Final Technical Report

World Trade Center Memorial and Development Plan: Data Recovery and Analysis of the WTC Ship

Blocks 54, Lot 1 and Block 56, Lots 15, 20, and 21
New York, New York

Prepared for:

The Lower Manhattan Development Corporation
One Liberty Plaza, 20th Floor
New York NY, 10006

Prepared by:

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August 2013

Management Summary

SHPO Project Review Number: 05PR04753

Site Number: A06101.018000

Involved State and Federal Agencies:

Lower Manhattan Development Corporation
Port Authority of New York and New Jersey

Phase of Survey: Data Recovery

Location Information

Location: Block 54, Lot 1 and Block 56, Lots 15, 20, and 21; Bounded by Liberty, West, Cedar, Washington, Albany, and Greenwich Streets.

County: New York

Minor Civil Division: 06101

Survey Area

Length: Approximately 60 feet

Width: Approximately 30 feet

Number of Acres Surveyed: <1 acre

USGS 7.5 Minute Quadrangle Map: Jersey City

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Date of Report: August 2013

Executive Summary

BACKGROUND

The Lower Manhattan Development Corporation (LMDC) is currently redeveloping the World Trade Center (WTC) Site in Lower Manhattan. As part of this redevelopment the Port Authority of New York and New Jersey (PANYNJ) is constructing an underground Vehicular Security Center (VSC) on two blocks (Blocks 56 and 54) adjacent to the south side of the WTC Site bounded counter clock-wise by Liberty, Route 9A/West Street, Cedar, Washington, Albany, and Greenwich Streets. From February 2009 through September 2011 AKRF provided archaeological monitoring during site excavation activities. On July 13, 2010, AKRF archaeologists were monitoring excavation and observed the curved timbers of the hull of what proved to be the stern of a buried ship (the "WTC Ship" or "ship remnant"). Shortly after discovery and a preliminary assessment of the ship, the New York State Historic Preservation Office (SHPO) determined the remains to be eligible for listing on the National Register of Historic Places. Construction efforts were diverted so as to avoid the location of the WTC Ship and LMDC directed AKRF to assemble a team of experts and conservators to plan and execute a short-term mitigation plan for the WTC Ship so that it could be removed from the site in a controlled manner before its condition was threatened by its exposure to the elements. The plan was implemented over a two-week period in late-July 2010. Remnants of the bow of the WTC Ship were discovered on the east half of the site in August 2011. These remains were documented and removed from the site within one week of their discovery. As of this writing, the remains are in stable condition and are undergoing a conditions analysis in anticipation of preservation at the Center for Maritime Archaeology and Conservation (CMAC), Texas A&M University.

This Technical Report was completed as part of an effort to mitigate the unavoidable adverse effect of construction of the VSC upon the WTC Ship pursuant to the WTC Memorial and Development Plan Programmatic Agreement dated April 22, 2004.

SITE DEVELOPMENT

The WTC Ship was discovered at a depth of between 11.5 and 20 feet below mean sea level, or between about 20 to 30 feet below the modern street grade, and appears to have been incorporated into the landfill making up Block 56 and Washington Street by the early 1790s. Prior to that time, the area had been an active waterway and was one of the busiest slips along the Hudson River. Three individuals are associated with the landfilling effort in the vicinity of the WTC Ship: (1) John G. Leake, who constructed and maintained the wharf to the south, in the vicinity of modern Cedar Street; (2) George Lindsay, who constructed and maintained the wharf to the north, along Liberty Street, and filled in the water lots on the north half of Block 56, including the location of the WTC Ship; and (3) Barnardus Swartwout Jr., who filled the water lots making up the south half of Block 56. The filling in of the ship's location appears to have occurred in response to a development boom along the Hudson River after the American victory in the Revolutionary War. The block was entirely filled and partially developed by 1818.

SHIP CONSTRUCTION

The correlation between the growth rings of the timber samples from the ship remnant is sufficiently strong to suggest that the WTC Ship was built (at least partially) from timbers that grew in the same locality in the Philadelphia region and that were felled in the late-18th century. Depending on how long the timber was seasoned or stored prior to the vessel's construction, the ship may have been built between the late 1770s and the 1780s. Several different wood types were used to construct the ship, including spruce and pine (soft woods used for the internal planking), white oak (a hard wood used for the vessel's frames, deck beams, and some ceiling planks), and hickory (a durable wood that was used for the keel). The original intact vessel would likely have had a breadth of more than 20 feet and a length of 50 to 60 feet. Several hundred pieces of the vessel were recovered, including the inner portion of the hull (or ceiling planking); the strong heavy frames that provided the ship's strength and maintained its shape; large flat planks that comprised the outer portion of the hull; the stern knee, which weighed over 500 pounds and supported the sternpost and rudder; the keel and keelson; and a small deck that likely supported a brick galley hearth. The hearth would have been used by the ship's crew to cook food and generate warmth. The majority of the fasteners used to construct the WTC Ship were iron and few wooden pegs (trunnels) were observed.

Unusual aspects of the ship's construction led to the hypothesis that the ship was constructed in a small shipyard, likely in close proximity to where the trees grew. If the ship was constructed in the Philadelphia area, the center of America's shipbuilding industry in the 18th century, it is unknown if it was constructed for use in that region or for use elsewhere. The ship is consistent with the construction methodology of a class of ship known as the Hudson River Sloop. Like Hudson River Sloops, which were designed specifically to transport large cargoes and groups of passengers along the shallow, rocky waters of the Hudson River, the WTC Ship had a broad beam, shallow draft, and a mast that was stepped aft of the bow by approximately one-third of its overall length.

These construction decisions would have maximized the amount of cargo space at the expense of speed and strength. Therefore, the WTC Ship was most likely used as a merchant trading vessel in shallow, protected waters—such as those along the coastal United States and/or Hudson River—and was not likely built to be an ocean-going vessel. However, the remains of shipworms that infested its timbers prove that the vessel went as far as the Caribbean, or a similar locale with warm, salty waters. The WTC Ship was subjected to hard use during its active period, and its keel was heavily worn, presumably from frequent landings. Many repairs were observed in its outer planking, frames, and ceiling planking. As timbers were damaged or rotted, they were replaced with new timbers or smaller filler pieces. It is therefore possible that it was constructed for use in a sheltered river environment, but was ultimately used to transport cargo to distances greater than those intended by the shipbuilder, resulting in significant wear and tear to the vessel.

If the ship was constructed between the 1770s and the 1780s, as the dendrochronological analysis of its timbers would suggest, and incorporated into the landfill by the 1790s, the ship would therefore have experienced a very short period of active use, and was possibly only on the water for 10 to 20 years. It is possible that the re-use of timbers from an older vessel or the replacement of older timbers with freshly cut specimens could prevent the identification of the actual date of the ship's construction. It would appear that years of hard use, frequent repairs, and significant shipworm infestation resulted in a shortened functional lifespan for the vessel.

MARINE LIFE

It is not known if the vessel went to the Caribbean frequently, or if its sole journey to that area resulted in the shipworm damage that brought about its ultimate demise. However, the evidence of marine life observed and collected during the ship's removal provides insight into the events that surrounded the deposition of the WTC Ship after it was no longer sea worthy. The remains of marine organisms found both on and within the ship appear to indicate that the vessel sat in or near its present location (or in a similar location) and was partially submerged for at least two years before the land around it was filled in. Oysters and barnacles attached to the sternpost, planks, and keel provide compelling evidence that the ship remnant was exposed to the water of the lower Hudson River for some time prior to landfilling. Oysters, which do not tend to survive travel from one port to another due to their sensitivity to salinity, were found on the hull of the ship remnant, suggesting that the vessel was submerged in or near the site throughout the two- to three-year life span of the largest oysters that were collected.

There is no evidence that sacrificial layers, such as sheathing, that may once have protected the hull's exterior were present in the locations in which the mollusks were growing. The lack of these protective timbers appears to suggest that during that period when the mollusks were given the opportunity to grow on the vessel, the WTC Ship was either neglected, under repair, or abandoned. Similarly, relatively immobile species—such as clams found within the ship remnant's frames—suggest that the interior of the ship was sufficiently exposed to the open waters of the estuary that sediments could accumulate and that these species could recruit to the site and grow. Assuming that the clams did not infiltrate the vessel's frames during the landfilling process, the presence of these species suggests that the vessel was abandoned on the river bottom for a long enough period to allow the clams to reach maturity.

It is possible that the vessel was used as a floating storage hulk before burial; its permanent placement along one of the docks in the vicinity of the VSC Site would have allowed for the growth of the marine organisms on and within its timbers. This possibility is consistent with historical documentation relating to New York harbor in the late 18th and early 19th centuries. Numerous references to abandoned hulks in the slips along the Hudson and East Rivers can be found in the *Minutes of the Common Council*. Further, references to neglected and abandoned wharves and slips left to accumulate silt and refuse are also common, particularly during periods of economic downturn.

