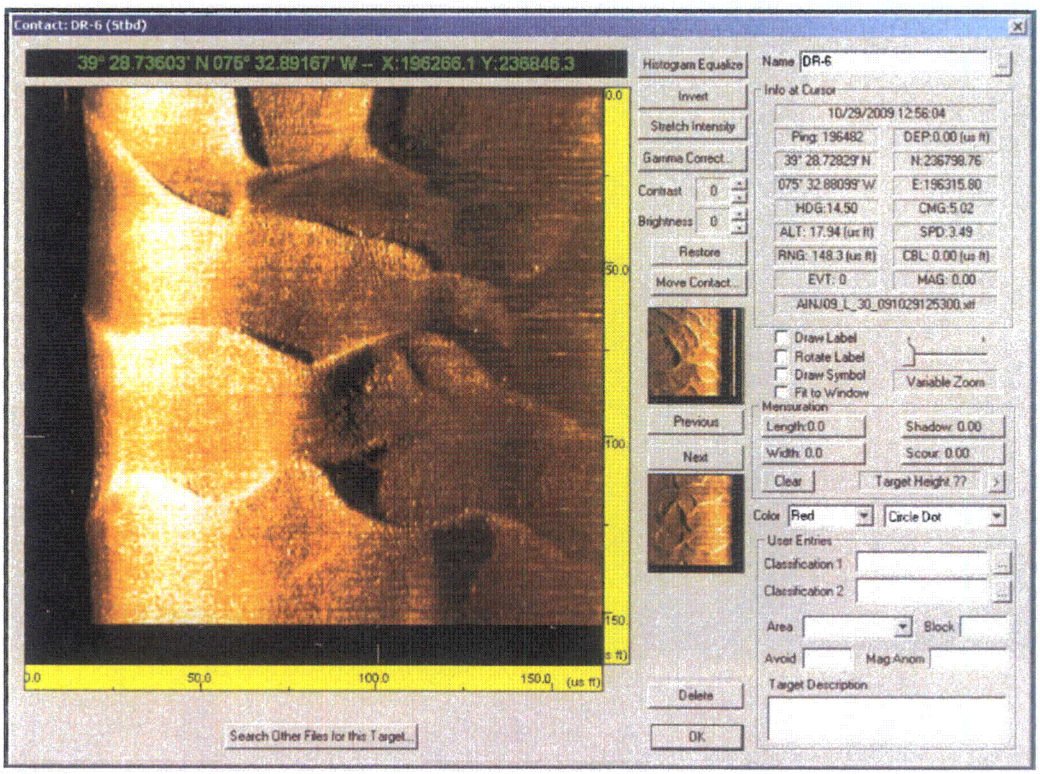
150.0
(us ft)

DR-5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Move Contact...
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OK
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N:236798.76
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E:196315.80
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ALT: 17.94 (us ft)
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Circle Dot
User Entries
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Classification 2
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Avoid
Mag Anom
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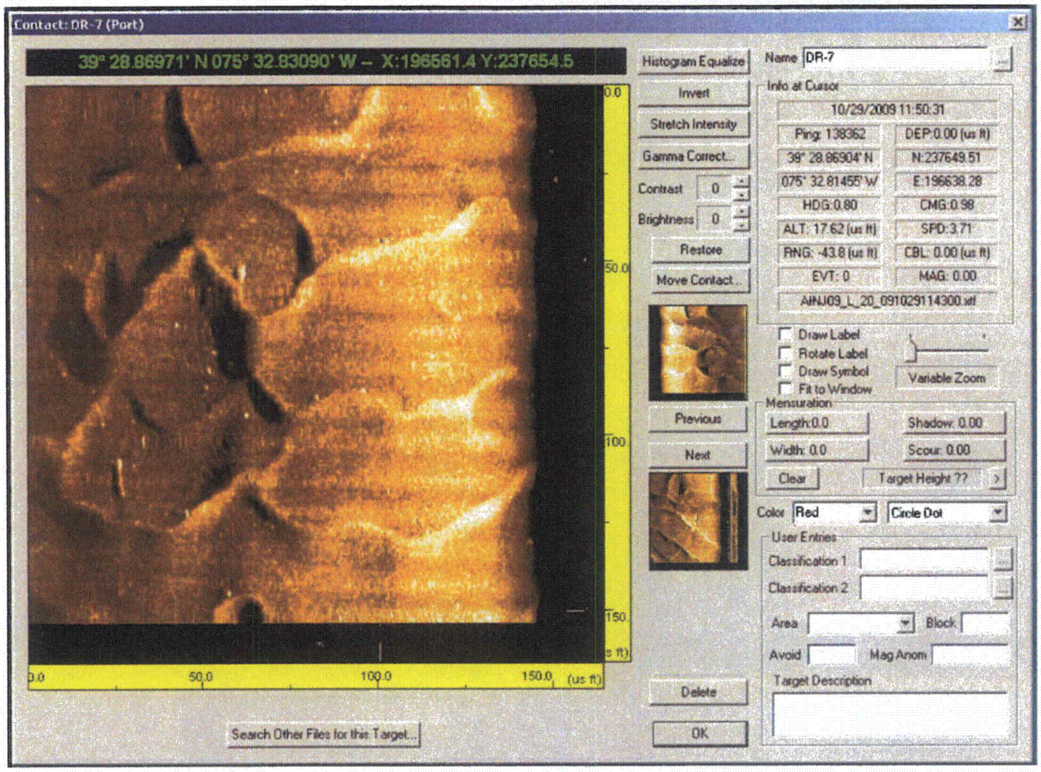
150.0
(us ft)

