Near Shore Remote Sensing Survey of the Arverne and Edgemere Areas

East Rockaway Inlet and Jamaica Bay Integrated Hurricane Sandy General Reevaluation Report, New York

Contract No. W912DS-18-D-0007
Order No. W912DS-20-F-0093

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February 2021

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Abstract

This report presents the results of the Near Shore Remote Sensing of the Arverne and Edgemere Areas in Connection with the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Integrated Hurricane Sandy General Reevaluation Report, New York. The remote sensing survey of the Area of Potential Effects (APE) for the Arverne and Edgemere Areas was conducted by a team from Dolan Research, Inc. (Dolan Research) under the direction of Lee Cox on September 23, 2020. The remote sensing survey simultaneously collected magnetic, acoustic, sub-bottom, and bathymetric data. The purpose of the survey was to locate, identify, and preliminarily assess the significance of potential submerged cultural resources that might be impacted during construction activities in the Arverne and Edgemere Areas. The underwater survey was designed to generate sufficient magnetic and acoustic remote sensing data to identify anomalies suggestive of potential submerged cultural resources. Analysis of the remote sensing data aimed to isolate targets of potential historical significance that might require further investigation or avoidance. The analysis of results was carried out by Dolan Research in conjunction with the Research and Archaeology staff of the Lake Champlain Maritime Museum (LCMM) and First Environment, Inc. (First Environment).

The remote sensing data upon which this survey was conducted examined approximately 50.6 hectares (125 acres) of sea floor in the three underwater study areas for the project. At Arverne East, 8.9 hectares (22 acres) were examined. At Arverne West, 34.3 hectares (60 acres) were examined, and at Edgemere, 17.4 hectares (43 acres) were examined.

A total of 66 targets were identified in the remote sensing data sets across the three project areas. Seventeen of those targets generated signatures that were suggestive of man-made features and comprised dimensions that could be attributed to potentially significant submerged cultural resource sites, 2 in the Edgemere Project Area, 10 in the Arverne East Project Area, and 5 in the Arverne West Project Area.

LCMM offers the following conclusions and recommendations for the three project areas within the APE for the underwater portion of the project:

1. Analysis of the side-scan sonar, magnetometer, and sub-bottom profiler data indicate that there are 17 submerged archaeological or historic resources within the APE for the project.
2. Avoidance is recommended for all 17 of the potentially significant sites.
3. If avoidance is not an option at these 17 locations, additional Phase IB underwater archaeological investigations are recommended at these potentially significant remote sensing target locations.
4. No further archaeological examination is required of the 49 targets that were not determined to be significant.
5. Should additional work outside of the defined APE be proposed during the development of this project, LCMM notes that additional archaeological assessment may be required. Therefore, LCMM recommends that it, or other CRM professionals, review any adjustments to the APE that may fall outside of the current underwater study area. Additionally, the results of any additional remote sensing studies that may be conducted during the course of the project should be reviewed to ensure that any as yet unidentified shipwrecks or underwater archaeological resources that are revealed can be avoided.

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1.0 Introduction

This report presents the results of the Near Shore Remote Sensing Survey of the Arverne and Edgemere Areas in Connection with the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay Integrated Hurricane Sandy General Reevaluation Report, New York.

1.1 Project Description

The East Rockaway Inlet to Rockaway Inlet project area consists of the Atlantic Shorefront Component, which includes approximately six miles of shorefront on the Rockaway Peninsula entirely within the Borough of Queens, New York City (NYC), and the Jamaica Bay Component, which includes three separate areas where High Frequency Flood Risk Reduction Features (HFFRRFs) are planned. The Edgemere HFFRRF Area is located in Mid-Rockaway in Edgemere, New York in Queens Borough along the bayshore between Beach 35th Street and Beach 51st Street. The Arverne HFFRRF is located in Arverne, New York, in Queens Borough along the bayshore between Beach 58th Street and Beach 75th Street. Finally, the Hammels Area is located in Mid-Rockaway along the bayshore between Beach 77th Street and Beach 88th Street.

The proposed bayside work features a series of floodwalls, berms, pumps, and nature-based features to prevent flooding to the backbay areas. Construction of these HFFRRFs has the potential to adversely affect existing cultural resources in the area. The sand used for the Atlantic Shoreline features will come from three borrow areas along the Atlantic shoreline. Borrow Areas A-West and A-East have been surveyed and a few anomalies were identified, and B-West has not been previously investigated.

The purpose of the current Phase I underwater archaeological investigation was to locate, identify, and preliminarily assess the significance of potential submerged cultural resources that might be impacted during construction activities in the area of the Arverne and Edgemere HFFRRFs. This remote sensing survey simultaneously collected magnetic, acoustic, sub-bottom, and bathymetric data. The underwater survey was designed to generate sufficient magnetic and acoustic remote sensing data to identify anomalies suggestive of potential submerged cultural resources. Analysis of the remote sensing data aimed to isolate targets of potential historical significance that might require further investigation or avoidance.

1.2 Project Location and Description

The Area of Potential Effect (APE) includes three separate areas where HFFRRFs are planned to be built along several shorelines in Jamaica Bay, Queens Borough, New York. The Arverne HFFRRF has two sections (West and East) and is in Arverne, New York, along the Jamaica Bayshore between Beach 58th Street and Beach 75th Street. The Arverne East Project Area transects an active commercial marina (Marina 59) at the south end of that project area. The Edgemere HFFRRF is in Mid-Rockaway in Edgemere, New York, along the Jamaica Bayshore between Beach 35th Street and Beach 51st Street. A network of wood pilings from an abandoned marina is present at the west end of the Edgemere Project Area. The boundaries for the remote sensing survey of the defined APE are shown in Figure 1. The spatial limits of these three project areas were provided by the U.S. Army Corps of Engineers, New York District.

All three project areas are in the tidal zone and water depth (mean low water) ranged from less than two feet (0.6m) along the shorelines to more than 50 feet (15.2m) in a small part of the Edgemere Project Area. Water depths in the Arverne East Project Area were consistently deep (> 15 feet (4.5m) across most of the Project Area.

1.3 Report Organization

This report contains five chapters, a bibliography, and three appendices. Chapter 1 contains introductory and background information pertinent to the project. Chapter 2 presents the maritime context, prehistoric, and historic background for the project area. Chapter 3 presents the methodological approaches used to gather and analyze data for this Phase I underwater archaeological investigation. Chapter 4 presents the results of the survey and data analysis, and Chapter 5 presents a summary of findings and recommendations for this Phase I underwater archaeological investigation. The Bibliography presents the sources that were referenced in the production of this report. Appendix 1 contains resumes of key project team members. Appendix 2

presents the Survey Vessel Set Up Sheet. Appendix 3 presents details on the remote sensing equipment used in this survey.

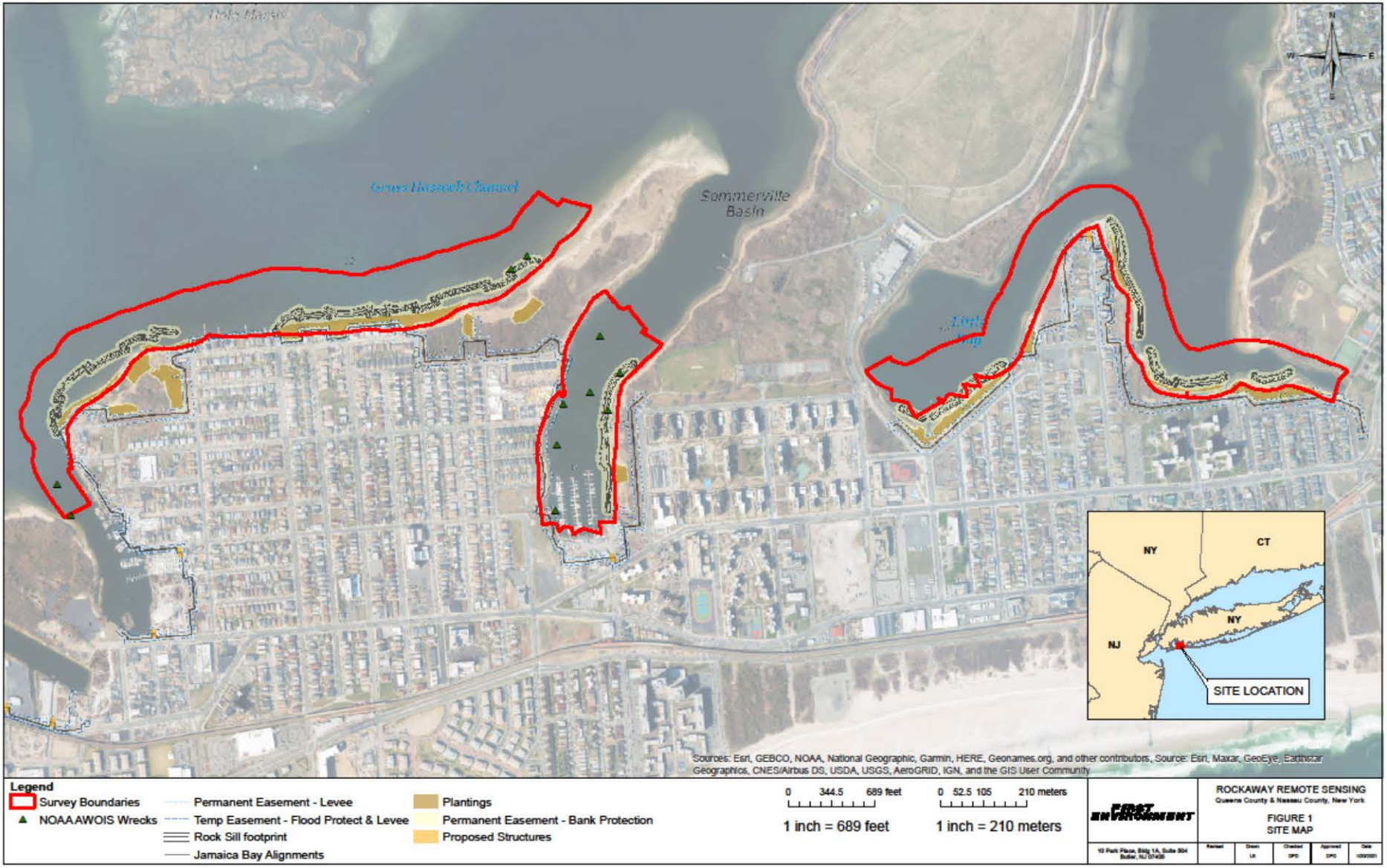

Figure 1. Project Locations of the Edgemere and Arverne (West and East) Near Shore Remote Sensing Survey Areas. Includes NOAA AWOIS Wrecks.

2.0 Historic Context

2.1 Geologic Background

Potential resources that may be encountered in the Near Shore remote sensing areas of Arverne and Edgemere include historic shipwrecks and submerged prehistoric sites. While encountering shipwreck sites in this area has high potential, the probability for finding submerged prehistoric sites within the project areas of Jamaica Bay is low to moderate. Undocumented shipwreck sites can be discovered in a project area using remote sensing equipment; however, submerged prehistoric sites are not conclusively identified in this manner. Instead, predictive models for regional locations of prehistoric sites are created generally based on landscape features such as proximity to water and other resources, and low to no slope of the land. Remote sensing technologies can help to capture features such as paleochannels and the progression of glaciofluvial movements from the Pleistocene epoch to the estuarine sedimentary deposits of the early Holocene. These features may clarify which areas, now submerged, may have been utilized by humans when the land was exposed (Panamerican Consultants, Inc., 2005; Panamerican Consultants, Inc., 2020; Schwab et al., 2000; Schwab et al., 2000).

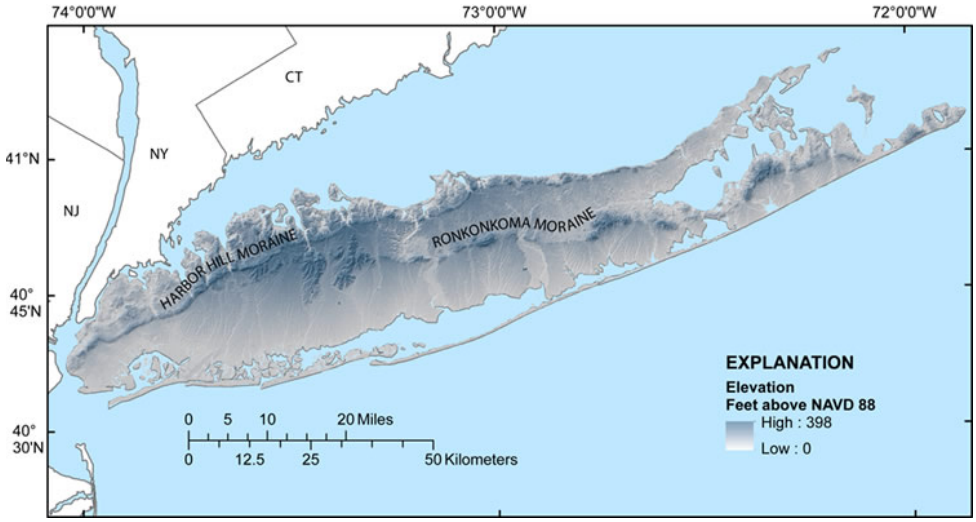

Figure 2. Harbor Hill Moraine and Ronkonkoma Moraine, Courtesy of wikipedia.org.

The Ronkonkoma Moraine and the Harbor Hill Moraine generally run east to west across present day Long Island, as seen in Figure 2. The Ronkonkoma Moraine formed during the Pleistocene epoch, early in the Wisconsin Stage, while the Harbor Hill Moraine represents the last glacial maximum of the Wisconsin Stage glacier and the most recent advance of the last glacier in this region about 20,000 years before present (Schuldenrein et al., 2014:54; Stoffer and Messina, 1996). By the Holocene, this glacier was likely melted completely, the gravel, rock, and sand moved by the runoff was deposited on the expansive outwash plain to the coast and the edge of the continental shelf. The sediments that make up this outwash plain are unconsolidated deposits of materials from the Cretaceous period through the present day, resting on a deep crystalline bedrock floor. The southern ocean facing shore of Long Island also resets upon many deposits of unconsolidated sediments and bedrock, with surface materials beach and wind-blown, medium to course gained sands containing shell fragments (Panamerican Consultants, Inc., 2004:2-1). Jamaica Bay and Rockaway Beach are some of the many lagoonal systems in this region that lie across the extent of the southern shore of Long Beach Island, formed from the barrier the island mass creates with the ocean and the changing sea levels over time. The salt marsh deposits that make up Jamaica Bay are fairly recent in geological time, with large portions of these deposits covered over by 20th century landfill deposits (Panamerican Consultants, Inc., 2004:2-2).

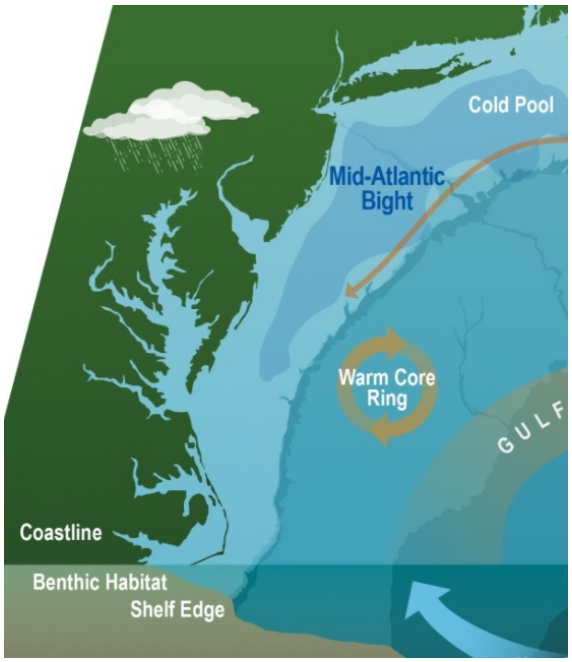

Figure 3. Mid Atlantic Bight, Courtesy of

https://www.integratedecosystemassessment.noaa.gov/regions/northeast/mid-atlantic-bight.

The Near Shore remote sensing areas in Arverne and Edgemere within Jamaica Bay all lie within the prehistoric outwash plains of the Ronkonkoma and Harbor Hill terminal moraines described above. These outwash plains are referred to as the Mid-Atlantic Bight portion of the Continental Shelf, generally delineated in Figure 3. The melting of glaciers in this region contributed to sea level rise and to isostatic rebound of the land, which can be separated into three 'meltwater pulses' between 12,000 and 9,500 years before present. The mid-shelf scarp shown in Figure 4 is likely the shoreline during the Younger Dryas period (12,000- 13,000 years before present), and is largely associated with the drastic expansion of human population into areas previously occupied by glaciers in this region (Panamerican Consultants, Inc., 2020; Stoffer and Messina, 1996).

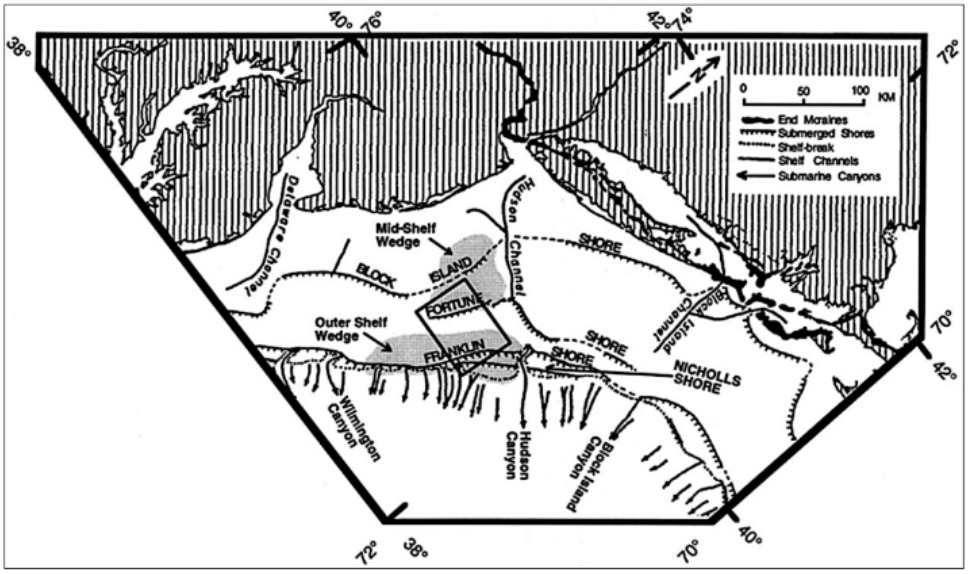

Figure 4. Mid Shelf Scarp and Paleoindian Shorelines of Project Areas, Courtesy of Panamerican Consultants, Inc. 2020:6

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2.2 Paleoenvironment

The Paleoindian shoreline mentioned above as the mid-shelf scarp or wedge is currently about 130 feet (40 m) below sea level. The New York Bight region follows eustatic models of sea rise from the late Pleistocene to the early Holocene, as the hinge line of isostatic response to glacial weight lies to the south of the survey area (Panamerican Consultants, Inc., 2020:4). The shorelines shifted over time, along with the meltwater pulses, especially in the dynamic areas close to the Hudson paleochannel. Because of the massive flooding events through the Hudson paleochannel and the relatively shallow surrounding areas around this outlet, there is the possibility that Jamaica Bay contains ephemeral sites relating to the Paleoindian, Archaic, Woodland, and European Contact periods.

Sea rise levels for the New York Bight area, between 12,000 to 10,000 years before present, began to inundate the Continental Shelf along with any present evidence of human occupation. The habitable coastal outwash plains of this region stretched about 60 miles (97km) across the Continental Shelf during the Paleoindian period. By 9,000 years before present, this area shrunk to a 10-mile (16km) outwash plain and by 6,000 years before present, sea levels were close to present day levels (Schuldenrein et al., 2014: 25-27).

Examples of Paleoindian features that could be encountered include weir features from the lee of paleobarrier features or midden deposits in close proximity to paleochannels. Other maritime elements of prehistoric cultural material from this region include watercraft and fishing technology elements, though preservation of organics such as bone, leather, or wood have a low chance of surviving in the turbulent, acidic environment of coastal areas of this region (Merwin, 2019: 85). In 1994, the Sea Bright Borrow Area dredging site used to fortify part of Monmouth Beach, New Jersey was found to contain prehistoric artifacts dating from the Early to Late Archaic period (Panamerican Consultants, Inc., 2020: 8-9). The Corcione Collection was collected from the Monmouth Beach site where sediments from the Sea Bright Borrow Area were deposited. The collection contains over 200 stone artifacts, making this one of the largest prehistoric collections to be recovered offshore in eastern North American. The Sea Bright Borrow Area dredging site is within 15-20 miles (24-32km) southwest of the nearshore Arverne and Edgemere project areas. Additionally, Pleistocene animal remains, such as Mastodon elements, have been recovered by fishing trawlers in other nearby offshore locations, indicating that this region was exposed and utilized by humans and the animals they hunted. Due to the stabilization that occurred around 6,000 years before present, where sea levels reached present day levels, there are more data available for Late Archaic sites in nearshore areas than those of Paleoindian and Early Archaic sites that have since been inundated.

Sea level rise in this area resulted in specific sedimentation patterns that are well documented regionally for areas like the New York Bight, but not well defined for smaller localities such as Jamaica Bay (Merwin, 2019: 83; Schuldenrein et al., 2014:26). Additionally, historic era modifications to the landscape in Jamaica Bay has likely destroyed prehistoric sites, resulting in the absence of a material record for prehistoric occupation (Merwin, 2019: 83; Schuldenrein et al., 2014: 28). In predictive models for earlier sites, location and abundance are largely guided by the changing geomorphic environment described above, while later period models and trends are guided more by variable subsistence practices (Schuldenrein et al., 2014: 28).

The New York Bight region during the Late Pleistocene was mostly boreal forest, with mainly coniferous trees such as spruce. During the Holocene between 8,000 to 10,000 years before present, pines almost completely replaced the spruce trees, indicating the warming of the climate in the area; and around 4,000 years before present, oaks made up about 50 percent of the now deciduous forests (Merwin, 2019: 83). These changes in forestation of the region also meant a change in available animal and plant resources for people throughout time. Further, regional maritime adaptations would also be dependent on available resources of the surrounding environment through time (Panamerican Consultants, Inc., 2004: 3-1 to 3-2).

2.3 Prehistoric Cultural History

The potential range of prehistoric human occupation of the survey areas extend from pre-Clovis through Woodland culture groups, and potentially extending through to European Contact. Pre-Clovis assertions in other areas may be used to infer the presence of humans in this region before the Last Glacial Maximum retreated and therefore likely through the transition phases of melting (Panamerican Consultants, Inc., 2020:13-14). Clovis-era material culture is largely associated with the diagnostic fluted point technology as well as other chipped-stone tools dating to the Late Pleistocene, documented across eastern North America in

abundance. Most evidence of Paleoindian sites are isolated finds of projectile points, but likely the most thoroughly studied Paleoindian site from the greater New York Bight area is the Shawnee-Minisink site in eastern Pennsylvania (Merwin, 2019: 86).

The earliest Archaic sites are accepted as a continuation of Clovis technology and culture through the change of points to notched projectiles from the former lanceolate varieties, and people continued to function in the same smaller, migratory bands or groups, gathering plant foods and resources and hunting game (Panamerican Consultants, Inc., 2004: 3-3; Panamerican Consultants, Inc., 2020:15). Rising sea levels at this time pushed back available areas for human occupation and inundated existing sites. Stone tool technologies of the Early Archaic period include corner-notched, stemmed, and bifurcate varieties with some serrated edges, and a marked shift in preference of raw materials to favor non-cryptocrystallin stones such as argillite (Panamerican Consultants, Inc., 2004: 3-3 to 3-4; Panamerican Consultants, Inc., 2020:15).

Middle Archaic sites, dated between 8,500 to 5,000 years before present, have been more abundantly located, showing diagnostic differences in both bifurcated and stemmed point technologies as well as groundstone tools from the earlier period. Middle Archaic sites are generally larger and often had multiple uses. It is sometimes difficult to discern Late Archaic sites from Middle Archaic based on material culture alone; however, these later sites are often larger indicating an increase of people as well as indications of longer length of stay at sites (Panamerican Consultants, Inc., 2020: 15). Based on more inland studies of this time period in current New York State, human populations in the region rose significantly during the Middle to Late Archaic period; and during the latter, sea levels rose to modern coastline levels (Merwin, 2019: 87-88). Because sea levels have remained about the same since this last rise, Woodland sites are not expected on the Continental Shelf as Paleoindian and Archaic sites are, but instead would only be present in near-present day shore areas (Merwin, 2019: 89). It should be noted that archaeological sites along modern coastlines are in danger of being submerged from current sea level rise (Merwin, 2019: 89).

The shift from Late Archaic to Early Woodland is generally marked by a transition towards horticulture subsistence strategy in addition to the hunting and gathering pattern, as well as the appearance of ceramics (Schuldenrein, 2014:114, 127-128). The Early to Late Woodland period spans from 3,000 years before present up to European Contact. The Transitional period between Late Woodland and European Contact is sometimes dated locally by the presence of the Classons Point phase of East River tradition, with other material culture including site locations at higher elevations to avoid tidal surges, shell-tempered pottery, and European trade goods (Schuldenrein, 2014: 128).

Around the time of contact, the coastal regions of New England were densely populated with indigenous peoples from a myriad of ethnically diverse backgrounds. Although these people are often described under larger European-derived umbrella-terms, it should be noted that these umbrella associations do not always align with the histories that Native descendent communities know, nor do they often account for the level of diversity among the groups placed under single umbrellas. Present day New York Harbor was a main hub of cultural contact and osmosis between many ethnically diverse Native American groups and newly arrived Europeans beginning in the early 16th century.

The Cultural Resources Information System (CRIS) for New York State (NYS) shows 11 prehistoric sites within about a 10-mile (16km) radius from the nearshore project areas within Jamaica Bay. Of those prehistoric sites, five are associated with known Canarsie village sites, including burials, and are dated either to Late Woodland through European Contact or were left undated. Of the six remaining prehistoric sites within a 10-mile (16km) radius of the nearshore project areas, one is dated Late Archaic to Contact, one more contains a burial dating to the Late Woodland period, three more contained projectile points dating from the Middle to Late Woodland Period, and one final prehistoric site was left undated (CRIS). All of these prehistoric sites lie above the northeast shore of Jamaica Bay. Additionally, a 2014 study of Jamaica Bay and surrounding areas, deemed Jamaica bay to have moderate archaeological sensitivity. The salt marshes in Jamaica Bay were formed less than 1,000 years ago and they are not back barrier salt marshes seen in surrounding areas like South Oyster Bay. This study also concludes that the area of Jamaica Bay would have been available for human occupation beginning during the Paleoindian period and extending into the Woodland period (Schuldenrein et al., 2014: 144, Figure 9-1).

2.4 General History of Project Area

While the state of New York has been settled for several thousand years by various ethnically diverse Native American groups, the general history of the project area is primarily focused on an abbreviated background of the region since European settlement. With the "discovery" of the region by the Italian explorer Giovanni da Verrazano in 1524 and the subsequent colonization by the Dutch in the 17th century, New York slowly grew and prospered primarily through trade (Workers of the Writer's Program of the Works Projects Administration for the City of New York. 2004:22; Panamerican. 2020:15, 19). With the seizure of the colony by the British in the late 17th century, the settlements in New York further grew. Through periods of intermittent warfare, the event of the American Revolution, and the founding of the United States in the late 18th century, the region expanded further and continued to prosper in trade. The development of inter-regional railways, canals, and trans-Atlantic routes further changed New York, and by the late 19th and early 20th centuries, the state became one of the most important hubs for global commerce. Today, New York State continues to develop as one of the leading industrial and financial centers in the United States.

Europe's first exposure to New York was during the voyages of Giovanni da Verrazano, an Italian from Florence sailing for Francois I, the king of France. Sailing from Europe in 1524 to chart a route to China, he ended up on the eastern coast of what is now the continent of North America. Verrazano traveled far enough north and east to enter New York Bay to reconnoiter the region before continuing his voyage back to France. However, the French did not follow up on Verrazano's discovery which left the area open to exploration by the Dutch in the 17th century. (Workers of the Writer's Program of the Works Projects Administration for the City of New York, 2004:22-23).

Henry Hudson, an Englishman in the employ of the Dutch East India Company, was the next European after Verrazano to travel into the New York region from the Atlantic Ocean. Working with the Dutch, Hudson and his fellow settlers laid claim to the region and founded a small colony and trading venture in Manhattan. As a small but established trading post, the Dutch called this region the New Netherlands in 1614 and controlled fur-trading operations throughout the surrounding country. In 1623, the Dutch West India Company took over trading operations of the region, and the town of New Amsterdam was founded in 1625 (Workers of the Writer's Program of the Works Projects Administration for the City of New York, 2004:23-26).

In 1664, the British took control of New Amsterdam from the Dutch, renamed it New York, and established the Port of New York. Resuming trading operations already established by the Dutch, the British Monarchy continued to develop commercial activities in the area as the Atlantic seaboard provided the perfect route for exports going out of the colony and for imports coming in from Europe (Brouwer, 1990:3-13). Flour replaced furs as the main export and was shipped mainly to the West Indies. Well into the 18th century, exports included whale oil, beaver pelts, and some tobacco to England with flour, pork, bread, peas, and horses sent to the West Indies. Imports from England and the West Indies included manufactured goods, rum, molasses, and sugar (Panamerican, 2020:17). Shipping increased considerably by the middle of the 18th century, imports included "fish oil, blubber, whale fins, turpentine, seal skins, hops, cider, bricks, coal, lamp black, wrought iron, tin, brasury [sic], joinery, carriages and chairs." Exports included chocolate, lumber, "and import goods from both the West Indies and Europe" (Panamerican, 2020:17).

Into the 18th century, interior settlements surrounding New York were well populated to support the largescale production of goods for export to the surrounding colonies, and abroad to Europe. Due to the increased trade, the port of New York further expanded with rudimentary, but accessible, interior trade routes connecting to other colonies. There was also an increase in shipbuilding and a need for larger, more economical ships to handle and transport the ever-increasing amount of trade goods. In 1770, New York stood fourth after Philadelphia, Boston, and Charleston among the leading North American ports in total tonnage of imports and exports. Population growth also increased in the region in tandem with the surge in commercial activities (Workers of the Writer's Program of the Works Projects Administration for the City of New York, 2004:45-62; Albion 1984:2-5). However, commerce and trade significantly slowed while the British occupied the state and port during the Revolutionary War. Other events such as the Yellow Fever epidemics of 1795 and 1798, the Embargo Act of 1807, and the shutdown of the port during the War of 1812 further stagnated growth in the region (Panamerican, 2020:19).

As the 19th century progressed and the War of 1812 ended, New York once again began to slowly grow. The development and use of railroads in the state allowed for major rail lines to connect the entire region to the interior of the United States, with 12 rail lines directly provisioning the port of New York with freight service (Workers of the Writer's Program of the Works Projects Administration for the City of New York, 2004:246-247). The opening of the Erie Canal in 1825 contributed to the expansion of commercial activities. The canal connected the western part of the United States in the Great Lakes region to the eastern seaboard along with the Champlain Canal, which connected the Hudson River to the Saint Lawrence seaway in Canada (Whitford, 1922:13-15). Large clipper and packet ships bound for markets in Europe, Asia, and the Western United States contributed to the broader trends of economic development.

In addition to the use of rails and canals, the invention of steam technology and the advancement of ships using steam-power further contributed to the growth of the region. Massive excursion lines such as the Hudson River Day Line allowed for effective and timely service from New York City to cities like Albany on the Hudson River (Ringwald, 1965). Steamships in the late 19th century eventually replaced traditional sailing craft as the primary cargo haulers and immigration transports to the United States. Well into the 20th century steamships became larger and more efficient in oceanic travel until petroleum-powered engines eventually replaced older steam-engine technology. The advent of automobiles and the development of the inter-state roads and highways in New York further expanded the progression of the region. The First World War and eventually the Second World war led to increases in global commerce for the port of New York as well.

By the middle of the 20th century, the state of New York had established itself as a central hub for global commerce. Newer and more economic modes of seaborne transportation, such as the container ship, allowed for goods and materials to be packaged and handled in standardized freight containers. New York State combined the main Atlantic port with New Jersey to become the Port of New York and New Jersey and became one of the most advanced and developed ports in the United States (Brouwer, 1990:54, 204-205). Today, the region of New York is known for its tourism and the iconic city of New York. The Atlantic seaboard of the state continues to serve as one of the busiest ports in the United States with imports and exports constantly flowing through the shared port with the state of New Jersey.

2.5 Maritime History of Project Area

The Maritime History of Rockaway Inlet and the surrounding New York Bay region is diverse and spans from the Paleoindian era to the present day. As a maritime community, the area is known for its commercial activities and fisheries that developed from the early 17th century. While the area and surrounding New York harbors expanded into the 18th and 19th centuries, so too did the use of different types of watercraft. From the simple canoes and early Hudson River sloops, technological development brought the advent of steamboats, canal boats, and trans-Atlantic clipper ships. The infrastructure of the New York ports also developed with rail lines, terminals, wharves, and freight facilities. Well into and throughout the 20th century, the use of lighters, barges, and more modern craft such as oceanic container ships in the port of New York (later known as the Port of New York and New Jersey) dominated the maritime landscape and led to an exponential increase in global commerce. Today, the Port of New York and New Jersey is one of the largest and most technologically advanced ports in the United States.

Figure 5, which depicts one of the first prints of New Amsterdam, hints at the diversity of watercraft used in the regions even during the earliest years of colonization with several canoes in the foreground, a small two-masted sailing vessel in the middle, and three larger square-rigged vessels in the background.

Figure 5. The earliest view of New Amsterdam from a book printed by Joost Hartgen in Amsterdam, 1651, Courtesy of Bank of Manhattan, 1915.

The earliest known maritime commercial activity to take place on the broader New York harbor area started in the early 17th century and focused on the fur trade. The first-known cargo manifest from the vessel *Wapen van Amsterdam* (*Arms of Amsterdam*) clearing port listed 7,246 beaver skins, 852 otter, 48 mink, 36 wildcat, and 34 muskrat pelts, and "many logs of oak and nut wood" (Workers of the Writer's Program of the Works Projects Administration for the City of New York, 2004:34). Based on modern monetary values, the cargo was worth about $25,000.00. The Dutch West India Company maintained a monopoly on the trade and fixed prices on all imports and exports. However, the trade was not as profitable as expected and due to unreasonable maritime regulations imposed by the regional governors, many colonists turned to the occupation of smuggling (Workers of the Writer's Program of the Works Projects Administration for the City of New York, 2004:35). Slavery was another commercial venture for the colony, yet it was not a profitable enterprise for the Dutch colony.

For most of the early part of the 17th century, many of the larger ships operating in the area were built abroad. The vessels were generally owned by the West India Company and ships owned by other interests in Holland (Bank of Manhattan Company, 1915:9-12). While smaller boats were more than likely made in the surrounding region, the first documented large scale shipbuilding venture began in 1631, with the construction of the vessel *Nieuw Nederlandt* (*New Netherland*) on the banks of the East River (Workers of the Writer's Program of the Works Projects Administration for the City of New York, 2004:39). The ship was built much larger than the typical smaller Dutch vessels made for shallow canals and coastal waters of Holland. There are two conflicting accounts of the actual tonnage with one stating the vessel was 600 tons while the other put the ship at 800 tons (Workers of the Writer's Program of the Works Projects Administration for the City of New York, 2004:39). Dutch shipbuilders also constructed coastal sailing vessels such as sloops and ketches given the lack of infrastructure to make larger ocean rated vessels.

By 1664, the British sent a naval flotilla of four men-of-war ships to the colony of New Amsterdam and wrested control of the region from the Dutch (Workers of the Writer's Program of the Works Projects Administration for the City of New York, 2004:44). Given the ineffectiveness of local rule, the Dutch surrendered the colony with no resistance and the area was renamed New York. Under British rule, the colony was opened up to British

trade and interests while supporting continued Dutch commercial ventures. As New York slowly grew, the number of vessels and port activity increased. Statistics from 1683 list three ships, 62 schooners, three barks, 23 sloops, and 41 small boats. By 1696, the number of vessels rose to 60 ships, 62 sloops, 40 square-rigged vessels, and 60 small boats (Hall, 1884:115; Albion, 1984:3; Panamerican, 2020:19-20).

One of the most iconic vessels to be used for trade in the region was the Hudson River sloop. Modified from the original Dutch yacht design used earlier in the 17th century, the Hudson River sloop retained a rounded, full bottom and a characteristic broad beam of most Dutch vessels at the time. The vessel type also had a very light draft, which made it ideal for traveling through the shallows of the Hudson River. The sloop was the standard vessel for transportation and hauling freight between New York and Albany. Also, they were used in coastal commercial trade and passenger service along with shipping to and from the West Indies. By 1771, Hudson River sloops were modified into large, sturdy boats with a record number of 125 being used for service between Albany and New York (Hall, 1884:115).

During the beginning of the 18th century, maritime commercial development was relatively slow. However, many of the settlements within the interior of the surrounding region were profitable in manufacturing exportable goods. Merchants were primarily engaged with trade in the West Indies where provisions were shipped from New York in exchange for products made in the West Indies. In turn, these products were taken to England and exchanged for manufactured goods. Privateering was another lucrative business in New York as many pirates were engaged in slavery, smuggling, and taking the prize of ships (Workers of the Writer's Program of the Works Projects Administration for the City of New York, 2004:53-61).

The industry of shipbuilding and commerce exponentially increased over the years in addition to maritime infrastructure. Docking and shipping facilities were developed, and the number of ship owners and consortiums rose (Workers of the Writer's Program of the Works Projects Administration for the City of New York, 2004:61-62). Leading to an ever-increasing capitalistic market system, the British Monarchy imposed harsh restrictions and taxation. This was a contributing factor leading to the outbreak of the Revolutionary War and by 1775, trade had slowed yet again due to this same issue. During the war, New York was predominantly used as a naval base for the British fleet given its strategic importance and location.

After the end of the Revolutionary War, trade renewed again at the tail end of the 18th century and by 1797 New York had become one of the leading seaports in the world (Panamerican, 2020:20). Through the 19th century, American shipbuilding in New York continued to thrive and newer technology such as steam power was introduced. Represented in Figure 6, the successful test and launch of Robert Fulton's *Hudson River Steam Boat* in 1807 ushered in a new era of maritime commerce. Owning a monopoly on all steamboat production until 1824, Fulton's control was deemed unconstitutional by the United States Supreme Court. This opened up the steamboat business to competing companies and newer and larger vessels (Ringwald, 1965:1-12). By the 1840s, the use of steamboats along the Hudson River and ports of New York was at a peak given the increasing amount of steamers in service (Ringwald, 1965:7).

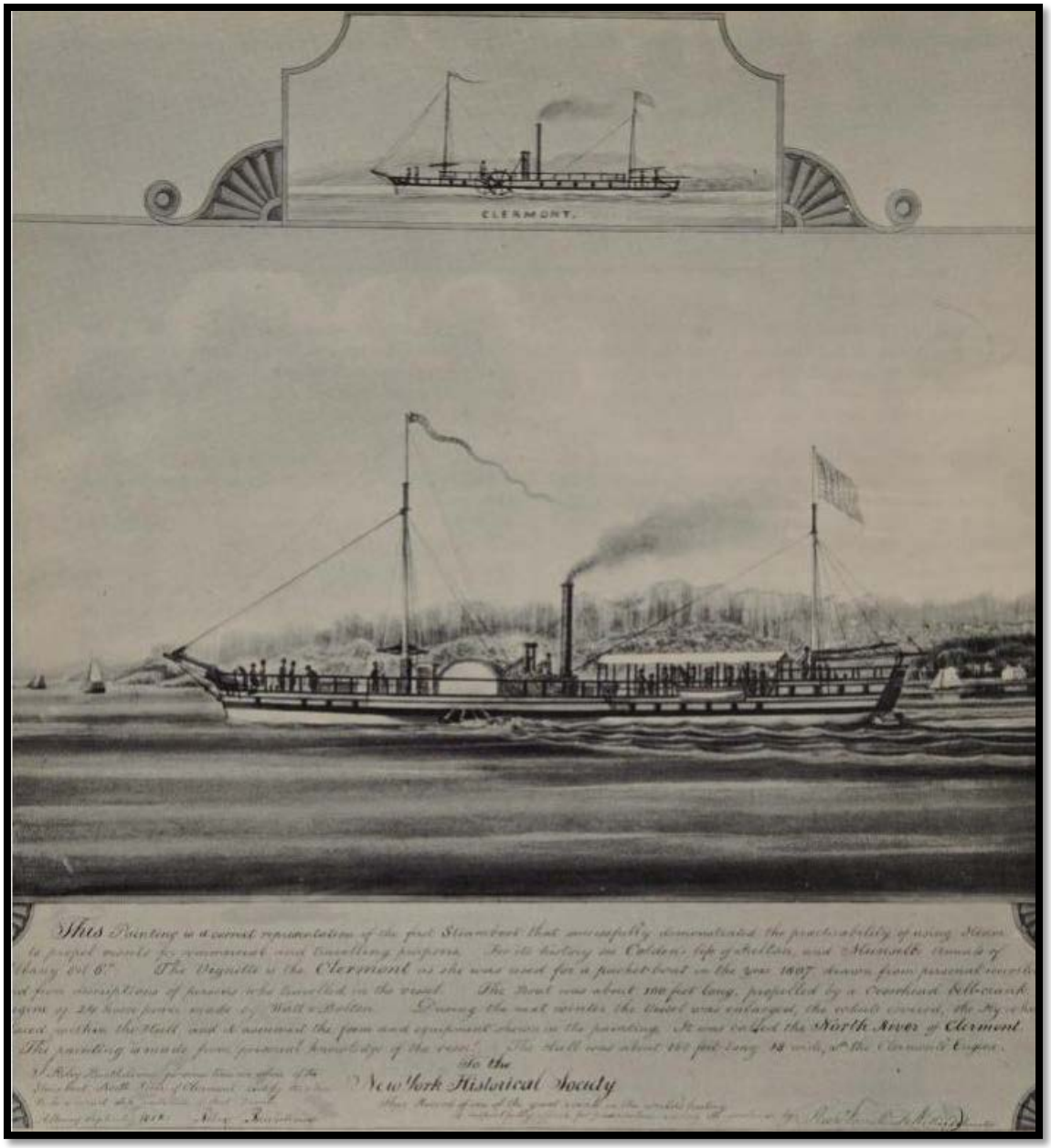


Figure 6. Watercolor painting of *North River Steam Boat* (also known as *Claremont*) by Richard Varick De Witt, 1858, Courtesy of Ringwald 1965.

The opening of the Erie Canal in 1825 contributed to the broadening of marine commercial activities in the ports of New York. The Erie Canal connected the western part of the United States to the eastern seaboard along with the northern connection through the Champlain Canal. Traditional canal boats and sailing canal boats were common vessels seen throughout the ports (Whitford, 1922:13-15). Trans-Atlantic clipper ships and packets bound for markets in Europe, Asia, and the Western United States contributed to the broader trends of economic development as well. By the middle of the 19th century, the ports of New York had radically developed into a bustling hub of trade. Figure 7 depicts a view of New York Harbor in 1849 with several Hudson River steamboats, square-rigged three-masted ships, and smaller sail-rigged vessels, most likely sloops.

Figure 7. View of New York, 1849, Courtesy of the Bank of Manhattan Company 1915.

Other canals constructed in Delaware, Maryland, and Pennsylvania further bolstered commercial activity and maritime transportation through inland waterways connecting to the ports of New York. The Delaware & Raritan Canal brought coal from Pennsylvania to New Brunswick, New Jersey. Canal boats and barges were instrumental in hauling cargoes of coal, with steam tugs acting as towboats for them. Facilitating the increased coal trade into the Upper New York Bay area was the Arthur Kill and Kill Van Kull waterways, which were important corridors for waterborne transportation. The expansion of rail lines and terminals into the region further increased the amount of coal into the maritime ports by the middle and late 19th century (Albion, 1984:134-137).

Historically, the broader New York region and Jamaica Bay, in particular, was known for its fisheries of clams, crabs, and oysters (Bellot, 1917:62). With the various interspersed islands and shallow draft navigable waterways, it is the perfect area for fishing using small watercraft like sloops, canoes, and pettyaugers.[1] After European settlement, the town started to impose restrictions on fishing and the indiscriminate taking of shellfish in a notice from July 1763 stating the following:

> "Whereas divers persons, without any right or license to do so, have of late, with sloops, boats, and other craft, presumed to come to Jamaica bay and taken, destroyed and carried away quantities of clams, mussels, and other fish, to the great damage of said town, this is to give warning to all persons who have no right or liberty that they do forbear to commit any such trespass in the bay in the future; otherwise they will be prosecuted at law for the same by Thomas Cornell, Jr., and Waters Smith. By order of the town" (Bellot, 1917:62).

By 1869, the town adopted measures to further control fishing access to Jamaica Bay by recommending the exclusion of all non-residents from the fisheries in the bay. Stakes and other obstructions illegally standing in the bay and local marshes were to be removed as well. In 1871, the Legislature passed an act that authorized the board of auditors to lease to residents of Jamaica Bay portions of land under the water for planting oysters. Conditions were ascribed for each lease and penalties if any trespass were to occur on leased allotments. However, by the early 20th century the local fishing trade changed with more people fishing for leisure rather than for-profit (Bellot, 1917:63). People also flocked to the area for vacation as the local villages had

[1] A pettyauger is a vessel that is also known as a type of large dugout canoe termed a "periauger." Referenced in the late 18th century journal of Landon Carter, a member of the House of Burgesses and prominent landowner in Virginia, the term pettyauger may be a corrupted version of the word from 1776 that has since been lost. Other examples in the United States at the time are petty augur, pettiaguer, pirogue, and pettiaugre (Wolfe 2011).

prominent summer resorts. Pleasure vessels such as catboats, single-engine motorboats, luxury motor launches, and large excursion steamers were common in the summer months.

Railroads and connecting terminal facilities in the harbors of New York also had an impact on the development of maritime commerce and building in the latter 19th century and well into the 20th century. Twelve rail lines served the port directly with the New York Central having direct access to Manhattan with freight service (Workers of the Writer's Program of the Works Projects Administration for the City of New York, 2004:246-247). Railroad companies servicing the port had to be able to manage outgoing freight, goods, and people to their final destinations via the water. Additionally, incoming cargoes from ocean-going vessels were far greater in tonnage than cargo transported overland. A system of using lighters to transport various merchandise and freight from these vessels to wharves and terminals was devised, primarily using barges with cranes called "stick lighters" as shown in Figure 8. Lighters are defined as a vessel with a deck used to convey freight about harbors or in contiguous waters and consisted of a variety of craft, such as self-propelled barges, tow-assisted barges, sail-equipped craft, and steam-powered tugboats (Harding, 1912:14-15; Panamerican, 2020:21-22).

Figure 8. Stick lighters unloading a ship in New York Harbor in the early 20th century, Courtesy of the New York Lighterage Company.

As the ports of New York developed at the end of the 19th century, the use of clipper ships and sail packets gradually came to an end with the increased use of railways and canals. The opening of the Suez Canal in 1869 had a substantial impact on commercial activity in New York harbors as well. The Suez Canal allowed more direct shipping through the North Atlantic to the Indian Ocean destined for markets in Europe and Asia. The route negated the need for ships to spend more time circumnavigating the dangerous route around Africa (Britannica, 2020). Advancements in steam technology, such as the development of the triple expansion steam engine and the use of screw propellers over paddle wheels, resulted in better and larger steamships rated for ocean service. Ultimately, these factors led to a decline in shipbuilding, especially wooden-hulled vessels, by the end of the century (Brouwer 1990:46; Workers of the Writer's Program of the Works Projects Administration for the City of New York, 2004:154-187).

In the 20th century, the Port of New York was brimming with lighters, ferries, excursion steamboats, and newer steel-hulled ocean liners. The construction of the Barge Canal from 1903 to 1918 allowed newer and larger canal boats and ships to transport goods like grain from the Midwestern states of the U.S. into the Atlantic seaboard. The introduction of the automobile and subsequent highway systems had no real impact on marine

transportation in the harbors until the 1930s when the use of private automobiles took away much of the business of excursion vessels (Brouwer, 1990:51-54). Many of the communities alongside the coastal areas of New York, particularly Rockaway Inlet and Jamaica Bay, established summer resorts. These resorts drew thousands of people from the region to the various beaches and boardwalks that lined the Atlantic Ocean (Panamerican, 2020:23-31). Recreational boating and fishing became in vogue, where rowboats, sailboats, and petroleum-powered motorboats were common craft seen in the area.

Both the First and Second World Wars briefly brought increases in commercial activity and modern shipbuilding. However, by 1950 much of the impetus driving these activities fell. The development of container ships and their modern counterparts led to the construction of new terminals and infrastructure adapted to handling standardized freight containers. Container ships could easily and quickly transfer their cargos to trains, trucks, and specialized ships (Brouwer, 1990:54, 204-205). The area also incorporated the harbors of New Jersey and became known as the Port of New York and New Jersey. The use of lighters gradually slowed and ultimately ceased by 1976 as they could not compete with the containership trade. Much of these vessels and other vessels related to the lighterage system were deposited and abandoned in derelict areas and shorelines around the entire Port of New York and New Jersey (Panamerican, 2020:22).

Today, the Port of New York and New Jersey is the third busiest port in the United States (The Port Authority of New York and New Jersey, 2020). Infrastructure improvements continue to be made as commercial activity is propelled by the containership trade. Much of the area is littered with the remains of ship graveyards where the practice of ship abandonment was instituted for the deposition of unwanted vessels and scrapped ships. Most notable are the Arthur Kill and Kill Van Kull areas, which are ripe with abandoned vessels primarily dating to the late 19th century and throughout the 20th century (Raber et al, 1995). However, given the historic use of the area, there is the potential to find earlier vintage vessels from the 18th century. Additionally, there is a list of known vessels that have foundered and wrecked from East Rockaway Inlet to Jones Inlet (Panamerican 2020:60-72).

2.6 History of Rockaway

From 1624 to 1664, western Long Island, Manhattan, and parts of the Hudson Valley were part of New Netherlands and controlled by the Dutch West India Company. In 1664, James the Duke of York sent Colonel Richard Nichols to seize the colony whereupon New Netherlands came under English rule. Despite the availability of the bay for travel, early travelers did not use the waters of Jamaica Bay as an avenue for settlement of the area but utilized land routes. The first white owner of what is now Rockaway was John Palmer who received a patent for the land from English governor, Thomas Dongan. Palmer soon sold his land to the first known white settler in the Rockaway peninsula, Richard Cornell, who around 1690 constructed a house at what is now known as Far Rockaway (Bellot, 1917:10-11). In the early 18th century, other families began moving into the area. Early settlers included John Mott and family, John Cornaga, Ezekiel Jennings, John Norton, and others. According to Frederick Black, before the middle of the 19th century nearly all those living in the land surrounding Jamaica Bay engaged in farming for a living (Black 1981:18).

During the American Revolution, the majority of residents in the Rockaway area remained loyal to the Crown. However, there were some who sided with the Americans and minor military encounters took place on the peninsula. Benjamin Cornell of Far Rockaway was a lieutenant in the American Army. A company of 90 men from Far Rockaway joined the newly formed American militia on May 17, 1776 (Bellot, 1917:29). The militia placed guards on the coast, at David Mott's and Hog Island Inlet to watch for a British landing. The British arrived in August and, following the Battle of Long Island on August 27, 1776, the American Army and many of those loyal to the cause fled. Following the victory of the British, the entire area remained under British occupation until the end of the war in 1783 (Black, 1981:19).