ARTIFACT ANALYSIS

Analysis of the thousands of artifacts recovered during the discovery, documentation, and removal of the ship remnant has revealed a complex mosaic of activities representative of the vibrant local community, the landfill used to develop the project site, and very likely information regarding the use and operation of the ship itself. Regarding the local community, the artifacts recovered from the original river bottom included excess shoe parts likely discarded into the slip, a portion of a wooden barrel used to store or ship goods, an anchor, butchered animal bones and horn cores, and ceramics and bottles. The fill itself contained a great variety of refuse likely discarded by the city's colonial residents at local dumps, dumps which were later used to fill in the slip as the developing city continued to grow westward, out into the waters of the Hudson River. Finally, from the partially sealed voids amongst the ship remnant's timbers, the field team recovered hundreds of pits, seeds, nuts, and animal bones that may have been consumed by the ship's crew or were the remains of cargo shipped up and down the Hudson or along the coast. Also recovered were arms accessories and projectiles likely used by the crew for hunting purposes or possibly to defend the ship from pirates. Of final note, the field team recovered tool handles, eating utensils, dishes, fragments of tobacco pipes, and even buttons, buckles, a cufflink, and the finger of a leather glove, all items that were likely the personal possessions of the ship's crew or passengers.

SIGNIFICANCE AND INTEGRITY

The value of an archaeological site—by definition a unique, non-renewable, and irreplaceable resource—can be measured by the rarity of the site type, the importance of the information it can provide, and, more subjectively, the ability of the resource to provide a connection between the current residents of a geographic place and their historic predecessors. Historic ships are data-rich and highly complex structures that often span the disciplines of history, biology, chemistry, anthropology, economics, and engineering. They played a central role in the development of New York State and of New York City as a center of commerce and they helped the United States become a global economic power. However, of the many thousands of archaeological sites that have been excavated in New York State, including several hundred that have been listed on the State's Register of Historic Places, only a very small number of them are shipwrecks. In fact only about a dozen Colonial-era merchant ships have ever been professionally recorded nationwide.

The WTC Ship represents a combination of a very rare site type with a high research value and a discovery that engaged the interest and curiosity of the public, partly due to its discovery near the WTC Site, a site of great significance as a symbol of New York City's importance in global trade. The WTC Ship is significant for its association with the rise in prominence of the Port of New York during the late 18th century, its association with the development of New York City's Hudson River shoreline, and for being an early example of a river sloop, a ship type that emerged during the early 19th century as an important ship type on the Hudson River. The fact that the general public has expressed an interest in this discovery indicates that the *value* of the WTC Ship also includes its ability to convey to New York City residents and visitors an appreciation of the city's river-based mercantile past discovered at a place already infused with meaning and significance, a site where the LMDC and the PANYNJ are currently overseeing a major rebuilding effort.

While the WTC Ship has lost some elements of integrity, it still possesses others to an important degree. Most importantly, the site where the WTC Ship was discovered has been continuously associated with trade and commerce for more than 300 years; from its use as a small port in a young colony, to being the site of the World Trade Center, a location of world renown and symbolic of the United States' role in international trade and commerce, to its future use once reconstruction is completed. As a merchant vessel discovered beneath landfill, the WTC Ship conveys both the historic importance of river-based trade to New York and its dynamism and growth.

Acknowledgements

We don't yet know the names of the individuals who built the vessel we now call the WTC Ship in the Philadelphia area more than two centuries ago. Nor do we know the names of those who sailed it up to the then-British colony of New York and perhaps as far south as the Caribbean where it became infested with shipworms before it was buried beneath 20 feet of fill by the 1790s. But we do know the names of the many individuals who raised the vessel again after its more than 200-year slumber and allowed it to continue its journey. This time its voyage would not be by open sea or up and down the Hudson River. Instead, it traveled by crane and truck, packed in two 30-yard shipping containers, from the muddy depths of the World Trade Center redevelopment to its temporary stay in Maryland, and then on to Texas where it will hopefully be preserved before a final trip back home to be reconstructed and displayed in New York.

Chapter 1 provides a listing of each formal contributor to this report and their respective research area. However, the authors of this report would like to acknowledge the following skilled and hard-working individuals who played important roles in this collaboration and sincerely apologize for anyone we've overlooked:

Lower Manhattan Development Corporation: Philip Plotch, Goldie Weixel, and the LMDC Board of Directors;

Carter Ledyard & Milburn LLP: Stephen Kass and Judith Wallace;

Port Authority of New York and New Jersey: Tony Zandirad, Robert Coyne, Debra Simonelli, Ursula Shulzycki, Raymond Hennessey, Timothy Stickleman, and the many Port employees who operated lights and managed site security and safety and provided other services including surveying and photo documentation;

New York Office of Parks, Recreation and Historic Preservation: Douglas Mackey, Wm. Brian Yates, and Mark Peckham;

New York City Landmarks Preservation Commission: Amanda Sutphin;

EE Cruz Heavy Construction: Rui, Jackie, Adolfo, Walter, Mike, and the many other crew members, the operators of the excavators and cranes, and of course, Joaquim "Adrian" Medeiros, the Site Supervisor after whom we named the ship in the field;

Yonkers Contracting Company, Inc.: Pat, Ozzie, and Tony, and all the other individuals who helped us discover and protect the bow of the ship;

The staff at the **Essex World Café** and **O'Hara's Bar and Grill** who fed and hydrated us; and

Last but certainly not least, the many **AKRF staff members** who traded their shoes for boots to help out in the field; attended last-minute meetings; gathered supplies; washed, researched, and analyzed artifacts in the lab; chauffeured the archaeologists around in company cars; edited drafts and prepared report figures; and provided other invaluable assistance, without which we could not have completed this project:

Andrew Bernick, Sergei Burbank, Chris Calvert, Claudia Cooney, Kevin Edwards, Judita Eisenberger, Jean Fox, Kerry Gallagher, Stephen Grens, Eunice Inquimboy, Anne Locke, Kenneth Mack, Jessica Striebel MacLean, Emma Marconi, JoLayne Morneau, W.R. Reynolds, Peggy Rosenblatt, Jordan Schuler, Shawn Shotzberger, Christian Thompson, Jeanine Tucker, Nancy Vega, and Rolando Vega.

Top row (l-r): Drew Fulton (Drew Fulton Photography); Raymond Hennessy (PANYNJ); Rui Reyes (EE Cruz); Jackie Madeira (EE Cruz); Adolfo Rodrigues (EE Cruz); John K. (EE Cruz); Kathleen Galligan (Pemaquid Art and Science); Joaquim "Adrian" Medeiros (EE Cruz Site Foreman); Elizabeth D. Meade (AKRF); Christian Thompson (AKRF).

Bottom row (l-r): Diane Dallal (AKRF); Claudia Cooney (AKRF); Tony Zandirad (PANYNJ); Caitlin Shaffer (MAC Lab); Carrie Atkins Fulton (Cornell University); Nichole Doub (MAC Lab).

Seated: Dr. Warren Riess (Pemaquid Art and Science); A. Michael Pappalardo (AKRF); Molly McDonald (AKRF).

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A. PROJECT LOCATION AND DESCRIPTION

The Lower Manhattan Development Corporation (LMDC) is currently redeveloping the World Trade Center (WTC) Site, an approximately 16-acre parcel bounded by Liberty, Church, and Vesey Streets, and Route 9A (see **Figure 1-1**). The redevelopment also includes two adjacent blocks to the south of the WTC Site known as the "Southern Site," which include Block 54 (Lot 1), bounded by Liberty, Washington, Albany, and Greenwich Streets, and Block 56 (Lots 15, 20, and 21), bounded by Route 9A/West Street and Liberty, Cedar, and Washington Streets. The Southern Site also includes the streetbeds of Liberty and Cedar Streets between Greenwich Street and Route 9A/West Street and Washington Streets between Cedar and Liberty Streets (see **Figure 1-2**). The Port Authority of New York and New Jersey (PANYNJ) is constructing an underground Vehicular Security Center (VSC) on the Southern Site (Blocks 56 and 54), an area determined through documentary research to possess archaeological sensitivity (HPI 2003, 2004; AKRF 2009). In acknowledgement of the site's sensitivity and in accordance with a Memorandum of Agreement (MOA) between the PANYNJ, the Federal Transit Administration (FTA), the New York State Historic Preservation Office (SHPO), and the Advisory Council on Historic Preservation (ACHP), the PANYNJ retained AKRF to provide archaeological monitoring during site excavation activities from February 2009 through September 2011.