DR-6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Brightness 0
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Move Contact...
Previous
Next
Delete
OK
Search Other Files for this Target...
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N:237649.51
075° 32.81455' W
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CMG:0.98
ALT: 17.62 (us ft)
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Scour: 0.00
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Circle Dot
User Entries
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Block
Avoid
Mag Anom
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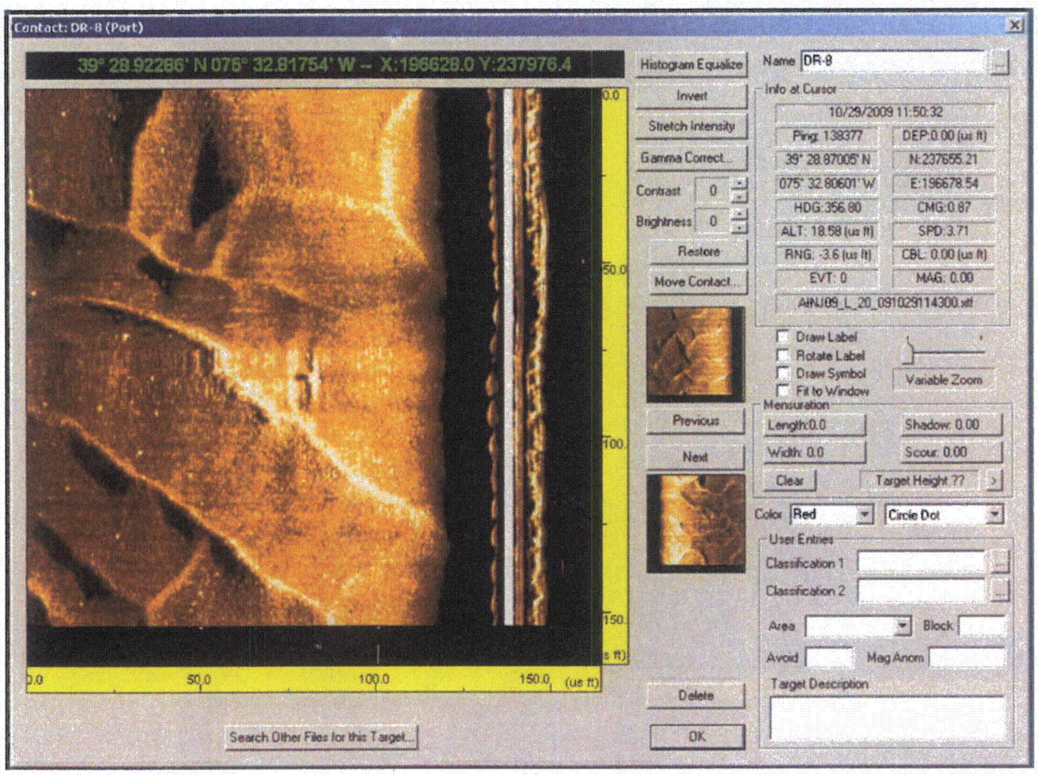
150.0
(us ft)

DR-7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Move Contact...
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Next
Delete
OK
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ALT: 18.58 (us ft)
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Circle Dot
User Entries
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Mag Anom
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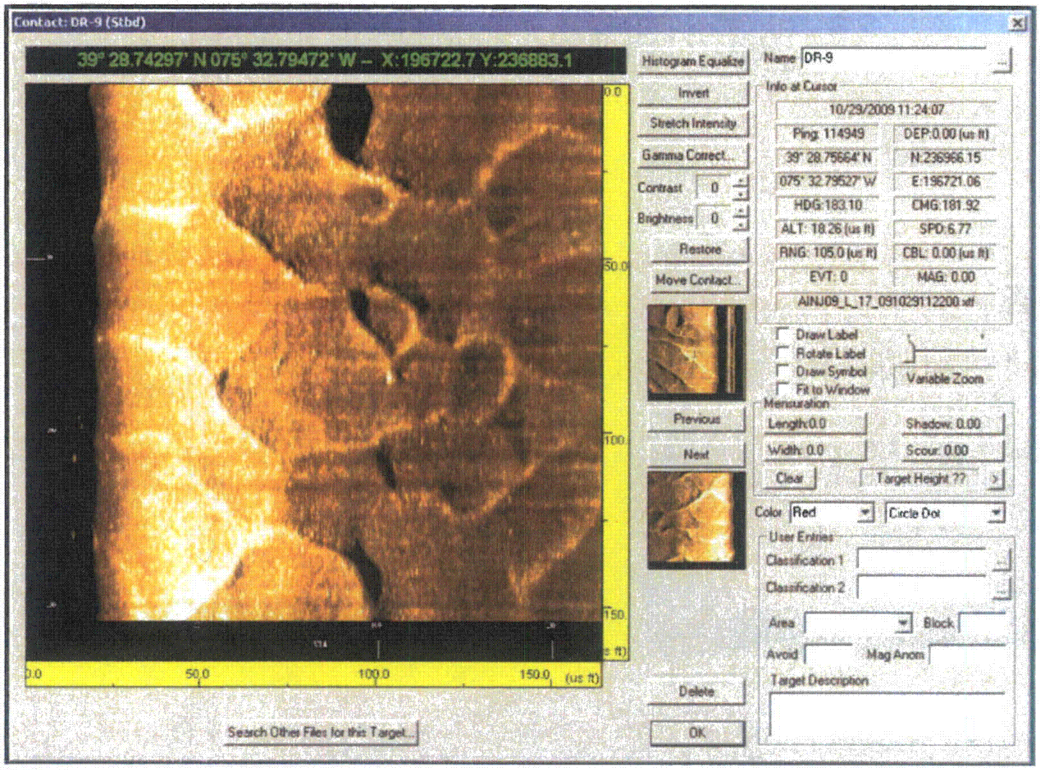
(us ft)