Events on the ocean side of the Rockaway Peninsula have been recounted by Michael Krivor and Stephen James as part of the remote sensing project off the Rockaway coastline in 2005 (Krivor, 2005). Krivor recounted the change from fur exportation to that of flour after the change to British rule but explains that other exports included whale oil, beaver pelts, tobacco, pork, bread, peas, and horses while imports from England and the West Indies included manufactured goods, rum, molasses, and sugar. Shipping continued to increase in New York during the 1700s and beyond. Privateering or the preying on enemy commerce was also common and often strayed into piracy. All of these activities added to the growth of New York as a shipping

center, and by the early 19th century, the port was larger than that of Philadelphia or Boston. Steam power brought sidewheel steamers, tugboats, and later transatlantic liners, some of which are known to have wrecked near the approaches to New York (Krivor, 2005:7-8).

The Rockaway peninsula began to attract the upper classes of New York City as early as the 1830s. In 1830, John Leake Norton formed the Rockaway Association, purchased land from the Cornell estate, and constructed the Marine Pavilion on the former location of the Cornell homestead which was razed during the project. This was an elite hotel associated with such persons as John A. King, governor of New York State, and Philip Hone, former New York City mayor. The hotel attracted summer vacationers such as Henry Wadsworth Longfellow, Washington Irving, and others. The Pavilion is depicted on Hassler's 1844 map and Dripps' 1852 map as seen in Figures 9 and 10. It was destroyed by fire in 1864 (Bellot, 1917:84). Other hotels, including one owned by Henry Mott, sprang up to accommodate summer vacationers and in 1868, the Wave Crest Land Company, formed of lands previously owned by John Norton, began to sell lots in the area for summer cottages to wealthy New Yorkers (Bellot 1917:21).

Lands in the project area to the west of Far Rockaway remained largely unsettled marsh. Dripps's survey map prepared in 1852 shows the areas encompassing present-day Arverne and Edgemere as "Hassock" - a term meaning clumps of grass or matted vegetation in marshy or boggy ground. One feature on this map familiar to modern readers will be Brant Point at the western tip of Arverne. The waterway north of Arverne was known as "Sweet Water" after the Sweetwater creek that once passed through Arverne. Present-day Rockaway Community Park and the Department of Sanitation lands between Arverne and Edgemere were then a series of marshy islands. As the 1844 map shows depths along Broad Channel and Sweet Water in the vicinity of Arverne, these waters were likely considered to be of some importance as a shipping lane (see Figures 9 and 10).

Figure 9. Greater Project Area in 1844, Courtesy of Hassler 1844.

Figure 10. Greater Project Area in 1852, Courtesy of Dripps 1852

In the early 1880s, New York lawyer Remington Vernam purchased much of what is now known as Arverne from the Cornell heirs. According to Alfred Bellot, at that time, there was virtually no development in Arverne save for a few small "fisherman's shacks" (Bellot, 1917:98). Vernam began to subdivide his planned community and sold lots. He leveled the sand dunes and filled in the marsh. Streets were mapped out, gas and water mains laid. Early development of Arverne favored the Atlantic Ocean side of the peninsula which Vernam called, "Arverne By The Sea." In 1882, the first houses were built by William Scheer, Frederick Bessler, Martin Meyer, and Remington Vernam. Vernam erected the immense Arverne Hotel in 1888 (Bellot, 1917:98-99). The J. B. Beers and Company map from 1886 shows several houses, including that of Remington Vernam, within, "Averne (sic) By The Sea," as shown in Figure 11.

Before the advent of the automobile, the only feasible way for most people to travel to the area was by railroad. The Rockaway Railway, a division of the South Side Railroad, was a steam railroad that first provided train service between Far Rockaway and Rockaway Beach, passing through Arverne near the Atlantic coast. Later, part of the Long Island Railroad Company track was moved inland from the beach and a station centrally located at Arverne. By the early 1900s, the line had been electrified (Bellot, 1917:34-35). After 1900, land south of the railroad tracks filled up and Vernam began developing the marshlands on the Jamaica Bay side. He began filling in the marsh and laying out streets and lots and he even began digging a canal, known as the Amstel Canal, which was reminiscent of the Amstel Canal in Amsterdam, Netherlands. It ran from Beach 77th Street to Beach 63rd Street and then turned northward toward Jamaica Bay (Bellot, 1917:100-101).

Frederick J. Lancaster began purchasing land for neighboring Edgemere in 1892. Originally called "New Venice," Fred Lancaster bought 100 acres (40.4 hectares) of land stretching from the ocean to Jamaica Bay. He built the Edgemere Hotel and many smaller hotels and sold off parcels for house lots. Just as with Arverne, Edgemere originally consisted of marshlands, and prior to construction, he drained and filled the lands. Progress in Edgemere proceeded slower along Jamaica Bay than with Arverne and both developments concentrated on the ocean side until those lots were taken, which is shown in Figures 12 through 17. In 1914, Lancaster sold off the last lots, ending his ownership (Bellot, 1917:96; Waldman and Solecki, 2018:75).

In 1907, shortly before his death, Remington Vernam sold the entire northern section of Arverne to the Sommerville Realty Company. The company made quick progress on filling in the remaining marsh, constructing a bulkhead at the shoreline, and filled it in with sand pumped from the bay (Bellot, 1917:100). A plat filed for the sale in 1907 shows the beginnings of a bulkhead and "Old Barbadoes Creek - now Closed" running from just south of the Amstel Canal at Vernam Basin eastward to what is now known as Sommerville Basin. The creek was evidently filled in by Vernam or the Sommerville Realty Company as was the Sweetwater Creek that originally ran from the west end of Amstel Canal in a northerly direction to the bay near Vernam Avenue (now Beach 67th Street), bisecting northern Arverne.

This plat shows two buildings near the northern shoreline on the east side of Vernam Avenue (Beach 67th Street), one of which is labeled a "Pier Ho(use)." (Figure 13) The company also laid out modern streets and parkways and filled in the Amstel Canal which first became Amstel Boulevard and later became part of Beach Channel Drive and Beach 71st Street, as shown in Figure 14, Bayfield Avenue (then known as Isabel Avenue) was shown in 1909 as partially submerged and directly on the shore (see Figure 13). The construction of bulkheads and fill created a significant amount of new land on the northern shore of Arverne (Figure 19). Newspapers advertised the opening of "Arverne's New Addition" (*Brooklyn Daily Eagle,* April 9, 1909:16). Individuals along the bay also made attempts to protect and increase their land area. In 1912, newspapers reported that William Scheer, who owned the tract of land west of Somerville Park and east of Jamaica Bay, constructed a bulkhead along his section of the bay, giving him considerably more property (Bellot, 1917:101).

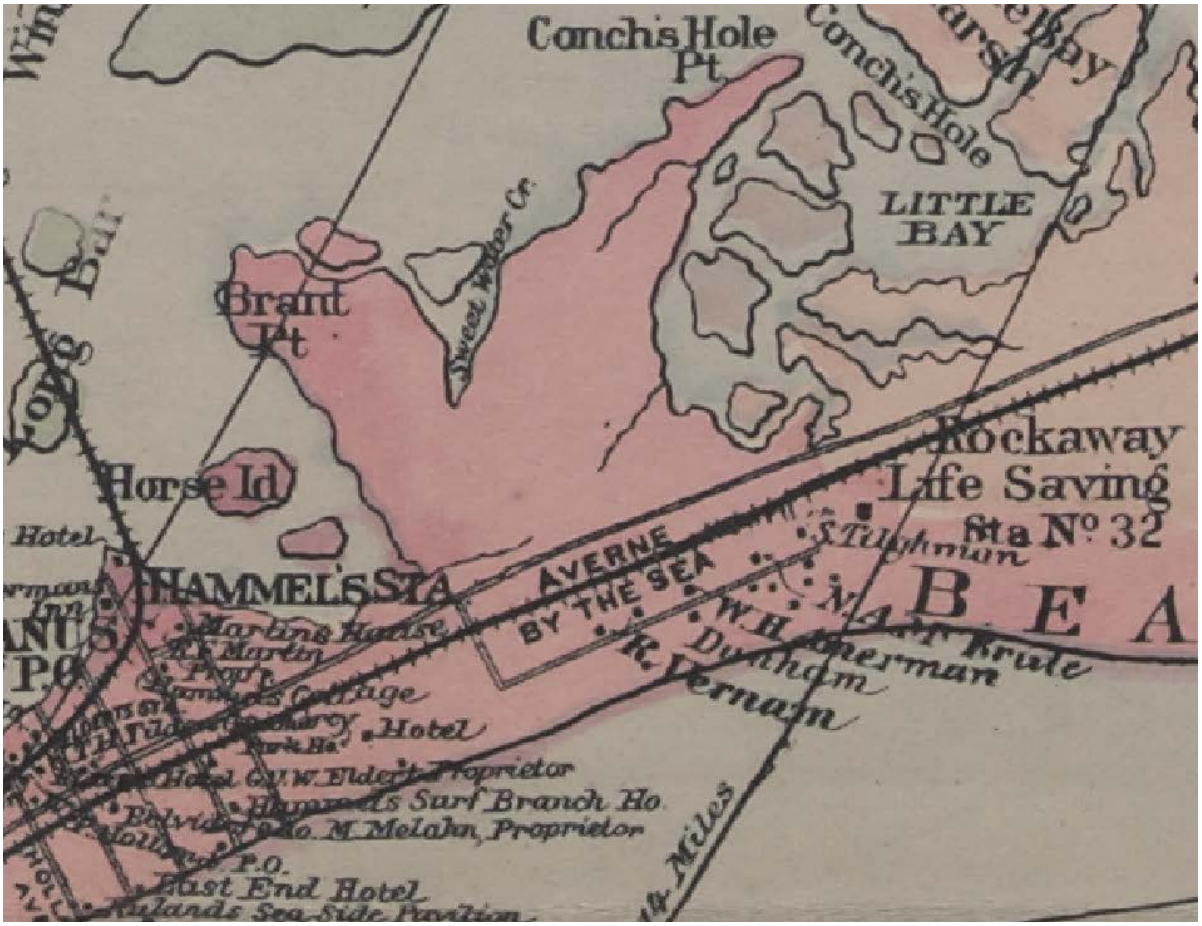


Figure 11. Beers Map showing Arverne and Early Development of "Averne By The Sea," Courtesy of Beers, 1886.

Figure 12. Edgemere and eastern part of Arverne in 1907, Courtesy of Hyde 1907.

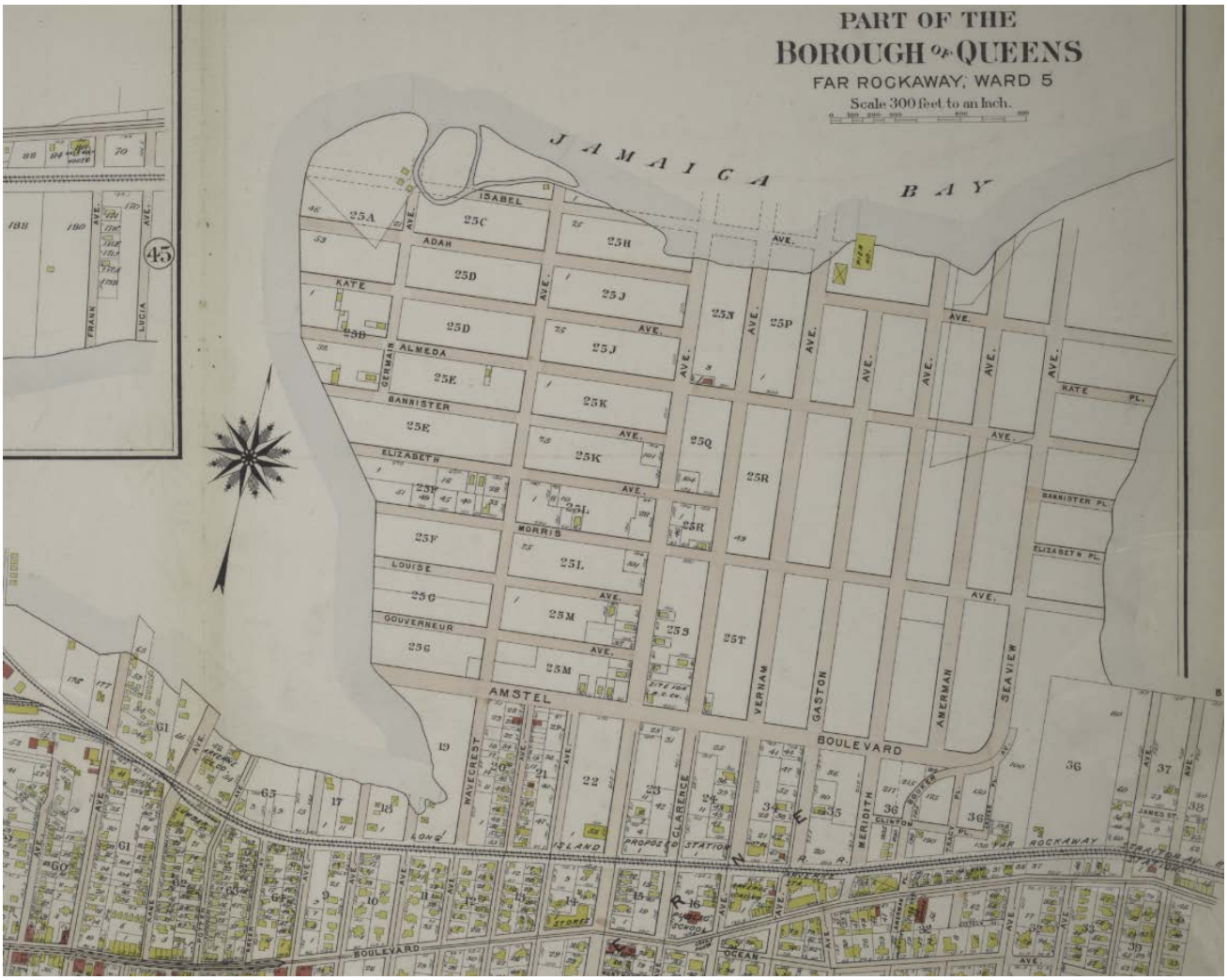


Figure 13. Development in Arverne along Jamaica Bay in 1909, Courtesy of Bromley 1909.

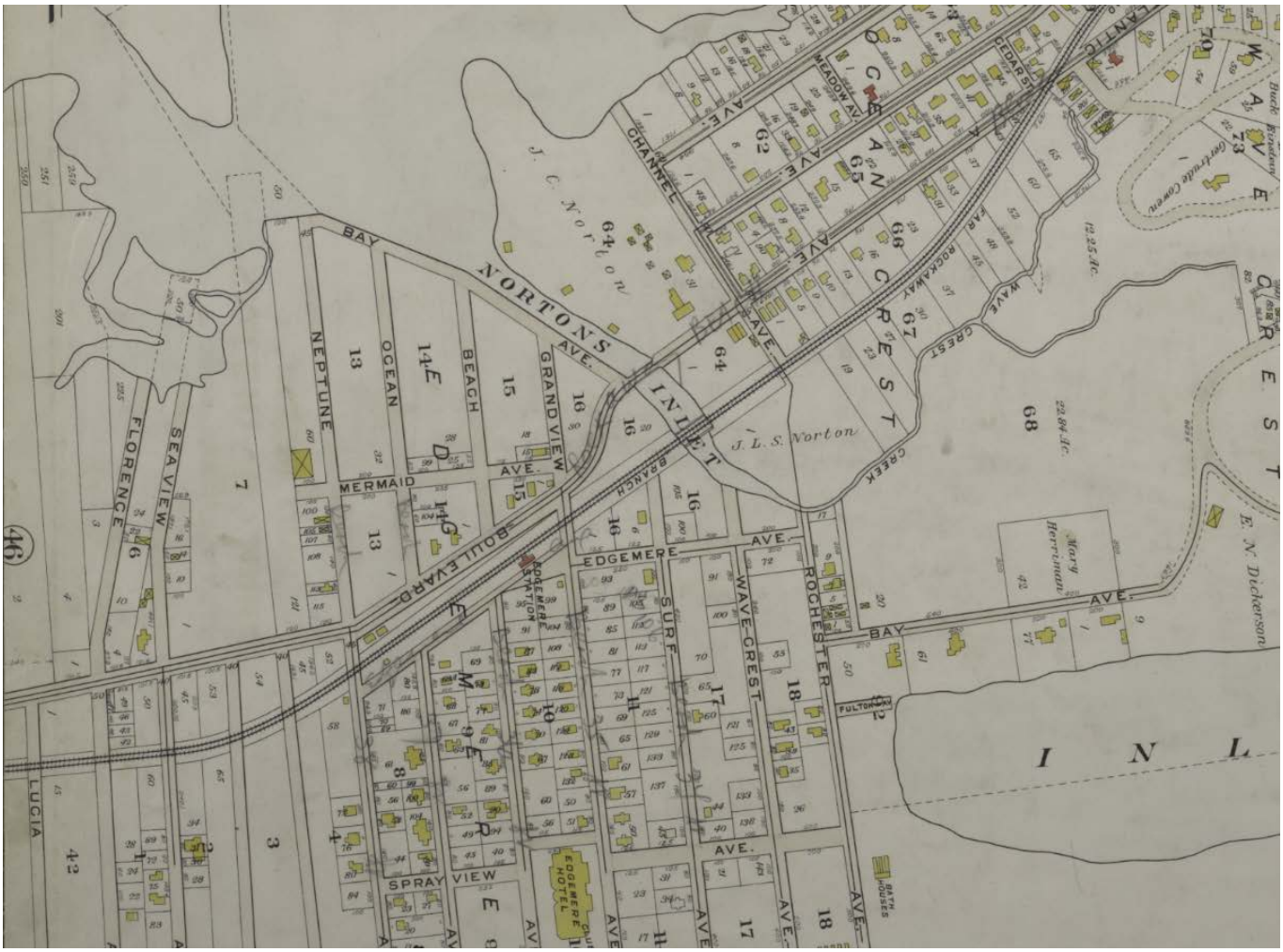


Figure 14. Eastern part of Edgemere in 1909, Courtesy of Bromley 1909.

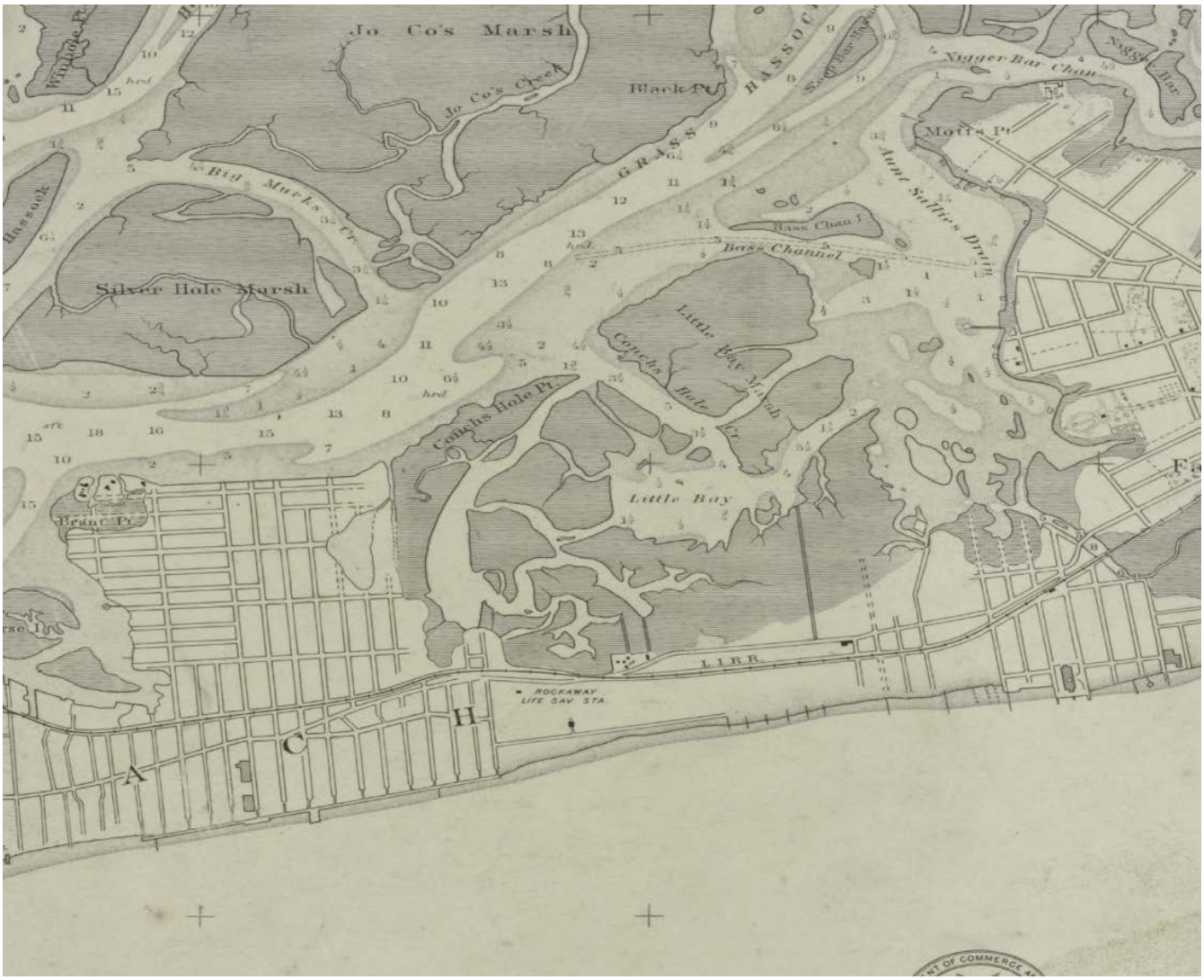


Figure 15. Greater Project Area in 1911, Courtesy of Tittmann 1911.

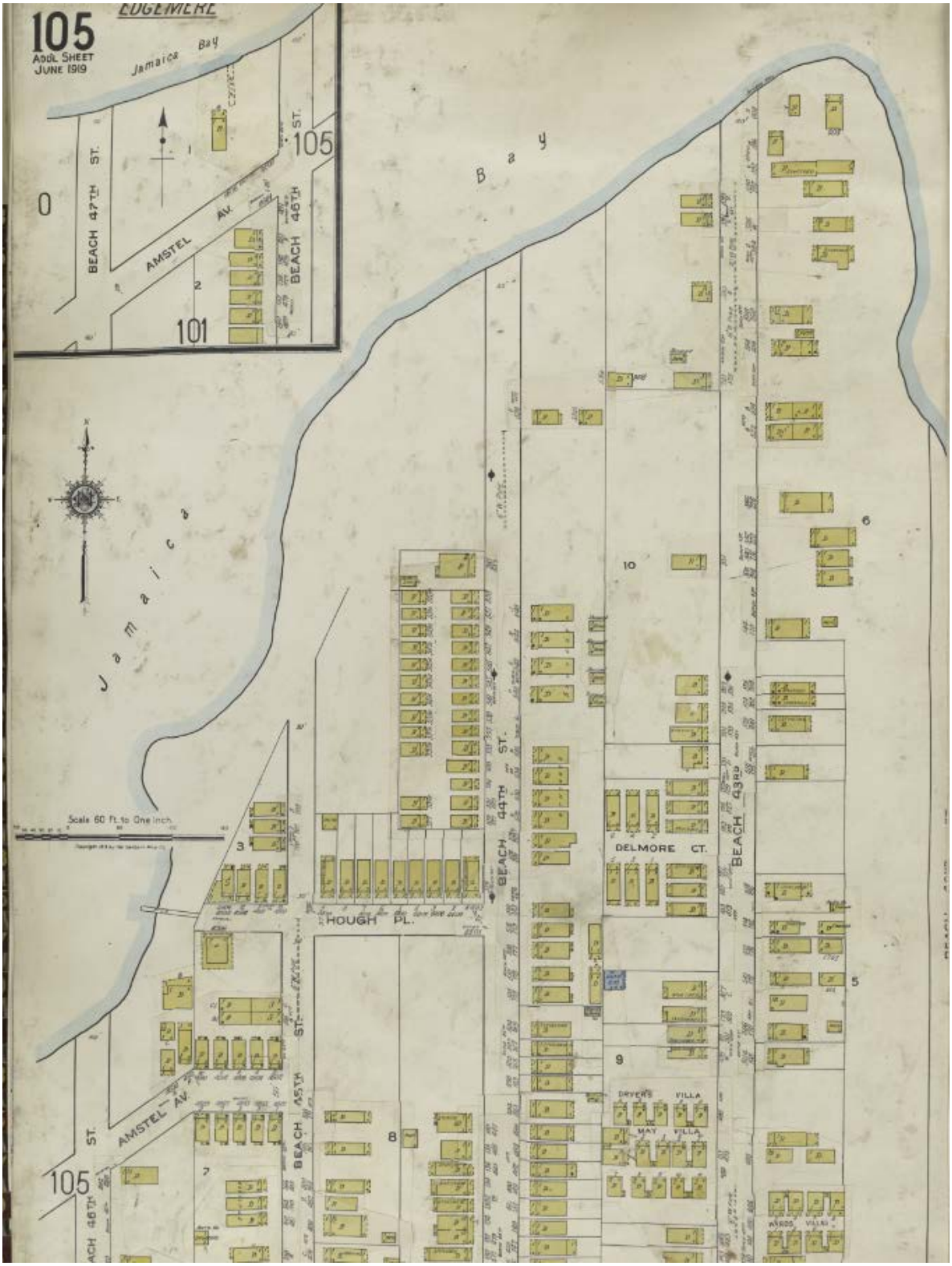


Figure 16. Part of Edgemere in 1922 showing development, Courtesy of Sanborn 1912, updated 1922.

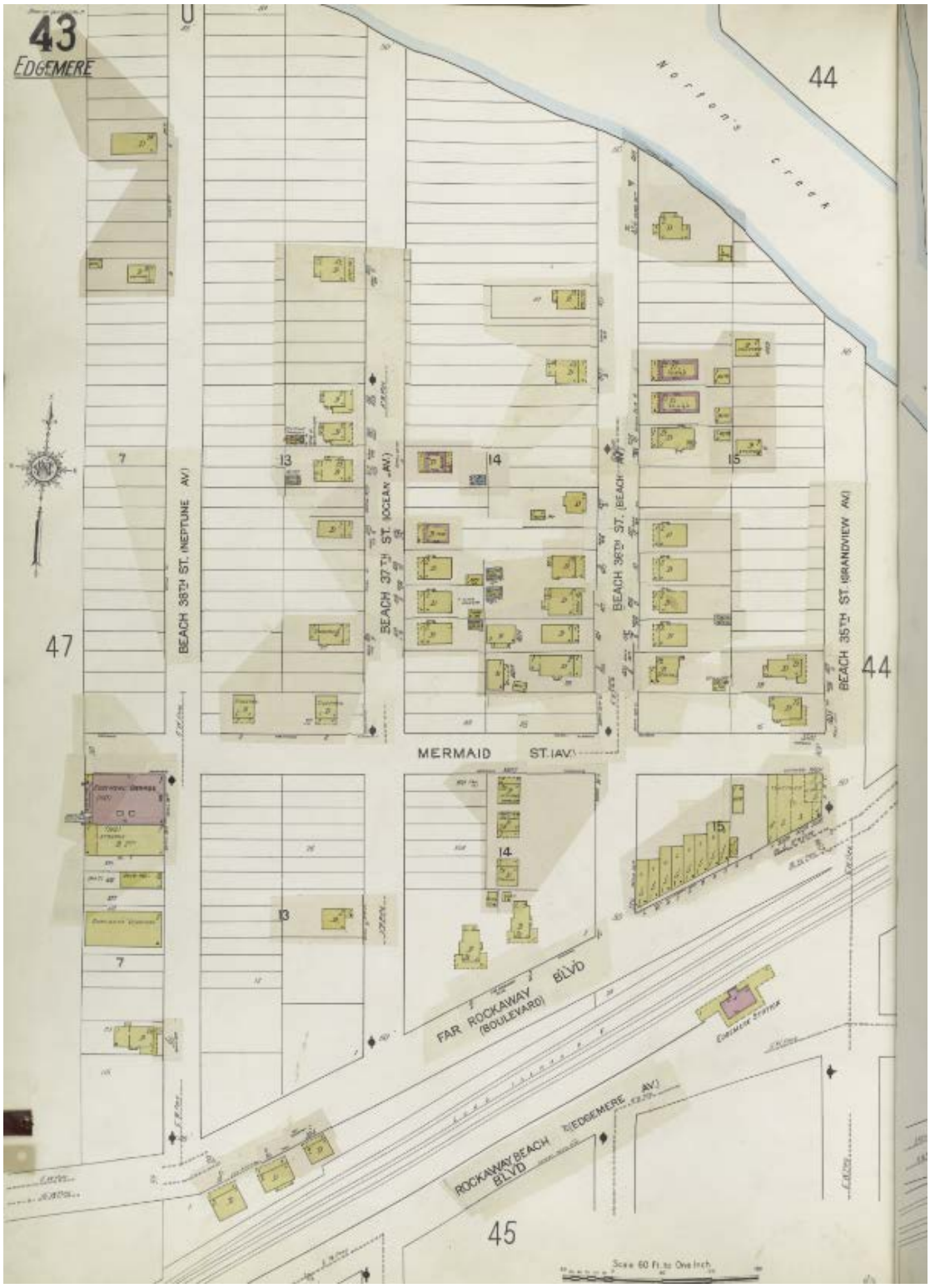


Figure 17. Eastern Part of Edgemere in 1922 showing development, Courtesy of Sanborn 1912, updated 1922.

Figure 18. Plat of Sommerville Park prepared for the Title Guarantee and Trust Company (Courtesy of the Surveyor for the City of New York 1907).

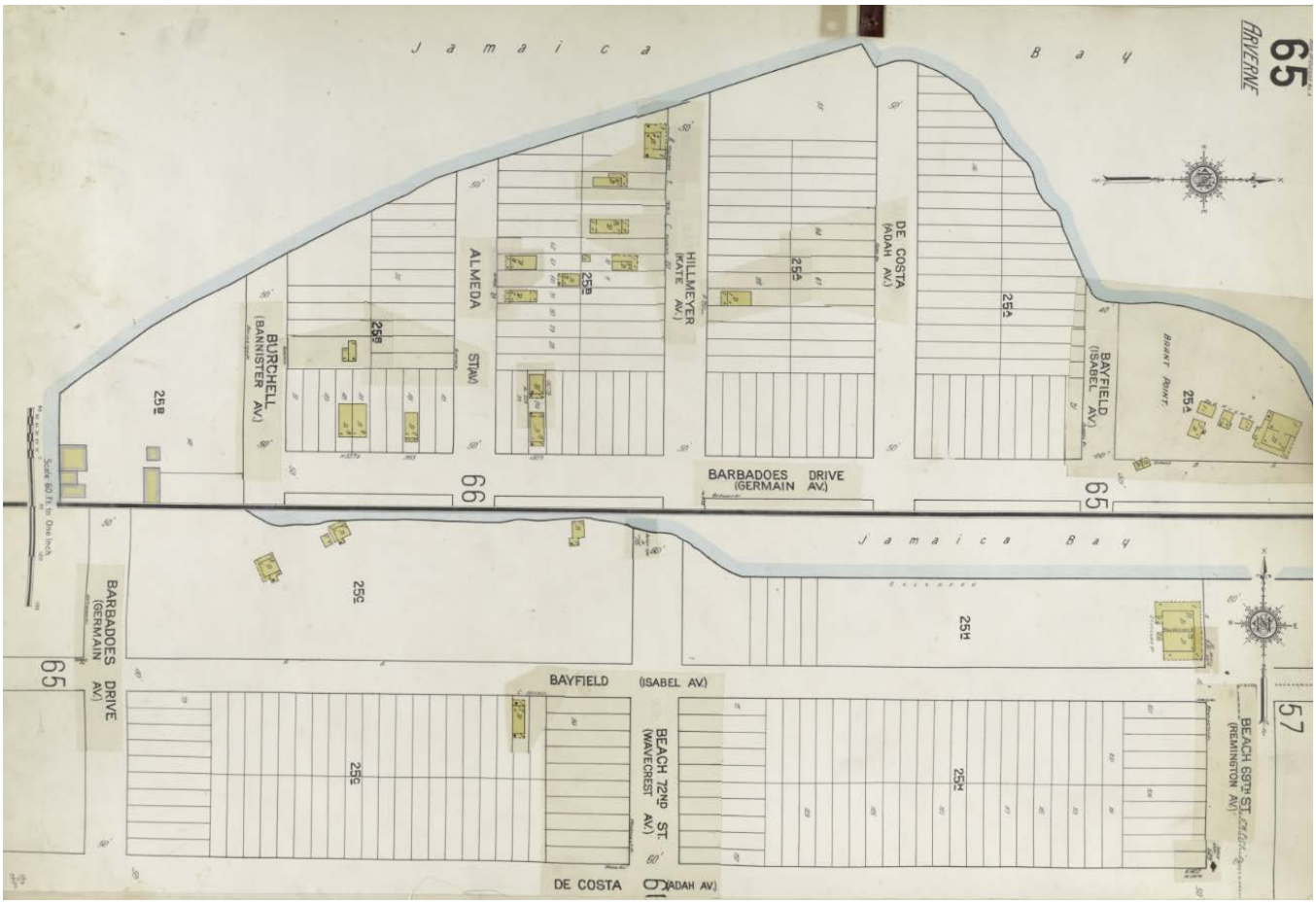


Figure 19. Part of Arverne in 1912 (updated 1922) showing development and bulkhead, Courtesy of Sanborn 1912, updated 1922

On January 1, 1898, Queens became part of the City of New York. Following annexation, the City changed the original street names for Arverne that were introduced by Remington Vernam to numbered streets. The east-west street names were later changed by the Sommerville Realty Company when it acquired the property around 1907. Previously thought of as a recreation area for the growing population of the city, the area became increasingly used as a receptacle for the city's waste (Waldman and Solecki 2018:1). By 1912 the city had already built a garbage incinerator in the north section of Arverne before much residential development had taken place, as seen in Figure 20.

Destruction, both man-made and natural, has always plagued the area. On June 15, 1922, a great fire spread through Arverne destroying an estimated 400 houses and hotels and leaving an estimated 10,000 or more people homeless. Newspapers nationwide carried the story (*Brooklyn Daily Eagle*, June 16, 1922:1).

Natural forces constantly altered the shoreline. Bellot referred to the frequent changes of topography:

> "The beach at Far Rockaway, and for many miles east and west, is undergoing frequent local changes. Many times the surf washes away several rods in width during a single storm, and perhaps the next storm adds more than has been re- moved by the preceding one. The sea often makes inlets to the bays and marshes, and as often fills up others, and for this reason, if no other, it is impossible to correctly give a geographical history of this section. The flow of the ocean is from east to west and while thousands of tons of sand are frequently washed away at easterly points and entrances to inlets and small harbors, this sand is deposited on and adds to the westerly portions of the same places" (Bellot, 1917:94).

These destructive forces plagued both the ocean and bay regularly, destroying homes, piers, boardwalks, and watercraft and at times washing entire lots into the sea. Newspapers recount these events on a routine basis.

These storms routinely sank vessels, both large and small, on both sides of the peninsula. Incidents on the ocean side involving large vessels and loss of life or expensive cargoes were usually recorded, but smaller craft and wrecks taking place on the bay were not. The true number of vessels lost in these waters will never be known. The following list serves as an example of the frequency of such occurrences:

- In 1827, it was reported that a "brig came on shore on Rockaway bar on Tuesday morning. No particulars ascertained" (*Long Island Farmer and Queens County Advertiser,* February 1, 1827:3).
- On April 16, 1834, the *Long Island Farmer and Queens County Advertiser* noted that the ship *Caledonia* from Liverpool struck a bar off Rockaway and was swamped. The cargo had consisted of salt, coals, and slates and was a total loss (*Long Island Farmer and Queens County Advertiser,* April 16, 1834:3).
- In 1835, the Sloop *Meridian*, laden with oysters was stranded on the Rockaway shoals (*Long Island Farmer and Queens County Advertiser* December 16, 1835:3).
- On November 20, 1836, the Irish ship *Bristol* wrecked off the Rockaway Shoals while waiting for a pilot escort into the narrows (The Ancient Order of Hibernians, November 30, 2011).
- On January 11, 1879, the *Roslyn News* reported that seven vessels had already been wrecked along the coast of Long Island including the schooner *John H. Thompson*, with salt at Rockaway, the schooner *Gazelle*, with lumber at Jones Inlet, the schooner *Win. H. Hopkins*, with coal, at Rockaway (*Roslyn News,* January 11, 1879:2).

In response to the wrecks of the *Bristol*, *Mexico*, and many other ships, one newspaper article reported a new bill for a "Board of Commissioners of Pilots" requiring licensing of pilots. The proposal included telegraph lines for communication and the establishment of life station houses along the Long Island coast. Another article on the same day in 1837 noted that a gale last Friday had caused "several vessels" to be wrecked and many lives lost on the shoals (*Long Island Farmer and Queens County Advertiser* February 22, 1837:6). Belatedly, in 1846 the New York State Legislature took up the bill establishing the New York Offing Magnetic Telegraph Association to run the entire length of the Long Island Shore on the Long Island Railroad right-of-way (*Long Island Farmer and Queens County Advertiser,* May 26, 1846:2).

Newspapers also recorded the damage done on land:

- An 1885 storm put Miller's Hotel at Broad Channel at risk when the land underneath sank at least a foot (Waldman 2018:45).
- In 1887, a storm swept across Jamaica Bay and caused a large amount of damage to the area (Waldman 2018:45).
- A massive September 1889 storm (possibly a tropical storm or hurricane) caused enormous loss of property, submerging the West End, Manhattan, and Oriental hotels and the railway running between Rockaway Beach, Arverne, and Far Rockaway. The bridge connecting Arverne and Rockaway Beach was swept away and all small islands in Jamaica Bay were covered with water (Waldman 2018:45).
- On September 17, 1903, the *Brooklyn Times Union* reported severe damage from a hurricane that destroyed buildings, docks, moorings, and many dozens of watercraft (*Brooklyn Times Union,* September 17, 1903:11).
- A great storm on January of 1914 tore up streets, destroyed houses, and wrecked a large portion of the boardwalk at Arverne (Bellot, 1917:100; *Brooklyn Daily Eagle,* January 5, 1914:4).

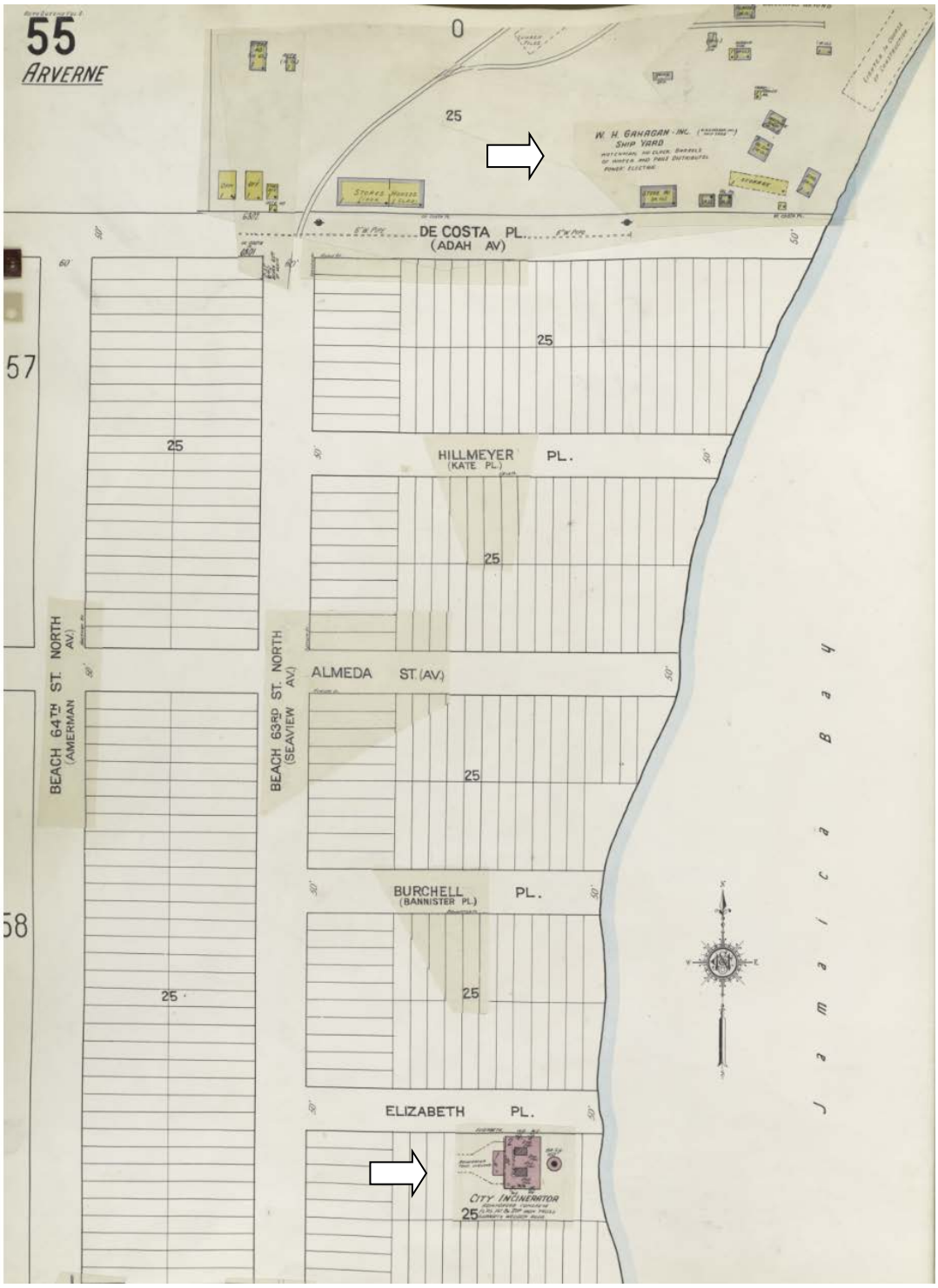


Figure 20. Sanborn map of Arverne section showing city incinerator constructed prior to housing development. The W. H. Gahagan Shipyard is to the upper right, Sanborn 1922, updated 1922.

2.7 Commerce and Recreation on Jamaica Bay

Although Frederick Black states that evidence of colonial trade by ship between Jamaica Bay and other ports remains undocumented, it is possible that some trade existed. Trade vessels and larger fishing vessels may be documented beginning in 1867 in the "Merchant Vessels of the United States," published annually since 1867. Although presently the volume designates the port of all vessels in the metropolitan area as simply New

York, prior to the consolidation of New York, independent towns were named (Black 1981:81). According to Black, in the 19th century sailing sloops were commonly used within the bay, and "steam-powered towboats and lighters were numerous by 1906, and one list for that year includes 29 such vessels then operating in the bay" (Black 1981:67-68).

The majority of bay traffic took the form of recreational fishing vessels and light craft. However, some commercial concerns existed, and these businesses likely utilized the waterways. The 1922 Sanborn map that shows the city incinerator at Arverne also depicts the W. H. Gahagan, Inc. shipyard along the Sommerville Basin in what is now known as the Dubos Point Wildlife Sanctuary. Within the shipyard, the top right corner of this map shows a "Lighter In Course of Construction" (see Figure 20). In Arverne at Vernam Basin, Sanborn maps from 1922 in Figure 21 show the Benn-Rigel Contracting and Supply Company, Inc. In that same year, a smaller boat works is shown at the base of Vernam Basin (Figure 24), and multiple boats and barges are seen in aerial images from 1924 in both Vernam and Sommerville Basins, as shown in Figures 22 and 23.

There appear to be three recreational piers on the north shore of Arverne along Bayfield Avenue at this time (see Figure 23). In Figure 25, aerial imagery from 1969 also shows what appear to be multiple commercial vessels along the shores of Arverne on both east and west sides. Not surprisingly, the 1954 and 1969 USGS maps and later NOAA charts show wreck symbols at these locations. These same maps depict recreational piers at the base of Sommerville Basin, beginning in the 1950s, owned by the Sommerville Yacht Club depicted in Figures 26 through 28. The shores along Edgemere never experienced the same commercial development and seems to have been restricted to a few recreational docks and piers.

Throughout the 19th and early 20th century, recreational fishing was extremely popular in the bay. In the late 1800s, Waldman and Solecki estimated that approximately 5,000 individual fishing vessels were using the bay for recreational fishing on a yearly basis. Brant Point, Broad Channel, and Edgemere were popular fishing spots. Commercial fishermen also frequented the bay, causing conflicts between recreational fishing and commercial interests. Hunting and harvesting/seeding oysters were also common activities. Sailing and sailboat racing organized by local yacht clubs remained major recreational activities on Jamaica Bay through the early 20th century. Later, motorboat races were popular (Waldman and Solecki, 2018:10, 37).

Other conflicts arose between recreational users and the industrial concerns as well as from poorly planned communities that dumped raw sewage into the bay and ocean. These activities poisoned the oyster beds and restricted bathers' ability to swim, causing typhoid fever to run through the communities on several occasions (Waldman and Solecki, 2018:31-32, 49-53). In 1897, it was discovered that the village of Arverne emptied its sewage into the Brant Channel. This channel had been seeded with oysters by residents who were now complaining about the sewage contaminating their investment (*The Sag Harbor Corrector,* July 17, 1897:2).

Figure 21. Sanborn map of Arverne section showing Benn-Rigel Contracting and Supply Company, Inc., Courtesy of Sanborn 1912, updated 1922.

Figure 22. Aerial photograph of Edgemere in 1924, Courtesy of the New York Bureau of Engineering 1924. With survey boundary overlay.

Figure 23. Aerial photograph of Arverne and part of Edgemere in 1924, Courtesy of the New York Bureau of Engineering 1924. With survey boundary overlay.

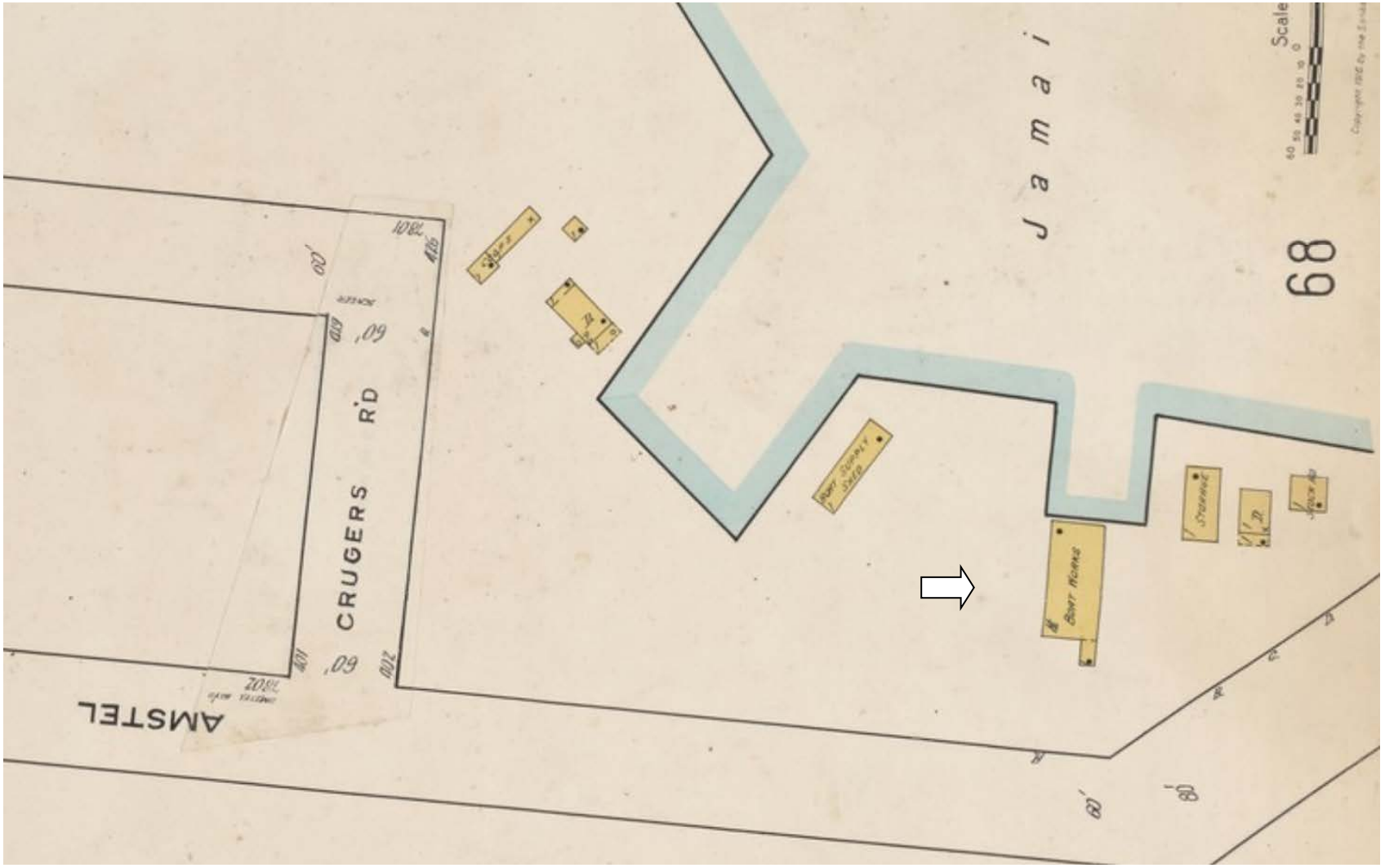


Figure 24. Sanborn map of Arverne section showing Boat Works at Vernam Basin, Courtesy of Sanborn 1912, updated 1922.