On July 13, 2010, AKRF archaeologists were monitoring excavation and observed the curved timbers of the hull of what proved to be the stern of a buried ship (the "WTC Ship" or "ship remnant"). Shortly after discovery and a preliminary assessment of the ship, the SHPO determined the remains to be eligible for listing on the National Register of Historic Places. After consultation with SHPO, the New York Landmarks Preservation Commission (LPC), the LMDC directed that construction efforts be diverted so as to avoid the location of the WTC Ship while AKRF assembled a team of experts and conservators to plan and execute a short-term mitigation plan for the WTC Ship ("Emergency Mitigation Plan"). The Emergency Mitigation Plan was necessary so that the ship could be removed from the site in a controlled manner to mitigate the unavoidable adverse effects of exposure to the elements. The Emergency Mitigation Plan was circulated among the group of Consulting Parties identified during the redevelopment's planning process and formally adopted by the LMDC. The Plan was then implemented over a two-week period in late-July 2010, during which time the ship remains were documented and removed from the site. Remnants of the bow of the same ship were discovered on the east half of the site in August 2011 (see **Figure 1-3**). In accordance with the Emergency Mitigation Plan, these remains were documented and removed from the site in August 2011. As of this writing, all recovered remains of the ship are in stable condition and are undergoing a conditions analysis at the Center for Maritime Archaeology and Conservation (CMAC), Texas A&M University in anticipation of potential preservation and eventual display at the New York State Museum (NYSM).

B. LEGISLATIVE FRAMEWORK

LMDC prepared a Generic Environmental Impact Statement (GEIS) in March 2004 to evaluate the impacts of implementation of the World Trade Center Memorial and Redevelopment Plan in compliance with the National Environmental Policy Act (NEPA), Section 106 of the National Historic Preservation Act (NHPA), and the New York State Environmental Quality Review Act (SEQRA). The GEIS resulted in the preparation of a Programmatic Agreement between the LMDC, the Advisory Council on Historic Preservation (ACHP), and SHPO that specified the treatment of archaeological resources and the treatment of unanticipated adverse effects on unknown historic properties.

LMDC, as lead agency, in cooperation with the United States Department of Housing and Urban Development and the PANYNJ completed the Final Generic Environmental Impact Statement (FGEIS) on the World Trade Center Memorial and Redevelopment Plan pursuant to NEPA in April 2004. The FGEIS considered potential impacts to historic resources including potential archaeological resources on the original 16-acre WTC Site and the Southern Site. To satisfy Section 106 of NHPA, a Programmatic Agreement (the "Programmatic Agreement"), dated April 22, 2004, was signed by the ACHP, the SHPO, and LMDC. Among other stipulations, the Programmatic Agreement provided that LMDC, in coordination with PANYNJ, would ensure that measures relating to Archaeological Resources (Stipulation 6) and Unanticipated Adverse Impacts or Unknown Historic Properties (Stipulation 7) would be undertaken.

This Technical Report was completed as part of an effort to mitigate the unavoidable adverse effect of construction of the VSC upon the National Register-eligible ship remains, per Stipulation 7 of the Programmatic Agreement. This Technical Report provides a description of the research goals and methods followed, establishes relevant contexts for the history of the project site, the field of maritime archaeology, and other ship discoveries, discusses the archaeological context in which the ship was discovered, and provides analyses of the ship itself, the artifacts discovered in association with the ship, and summaries of the results of the work of a number of specialists. The report concludes with a brief synthesis of the collected information and a National Register eligibility statement. The content and scale of this report is based on consultation conducted between the LMDC, LPC, and SHPO in 2011 and 2012. A separate Archaeological Monitoring Report discussing the overall results of monitoring during the excavation of the VSC Site has been prepared by AKRF for the PANYNJ (AKRF 2012a).

C. TEAM SPECIALISTS AND REPORT CONTRIBUTORS

LMDC and its consultant AKRF assembled a team of experts in nautical history, maritime archaeology, and artifact conservation. The AKRF archaeological group led the project team and managed the project (A. Michael Pappalardo, Elizabeth D. Meade, Molly R. McDonald, and Diane Dallal). AKRF also provided staff and equipment during the removal and analysis of the WTC Ship. The following individuals and organizations comprised the project team:

- Warren Riess, Ph.D., of the University of Maine and Pemaquid Art and Science, was brought on to serve as the Principal Investigator of the excavation of the WTC Ship. Dr. Riess previously documented a portion of a ship discovered and excavated at 175 Water Street—formerly referred to as the "Ronson Ship" and subsequently identified by Dr. Riess as the *Princess Carolina* (Riess and Smith, in press)—and is an expert on the documentation and recovery of historic vessels.
- Carrie Atkins Fulton, a Ph.D. candidate at Cornell University served as the Assistant Principal Investigator during the investigation of the ship remnant. Ms. Fulton has extensive experience with the investigation of sunken vessels and is an expert in their digital documentation and analysis.
- Robert A. Blanchette, Ph.D., a professor at the University of Minnesota, is a specialist in the identification of wood species and analyzed timber samples collected from the aft portion of the ship remnant in order to determine the genus and species of each.
- Mr. Norman Brouwer, a noted maritime historian and ship expert formerly with South Street Seaport Museum in New York, NY and currently affiliated with the Mystic Seaport Museum in Mystic,

Connecticut. Mr. Brower visited the site two days after the WTC Ship was found and provided guidance regarding how to excavate and analyze the WTC Ship.

- John Smits and Caitlin Uihlein, formerly of Corinthian Data Capture, LLC, of Wantagh, New York, provided 3D laser-scanning and data processing services before and during the excavation of the WTC Ship.
- Drew Fulton, of Drew Fulton Photography, served as a photographer during the removal of the stern of the WTC Ship.
- Kevin J. Eckelbarger, Ph.D., a professor at the University of Maine, is a specialist in marine invertebrates and deep-sea biology. Dr. Eckelbarger identified the species of shipworms that infested the timbers of the WTC Ship and provided answers to questions on the subject.
- Kathleen Galligan, an archaeologist and artist, provided field assistance and prepared numerous drawings of the ship's timbers *in situ* and created artists' renderings of key parts of the WTC Ship.
- Allan S. Gilbert, Ph.D., Professor of Anthropology at Fordham University, is a recognized expert in historic brickmaking . Dr. Gilbert completed a preliminary visual inspection of the brick and mortar samples associated with the WTC Ship.
- The Tree Ring Laboratory at the Lamont-Doherty Earth Observatory at Columbia University in Palisades, New York, completed the dendrochronological analysis. The Tree Ring Lab's staff included Drs. Brendan Buckley, Neil Pederson, Dario Martin-Benito, Laia Andreu, Edward R. Cook, and Paul Krusic.
- The Maryland Archaeological Conservation Laboratory ("MAC Lab"), part of the State of Maryland's Jefferson Patterson Park and Museum in Saint Leonard, Maryland, was hired for conservation services during the removal and temporary storage of the timber elements of the stern of the WTC Ship.
- Gary McGowan, a conservator with expertise in wood, metal and leather artifacts from the firm Cultural Preservation and Restoration, Inc. (CPR) provided artifact conservation and consultation services.
- Justine W. McKnight, an archaeobotanical consultant in Severna Park, Maryland, completed the flotation and macro-botanical analysis of 12 soil samples collected from within the ship remnant and from the VSC Site.
- Daniel J. Sivilich, an ordnance specialist and President of the non-profit organization Battlefield Restoration & Archaeological Volunteer Organization (BRAVO), analyzed the ammunition and military artifacts recovered from the ship remnant.
- Peter Fix, Ph.D. and Donny L Hamilton, Ph.D., Center for Maritime Archaeology and Conservation (CMAC), Texas A&M University, are currently serving as team conservators and providing a detailed conditions assessment in advance of preservation.

D. REPORT ORGANIZATION

This Technical Report was completed as part of an effort to mitigate the unavoidable adverse effect of construction of the VSC upon the WTC Ship pursuant to the WTC Memorial and Development Plan Programmatic Agreement dated April 22, 2004. **Chapter 2** provides a description of the research goals, guidance on the application of National Register eligibility criteria, and the field, lab, and analytical methods followed. **Chapters 3** and **4** establish relevant contexts for the history of the project site, the field of maritime archaeology, Hudson River Sloops, other ship discoveries, and the discovery of historic ships in Manhattan landfill. A discussion about the discovery and archaeological context of the ship is provided in **Chapter 5. Chapter 6** presents a detailed technical analysis of the ship's individual timbers and **Chapter 7** provides an analysis of the artifacts discovered in association with the ship and summaries of the results of the work of a number of specialists. Finally, **Chapter 8** provides a brief synthesis of the presented data and a summary of the significance of this discovery. A glossary of terms related to ships and maritime archaeology is included at the end of this report. Finally, reports prepared during special analyses (e.g., dendrochronology, flotation analysis, analysis of faunal remains and ordnance, etc.) are included as **Appendices A** through **G**.