DR-8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Brightness
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Previous
Next
Delete
OK
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CMG:181.92
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Mag Anom
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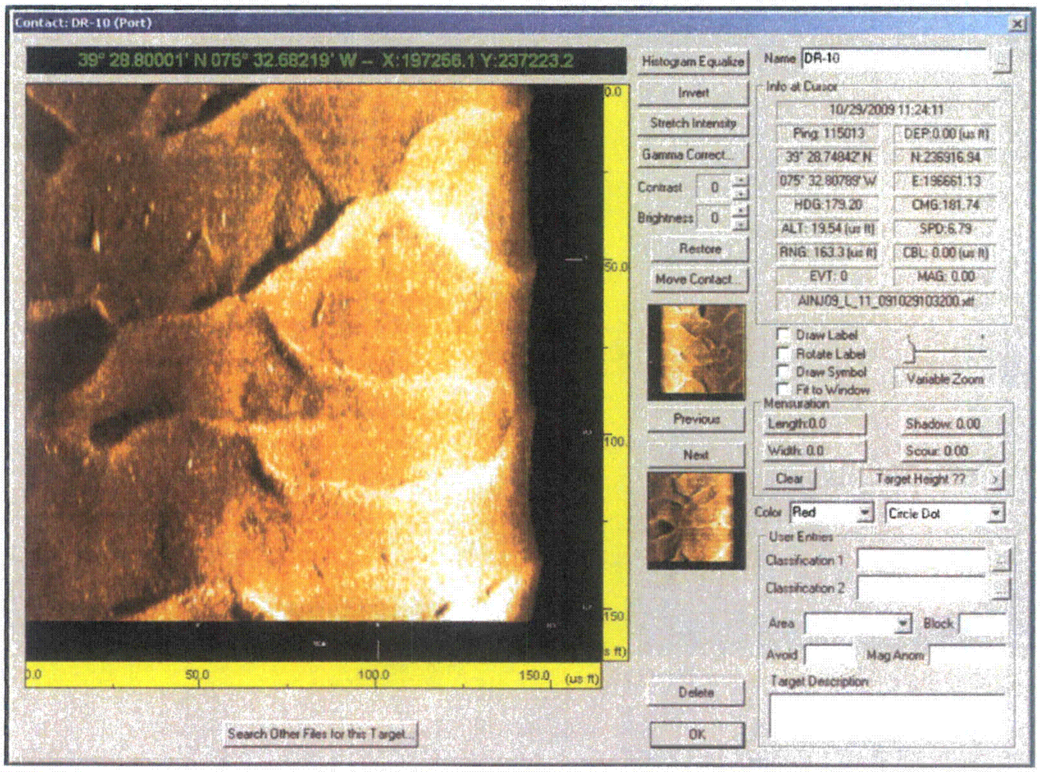