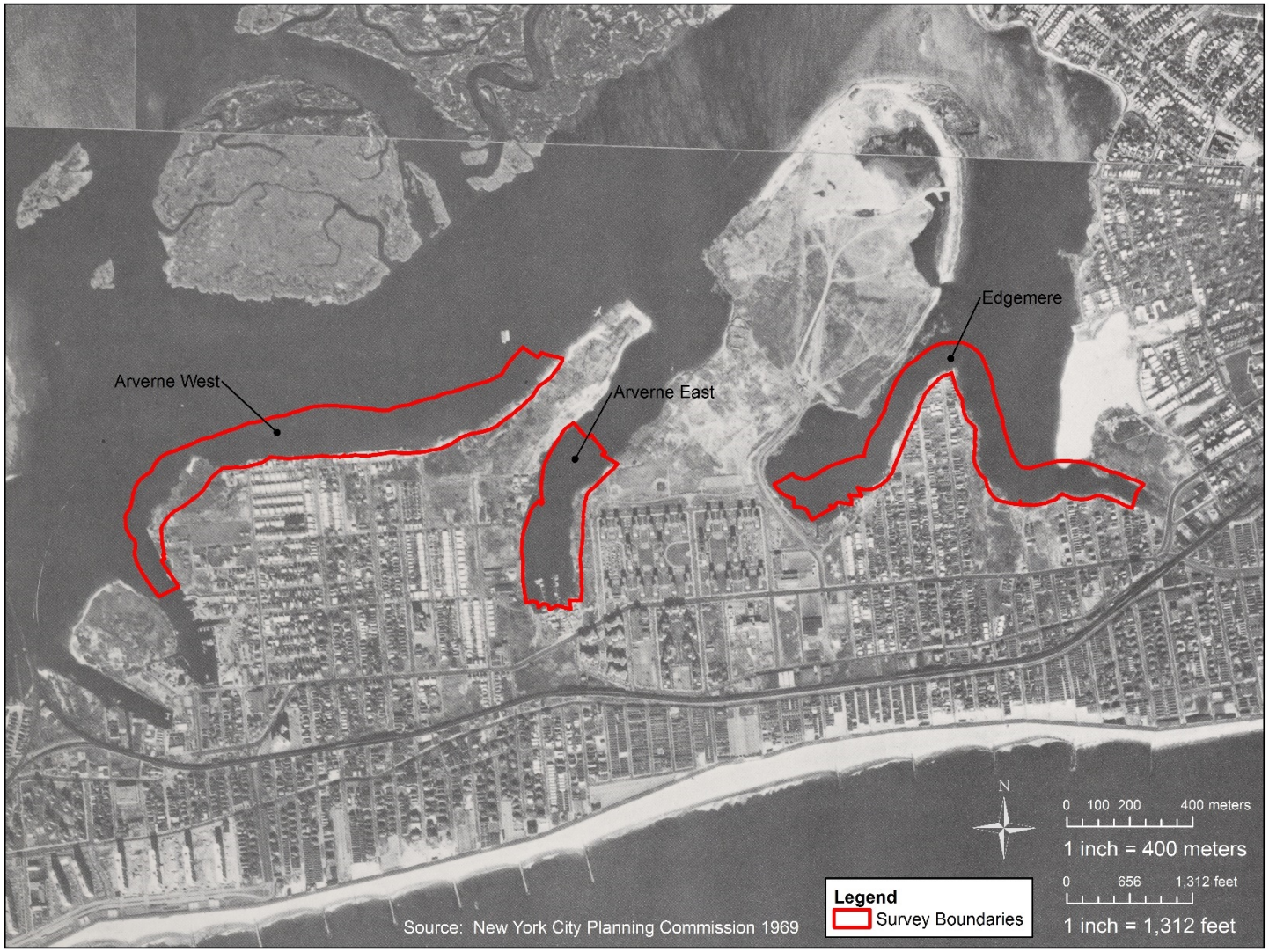


Figure 25. Aerial Image showing watercraft in Vernam and Sommerville Basins in 1969, New York City Planning Commission 1969. With survey boundary overlay.

Figure 26. USGS map showing project area in 1954, Courtesy USGS 1954.

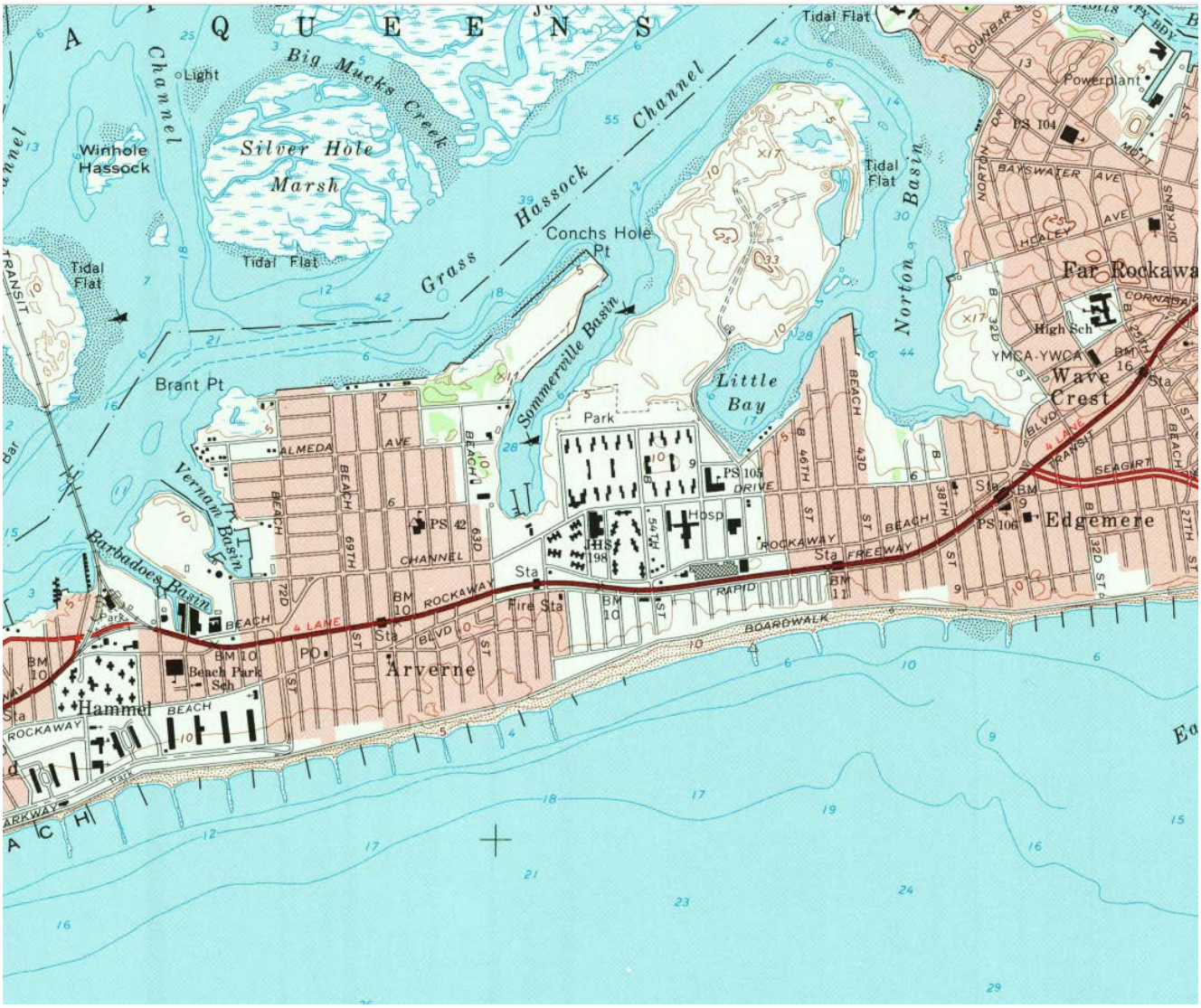


Figure 27. USGS map showing project area in 1969, Courtesy of USGS 1969.

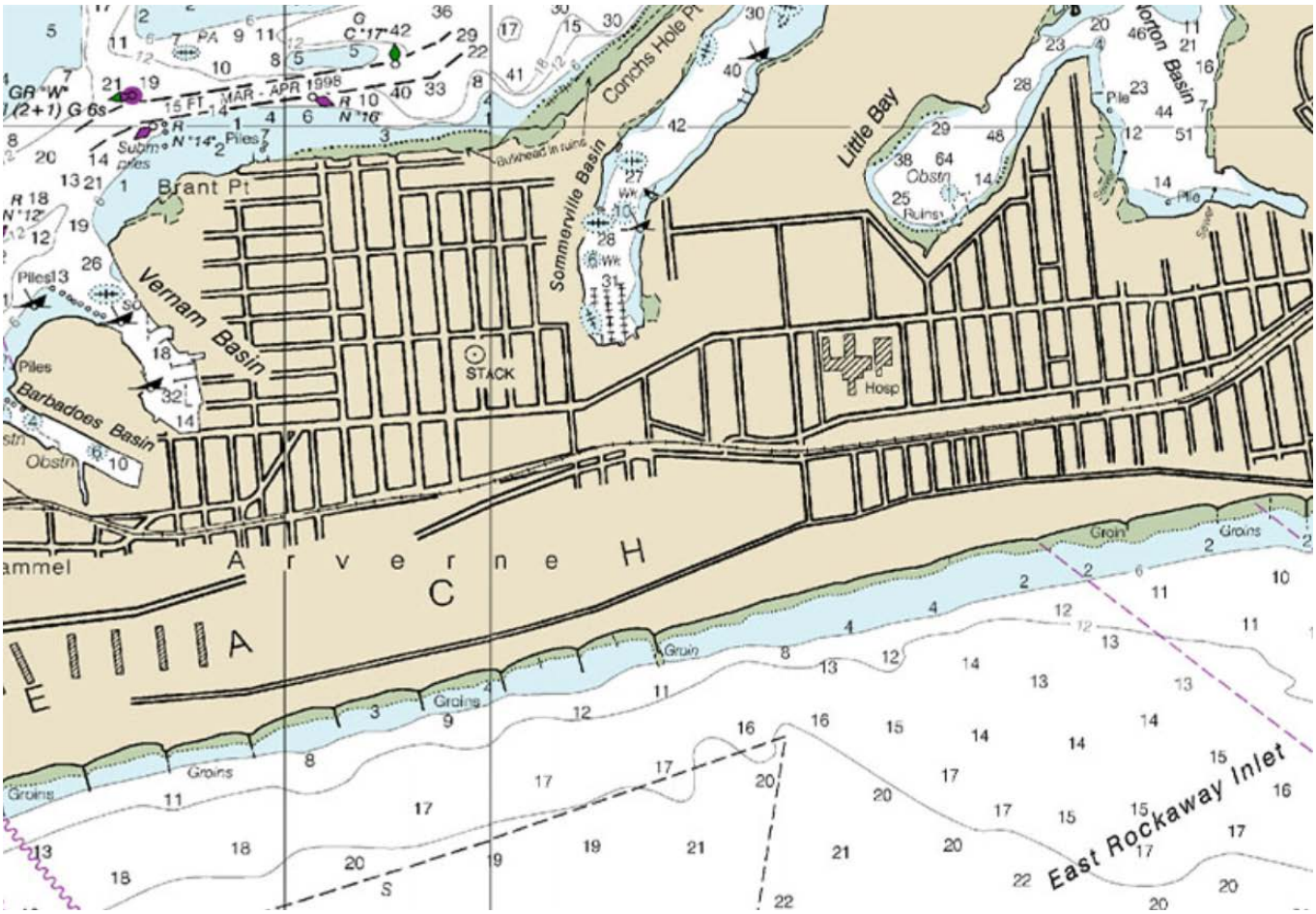


Figure 28. NOAA Chart of Jamaica Bay and Rockaway Inlet, Courtesy of NOAA 2017.

Between Arverne and Edgemere lies a peninsula that is now known as Rockaway Community Park or Edgemere Park. The area was once a group of marshy islands with different names at various times. These were slowly filled in starting in the late 19th century and by the early to middle of the 20th century, the city used the peninsula as a landfill. The land on the peninsula was firm enough by then for use as the Rockaway Airport which began operations in 1939 between Beach 46th and Beach 54th Street (see Figure 23). The airport was not associated with the Rockaway Air Station constructed during World War II at the end of the Rockaway peninsula. The airport, which was the headquarters of the Women's Flyers Association of America, closed in 1958 to make room for the Edgemere Housing project (Alba, 2020).

Over the years, businesses proposed several plans to make the bay a commercial waterway from the late 1800s to the middle of the 20th century. Several private companies and individuals undertook dredging during the 19th century but in the 20th century, governmental agencies performed the most significant alterations to the bay. The Jamaica Bay Improvement scheme planned to create an ocean port and commercial/industrial center in the bay. In 1910, a commission appointed by the Mayor of New York City announced their findings in a pamphlet published by the *Brooklyn Daily Eagle* in which they recommended the development of such a port (Brooklyn Daily Eagle, 1910). The essence of the plan called for the elimination of all marshes and meadows within the bay and the creation of two large and entirely bulkheaded islands. All the lowlands would also be filled and bulkheaded and the bay would have been essentially a circular canal between the mainland and the two islands. Some money was appropriated, some dredging occurred, but no comprehensive plan was formed (Black, 2018:71-72). This idea continued in some fashion well into the late 1930s but never implemented. Instead, with no clear plan for the region and the failure of the City to attract large-scale private development, Jamaica Bay became a residential community, a recreational landscape, and an area to deposit the City's vast amount of waste with landfills, sewage treatment facilities, as well as the location of the John F. Kennedy International Airport.

2.8 Previous Archaeology

Prior cultural resource assessments have been conducted for ecosystem restoration projects around Jamaica Bay by Panamerican Consultants, Inc. In a 2003 report, Panamerican cited the potential for prehistoric and historic resources along the bay; however, the focus of previous work was mostly outside of the present APE. In 2006, another report was done for an ecological restoration project at Bayswater State Park and Paerdegat Basin. Panamerican also conducted a remote sensing survey of the Rockaway Borrow Area in 2005 and identified 67 anomalies of which three are considered potentially significant. There were no plans to investigate these anomalies any further as the District planned to avoid them. Lastly, Panamerican also conducted previous archaeological research in their 2020 report for the National Register of Historic Places Eligibility Evaluation of Groins & Near Shore Remote Sensing Survey in Connection with the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay (Panamerican, 2020:54-60). Previous archaeology surveys conducted on the Atlantic Seaboard side of Rockaway Peninsula are mentioned in the B-West report.

In 2003, Panamerican conducted a survey for the Cultural Resources Baseline Study, Jamaica Bay Ecosystem Restoration Project, Kings, Queens, and Nassau Counties, New York. The project was comprised of 12 restoration sites around Jamaica Bay and the objective of the project was to describe the prehistoric and historical development of Jamaica Bay. An evaluation of how restoration activities would impact any potentially significant cultural resources was central to the project purpose and goals (Panamerican, 2003:ii). Conclusions from background research and surveys of the restoration sites within Jamaica Bay found the presence of potentially significant cultural resources within the surrounding area, with the remains of the historic period cultural landscapes found embedded at Dead Horse Bay, Fresh Creek, Spring Creek, and Motts Point. Other locations denoted the potential for additional historic and prehistoric sites. The presence of potentially significant marine resources was mentioned in the report as well, yet the possibility for these resources was determined to be the subject of further study (Panamerican, 2003:iii).

The 2005 remote sensing survey was a remote-sensing survey conducted for the proposed borrow area for the East Rockaway, Reformulation Project in Queens County, New York. Located offshore on the Atlantic Coast of New York and in between the East Rockaway Inlet and Rockaway Inlet, the borrow area was investigated for the potential of significant cultural resources. The results of the survey revealed the presence of 67 magnetic anomalies unevenly distributed throughout the project borrow area, with many of the anomalies associated with artificial reefing material along with an underwater pipeline. The side scan sonar recorded 135 anomalies, most of which are either geologic features or related to the artificial reef material. However, three anomalies were found to have the potential to represent significant cultural resources and the report called for avoidance. If avoidance were not possible, additional archaeological investigations could be conducted (Panamerican, 2005:43-58).

The 2006 Panamerican report for the Phase 1A study for the Bayswater State Park and Paerdegat Basin was conducted to assess the potential for cultural resources in the two sites for the Jamaica Bay Ecosystem Restoration Project. Investigations in the area found the presence of extant historic structure remains with the potential for additional historic features. The historic features are related to property in the western section of Bayswater State Park that was a residence, hospital and day camp from 1886 to 1990. Additionally, a concrete seawall and the remains of a bulkhead from 1901 were found in the Park with houses on stilts dating to the 1930s, a boat builder's shop adjacent to the south side of Paerdegat Basin, and historic marsh deposits (Panamerican, 2006:5-1). No other archaeological resources were mentioned.

The 2020 Panamerican report denoted a cultural resources investigation was done by Stephen Kopper in 1979 within the immediate project area in connection with a previous project by the United States Army Corps of Engineers. The project involved the placement of sand on Rockaway Beach between 19th Beach Street and 149th Beach Street, the east jetty at the western end of Atlantic Beach, the East Rockaway Inlet navigation channel, and offshore borrow areas (Panamerican, 2020:54). A Phase IB survey of the Rockaway and Atlantic Beach shorelines was conducted; however, no underwater survey or coring was performed as part of the survey. Kopper noted that only modern materials were found in addition to one area of weathered planks with hand-wrought metal spikes were found during the survey of the beach. Kopper listed the known shipwrecks off Rockaway Beach and suggested that although no known shipwreck was within that project area, the potential for buried significant vessels exists. He concluded that the dredging of inlet sands and the disposal of the material on the beach should not impact any known or unknown important sites, although dredging might expose unknown prehistoric sites or shipwrecks. Other archaeological assessments were made for submerged

cultural resources and shipwreck but were done outside of the project area on the Atlantic side of Long Beach (Panamerican, 2020:55-60).

The New York State Cultural Resource Information System (CRIS) does not indicate the presence of any known archaeology sites within the project APE for Arverne Areas or Edgemere Areas. The same is true for Area B-West, an offshore borrow area being investigated in conjunction with the Nearshore areas of Arverne and Edgemere. However, it should be noted that the CRIS does not currently contain a robust number of submerged sites included within its system anywhere across the state of New York. For the site of B-West, three projects were located on the CRIS within a two-mile radius, and one archaeological survey, seen in Tables 1 and 2. The 2002 archaeological survey within two miles from B-West does not indicate any archaeological sites. The three listed projects do not have associated reports available on the CRIS.

Table 1: Three Projects within 2-mile radius of B-West

PROJECT NUMBER	PROJECT NAME	STATUS
15PR00423	Liberty Natural Gas Deepwater Port and T-Line	Closed
15PR05581	BOEM New York Visual Simulations/Area Identification Offshore Wind Project New York Call Area	Open
19PR03247	NYSDEC Artificial Reef Program	Closed

Table 2: One Archaeological Survey within 2-mile radius of B-West

ARCHAEOLOGICAL SURVEY NUMBER	PROJECT NAME
02SR52309	Excerpts of Cultural Resource Related Information from Article VII Application to New York State Public Service Commission for Proposed Neptune Regional Transmission System, Sayerville, NJ to West 49th Street, Manhattan and Newbridge Road, Hempstead, Nassau County, NY

The Edgemere Area has a total of five projects within the APE and zero Archaeological Surveys included within the APE. Reports for the five listed projects were not available on the CRIS. The list of projects within the Edgemere Area APE can be seen in Table 3.

Table 3: Projects Within Remote Sensing Survey Area for Edgemere

PROJECT NUMBER	PROJECT NAME	STATUS
15PR00559	Beach Channel Senior Residences	Closed
16PR02836	RISE:NYC - NYC Daylighting	Closed
19PR08710	The Reconstruction of Shoreline Protection Measures at Rockaway Community Park	Closed
20PR00170	Reconstruction of Michaelis-Bayswater Park	Closed
20PR02829	Far Rockaway Substation to Arverne Substation, Transmission Circuit 33-309 Reconductoring	Closed

The adjacent Arverne Areas East and West have a total of five Projects and two Archaeological Surveys within the remote sensing survey areas, seen in Tables 4 and 5. Reports for the five listed projects are not available from the CRIS. The available Archaeological Survey report entitled, “Archaeological Overview and Assessment Gateway National Recreation Area, Jamaica Bay unit Kings & Queens Counties, New York” dated 2011 revealed no archaeological sites in the remote sensing survey areas Arverne East and Arverne West.

Table 4: Projects within Remote Sensing Survey Areas Arverne East and Arverne West

PROJECT NUMBER	PROJECT NAME	STATUS
16PR02836	RISE:NYC - NYC Daylighting	Closed
19PR08710	The Reconstruction of Shoreline Protection Measures at Rockaway Community Park	Closed
20PR03435	NYCDPR - Thursby Basin Park	Closed
18PR02858	Lexx Core Rentals 2 LLC (Bayfield & Beach 67th)	Closed
20PR03835	74-22 Almeda Avenue Demolition	Closed

Table 5: Archaeological Surveys within Remote Sensing Survey Areas Arverne East and Arverne West

ARCHAEOLOGICAL SURVEY NUMBER	ARCHAEOLOGICAL SURVEY NAME
03SR54974	Cultural Resources Baseline Study, Jamaica Bay Ecosystem Restoration Project, Kings, Queens, and Nassau Counties, New York (Final Report)
19SR00327	Archaeological Overview and Assessment Gateway National Recreation Area. Jamaica Bay Unit Kings & Queens Counties, NY

3.0 Methodology

3.1 Project Environment

The Area of Potential Effect (APE) includes three separate areas where HFFRRFs are planned to be built along several shorelines in Jamaica Bay, Queens Borough, New York. The Arverne HFFRRF has two sections (West and East) and is in Arverne, New York, along the Jamaica Bayshore between Beach 58th Street and Beach 75th Street. The Arverne East Project Area transects an active commercial marina (Marina 59) at the south end of that project area. The Edgemere HFFRRF is in Mid-Rockaway in Edgemere, New York, along the Jamaica Bayshore between Beach 35th Street and Beach 51st Street. A network of wood pilings from an abandoned marina is present at the west end of the Edgemere Project Area (Figure 1). The spatial limits of the three project areas were provided by the U.S. Army Corps of Engineers, New York District.

All three project areas are in the tidal zone and water depth (mean low water) ranged from less than 2 feet (0.6m) along the shorelines to more than 50 feet (15.2m) in a small part of the Edgemere Project Area. Water depths in the Arverne East Project Area were consistently deep (> 15 feet (4.5m) across most of the Project Area.

3.2 Project Personnel

The field crew consisted of: Lee Cox, RPA; maritime archaeologist (Dolan Research) – resume can be found in Appendix 1; George Rollins, boat captain and remote sensing specialist (Waterway Surveys); and Rob Propster, remote sensing technician (Waterway Surveys).

3.3 Fieldwork Introduction

Comprehensive remote sensing surveys were conducted in Jamaica Bay within the three project areas on 23 September 2020. The remote sensing survey simultaneously collected magnetic, acoustic, sub-bottom, and bathymetric data and all work was completed during the high-tide cycle. The purpose of the remote sensing survey was to locate, identify, and preliminarily assess the significance of potential submerged cultural resources that might be impacted by flood control related shoreline constructions activities. The underwater survey was designed to generate sufficient remote sensing data to identify anomalies suggestive of potential submerged cultural resources. Analysis of the remote sensing data aimed to isolate targets of potential historical significance that might require further investigation or avoidance.
All survey work was conducted during a high-tide cycle and all remote sensing data were collected

simultaneously. The magnetometer and side-scan sonar transducers were towed aft of the survey vessel; 80 feet (24.3m) and 20 feet (6m) back, respectively. The sub-bottom transducer was mounted amidships, one foot below the water. All offsets from the DGPS antennae to the three transducer locations were recorded and logged into the navigational computer.

3.4 Technology Employed

All the remote sensing survey operations were conducted from a 23 foot (7m) long by eight foot (2.4m) wide Parker fiberglass survey vessel, which is suitable for shoal water operations. The vessel was outfitted with a Yamaha 225hp, four-stroke outboard engine. Magnetic, acoustic, sub-bottom, and bathymetric data were collected simultaneously across the B-West project area. Remote sensing data were collected around the high tide cycle. The survey's horizontal reference is the New York (Long Island) State Coordinate System, NAD83, in feet. Detailed specification sheets for this equipment can be found in Appendix 3.

3.4.1 Side Scan Sonar

Sonar data were gathered with a Marine Sonic HDS two-channel digital side-scan sonar unit with a dual frequency 600/1200kHz side-scan sensor. The sonar sensor was towed five feet (1.5m) below the water surface from the bow of the survey vessel and operated at a range of 120 feet (36.5m) in either channel. This created a swath of acoustic coverage 240 feet (73.1m) wide on each survey lane. Marine Sonic data acquisition software was used to merge the acoustic data with real-time positioning data.

3.4.2 Magnetometer

Magnetic data were collected with a Geometrics 881 cesium marine magnetometer, capable of +/- 1/10 gamma resolution. A 10 Hz sampling rate by the magnetometer's towed sensor, coupled with a four-knot vessel speed generated a magnetic sample every 0.58 feet (0.1m). The magnetometer sensor was towed with a float 40 feet (12.1m) aft from the port side of the survey vessel.

3.4.3 Sub Bottom Profiler

A 10-kHz SyQwest, Inc. StrataBox HD sub-bottom profiling system was used to collect sub-bottom data. This boom-mounted profiling system is capable of up to 100 feet (30.4m) of sediment penetration in ideal conditions and strata resolution of approximately 2.36 inches (5.9cm). The sub-bottom transducer was attached to the port side of the survey vessel's hull, amidships.

3.4.4 Survey Vessel

All the remote sensing survey operations were conducted from a 23 foot (7m) long by eight foot (2.4m) wide Parker fiberglass survey vessel which is suitable for shoal water operations. The vessel was outfitted with a Yamaha 225hp, four-stroke outboard engine.

3.4.5 Bathymetry

Bathymetry data were obtained by using an Odom CV100 single-beam fathometer operating at 200 kHz with the transducer mounted directly below a Leica GS18 GPS antenna to minimize offsets. The CV100 was calibrated for the localized sound velocity with a Digibar Pro sound velocity cast. Horizontally, the data is referenced to the New York State Grid (NY-LI) based on NAD83(2011). Vertically, single-beam data is referenced to NAVD88 computed using the Geoid18. Quality control checks against RTK Tides were done using the United States Geological Survey's automatic tide station #01311850 in Jamaica Bay at the Inwood Marina and the National Oceanic and Atmospheric Administration's automatic tide station #8531680 operating in Sandy Hook, New Jersey.

3.4.6 Position Keeping Equipment

The boat's horizontal and vertical positions were obtained by using a Leica GS18 GPS unit with Real-Time Kinematic (RTK) corrections coming from the NYDOT NTRIP server via a cellular internet connection. A Windows 10 laptop running Hypack 2020 interfacing the positioning, single-beam and magnetometer data was used for survey acquisition and data processing. Positioning data for side-scan sonar and sub-bottom data were obtained with a Hemisphere differential GPS and all post-processing for those two data sets was achieved with their specific software programs. All magnetometer, side-scan sonar, sub-bottom, and bathymetric offsets on the vessel survey are depicted in a cutsheet of the boat's set up (Appendix 2).

The onboard laptop running Hypack, was used to guide the survey vessel precisely along predetermined survey lines that had been established parallel with the shorelines at 100-foot offsets (Figure 29). While surveying, vessel positions were continually updated on the computer monitor to assist the vessel operator, and the X,Y data were continually logged onto all remote sensing units for post-processing and plotting. Bathymetric data were collected and contoured at one-foot intervals to provide additional remote sensing information for the evaluation of remote sensing targets (Figures 30 and 31).

Figure 29. Survey Tracks in the Three Nearshore Survey Areas – Arverne West, Arverne East, and Edgemere

Notes: 1) Lane Spacing = 100 feet
2) Survey lanes were completed parallel with adjacent shorelines. Lanes in the Arverne East area terminated between a series of docks at Marina 59.
3) The limits of the three survey areas were provided by the NYCOE
4) Background Grid = New York (Long Island) State Plane Coordinates, NAD83, feet

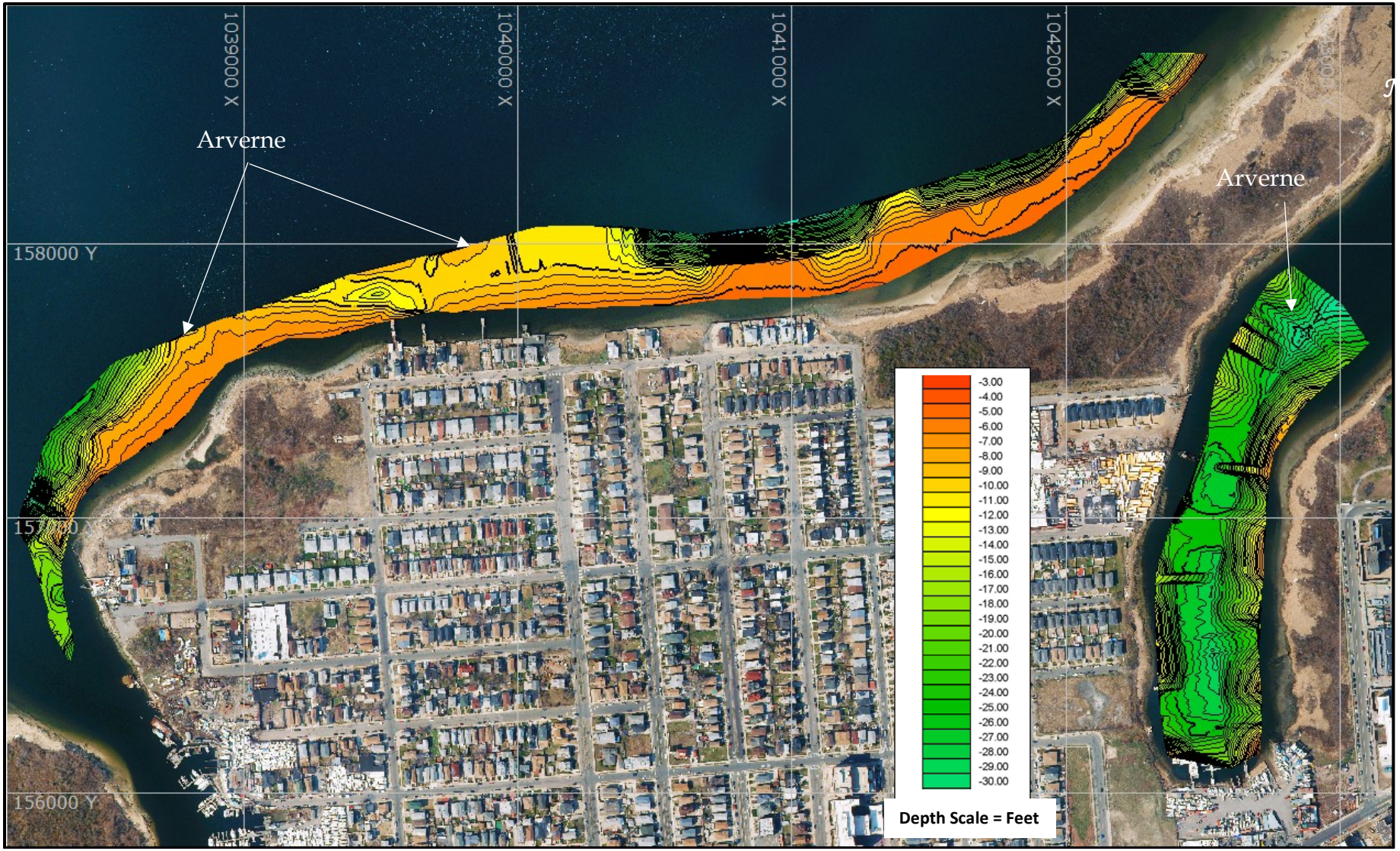


Figure 30. Bathymetric Contours of the Arverne West and East Project Areas

1000′

Notes: 1) Depth Contour Intervals = One Foot
2) Background Grid = New York State Plane Coordinates, NAD83, feet

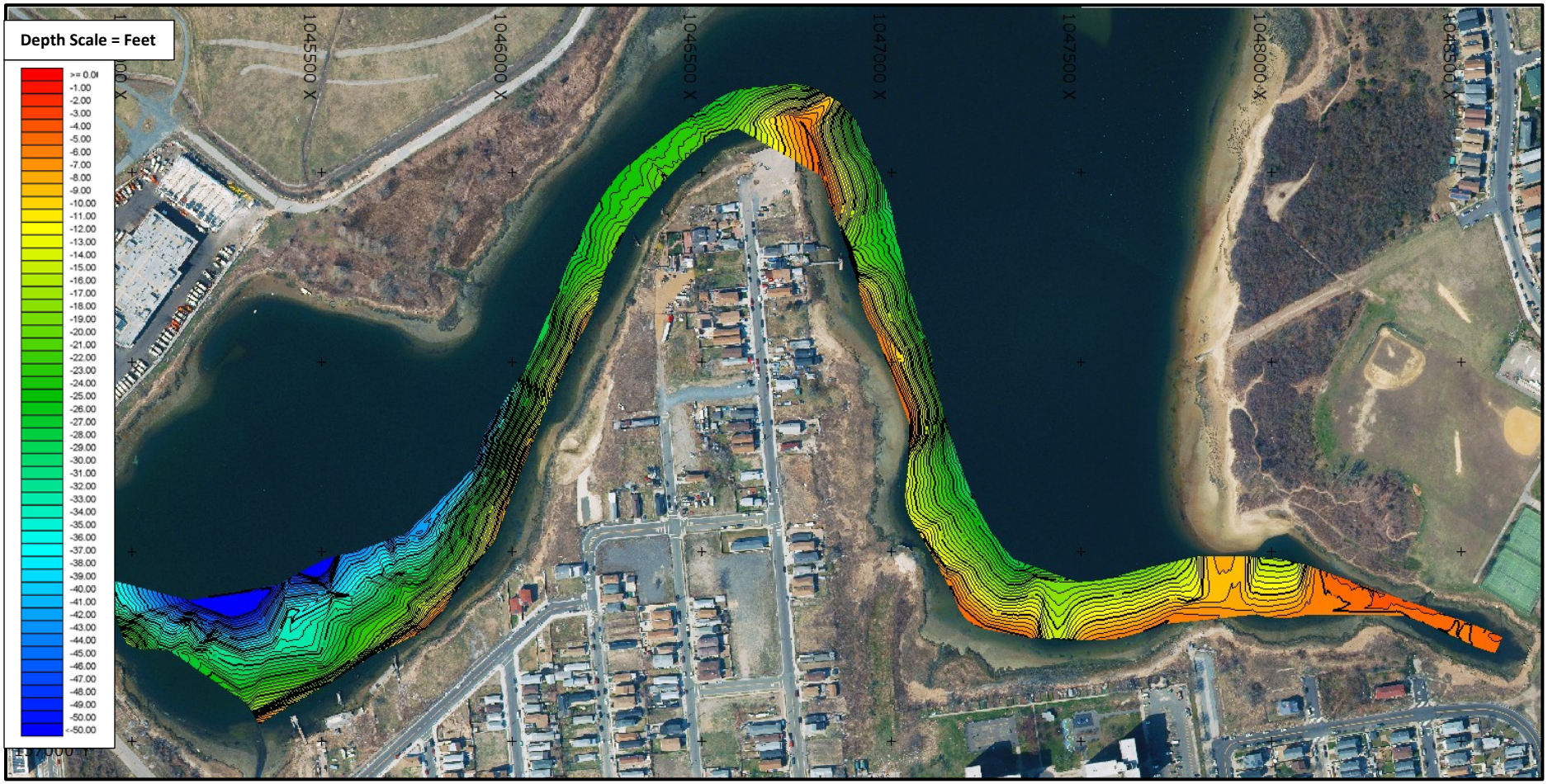


Figure 31. Bathymetric Contours of the Edgemere Project Area

Notes: 1) Depth Contour Intervals = One Foot
2) Background Grid = New York State Plane Coordinates, NAD83, feet

3.5 Data Products

3.5.1 Data Products - Magnetometer

The magnetometer collected data on the ambient magnetic field strength by measuring the variation in cesium electron energy states. As the sensor passed over objects containing ferrous metal, a fluctuation in the earth's magnetic field was recorded. The fluctuation was measured in nanoteslas (nT) and is proportional to the amount of ferrous metal contained in the sensed object and the distance from the sensor.

Magnetic data were edited for detailed analysis of all anomalies. During the editing process background noise spikes were removed and a magnetic contour map was created with 10-nT (or gamma) intervals for the survey area. Magnetic data editing consisted of using Hypack's magnetic data editing program to review raw data (of individual survey lines) and to delete any artificially induced noise or data spikes. Once all survey lines for the project area were edited, the edited data were converted to an XYZ file also using Hypack (easting and northing coordinates, and magnetometer data – measured in nT). Next, the XYZ files were imported into a Triangular Irregular Network (TIN) modeling program in Hypack, that was used to contour the data in 10-nT intervals (Figures 32 and 33).

Figure 32. Magnetic Contours (Total Field) at 10 nT (gamma) Intervals at the Arverne (West and East) Project Areas

Notes:
1) Contour Interval = 10 nT (gamma)
2) High levels of magnetic disturbance were recorded across the entire Arverne East area due to bulkheads, debris, marina docks and numerous large shipwrecks.
3) Significant magnetic noise was recorded along the entire shorelines due to presence of bulkheads, docks, and other shoreline related structures.
4) Background Grid = New York (Long Island) State Plane Coordinates, NAD83, feet

Figure 33. Magnetic Contours (Total Field) at 10 nT (gamma) Intervals at the Edgemere Project Area

Notes: 1) Contour Interval = 10 nT (gamma)
2) Significant magnetic disturbance was recorded along the entire shorelines, particularly on the eastern end of the area due to pipe outfalls and other shoreline.
3) No magnetic data were collected in the abandoned marina complex at western end of area due to presence of numerous visible navigational hazards.
4) Background Grid = New York (Long Island) State Plane Coordinates, NAD83, feet

3.5.2 Data Products - Side Scan Sonar

The side-scan sonar derives its information from reflected acoustic energy. Side-looking sonar, which transmits and receives swept high-frequency bandwidth signals from transducers mounted on a sensor that is towed from a survey vessel. Two sets of transducers mounted in an array along both sides of the towfish generate the short duration acoustic pulses required for high-resolution images. The pulses are emitted in a thin, fan-shaped pattern that spreads downward to either side of the towfish in a plane perpendicular to its path. As the fish is towed along the survey track line, this acoustic beam sequentially scans the bottom from a point beneath the fish outward to each side of the track line.

Acoustic energy reflected from any bottom discontinuities (exposed pipelines, rocks, or other obstructions) is received by the set of transducers, amplified, and transmitted to the survey vessel via a tow cable. The digital output from state-of-the-art sonar units is essentially analogous to a high angle oblique photograph provided detailed representations of bottom features and characteristics. Sonar allows display of positive relief (features extending above the bottom) and negative relief (such as depressions) in either light or dark opposing contrast modes on a video monitor. Examination of the images thus allows a determination of significant features and objects present on the bottom within a survey area.

Raw sonar records were inspected for potential man-made features and obstructions present on the bottom surface. Sonar data were saved in separate files for each survey lane. Individual acoustic data files were initially examined using SeaScan acoustic data review software to identify any unnatural or man-made features in the records. Once identified, acoustic features were described using visible length, width, and height from the bottom surface. Acoustic targets are normally defined according to their spatial extent, configuration, location, and environmental context. As a last step, edited acoustic data were merged into geo-referenced sonar mosaics for each of the three Project Areas that were then overlaid onto aerial photographs (Figure 34). The sonar mosaics were also overlaid with the magnetic contour maps of the three Project Areas (Figures 35 and 36).

Figure 34: Side Scan Sonar Mosaic of the Arverne West, Arverne East, and Edgemere Survey Areas. Courtesy Google Earth

Figure 35. Sonar Mosaic and Magnetic Contours at 10 nT (gamma) Intervals at Arverne (West and East) Project Areas

Notes: 1) Contour Interval = 10 nT (gamma)
2) Background Grid = New York (Long Island) State Plane Coordinates, NAD83, feet

Figure 36. Sonar Mosaic and Magnetic Contours at 10 nT (gamma) Intervals at Edgemere Project Area

Notes: 1) Contour Interval = 10 nT (gamma)
2) Background Grid = New York (Long Island) State Plane Coordinates, NAD83, feet

3.5.3 Data Products – Sub Bottom Profiler

Sub-bottom survey data utilizes reflective energy to interpret conditions below the sea floor. Reflective energy intensity depends on different densities of the sea floor and can be affected by various factors. The primary interpretation is that the denser (harder) the riverbed, the stronger the reflective signal. The reflected signal travels back through the water to the boat mounted transducer/receiver assembly that is fixed with DGPS coordinates. This data is returned to on-board computers for real time display and digital filing. All sub-bottom data were saved in RAW formats in Stratabox software, Version 2.20, developed by Ocean Equipment Corporation. During post-processing sub-bottom data were converted to JPEG formats.

The quality of these records depends greatly on the presence of subsurface horizons or anomalies that reflect the acoustic energy. Differences in soil types, density, water content, gas pockets, and degree of solidification greatly influence the reflective properties of buried layers. There are several other factors that bear upon the success of sub-bottom reflective surveys. These can be grouped into three areas: external, vessel, and instrumentation limitations. All these factors make it difficult to identify individual features in the sub-bottom strata. Sub-bottom profiling acoustic data for each survey lane were reviewed to identify subsurface signatures of potential man-made structures or remnants of prehistoric landforms. Representative data from survey lines in each of the three survey areas are presented in Figures 37-40.

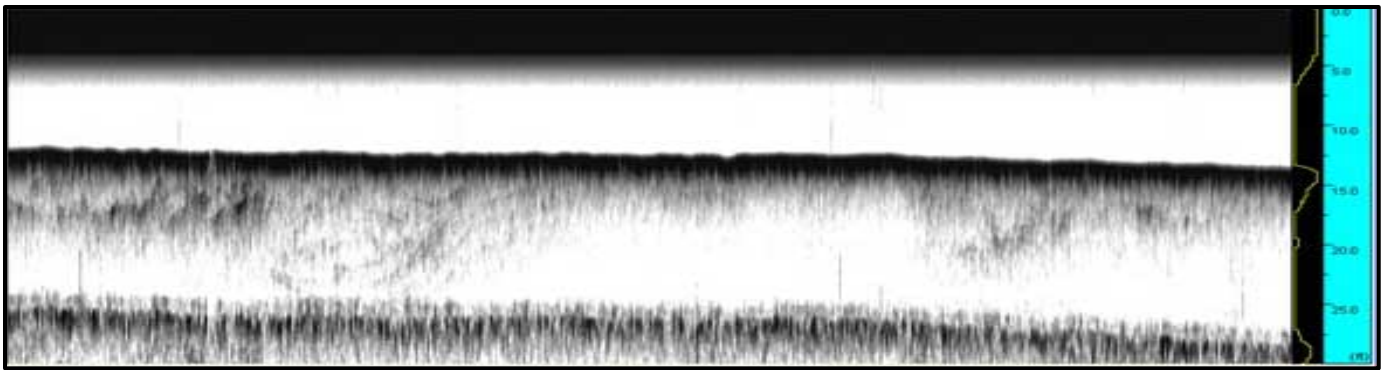


Figure 37. Representative Sub Bottom Data: Arverne West Project Area - Survey Lane 3

Notes: 1) File # 115139
2) Scale in Feet

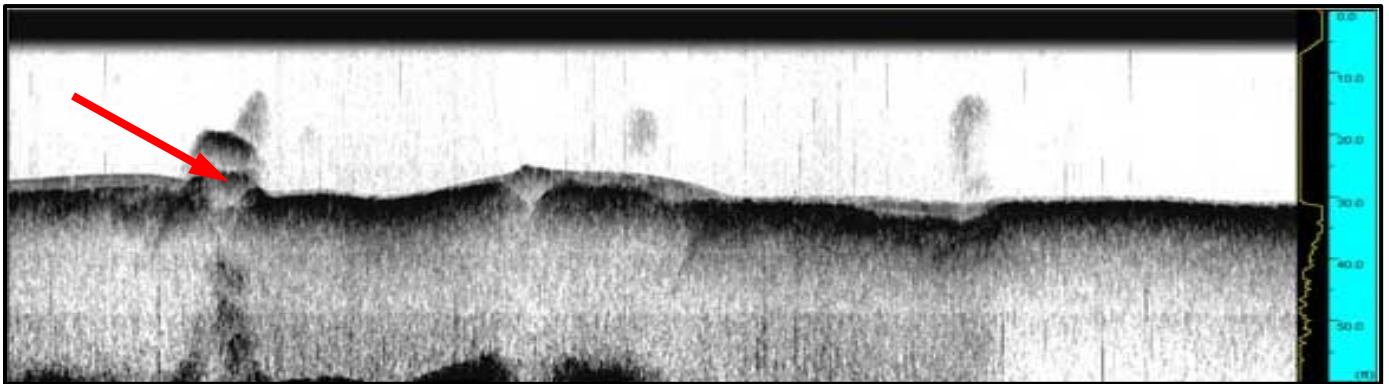


Figure 38. Representative Sub Bottom Data: Arverne East Project Area - Survey Lane 1

Notes: 1) File # 121030
2) Scale in Feet
3) Large Wreck (Target 13-1) is indicated with red arrow

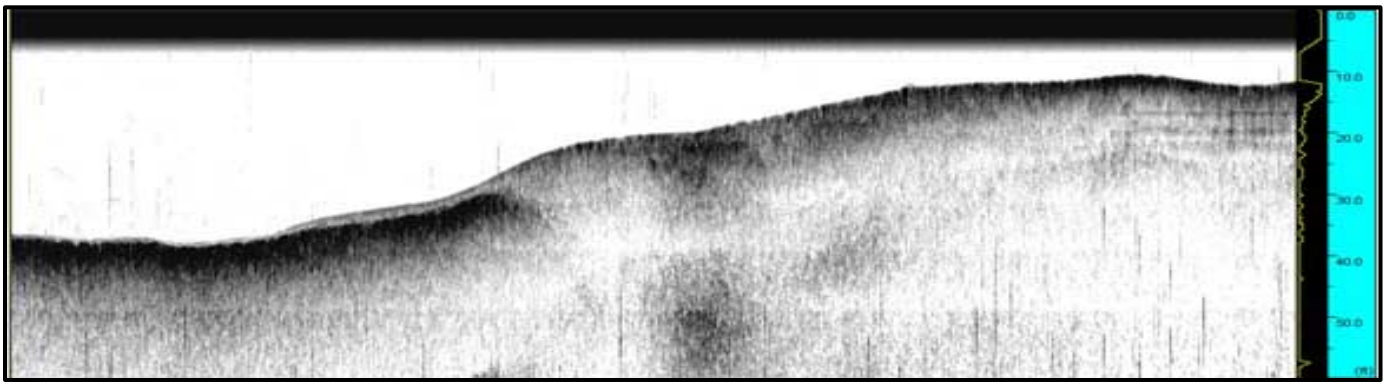


Figure 39. Representative Sub Bottom Data: Arverne East Project Area - Survey Lane 3

Notes: 1) File # 124107
2) Scale in Feet

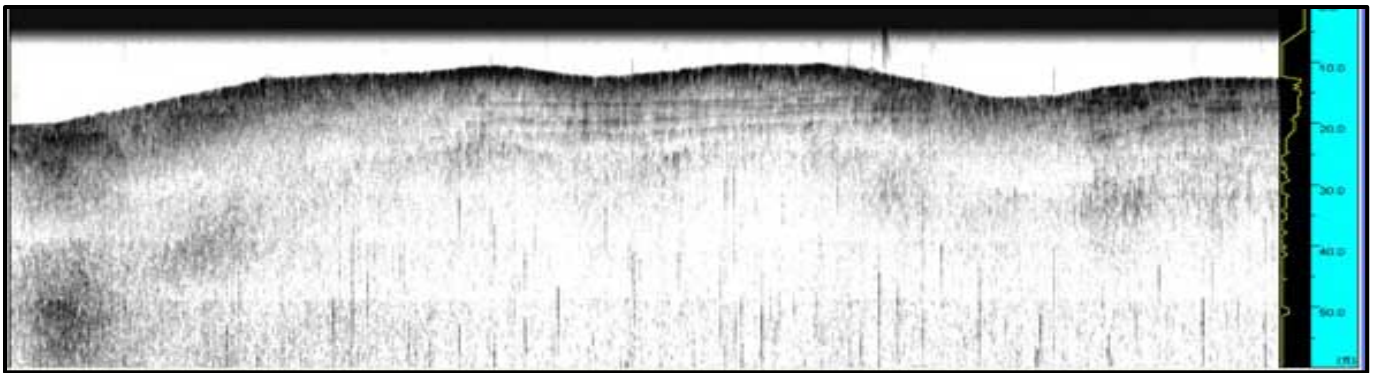


Figure 40. Representative Sub Bottom Data: Edgemere Project Area - Survey Lane 1

Notes: 1) File # 131833
2) Scale in Feet

3.6 Evaluation of Remote Sensing Targets

Target signatures were evaluated using the National Register of Historic Places (NRHP) criteria as a basis for the assessment. For example, although a historic object might produce a remote sensing target signature, it is unlikely that a single object (such as a historic anchor or cannon ball) has the potential to meet the criteria for nomination to the NRHP.

Target assessment was based primarily on the nature and characteristics of the acoustic and magnetic signatures. Shipwrecks – large or small – often have distinctive acoustic signatures, which are characterized by geometrical features typically found only in a floating craft. Most geometrical features identified on the bottom (in open water) are manmade objects. Often an acoustic signature will have an associated magnetic signature. Generally, if the acoustic signature demonstrates geometric forms or intersecting lines with some relief above the bottom surface and have a magnetic signature of any sort; it can be categorized as a potentially significant target. Often, modern debris near docks, bridges, or an anchorage is easily identified solely based on the characteristics of its acoustic signature. However, it is more common to find material partially exposed. Frequently, these objects produce a record that obviously indicates a man-made object, but the object is impossible to identify or date. Also, in making an archaeological assessment of any sonar target, the history and modern use of the waterway must be taken into consideration. Naturally, historically active areas tend to have greater potential for submerged cultural resources. The assessment process prioritizes targets for further underwater archaeological investigations.

Magnetic target signatures alone are more difficult to assess. Without any supporting acoustic records, the type of bottom sediments and the water currents become more important to the assessment process. A small, single-source magnetic signature has the least potential to be a significant cultural resource. Although it might represent a single historic object, this type of signature has limited potential to meet NRHP criteria.

A more complex magnetic anomaly, represented by a broad monopolar or dipolar type signature, has a greater potential to be a significant cultural resource, depending on bottom type. Shipwrecks that occur in areas where the sea floor is relatively firm tend to remain exposed and are often visible on sonar records. A magnetic anomaly that is identified in such an area and has no associated acoustic signature frequently can be discounted as being a historic shipwreck. Most likely, such an anomaly is modern debris such as wire rope, chain, discarded materials, or other ferrous material.

Soft migrating sand or mud can bury large wrecks, leaving little or no indication of their presence on the bottom surface (via sonar data). The types of magnetic signatures that a boat or ship might produce are infinite, because of the large number of variables including location, position, chemical environment, other metals, vessel type, cargo, sea state, etc. These variables are what determine the characteristics of every magnetic target signature. Since shipwrecks often occur in a dynamic environment, many of the variables are subject to constant change. Thus, in assessing a magnetic anomalies potential to represent a significant cultural resource, investigators must be circumspect in their predictions.

Broad, multi-component signatures (again, depending on bottom characteristics and other factors) often have the greatest potential to represent a shipwreck. On the other hand, high-intensity, multi-component, magnetic signatures (without an accompanying acoustic signature) in areas of relatively high velocity currents can be discounted as a historic resource. Eddies created by the high-velocity currents almost always keep some portion of a wreck exposed. Generally, wire rope or some other low-profile ferrous debris produces this type of signature in these circumstances. Many types of magnetic anomalies display characteristics that are not easily interpreted. The only definitive method of determining the nature of the object creating these anomalies is by physical examination.

Typically, target locations with suspect cultural resource images on the sonar records coupled with associated and appropriate magnetic signatures are classified as high probability targets.

3.7 Submerged Cultural Resources Potential

Historic research reveals that many shipwrecks are reported in the offshore areas near Rockaway, but there is little to no evidence of shipwreck sites located in the areas that constitute the survey areas of Arverne (East and West) and Edgemere. While historic research has not revealed any specific historic wrecks in the project APEs, it does clearly show that New York Harbor has been one of the busiest maritime trading corridors on the east coast of the United states. As such, the most likely potential underwater archaeological sites in this portion of the Jamaica Bay would be abandoned commercial vessels associated with shipyards and recreational/fishing craft that sunk after coastal storms.

3.7.1 NYS CRIS Sites

The NYS CRIS does not indicate the presence of any known archaeology sites within the project APE. However, it should be noted that the CRIS system does not currently contain a robust number of submerged sites included within its system anywhere across the state of New York.

3.7.2 NOAA AWOIS Wrecks

The Coast Survey Program of the National Oceanic and Atmospheric Administration (NOAA) maintains the Automated Wreck and Obstruction Information System (AWOIS), which contains information on over 10,000 submerged wrecks and obstructions in the coastal waters of the United States, including New York Harbor and Jamaica Bay.

3.7.3 Arverne West

For the Arverne West survey area the NOAA AWOIS indicates the presence of three wrecks within the survey area and one on its southwestern margin.