The data recovery and analysis of the WTC Ship, a Colonial-era ship discovered in a former Hudson River slip that was gradually filled in over the course of three decades of coastal development, provided an opportunity to recover significant information on a range of topics. This chapter provides the overall research design for this data recovery, referring specifically to relevant National Register guidance, a description of the research themes and questions that guided the effort, and the various field and analytical methods that were followed.

A. RESEARCH DESIGN

EVALUATING SIGNIFICANCE

According to *National Register Bulletin No. 20, Nominating Historic Vessels and Shipwrecks to the National Register of Historic Places* ("NR Bulletin 20;" NPS 1992),[1] a shipwreck is:

> *A submerged or buried vessel that has foundered, stranded, or wrecked. This includes vessels that exist as intact or scattered components on or in the sea bed, lake bed, river bed, mud flats, beaches, or other shorelines, excepting hulks [which are by definition not buried or submerged] (*NPS 1992).

In general, for a property to be eligible for listing in the National Register, it must possess integrity of location, design, setting, materials, workmanship, feeling, and association and meet at least one of four criteria that demonstrate its historical, architectural, archaeological, engineering, or cultural significance:[2]

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

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

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

D. Yielded information important in history.

The aspect or quality of a shipwreck's integrity must be considered in light of the criteria used to evaluate its significance. A resource considered eligible under Criteria A, C, and D should retain the integrity of its physical features, though this may not be necessary under Criteria B.

NR Bulletin 20 provides guidance for the application of these criteria to shipwrecks. In order to qualify for listing under Criterion A, the area or theme of significance must be established. Areas of significance for maritime resources include *Commerce*, the use of merchant vessels in maritime trade and commercial

[1] Available at: http://www.nps.gov/nr/publications/bulletins/nrb20/vs1.HTM.

[2] See criteria listed at: http://www.nps.gov/history/nr/listing.htm

activities, and *Engineering*, vessels that represent technological developments in hull form or other structural aspects. Under Criterion C, vessels must also be listed within specific categories, including *Architecture*, if a vessel is a good representative of a specific ship or functional type, and *Engineering*, if aspects of the ship's construction or form are significant in the evolution of ship technology or propulsion methods. Criterion D requires that a vessel yielded information important to history.

EVALUATING INTEGRITY

There are seven aspects or qualities of integrity considered in an eligibility evaluation. Since the WTC Ship (and shipwrecks in general) are often fragmentary and represent only a portion of the original vessel, the detailed guidance for shipwrecks provided in NR Bulletin 20 was considered.

LOCATION

Integrity of location requires that a shipwreck is located within its port of construction or port of call. It is understood however, that the fragility of historic ship remains often require their removal from their original location. The location where the WTC Ship was discovered was also likely the location where it had once operated as a merchant vessel. However, VSC construction, analysis, and short-term preservation required its removal.

DESIGN

This aspect concerns the composition, design, color, texture, and workmanship of the vessel in light of its historic character. As with many shipwrecks, the WTC Ship represents only a portion of the original complete vessel.

SETTING

National Register guidance generally requires that a ship is located in the original setting of its use or at least in an area with a setting that does not "detract from appreciating the vessel as a water-borne craft" (NPS 1992). However, as with *location*, fragile remains require storage or display in appropriate facilities. The WTC Ship was found in an area of historic landfill, in a setting that is an important reminder of the growth of Manhattan Island into the surrounding rivers, with boats and ships often found in that setting.

MATERIALS

The physical materials that make up a vessel must be intact and preserved in order to maintain integrity of materials. As found, the ship remnant only represented a portion of the materials that comprised the original vessel.

WORKMANSHIP

The quality of workmanship concerns such aspects as the fasteners, construction techniques, and materials used in a historic ship. A historic vessel that has been extensively rebuilt with new materials or modern fasteners would lack integrity of workmanship. As found, the ship remnant is only a fragment of the original WTC Ship, but its workmanship has not been altered since the time that it was incorporated into the landfill.

FEELING

As stated in NR Bulletin 20, "integrity of feeling means that the vessel evokes an aesthetic or historic sense of the past."[1] This would require the preservation of a ship's "significant physical characteristics." The level of public interest that arose after the discovery of the WTC Ship indicates that even though only a portion of the original ship was recovered, the vessel evokes a strong response.

ASSOCIATION

Integrity of association is maintained by maintaining a historic vessel at a site related to its historic significance.

MITIGATING ADVERSE EFFECTS

As stated earlier, the SHPO determined that the WTC Ship was considered National Register-eligible after completion of a site visit and a review of available date. Preservation of the ship remnant in place was impossible due to the adverse effect of the elements (e.g., high temperatures and direct sunlight) on the remnant and the nature of the construction site in which it was discovered. In accordance with 36 CFR 800.5 and 800.6, LMDC prepared an Emergency Mitigation Plan and circulated it among the Consulting Parties identified during the redevelopment's planning process. The Emergency Mitigation Plan called for the collection of significant information from the ship remains through excavation/data recovery and other scientific means as part of the process of mitigating the unavoidable adverse effects of the project upon historic properties.

B. RESEARCH THEMES AND QUESTIONS

The data recovery and analysis of the WTC Ship provided an opportunity to recover information pertaining to three broad and interrelated research themes: (1) maritime archaeology; (2) the development of Manhattan's Hudson River coastline; and (3) the process of landfilling itself. Within these themes, which are discussed below, the data recovery provided an opportunity to address several research questions related to the ship's construction, associated artifacts and samples, and the site where it was discovered. As a separate but related research effort, the research team examined and characterized the many collected artifacts and samples to determine the nature of the assemblage.

Each of these topics has been addressed to some degree in this report and it is hoped that future researchers can develop these topics further. In addition, future researchers may develop other research questions or apply new methods or technology to collect additional information beyond that described in the following sections.

RESEARCH THEME 1: MARITIME ARCHAEOLOGY

Maritime archaeologists study shipwrecks to gather information about the history of nautical cultural activity that could not be recovered from any other source. This is especially true of vessels constructed before the mid-19th century, before written records and plans were systematically prepared or preserved. In a maritime archaeological site, a shipwreck can provide new information about the history of maritime technology, economics, warfare, biology, and forestry. The artifacts recovered from the ship can often provide information about its cargo, munitions, and crew or passengers, the details of which may never have been included within the written historical record.

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[1] http://www.nps.gov/nr/publications/bulletins/nrb20/vs1.HTM

The detailed examination and technical analysis of each of the elements and fasteners that comprise a ship provides information regarding how a vessel was constructed, the materials used to build it, and its life during its period of active use. This analysis can allow for the determination of the construction sequence of a vessel and reveal aspects of its use and ultimate demise. Other analyses can include an examination of the marine life affixed to or associated with a ship's timbers, the identification of the wood species used to construct a ship, the age of the timbers (as determined through dendrochronological analysis), and the examination of features such as a possible galley hearth. A final line of inquiry is comparative analysis, comparing and contrasting the WTC Ship with similar vessels that have been archaeologically investigated.

IDENTIFICATION OF THE WTC SHIP

Questions related to the identification of the WTC Ship range from fairly general to very specific: Where and when was the WTC Ship constructed? Who may have built and operated it? For what function was it built and in what other activities may it have been engaged in during its period of service? Over what geographic range did its operation extend? What were the dimensions and functional characteristics of the original ship? What was its complete length, breadth, depth of hold, and draft? What type of rigging would have been used on the vessel? Was the ship partly disassembled or salvaged prior to its deposition and subsequent incorporation into the landfill?

Finding the answers to these questions requires the analysis and documentation of the WTC Ship and its associated artifacts. This includes specialized analysis of the wood, soils, associated marine organisms, and wood parasites that were collected during the data recovery. The digital modeling and three-dimensional reconstruction of the ship remnant could also provide detailed information about the relationship between the ship's size and its operating characteristics, which would help to answer some of the questions posed above.

DEVELOPMENT OF A HISTORIC AND COMPARATIVE MARITIME CONTEXT FOR THE WTC SHIP

Additional research questions pertain not to the WTC Ship itself, but to the cultural, historical, and environmental contexts associated with it. For example: How does the WTC Ship fit within our understanding of 18th century maritime commerce and technology? At what level is the WTC Ship considered to be significant (i.e., local, regional, or national)? Addressing these questions requires the examination of the documentary record, consultation with other maritime archaeologists and the SHPO, and the comparison of the WTC Ship to other discoveries in the state and region.