DR-9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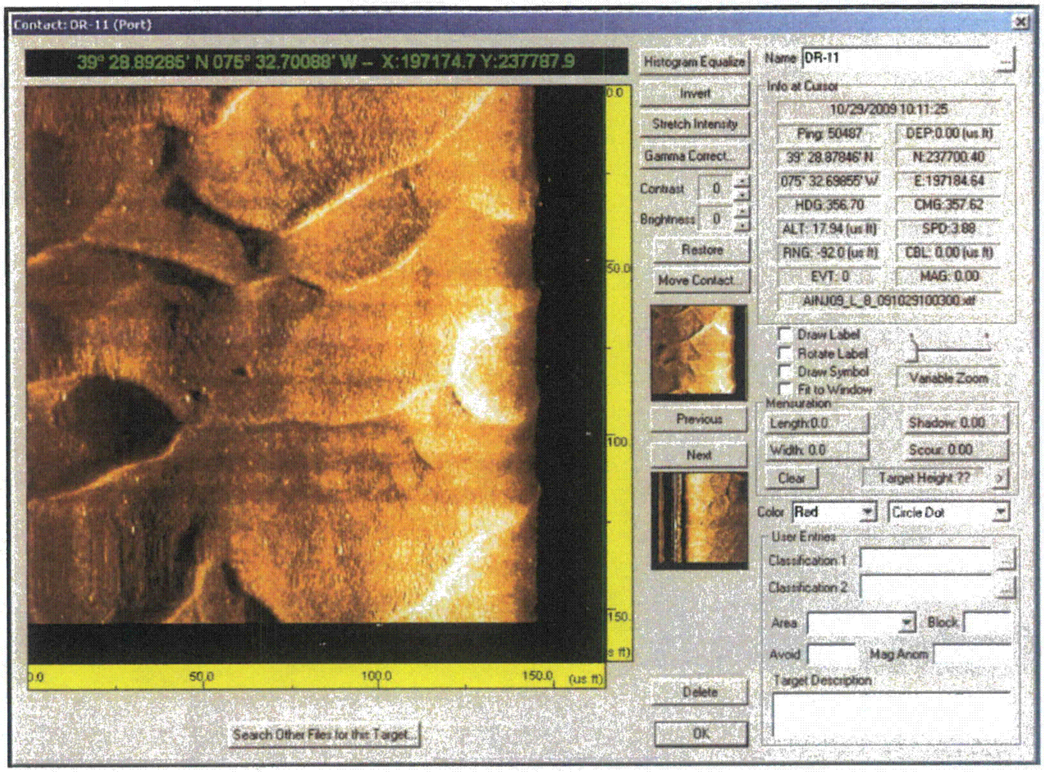
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Color Red
Circle Dot
User Entries
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Avoid
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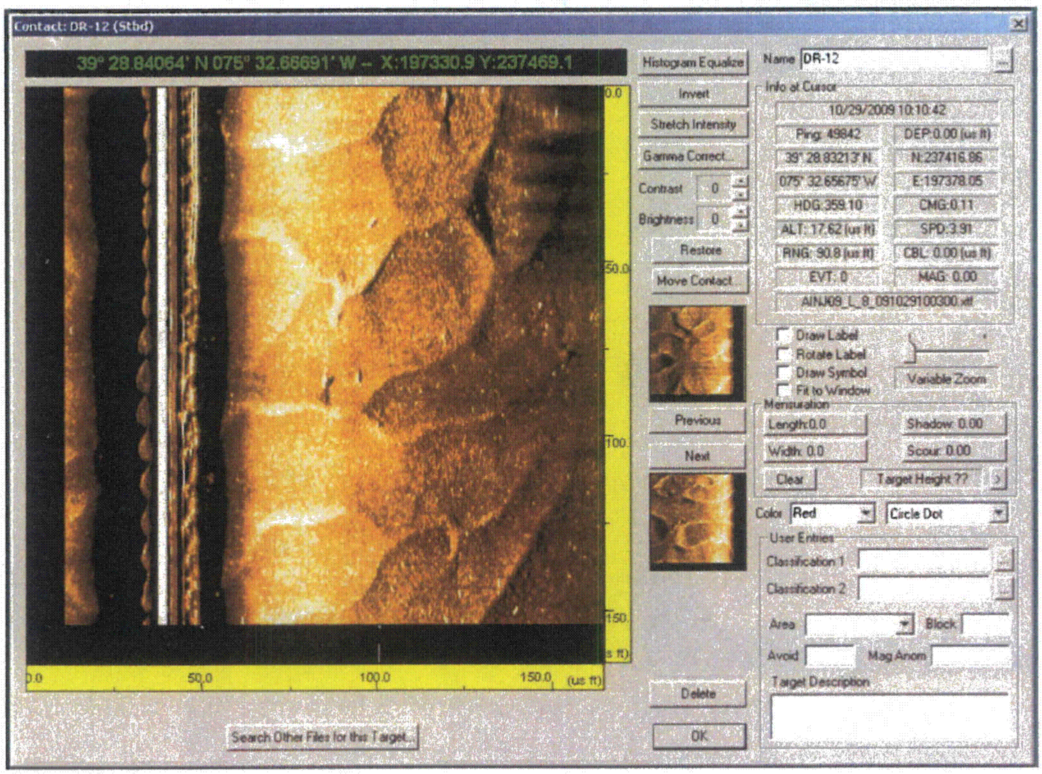
(us ft)