Table 6: NOAA AWOIS Wrecks in Arverne West APE

AWOIS ID	Type	Latitude	Longitude
Wreck 5391	Wrecks - Visible	40.595264	-73.804756
Wreck 5339	Wrecks - Submerged, dangerous	40.595947	-73.805145
Wreck 5341	Wrecks - Submerged, non-dangerous	40.600658	-73.792053
Wreck 5394	Wrecks - Submerged, non-dangerous	40.60096	-73.791603

3.7.4 Arverne East.

For the Arverne west survey area, the NOAA AWOIS indicates the presence of seven wreck sites distributed along its length.

Table 7: NOAA AWOIS Wrecks in Arverne East APE

AWOIS ID	Type	Latitude	Longitude
Wreck 5366	Wrecks - Submerged, dangerous	40.595356	-73.790794
Wreck 5408	Wrecks - Submerged, dangerous	40.596806	-73.790749
Wreck 5377	Wrecks - Submerged, dangerous	40.597698	-73.790565
Wreck 5353	Type: Wrecks Visible	40.597557	-73.789276
Wreck 5416	Wrecks - Submerged, dangerous	40.597961	-73.789795
Wreck 5386	Wrecks - Visible	40.598373	-73.788933
Wreck 5368	Wrecks - Submerged, dangerous	40.599186	-73.789497

3.7.5 Edgemere

The NOAA AWOIS does not indicate the presence of any wreck sites within the Edgemere APE.

3.7.6 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, generally excepting reconstructions and reproductions, are considered historic if they are eligible for listing in the National Register of Historic Places at a local, regional, national, or international level of significance. To be eligible for the National Register of Historic Places, 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." To be considered significant the vessel or site must meet one or more of four National Register criteria:

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 regarding 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 Jamaica Bay environment. Architecture, commerce, engineering, industry, invention, maritime history, transportation are potentially applicable data categories for the type of submerged cultural resources that may be expected in the Jamaica Bay study areas.

4.0 Results

While both the side-scan sonar and magnetometer data sets were analyzed, an emphasis was placed on the side-scan sonar imagery due to the unreliability of magnetic data attributable to the very high levels of background disturbances in the earth's magnetic field across all three project areas, Arverne East, Arverne West, and Edgemere areas. These disturbances were generated by the proximity of ferrous materials along all the shorelines in the project areas. Magnetic disturbances were generally recorded across all three of the Project Areas. Sonar and sub-bottom records were inspected for potential man-made features present on and beneath the bottom surface. All side-scan sonar targets were analyzed according to their spatial extent, configuration, location, and environmental context. Overall, the goal of the remote sensing survey was to determine the number, locations, cultural affiliations, components, spatial distribution, data potential, and other salient characteristics of all potential significant submerged cultural resources within the three Jamaica Bay Project Areas.

A total of 66 side-scan sonar targets were identified from the remote sensing survey: 14 in the Arverne West Project Area; 26 in the Arverne East Project Area; and 26 in the Edgemere Project Area. The types of targets within each project area were broken down into three general target types: Small Boats; Linear/ Rectangular/Debris; and Potentially Significant Sites. A complete listing and description of all remote sensing targets are contained in Tables 8-10.

4.1 Arverne West

The 14 targets in the Arverne West Project Area were classified as eight Small Boat sites, one linear/rectangular/debris site, and five Potentially Significant sites (Figure 41 and Table 8). Of the five Potentially Significant Sites in the Arverne West Project Area, four are suggestive of hulls of large vessels and one is the framework from a suspect crane or navigational-aid tower. One of the wreck sites is a partially exposed, large tugboat and the other three wrecks appear to be wooden hulled, square-ended barges.

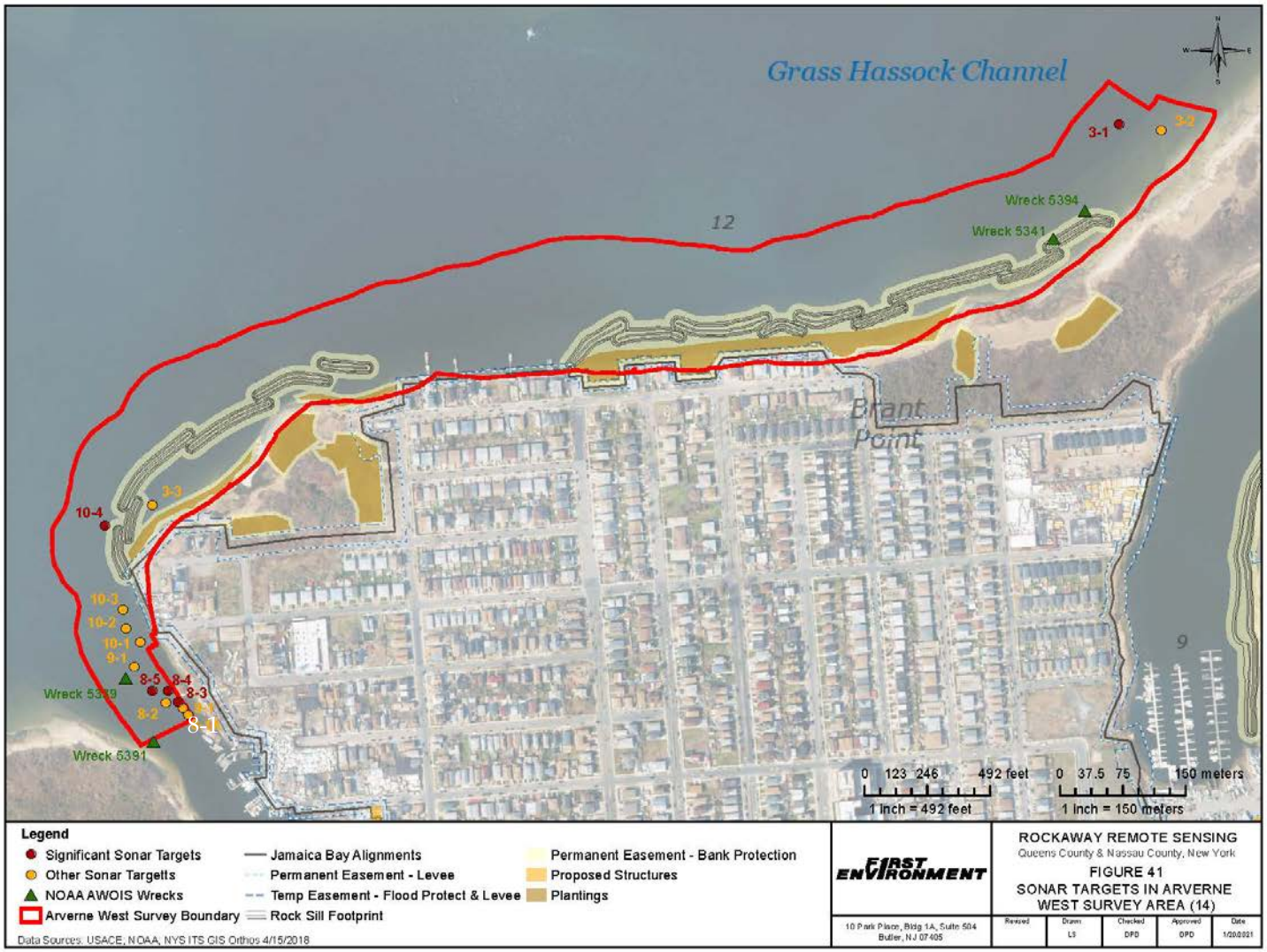
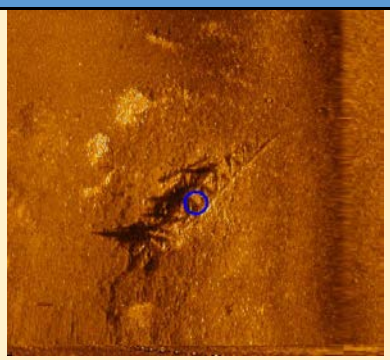
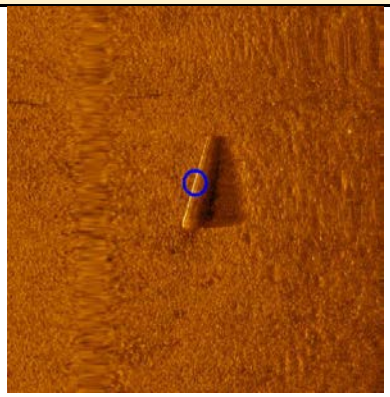


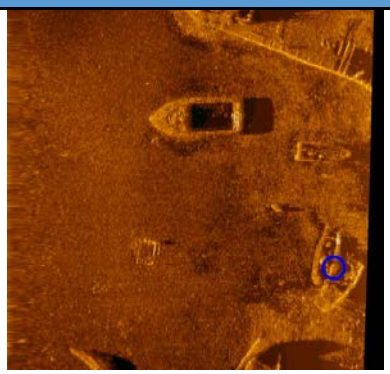
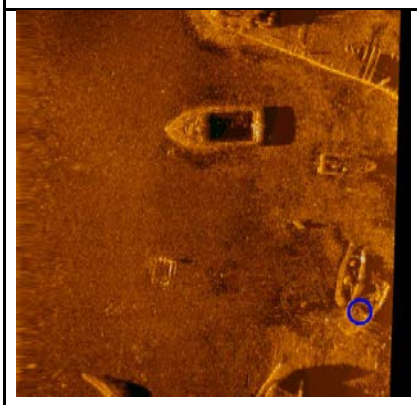
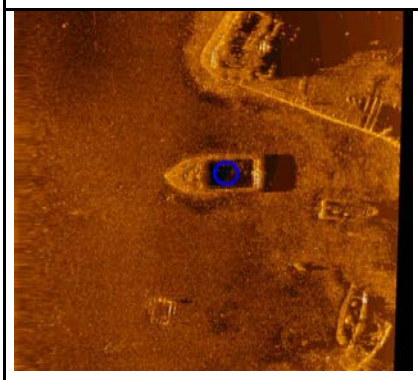
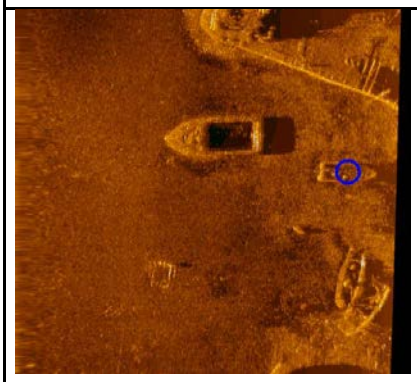
Figure 41. Sonar Targets in Arverne West Survey Area (14)

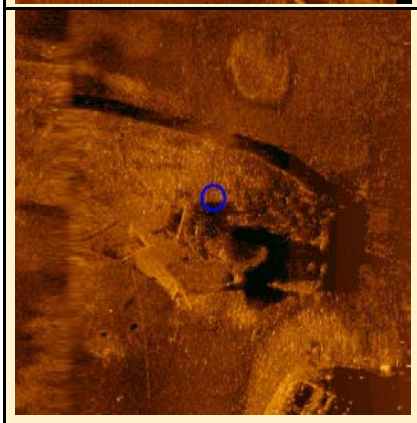
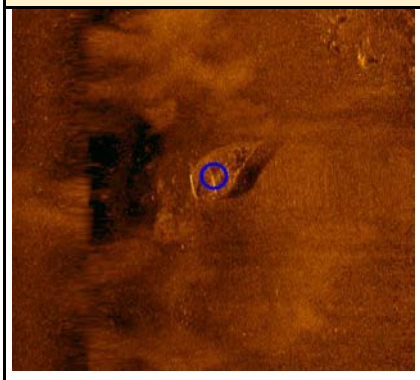
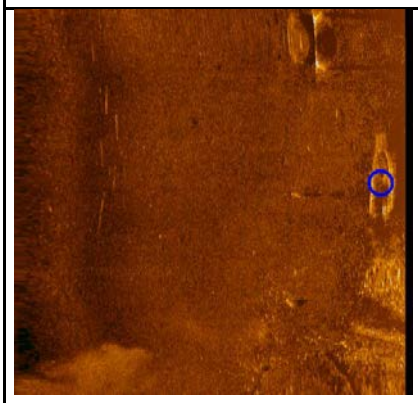
Note: 1) Locations of 14 sonar targets are indicated and listed in Table 8.

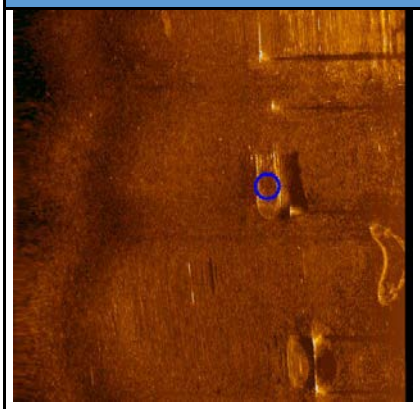
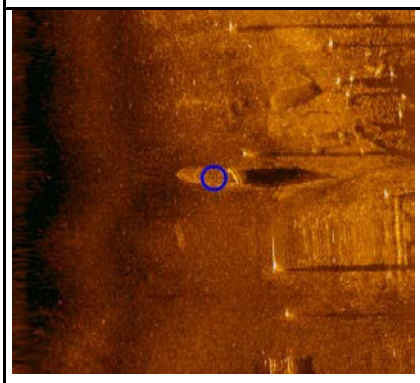
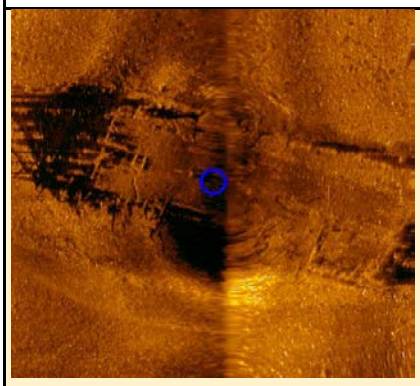
Table 8. Sonar Targets in Arverne West Survey Area (14)

Notes: 1) Coordinates are expressed in New York (Long Island) State Plane Coordinates, feet
2) Shaded Targets = Potentially Significant (5)
3) See Figure 41

Target Image	Target Information	Characteristics
	3-1 ● Click Position 40° 36.11343' N 073° 47.46796' W (WGS84) (X) 1042250.08 (Y) 158630.49 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Arverne West\2020SEP23_0003.sds ● Line Name: 2020SEP23_0003	Dimensions and attributes ● Target Width: 7.92 US ft ● Target Height: 3.43 US ft ● Target Length: 48.77 US ft ● Mag Anomaly: Yes ● Description: A long rectangular feature that is partially buried. This feature has framing components.
	3-2 ● Click Position 40° 36.10938' N 073° 47.43165' W (WGS84) (X) 1042418.16 (Y) 158606.35 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Arverne West\2020SEP23_0003.sds ● Line Name: 2020SEP23_0003	Dimensions and attributes ● Target Width: 3.14 US ft ● Target Height: 2.90 US ft ● Target Length: 28.37 US ft ● Mag Anomaly: No ● Description: A linear feature lying flat on the bottom - suspect displaced wood pile
	3-3 ● Click Position 40° 35.86871' N 073° 48.28632' W (WGS84) (X) 1038465.87 (Y) 157135.82 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Arverne West\2020SEP23_0003.sds ● Line Name: 2020SEP23_0003	Dimensions and attributes ● Target Width: 35.62 US ft ● Target Height: 0.40 US ft ● Target Length: 84.20 US ft ● Mag Anomaly: Yes ● Description: Long rectangular structure that is partially buried. Possibly the bottom of a barge-like vessel. At least four parallel stringers are exposed. Other linear debris is strewn on the bottom in this vicinity.

Target Image	Target Information	Characteristics
	**8-1** ● Click Position 40° 35.73765' N 073° 48.26047' W (WGS84) (X) 1038587.30 (Y) 156340.27 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: C:\SonarWiz-Projects\Arverne West\CSF\2020SEP23_0008-CH12-to-2020SEP23_0010-CH12.csf ● Line Name: 2020SEP23_0008-CH12-to-2020SEP23_0010-CH12	**Dimensions and attributes** ● Target Width: 7.60 US ft ● Target Height: 2.24 US ft ● Target Length: 16.74 US ft ● Mag Anomaly: Yes ● Description: Two small boats lying side by side near shoreline. Each boat is approximately 17' x 7'. Four small boat wrecks lie in this vicinity.
	**8-1A** ● Click Position 40° 35.73309' N 073° 48.25647' W (WGS84) (X) 1038605.88 (Y) 156312.65 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: C:\SonarWiz-Projects\Arverne West\CSF\2020SEP23_0008-CH12-to-2020SEP23_0010-CH12.csf ● Line Name: 2020SEP23_0008-CH12-to-2020SEP23_0010-CH12	**Dimensions and attributes** ● Target Width: 7.45 US ft ● Target Height: 2.20 US ft ● Target Length: 16.67 US ft ● Mag Anomaly: Yes ● Description: Small square ended boat laying alongside of 2nd boat of similar size. Four small boat wrecks lie in this vicinity.
	**8-2** ● Click Position 40° 35.74124' N 073° 48.27533' W (WGS84) (X) 1038518.47 (Y) 156361.90 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: C:\SonarWiz-Projects\Arverne West\CSF\2020SEP23_0008-CH12-to-2020SEP23_0010-CH12.csf ● Line Name: 2020SEP23_0008-CH12-to-2020SEP23_0010-CH12	**Dimensions and attributes** ● Target Width: 12.54 US ft ● Target Height: 4.12 US ft ● Target Length: 29.07 US ft ● Mag Anomaly: Yes ● Description: 29' x 12' boat lying flat on bottom surface. Four small boat wrecks lie in this vicinity.
	**8-3** ● Click Position 40° 35.74168' N 073° 48.26529' W (WGS84) (X) 1038564.94 (Y) 156364.68 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: C:\SonarWiz-Projects\Arverne West\CSF\2020SEP23_0008-CH12-to-2020SEP23_0010-CH12.csf ● Line Name: 2020SEP23_0008-CH12-to-2020SEP23_0010-CH12	**Dimensions and attributes** ● Target Width: 6.01 US ft ● Target Height: 1.34 US ft ● Target Length: 16.07 US ft ● Mag Anomaly: Yes ● Description: Small boat (16') lying flat on the bottom surface. Four small boat wrecks lie in this vicinity.

Target Image	Target Information	Characteristics
	**8-4** ● Click Position 40° 35.74887' N 073° 48.27333' W (WGS84) (X) 1038527.64 (Y) 156408.28 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: C:\SonarWiz-Projects\Arverne West\CSF\2020SEP23_0008-CH12-to-2020SEP23_0010-CH12.csf ● Line Name: 2020SEP23_0008-CH12-to-2020SEP23_0010-CH12	**Dimensions and attributes** ● Target Width: 28.98 US ft ● Target Height: 7.40 US ft ● Target Length: 101.40 US ft ● Mag Anomaly: Yes ● Description: The stern section of a large tug. The bow end of this tug is exposed on/next to the shoreline.
	**8-5** ● Click Position 40° 35.74873' N 073° 48.28702' W (WGS84) (X) 1038464.28 (Y) 156407.26 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: C:\SonarWiz-Projects\Arverne West\CSF\2020SEP23_0008-CH12-to-2020SEP23_0010-CH12.csf ● Line Name: 2020SEP23_0008-CH12-to-2020SEP23_0010-CH12	**Dimensions and attributes** ● Target Width: 38.02 US ft ● Target Height: 8.31 US ft ● Target Length: 126.65 US ft ● Mag Anomaly: Yes ● Description: A large square ended vessel with a tapered bow is resting flat on the bottom surface. The large hull (126' x 38') also has collapsed debris on its deck - possibly part of a cabin. This wreck site has more than 8' of elevation above the surrounding bottom surface.
	**9-1** ● Click Position 40° 35.76457' N 073° 48.30219' W (WGS84) (X) 1038393.84 (Y) 156503.30 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: C:\SonarWiz-Projects\Arverne West\CSF\2020SEP23_0008-CH12-to-2020SEP23_0010-CH12.csf ● Line Name: 2020SEP23_0008-CH12-to-2020SEP23_0010-CH12	**Dimensions and attributes** ● Target Width: 12.23 US ft ● Target Height: 4.08 US ft ● Target Length: 23.41 US ft ● Mag Anomaly: Yes ● Description: A squared ended vessel with a tapered bow is lying flat on the bottom surface. Suggestive of a sailboat hull
	**10-1** ● Click Position 40° 35.78006' N 073° 48.29683' W (WGS84) (X) 1038418.45 (Y) 156597.40 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: C:\SonarWiz-Projects\Arverne West\CSF\2020SEP23_0008-CH12-to-2020SEP23_0010-CH12.csf ● Line Name: 2020SEP23_0008-CH12-to-2020SEP23_0010-CH12	**Dimensions and attributes** ● Target Width: 8.44 US ft ● Target Height: 0.00 US ft ● Target Length: 19.91 US ft ● Mag Anomaly: Yes ● Description: Small boat lying flat on bottom near shoreline

Target Image	Target Information	Characteristics
	10-2 ● Click Position 40° 35.78917' N 073° 48.30878' W (WGS84) (X) 1038363.02 (Y) 156652.62 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: C:\SonarWiz-Projects\Arverne West\CSF\2020SEP23_0008-CH12-to-2020SEP23_0010-CH12.csf ● Line Name: 2020SEP23_0008-CH12-to-2020SEP23_0010-CH12	Dimensions and attributes ● Target Width: 7.14 US ft ● Target Height: 2.01 US ft ● Target Length: 19.60 US ft ● Mag Anomaly: Yes ● Description: A small boat hull is lying flat on the bottom adjacent to a piling near shoreline.
	10-3 ● Click Position 40° 35.80103' N 073° 48.31128' W (WGS84) (X) 1038351.29 (Y) 156724.60 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: C:\SonarWiz-Projects\Arverne West\CSF\2020SEP23_0008-CH12-to-2020SEP23_0010-CH12.csf ● Line Name: 2020SEP23_0008-CH12-to-2020SEP23_0010-CH12	Dimensions and attributes ● Target Width: 6.44 US ft ● Target Height: 5.61 US ft ● Target Length: 20.75 US ft ● Mag Anomaly: Yes ● Description: A small boat is lying perpendicular to the shoreline.
	10-4 ● Click Position 40° 35.85552' N 073° 48.32641' W (WGS84) (X) 1038280.53 (Y) 157055.29 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: C:\SonarWiz-Projects\Arverne West\CSF\2020SEP23_0008-CH12-to-2020SEP23_0010-CH12.csf ● Line Name: 2020SEP23_0008-CH12-to-2020SEP23_0010-CH12	Dimensions and attributes ● Target Width: 36.77 US ft ● Target Height: 6.49 US ft ● Target Length: 107.70 US ft ● Mag Anomaly: Yes ● Description: A large squared ended barge-like wood hull is lying flat on the bottom.

4.2 Arverne East

Twenty-six targets were identified in the Arverne East Project Area (Figure 42 and Table 9). Many of the small boat targets were located directly under floating docks at Marina 59 at the south end of the project area. The 26 targets in this area were characterized as follows: eight were listed as Small Boats, eight were Linear/Rectangular/Debris sites, and 10 were Potentially Significant sites. Two of these 10 sites, Targets 16-3 and 16-8, lie alongside the shoreline and may be either square ended barges or failed sections of dock. All the potentially significant sites in Arverne East were large rectangular sites ranging in length from 89 feet (27.1m) to 176 feet (53.6m). Five of the sites were over 100 feet (30.4m) long and the average width was approximately 27 feet (8.2m). The sites include square-ended barges, tugs, sailing vessels, work boats and possible sections of collapsed docks. Most appear to be wood hull vessels.

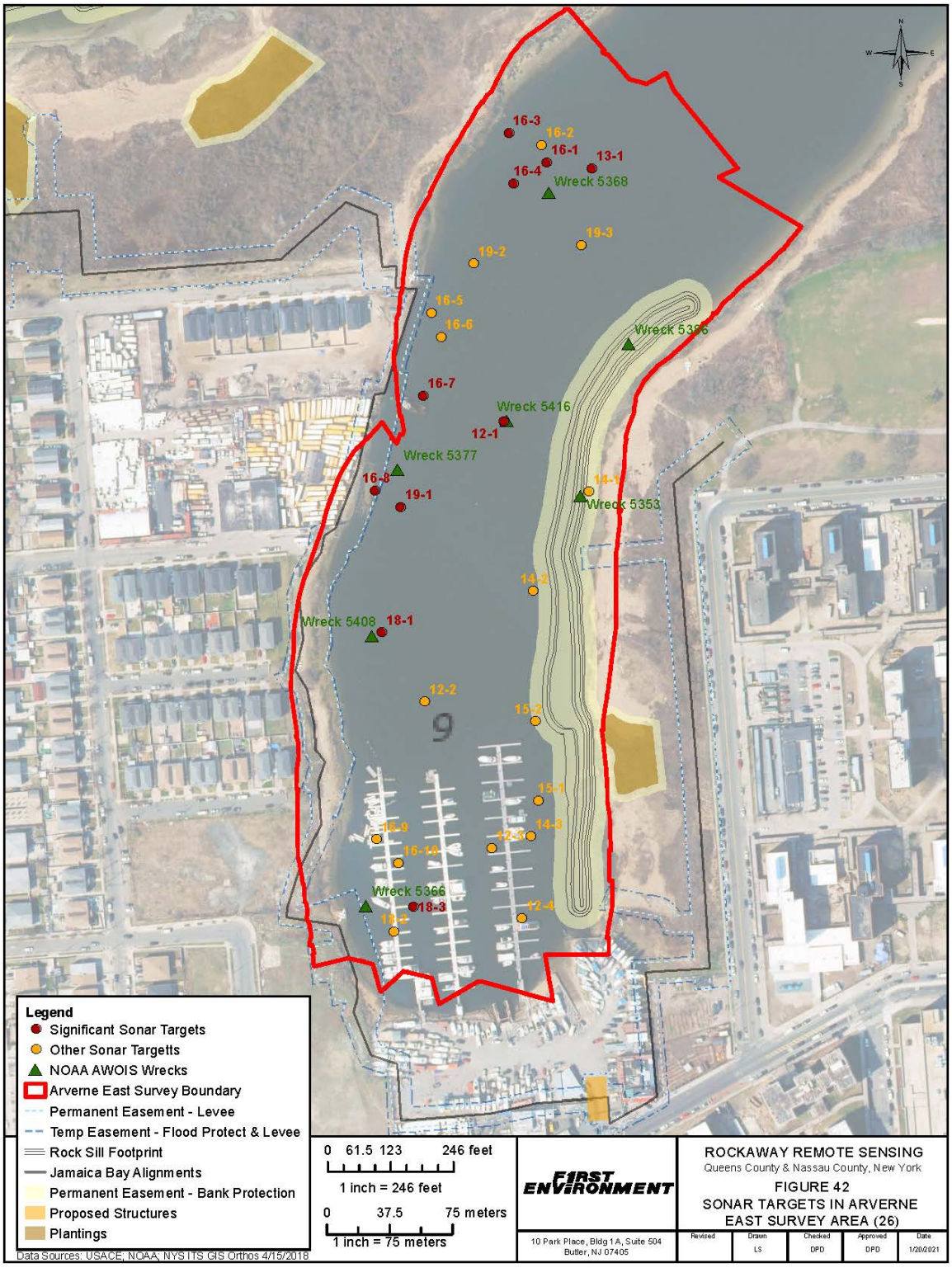
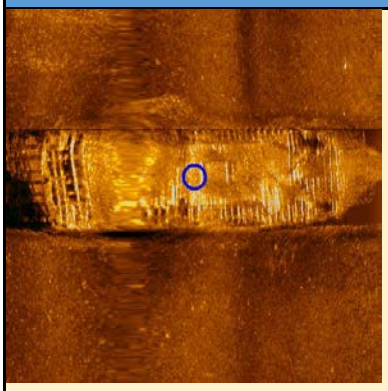
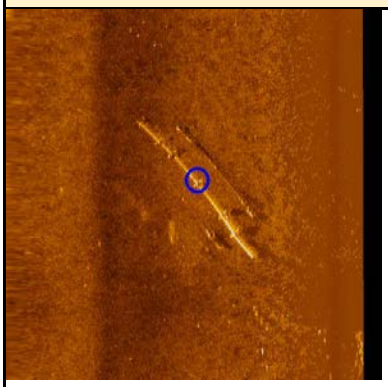
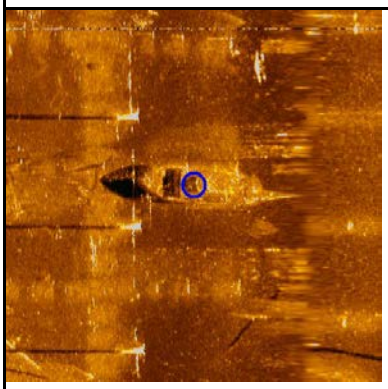


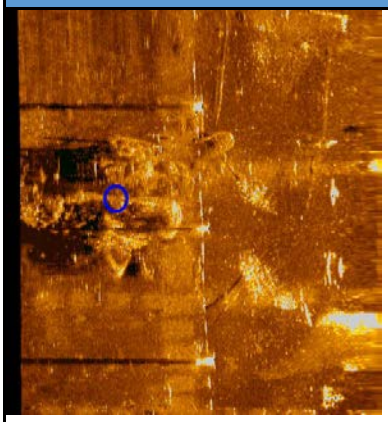
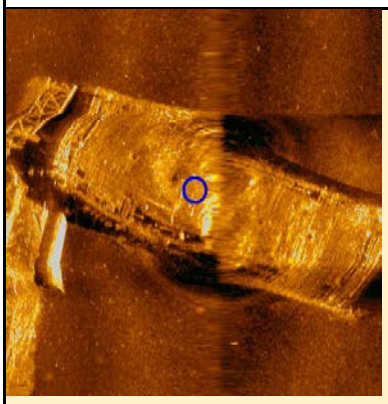
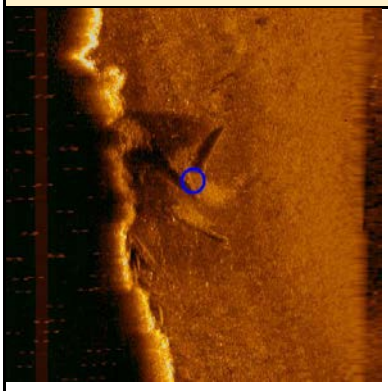
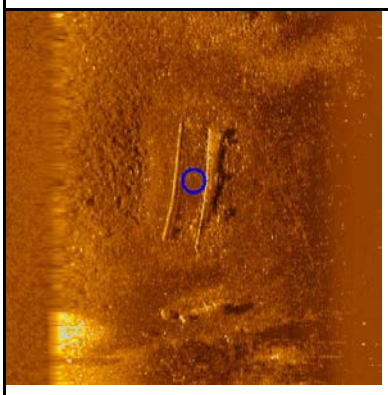
Figure 42. Sonar Targets in Arverne East Survey Area (26)

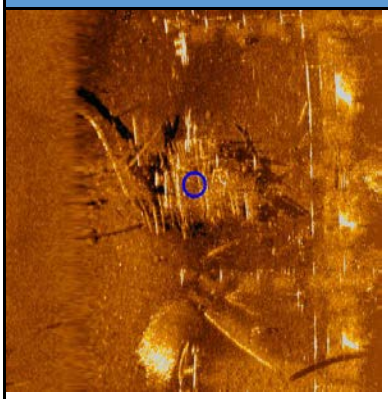
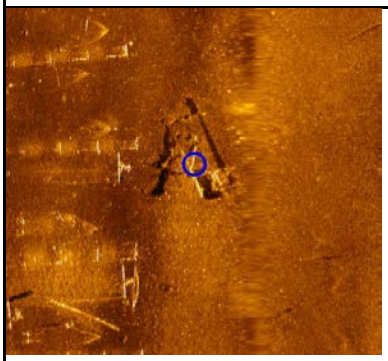
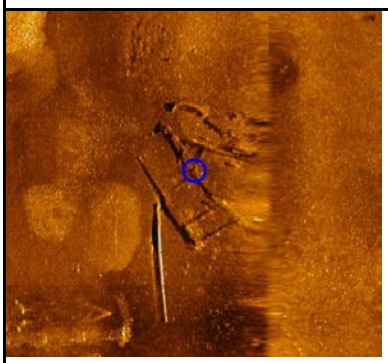
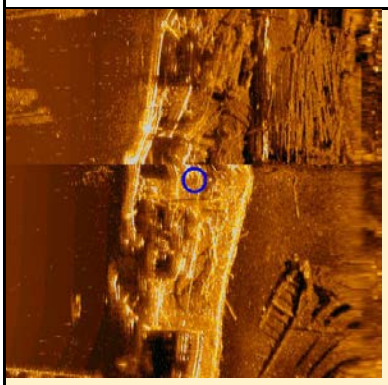
Notes: 1) Locations of 26 sonar targets are indicated and listed in Table 9.
2) Marina 59 was located at the south end of this project area

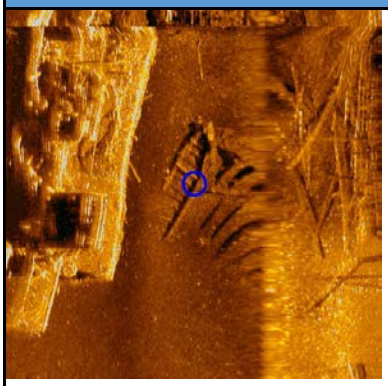
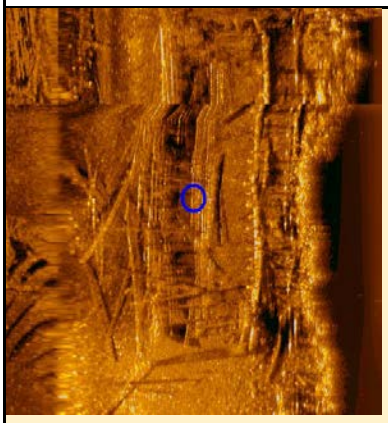
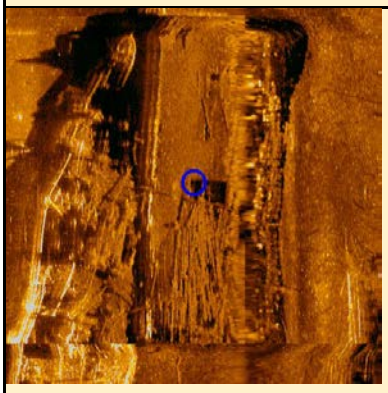
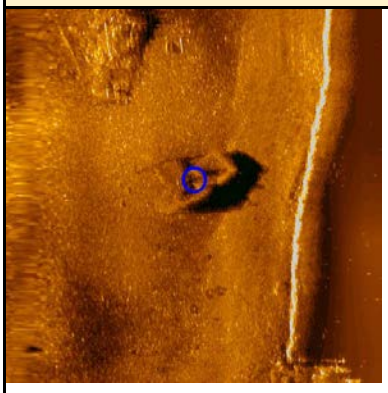
Table 9. Sonar Targets in Arverne East Survey Area (26)

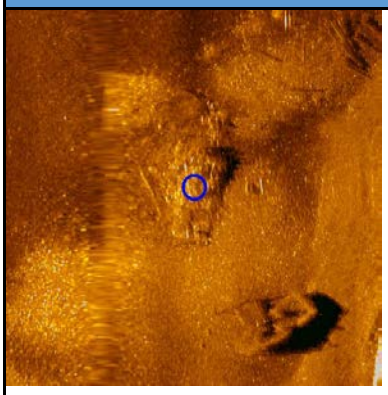
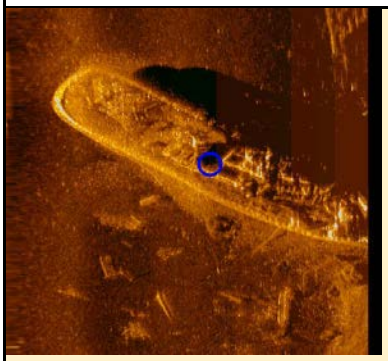
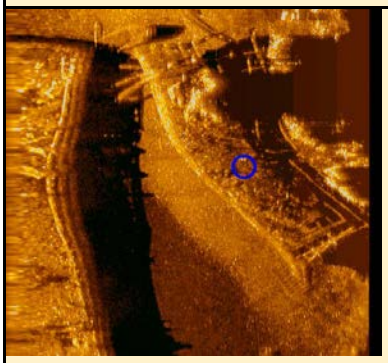
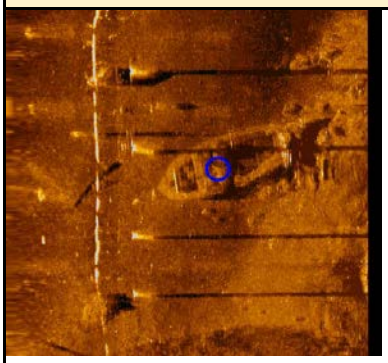
Notes: 1) Coordinates are expressed in New York (Long Island) State Plane Coordinates, feet
2) Shaded Targets = Potentially Significant (10)
3) See Figure 42.

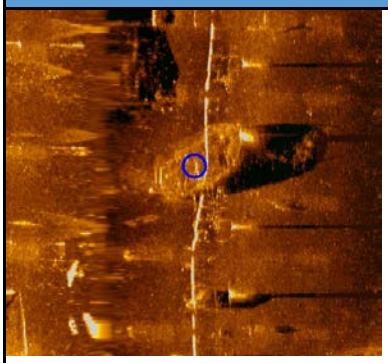
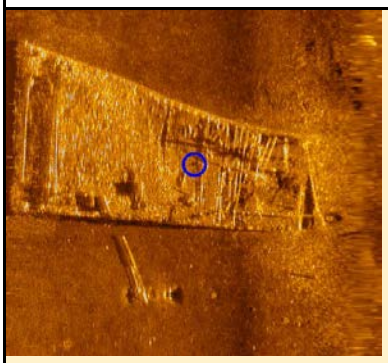
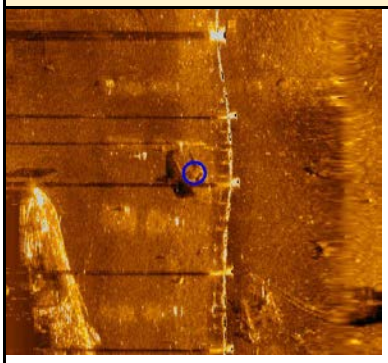
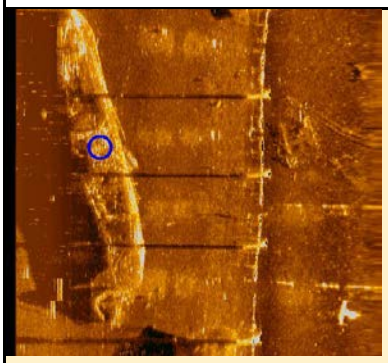
Target Image	Target Info	User Entered Info
	**12-1** ● Click Position 40° 35.87763' N 073° 47.38911' W (WGS84) (X) 1042618.42 (Y) 157199.60 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Arverne East\2020SEP23_0012.sds ● Line Name: 2020SEP23_0012	**Dimensions and attributes** ● Target Width: 30.63 US ft ● Target Height: 7.90 US ft ● Target Length: 121.44 US ft ● Mag Anomaly: Yes ● Description: A large bluff bowed wood hull barge-like vessel. Hull is 121' x 30' and rises approximately 8 feet off the bottom surface.
	**12-2** ● Click Position 40° 35.78729' N 073° 47.42283' W (WGS84) (X) 1042463.67 (Y) 156650.69 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Arverne East\2020SEP23_0012.sds ● Line Name: 2020SEP23_0012	**Dimensions and attributes** ● Target Width: 16.96 US ft ● Target Height: 0.00 US ft ● Target Length: 55.49 US ft ● Mag Anomaly: Yes ● Description: A 55' long linear feature (suspect drive shaft) is attached to a partially buried rectangular feature (possible lower section of a former boat hull).
	**12-3** ● Click Position 40° 35.73993' N 073° 47.39452' W (WGS84) (X) 1042595.41 (Y) 156363.40 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Arverne East\2020SEP23_0012.sds ● Line Name: 2020SEP23_0012	**Dimensions and attributes** ● Target Width: 9.85 US ft ● Target Height: 3.56 US ft ● Target Length: 29.72 US ft ● Mag Anomaly: Yes ● Description: Small boat is lying flat on bottom in the center slipway of marina.

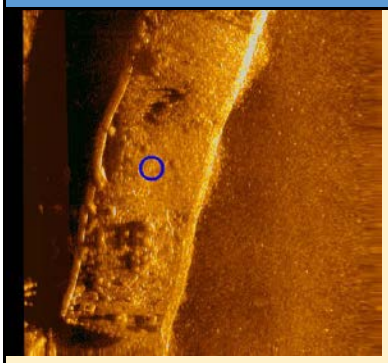
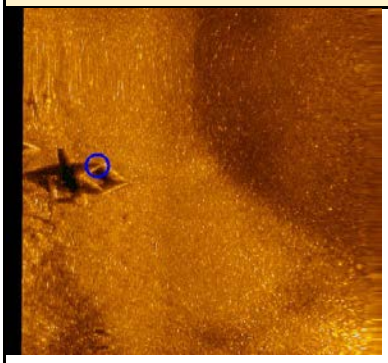
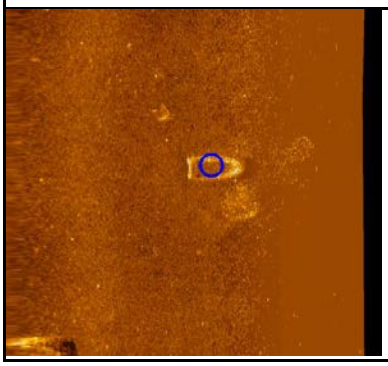
Target Image	Target Info	User Entered Info
	**12-4** ● Click Position 40° 35.71739' N 073° 47.38175' W (WGS84) (X) 1042654.84 (Y) 156226.68 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Arverne East\2020SEP23_0012.sds ● Line Name: 2020SEP23_0012	**Dimensions and attributes** ● Target Width: 41.24 US ft ● Target Height: 4.21 US ft ● Target Length: 54.68 US ft ● Mag Anomaly: ● Description: Large cluster of debris that appears to contain several small boat hulls. This debris cluster is in the center slipway at marina.
	**13-1** ● Click Position 40° 35.95899' N 073° 47.35156' W (WGS84) (X) 1042791.04 (Y) 157694.01 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Arverne East\2020SEP23_0013.sds ● Line Name: 2020SEP23_0013	**Dimensions and attributes** ● Target Width: 32.53 US ft ● Target Height: 9.63 US ft ● Target Length: 122.53 US ft ● Mag Anomaly: Yes ● Description: Large square ended barge- like vessel that has more than 9' of elevation off the bottom surface. A section of framework is laying off the near shore end. This wreck is laying perpendicular to another larger wreck (Target 16-1) on the inshore side.
	**14-1** ● Click Position 40° 35.85482' N 073° 47.35315' W (WGS84) (X) 1042785.17 (Y) 157061.51 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Arverne East\2020SEP23_0014.sds ● Line Name: 2020SEP23_0014	**Dimensions and attributes** ● Target Width: 23.68 US ft ● Target Height: 1.37 US ft ● Target Length: 33.25 US ft ● Mag Anomaly: Yes ● Description: A scatter of linear debris along the shoreline that covers an area approximately 33' x 24'
	**14-2** ● Click Position 40° 35.82285' N 073° 47.37671' W (WGS84) (X) 1042676.60 (Y) 156867.07 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Arverne East\2020SEP23_0014.sds ● Line Name: 2020SEP23_0014	**Dimensions and attributes** ● Target Width: 13.98 US ft ● Target Height: 0.00 US ft ● Target Length: 35.12 US ft ● Mag Anomaly: Yes ● Description: Rectangular, flat feature is partially buried in the bottom sediments.

Target Image	Target Info	User Entered Info
	**14-3** ● Click Position 40° 35.74369' N 073° 47.37808' W (WGS84) (X) 1042671.43 (Y) 156386.43 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Arverne East\2020SEP23_0014.sds ● Line Name: 2020SEP23_0014	**Dimensions and attributes** ● Target Width: 24.22 US ft ● Target Height: 0.00 US ft ● Target Length: 32.43 US ft ● Mag Anomaly: Yes ● Description: A cluster of wooden debris is lying flat on the bottom in the eastern slipway of marina. Suggestive of dock debris.
	**15-1** ● Click Position 40° 35.75531' N 073° 47.37486' W (WGS84) (X) 1042686.15 (Y) 156457.00 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Arverne East\2020SEP23_0015.sds ● Line Name: 2020SEP23_0015	**Dimensions and attributes** ● Target Width: 12.05 US ft ● Target Height: 2.74 US ft ● Target Length: 30.12 US ft ● Mag Anomaly: Yes ● Description: Rectangular feature with several linear components is in the eastern slipway of marina.
	**15-2** ● Click Position 40° 35.78082' N 073° 47.37603' W (WGS84) (X) 1042680.37 (Y) 156611.90 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Arverne East\2020SEP23_0015.sds ● Line Name: 2020SEP23_0015	**Dimensions and attributes** ● Target Width: 16.43 US ft ● Target Height: 1.42 US ft ● Target Length: 38.87 US ft ● Mag Anomaly: Yes ● Description: At least 2 rectangular features with linear components are lying flat on the bottom in the eastern slipway of marina.
	**16-1** ● Click Position 40° 35.96101' N 073° 47.37056' W (WGS84) (X) 1042703.04 (Y) 157706.06 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Arverne East\2020SEP23_0016.sds ● Line Name: 2020SEP23_0016	**Dimensions and attributes** ● Target Width: 37.01 US ft ● Target Height: 9.55 US ft ● Target Length: 176.53 US ft ● Mag Anomaly: Yes ● Description: A large ship hull (176' x 36') that extends up than 9' above the bottom surface. Part of a cluster of five wrecks near the western shoreline in cove.

Target Image	Target Info	User Entered Info
	16-2 ● Click Position 40° 35.96665' N 073° 47.37278' W (WGS84) (X) 1042692.73 (Y) 157740.32 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Arverne East\2020SEP23_0016.sds ● Line Name: 2020SEP23_0016	Dimensions and attributes ● Target Width: 15.66 US ft ● Target Height: 1.62 US ft ● Target Length: 37.20 US ft ● Mag Anomaly: Yes ● Description: A rectangular section of a smaller boat hull is lying flat on the bottom amid numerous wrecks in this vicinity. This feature is partially buried.
	16-3 ● Click Position 40° 35.97046' N 073° 47.38666' W (WGS84) (X) 1042628.42 (Y) 157763.30 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Arverne East\2020SEP23_0016.sds ● Line Name: 2020SEP23_0016	Dimensions and attributes ● Target Width: 32.66 US ft ● Target Height: 1.09 US ft ● Target Length: 89.18 US ft ● Mag Anomaly: Yes ● Description: A disarticulated lower hull of a square-ended vessel. Highly deteriorated wood structure is laying adjacent to the western shoreline bulkhead. Suspect hull of square ended vessel or a failed section of dock.
	16-4 ● Click Position 40° 35.95416' N 073° 47.38464' W (WGS84) (X) 1042637.97 (Y) 157664.35 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Arverne East\2020SEP23_0016.sds ● Line Name: 2020SEP23_0016	Dimensions and attributes ● Target Width: 27.36 US ft ● Target Height: 07.42 US ft ● Target Length: 98.47 US ft ● Mag Anomaly: Yes ● Description: A square ended wood hull barge like vessel. This large hull is laying adjacent to wreck identified as Target 16-1. Part of cluster of 5 wrecks in this vicinity.
	16-5 ● Click Position 40° 35.91249' N 073° 47.41972' W (WGS84) (X) 1042476.25 (Y) 157410.95 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Arverne East\2020SEP23_0016.sds ● Line Name: 2020SEP23_0016	Dimensions and attributes ● Target Width: 9.35 US ft ● Target Height: 0.00 US ft ● Target Length: 26.00 US ft ● Mag Anomaly: Yes ● Description: A small boat is lying flat on bottom near western shoreline in cove.

Target Image	Target Info	User Entered Info
	16-6 ● Click Position 40° 35.90483' N 073° 47.41559' W (WGS84) (X) 1042495.46 (Y) 157364.43 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Arverne East\2020SEP23_0016.sds ● Line Name: 2020SEP23_0016	Dimensions and attributes ● Target Width: 13.13 US ft ● Target Height: 0.00 US ft ● Target Length: 25.71 US ft ● Mag Anomaly: Yes ● Description: A rectangular mound on the bottom is suggestive of a partially buried small boat hull. Located near boat wreck identified as Target 16-5.
	16-7 ● Click Position 40° 35.88579' N 073° 47.42309' W (WGS84) (X) 1042461.04 (Y) 157248.79 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Arverne East\2020SEP23_0016.sds ● Line Name: 2020SEP23_0016	Dimensions and attributes ● Target Width: 25.48 US ft ● Target Height: 7.92 US ft ● Target Length: 105.13 US ft ● Mag Anomaly: Yes ● Description: Larger boat (suspect tug) with a rounded stern that is laying perpendicular to the shoreline. Bow extends to the shoreline and is visible. This wreck is close to wreck site identified as Target 12-1
	16-8 ● Click Position 40° 35.85526' N 073° 47.44368' W (WGS84) (X) 1042366.19 (Y) 157063.17 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Arverne East\2020SEP23_0016.sds ● Line Name: 2020SEP23_0016	Dimensions and attributes ● Target Width: 28.07 US ft ● Target Height: 5.17 US ft ● Target Length: 85.35 US ft ● Mag Anomaly: Yes ● Description: Either a square-ended wood hull barge-like wreck or failed section of dock is lying adjacent to the western shoreline. Large wreck (Target 19-1) is lying along the offshore side of this site.
	16-9 ● Click Position 40° 35.74284' N 073° 47.44323' W (WGS84) (X) 1042369.90 (Y) 156380.56 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Arverne East\2020SEP23_0016.sds ● Line Name: 2020SEP23_0016	Dimensions and attributes ● Target Width: 16.73 US ft ● Target Height: 2.45 US ft ● Target Length: 44.19 US ft ● Mag Anomaly: Yes ● Description: A 44' x 16' boat hull is lying in the western slipway of the marina.

Target Image	Target Info	User Entered Info
	**16-10** ● Click Position 40° 35.73527' N 073° 47.43397' W (WGS84) (X) 1042412.85 (Y) 156334.65 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Arverne East\2020SEP23_0016.sds ● Line Name: 2020SEP23_0016	**Dimensions and attributes** ● Target Width: 13.23 US ft ● Target Height: 5.26 US ft ● Target Length: 32.75 US ft ● Mag Anomaly: Yes ● Description: A 33' x 13' boat is lying under a floating dock in the western slipway of marina.
	**18-1** ● Click Position 40° 35.80959' N 073° 47.44078' W (WGS84) (X) 1042380.27 (Y) 156785.89 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Arverne East\2020SEP23_0018.sds ● Line Name: 2020SEP23_0018	**Dimensions and attributes** ● Target Width: 32.11 US ft ● Target Height: 4.34 US ft ● Target Length: 93.24 US ft ● Mag Anomaly: Yes ● Description: A square ended barge-like wreck is lying perpendicular to the western shoreline of cove. Wreck is approximately 80' from the former bulkhead wall along the western shoreline.
	**18-2** ● Click Position 40° 35.71312' N 073° 47.43604' W (WGS84) (X) 1042403.59 (Y) 156200.14 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Arverne East\2020SEP23_0018.sds ● Line Name: 2020SEP23_0018	**Dimensions and attributes** ● Target Width: 5.53 US ft ● Target Height: 1.12 US ft ● Target Length: 13.46 US ft ● Mag Anomaly: Yes ● Description: Small dingy-type work boat is lying in the western slipway of marina.
	**18-3** ● Click Position 40° 35.72120' N 073° 47.42781' W (WGS84) (X) 1042441.56 (Y) 156249.29 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Arverne East\2020SEP23_0018.sds ● Line Name: 2020SEP23_0018	**Dimensions and attributes** ● Target Width: 17.77 US ft ● Target Height: 5.27 US ft ● Target Length: 92.51 US ft ● Mag Anomaly: Yes ● Description: An extended oblong feature that is approximately 92' x 18'. Suspect boat hull that is lying under floating dock at the western slipway of marina.