RESEARCH THEME 2: DEVELOPMENT OF THE PROJECT SITE

The process of developing land along the riverside increased the surface area of the island of Manhattan and created a stable, uniform shoreline. It also increased the efficiency of local shipping by extending the commercial waterfront out into deeper waters and allowed ships to dock at landside wharves instead of anchoring out in the river. The waterfront's close proximity to the trade ships that docked at those wharves led to the construction of markets, storefronts, warehouses, and other commercial structures which were "conveniently close to landings where farmers could moor their boats and unload livestock and produce for sale" (Cantwell and Wall 2001: 226). In this way, land-making had a crucial impact on the development of New York's burgeoning economy. Therefore, understanding the chronology of the development of the site in which the ship remnant was discovered can provide detailed information about the commercial and industrial efforts of New York City's early residents.

LAND OWNERSHIP, LAND USE, AND CHRONOLOGY OF LANDFILLING ACTIVITIES AT THE DISCOVERY SITE

Among the key research questions associated with this investigation of the WTC Ship pertain to its deposition on the riverbed and incorporation into the landfill. Who owned the lots on and adjacent to the site of the WTC Ship's discovery? When was the area filled in and by whom? What types of activities took place in the area during this time period? A variety of historic and documentary resources is available to help answer these questions. A clear understanding of the site-specific historic record can provide a foundation for interpreting landfill-related artifacts recovered from within and around the ship remnant.

SINKING OF THE WTC SHIP

The WTC Ship was discovered at what was formerly the approximate bottom of the Hudson River in an area that was intentionally landfilled during the late-18th and early-19th centuries. What events led to its deposition in this location? Was it deposited intentionally as part of the introduction of landfill or did it sink at an earlier time and was later inadvertently buried during the landfilling process? These questions require an understanding of the marine and fill sediments collected from within and around the ship remnant and the analysis of the remains of marine organisms recovered from on, around, and within the ship remnant. Understanding the chronology of the ship remnant's deposition will also rely upon the results of dendrochronological analysis and other documentary evidence as described above.

RESEARCH THEME 3: ANALYSIS OF LANDFILL

Waterfront land constructed prior to the mid-19th century in North America has increasingly been the focus of archaeological inquiry. The physical structure of landfill-retaining devices and the fill contained within them can be examined to learn a great deal about the social, cultural, and economic contexts of made land. In New York City, several archaeological investigations have examined wharves, slips, and bulkheads along the East River waterfront of Lower Manhattan and Brooklyn. A small number of archaeological studies have been conducted along the Hudson River waterfront of Lower Manhattan, although an increase in waterfront development in recent years has allowed archaeologists to pay greater attention to historic landfill deposits in that area.

LANDFILL-RETAINING STRUCTURES

In New York City before the mid-19th century, most of the wharves, slips, and bulkheads that made up the waterfront were constructed of wood. As new shoreline structures were constructed progressively further into the water over time, the bulkheads and wharves that previously lined the shoreline became incorporated into Manhattan's landmass. As a result, former waterfront structures became locked into the landfill, in many cases several blocks away from the current shoreline.

Various types of wood landfill retaining structures were historically used to build wharves, bulkheads, and other waterfront structures. Most often, landfill-retaining structures in New York City and throughout North America were built using stacked-log construction methods, similar to the technique used to build log houses. In several instances ships have been discovered integrated into the landfill system.

LANDFILL DEPOSITS AND ASSOCIATED ARTIFACTS

Research questions associated with this aspect of the ship remnant include: What was the composition of the fills used to create the project site? What types of artifacts were contained in the fill? How does the artifact assemblage recovered from the fill differ from that recovered from the original river bottom or from the ship? In addition to examining the attributes of landfill-retaining structures, the fill material contained within these structures has also been used to glean additional information on constructed land and its context. Documented fill materials range from large-aggregate fill, such as stones, cobbles, ballast, or cordwood to fine fill, such as sand, silt, and refuse. The distinction between refuse-containing fills (as opposed to clean fills) has been the subject of some study, particularly in New York City, where clean fill ordinances were enacted in the late-18th century as a sanitary measure (Cantwell and Wall 2001). Refuse deposits that sank to the river bottom before landfilling began can also be valuable archaeological resources (Huey 1984).

DEPOSITIONAL CONTEXT OF THE WTC SHIP

As mentioned above, the WTC Ship was discovered at what was the river bottom prior to landfilling activities. What is its archaeological relationship to the river bottom, the fill deposits, and adjacent landfill-retaining structures? Was the ship deposited intentionally as part of the introduction of landfill or did it sink sometime earlier and inadvertently buried? Finding the answers to these questions would require an understanding of the nature of both the fill and landfill-retaining structures encountered above and around the ship remnant; and analysis of shellfish remains recovered from on, around, or within the ship remnant. Understanding the depositional context of the ship will also rely upon the results of dendrochronological analysis and documentary evidence.

C. FIELD METHODS

FIELD DOCUMENTATION METHODS

The recordation of the vessel's timbers was completed in stages in tandem with the removal of those timbers. The recording of each "layer" of the hull immediately preceded its removal. During the recovery of the stern, the ship remains were documented and removed in the following order: (1) the orlop deck (exposing the entirety of the ceiling plank layer beneath it); (2) the ceiling planks; (3) the keelson and the vessel's frames; and (4) the outer planks, keel, stern knee, and sternpost. A similar strategy at a much smaller scale was employed during the investigation of the limited bow remains: the ceiling planks were removed first, followed by the frames, the outer planking, and then the stempost.

The rapid work needed to excavate the WTC Ship from an active construction site made it difficult to thoroughly verify the accuracy of the data while in the field. Therefore, six overlapping data collection methods were used to record the site and to provide redundancy in the event of lost or inconsistent data. Those methods included: (1) standard archaeological mapping, (2) close-up illustrations, (3) detailed photography, (4) three-dimensional laser scanning, (5) three-dimensional panorama photography, and (6) video walk-overs/dictation by the principal investigator.[1] The original field forms and data sheets used during the field investigation of the ship remnant have been included in this report as **Appendix A**.

Common methods of recording were used, including measurements taken relative to a baseline or grid squares, and survey equipment (Ansel et al. 1993). These methods, while effective, require a lot of time and tend to be limited in accuracy. Therefore, these strategies were only used for a small number of control points on the bow and stern. Recent advances have implemented photomodeling (based on enhanced three-dimensional photogrammetry) and laser scanning in order to quickly and accurately

[1] Because of the fragmentary nature of the bow remains, three-dimensional scanning and panoramic photography were not completed for the bow and close-up illustrations were not completed for all timbers individually.

record a ship, and these methods were used during the documentation of the much larger stern (Green et al. 2002).

The combination of several methods used to document the timber elements *in situ* as each layer of the ship remnant was removed are described in the following sections.

LABELING OF INDIVIDUAL ELEMENTS

During the documentation process, each timber element in a particular layer was labeled with a unique identification code in a manner consistent with the methodology and nomenclature outlined by J. Richard Steffy's *Wooden Shipbuilding and the Interpretation of Shipwrecks* (1994). For the stern, Ms. Fulton and Dr. Riess assigned the unique identification codes using a system of letter and number combinations based on the function and location of the timbers (see **Figure 2-1A**).

The orlop deck planking was given the functional designation "OP," and the planks were labeled sequentially along a longitudinal run. Each run was given a number and the individual planking making it up was given a sub-designate (i.e., OP 2/1, OP 2/2, OP 2/3 represent three consecutive planks in the second longitudinal run). Because the beams for the orlop deck (abbreviation "ODB") were broken into multiple fragments (discussed below), each beam was given a number and the fragments labeled sequentially from south to north (e.g., ODB 1/1, ODB 1/2, ODB 1/3 refer to three fragments within beam 1).

The ceiling planking was designated according to its location either north ("CN") or south ("CS") of the keelson and was numbered sequentially according to which strake—or run of planking—it belonged. The numbers of the strakes increased with increased distance from the keel. Sub-designates were given to individual ceiling planks within each strake from east to west (i.e., CN 4/1, CN 4/2, and CN 4/3 represent the easternmost three pieces of the fourth run of ceiling planking on the north half of the ship remnant). Using a similar methodology, the outer planking was labeled based on its location relative to the keel. The port planking (on the northern half of the ship remnant) was labeled as "PN" and the starboard planking (the southern half of the ship remnant) was labeled as "PS." Strakes were labeled sequentially starting at the keel and increased toward the northern and southern edges of the ship remnant. Individual planks within each strake were given sub-designates from east to west (i.e., PN 5-1, 5-2, 5-3).

Finally the frames were labeled sequentially from west to east, starting with frame aligned with the sternpost, which was identified as F0. On the port (north) side, the frames were labeled "FN" and on the starboard side the frames were labeled "FS." The floor timbers that spanned the keel were labeled "FNFS." Futtocks on the port side were given a hyphenated sub-designate odd number (e.g., FN 14-1, FN 14-3) and futtocks on the starboard side were given a hyphenated sub-designate even number (e.g., FS 14-2).