DR-11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Previous
Next
Delete
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N:237416.86
075° 32.65675' W
E:197378.05
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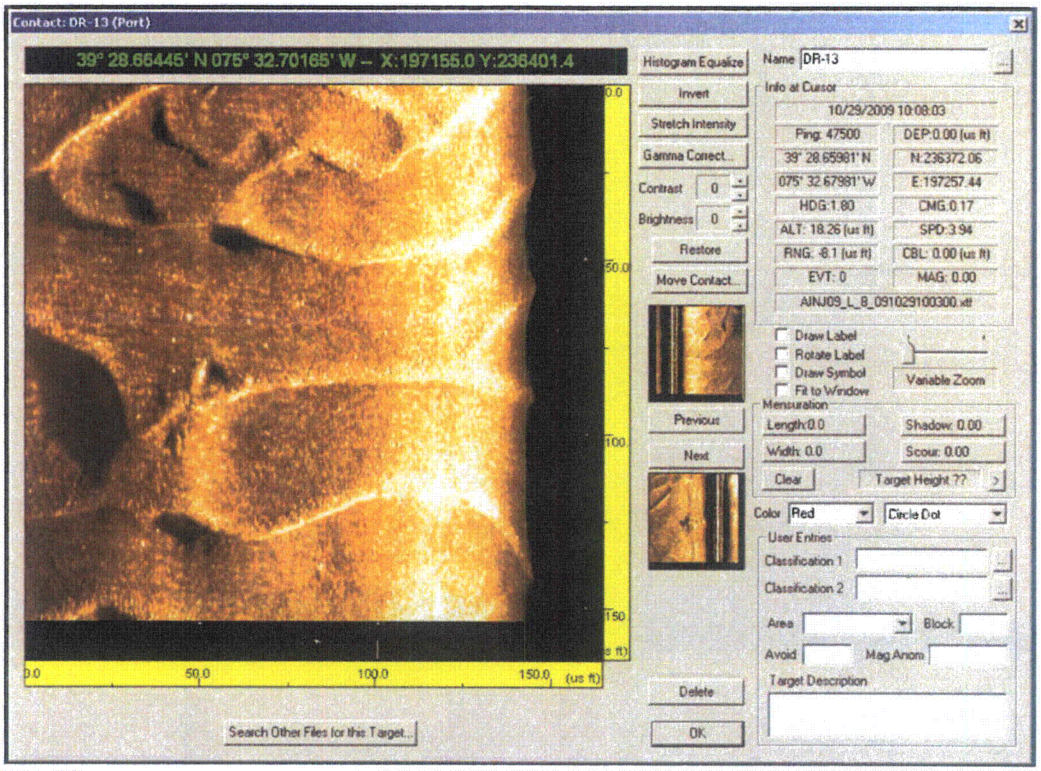
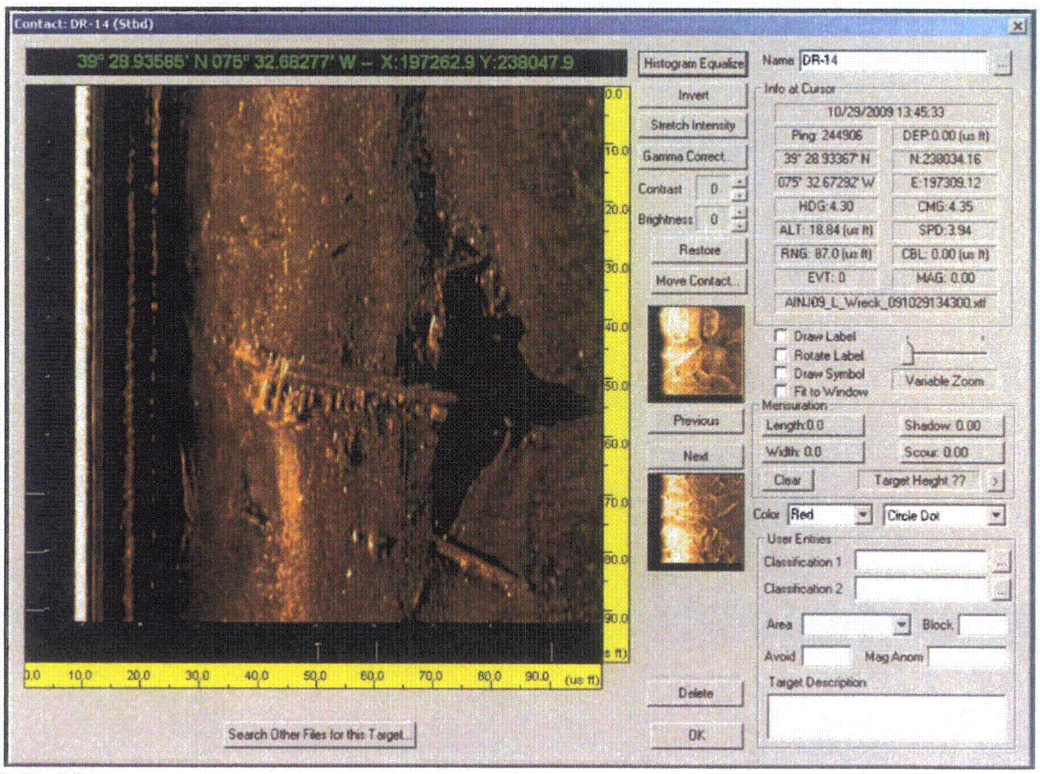
CMG:0.11
ALT: 17.62 (us ft)
SPD:3.91
RNG: 90.8 (us ft)
CBL: 0.00 (us ft)
EVT: 0
MAG: 0.00
AINJ09_L_8_091029100300.xtf
Draw Label
Rotate Label
Draw Symbol
Fit to Window
Variable Zoom
Mensuration
Length:0.0
Shadow: 0.00
Width: 0.0
Scour: 0.00
Clear
Target Height ??
Color Red
Circle Dot
User Entries
Classification 1
Classification 2
Area
Block
Avoid
Mag Anom
Target Description
0.0
50.0
100.0
150.0
(us ft)