Target Image	Target Info	User Entered Info
	**19-1** ● Click Position 40° 35.85009' N 073° 47.43284' W (WGS84) (X) 1042416.44 (Y) 157031.91 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Arverne East\2020SEP23_0019.sds ● Line Name: 2020SEP23_0019	**Dimensions and attributes** ● Target Width: 35.48 US ft ● Target Height: 8.02 US ft ● Target Length: 120.26 US ft ● Mag Anomaly: ● Description: Square ended barge is lying parallel and adjacent to site identified as Target 16-8.
	**19-2** ● Click Position 40° 35.92845' N 073° 47.40151' W (WGS84) (X) 1042560.31 (Y) 157508.03 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Arverne East\2020SEP23_0019.sds ● Line Name: 2020SEP23_0019	**Dimensions and attributes** ● Target Width: 6.98 US ft ● Target Height: 4.66 US ft ● Target Length: 8.21 US ft ● Mag Anomaly: yes ● Description: A square feature that extends almost five feet off the bottom surface.
	**19-3** ● Click Position 40° 35.93440' N 073° 47.35618' W (WGS84) (X) 1042770.02 (Y) 157544.66 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Arverne East\2020SEP23_0019.sds ● Line Name: 2020SEP23_0019	**Dimensions and attributes** ● Target Width: 6.67 US ft ● Target Height 1.02 US ft ● Target Length: 15.36 US ft ● Mag Anomaly: ● Description: Small boat hull that is partially buried.

4.3 Edgemere

Twenty-six targets were identified in the Edgemere Project Area (Figure 43 and Table 10). Many of the small boat targets were located around the pilings at the abandoned marina complex at the western end of this project area. The 26 targets in this area were characterized as follows: 15 were listed as Small Boats; nine were Linear/Rectangular/Debris sites; and two were Potentially Significant wreck sites. One of the Potentially Significant wreck sites appears to be the bow section of a boat hull that has been broken and the second site is a square ended barge that partially buried under the shoreline.

In summary, a total of 66 targets were identified in the remote sensing data sets across the three project areas and 17 of those targets generated signatures that were suggestive of man-made features and comprised dimensions that could be attributed to potentially significant submerged cultural resource sites.

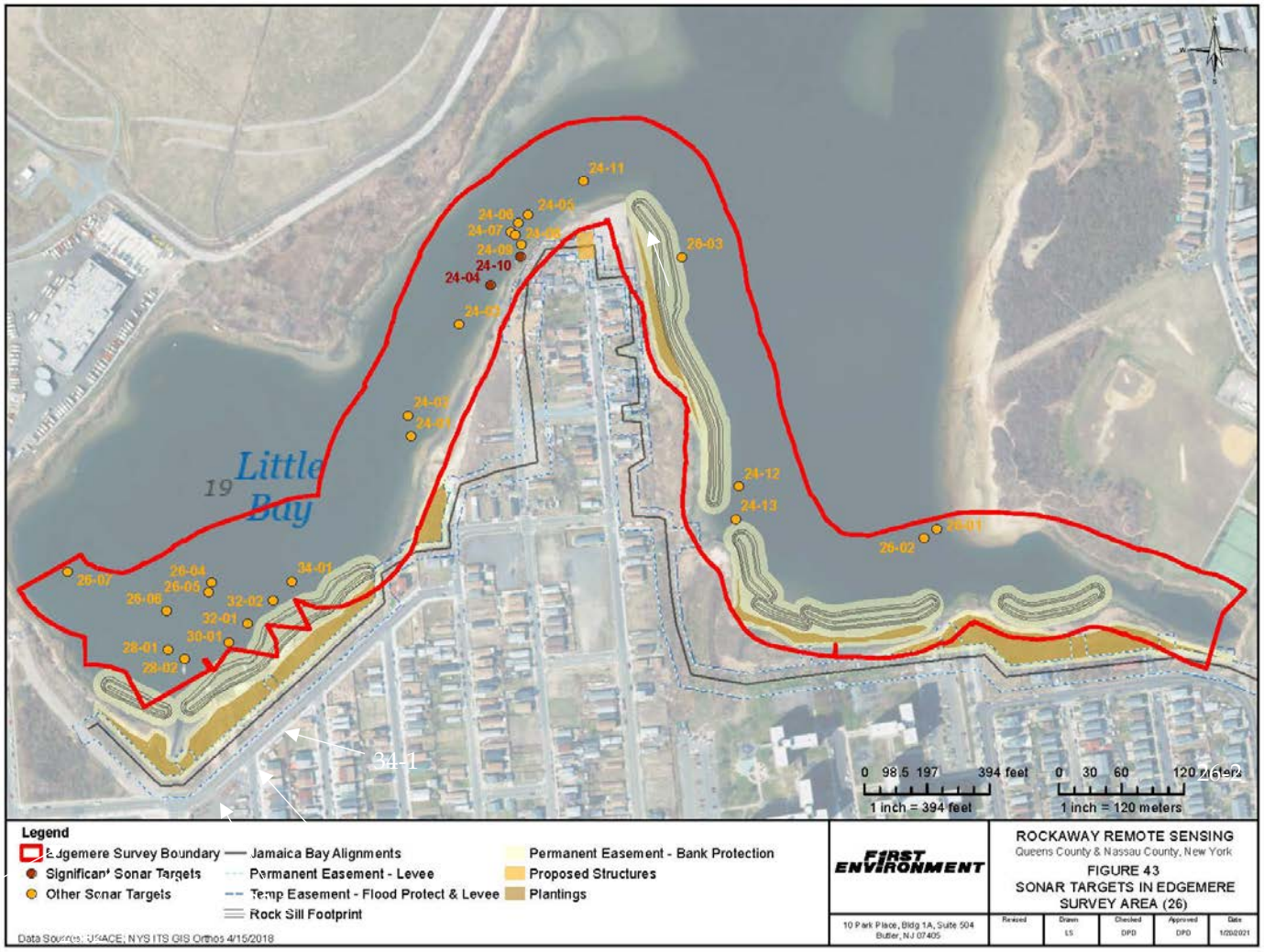
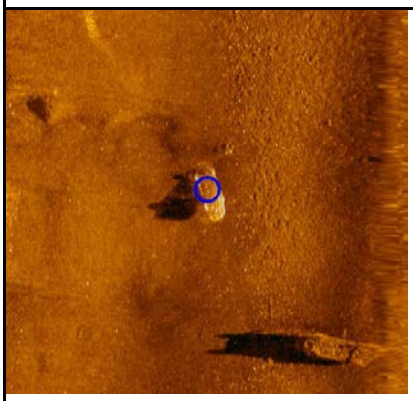
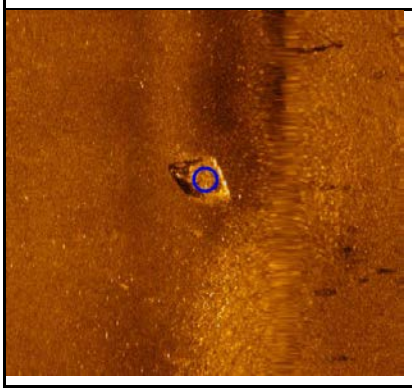


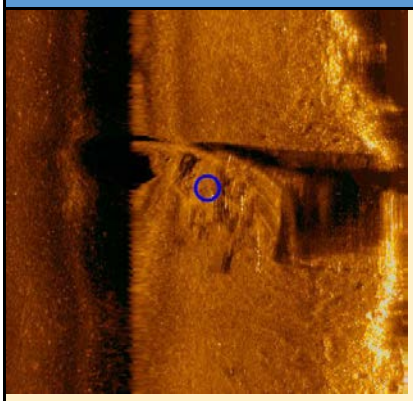
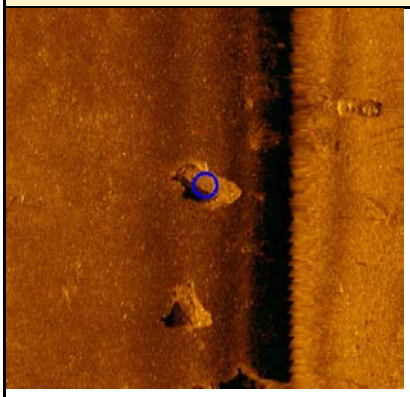
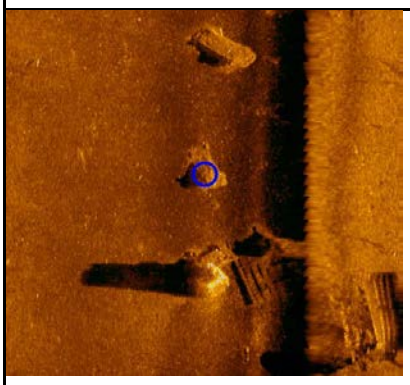
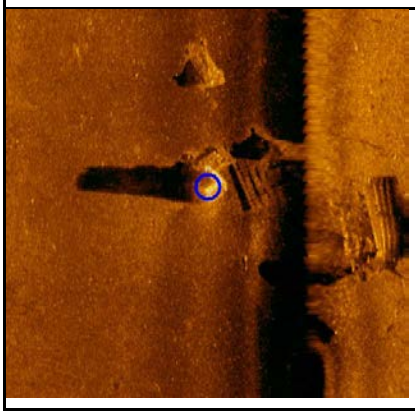
Figure 43. Sonar Targets in Edgemere Project Area (26)

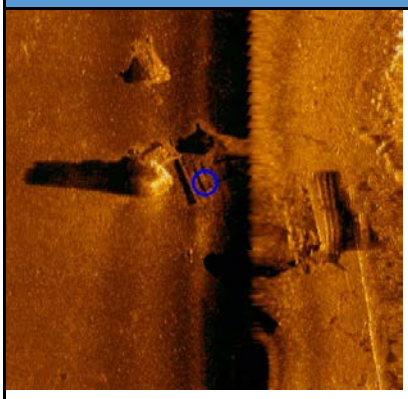
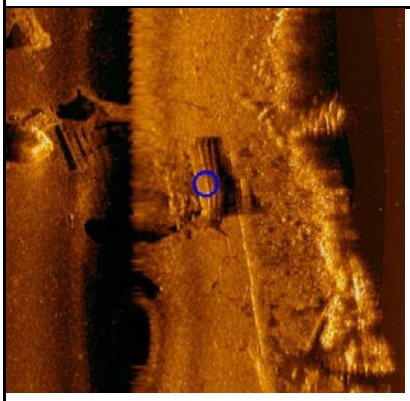
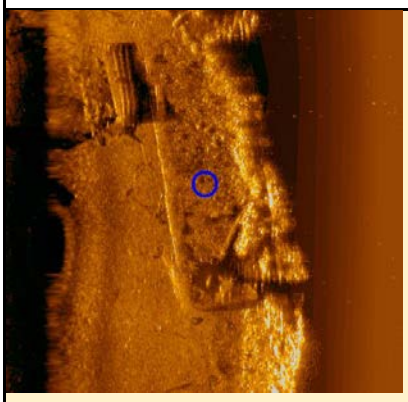
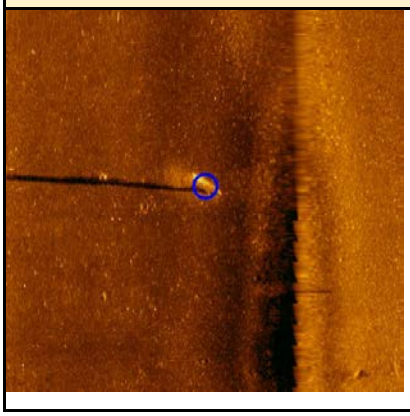
Notes: 1) Locations of 26 sonar targets are indicated and listed in Table 10.
2) An abandoned marina complex was located at the western end of the project area

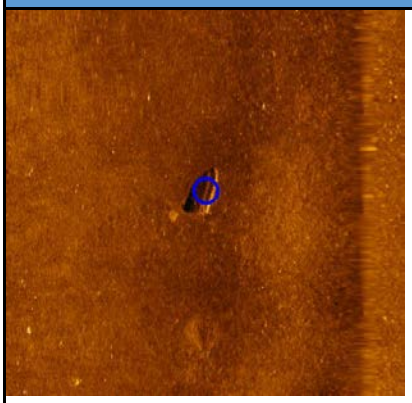
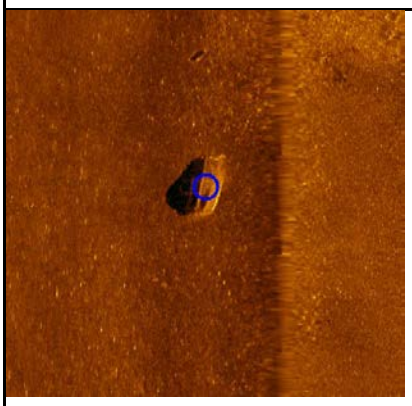
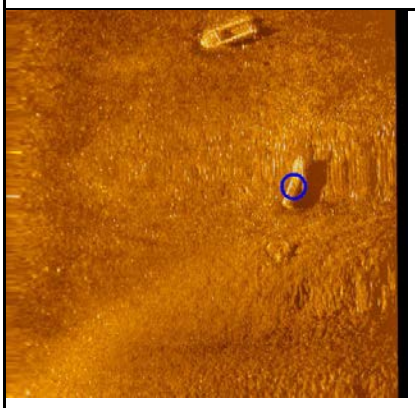
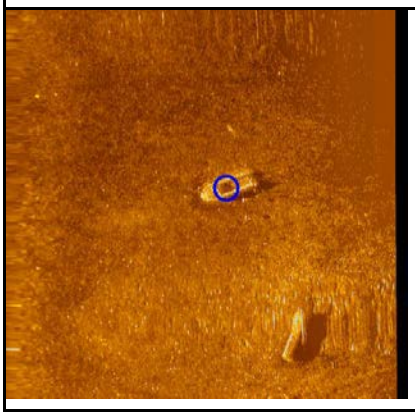
Table 10. Sonar Targets in Edgemere Survey Area (26)

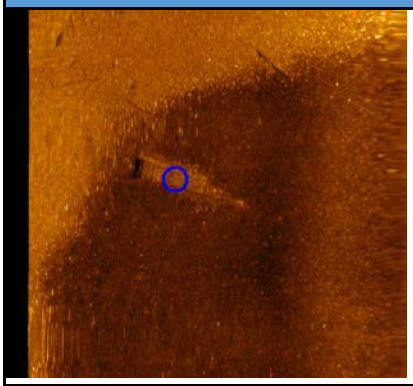
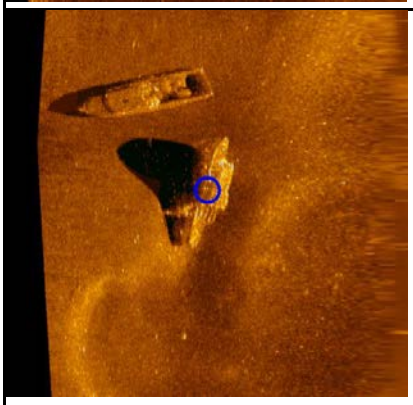
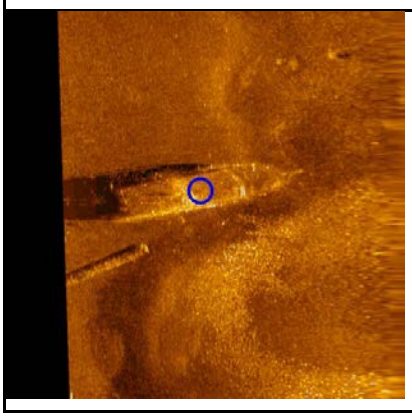
Notes: 1) Coordinates are expressed in New York (Long Island) State Plane Coordinates, feet
2) Shaded Targets = Potentially Significant (2)
3) See Figure 43

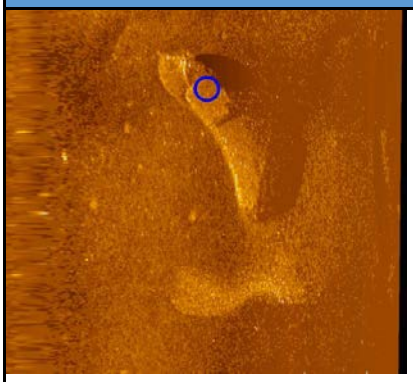
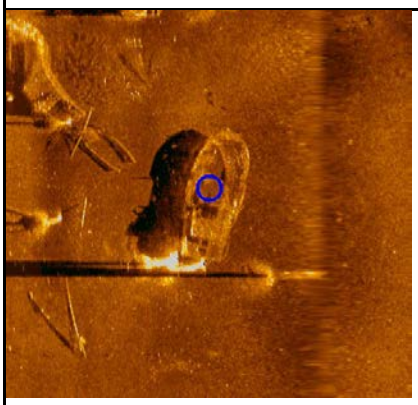
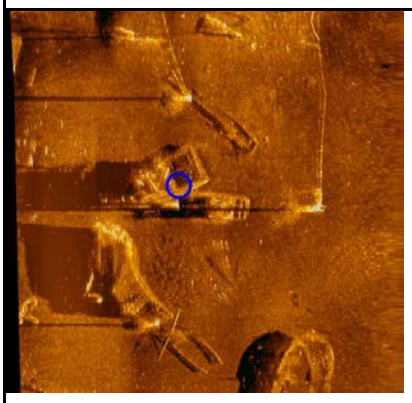
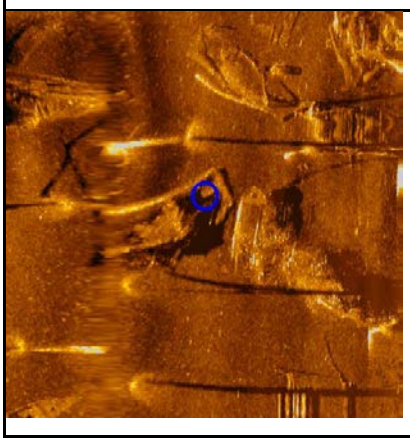
Target Image	Target Info	User Entered Info
	24-01 ● Click Position 40° 35.98319' N 073° 46.64451' W (WGS84) (X) 1046063.11 (Y) 157849.10 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Edgemere\2020SEP23_0024.sds ● Line Name: 2020SEP23_0024	Dimensions and attributes ● Target Width: 7.65 US ft ● Target Height: 6.92 US ft ● Target Length: 20.33 US ft ● Mag Anomaly: Yes ● Description: Small boat hull is lying at an angle on bottom. Close to boat wreck identified as Target 24-2
	24-02 ● Click Position 40° 35.99370' N 073° 46.64635' W (WGS84) (X) 1046054.41 (Y) 157912.85 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Edgemere\2020SEP23_0024.sds ● Line Name: 2020SEP23_0024	Dimensions and attributes ● Target Width: 7.44 US ft ● Target Height: 3.57 US ft ● Target Length: 15.19 US ft ● Mag Anomaly: Yes ● Description: Small boat hull lying on bottom in vicinity of bat wreck identified as Target 24-1.
	24-03 ● Click Position 40° 36.04076' N 073° 46.61143' W (WGS84) (X) 1046215.33 (Y) 158199.04 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Edgemere\2020SEP23_0024.sds ● Line Name: 2020SEP23_0024	Dimensions and attributes ● Target Width: 8.91 US ft ● Target Height: 1.29 US ft ● Target Length: 12.36 US ft ● Mag Anomaly: Yes ● Description: Rectangular feature lying flat on the bottom surface.

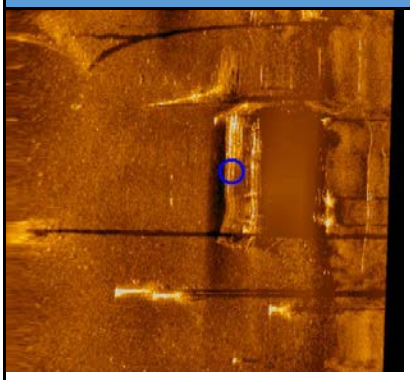
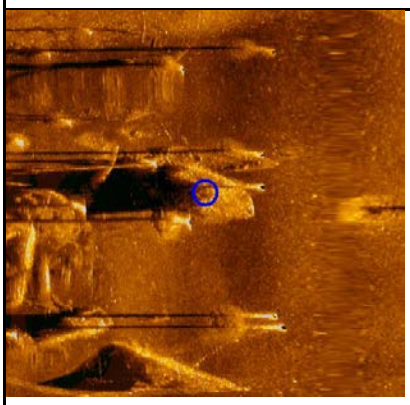
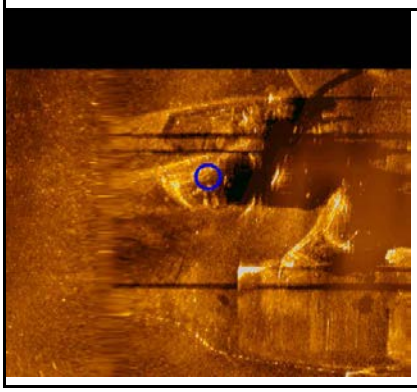
Target Image	Target Info	User Entered Info
	24-04 ● Click Position 40° 36.06104' N 073° 46.59028' W (WGS84) (X) 1046312.88 (Y) 158322.40 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Edgemere\2020SEP23_0024.sds ● Line Name: 2020SEP23_0024	Dimensions and attributes ● Target Width: 23.09 US ft ● Target Height: 6.20 US ft ● Target Length: 50.70 US ft ● Mag Anomaly: Yes ● Description: The bow end of a broken hull. The stern portion of the hull appears to be missing.
	24-05 ● Click Position 40° 36.09745' N 073° 46.56449' W (WGS84) (X) 1046431.68 (Y) 158543.80 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Edgemere\2020SEP23_0024.sds ● Line Name: 2020SEP23_0024	Dimensions and attributes ● Target Width: 7.34 US ft ● Target Height: 2.75 US ft ● Target Length: 17.92 US ft ● Mag Anomaly: Yes ● Description: Small inverted boat hull.
	24-06 ● Click Position 40° 36.09343' N 073° 46.57116' W (WGS84) (X) 1046400.87 (Y) 158519.33 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Edgemere\2020SEP23_0024.sds ● Line Name: 2020SEP23_0024	Dimensions and attributes ● Target Width: 7.01 US ft ● Target Height: 2.98 US ft ● Target Length: 10.88 US ft ● Mag Anomaly: Yes ● Description: Rectangular feature near cluster of other targets.
	24-07 ● Click Position 40° 36.08856' N 073° 46.57620' W (WGS84) (X) 1046377.61 (Y) 158489.71 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Edgemere\2020SEP23_0024.sds ● Line Name: 2020SEP23_0024	Dimensions and attributes ● Target Width: 7.92 US ft ● Target Height: 7.57 US ft ● Target Length: 8.55 US ft ● Mag Anomaly: Yes ● Description: Upright square feature. Lying near cluster of other targets in this vicinity.

Target Image	Target Info	User Entered Info
	**24-08** ● Click Position 40° 36.08699' N 073° 46.57358' W (WGS84) (X) 1046389.79 (Y) 158480.18 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Edgemere\2020SEP23_0024.sds ● Line Name: 2020SEP23_0024	**Dimensions and attributes** ● Target Width: 7.58 US ft ● Target Height: 1.27 US ft ● Target Length: 20.38 US ft ● Mag Anomaly: Yes ● Description: Rectangular feature is lying flat on the bottom near cluster of other targets.
	**24-09** ● Click Position 40° 36.08183' N 073° 46.56930' W (WGS84) (X) 1046409.68 (Y) 158448.94 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Edgemere\2020SEP23_0024.sds ● Line Name: 2020SEP23_0024	**Dimensions and attributes** ● Target Width: 8.02 US ft ● Target Height: 2.52 US ft ● Target Length: 22.80 US ft ● Mag Anomaly: Yes ● Description: Rectangular feature that appears to be an inverted hull of small boat. Lying next to a partially buried barge-like wreck that is partially under the shoreline.
	**24-10** ● Click Position 40° 36.07583' N 073° 46.56968' W (WGS84) (X) 1046407.98 (Y) 158412.48 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Edgemere\2020SEP23_0024.sds ● Line Name: 2020SEP23_0024	**Dimensions and attributes** ● Target Width: 29.10 US ft ● Target Height: 0.00 US ft ● Target Length: 77.18 US ft ● Mag Anomaly: Yes ● Description: Partially buried hull of a barge-like vessel. Located along the shoreline and partially buried under the shoreline.
	**24-11** ● Click Position 40° 36.11485' N 073° 46.52654' W (WGS84) (X) 1046607.05 (Y) 158649.94 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Edgemere\2020SEP23_0024.sds ● Line Name: 2020SEP23_0024	**Dimensions and attributes** ● Target Width: 1.64 US ft ● Target Height: 9.35 US ft ● Target Length: 9.66 US ft ● Mag Anomaly: Yes ● Description: A linear feature that extends vertically up out of the bottom.

Target Image	Target Info	User Entered Info
	**24-12** ● Click Position 40° 35.95661' N 073° 46.42184' W (WGS84) (X) 1047094.11 (Y) 157690.30 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Edgemere\2020SEP23_0024.sds ● Line Name: 2020SEP23_0024	**Dimensions and attributes** ● Target Width: 5.54 US ft ● Target Height: 0.00 US ft ● Target Length: 14.02 US ft ● Mag Anomaly: Yes ● Description: Inverted hull of small boat.
	**24-13** ● Click Position 40° 35.93983' N 073° 46.42415' W (WGS84) (X) 1047083.69 (Y) 157588.40 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Edgemere\2020SEP23_0024.sds ● Line Name: 2020SEP23_0024	**Dimensions and attributes** ● Target Width: 7.13 US ft ● Target Height: 0.00 US ft ● Target Length: 15.65 US ft ● Mag Anomaly: Yes ● Description: Inverted hull of a small boat.
	**26-01** ● Click Position 40° 35.93448' N 073° 46.28746' W (WGS84) (X) 1047716.40 (Y) 157557.57 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Edgemere\2020SEP23_0026.sds ● Line Name: 2020SEP23_0026	**Dimensions and attributes** ● Target Width: 5.98 US ft ● Target Height: 1.74 US ft ● Target Length: 15.11 US ft ● Mag Anomaly: Yes ● Description: Rectangular feature - suspect small boat hull. Lying close to boat hull identified as Target 26-02.
	**26-02** ● Click Position 40° 35.92974' N 073° 46.29617' W (WGS84) (X) 1047676.17 (Y) 157528.65 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Edgemere\2020SEP23_0026.sds ● Line Name: 2020SEP23_0026	**Dimensions and attributes** ● Target Width: 5.01 US ft ● Target Height: 1.99 US ft ● Target Length: 15.72 US ft ● Mag Anomaly: Yes ● Description: An upright hull of a small boat lying flat on the bottom surface. Lying close to boat hull identified as Target 26-01.

Target Image	Target Info	User Entered Info
	26-03 ● Click Position 40° 36.07533' N 073° 46.46032' W (WGS84) (X) 1046914.14 (Y) 158410.72 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Edgemere\2020SEP23_0026.sds ● Line Name: 2020SEP23_0026	Dimensions and attributes ● Target Width: 6.61 US ft ● Target Height: 0.21 US ft ● Target Length: 30.55 US ft ● Mag Anomaly: Yes ● Description: Long rectangular feature that is partially buried.
	26-04 ● Click Position 40° 35.90760' N 073° 46.78012' W (WGS84) (X) 1045436.60 (Y) 157388.53 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Edgemere\2020SEP23_0026.sds ● Line Name: 2020SEP23_0026	Dimensions and attributes ● Target Width: 12.09 US ft ● Target Height: 7.14 US ft ● Target Length: 32.18 US ft ● Mag Anomaly: Yes ● Description: Boat with cabin with resting on its side near former marina complex. Lying next to wreck site identified as Target 26-05
	26-05 ● Click Position 40° 35.90272' N 073° 46.78198' W (WGS84) (X) 1045428.08 (Y) 157358.86 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Edgemere\2020SEP23_0026.sds ● Line Name: 2020SEP23_0026	Dimensions and attributes ● Target Width: 10.87 US ft ● Target Height: 5.80 US ft ● Target Length: 38.43 US ft ● Mag Anomaly: Yes ● Description: 38' long boat hull lying upright on the bottom near marina complex. Lying next to wreck identified as Target 26-04
	26-06 ● Click Position 40° 35.89312' N 073° 46.81093' W (WGS84) (X) 1045294.22 (Y) 157300.22 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Edgemere\2020SEP23_0026.sds ● Line Name: 2020SEP23_0026	Dimensions and attributes ● Target Width: 13.95 US ft ● Target Height: 4.28 US ft ● Target Length: 53.15 US ft ● Mag Anomaly: Yes ● Description: A 53 boat hull is lying upright on bottom next to former marina complex.

Target Image	Target Info	User Entered Info
	26-07 ● Click Position 40° 35.91342' N 073° 46.87787' W (WGS84) (X) 1044984.12 (Y) 157422.69 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Edgemere\2020SEP23_0026.sds ● Line Name: 2020SEP23_0026	Dimensions and attributes ● Target Width: 13.27 US ft ● Target Height: 6.66 US ft ● Target Length: 32.10 US ft ● Mag Anomaly: Yes ● Description: A 32' long boat with cabin is lying upright on the bottom.
	28-01 ● Click Position 40° 35.87287' N 073° 46.80991' W (WGS84) (X) 1045299.25 (Y) 157177.28 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Edgemere\2020SEP23_0028.sds ● Line Name: 2020SEP23_0028	Dimensions and attributes ● Target Width: 14.68 US ft ● Target Height: 7.93 US ft ● Target Length: 38.01 US ft ● Mag Anomaly: Yes ● Description: A boat with cabin is upright on bottom surface in the former marina complex.
	28-02 ● Click Position 40° 35.86829' N 073° 46.79845' W (WGS84) (X) 1045352.39 (Y) 157149.58 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Edgemere\2020SEP23_0028.sds ● Line Name: 2020SEP23_0028	Dimensions and attributes ● Target Width: 39.87 US ft ● Target Height: 0.00 US ft ● Target Length: 70.30 US ft ● Mag Anomaly: Yes ● Description: A cluster of hull parts is lying on the bottom near offshore corner of the former marina complex. Wreckage is found across an area approximately 70' x 40'.
	30-01 ● Click Position 40° 35.87668' N 073° 46.76843' W (WGS84) (X) 1045491.17 (Y) 157200.86 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Edgemere\2020SEP23_0030.sds ● Line Name: 2020SEP23_0030	Dimensions and attributes ● Target Width: 0.00 US ft ● Target Height: 0.00 US ft ● Target Length: 53.56 US ft ● Mag Anomaly: Yes ● Description: Parts of numerous small boats hulls are scattered among pilings at the offshore side of the former marina complex. There are multiple small boat wrecks at this location.

Target Image	Target Info	User Entered Info
	**32-01** ● Click Position 40° 35.88638' N 073° 46.75566' W (WGS84) (X) 1045550.13 (Y) 157259.96 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Edgemere\2020SEP23_0032.sds ● Line Name: 2020SEP23_0032	**Dimensions and attributes** ● Target Width: 12.73 US ft ● Target Height: 4.74 US ft ● Target Length: 39.28 US ft ● Mag Anomaly: Yes ● Description: Rectangular feature that appears to be a section of dock from the former marina complex.
	**32-02** ● Click Position 40° 35.89846' N 073° 46.73850' W (WGS84) (X) 1045629.37 (Y) 157333.49 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Edgemere\2020SEP23_0032.sds ● Line Name: 2020SEP23_0032	**Dimensions and attributes** ● Target Width: 14.58 US ft ● Target Height: 0.00 US ft ● Target Length: 29.76 US ft ● Mag Anomaly: Yes ● Description: Small boat hull is lying upright on the bottom between several pilings from the former marina complex.
	**34-01** ● Click Position 40° 35.90805' N 073° 46.72549' W (WGS84) (X) 1045689.48 (Y) 157391.85 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Edgemere\2020SEP23_0034.sds ● Line Name: 2020SEP23_0034	**Dimensions and attributes** ● Target Width: 26.51 US ft ● Target Height: 0.00 US ft ● Target Length: 48.95 US ft ● Mag Anomaly: Yes ● Description: Large debris pile is clustered in former marina complex.

5.0 Summary and Recommendations

A total of 66 side-scan sonar targets were identified from the remote sensing survey: 14 in the Arverne West Project Area; 26 in the Arverne East Project Area; and 26 in the Edgemere Project Area. Of these 66 sites, 17 have been determined to be Potentially Significant Sites. The remaining 49 sites have been evaluated to be not historically significant - the locations of these 49 sites should be noted in project development, but no further archaeological research needs to be conducted on these sites.

The 17 potentially significant sites detected in the survey of the Arverne and Edgemere APE are distributed as follows:

- Arverne West: 5 sites
- Arverne East: 10 sites
- Edgemere: 2 sites

These 17 potentially significant sites are discussed in detail below, and recommendations are presented for each.

5.1 Arverne West Target Evaluation and Recommendations

There are five Potentially Significant Sites in the Arverne West Project Area (Figure 44).

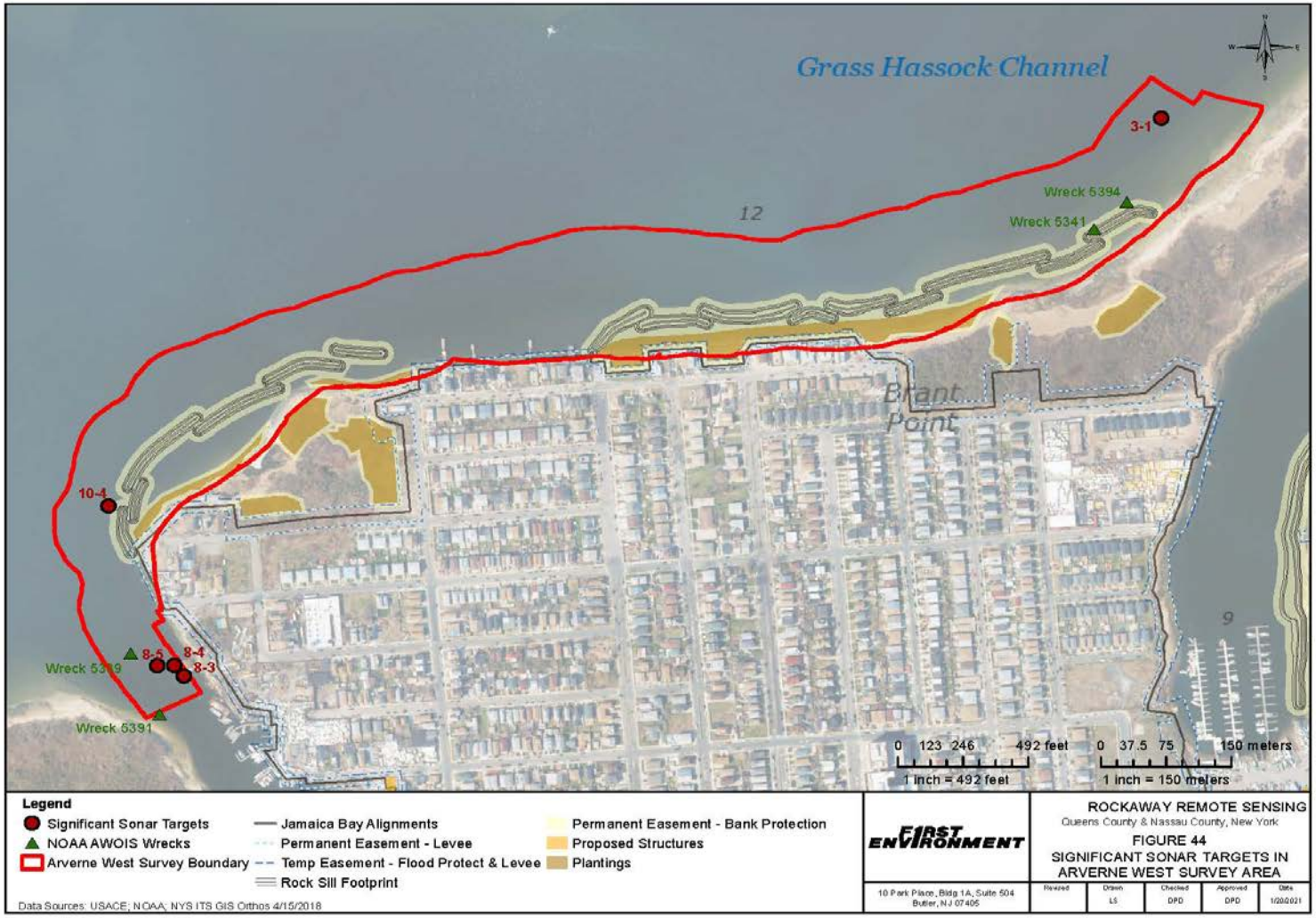
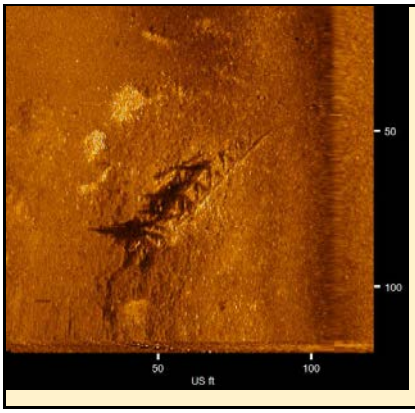


Figure 44. Potentially Significant Sonar Targets in Arverne West Survey Area (5)

Table 11: Target 3-1

	3-1 ● Click Position 40° 36.11343' N 073° 47.46796' W (WGS84) (X) 1042250.08 (Y) 158630.49 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Arverne West\2020SEP23_0003.sds ● Line Name: 2020SEP23_0003	Dimensions and attributes ● Target Width: 7.92 US ft ● Target Height: 3.43 US ft ● Target Length: 48.77 US ft ● Mag Anomaly: Yes ● Water Depth: 24' ● Description: A long rectangular feature that is partially buried. This feature has framing components and may be associated with a section of a crane or part of a navigational-aid structure .

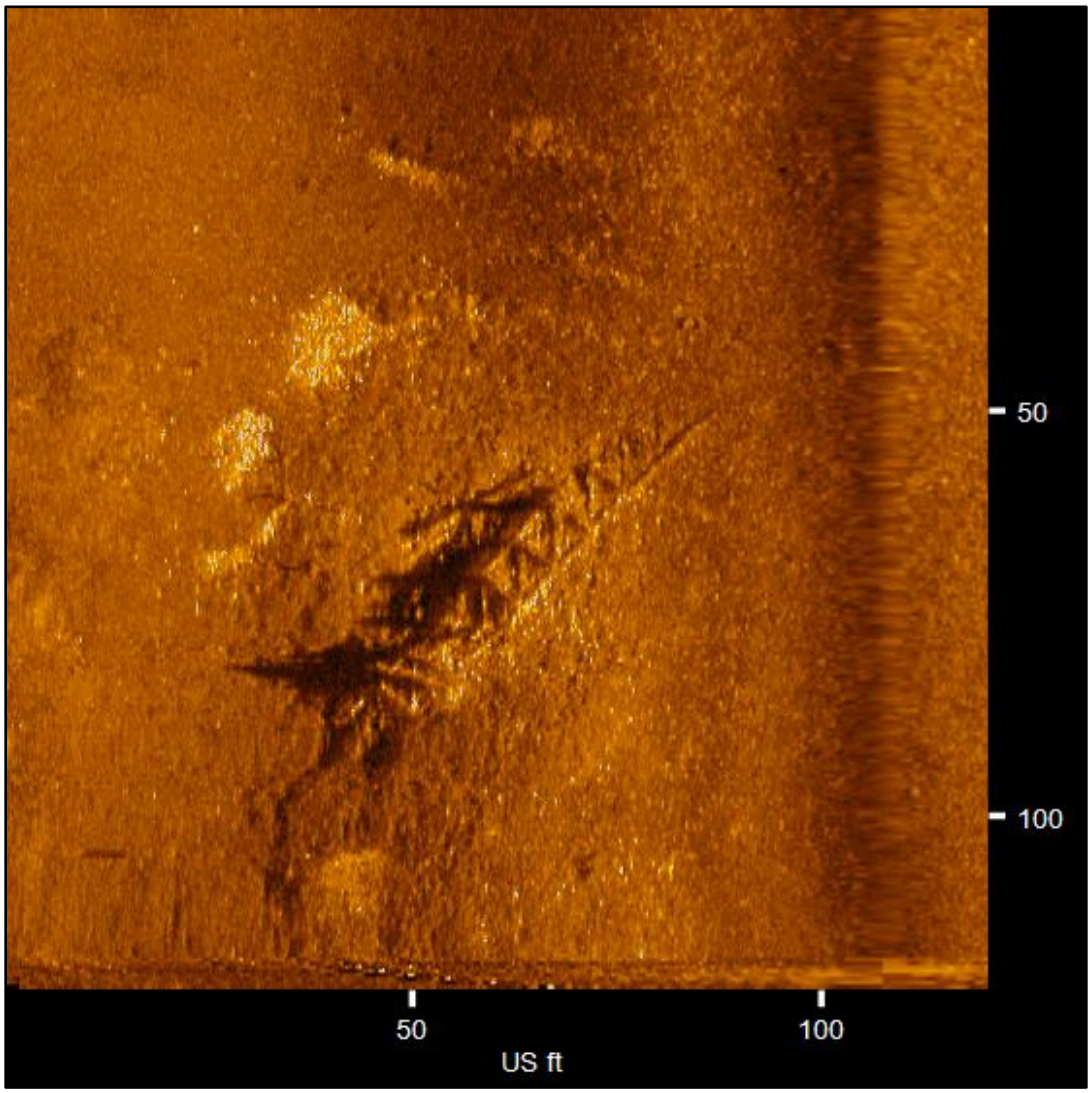


Figure 45: Target 3-1, Potential Lattice Truss Structure, Courtesy of Dolan Research.

5.1.1 Evaluation

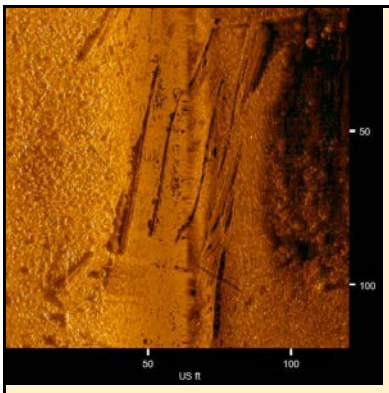
Target 3.1 appears to be a piece of debris that includes lattice truss structures of the type that are used in various pieces of heavy machinery (crane booms), tower and bridge construction, or navigational-aid structure. Without additional contextual information it is impossible to more clearly characterize this debris or its significance.

Potentially significant under NRHP Criteria C: Embodiment of the distinctive characteristics of a type, period, or method of construction,

5.1.2 Recommendation

Avoidance is recommended for Target 3-1. If this is not an option, then additional archaeological investigation will be needed to further characterize and determine the significance of this structure.

Table 12: Target 3-3

	**3-3** ● Click Position 40° 35.86871' N 073° 48.28632' W (WGS84) (X) 1038465.87 (Y) 157135.82 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Arverne West\2020SEP23_0003.sds ● Line Name: 2020SEP23_0003	**Dimensions and attributes** ● Target Width: 35.62 US ft ● Target Height: 0.40 US ft ● Target Length: 84.20 US ft ● Mag Anomaly: Yes ● Water Depth: < 8' ● Description: Long rectangular structure that is partially buried. Possibly the bottom of a barge-like vessel. At least four parallel stringers are exposed. Other linear debris is strewn on the bottom in this vicinity.

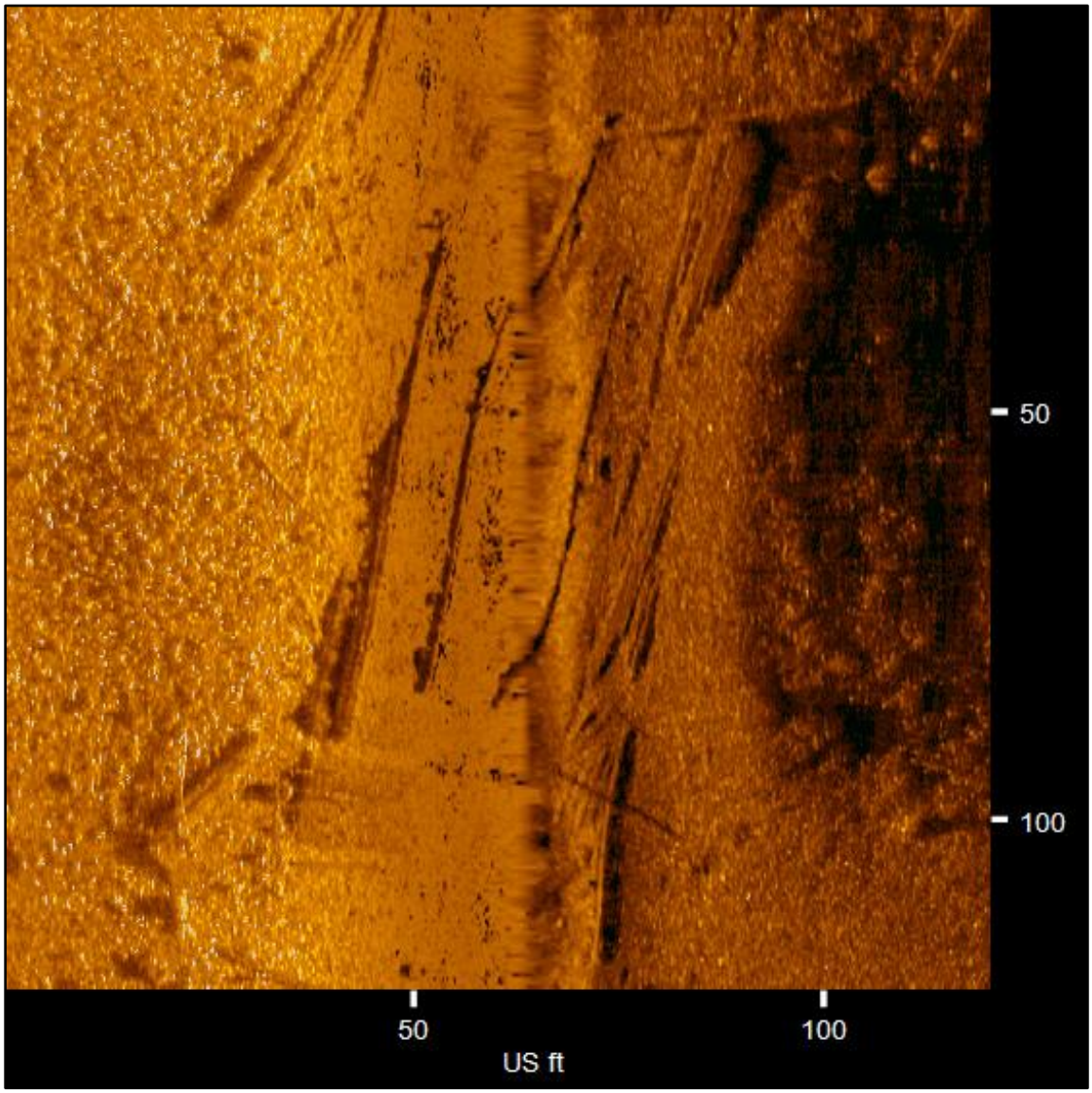


Figure 46: Target 3-3, Potential early 20th Century Barge, Courtesy of Dolan Research.

5.1.3 Evaluation

Target 3-3 demonstrates features that suggest it represents the bottom portions of a barge. This is indicated by the square shape of the wreckage and the longitudinal stringers that would have supported the work vessels bottom. The main wreck components are also surrounded by other linear debris that may be fragments of the vessel and is partially buried. The dimensions of this barge and its wood construction indicate a construction date in the early 20th century.

Potentially significant under NRHP Criteria A: Association with events that have made a significant contribution to the broad patterns of our history; and Criteria C: Embodiment of the distinctive characteristics of a type, period, or method of construction.

5.1.4 Recommendation

Avoidance is recommended for Target 3-3. If this is not an option, additional archaeological investigation will be needed to further characterize and determine the significance of this wreckage.

Table 13: Target 8-4

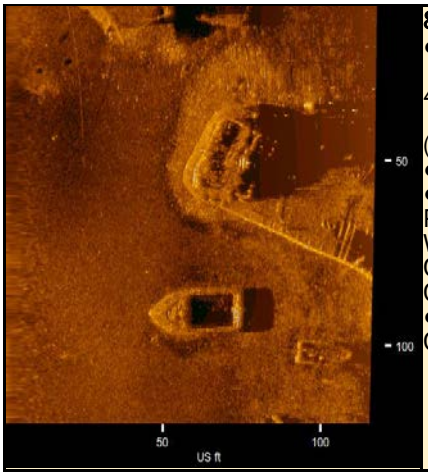
	8-4 ● Click Position 40° 35.74887' N 073° 48.27333' W (WGS84) (X) 1038527.64 (Y) 156408.28 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: C:\SonarWiz-Projects\Arverne West\CSF\2020SEP23_0008-CH12-to-2020SEP23_0010-CH12.csf ● Line Name: 2020SEP23_0008-CH12-to-2020SEP23_0010-CH12	**Dimensions and attributes** ● Target Width: 28.98 US ft ● Target Height: 7.40 US ft ● Target Length: 101.40 US ft ● Mag Anomaly: Yes ● Water Depth: 30'- 0" ● Description: The stern section of a large tug. The bow end of this tug is exposed and visible on/next to the shoreline. Two small boat wrecks (targets 8-2 & 8-3) and a large wreck (target 8-5) are lying near this target.

Figure 47: Target 8-4, Stern of Large Tugboat, Stern Indicated by Arrow, Courtesy of Dolan Research.

5.1.5. Evaluation

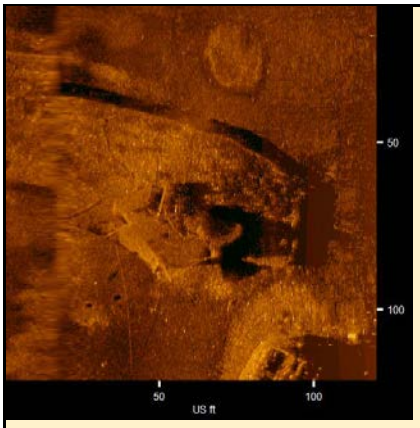
Target 8-4 is the stern of a large metal tug that has sunk near the shoreline. A pilot house is clearly visible in the stern of the vessel and some of the decking has been torn away showing the metal deckbeams beneath. The bluff bow of the tug is exposed above water and can be seen in aerial photography (Figure 47).

Figure 48: Bow of Target 8-4 Visible above Water, Courtesy of Google Earth Pro.

5.1.6 Recommendation

Avoidance is recommended for Target 8-4. If this is not an option, additional archaeological investigation will be needed to further characterize and determine the significance of this wreckage.