Due to the fragmentary nature of the bow section, the timbers in the bow were labeled according to their use and numbered sequentially from south to north (starboard to port). The ceiling planking was labeled "BC," the frames as "BF," and the outer planking as "BOP." Timbers not found *in situ* (e.g., those timbers located within the fill that appeared to be ship-related but were not directly articulated with the rest of the ship remnant) were labeled as "unknown" and designated based upon their location in the south or north side of the site. Measurements were taken from known datum points in order to plot the bow remnant.

For both the bow and the stern, the labeled fragments of those timbers that broke upon removal were assigned additional letters (e.g., -A, -B, and -C) and the orientation relative to the main timber was noted on each label. Because of the method of transportation, some timbers had to be broken (including the keel and some outer planking) and these purposefully broken timbers were also given alphabetical sub-designates. Several pieces were not in their original provenience or were found outside of the ship, so these timbers were labeled, "OUT," and were given a unique numerical or letter designation. Some timbers from the ceiling planking had been removed during the preliminary excavation period (before July 25th, 2013) and were given designates "BZ" since absolute location was unknown.

After an identifier was created for each timber, Tyvek tags measuring approximately 2 inches by 4 inches were stapled to each timber using rust-proof Monel roofing staples (see **Figure 2-1B**). Blue tags were used for the stern and red tags for the bow. The Tyvek material was chosen for labeling due to its durability and water resistance and blue and red tags were chosen because they were more suitable for photographic documentation. The tags used for the timbers of the stern were pre-printed with the unique site number assigned to the WTC Ship by SHPO prior to documentation and removal activities. The site name and date was written on each tag used to label the timbers of the bow. As unique identification codes were assigned to each timber while in the field, that number was written on each tag using a permanent marker.

DOCUMENTATION OF INDIVIDUAL ELEMENTS

Prior to the commencement of the documentation and removal of the stern, standard field inventory forms were created for the recordation of individual each timber elements. The field forms were printed on standard letter-size (8.5 by 11 inches) paper that had been laminated for weatherproofing and stored in three-ring binders. The standard inventory form contained basic project information as well as blank fields for entering data such as the location, function, shape and dimensions of a timber, as well as other characteristics such as the presence of nails, joinery, or fasteners. The forms also contained an empty field in which a sketch of each timber could be made. The archaeological field team typically worked in teams of two to enter data on these inventory forms (see **Figure 2-2A**). The dimensions of the timbers and their position in relation to surrounding timbers and features were measured using standard measuring tapes. Data and sketches were entered onto the forms using pencils or fine-pointed permanent markers. Completed vessel forms were returned to the binder and were digitized after the completion of field activities.

In addition, each timber was mapped on large-format drawings of the stern that had been produced by AKRF using preliminary data collected by Corinthian Data Capture (see below) affixed to a rigid backing. Whereas the standard field forms were used to document individual timber elements, these large-format drawings facilitated the recordation of the ship remnant as a whole and documented the inter-relation of the individual elements. The large-format drawings included the outlines of the ship remnant and of each clearly visible vessel timber; any areas where individual timbers were not visible or could not be clearly defined were left blank. Several versions of the drawings were produced so that each layer exposed during the removal process could be recorded on a separate sheet. As unique identification codes were assigned to each timber, the timbers were sketched onto the large-format vessel plan and annotated with the appropriate timber identification code (see **Figure 2-2B**).

Field documentation forms were also prepared for the removal of the bow. However, given the fragmentary nature and small size of the bow timbers, the timbers were documented through to-scale field drawings and photographs of all the *in situ* timbers and were not recorded on individual sheets or via large-format drawings.

THREE-DIMENSIONAL LASER SCANNING

Throughout the course of the archaeological investigation, the WTC Ship was recorded by Corinthian Data Capture, LLC of Wyandanch, New York. Using a mid-range laser scanner (*FARO Photon 120*), a three-dimensional digital image—commonly referred to as a "point cloud"—was created. The scanner is a self-contained unit set atop a tripod that utilizes phased-base technology. Scanning is a line-of-sight process, capturing distinct three-dimensional points of any object within range of the laser's beam. During a scan, the scanner emits highly focused pulses of infra-red light that document everything within a 360 degree field of horizontal view and a 320 degree field of vertical view. It has a range of approximately 200 feet within a 90 degree vertical plane from the scanner. Each point is given an x, y, and z value relative to the center point of the scanner. Each point is also assigned a greyscale value, providing a black and white image when viewed in the computer software. The scanner is self-leveling, providing an accurate assessment of true vertical and horizontal planes within each scan. A series of spherical and placard targets were placed within the field of view of each scan to serve as referenced targets when aligning multiple scans.

To ensure adequate coverage of the ship remnant, scans were completed from multiple vantage points both around and on the vessel. These scans were taken at a resolution value of 1/4, which provides a high degree of detail, producing a dense point cloud image with multiple data points. This enables slight variations in the wood members, deviations as little as an eighth of an inch or less, to be recorded for future study and analysis. Reference targets were set up around the perimeter of the ship remnant. A survey crew from the New York City Metropolitan Transportation Authority (MTA) was on site the first day of scanning, and recorded survey geospatial reference data for each of the spherical targets. This enabled the WTC Ship to be tied into the datum elevations and boundary locations of the WTC Site.

The scanning of the ship was done within days of the initial discovery and before any timber elements were removed from the ship remnant. Scans were completed at two additional points during the archaeological investigation: after removal of the orlop deck and ceiling planks and after removal of the keelson and frames. Photographs of the process were also taken to provide a record of the ship remnant, scanner, and targets.

Once field scanning was completed, all data was downloaded from the scanner. This data is brought into software called *Scene*, which is proprietary software for processing of FARO point cloud data. The individual scans were processed to clean the data of extraneous points and to align the scans to one another, both manually and through the use of computer algorithms within the program. The final assembled file contained all individual scans processed and aligned to create a full three-dimensional image of the WTC Ship and surrounding site.

ARTIFACT AND SOIL SAMPLE COLLECTION

Throughout the excavation, documentation, and removal of both the bow and the stern, archaeologists sampled artifacts as they were encountered either as spot or surface finds or through water screening. These artifacts were bagged in acid-free polyethylene zip-lock bags and labeled with provenience information. Artifacts were then placed into a secure on-site storage container or were transported directly to the AKRF laboratory facility. In addition, soil was systematically sampled and water-screened from several contexts, including from between the vessel frames and from beneath the ship remnant. During the removal of the stern, the dense clayey soils collected from between the timbers were water-screened on-site using hoses and screens with quarter-inch mesh. This technique allowed the archaeological team to collect large artifacts as well as small objects, including shells, seeds, bird shot pellets, and small plant materials. An effort was made to record the context of artifact and soil samples. Sometimes these contexts were specific (e.g., "*between frames BF3 and BF4"*) and sometimes they were only general (e.g., "*north of ship during initial discovery"*).

During the removal of the ship remnant's timbers, soil samples were collected from eleven unique contexts in the stern, one sample from a location within the west half of the VSC Site (which served as a control sample), and seven soil samples were collected from in and around the timbers of the bow. As part of the artifact processing, the soil samples collected from the stern were selected for flotation, based on their stratigraphic position, relationship to the ship remnant, or their potential analytical significance.

REMOVAL AND TEMPORARY ON-SITE STORAGE OF TIMBERS

Following the documentation phase of each layer of the stern, archaeologists removed each timber element and transferred it to the on-site conservators for processing and packing. Each timber element was carefully pried loose using cedar or pine wedges and rubber mallets. Depending on the size and fragility of the timber, multiple archaeologists or laborers worked together to loosen and lift each element, trying to minimize damage either to the timber or to adjacent portions of the ship remnant. Long or fragile timbers were transferred directly onto plywood splints. Members of the field team or EE Cruz crew carried each timber from the ship to the conservators (see **Figure 2-3A**).

After removal, each element was wrapped with polyethylene foam and plastic sheeting sealed with duct tape and/or plastic ties to protect the timbers and to retain moisture. The exterior of the wrapped timber was then labeled with the timber's unique identification code. Each timber was then positioned within one of two 10-yard storage containers that had been outfitted with wood shelving constructed specifically to protect the timbers (see **Figure 2-3B**). In limited instances, when timbers (such as the keelson) were too long to fit within the storage container, the on-site conservation crew directed the breakage of the timbers in a controlled manner. This was achieved by the manual or machine-assisted snapping of the timbers in such a way that they could be reassembled in the future with a minimally visible seam. When all of the vessel timbers had been removed, the storage containers were lifted out of the excavation site with a crane and trucked to the MAC Lab in Saint Leonard, Maryland, for immediate processing.