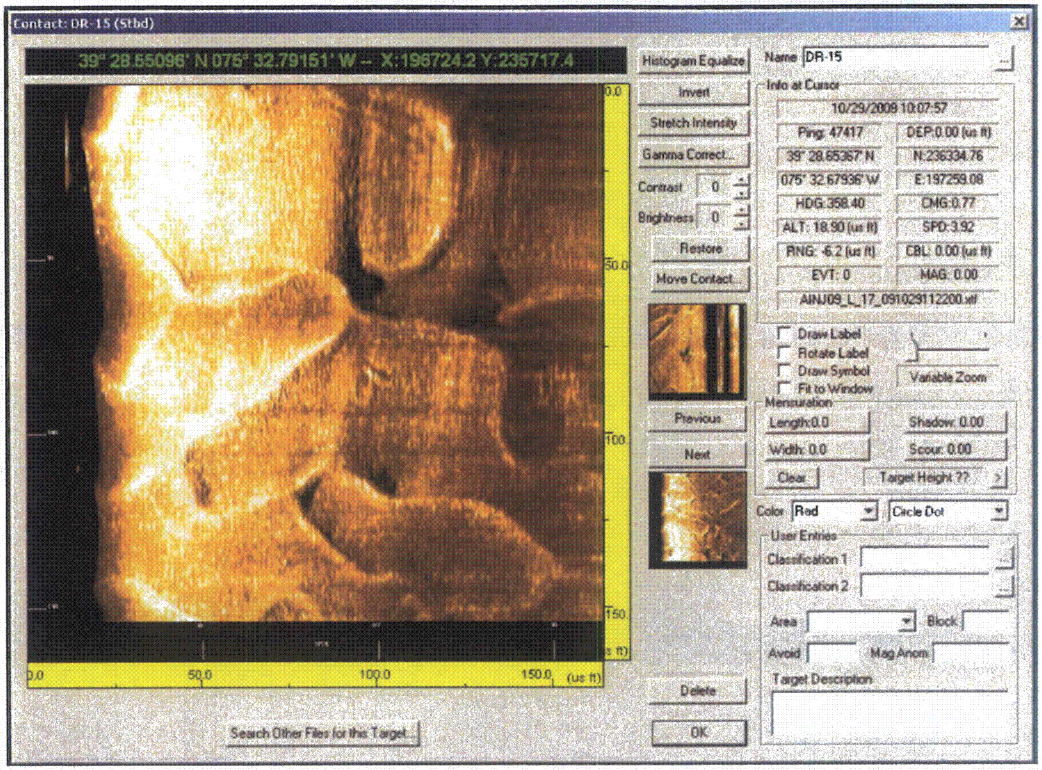
DR-12


Contact: DR-13 (Port)
39° 28.66445' N 075° 32.70165' W – X:197155.0 Y:236401.4
Histogram Equalize
Invert
Stretch Intensity
Gamma Correct...
Contrast 0
Brightness 0
Restore
Move Contact...
Previous
Next
Delete
OK
Search Other Files for this Target...
Name DR-13
Info at Cursor
10/29/2009 10:08:03
Ping: 47500
DEP:0.00 (us ft)
39° 28.65981' N
N:236372.06
075° 32.67981' W
E:197257.44
HDG:1.80
CMG:0.17
ALT: 18.26 (us ft)
SPD:3.94
RNG: -8.1 (us ft)
CBL: 0.00 (us ft)
EVT: 0
MAG: 0.00
AINJ09_L_8_091029100300.xtf
Draw Label
Rotate Label
Draw Symbol
Fit to Window
Variable Zoom
Mensuration
Length:0.0
Shadow: 0.00
Width: 0.0
Scour: 0.00
Clear
Target Height ??
Color Red
Circle Dot
User Entries
Classification 1
Classification 2
Area
Block
Avoid
Mag Anom
Target Description
0.0
50.0
100.0
150.0
(us ft)

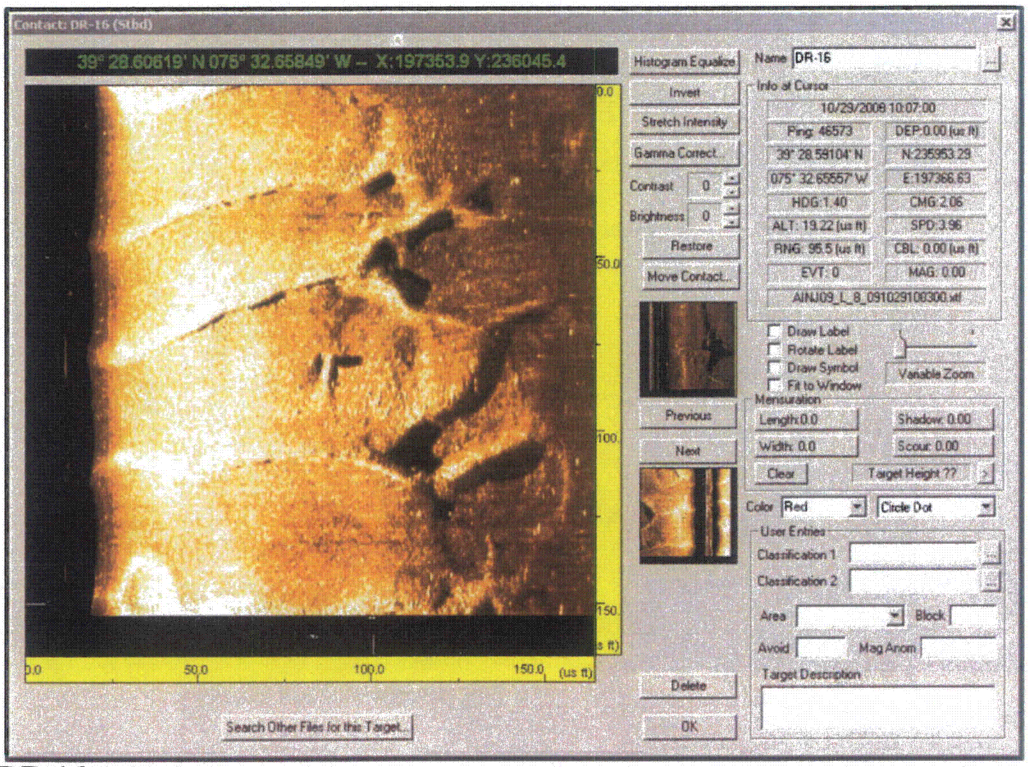
DR-13


Contact: DR-14 (Stbd)
39° 28.93565' N 075° 32.68277' W – X:197262.9 Y:238047.9
Histogram Equalize
Invert
Stretch Intensity
Gamma Correct...
Contrast 0
Brightness 0
Restore
Move Contact...
Previous
Next
Delete
OK
Search Other Files for this Target...
Name DR-14
Info at Cursor
10/29/2009 13:45:33
Ping: 244906
DEP:0.00 (us ft)
39° 28.93367' N
N:238034.16
075° 32.67292' W
E:197309.12
HDG:4.30
CMG:4.35
ALT: 18.84 (us ft)
SPD:3.94
RNG: 87.0 (us ft)
CBL: 0.00 (us ft)
EVT: 0
MAG: 0.00
AINJ09_L_Wreck_091029134300.xtf
Draw Label
Rotate Label
Draw Symbol
Fit to Window
Variable Zoom
Mensuration
Length:0.0
Shadow: 0.00
Width: 0.0
Scour: 0.00
Clear
Target Height ??
Color Red
Circle Dot
User Entries
Classification 1
Classification 2
Area
Block
Avoid
Mag Anom
Target Description
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
(us ft)