Table 14: Target 8-5

	8-5 ● Click Position 40° 35.74873' N 073° 48.28702' W (WGS84) (X) 1038464.28 (Y) 156407.26 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: C:\SonarWiz-Projects\Arverne West\CSF\2020SEP23_0008-CH12-to-2020SEP23_0010-CH12.csf ● Line Name: 2020SEP23_0008-CH12-to-2020SEP23_0010-CH12	Dimensions and attributes ● Target Width: 38.02 US ft ● Target Height: 8.31 US ft ● Target Length: 126.65 US ft ● Mag Anomaly: Yes ● Water Depth 32': ● Description: A large square ended vessel with a slightly tapered bow is resting flat on the bottom surface. The large hull (126' x 38') also has collapsed debris on its deck - possibly part of a cabin. This wreck site has more than eight feet of elevation above the surrounding bottom surface. The stern of tug wreck (Target 8-4) is located just south of this target.

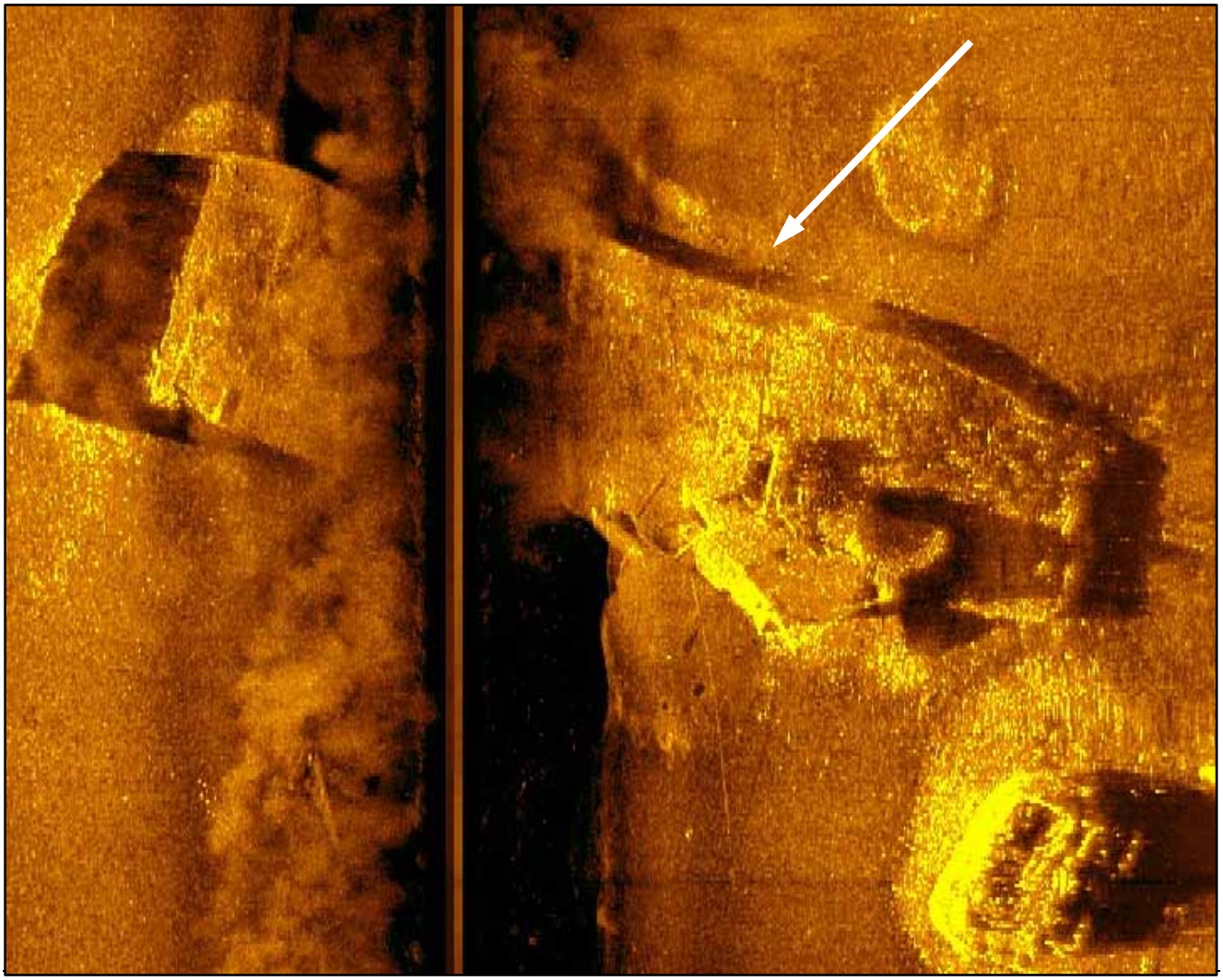


Figure 49: Target 8-5, Square Ended Vessel, Courtesy of Dolan Research.

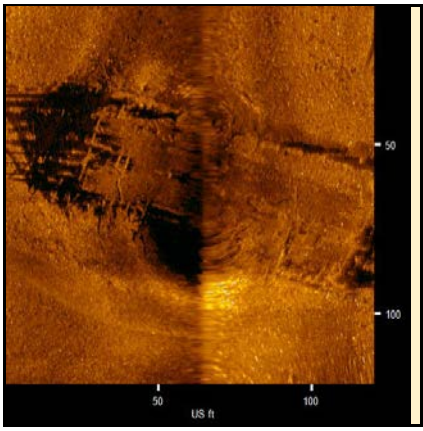
5.1.7 Evaluation

Target 8-5 is a large square ended vessel that tapers slightly at the bow and stern. There appears to be a large pile of debris on the deck of this vessel that may indicate the remains of the cabin or deckhouse.

5.1.8 Recommendation

Avoidance is recommended for Target 8-5. If this proves impossible in the project design, additional archaeological investigation will be needed to determine the significance of this target.

Table 15: Target 10-4

	**10-4** ● Click Position 40° 35.85552' N 073° 48.32641' W (WGS84) (X) 1038280.53 (Y) 157055.29 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: C:\SonarWiz-Projects\Arverne West\CSF\2020SEP23_0008-CH12-to-2020SEP23_0010-CH12.csf ● Line Name: 2020SEP23_0008-CH12-to-2020SEP23_0010-CH12	**Dimensions and attributes** ● Target Width: 36.77 US ft ● Target Height: 6.49 US ft ● Target Length: 107.70 US ft ● Mag Anomaly: Yes ● Water Depth:19' ● Description: A large squared ended barge-like wood hull is lying flat on the bottom.

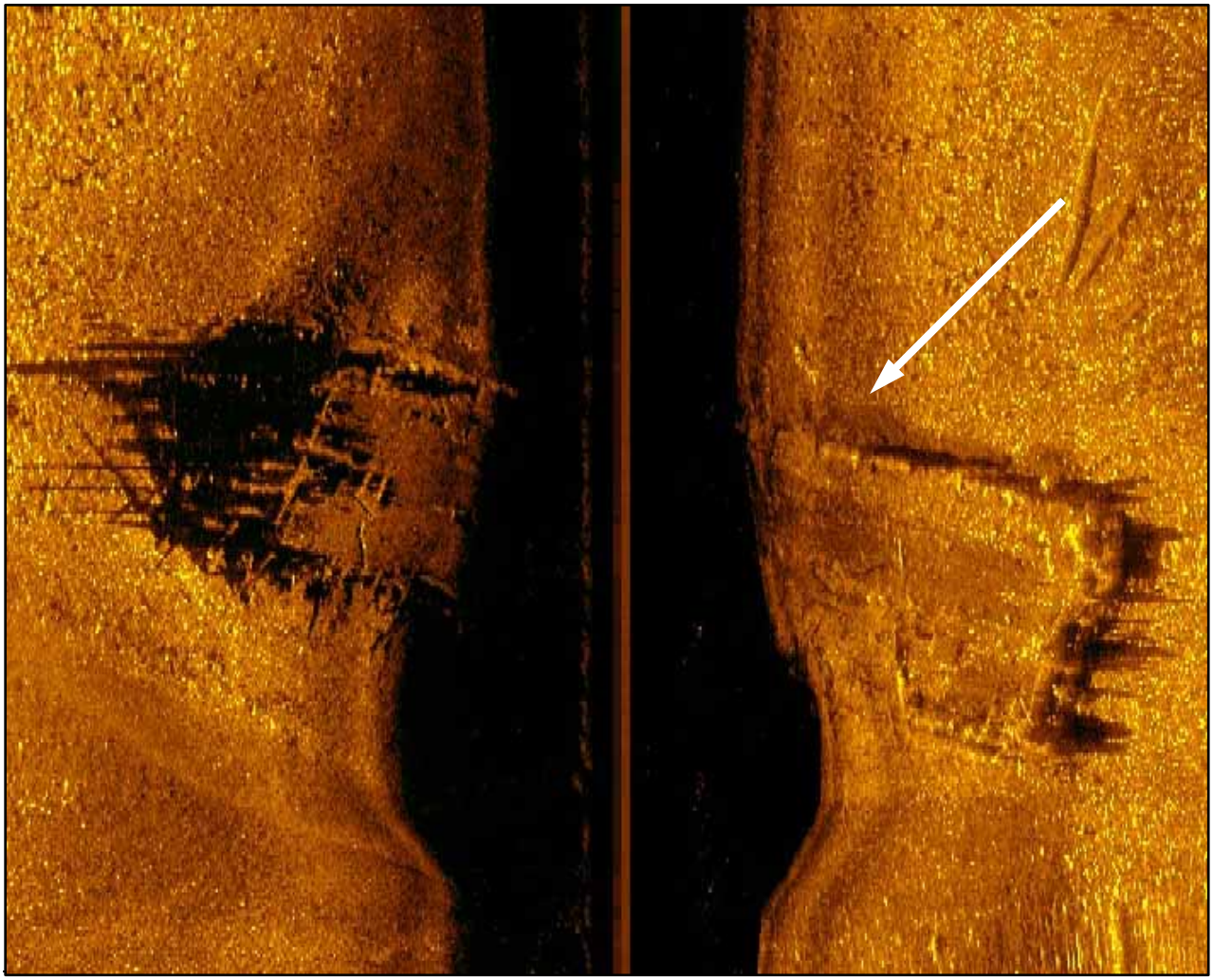


Figure 50: Target 10-4, Square-Ended Wooden Deck Barge with Raked Ends, Courtesy of Dolan Research.

5.1.9 Evaluation

Target 10-4 appears to be the remains of wooden deck barge with raked ends. The sonar image demonstrates that the vessel stands as much as 6 feet (2m) off the sea floor.

Potentially significant under NRHP Criteria A: Association with events that have made a significant contribution to the broad patterns of our history; and Criteria C: Embodiment of the distinctive characteristics of a type, period, or method of construction.

5.1.10 Recommendation

Avoidance is recommended for Target 10-4. If this is not an option, additional archaeological investigation will be needed to further characterize and determine the significance of this Wreckage.

5.2 Arverne East Target Evaluation and Recommendations

There are ten Potentially Significant Sites in the Arverne East Project Area (Figure 51).

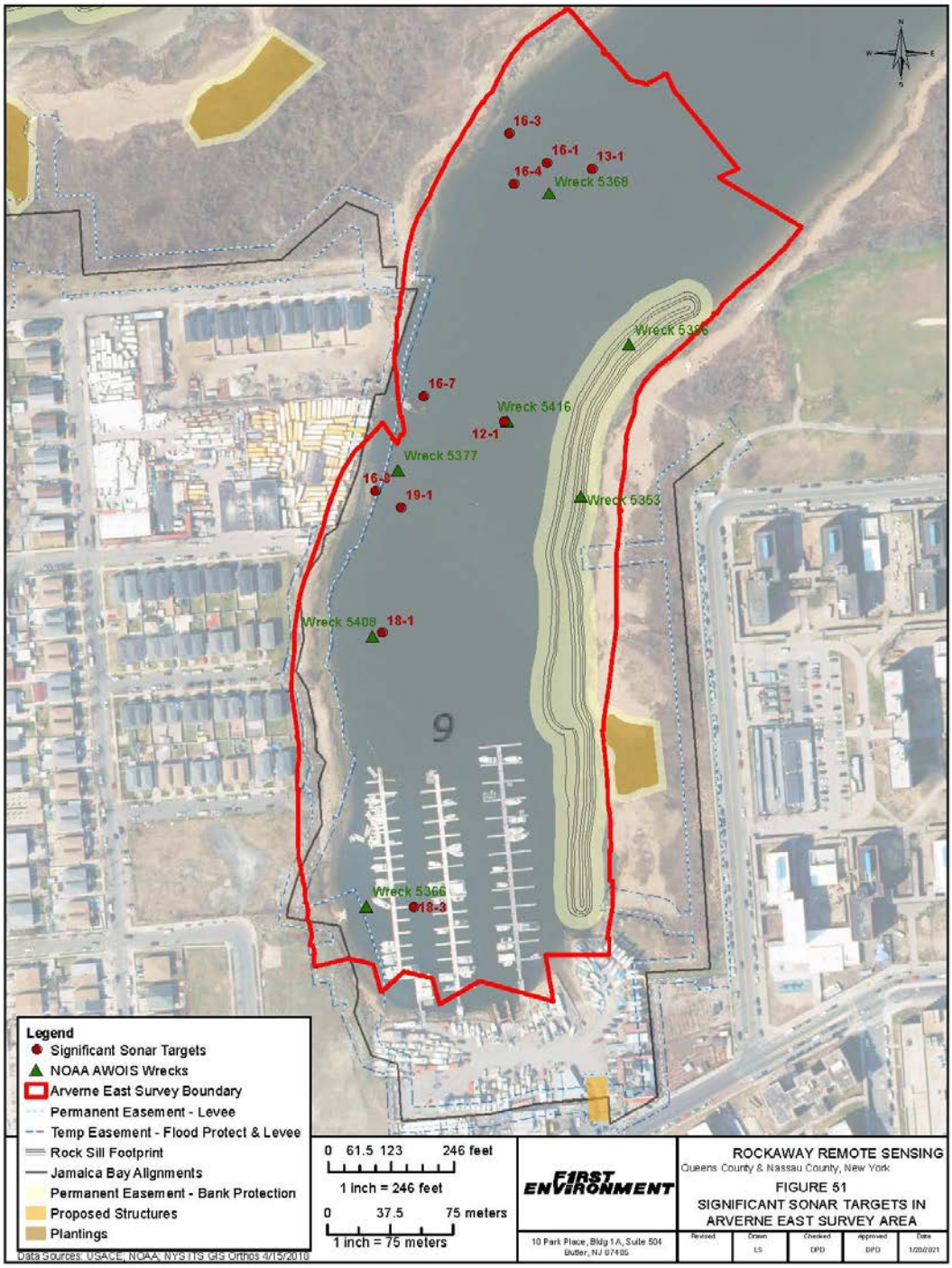
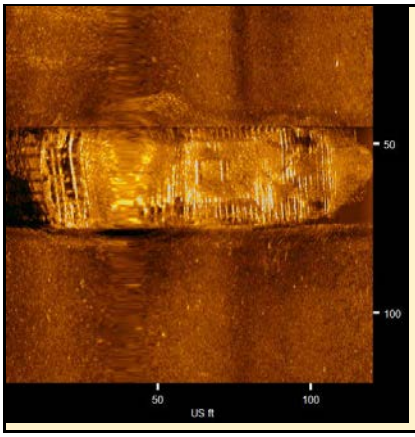


Figure 51. Potentially Significant Sonar Targets in Arverne East Survey Area (10)

Table 16: Target 12-1

	**12-1** ● Click Position 40° 35.87763' N 073° 47.38911' W (WGS84) (X) 1042618.42 (Y) 157199.60 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Arverne East\2020SEP23_0012.sds ● Line Name: 2020SEP23_0012	**Dimensions and attributes** ● Target Width: 30.63 US ft ● Target Height: 7.90 US ft ● Target Length: 121.44 US ft ● Mag Anomaly: Yes ● Water Depth: 23' ● Description: A large bluff bowed wood hull barge-like vessel Hull is 121' x 30' and rises approximately eight feet off the bottom surface.

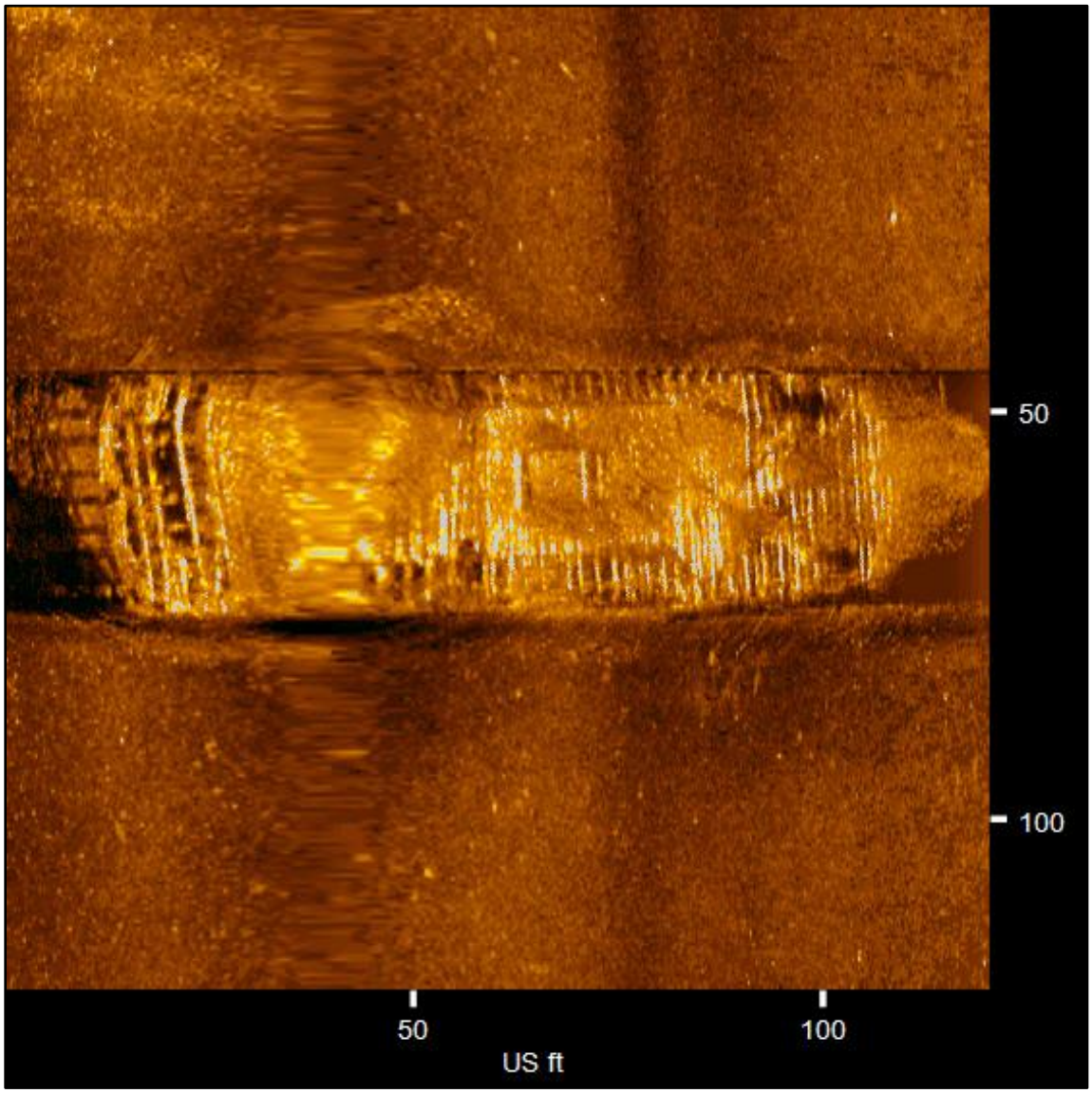


Figure 52: Target 12-1, Large Wooden Hulled Wreck with Bluff Bow, Courtesy of Dolan Research.

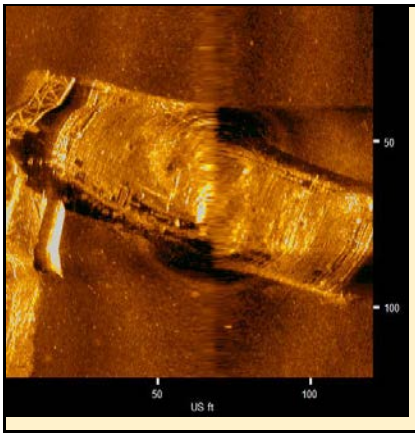
5.2.1 Evaluation

Target 12-1 is the remains of a large bluff ended wooden barge, measuring 121 feet (36.8m) in length and 30 feet (9.1m) in beam. Much of the deck planking has fallen off this vessel revealing the deck beams below. However, there is evidence of at least one cargo hatch still present amidships.

5.2.2 Recommendation

Avoidance is recommended for Target 12-1. If this is not an option, additional archaeological investigation will be needed to further characterize and determine the significance of this wreckage.

Table 17: Target 13-1

	**13-1** ● Click Position 40° 35.95899' N 073° 47.35156' W (WGS84) (X) 1042791.04 (Y) 157694.01 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Arverne East\2020SEP23_0013.sds ● Line Name: 2020SEP23_0013	**Dimensions and attributes** ● Target Width: 32.53 US ft ● Target Height: 9.63 US ft ● Target Length: 122.53 US ft ● Mag Anomaly: Yes ● Water Depth: 24' ● Description: Large square ended barge like vessel that has more than 9' of elevation off the bottom surface. A section of framework is laying off the near shore end. This wreck is laying perpendicular to another larger wreck on the inshore side

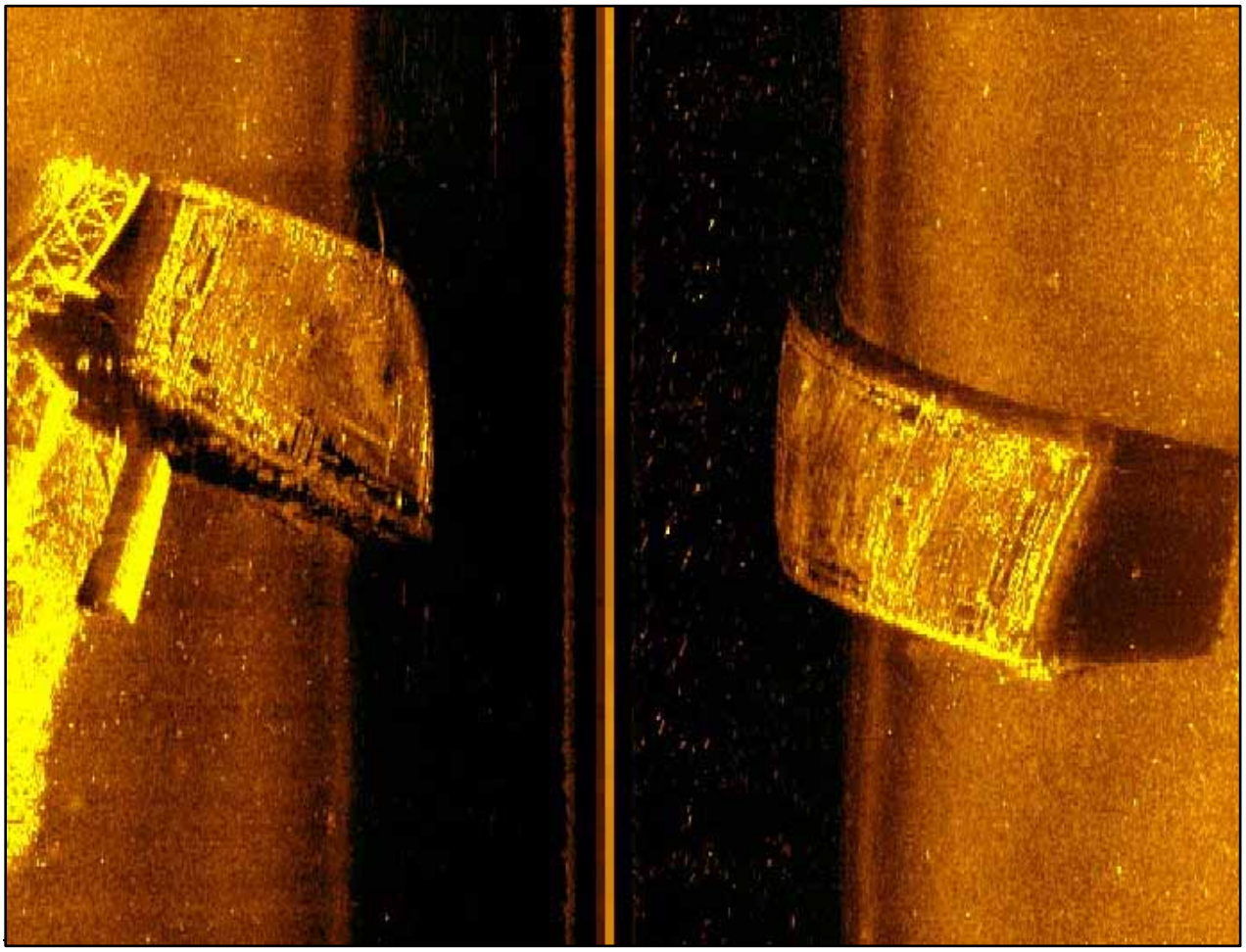


Figure 53: Target 13-1, Square-Ended Wreck Bisected by the Sonar Transect, Left Edge of Image Intersects with Another Large Wreck, Courtesy of Courtesy of Dolan Research.

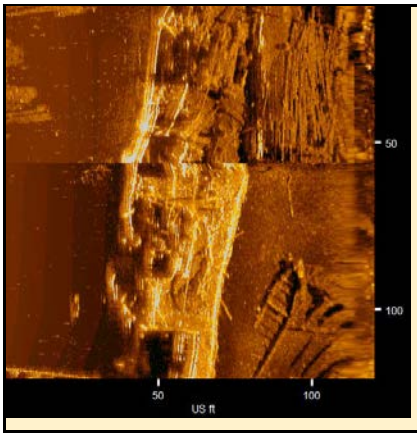
5.2.3 Evaluation

Target 13-1 is a large decked barge that rest flat on the bottom of Arverne East Survey area. The barge appears to be relatively intact. There is no evidence of structures or machinery on the deck of the vessel. A section of lattice braced metal work lies off one end of the vessel, but it is impossible to determine if it is related to the barge site.

5.2.4 Recommendation

Avoidance is recommended for Target 13-1. If this is not an option, additional archaeological investigation will be needed to further characterize and determine the significance of this wreckage.

Table 18: Target 16-1

	**16-1** ● Click Position 40° 35.96101' N 073° 47.37056' W (WGS84) (X) 1042703.04 (Y) 157706.06 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Arverne East\2020SEP23_0016.sds ● Line Name: 2020SEP23_0016	**Dimensions and attributes** ● Target Width: 37.01 US ft ● Target Height: 9.55 US ft ● Target Length: 176.53 US ft ● Mag Anomaly: Yes ● Water Depth: 19' ● Description: Al large ship hull (176' x 37') that extends for than 9' above the bottom surface. Part of a cluster of five wrecks near the shoreline.

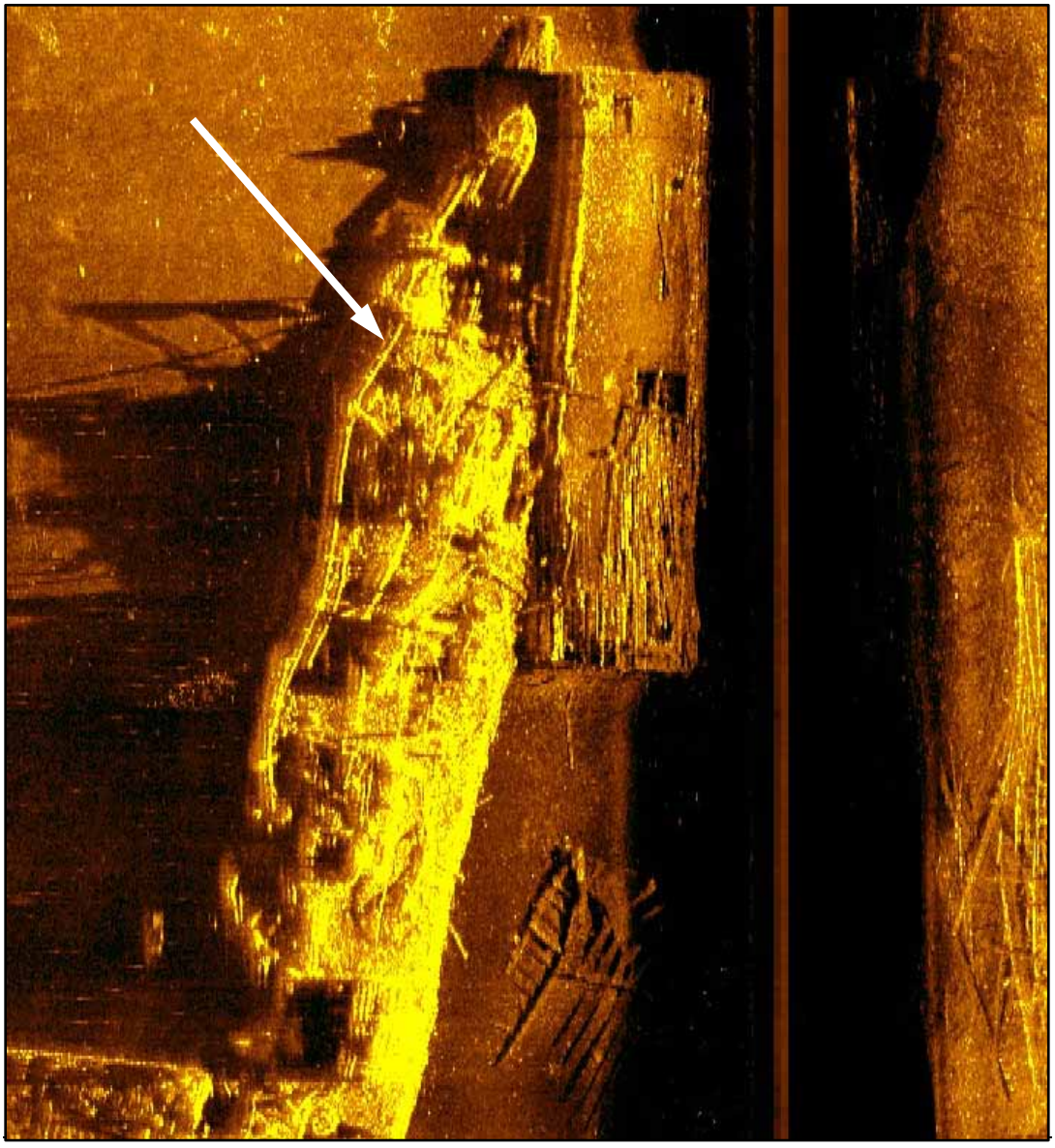


Figure 54: Target 16-1, Large Wreck with Tapered Bow, Part of Cluster of Five Wrecks, Target 16-4 Lies to Starboard, Courtesy of Dolan Research.

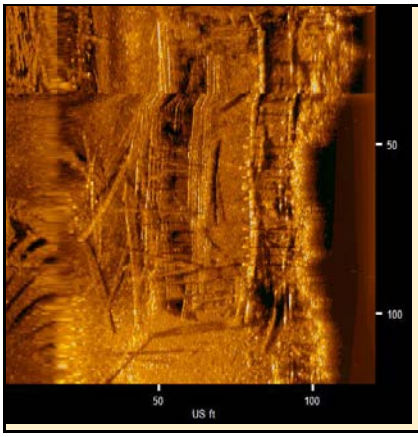
5.2.5 Evaluation

Target 16-1 is the remains of a large vessel that is badly damaged and broken up. With and length of 176 feet (53.6m) and a beam of 37 feet (11.2m) and standing up to 9 feet (2.7m) off the bottom of the study area, this target is a massive feature. However, the jumbled nature of the remains as displayed in the sonar data are difficult to interpret further.

5.2.6 Recommendation

Avoidance is recommended for Target 16-1. If this is not an option, additional archaeological investigation will be needed to further characterize and determine the significance of this wreckage.

Table 19: Target 16-3

	**16-3** ● Click Position 40° 35.97046' N 073° 47.38666' W (WGS84) (X) 1042628.42 (Y) 157763.30 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Arverne East\2020SEP23_0016.sds ● Line Name: 2020SEP23_0016	**Dimensions and attributes** ● Target Width: 32.66 US ft ● Target Height: 1.09 US ft ● Target Length: 89.18 US ft ● Mag Anomaly: Yes ● Water Depth: <12' ● Description: A disarticulated rectangular structure made of wood. Site may represent a deteriorated wood hull of a square ended barge or a collapsed section of dock along the shoreline.

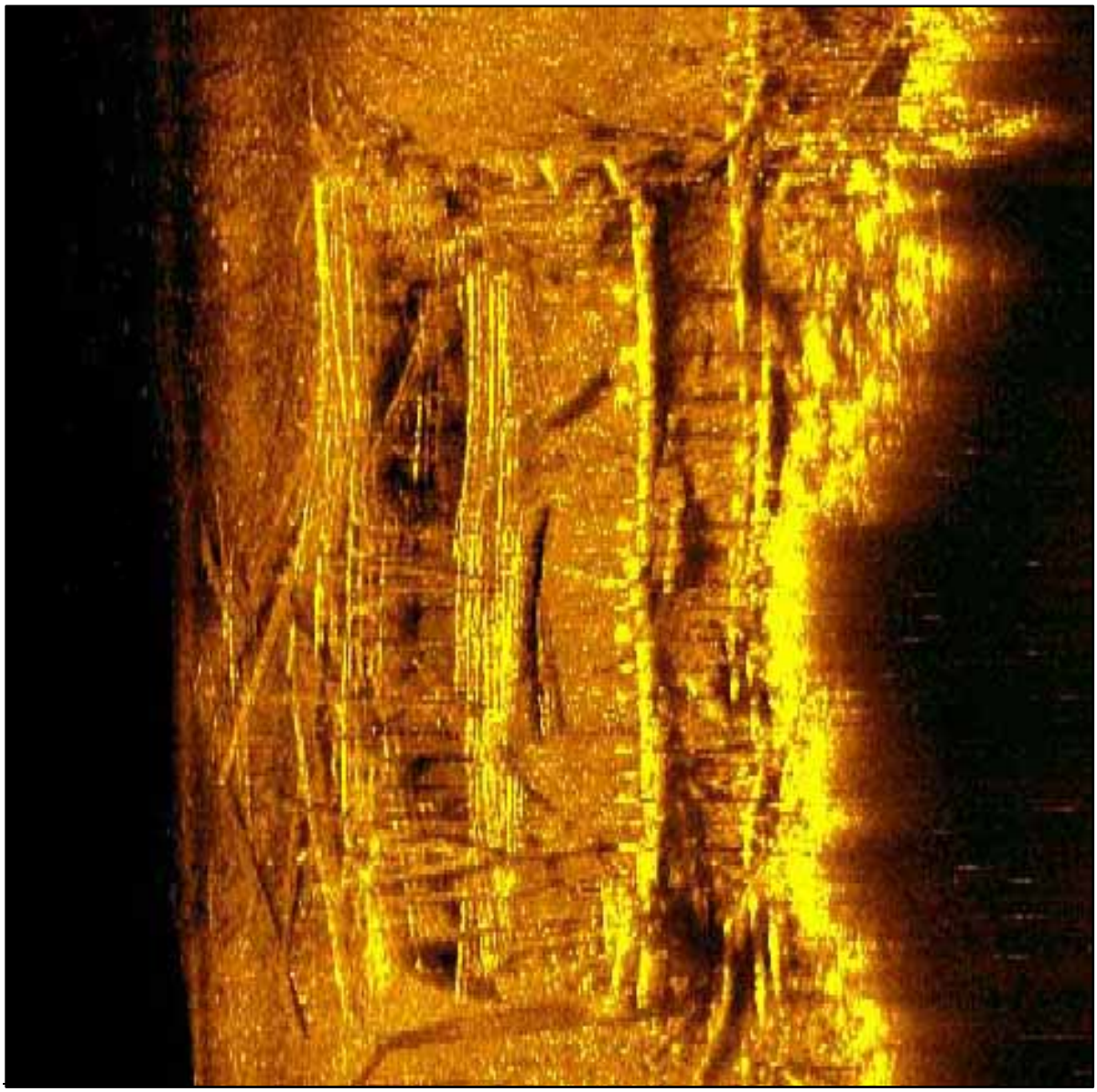


Figure 55: Target 16-3, Square- Ended Barge, Highly Disarticulated, Courtesy of Dolan Research.

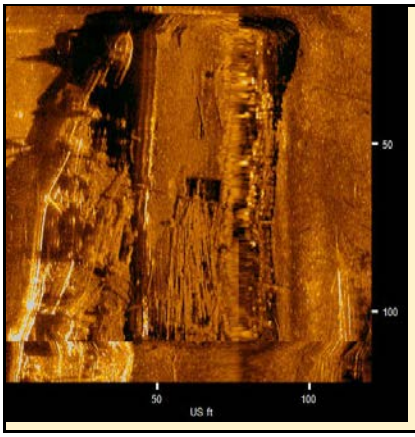
5.2.7 Evaluation

Target 16-3 demonstrates features suggestive of the bottom portions of a barge. This is indicated by the square shape of the wreckage and the longitudinal stringers that would have supported the work vessel's bottom. The main wreck components are also surrounded by other linear debris that may be fragments of the vessel. The dimensions of this barge and it wood construction indicate a construction date in the early 20th century.

5.2.8 Recommendation

Avoidance is recommended for Target 16-3. If this proves impossible in the project design, additional archaeological investigation will be needed to determine the significance of this target.

Table 20: Target 16-4

	**16-4** ● Click Position 40° 35.95416' N 073° 47.38464' W (WGS84) (X) 1042637.97 (Y) 157664.35 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Arverne East\2020SEP23_0016.sds ● Line Name: 2020SEP23_0016	**Dimensions and attributes** ● Target Width: 27.36 US ft ● Target Height: 7.42 US ft ● Target Length: 98.47 US ft ● Mag Anomaly: Yes ● Water Depth: 20' ● Description: A square ended wood hull barge like vessel. This hull is laying adjacent to the large wreck identified as 16-1.

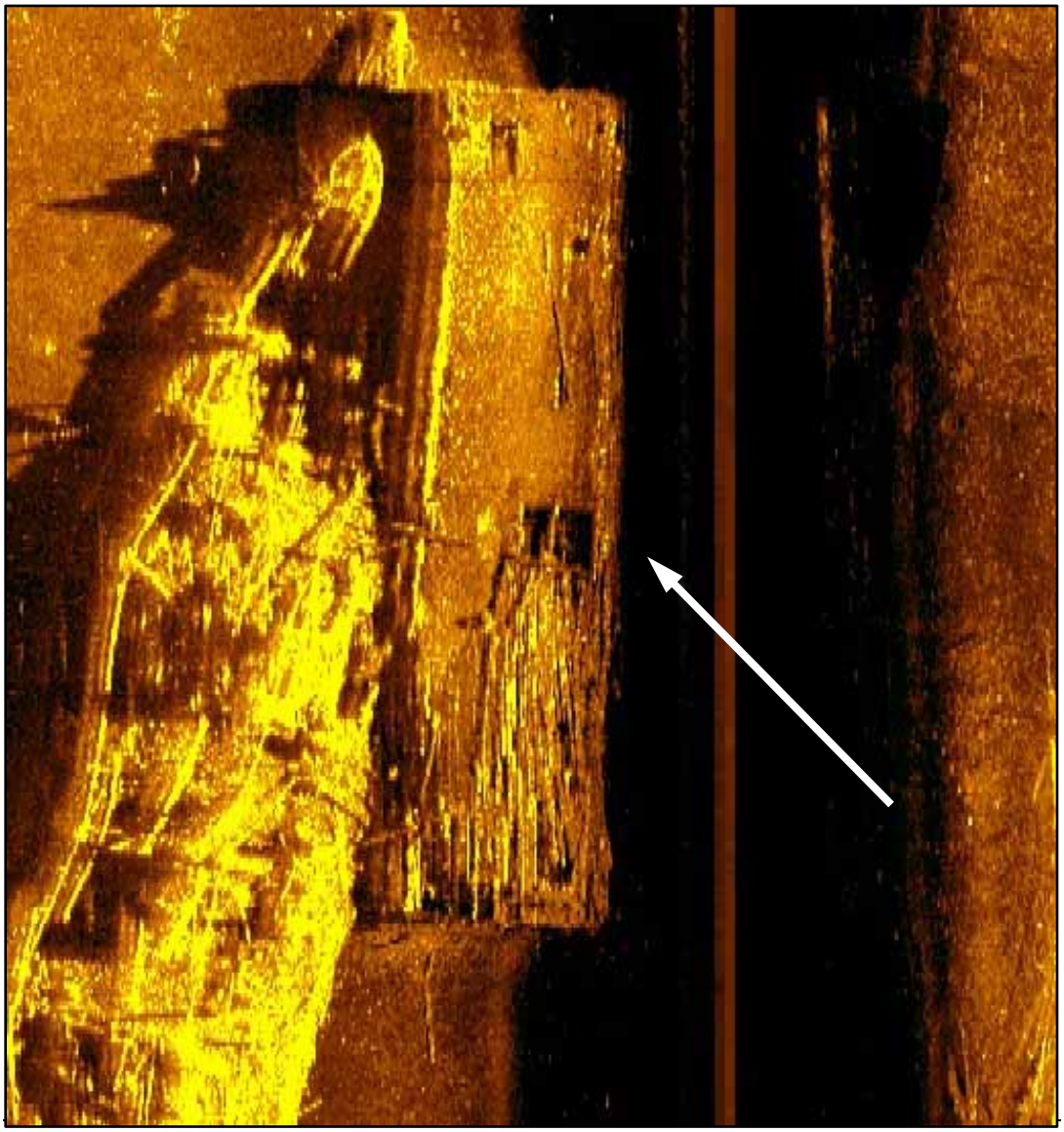


Figure 56: Target 16-4 Indicated by Arrow, Large Wooden Deck Barge, Lies Adjacent to Target 16-1, Courtesy of Dolan Research.

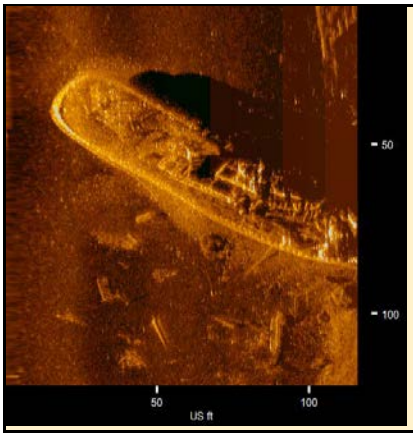
5.2.9 Evaluation

Target 16-4 is the remains of a large wooden deck barge that rests flat on the bottom of the study area, directly adjacent to Target 16-1 though there is no evidence that they are related to one another. A portion of the barge's deck planking is pulled away, but the majority remains intact and a number of small hatchways are apparent in the deck. No other machinery or evidence of structures on the vessel are present.

5.2.10 Recommendation

Avoidance is recommended for Target 16-4. If this proves impossible in the project design, additional archaeological investigation will be needed to determine the significance of this wreck.

Table 21: Target 16-7

	**16-7** ● Click Position 40° 35.88579' N 073° 47.42309' W (WGS84) (X) 1042461.04 (Y) 157248.79 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Arverne East\2020SEP23_0016.sds ● Line Name: 2020SEP23_0016	**Dimensions and attributes** ● Target Width: 25.48 US ft ● Target Height: 7.92 US ft ● Target Length: 105.13 US ft ● Mag Anomaly: Yes ● Water Depth: 24' at offshore end ● Description: Large boat (suspect tug) with a rounded stern that is laying perpendicular to the shoreline. Bow extends to the shoreline and is visible. This wreck is close to wreck site target 12-1

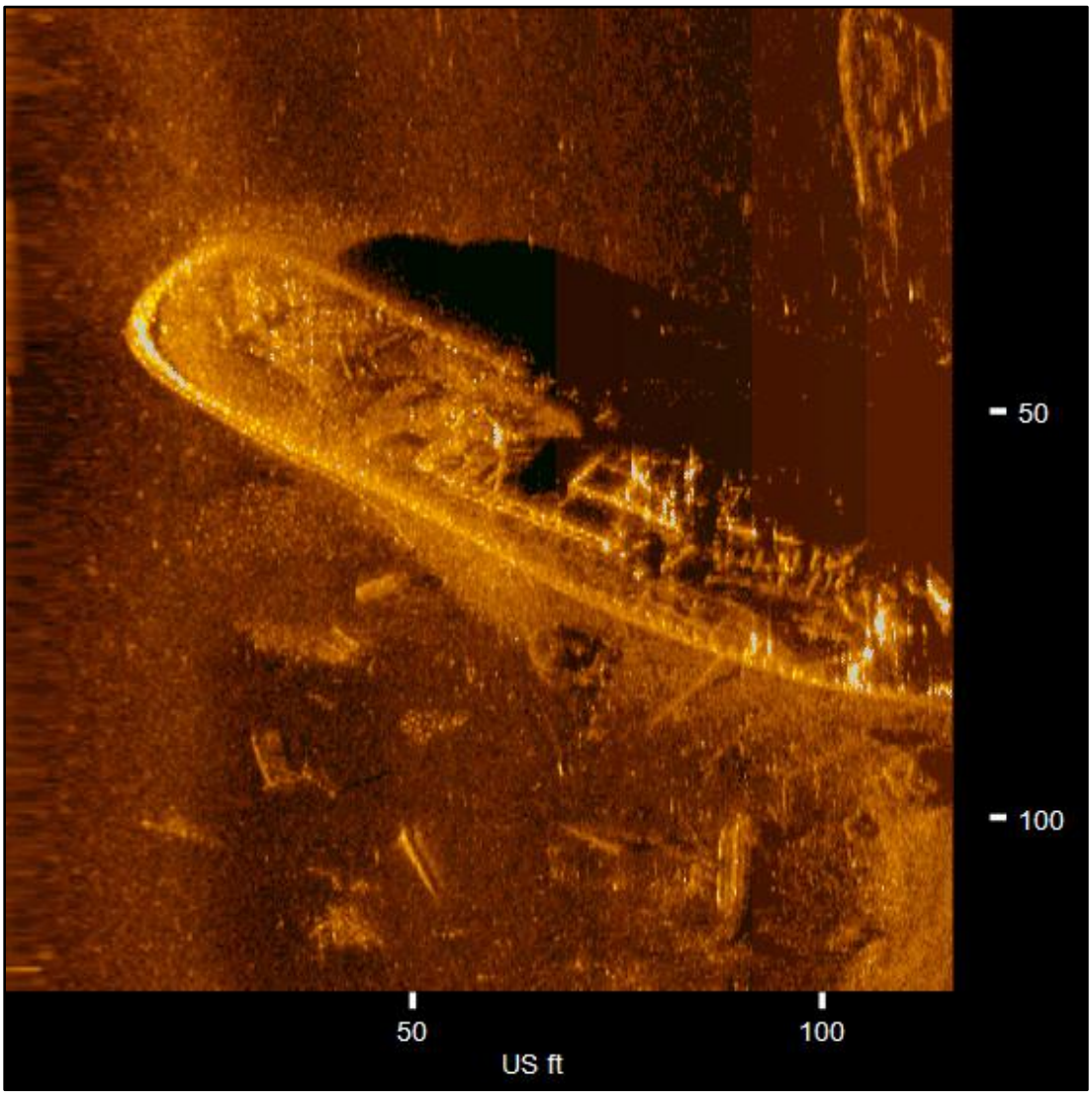


Figure 57: Target 16-7, Large Steel Hulled Wreck, Potentially Tugboat, Courtesy of Dolan Research.

5.2.11 Evaluation

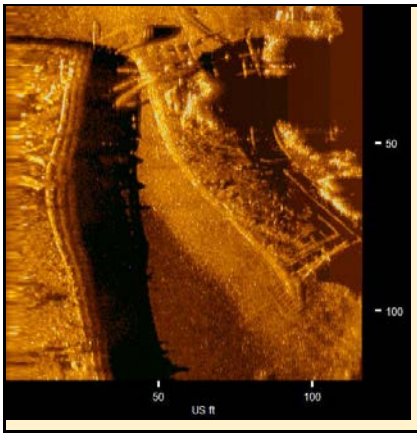
Target 16-7 appears to be the remains of a large steel hulled vessel, suspected to be a Tugboat, lying perpendicular to the shoreline. There is a large jumble of debris visible on the deck of the vessel in the raw sonar image that may be the remains of a deckhouse and/or deck machinery. The bow of this vessel extends above water and is visible in aerial photography (Figure 58).

Figure 58: Bow of Target 16-7 visible above water, Courtesy of Google Earth.

5.2.12 Recommendation

Avoidance is recommended for Target 16-7. If this proves impossible in the project design, additional archaeological investigation will be needed to determine the significance of this target.

Table 22: Target 16-8

	**16-8** ● Click Position 40° 35.85526' N 073° 47.44368' W (WGS84) (X) 1042366.19 (Y) 157063.17 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Arverne East\2020SEP23_0016.sds ● Line Name: 2020SEP23_0016	**Dimensions and attributes** ● Target Width: 28.07 US ft ● Target Height: 5.17 US ft ● Target Length: 85.35 US ft ● Mag Anomaly: Yes ● Water Depth: < 8' ● Description: Either a square ended wood hull barge-like wreck or a failed dock structure is lying adjacent to the shoreline. Wreck (Target 19-1) is lying along the offshore side of this target.

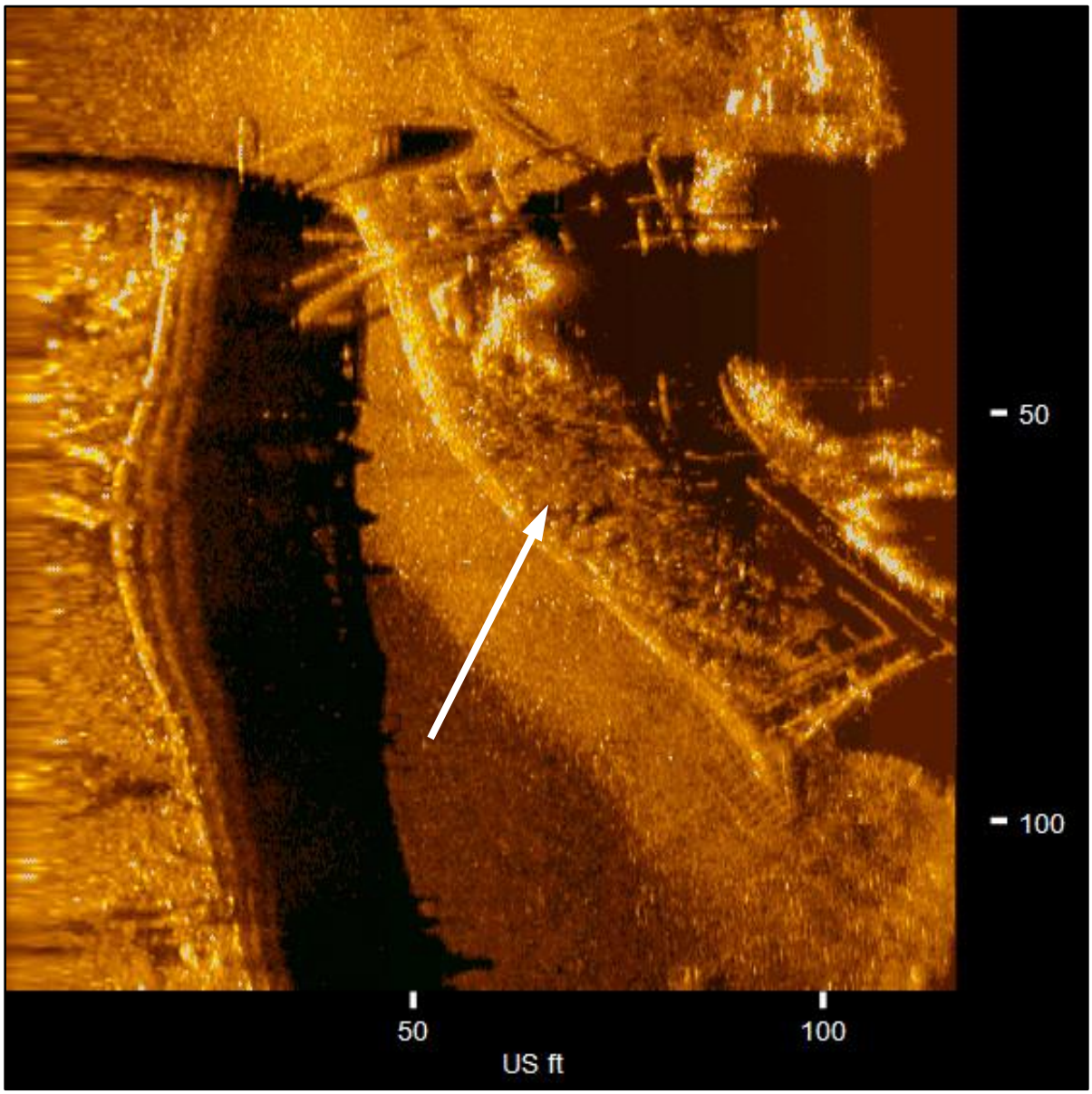


Figure 59: Target 16-8, Square-Ended Vessel, Indicated by Arrow, Courtesy of Dolan Research.