During the removal of the fragments of the bow in August 2011, timbers were removed and individually wrapped with plastic sheeting and sealed with duct tape. Several of the bow pieces were first placed on Styrofoam boards before wrapping due to their poor condition. The timbers were then transferred to the AKRF laboratory where some were submerged in plastic bins filled with water. The timbers were unwrapped, examined, and documented through sketches and photography. The timbers were then wrapped with damp cloths, polyethylene foam, and plastic sheeting, and then sealed with plastic ties and duct tape. The timbers were then packed into hard plastic crates or were affixed to wooden or sturdy Styrofoam boards. The wrapped timbers were then secured in a shipping crate and transferred to CMAC at Texas A&M University in College Station, Texas, which took possession of the timbers of the stern in April 2011 (see below).

D. DOCUMENTATION AND ANALYSIS OF WTC SHIP'S TIMBERS

The documentation and analysis of the individual ship timbers in a laboratory setting is a three-part process: (1) initial recording; (2) processing or compilation; and (3) historic analysis. Each phase builds upon the prior to enhance the understanding of late-18th century ship construction and is designed to address the research topics outlined earlier in this chapter.

TIMBER SPECIES IDENTIFICATION

Robert A. Blanchette, PhD., a professor at the University of Minnesota, is a specialist in the identification of wood species. Dr. Blanchette analyzed samples of the frames, planks, and other unique components of the ship remnant's timbers in order to determine the genus and species of each. The samples were taken from the timbers of the stern by Carrie Atkins Fulton using minimally invasive methods and were shipped to Dr. Blanchette for analysis. The timbers of the bow were not subject to wood species identification analysis. The information gained through this analysis has aided in the interpretation of the vessel's construction methodology and geographical origins as it was essential to the dendrochronological analysis of the timbers (see below). The results of Dr. Blanchette's analysis are discussed below and his report is included as **Appendix F**.

DENDROCHRONOLOGY

Dendrochronology is the science of determining the age of a timber sample by analyzing its tree rings. The analysis of timbers using dendrochronology can result in the identification of the dates that a particular tree grew and was cut down. Trees in the same geographic area tend to exhibit similar growth patterns and are similarly affected by changes in rainfall and other climatic variables. Dendrochronology compares the width of the annual growth rings in a given sample to a master chronology for a particular geographic location. Statistical analysis of the correlation between the sample's growth pattern and those of various master chronologies can indicate where and when a tree once grew.

The Tree Ring Laboratory at the Lamont-Doherty Earth Observatory at Columbia University ("The Tree Ring Lab") in Palisades, New York, completed the dendrochronological analysis. The Tree Ring Lab completed the sampling and analysis of 23 timber samples associated with the ship remnant's stern. Samples from the timbers of the ship remnant were taken using minimally invasive techniques by Dr. Paul Krusic at the MAC Lab in early September 2010. In most cases, it was possible to take cross sections, which allows the scientists to study multiple radii to establish a stronger tree ring chronology.

The samples taken by the Tree Ring Lab were chosen with the aim of collecting data that would be the most useful to subsequent interpretive analyses. Goals of the sampling strategy included collection of timbers representing variety of structural functions (frames, keel, planks, etc.) and collection of timbers in sufficiently good condition to allow for successful analysis. Samples retaining a "waney" edge, or outer growth rings (adjacent to a tree's bark), are favored where possible, since samples with a waney edge are capable of providing the best evidence for a felling date, or the date the tree was cut down. When a waney edge is lost through timber processing, it is impossible to determine an exact felling date for a given timber. Further, samples that retain more than one hundred growth rings are preferred so as to provide ample data for greater accuracy in cross-dating timber samples.

The duration of the Tree Ring Lab's analysis at their laboratory in Palisades was approximately nine months. In order to prevent the waterlogged timber samples from warping and cracking as they dried, the samples were slowly dried at cool temperatures in refrigerators at the Tree Ring Lab. Samples that were in poor condition were glued to wooden boards to prevent further damage. After drying, samples were sanded multiple times with increasingly fine sandpaper until the tree's rings were clearly visible. The growth rings of each sample then measured along two radii to approximately 0.001-millimeter precision.

The series of measurements for each sample was then compared to master dating chronologies for various regions using *COFECHA*, a standard computer program for this type of analysis. The series of measurements for each sample of the same species (in this case, oak) was also used to create an average annual radial chronology of all the dated samples from the vessel. Average annual radial growth chronologies reduce the individual variability that results from factors other than climate and as such are a more reliable dating tool for sample assemblages. The average annual radial growth chronology was also compared to master dating chronologies for various regions. A Spearman ranking system was used to quantify how closely the tree ring series of the sample correlated to the master chronology for the species in a particular geographic region.

When the analysis was complete, the Tree Ring Lab submitted a Final Report (dated May 11, 2011) that presented the results of their findings, including a positive date for each sample where possible. The findings of this study are summarized in this report and the Final Report is included here as **Appendix G**.

THREE-DIMENSIONAL MODELING

Traditionally, archaeologists studying historic vessels produce full-scale (1:1) manual tracings of each timber on sheets of clear plastic or glass. These drawings are annotated with tool marks, notches, nails, and stains observed on the timbers (Steffy 1994: 202). Recent technological advances have led to the inclusion of digital recording techniques in the documentation of historic vessels. Tools such as the photogrammetric software *PhotoModeler Scanner* allow archaeologists to reproduce three-dimensional images of individual timbers in order to more accurately record their complex shapes and those intricate details that cannot be recorded manually. By implementing these techniques in concert, archaeologists are able to piece together boat and ship reconstructions and develop comprehensive analyses of the remains (Steffy 1994: 214).

A combination of both of these traditional and modern recording techniques was used to record the timbers of the WTC Ship. The recording of the stern was conducted by the AKRF Team on the premises of the MAC Lab. The team began recording the bow remains at the AKRF laboratory and completed it at Texas A & M. Full-size (1:1 scale) tracings on sheets of plastic were made of highly diagnostic timbers. The frames were the main focus of the tracings since they contain information about the curvature of the ship and the fastening of the outer and ceiling planking. Other timbers were traced or sketched as needed to accurately record unique features such as tool marks, fastening patterns, and other identifying or diagnostic features. Tracings were also made of the frames of the bow. Three-dimensional models of each timber were created using the software *PhotoModeler Scanner*. This process involved taking a series of high-resolution photographs of the various sides of each of the ship's timbers and entering them into the program where a form of photogrammetry is used to calculate measurements and generate point cloud data. This data was then turned into a triangulated mesh and imported as a three-dimensional model into a software program called *Rhinoceros*. In *Rhinoceros*, additional details were added to some of the timbers, such as the reconstruction of nails and spikes.

VISUAL INSPECTION AND ANALYSIS OF SHIP TIMBERS

During and after the documentation of each ship element, the timbers were carefully studied and examined. This information was collected through the visual examination of each element and documented through photography and tracings, as described above. A digital database containing information relating to all observations was then created. The database listed all timber elements according to their assigned unique identifying number and an artifact name referring to its function and what portion of it was being analyzed. Relevant information from this database is included in **Chapter 6: Technical Analysis of the WTC Ship and its Components**.

Each timber was inspected and observations were made regarding the following fields:

- **Nails**: the number and placement (i.e., to outer planking, to frame, to ceiling planking, and through the timber) of nails in each timber was recorded. The diameter and width of each nail was recorded, as was the depth of the nail hole or the length of the nail, and the angle of the nail relative to 90 degrees, when measurable.
- **Trunnels**: the number and placement (i.e., to outer planking, to frame, and to ceiling planking) of trunnels was recorded during this analysis. The diameter of the trunnels was measured, and notes were made to identify filled and empty trunnel holes.
- **Number of Impressions**: the number of impressions of other timber elements left on each timber was recorded. This included impressions left by outer planking, frames, ceiling planking, beams, deck planking, and/or the keelson.
- **Measurements**: general measurements of each timber were recorded, as were measurements of specific attributes of each timber (i.e., the notch in the floor timbers for the keel). Measurements included sided dimensions (generally the width), molded dimensions (generally the thickness), length, and depth of notches.

- **Condition of Timber Elements**: timbers were identified as broken or complete.
- **Marine Growth**: the presence or absence of marine growth (e.g., oysters, bryozoans, and barnacles) was identified for each timber.
- **Caulking**: the presence or absence of caulking was noted for each timber.
- **Other**: the database included other information, including whether or not tracings of the timber were made, whether or not samples were taken for dendrochronological analysis, the wood species as identified by Dr. Robert Blanchette (see Appendix F), the date and orientation of all photographs that were taken of the timber, and the date that a digital model (if any) was created.