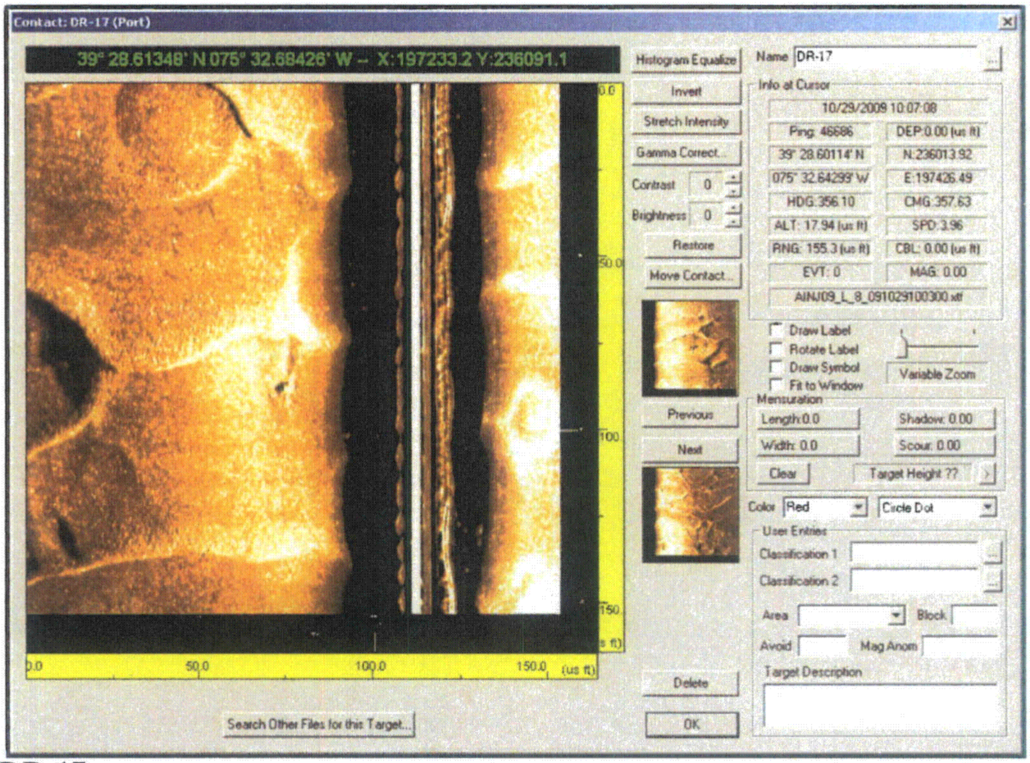
DR-14


Contact: DR-15 (Stbd)
39° 28.55096' N 075° 32.79151' W -- X:196724.2 Y:235717.4
Histogram Equalize
Invert
Stretch Intensity
Gamma Correct...
Contrast 0
Brightness 0
Restore
Move Contact...
Previous
Next
Delete
OK
Search Other Files for this Target...
Name DR-15
Info at Cursor
10/29/2009 10:07:57
Ping: 47417
DEP:0.00 (us ft)
39° 28.65367' N
N:236334.76
075° 32.67936' W
E:197259.08
HDG:358.40
CMG:0.77
ALT: 18.90 (us ft)
SPD:3.92
RNG: -6.2 (us ft)
CBL: 0.00 (us ft)
EVT: 0
MAG: 0.00
AINJ09_L_17_091029112200.xtf
Draw Label
Rotate Label
Draw Symbol
Fit to Window
Variable Zoom
Mensuration
Length:0.0
Shadow: 0.00
Width: 0.0
Scour: 0.00
Clear
Target Height ??
Color Red
Circle Dot
User Entries
Classification 1
Classification 2
Area
Block
Avoid
Mag Anom
Target Description
0.0
50.0
100.0
150.0
(us ft)

DR-15


Contact: DR-16 (Stbd)
39° 28.60619' N 075° 32.65849' W -- X:197353.9 Y:236045.4
Histogram Equalize
Invert
Stretch Intensity
Gamma Correct...
Contrast 0
Brightness 0
Restore
Move Contact...
Previous
Next
Delete
OK
Search Other Files for this Target...
Name DR-16
Info at Cursor
10/29/2009 10:07:00
Ping: 46573
DEP:0.00 (us ft)
39° 28.59104' N
N:235953.29
075° 32.65557' W
E:197366.63
HDG:1.40
CMG:2.06
ALT: 19.22 (us ft)
SPD:3.96
RNG: 95.5 (us ft)
CBL: 0.00 (us ft)
EVT: 0
MAG: 0.00
AINJ09_L_8_091029108300.xtf
Draw Label
Rotate Label
Draw Symbol
Fit to Window
Variable Zoom
Mensuration
Length:0.0
Shadow: 0.00
Width: 0.0
Scour: 0.00
Clear
Target Height ??
Color Red
Circle Dot
User Entries
Classification 1
Classification 2
Area
Block
Avoid
Mag Anom
Target Description
0.0
50.0
100.0
150.0
(us ft)