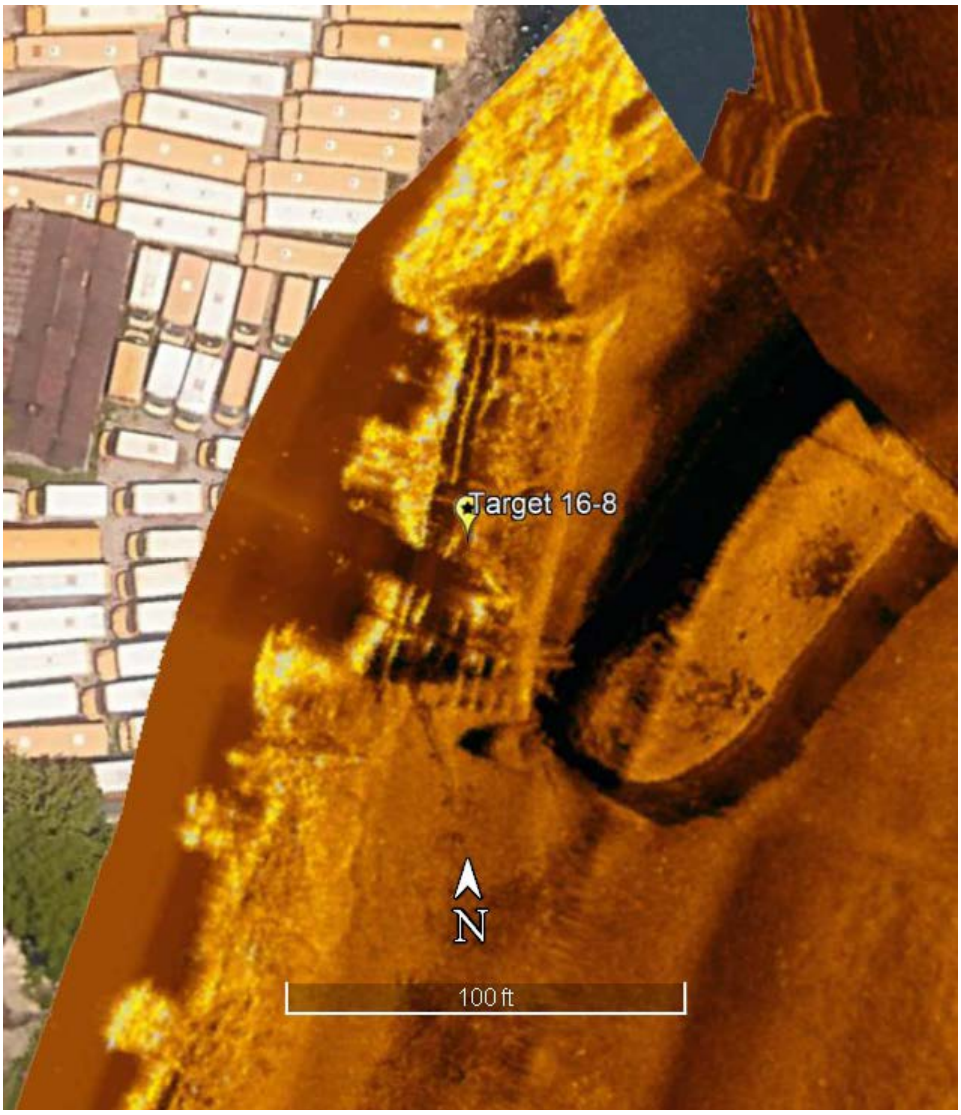


Figure 60: Target 16-8 as shown in the sonar mosaic. Courtesy of Dolan Research.

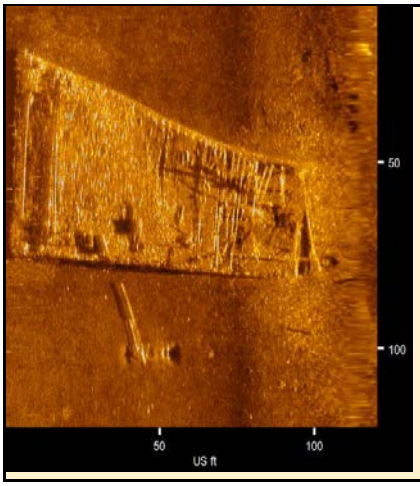
5.2.13 Evaluation

Target 16-8 represents the remains of a wooden barge that is resting flat on the bottom of the Arverne East Study area. The sonar images suggest that we are seeing the bottom of barge structure, indicated by the vessel's rectangular shape and the numerous longitudinal stingers visible. These timbers would give support the bottom of the vessel as well as the deck structures. The rake timbers are also visible on one end of the barge. Target 19-1 lies to the right of this Target 16-9 on the offshore side of the site.

5.2.14 Recommendation

Avoidance is recommended for Target 16-8. If this proves impossible in the project design, additional archaeological investigation will be needed to determine the significance of this target.

Table 23: Target 18-1

	**18-1** ● Click Position 40° 35.80959' N 073° 47.44078' W (WGS84) (X) 1042380.27 (Y) 156785.89 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Arverne East\2020SEP23_0018.sds ● Line Name: 2020SEP23_0018	**Dimensions and attributes** ● Target Width: 32.11 US ft ● Target Height: 4.34 US ft ● Target Length: 93.24 US ft ● Mag Anomaly: Yes ● Water Depth: 18'-27' ● Description: A square ended barge-like wreck is lying perpendicular to the western shoreline of cove. Wreck is approximately 80' from the former bulkhead wall along the shoreline. One end of this site is in deeper water.

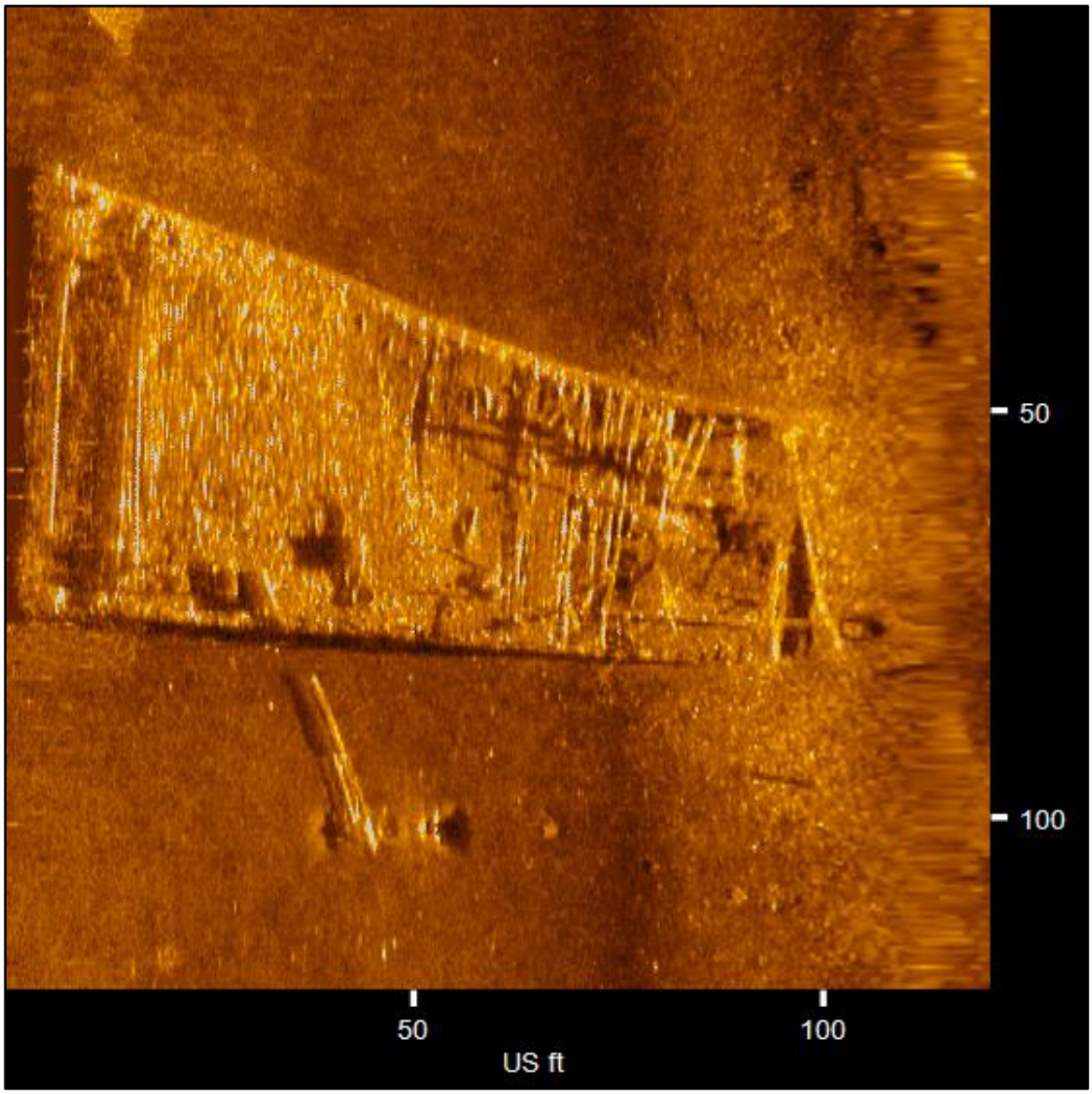


Figure 61: Target 18-1, Square-Ended, Wooden Hulled Vessel, Image Courtesy of Dolan Research.

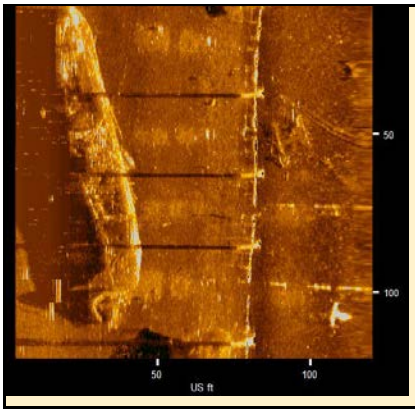
5.2.15 Evaluation

Target 18-1 is likely the remains of a square-ended, wooden deck barge that is laying perpendicular to the shoreline. The majority of the vessel's wooden deck is still intact though a few portions have peeled away, revealing the transverse deck beams below. There is no evidence of hatchways, a deckhouse, or vessel equipment on the deck of the barge.

5.2.16 Recommendation

Avoidance is recommended for Target 18-1. If this proves impossible in the project design, additional archaeological investigation will be needed to determine the significance of this target.

Table 24: Target 18-3

	**18-3** ● Click Position 40° 35.72120' N 073° 47.42781' W (WGS84) (X) 1042441.56 (Y) 156249.29 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Arverne East\2020SEP23_0018.sds ● Line Name: 2020SEP23_0018	**Dimensions and attributes** ● Target Width: 17.77 US ft ● Target Height: 5.27 US ft ● Target Length: 92.51 US ft ● Mag Anomaly: Yes ● Water Depth: 23' ● Description: An extended oblong feature that is approximately 92' x 18'. Suspect boat hull that is lying under floating docks at the western slipway of a marina.

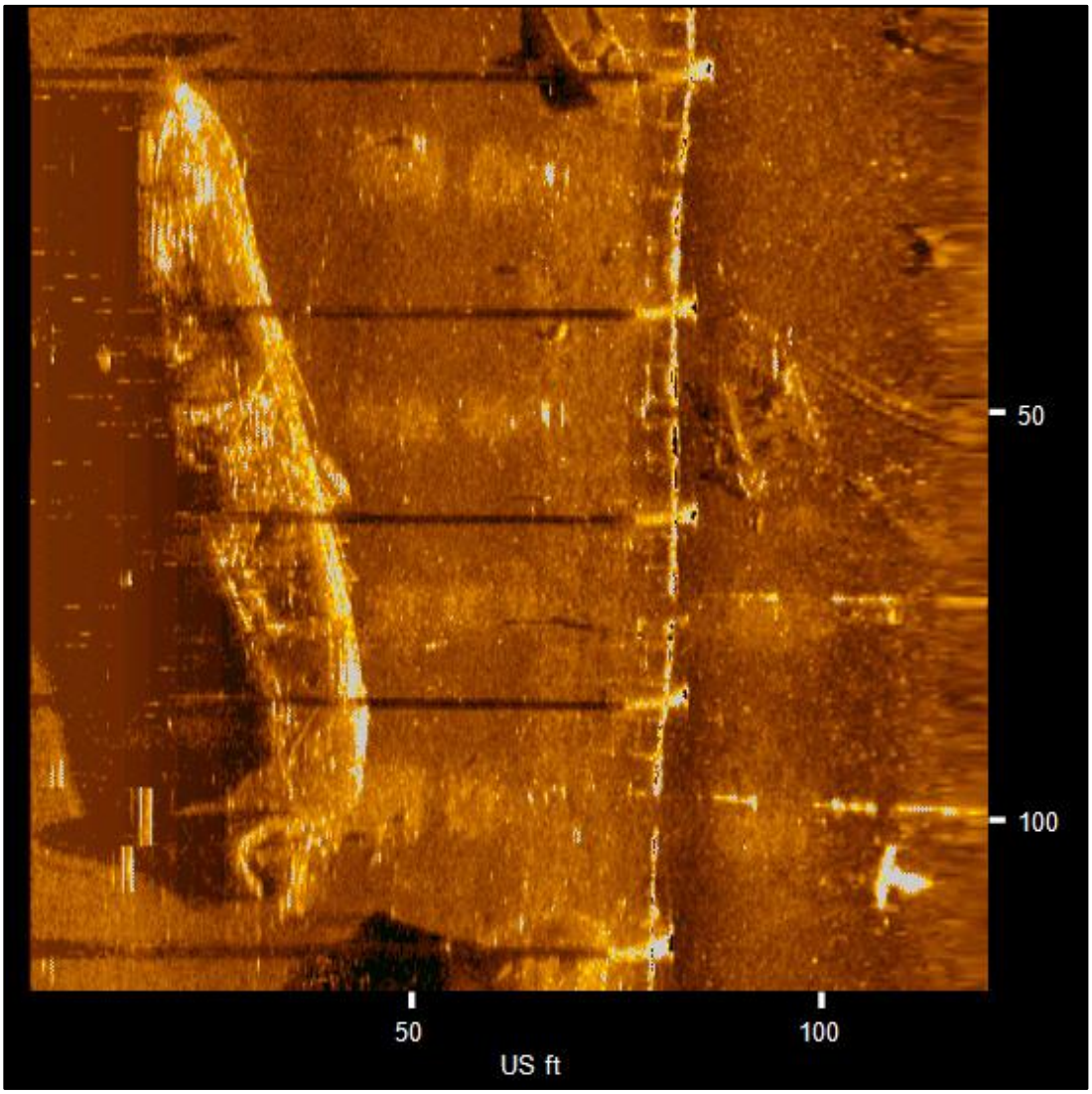


Figure 62: Target 18-3, Wreck Lying Directly Under a Dock at a Marina (five dock piles are visible). A small boat wreck (Target 18-2) is visible at the top of the image. Courtesy of Dolan Research

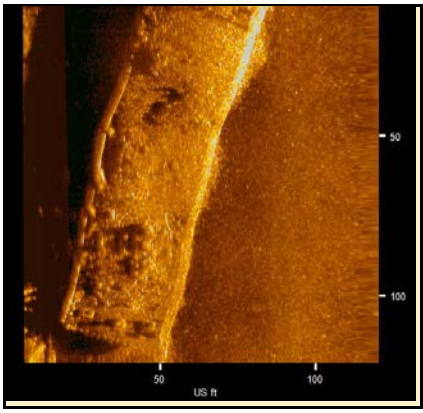
5.2.17 Evaluation

Target 18-3 is a large oblong feature that is suspected of being vessel hull, lying directly under a dock (five dock piles are visible). Its location under the floating docks of the functioning marina made it difficult to obtain additional imagery that may have added to our understanding of this vessel. Target 18-2 is visible at top of image.

5.2.18 Recommendation

Avoidance is recommended for Target 18-3. If this proves impossible in the project design, then additional archaeological investigation will be needed to determine the significance of this target.

Table 25: Target 19-1

	**19-1** ● Click Position 40° 35.85009' N 073° 47.43284' W (WGS84) (X) 1042416.44 (Y) 157031.91 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Arverne East\2020SEP23_0019.sds ● Line Name: 2020SEP23_0019	**Dimensions and attributes** ● Target Width: 35.48 US ft ● Target Height: 8.02 US ft ● Target Length: 120.26 US ft ● Mag Anomaly: 14'-21' ● Description: Square-ended barge is lying parallel and adjacent to site identified as 16-8.

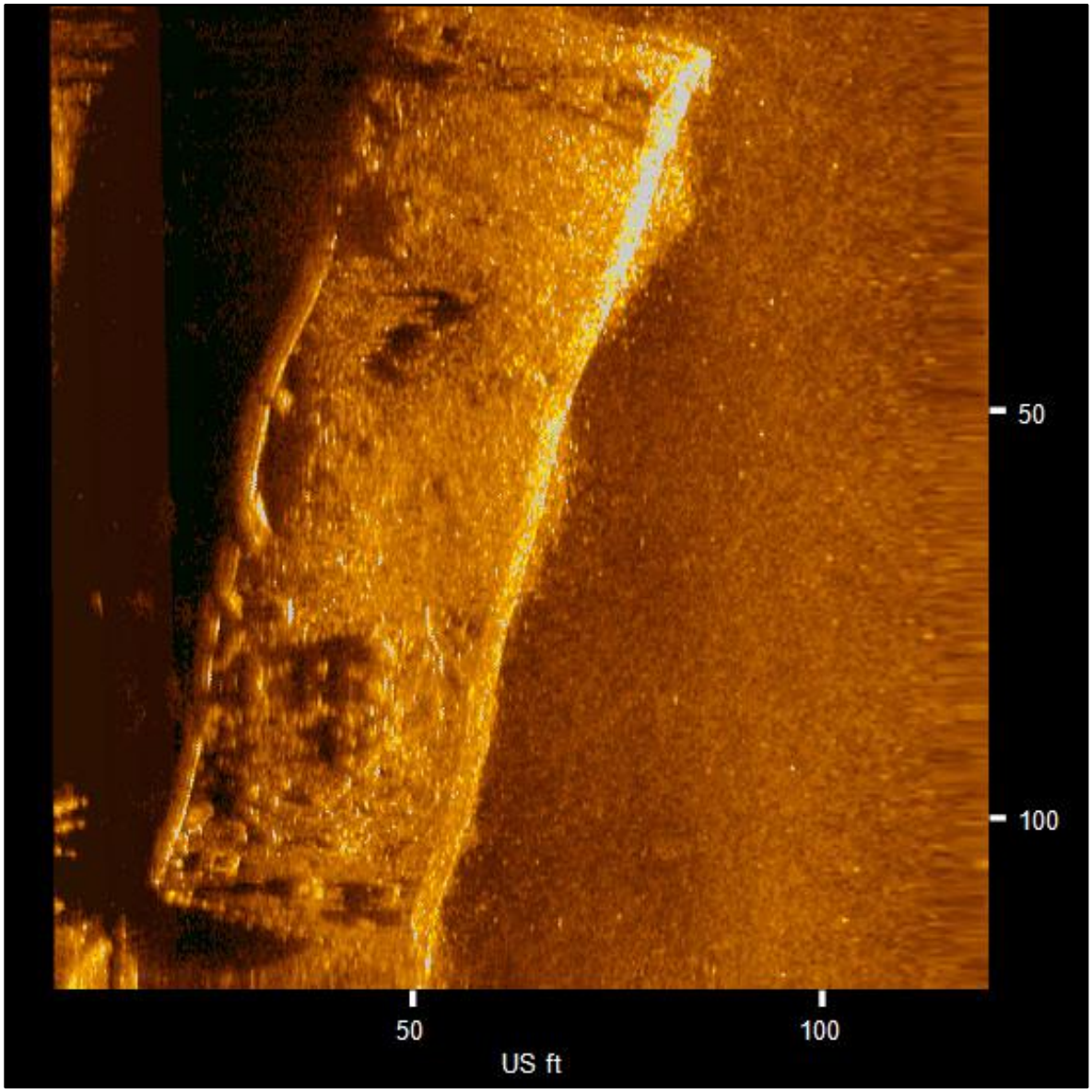


Figure 63: Target 19-1, Square-Ended, Wooden Deck Barge, Courtesy of Dolan Research.

5.2.19 Evaluation

Target 19-1 is the remains of a large, square-ended, wooden deck barge. The vessel appears to be relatively intact. The large deck does not show evidence of any structures like deck houses or equipment. This wreckage lies directly adjacent to Target 16-8, also the remains of a barge. There is no indication that the two vessels relate to one another in any way.

5.2.20 Recommendation

Avoidance is recommended for Target 19-1. If this proves impossible in the project design, then additional archaeological investigation will be needed to determine the significance of this target.

5.3 Edgemere Target Evaluation and Recommendations

There are two Potentially Significant Sites in the Edgemere Project Area (Figure 64).

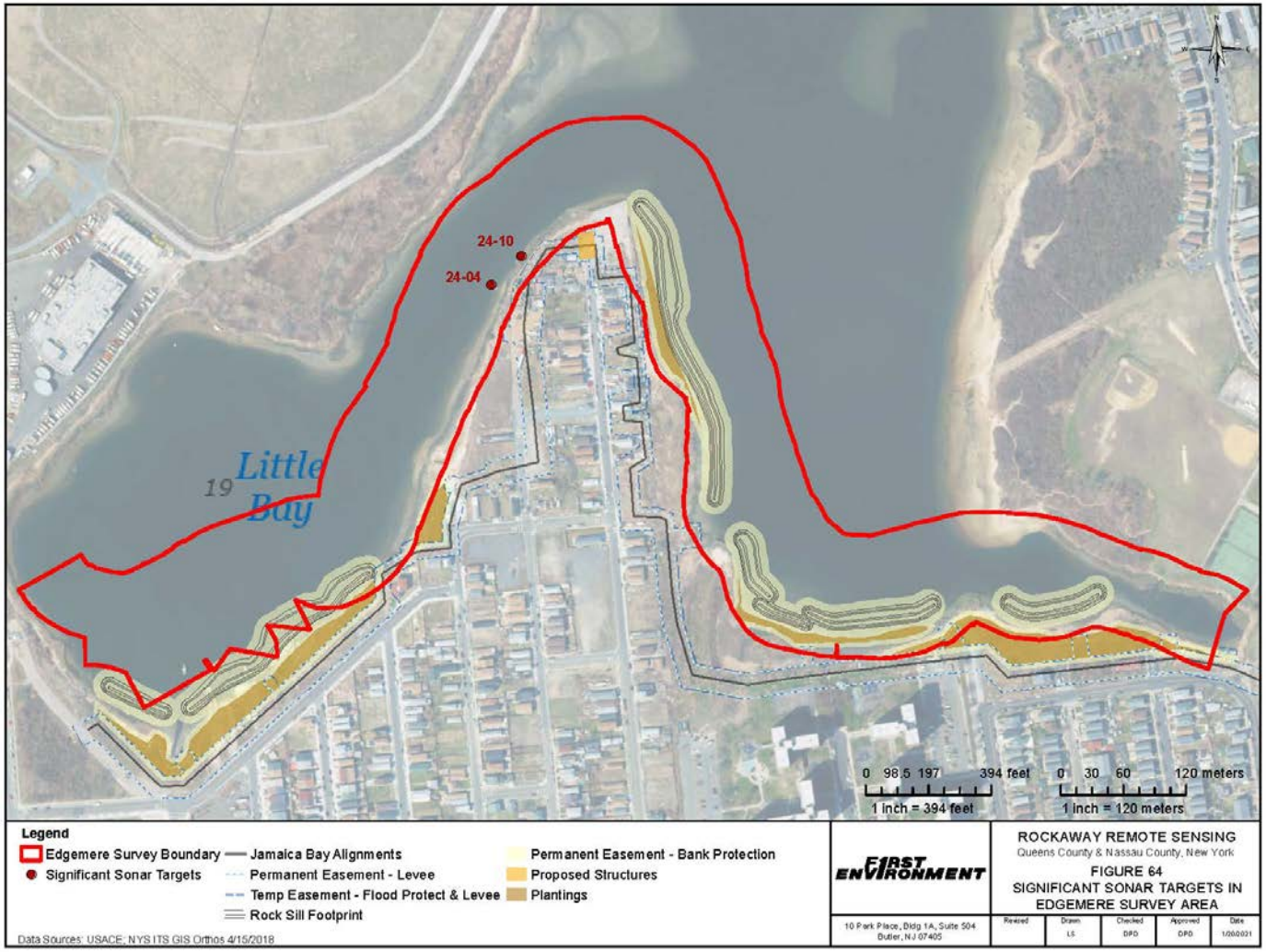
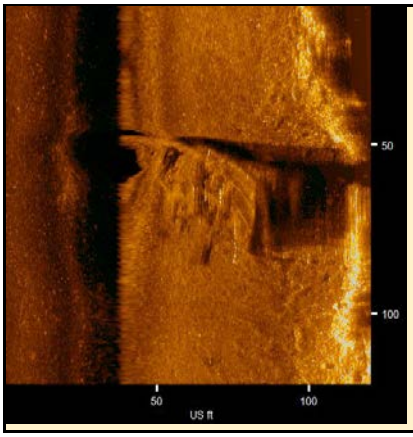


Figure 64. Potentially Significant Sonar Targets in Edgemere Survey Area (2)

Table 26: Target 24-4

	**24-4** ● Click Position 40° 36.06104' N 073° 46.59028' W (WGS84) (X) 1046312.88 (Y) 158322.40 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Edgemere\2020SEP23_0024.sds ● Line Name: 2020SEP23_0024	**Dimensions and attributes** ● Target Width: 23.09 US ft ● Target Height: 6.20 US ft ● Target Length: 50.70 US ft ● Mag Anomaly: Yes ● Water Depth:17' ● Description: The bow end of a broken hull. The stern portion of the hull appears to be missing.

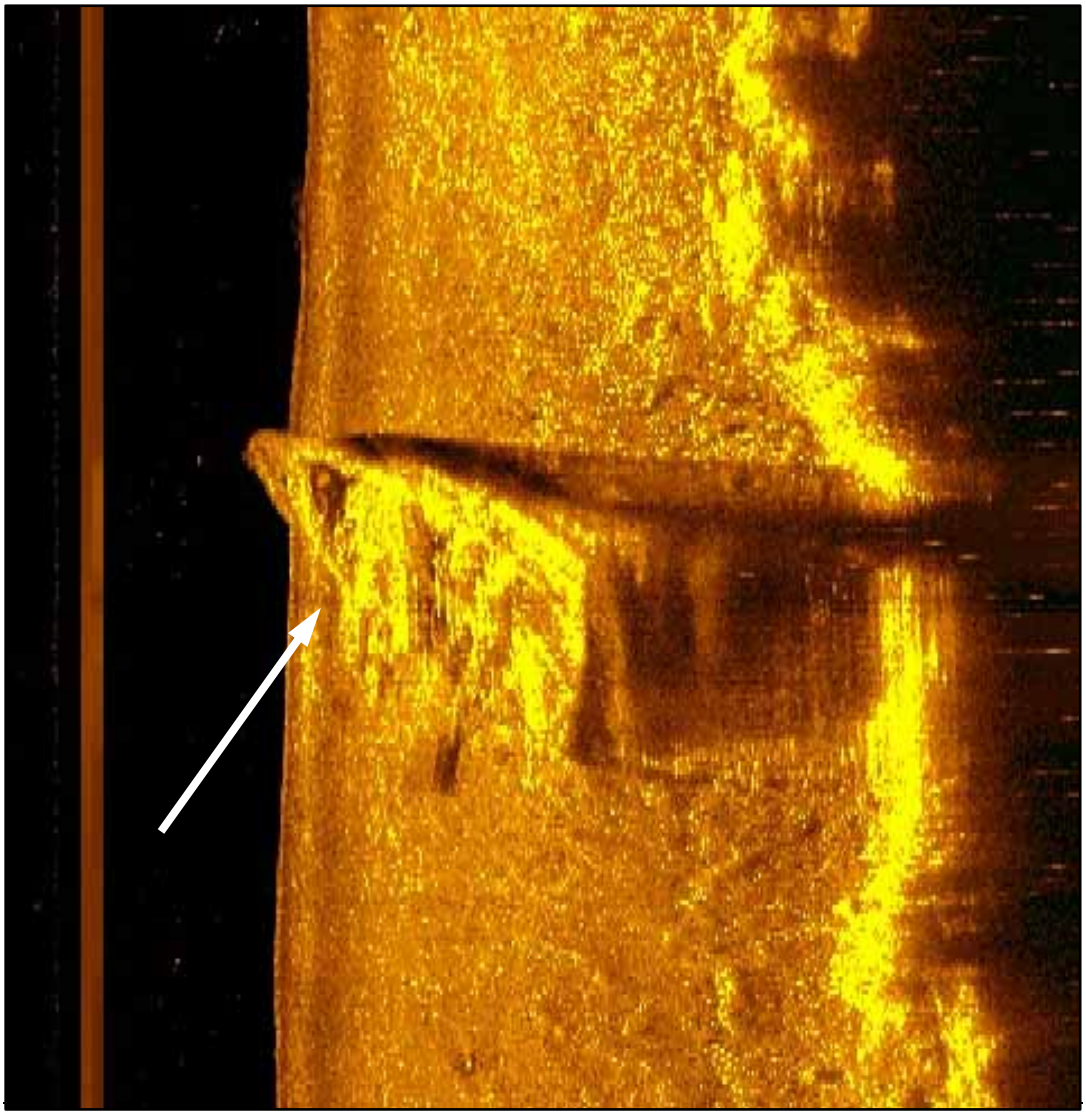


Figure 65: Target 24-4, Bow Section of Large Vessel Indicated by Arrow, Courtesy of Dolan Research.

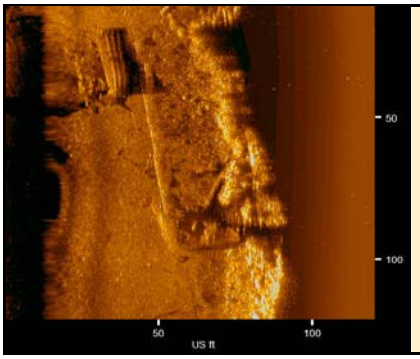
5.3.1 Evaluation

Target 24-4 appears to be a large portion of a much larger vessel. The sonar image indicates the bow of a vessel lying adjacent to the shoreline (to the right of the image) and measuring 50 feet (15.2m) long. This indicates that when intact, the vessel would have measured well over 100 feet (30.4m) long. The vessel fragment displays a sharply tapered bow section but is otherwise difficult to characterize. There appears to be a considerable amount of debris on the deck of the vessel, but it is unclear what the origin of that debris is and whether it is remnants of deck structures and/or ships equipment.

5.3.2 Recommendation

Avoidance is recommended for Target 24-4. If this proves impossible in the project design, then additional archaeological investigation will be needed to determine the significance of this target.

Table 27: Target 24-10

	**24-10** ● Click Position 40° 36.07583' N 073° 46.56968' W (WGS84) (X) 1046407.98 (Y) 158412.48 (Projected Coordinates) ● Map Projection: NY83-LIF ● Acoustic Source File: F:\Sonar Data\Rockaways\Nearshore\Edgemere\2020SEP23_0024.sds ● Line Name: 2020SEP23_0024	**Dimensions and attributes** ● Target Width: 29.10 US ft ● Target Height: 0.52 US ft ● Target Length: 77.18 US ft ● Mag Anomaly: Yes ● Water Depth: < 8' ● Description: Partially buried hull of a barge-like vessel. Located along the shoreline and partially buried under the shoreline. A small boat wreck (Target 24-9) is visible on the offshore side of the site.

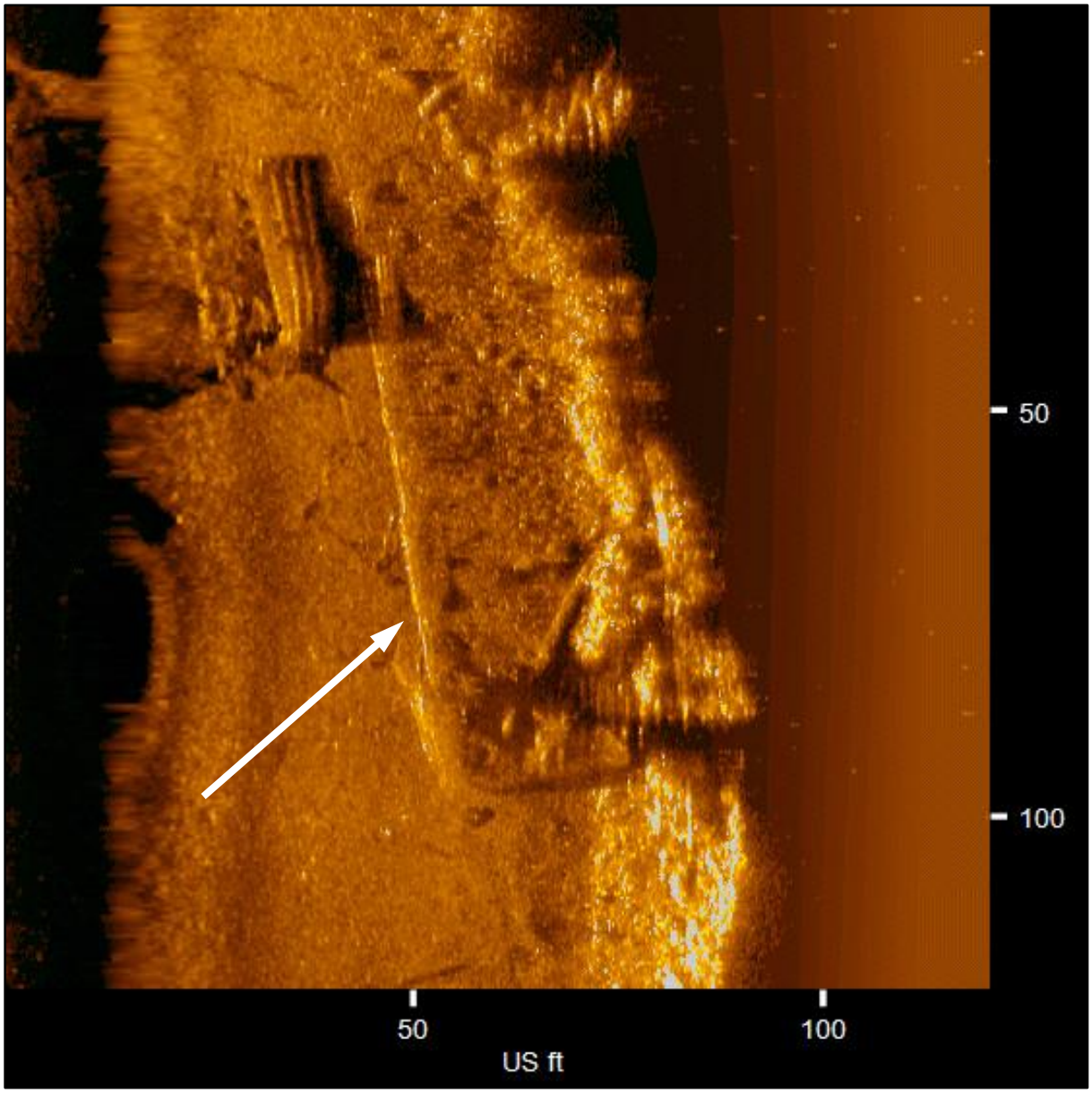


Figure 66: Target 24-10, Square-Ended Metal Barge, Rounded Corners Indicated by Arrow Courtesy of Dolan Research.

5.3.3. Evaluation

Target 24-10 is a barge partially buried, lying adjacent to the shoreline (to the right in the image). The one significant feature noted on this barge is the rounded corners, seen in the plan-view sonar image above. This is the only barge located in the project areas to display this particular characteristic. A portion of this wreckage is visible above the water, seen in Figure 67.

Figure 67: Target 24-10 Seen Partially Visible Above Water, Courtesy of Google Earth Pro.

5.3.4 Recommendation

Avoidance is recommended for Target 24-10. If this proves impossible in the project design, then additional archaeological investigation will be needed to determine the significance of this target.

6.0 Conclusion

The remote sensing data upon which this survey was conducted examined approximately 50.6 hectares (125 acres) of sea floor in the three underwater study areas for the project. At Arverne East, 8.9 hectares (22 acres) were examined. At Arverne West, 34.3 hectares (60 acres) were examined, and at Edgemere 17.4 hectares (43 acres) were examined.

A total of 66 targets were identified in the remote sensing data sets across the three project areas and 17 of those targets generated signatures that were suggestive of man-made features and comprised dimensions that could be attributed to potentially significant submerged cultural resource sites: two in the Edgemere Project Area, 10 in the Arverne East Project Area, and five in the Arverne West Project Area.

LCMM offers the following conclusions and recommendations for the APE for the underwater portion of the project:

1. Analysis of the side-scan sonar, magnetometer, and sub-bottom profiler data indicate that there are 17 potentially significant submerged archaeological or historic resources within the APE for the project.
2. Avoidance is recommended for all 17 of these potentially significant sites.
3. If avoidance is not an option at these 17 locations, additional Phase IB underwater archaeological investigations are recommended at these potentially significant remote sensing target locations.
4. No further archaeological examination is required of the 49 targets that were not determined to be significant (see Section 5.0 Summary and Recommendations).
5. Should additional work outside of the defined APE be proposed during the development of this project, LCMM notes that additional archaeological assessment may be required. Therefore, LCMM recommends that it, or other CRM professionals, review any adjustments to the APE that may fall outside the current underwater study area. Additionally, the results of any additional remote sensing studies that may be conducted during the course of the project should be reviewed to ensure that any as yet unidentified shipwrecks or underwater archaeological resources that are revealed can be avoided.

7.0 Bibliography

Alba, Joseph. (2020, March 2). *Rockaway Airport - New York Aviation History*. Metropolitan Airport News. https://metroairportnews.com/rockaway-airport/.

Ancient Order of Hibernians. (2011, November 30). Bristol and Mexico Memorial .https://www.nassauaoh.com/2011/11/30/bristol-and-mexico-memorial/.

Beers, J.B. & Co. (1886). *New Map of Kings and Queens Counties, New York*. (Map, paper and linen). Retrieved from Library of Congress, https://www.loc.gov/item/2013593269/.

Bellot, Alfred H. (1917). *History of the Rockaways from the Year 1685 to 1917.* Bellot's Histories, Inc.

Black, Frederick R. (1981). *Jamaica Bay: A History.* Prepared for Division of Cultural Resources, North Atlantic Regional Office, National Park Service, by Associate Professor of History C. W. Post Center, Long Island University.

Blanck, Maggie Land. (October 2014) . *The Red Hook Waterfront mid to late 1880s –Erie and Atlantic Basin.* Lighters. http://www.maggieblanck.com/BrooklynRedHook/RHWaterfront.html.

Bromley, G.W. and W.S. (1909). *Atlas of the City of New York, Borough of Queens, From Actual Surveys and Official Plans, Far Rockaway, Ward 5*. (Map).

Brooklyn Daily Eagle. (1910). Jamaica Bay Improvement: A New Gateway to America. *Brooklyn Daily Eagle,* No. 157.

Dripps, Mathew. (1852). *Map of Kings and part of Queens Counties, Long Island, N.Y.* (Map, Engraved and Printed by Korff Brothers). Retrieved from Library of Congress, https://www.loc.gov/resource/g3804n.la002117/?r=-0.16,0.373,1.355,1.051,0.

Encyclopedia Britannica. (n.d.) Suez Canal. In Britannica.com dictionary. Retrieved November 4, 2020, from https://www.britannica.com/topic/Suez-Canal.

Hall, Henry. (1884). *Report of the Tenth Census: Report on the Ship-Building Industry of the United States VIII*. Government Printing Office.

Harding, H. McL. (1912). Lighters and Lighterage in Harbor Freight Transference. *International Marine Engineering*, (XVII), 14-18.

Hassler, F. R., Prepared under the direction of F. R. Hassler, Superintendent of the Survey of the Coast of the United States, U.S. Coast Survey. (1844). *Map of New-York Bay and Harbor and the Environs*. Retrieved from http://www.davidrumsey.com/maps2331.html.

Hyde, E. Belcher. (1907). *Atlas of the Borough of Queens, City of New York: Based upon Official Plans and Maps on File in Various City Offices, Supplemented by Careful Field Measurements and Personal Observations*. (Map, Queens, Vol. 1, Double Page Plate No. 35; Part of Ward 5; Rockaway).

Johnson, Harry, and Fredrick S. Lightfoot. (1980). *Maritime New York in Nineteenth-Century Photographs*. Dover Publications.

Krivor, Michael C. and Stephen R. James. (2005). *Remote Sensing Survey of the Proposed Borrow Area for the East Rockaway Reformulation Project, Queens County, New York.* Prepared for the Environmental Analysis Section, U.S. Army Corps of Engineers, New York District by Panamerican Consultants, Inc. Memphis.

Merwin, Daria. (2019) Maritime Cultural Landscapes in the New York Bight. In Leslie Reeder-Meyers, John A. Turck, and Torben C. Rick (Eds.), *The Archaeology of Human-Environmental Dynamics on the North American Atlantic Coast* (pp. 81-106). University Press of Florida.

Panamerican Consultants, Inc. (2003). *Cultural Resources Baseline Study, Jamaica Bay Ecosystem Restoration Project, Kings, Queens and Nassau Counties, New York*. Prepared for Northern Archaeological Associates, Ins. under contract to U.S. Army Corps of Engineers.

Panamerican Consultants, Inc. (2004). *Phase IA Documentary Study for the Jamaica Bay Islands Ecosystem Restoration Project Brooklyn (Kings) and Queens County, New York*. Prepared for Northern Ecological Associates, Inc. under contract to U.S. Army Corps of Engineers.

Panamerican Consultants, Inc. (2005). *Final Report: Remote Sensing Survey of the Proposed Borrow Area for the East Rockaway Reformulation Project, Queens County, New York*. Prepared for U.S. Army Corps of Engineers under subcontract to Northern Ecological Associates, Inc.

Panamerican Consultants, Inc. (2006). *Phase IB Investigations of Bayswater State Park and Paerdegat Basin, Jamaica Bay Ecosystem Restoration Project, Kings, Queens and Nassau Counties, New York*. Prepared for the U.S. Army Corps of Engineers.

Panamerican Consultants, Inc. (2020). *National Register of Historic Places Eligibility Evaluation of Groins & Near Shore Remote Sensing Survey in Connection with the East Rockaway Inlet to Rockaway Inlet and Jamaica Bay: Integrated Hurricane Sandy General Reevaluation Report, New York.* Prepared for U.S. Army Corps of Engineers under contract to First Environment Boonton, New Jersey.

New York Bureau of Engineering (1924, July 1). *Sectional aerial Maps of the City of New York*. (Map, Sheets 30B and 31A. Photographed and assembled under the direction of the chief engineer, Arthur S. Tuttle). Retrieved from Library of Congress, https://www.loc.gov/item/96686421/.

New York City Planning Commission. (1969). *The Rockaways, Rockaway Point, Roxbury, Neponsit, Belle Harbor, Rockaway Park, Seaside, Broad Channel, Hammels, Somerville, Edgemere, Arverne, Bayswater, Wavecrest, Far Rockaway. (cont.).* (Map, MIT Press). Retrieved from New York Public Library, https://digitalcollections.nypl.org/items/c42cb93f-8fb2-ca65-e040-e00a18064e5c.

New York City Surveyor. *Map of Marsh Lots 10, 11, 12, 13, 14, and 15 at Rockaway Beach, Borough of Queens, City of New York, N.Y. New York (N.Y.).* (1907). Retrieved from Library of Congress, https://www.loc.gov/resource/g3804n.ct006624/?r=0.722,0.5,0.233,0.143,0.

Raber, M.S., T.R. Flagg, E. A. Wiegand, G. Weinstein, and N. Brouwer. (1995). *Cultural Resources Reconnaissance of the Kill Van Kull Reach: New York Harbor Collection and Removal of Drift Project.* Draft report submitted to Frederic R. Harris, Inc. On file, U.S. Army Corps of Engineers.

Ringwald, Donald C. (1965). *Hudson River Day Line: The Story of A Great American Steamboat Company*. Howell-North Books.

Sanborn Map Company. (1922). *Insurance Maps of the Borough of Queens, City of New York, Volume 8.* (Map, New York: Sanborn Map Company 1912, depicts 1922, Lionel Pincus and Princess Firyal Map Division.)

Schuldenrein, Joseph, Curtis E. Larsen, Michaeol Aiuvaslasit, Mark A. Smith. (2014, March). *Geomorphology/ Archaeological Borings and GIS Model of Submersed Paleoenvironment in the New York and New Jersey Harbor and Bight in Connection with the New York and New Jersey Harbor Navigation Project, Port of New York and New Jersey.* Prepared for Tetra Tech under contract to U.S. Army Corps of Engineers.

Schwab, W.C., E.R. Thieler, J.F. Denny, W.W. Danforth. (2000). *Seafloor Sediment Distribution Off Southern Long Island, New York: U.S. Geological Survey*. (Open-File Report 00-243). https://pubs.usgs.gov/of/2000/of00-243/figmaps.htm.

Stoffer, Phil and Paula Messina. (1996). *The Transient Atlantic Shoreline*. http://www.geo.hunter.cuny.edu/bight/coast.html.

The Port Authority of New York and New Jersey. *History*. https://www.panynj.gov/port/en/our-port/history.html.

Tittmann, O. H. (1911). *Jamaica Bay and Rockaway Inlet Long Island, New York.* U.S. Coast and Geodetic Survey.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service Coast Survey. (2017). *Jamaica Bay and Rockaway Inlet*.

United States Geological Survey. (1898). *New York, Brooklyn Quadrangle*. United States Government.

United States Geological Survey. (1947). *Far Rockaway, New York*. Prepared under the direction of the Chief of Engineers by the Army Map Service, War Department, Washington.

United States Geological Survey. (1954). *Far Rockaway, New York.* Prepared by the Army Map Service.

United States Geological Survey. (1969). *Far Rockaway, New York*. Prepared by United States Government.

Waldman, J. (2008) *Research Opportunities in the Natural and Social Sciences at the Jamaica Bay Unit of Gateway National Recreation Area*. Final Report to National Park Service, Jamaica Bay Institute.

Waldman J. and H. Solecki. (2018). *The Great Transformation: Exploring Jamaica Bay in the Late 19th and Early 20th Centuries Through Newspaper Accounts*. Natural Resource Report. U.S. Department of the Interior, National Park Service, Natural Resource Stewardship and Science Fort Collins, Colorado.

Whitford, Noble E. (1922). *History of the Barge Canal of New York State*. J.B. Lyon Company Printers.

Wolfe, Brendan. (2011, July 12). In Which We Delve Too Deeply into Petty Augers, Only To Find That No One Is Left Reading. *Encyclopedia of Virginia, The Blog*. https://evblog.virginiahumanities.org/2011/07/in-which-we-delve-far-too-deeply-into-petty-augers-only-to-find-no-one-is-left-reading/#comments.

Workers of the Writer's Program of the Works Projects Administration for the City of New York. (2004). *A Maritime History of New York.* Going Coastal Inc.

Newspapers

Arverne's New Addition. (1909, April 9). *Brooklyn Daily Eagle,* P.6. https://www.newspapers.com/image/53894272/.

Disastrous Gale – Three Vessels Lost. (1837, February 22). *Long Island Farmer and Queens County Advertiser,* P. 6. https://nyshistoricnewspapers.org/lccn/sn83031394/1837-02-22/ed-1/.

Hempstead Trying to Save its Bay. (1897, July 17). *The Sag Harbor Corrector,* P. 2. https://nyshistoricnewspapers.org/lccn/sn83031606/1897-07-17/ed-1/seq-2/.

Offing Magnetic Telegraph. (1846, May 26). *Long Island Farmer and Queens County Advertiser,* P. 2. https://nyshistoricnewspapers.org/lccn/sn83031394/1846-05-26/ed-1/.

Red Cross Aids 10,000 Made Homeless by $2,250,00 Fire in Arverne; Probe Started. (1922, June 16). *Brooklyn Daily Eagle*, P.1. https://www.newspapers.com/clip/9836633/red-cross-aids-10000-made-homeless-by/.

Rockaway Swept by the Hurricane. (1903, April 9). *Brooklyn Times Union,* P. 11.

Shipwreck. (1827, February 1). *Long Island Farmer and Queens County Advertiser,* P. 3. https://nyshistoricnewspapers.org/lccn/sn83031394/1827-02-01/ed-1/.

Shipwreck and Loss of Life. (1834, April 16). *Long Island Farmer and Queens County Advertiser,* P. 3. https://nyshistoricnewspapers.org/lccn/sn83031394/1834-04-16/ed-1/.

The Pilots. (1837, February 22). *Long Island Farmer and Queens County Advertiser,* P. 6. https://nyshistoricnewspapers.org/lccn/sn83031394/1837-02-22/ed-1/.

The Roslyn News. (1879, January 11). P. 2. https://nyshistoricnewspapers.org/lccn/sn95071389/1879-01-11/ed-1/.

Theater at Arverne Swept Away in Grip of Storm on Coast. (1914, January 5). *Brooklyn Daily Eagle,* P.4. https://www.newspapers.com/newspage/55515507/.

Wreck. (1836, December 16). *Long Island Farmer and Queens County Advertiser,* P. 3. https://nyshistoricnewspapers.org/lccn/sn83031394/1835-12-16/ed-1/.

Appendix 1: Key Personnel Resumes

DAVID C. BERG
First Environment, Inc.
Historic Preservation Specialist / Architectural Historian / Architectural Photographer

EDUCATION

M.A. Cert. / 1993 / Historic Preservation / University of Maryland
M.A. / 1990 / U.S. History / University of Maryland
B.A. / 1984 / History/ Wheaton College

EXPERIENCE

Mr. Berg is an Architectural Historian, Historic Preservation Specialist and Photographer with 30 years of professional experience managing historic preservation projects. He has prepared National Register of Historic Places Nomination Forms, cultural resource reports identifying historic sites and documenting National Register of Historic Places eligibility, and Section 106 reports evaluating potential effects to historic architectural properties in and adjacent to proposed project areas. Mr. Berg has prepared plans for the protection and maintenance of historic properties and has conducted mitigation efforts for buildings and structures, including written histories, the delineation of measured drawings and large-format photography in accordance with HABS-HAER-HALS standards.

RECENT PROJECT EXPERIENCE

Telecommunications Infrastructure and Tower Review, Nationwide. For Advantage Environmental Consultants, LLC of Severn, Maryland, performing Section 106 Review and coordination for FCC infrastructure and tower projects in 18 states in accordance with FCC Programmatic Agreements and state-specific requirements.

Section 110 Eligibility Assessment of Cold War Era Resources – Aberdeen Proving Ground (APG), Aberdeen, Maryland. Under contract to the Department of the Army, conducting an architectural resource survey and study (eligibility assessment) of certain Cold War-Era (CWE) facilities at APG. A total of 650 facilities are being evaluated.

Determination of Eligibility, 2100 Guilford Avenue, Baltimore, Maryland. For the Maryland Department of Motor Vehicles, prepared a formal Determination of Eligibility (DOE) for former Maryland Motor Vehicle Commission Offices at 2100 Guilford Avenue in Baltimore, Maryland. The building was found to be eligible for the National Register of Historic Places and at the State level for its role in the early history of the automobile age and the development of the Maryland Department of Transportation's Motor Vehicle Administration as well as the early history of the Maryland State Police.

HABS Level II Documentation, U.S. Coast Guard Station, Eatons Neck, New York. For the US Coast Guard, prepared photographic, graphic and written documentation of the historic Pump House at this Coast Guard facility.

HABS Level II Documentation, U.S. Naval Academy, Annapolis, Maryland. For the U.S. Naval Academy Alumni Association, prepared HABS Level II photographic, graphic and written documentation of three early twentieth century buildings at the U.S. Naval Academy in Annapolis. Buildings included the Gardener's Cottage, Stable Keepers Cottage and the Stable building.

Section 110 Eligibility Assessment of Cold War Era Resources – Joint Base McGuire-Dix-Lakehurst (JB-MDL). Under contract to the Department of the Army, Fort Worth District, Corps of Engineers, conducted an architectural resource survey and study (eligibility assessment) of certain Cold War-Era (CWE) facilities at JB-MDL in New Jersey. A total of 1,111 facilities were evaluated. Of these, 396 facilities were documented on NJ HPO survey forms either individually or combined on single forms in logical groups.

J. LEE COX, M.A., RPA
Dolan Research, Inc.
Principal Investigator / Underwater Archaeologist

EDUCATION:
M.A., Maritime History/Underwater Archaeology, East Carolina University, 1985
B.A., Anthropology/Archaeology, Duke University, 1981

SUMMARY OF EXPERIENCE:
J. Lee Cox, Jr., RPA is a professional underwater archaeologist with 34 years of submerged cultural resource experience and has directed hundreds of projects in 24 different states, primarily along the East Coast. The vast majority of his experience has focused on projects in New York, New Jersey, Pennsylvania and New England waters. He has obtained a thorough knowledge of Section 110 and Section 106 of the National Historic Preservation Act as amended (NHPA) and applying the National Register of Historic Places (NRHP) eligibility criteria to submerged cultural resources. Mr. Cox has widely recognized in his field and has presented research results and findings within academic and public sector venues and numerous publications. In addition, Mr. Cox has designed and directed a wide variety of remote sensing projects to locate and identify underwater debris and utilities for commercial clients in all types of marine environments.

The Society of Professional Archaeologists certified Mr. Cox in 1988 in underwater archaeology, marine survey, and museology. He is presently a member of the Register of Professional Archaeologists (RPA) and he is also HazMat certified. Mr. Cox serves as the firm's Principal Investigator on several ID/IQ's for underwater archaeological services for Federal and state agencies, including USACE, NJ Transit, MD SHA, SC DOT and VA DOT.

RELEVANT PROJECT EXPERIENCE:

Principal Investigator, NHPA Cultural Resources Investigations USACE NY and St Louis Districts, National Register Eligibility Studies of Three Breakwaters; Rouses Point, NY and Gordons Landing and Swanton Harbor, VT. American Recovery and Reinvestment Act 2009, Section 110 Compliance, Technical Report #5, submitted to NYCOE in conjunction with John Milner Associates.

Principal Investigator, Phase II Documentation, Underwater Archaeological Resources (Phase 1 Dredge Areas), Hudson River PCBs Superfund Site, Fort Edward and Moreau, Washington and Saratoga Counties, New York. Report submitted by URS and GE to U. S Environmental Protection Agency.

Principal Investigator, Phase I Underwater Investigations, Silver Run Project, Delaware River, Salem County, NJ and New Castle County, DE. Comprehensive Phase I project incorporating historical research, and acoustic, magnetic and seismic remote sensing data sets to identify and evaluate the significance of potential submerged cultural resources within the APE of a proposed utility crossing under Delaware Bay.

Principal Investigator, Phase I Underwater Investigations for West Point Transmission Project, Hudson River, New York. A Phase I underwater archaeological evaluation of geophysical datasets collected within the proposed path of a submerged transmission line under a 77-mile long stretch of the Hudson River, between Athens, Greene County, NY and Buchanan, Westchester County NY. Work conducted for ESS Group, Inc. (ESS) on behalf of the Powerbridge LLC's West Point Transmission Project.

Principal Investigator, Phases I and II Underwater Archaeological Investigations for New Jersey Beach Renourishment Projects. Eleven shipwreck sites and two offshore borrow areas were studied in conjunction with the beach restoration projects. Work conducted for U.S. Army Corps of Engineers, Philadelphia District.

Principal Investigator, Phase II Investigation of Target M4/S5, Proposed South Terminal Marine Infrastructure Park New Bedford, Massachusetts. The Phase II investigation included two principal components: additional underwater archeological investigation to collect more information on Target M4/S5, and documentary research to assist in confirming the identity the wreck as the *Thomas H. Lawrence*, a three-masted schooner constructed in Boston in 1891. Data collected from the underwater investigation and through historical research was used to evaluate the significance of the wreck in terms of the National Register of Historic Places eligibility criteria (36 CFR 60.4).

Paul Willard Gates. MA, MS, Registered Professional Archaeologist #10331
Phone: 717-368-1742
Email: pwgates84@gmail.com, paulg@lcmm.org

Education:

MA Maritime Studies, East Carolina University, Greenville, North Carolina, December 2019.
Thesis: *What Lies Beneath at the Pine Street Barge Canal Breakwater Ship Graveyard: Site Formation Processes as a Document of Change in Burlington, Vermont (C. 1820-1960).*
MS Historic Preservation. University of Vermont, Burlington, Vermont, December 2015.
BA History, University of Vermont, Burlington, Vermont, December 2007.

Professional Experience:

Lake Champlain Maritime Museum
Project Manager, July 2019 - present.
Conservation Technician and Archaeological Diver, May 2012 - August 2016.
Volunteer in Conservation Lab, September 2008 - May 2012.
Intern, May 2008 - August 2008.
East Carolina University, History Department
Graduate Assistant to Dr. Nathan Richards, August 2017 - December 2017.
Graduate Assistant to Dr. Donald Parkerson, January 2017 - May 2017.

Selected Projects:

- *Project Manager*, Historic Context for New York State Canal Corporation (NYSCC) Vessels to Aid in the Determination of Historic Significance. Lake Champlain Maritime Museum. Vergennes, Vermont. July 2019 – Present.
- *Principal Investigator*, Thesis Research and Fieldwork on the Pine Street Barge Canal Breakwater Ship Graveyard. Burlington, Vermont. January 2017 - October 2019.
- *Archaeological Diver*, Basin Harbor Shipwreck Underwater Archaeology Field School. Lake Champlain Maritime Museum. Vergennes, Vermont. May - June 2018.
- *Archaeological Technician and Conservator*, Pappy's Lane Wreck in Pamlico Sound, Outer Banks, North Carolina. East Carolina University Maritime Studies Program Fall Field School August 2017 - January 2018.
- *Graduate Student*, Morgan's Island Wreck, East Carolina University Maritime Studies Program Summer Field School, Bermuda. May 2017 - June 2017.

Selected Writings and Publications:

2020 Gates, Paul Willard. **Hudson River, New York Barrel Buoy Conservation Project.** New York State Museum. In - process

2019 Gates, Paul Willard, Cherilyn Gilligan, Christopher R. Sabick. **Historic Context for New York State Canal Corporation (NYSCC) Vessels to Aid in the Determination of Historic Significance.** New York State Parks, Recreation, and Historic Preservation. In - process.

2019 Gates, Paul Willard. ***What Lies Beneath at the Pine Street Barge Canal Breakwater Ship Graveyard: Site Formation Processes as a Document of Change in Burlington, Vermont (C. 1820-1960).*** Master's Thesis, submitted to East Carolina University Graduate School.

2018 Gates, Paul Willard, and George Huss. **Fall Field School in Outer Banks.** Published in *Stem to Stern* Volume 34, Newsletter for East Carolina University Maritime Studies Program.

2017 Sabick, Christopher R. and Paul Willard Gates, **Underwater Archaeological Resource Assessment Carried Out In Support Of The Tier II Boating Infrastructure Grant Project, Burlington Harbor, Chittenden County, Vermont.** Submitted to City of Burlington Parks, Recreation and Waterfront.

CHERILYN GILLIGAN

Archaeologist
RPA 17453

Vergennes, Vermont

(802) 475-2022

CherG@lcmm.org

Cherilyn Gilligan

PROFILE

Ms. Gilligan is an archaeologist with more than 10 years of experience in the field and lab. She has a working knowledge of the Section 106 process as well as the Federal Regulations for curation standards and practices. Her training in underwater photogrammetric technique is helping the Lake Champlain Maritime Museum to produce new site models of the Lake Champlain Underwater Historic Preserve. These efforts will help make our local historic resources more accessible to local communities and beyond.

EDUCATION:

M.A./ Applied Archaeology, Indiana University of Pennsylvania, 2017

B.A./ Anthropology, Minor in Plant and Soil Science, University of Vermont, 2008

EXPERIENCE:

Lake Champlain Maritime Museum **2010 to Present**
Staff Archaeologist

- CRM project management, research, and technical report writing.
- Management duties for writing grant proposals and fulfillment of agreements.
- Field supervisor for underwater and land excavations.
- Annual presentations for regional conferences on recent work.
- Data capture, processing, and production of photogrammetric site and artifact models.
- Advanced SCUBA Certification and training in underwater archaeological techniques.
- Cleaning, identifying, and cataloging artifacts according to Vermont curation guidelines.
- Conservation of a range of archaeological materials.

Navarro & Wright Consulting Engineers **2015-2016**
Archaeological Field Technician

A.D. Marble & Company **2015**
Archaeological Field Technician

AECOM **2015**
Archaeological Field Technician

McCormick Taylor **2015**
Archaeological Field Technician

CHERILYN GILLIGAN

Archaeologist

Vergennes, Vermont

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Cherilyn Gilligan

Recent Publications:

Gates, Paul W., Cherilyn A. Gilligan, Christopher R. Sabick. Lake Champlain Maritime Museum. *Historic Context for New York State Canal Corporation (NYSCC) Vessels to Aid in the Determination of Historic Significance*. Vergennes, Vermont: New York State Canal Corporation, 2020, Pending.

Gilligan, Cherilyn A., Christopher R. Sabick, Patricia N. Reid. Lake Champlain Maritime Museum. *Document Review and Archaeological Assessment of Selected Areas from the Revolutionary War and War of 1812, Plattsburgh, New York.* Vergennes, Vermont: City of Plattsburgh, American Battlefield Protection Program, National Park Service, 2019.

Sabick, Christopher R., Cherilyn A. Gilligan. Lake Champlain Maritime Museum. Phase 1B Underwater Archaeological Assessment and Inventory, Cohoes, Albany County, New York. Vergennes, Vermont: EPA, 2020, Pending.

Sabick, Christopher R., Cherilyn A. Gilligan. Lake Champlain Maritime Museum. *Phase I Underwater Archaeological Investigation for Proposed Crosslake Fibre Project in U.S. Waters of Lake Ontario from the U.S. – Canadian International Border to the Town of Wilson, Niagara County, New York*. Vergennes, Vermont: Ecology & Environment, Inc., March 2018.

Sabick, Christopher R., Sarah L. Tichonuk, and Cherilyn A. Gilligan. Lake Champlain Maritime Museum. Phase 3 Underwater *Archaeological Documentation of Anomaly 13 (A13), Subsite of the Onondaga Lake Superfund Site, Onondaga County, New York.* Vergennes, Vermont: Honeywell, Parsons, November 10, 2016.

Recent Presentations:

Gilligan, Cherilyn A. “Moravian Ethnic Diversity: An Archival and Faunal Analysis of Moravian Mission Towns in Colonial Ohio.” Paper presented at Society for Historical Archaeology, Saint Charles, Missouri, January 2019.

Gilligan, Cherilyn A. “Battle of Plattsburgh 2019 Research Highlights: Imagining the Common Soldier’s Experience.” Paper presented at Battle of Plattsburgh Event, Plattsburgh, New York, September 2019.

Gilligan, Cherilyn A. “Salt horse, salt horse, what brought you here?”: A look at Shipboard Diet Among the King’s Shipyard.” Paper presented at Society for Historical Archaeology, Boston, Massachusetts, January 2019.

References Available Upon Request

Christopher R. Sabick
30 MacDonough Dr.
Vergennes, VT 05491
(802) 578-8205

Education:

MA Anthropology, Texas A&M University, College Station, Texas, 2004.
Thesis: *His Majesty's Hired Transport Schooner* Nancy
BA Anthropology and History, Ball State University, Muncie, Indiana, 1995.

Professional Experience:

Lake Champlain Maritime Museum

Director of Research and Archaeology, March 2014-present
Interim Archaeological Director, September 2013 – March 2014
Director of Conservation, May 2000 – August 2013
Archaeological Conservator, June 1999 - May 2000

Selected Projects:

- Director, Matton Shipyard Archeological Inventory. October 2019-present
- Co-Director, Kings Shipyard Survey, Ticonderoga New York. May 2019-present
- Principal Investigator, Basin Harbor Shipwreck Underwater Archaeology Field School. May-June 2018
- Principal Investigator, Phase III Investigation of Wreck Site A13, Onondaga Lake, NY. 2014-2016
- Archaeological Director, Sloop Island Canal Boat 3D Sonar Documentation Project. July 2012-prestent
- Archaeological Diver, Onondaga Lake Cultural Resources Survey 2010-present
- Archaeological Diver, Hudson River PCB Superfund Clean-up. 2009-present
- Archaeological Diver and Conservator, Sloop Island Canal Boat Documentation Project. 2002-2003

Selected Publications:

2019 Sabick, Christopher R., Cherilyn Gilligan. **Matton Shipyard Archaeological Inventory, Cohoes, Albany County, New York**. In-process.

2018 Sabick, Christopher R, Cherilyn Gilligan. **Phase I Underwater Archaeological Investigation for Proposed Crosslake Fibre Project in U.S. Waters of Lake Ontario from the U.S.-Canadian International Border to the Town of Wilson, Niagara County, New York.** Submitted to New York SHPOs office.

2017 Sabick, Christopher R. and Paul Gates, **Underwater Archaeological Resource Assessment Carried Out In Support Of The Tier II Boating Infrastructure Grant Project, Burlington Harbor, Chittenden County, Vermont**. Submitted to City of Burlington Parks, Recreation and Waterfront.

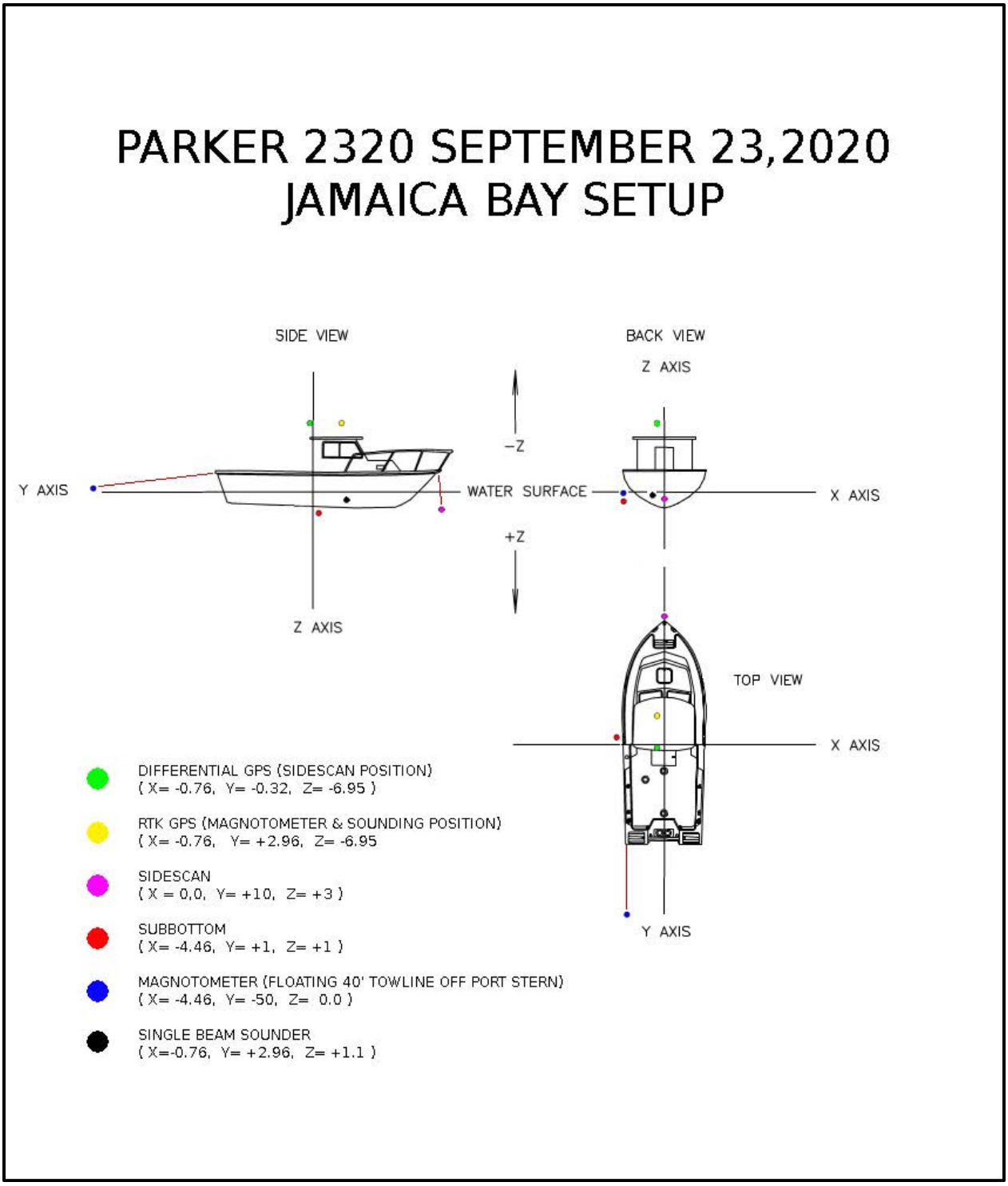
2016 Sabick, Christopher R., Sarah Lyman, Cherilyn Gilligan. **Phase III Underwater Archaeological Documentation of Anomaly (A13)**, **Subsite of the Onondaga Lake Superfund Site, Onondaga County, New York**. Submitted to New York SHPOs office.

2015 Sabick, Christopher R., Paul W. Gates. **Underwater Archaeological Resource Assessment for the North Hero-Grand Isle BFH 028-1(26) Bridge Rehabilitation Project**, **Grand Isle County, Vermont**. Submitted to Vermont Division of Historic Preservation and Hartgen Archaeological Associates.

2013 Sabick, Christopher R. **His Majesties' Royal Transport Schooner *Nancy*: History and Construction**. *Coffins of the Brave: The Archaeology of War of 1812 Shipwrecks.* Texas A&M University Press.

2012 Gates, Paul, Adam Kane, Christopher R. Sabick. **Fort Edward Canal Infrastructure Survey**. Submitted to USEPA Region 1.

Appendix 2: Survey Vessel Set Up



Cut Sheet of Offsets on Survey Boat

Notes: 1) Magnetometer, side scan sonar, sub bottom, and bathymetric transducers were deployed for survey

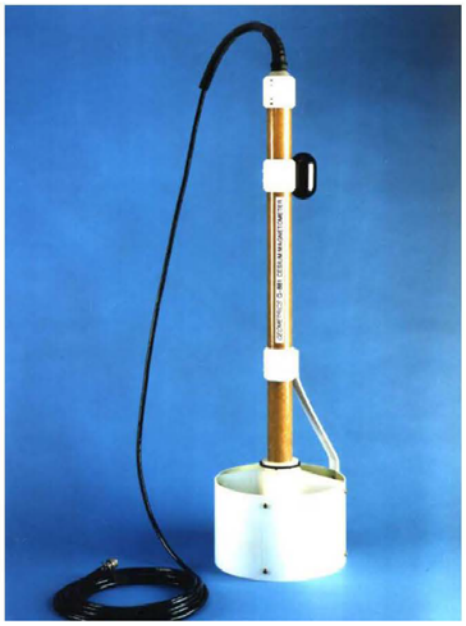
Appendix 3: Remote Sensing Equipment Specifications

Geometrics 881 Magnetometer

GEOMETRICS

G-881 MARINE MAGNETOMETER

- *CESIUM VAPOR HIGH PERFORMANCE - Improved range and probability of detecting all sized ferrous targets*
- *LOW SYSTEM PRICE - cost effective compared to competing technologies*
- *HIGH SENSITIVITY _ 0.01 nT/_Hz RMS with the internal CM-221 Mini-Counter*
- *DIGITAL OUTPUT - COMPUTER LOGGING Use your computer with MagLog-Lite™ RS-232 logging/display software or Geometrics supplied CM-201 View utility program*
- *EASY PORTABILITY & HANDLING - no winch - single man operation, 44 lbs with 200 ft cable*
- *COMBINE TWO SYSTEMS FOR INCREASED COVERAGE - CM-221 Mini-Counter provides multi-sensor data concatenation allowing side by side coverage which maximizes detection of small targets and reduces noise*



Very high resolution Cesium Vapor performance has been incorporated into a low cost, small size no-frills system for professional surveys in shallow water. High sensitivity and sample rates of total field measurements are maintained for all applications. The well proven Cesium sensor is combined with a unique new CM-221 Larmor counter and ruggedly packaged for small boat operation. Use your computer with our MagLog-Lite™ or MagLog NT™software to log, display and print RS-232 data transmissions from the mag and GPS receiver. Model G-881 is the lowest priced - highest performance fully operational marine mag system ever offered.

The G-881 is focused for operation in small boat, shallow water surveys. Being small and lightweight (44 lbs net) it is easily deployed and operated by one man. Power may be supplied from a 24 to 30 VDC battery supply. The tow cable uses high strength Kevlar and it's length is fixed at 200 ft (61 m). The shipboard end of the tow cable is attached to a junction box for quick and simple hookup to power and output of data into any small computer. (Upon request Geometrics will provide both computer and logging software for recording and display of magnetics and GPS location.) A rugged fiber-wound fiberglass housing incorporates selective orientation of the sensor and therefore maintains operations throughout the world with small limitations as to direction of survey in Equatorial regions.

The Cesium magnetometer provides nearly the same operating sensitivity and sample rates as the larger model G-880. Utility software is supplied with each magnetometer and allows display of data and recording to hard disk. Available options include a small notebook computer with MagLog™ installed which provides superior visual presentation of magnetics and GPS data, and a dot matrix printer for real time hard copy. Additional options include: Post

acquisition analog trace plotting software MagPlot, The G-881 system is particularly well suited for the detection and mapping of all sizes of ferrous objects. This includes anchors, chains, cables, pipelines, ballast stone and other scattered shipwreck debris, munitions of all sizes, aircraft, engines and any other object with magnetic expression. Objects as small as a 5 inch screwdriver are readily detected provided that the sensor is close to the seafloor and within practical detection range.(Refer to table at right).

The design of this special marine unit is directed toward the largest number of user needs. It is not intended to meet all marine requirements such as deep tow through long cables or monitoring fish altitude. Rugged design with highest performance at lowest cost are the goals.

and Surfer for Windows for generating contour maps.

Typical Detection Range For Common Objects

Ship 1000 tons	0.5 to 1 nT at 800 ft (244 m)
Anchor 20 tons	0.8 to 1.25 nT at 400 ft (120 m)
Automobile	1 to 2 nT at 100 ft (30 m)
Light Aircraft	0.5 to 2 nT at 40 ft (12 m)
Pipeline (12 inch)	2 to 3 nT at 125 ft (38 m)
Pipeline (6 inch)	2 to 3 nT at 80 ft (24 m)
100 KG of iron	2 to 3 nT at 50 ft (15 m)
100 lbs of iron	2 to 3 nT at 30 ft (9 m)
10 lbs of iron	3 to 4 nT at 15 ft (5 m)
1 lb of iron	2 to 3 nT at 8 ft (2.5 m)
Screwdriver 5 inch	0.5 to 2 nT at 12 ft (4 m)
1000 lb bomb	4 to 5 nT at 100 ft (30 m)
500 lb bomb	0.5 to 5 nT at 50 ft (16 m)
Grenade	1 to 2 nT at 6 ft (2 m)
20 mm shell	0.5 to 2 nT at 5 ft (1.8 m)

MODEL G-881 CESIUM MARINE MAGNETOMETER SYSTEM SPECIFICATIONS

OPERATING PRINCIPLE:	Self-oscillating split-beam Cesium Vapor (non-radioactive)
OPERATING RANGE:	20,000 to 100,000 nT
OPERATING ZONES:	The earth's field vector should be at an angle greater than 6° from the sensor's equator and greater than 6° away from the sensor's long axis. Automatic hemisphere switching.
CM-221 COUNTER SENSITIVITY:	<0.01 nT/ _Hz rms. Typically 0.5 nT P-P at a 0.1 second sample rate or 0.005 nT at 1 second sample rate. Up to 10 samples per second
HEADING ERROR:	±1 nT (over entire 360° spin and tumble)
ABSOLUTE ACCURACY:	<3 nT throughout range
OUTPUT:	RS-232 at 9600 Baud
MECHANICAL:	
Sensor Fish:	Body 2.75 in. (7 cm) dia., 5.75 ft (1.75 m) long with ring fin (15 in. OD), 27 lbs. (12.3 kg) Includes Sensor and Electronics
Tow Cable:	Kevlar Reinforced multiconductor tow cable. Breaking strength 4,000 lbs, 0.47 in OD, 200 ft maximum. Weighs 17 lbs (7.7 kg) with terminations.
OPERATING TEMPERATURE:	-30°F to +122°F (-35°C to +50°C)
STORAGE TEMPERATURE:	-48°F to +158°F (-45°C to +70°C)
ALTITUDE:	Up to 30,000 ft (9,000 m)
WATER TIGHT:	O-Ring sealed for up to 200 ft (61 m) depth operation
POWER:	24 to 32 VDC, 0.75 amp at turn-on and 0.5 amp thereafter
ACCESSORIES:	
Standard:	CM-201 View Utility Software operation manual and ship case
Optional:	AC Power supply, Surfer for Windows, GPS, Computer
MagLog-Lite™ or MagLog NT™ Software:	Logs, displays and prints Mag and GPS data at 10 Hz sample rate.

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE *6/98*

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GEOMETRICS Europe Manor Farm Cottage, Galley Lane, Great Brickhill, Bucks,
England MK179AB • 44-1525-261874 • Fax 44-1525-261867

GEOMETRICS China Laurel Industrial Co. Inc. - Beijing Office, Room 2509-2511, Full Link Plaza
#18 Chaoyangmenwai Dajie, Chaoyang District, Beijing, China 100020
10-6588-1126 (1127..1130), 10-6588-1132 • Fax 010-6588-1162

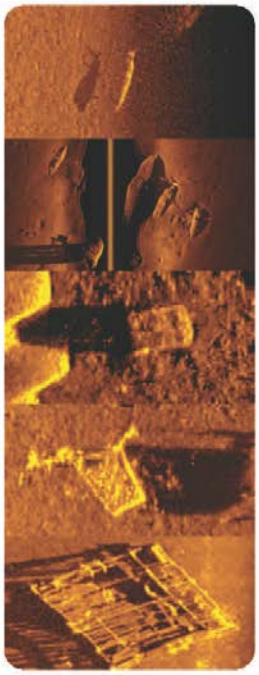
GEOMETRICS

Marine Sonic HDS Side-Scan Sonar

SEA SCAN® HDS

MARINE SONIC TECHNOLOGY

The Sea Scan HDS is the Backbone of the industry in digital Side Scan Sonar. Utilized by Military, Police, and Fire & Rescue Agencies all over the world! It is extremely rugged, and built for the harshest environments...



KEY FEATURES:

- Fully Digital
- Solid PVC Tow Body
- Enclosed Durable Fin Assembly
- Dual Frequencies, Your Choice
  300/900kHz - 600/1200kHz - 900/1800kHz
- 30m & 100m Kevlar Tow Cables
- Splash-Proof Topside Box
- Splash-Proof GPS
- Tools & Spares Kit
- Rugged Shipping & Storage containers
- 100% Made in the U.S.A

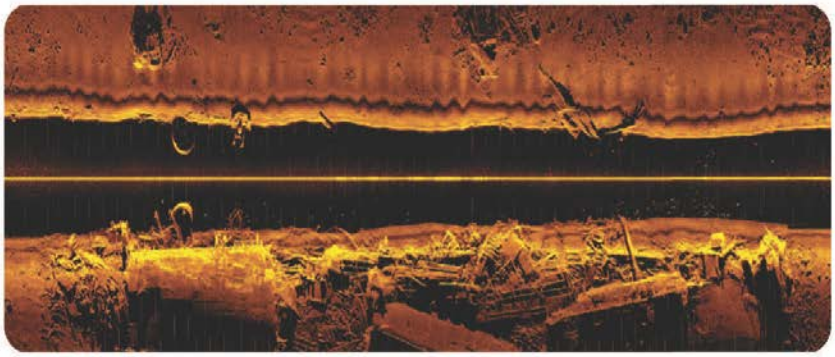
Known as the most trusted side scan system available the Sea Scan HDS is a glutton for abuse. Used by, and made for professionals who need their equipment to work anytime, everytime, in any enviroment, for every mission.

If it's locating lost mines in the old war zones of Cambodia, conducting a recovery in the swamps of North Carolina, or locating lost ships in the great lakes from the 1800's. The HDS won't fail you.

With the optional Magnetometer Integration kit you can seamlessly connect the HDS to your Marine Magnetics SeaSPY Magnetometer for dual operation.

User friendly, Rugged, Field Proven, & Ready when the mission calls. Put your trust in the Sea Scan HDS digital Side Scan Sonar.

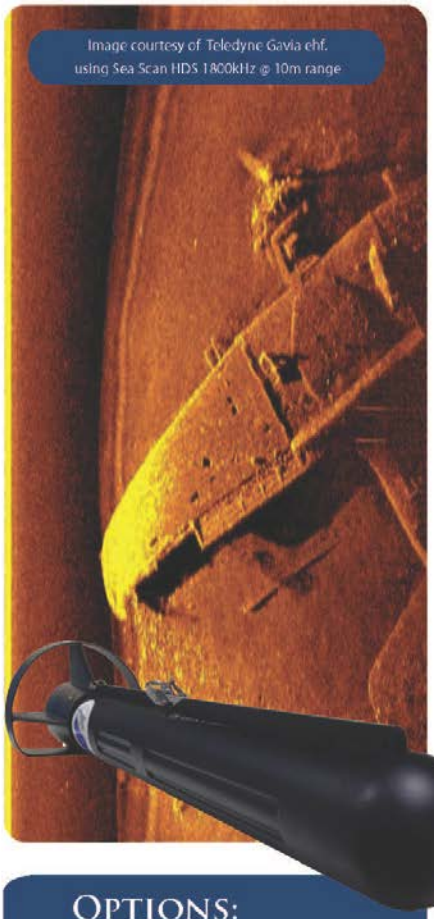
ATLAS NORTH AMERICA
A company of the ATLAS ELEKTRONIK Group



The standard Sea Scan® HDS system includes:

- A solid PVC 300/900, 600/1200 or 900/1800 kHz dual frequency tow fish that provides an excellent combination of long-range search capability and ultra high resolution images for the detection of small objects (additional frequencies available upon request).
- A portable splash-proof Topside Communications Unit (TCU) that connects through USB.
- 30m and 100m Kevlar tow cables (custom lengths also available).
- A tools and spares kit.
- A splash-proof USB GPS unit.
- Rugged splash-proof shipping cases for all components.
- All the software and manuals

SEA SCAN® HDS



TOW FISH SPECIFICATIONS

Construction	High Impact Billet PVC
Pulse Type	Tone Burst 20us @ 300 kHz, 10us @ 600 kHz, 6.67us @ 900 kHz, 5us @ 1200 kHz, 4.44us @ 1800 kHz
Frequency	300 kHz, 600kHz, 900kHz, 1200 kHz, 1800 kHz, 300/900 kHz, 600/1200 kHz, 900/1800 kHz
Range (Maximum)	200m @ 300 kHz, 75m @ 600 kHz, 50m @ 900 kHz, 25m @ 1200 kHz, 15m @ 1800 kHz
Horizontal Beam Width	0.4° 300kHz and above (one-way), < 0.6° @ 150 kHz, < 0.3° 300kHz and above (two-way)
Res. Across Track	3cm @ 300 kHz, 1.5cm @ 600 kHz, 1cm @ 900 kHz, 0.75cm @ 1200 kHz, 0.67cm @ 1800 kHz
Res. Along Track (Two-Way) @ End of Near Field	30.5cm @ 150 kHz , 30.5cm @ 300 kHz, 15.24cm @ 600 kHz, 10.16cm @ 900 kHz, 7.62cm @ 1200 kHz, 5.08cm @ 1800 kHz
Size	Length: 42" (106.7 cm) Diameter: 4" (10.16 cm)
Weight	45lbs (20.5 kg)
Depth Rating	300m

TOPSIDE COMMUNICATION UNIT (TCU)

Power	9-24 VDC < 10 watts
Connections	USB (2.0) to PC, Tow Fish, Power
Size	6.7" L x 4.8" W x 1.84" H

SEA SCAN SURVEY® SURVEY

Operating System	Windows XP, Vista, 7, and 8 or higher
Sonar Software	Sea Scan Survey, 3rd Party Interface Available
Data Format	SDS, Built in XTF Converter
Navigation Input	USB, RS-232 (NEMA 0183)

TOW CABLE

Tow Cable	Twisted Pair w/ Kevlar Strength Member
Cable Length	One 100m and One 30m included with the System, Custom Lengths Available Upon Request
Bend Radius	4"
Strength	750 lb. Safe Working Load

OPTIONS:

- Ruggedized Laptop
- Keel Weight & Line Weights
- Magnetometer Integration Kit
- Cable Reels & Winches
- Additional Cable Lengths

MARINE SONIC TECHNOLOGY
120 Newsome Drive, Suite H
Yorktown, VA. 23606
(804) 693-9602 - 1-800-447-4804
MarineSonic.com

ATLAS NORTH AMERICA
A company of the ATLAS ELEKTRONIK Group

SyQwest StrataBox HD Sub-Bottom Profiler

SyQwest Incorporated

StrataBox HD™

Marine Geophysical Instrument

The StrataBox HD™ is a portable high-resolution marine sediment imaging instrument capable of delivering 6cm of marine sediment strata resolution with bottom penetration of up to 40 meters. It is designed exclusively for inshore and coastal geophysical marine survey up to 150 meters of water depth.

NEW IMPROVED DESIGN

The sensor unit is extremely compact, interfaces directly to a standard laptop PC and comes complete with a light-weight and efficient acoustic transducer and Windows ® PC software.

Extremelyeasyto use, portability, and cost efficiencymake this device a perfect choice for shallow water marine geophysical applications

NEW FEATURES!!!

- Ethernet Link to PC
- CW & FM Chirp
- High Defintion Data Storage (16 bit, 96kHz, SEG-Y Format)
- UDP Interface to Software
- Internal Memory Storage (32 GB SD Flash Card)

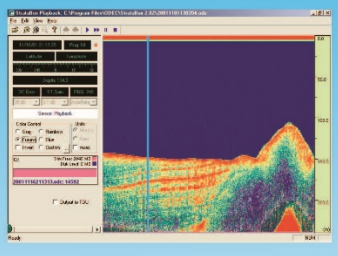
◆ Geographic Position Input;NMEA Compatible ◆ Depth Accuracy +/- 0.5%
◆ Strata Resolution: 6 cm with up to 40 meters bottom penetration
◆ Data Storage & Playback ◆ Zoom Modes ◆ Event Marks ◆ Sound Velocity
◆ Draft ◆ Low Input Power (12 watts) ◆ SEG-Y Output
◆ 10Khz standard, (3.5Khz Deep Water option available)

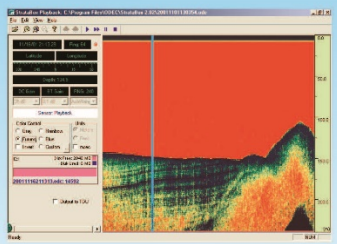
SyQwest Inc
30 Kenney Drive / Cranston, RI 02920
Tel: (401) 432-7129 Fax: (401) 432-7029
Email: sales@syqwestinc.com Web: www.syqwestinc.com

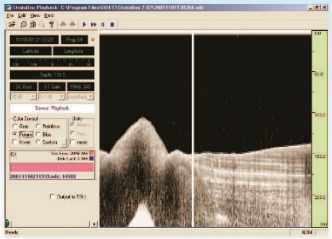
SyQwest Incorporated

StrataBox HD™

SPECIFICATIONS

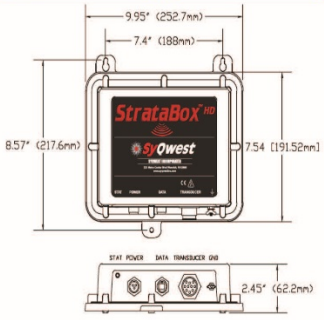






Units:	Feet or Meters
Depth Ranges:	0-15, 30, 60, 120, 240, 450 Feet. 0-5, 10, 20, 40, 80, 150 Meters. Auto-ranging Modes in all units.
Draft Offset:	0 to 30 feet (10 meters)
Manual Gates:	Shallow & Deep, (0.1 ft / 0.1mt resolution)
Shift Range:	1 foot (1meter) increments to bottom of selected range
Zoom Range:	15, 30, 60, 120, 240 feet 5, 10, 20, 40, 80 meters
Zoom Modes:	Bottom Zoom, Bottom Lock, Marker Zoom, Zoom (Playback Only)
Display:	Normal Data, Zoom Data, Selectable Color Palette
Depth Resolution:	0.1 feet (0.1 meters)
Depth Accuracy:	+/-0.5% of depth
Sound Velocity:	4600 - 5250 ft/sec (1400 - 1600 mt/sec)1 mt/sec int.
Navigation Input:	NMEA 0183, GLL, GGA, RMC, VTG, VHW, HDT. Selectable Baud Rate, RS-232 .
Data Output:	NMEA 0183; DPT, DBT, PMC; ODEC
StrataBox I/F:	Ethernet via RJ-45
Printer Output:	(Parallel Port) interface to Thermal Printers
Heave Input:	TSS1 Format, 9600 Baud Rate
Shallow Water Operation:	<2.5 meters; bottom type dependent
Transmit Rate:	Up to 10 Hz, depth and operator mode dependent.
Eventing:	Manual, Periodic, External (user selectable)
Frequency Output:	10 Khz (standard) 3.5Khz (*optional)
Data File Storage:	External- ODEC Format(8 bit, 800 pixel), SEG-Y Format envelope (16 bit, 96kHz rate), Internal-32 GB SD Flash.
Data File Playback:	Files played back and printed at Normal, Rapid Advance ,or Scroll Bar, with Pause and Zoom
Transmit Output Power:	300 Watts (pulsed), 1000 Watts capable
Input Power:	10-30 Volts DC, Nominal Power 12 watts, Reverse Polarity and Over Voltage Protected.
Dimensions:	25.4 cm (10") Length, 15.876 cm (6.25") Width, and 6.25 cm (2.5") Height. (sensor unit only)
Weight:	1.1 kg (2.4 lbs). (sensor unit only)
Environmental:	25°C to +60°C Operating Temperature (-55°C to +90°C Storage) Water Resistant to EN60529 IP65 EMC meets EN60945 Emissions,CE Compliant

Options:
- Over The Side Mount Kit
- 3.5Khz Operation
- Deep Water transducer
- TDU-850 Thermal Printer
- TDU-1200 Thermal Printer
- SonarWiz
- Hypack
- Triton SB Logger



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Tel: (401) 432-7129 Fax: (401) 432-7029
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Odem CV100 Single Beam Fathometer

A Teledyne Odom Hydrographic Echo Sounder Datasheet

Teledyne Odom Hydrographic

Echotrac CV100

Single or Dual Channel Echo Sounder

Compact Survey Solution

Move into the digital age with echo sounders from Teledyne Odom Hydrographic. If your survey does not require traditional paper records, then forget about piles of hard copy – the CV-100 has eliminated all that in favor of digital imaging on a PC-based data acquisition system.

With the same technology as the popular Echotrac CV and Echotrac MKIII, including Ethernet communications, Teledyne Odom's CV100 single or dual channel sounder is ready to simplify your transition to the convenience of an all-digital system.

Photo courtesy of Teledyne Oceanscience.

PRODUCT FEATURES

- Multiple time varied gain (TVG) curves (10, 20, 30, and 40 log)
- DSP digitizer with manual filter control
- Manual or auto scale changes (phasing)
- Calibration menu with controls for transducer draft and index plus sound velocity and bar depth controls
- Rugged and waterproof (IP65)
- Help menus
- Flash memory upgradeable
- Auto Gain and Auto Power Modes for minimal operator input
- Suitable for autonomous vessels

A Teledyne Marine Company

TELEDYNE ODOM HYDROGRAPHIC Everywhereyoulook™

A Teledyne Odom Hydrographic Echo Sounder Datasheet

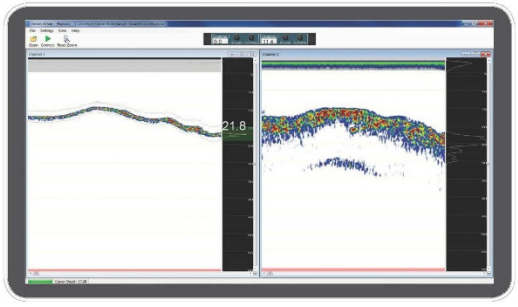
Echotrac CV100

Digital Hydrographic Echo Sounder

TECHNICAL SPECIFICATIONS

Single Channel Configuration[1]	High: 100kHz-750kHz (manual tuning in 1-kHz steps) Low: 3.5kHz-50kHz (manual tuning in 1-kHz steps) variable receiver bandwidth
Dual Channel Configuration	High: 100 kHz-340kHz Low: 24 kHz-50kHz
Resolution	0.01m, 0.1 ft.
Accuracy *(corrected for sound velocity)*	200kHz-0.01 m +/- 0.1% depth 33kHz-0.10 m +/- 0.1% depth
Output Power	Up to 300 watts RMS < 1 watt minimum
Ping Rate	Up to 20Hz in shallow water (10m) range
Depth Range	From <30cm to 600m (depending on frequency and transducer selected)
Input Power Requirement	9-32VDC < 15 watts
Weight	5kg (11lbs)
Dimensions	28cm W (11 in) x 23cm H (9 in) x 11.5cm (4.5 in) D
Mounting	Desktop or bulkhead mount (fixing hardware included)
Ports/Interface	Ethernet (LAN) plus 4 x RS232 or 3 x 232 and 1 x RS422 Inputs from external computer, motion sensor, sound velocity Outputs to external computer or remote display Output string: Odom Echotrac SBT, NMEA DBS, NMEA DBT, DESO 25 Heave Input-TSS1 or "Sounder Sentence" Echotrac Control SW - Simple Windows compatible graphical user interface Storage of full ping to seabed data in DSO format with e-Chart (easily compressed or converted to .XTF for additional processing)
Environmental	Operating 0-50°C Storage -20°-70°C
Options	Heave Sensor
Software Control & Logging Software	Windows based software included: eChart Display

1 Frequency agile in 2 bands (specify band at time of order).



eChart Software.

TELEDYNE ODOM HYDROGRAPHIC
Everywhereyoulook™
www.odomhydrographic.com

Teledyne Odom Hydrographic
1450 Seaboard Avenue, Baton Rouge, Louisiana 70810-6261 USA
Tel. +1-225-769-3051 Fax: +1-225-766-5122 Email: odom@teledyne.com

Leica GPS Positioning System

Leica GS18 T
Data sheet

Engaging software

The Leica GS18 T is accompanied with the revolutionary Captivate software, turning complex data into the most realistic and workable 3D models. With easy-to-use apps and familiar touch technology, all forms of measured and design data can be viewed in all dimensions. Leica Captivate spans industries and applications with little more than a simple swipe, regardless of whether you work with GNSS, total stations or both.

Seamlessly share data among all your instruments

Leica Infinity imports and combines data from your GNSS RTK rover, total station and level instruments for one final and accurate result. Processing has never been made easier when all your instruments work in tandem to produce precise and actionable information.

ACC»

Customer care only a click away

Through Active Customer Care (ACC), a global network of experienced professionals is only a click away to expertly guide you through any challenge. Eliminate delays with superior technical service, finish jobs faster and avoid costly site revisits with excellent consultancy support. Control your costs with a tailored Customer Care Package (CCP), giving you peace of mind you are covered anywhere, anytime.

PART OF HEXAGON

leica-geosystems.com

- when it has to be **right**

Leica Geosystems

Leica GS18 T

GNSS TECHNOLOGY		
Self-learning GNSS	Leica RTKplus SmartLink (worldwide correction service) SmartLink fill (worldwide correction service)	Adaptive on-the-fly satellite selection Remote precise point positioning (3 cm 2D)[1] Initial convergence to full accuracy 20 - 40 min, Re-convergence < 1 min Bridging of RTK outages up to 10 min (3 cm 2D)[1]
Leica SmartCheck	Continuous check of RTK solution	Reliability 99.99%
Signal tracking		GPS (L1, L2, L2C, L5), Glonass (L1, L2, L2C, L3[2]), BeiDou (B1, B2, B3[2]), Galileo (E1, E5a, E5b, Alt-BOC, E6[2]), QZSS (L1, L2C, L5, L6[2]), NavIC L5[3], SBAS (WAAS, EGNOS, MSAS, GAGAN), L-band
Number of channels		555 (more signals, fast acquisition, high sensitivity)
Tilt compensation	Increased measurement productivity and traceability	Calibration-free Immune to magnetic disturbances
MEASUREMENT PERFORMANCE & ACCURACY[1]		
Time for initialisation		Typically 4 s
Real-time kinematic (Compliant to ISO17123-8 standard)	Single baseline Network RTK	Hz 8 mm + 1 ppm / V 15 mm + 1 ppm Hz 8 mm + 0.5 ppm / V 15 mm + 0.5 ppm
Real-time kinematic tilt compensated	Topographic points (not for static control points)	Additional Hz pole tip uncertainty typically less than 8 mm + 0.4 mm/° tilt down to 30° tilt
Post processing	Static (phase) with long observations Static and rapid static (phase)	Hz 3 mm + 0.1 ppm / V 3.5 mm + 0.4 ppm Hz 3 mm + 0.5 ppm / V 5 mm + 0.5 ppm
Code differential	DGPS / RTCM	Typically 25 cm
COMMUNICATIONS		
Communication ports	Lemo Bluetooth®	USB and RS232 serial Bluetooth® v2.1 + EDR, class 1.5
Communication protocols	RTK data protocols NMEA output Network RTK	Leica, Leica 4G, CMR, CMR+, RTCM 2.2, 2.3, 3.0, 3.1, 3.2 MSM NMEA 0183 v4.00 and Leica proprietary VRS, FKP, iMAX, MAC (RTCM SC 104)
Built-in data links	GSM / UMTS / LTE phone modem Radio modem	Fully integrated, external antenna Fully integrated, receive and transmit, external antenna 403 - 470 MHz, 1 W output power, up to 28800 bps over air
External data links		GSM / GPRS / UMTS / LTE / CDMA and UHF / VHF modem
GENERAL		
Field controller and software	Leica Captivate software	Leica CS20 field controller, Leica CS35 tablet
User interface	Buttons and LEDs Web server	On / Off and Function button, 8 status LEDs Full status information and configuration options
Data recording	Storage Data type and recording rate	Removable SD card, 8 GB Leica GNSS raw data and RINEX data at up to 20 Hz
Power management	Internal power supply External power supply Operation time[4]	Exchangeable Li-Ion battery (2.8 Ah / 11.1 V) Nominal 12 V DC, range 10.5 - 26.4 V DC 7h receiving (Rx) data with internal radio, 5 h transmitting (Tx) data with internal radio, 6 h Rx/Tx data with internal phone modem
Weight and dimensions	Weight Dimensions	1.20 kg / 3.50 kg standard RTK rover setup on pole 173 mm x 173 mm x 108 mm
Environmental	Temperature Drop Proof against water, sand and dust Vibration Humidity Functional shock	-40 to 65°C operating, -40 to 85°C storage Withstands topple over from a 2 m survey pole onto hard surfaces IP66 / IP68 (IEC60529 / MIL STD 810G CHG-1 510.6 I / MIL STD 810G CHG-1 506.6 II / MIL STD 810G CHG-1 512.6 II) Withstands strong vibration (ISO9022-36-08 / MIL STD 810G 514.6 Cat.24) 95% (ISO9022-13-06 / ISO9022-12-04 / MIL STD 810G CHG-1 507.6 II) 40 g / 15 to 23 msec (MIL STD 810G 516.6 I)

LEICA GS18 T GNSS RTK ROVER	PERFORMANCE	UNLIMITED
SUPPORTED GNSS SYSTEMS		
Multi-frequency	✔	✔
GPS / GLONASS / Galileo / BeiDou / QZSS	✔ / • / • / • / •	✔ / ✔ / ✔ / ✔ / ✔
SUPPORTED GNSS SYSTEMS		
DGPS/RTCM, RTK Unlimited, Network RTK	✔	✔
SmartLink fill / SmartLink	• / •	✔ / •
POSITION UPDATE & DATA RECORDING		
5 Hz / 20 Hz positioning	✔ / ✔	✔ / ✔
Raw data / RINEX data logging / NMEA out	✔ / • / •	✔ / ✔ / ✔
ADDITIONAL FEATURES		
Tilt compensation	✔	✔
RTK reference station functionality	✔	✔
LTE Phone / UHF Radio (receive & transmit) modem	✔ / •	✔ / •

✔ Standard • Optional

[1] Measurement precision, accuracy, reliability and time for initialisation are dependent upon various factors including number of satellites, observation time, atmospheric conditions, multipath etc. Figures quoted assume normal to favourable conditions. A full BeiDou and Galileo constellation will further increase measurement performance and accuracy.

[2] Believe to comply, but subject to availability of BeiDou ICD and Galileo commercial service definition. Glonass L3, BeiDou B3, QZSS L6 and Galileo E6 will be provided through future firmware upgrade.

[3] Support of NavIC L5 is incorporated and will be provided through future firmware upgrade.

[4] Might vary with temperature, age of battery, transmit power of data link device.

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- when it has to be **right**

Leica Geosystems

February 5, 2021

Prepared by:
Lake Champlain Maritime Museum
Dolan Research, Inc.
First Environment, Inc.

US Army Corps of Engineers®