DR-16


Contact: DR-17 (Port)
39° 28.61348' N 075° 32.68426' W -- X:197233.2 Y:236091.1
Histogram Equalize
Invert
Stretch Intensity
Gamma Correct...
Contrast 0
Brightness 0
Restore
Move Contact...
Previous
Next
Delete
OK
Search Other Files for this Target...
Name DR-17
Info at Cursor
10/29/2009 10:07:08
Ping: 46686
DEP:0.00 (us ft)
39° 28.60114' N
N:236013.92
075° 32.64299' W
E:197426.49
HDG:356.10
CMG:357.63
ALT: 17.94 (us ft)
SPD:3.96
RNG: 155.3 (us ft)
CBL: 0.00 (us ft)
EVT: 0
MAG: 0.00
AINJ09_L_8_091029100300.xtf
Draw Label
Rotate Label
Draw Symbol
Fit to Window
Variable Zoom
Mensuration
Length:0.0
Shadow: 0.00
Width: 0.0
Scour: 0.00
Clear
Target Height ??
Color Red
Circle Dot
User Entries
Classification 1
Classification 2
Area
Block
Avoid
Mag Anom
Target Description
50.0
100.0
150.0
(us ft)
DR-17

Enclosure 11

NJ HPO letter HPO-A2010-343, January 29, 2010

State of New Jersey

DEPARTMENT OF ENVIRONMENTAL PROTECTION
NATURAL & HISTORIC RESOURCES, HISTORIC PRESERVATION OFFICE
P.O. Box 404, Trenton, NJ 08625-0404
TEL: (609) 984-0176 FAX: (609) 984-0578
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CHRIS CHRISTIE
Governor

KIM GUADAGNO
Lt. Governor

BOB MARTIN
Acting Commissioner

January 29, 2010

Jeffrey J. Pantazes
PSE&G Power LLC
Nuclear Development
244 Chestnut Street
Salem, New Jersey 08079

Dear Mr. Pantazes:

As Deputy State Historic Preservation Officer for New Jersey, in accordance with 36 CFR Part 800: Protection of Historic Properties, as published in the *Federal Register* on December 12, 2000 (65 FR 77725-77739) and amended on July 6, 2004 (69 FR 40544-40555), I am providing continuing consultation comments for the following proposed undertaking:

Salem County, Lower Alloways Creek Township
Submerged Cultural Resources Survey Report
Early Site Permit Application
Proposed Hope Creek/Salem Nuclear Power Station Expansion
Federal Energy Regulatory Commission

These consultation comments are in response to the following submitted cultural resource reports received at the Historic Preservation Office (HPO) on January 11, 2010:

James, Stephen R. Jr., Michael Murray, and Gordon P. Watts
December, 2009 *(Draft) Submerged Cultural Resources Survey of a Proposed Barge Facility and Water Intake, PSEG Early Site Permit Environmental Review, Delaware River, Salem, New Jersey.* Prepared for PSEG Power, LLC. Prepared by Panamerican Consultants, Inc., Memphis, TN.

800.4 Identifying Historic Properties

The above-referenced Phase I-level underwater archaeological survey identified 84 magnetic anomalies and 17 sidescan sonar targets within the area of potential effects (APE) for the proposed barge facility and water intake locations. The report states four clusters of magnetic and/or sidescan targets (Clusters 1, 2, 3, & 4) possess signatures strongly suggestive of shipwreck remains on the floor of the Delaware River. The report recommends Clusters 1, 2, 3 and 4 are avoided by project impacts. If impacts cannot be avoided, the report recommends a Phase II-level underwater archaeological survey to assess the eligibility potential of each cluster for listing on the National Register of Historic Places. The HPO *concurs* with this assessment.

For the potential shipwreck sites (clusters) to be avoided by project impacts, the cultural resources consultant shall develop a program of avoidance with buffer area free of navigation, river floor disturbance and anchor drag lines to be incorporated into project documents. For potential wreck sites that cannot be avoided, Phase II underwater survey will provide for evaluation of the National Register eligibility of the site(s) and assessment of project impacts. For properties on or eligible for National Register inclusion, recommendations must be provided for avoidance of impacts. If impacts cannot be avoided, analyses must be provided exploring alternatives to minimize and/or mitigate impacts. Means to avoid, minimize and/or mitigate impacts to National Register eligible properties will need to be developed and undertaken prior to project implementation.

All phases of the archaeological survey and reporting will need to be in keeping with the Secretary of the Interior's *Standards and Guidelines for Archeology and Historic Preservation*, and the HPO's *Guidelines for Phase I Archaeological Investigations: Identification of Archaeological Resources* and *Guidelines for Preparing Cultural Resources Management Archaeological Reports Submitted to the Historic Preservation Office*. These guidelines can be obtained through the HPO's web page (http://www.nj.gov/dep/hpo/1identify/survarkeo.htm). Evaluations to determine the National Register eligibility of archaeological sites must be in keeping with the National Park Service's 2000 National Register Bulletin, *Guidelines for Evaluating and Registering Archeological Properties*. The individual(s) conducting the work will need to meet the relevant Secretary of the Interior's Professional Qualifications Standards for archaeology (48 FR 44738-9).

Additional Comments

Thank you again for providing this opportunity for review and comment on the potential for the above-referenced undertaking to affect historic properties. We look forward to continued consultation on this undertaking. If you have any questions, please feel free to contact Vincent Maresca of my staff at (609) 633-2395 with questions regarding archaeology or Meghan Baratta (609-292-1253) with questions regarding historic architecture, historic districts, or historic landscapes.

Sincerely,

Daniel D. Saunders,
Deputy State Historic
Preservation Officer

c: Molly McDonald, AKRF