E. PROCESSING AND ANALYSIS OF ARTIFACTS AND SAMPLES

The field team collected approximately 2,000 artifacts from the landfill surrounding the vessel and from within the ship's timbers. In addition, more than 6,000 archaeobotanical remains were collected during the data recovery. The processing and analysis of this assemblage focused on the following questions: Are any of these artifacts and remains associated with the WTC Ship and its historic use(s) or did they accumulate in this location sometime after the ship sank? If it can be determined that some of the artifacts are associated with the ship, can the assemblage reveal differences in the activities that may have taken place in different areas of the vessel (such as between a hold where cargo may have been stored and a living area where the ship's crew may have lived and ate)?

This research topic required the examination of the many contexts assigned to artifacts in the field. These temporary contexts were then re-grouped into more manageable contexts so that comparisons could be made between the revised contexts to identify similarities and differences within the artifact assemblage. The artifact catalogue and an index of field and lab provenience information are provided in Appendix B.

ARTIFACT PROCESSING

Artifact washing began immediately after the transfer of the collection to the AKRF laboratory. Archaeologists processed the artifacts using standard archaeological techniques: artifacts were washed using soft-bristle brushes and a mild, non-ionic detergent, and then air-dried on racks. Fragile artifacts and those with non-stable surfaces (such as tin-glazed earthenwares) were washed separately without brushing. Metal artifacts were dewatered using acetone. Fragile artifacts were washed as gently as possible and care was taken not to let porous artifacts become waterlogged. All artifacts, including faunal material and metal, were washed. Fragile organic materials, including some timber, shell, leather, and rope samples, were stored in a refrigerator to maintain moisture and prevent decay.

During artifact washing, archaeologists identified artifacts from important contexts and/or artifacts suitable for exhibition as well as objects that might be in need of conservation. These items were transferred to Gary McGowan of Cultural Preservation and Restoration, Inc. (CPR), for professional conservation. Some leather and wood objects were freeze dried for potential display and/or further study. Conserved artifacts are identified as such in the artifact inventory (see **Appendix B**). Leather and wood not selected for conservation was dried slowly, with the leather objects beneath weights to prevent curling and shrinkage. Faunal materials were sent to zooarchaeologist Marie Lorraine Pipes and ordnance was sent to Daniel Sivilich. All data from the faunal analysis and ammunition analysis has been added to the general artifact inventory and the reports prepared by Ms. Pipes and Mr. Sivilich are saved as **Appendices C** and **D**, respectively.

After they were washed and dried, artifacts were separated by material (e.g., ceramic, glass, metal, shell, etc.) and to some extent by function (for example, brick, as an architectural item, was bagged separately from earthenware sherds and domestic items, even though both are frequently made of the same type of clay). The sorted artifacts were then placed in 4-millimeter thick polyethylene bags labeled with provenience information using permanent markers. Individual bags of sorted artifacts were then placed within a large polyethylene bag(s) for the entire provenience. All bags were pierced for air circulation.

ARTIFACT ANALYSIS

The AKRF Team was aided by subconsultants with specific knowledge of unique artifact types for certain specialized analyses. Relevant artifacts and other materials from the general collection were separated during artifact processing and were sent to the specialists to be analyzed according to generally accepted industry standards. The specialists' reports, where available, are included as appendices to the final report, and the results of their research are incorporated into the discussions presented in this report. Several thousand artifacts and faunal and botanical remains were recovered during discovery and removal of the ship remnant, including artifacts recovered by hand during excavation and soil clearing, through water screening, and through soil flotation. The majority of the botanical remains were recovered through the flotation of soil samples recovered from a number of contexts associated with the ship (see below).

A basic inventory was prepared to identify each artifact and to classify it by context, count, provenience, group, class, material, and function (see Appendix B). While not a full artifact catalogue, the inventory allowed for the analysis of specific types of artifacts recovered from discrete areas of the ship remnant and the surrounding area. The terms *Group* and *Class* are used in the inventory in accordance with NPS guidance to indicate an internally consistent set of related kinds of artifacts (e.g., Group: *Kitchen* and Class: *Dishes*). The term *Type* is also used in the inventory to more explicitly identify the types of activities expected to have occurred on the WTC Ship and to have resulted in the accumulation of artifacts in the landfill and on the river bottom (e.g., using Type: *Food storage/service* to refer to both beverage bottles and fragments of a ceramic serving platter). A second function of the inventory was to identify artifacts in need of stabilization, conservation, or more intensive analysis. Descriptive data from the ordnance, faunal, flotation, and marine organism analyses was added to the inventory, as were ship-related artifacts that were collected during the cleaning of the ship's timbers at the laboratory.

SPATIAL ANALYSIS

Although provenience information was collected in the field as artifacts were recovered, additional analysis was required to determine if those field designations were supported by identifiable differences within the assemblage and to correct errors made in the field (i.e., the identification of the stern as the bow). The first step in this analysis was grouping related proveniences into one of four theoretical primary contexts based on the location of the find, described below with their associated assumptions:

- ***Ship***: Artifacts recovered from the soils excavated from beneath the upper ceiling layer and above the outer planking of the ship remnant. These soils presumably originated in the landfill and/or river bottom and gradually filtered into the voids between the ship's timbers over time, perhaps carried by the flow of water or the pressure of the weight of the fill, effectively burying any artifacts already present in those voids that had accumulated during the ship's active use. An assumption in this context is that the fine, light soils filtering into the ship's voids did not contain a significant quantity of landfill or river bottom artifacts, which, as they were much larger and heavier than fine particles of sediment, would not have managed to enter the often enclosed voids. One would expect artifacts recovered from this context to be associated with the use or operation of the vessel, the cargo carried by the ship, or the crew who lived and worked on the vessel. These artifacts would also be expected to date to a relatively narrow period of time.
- ***Landfill***: Artifacts recovered from the fill deposits removed from above the ceiling layer or adjacent to the ship. These soils presumably accumulated on and around the ship when this portion of the

Hudson River was filled. The artifacts recovered from the fill had either (1) already been present in the fill, presumably a convenient land-side garbage dump, before they were re-deposited in this location; (2) had been directly deposited into the slip by local residents or merchants as it was being filled; or (3) a combination of both. One would expect artifacts recovered from this context to reflect a wide range of activities, both domestic and industrial, and to potentially span a long period of time.

- ***Landfill/Ship***: Artifacts collected from ambiguous contexts along the edges of the ship or in areas where artifacts associated with either the ship or the landfill could have easily mixed.
- ***River Bottom***: Artifacts collected from the sands, silts, and clayey silts of the Hudson River's river bottom. The project site was an active slip for many years prior to its being filled in. Over this period of time artifacts could have accumulated on the river bottom that accidently fell into the river during the loading or unloading of merchant vessels or that were intentionally discarded by local merchants or residents. In addition, some artifacts originally present in the fill could have migrated downward and into the river bottom over time. River bottom-associated artifacts could be expected to be older than those introduced in the fill, unless of course the fills deposited into the slip were from an even older land-side deposit. River bottom artifacts could also be expected to be less fragmented than redeposited refuse found in fill or even include complete vessels or sealed containers.

Once the assemblage was sorted into the above distinct primary contexts, the second step in analyzing the spatial distribution of artifacts required comparing the subsets to each other. Are there identifiable differences in the artifacts collected from each context or have they been mixed or disturbed to such an extent that these distinctions cannot be identified or supported? This determination could theoretically be made through a comparison of the quantities, types, and percentages of artifacts sorted by context. If a subset of the artifact assemblage can be identified that is defensibly associated with the ship's use and operation, more substantive spatial analysis may be possible regarding the use and operation of the ship. In order to begin to address this more substantive analysis the primary ship context was further divided into the following six arbitrary analytical units:

- **Western Portion of Stern ("A")**: Artifacts recovered from between the ceiling layer and outer planking, west of frame FNFS 10.
- **Middle Portion of Stern ("B")**: Artifacts recovered from between the ceiling layer and outer planking, between frames FNFS 10 and FNFS 18.
- **Eastern Portion of Stern ("C")**: Artifacts recovered from between the ceiling layer and outer planking, east of frame FNFS 18.
- **Orlop Deck**: Artifacts recovered from beneath the orlop deck and on top of the ceiling layer.
- **Stern Knee**: Artifacts recovered from the soils that accumulated around the stern knee on top of the outer planking.
- **Unidentified Ship**: Artifacts recovered from on top of the outer planking after all of the frames had been removed.

Comparison of the artifacts collected from each of these arbitrary analytical units to each other, to the Ship context as a whole, and to the other primary contexts may lead to the identification of similarities and/or differences. If differences are identified, they may be due in part to different types of activities occurring in different parts of the ship. For example, if the forward (eastern) portion of the ship served as the hold and the crew slept and prepared food for themselves in the vicinity of the orlop deck, one would expect to see differences in the types and quantities of artifacts recovered from each area.

BRICK AND MORTAR ANALYSIS

A brick feature, possibly the remains of a galley hearth, was located on the orlop deck of the stern of the ship remnant and was identified and recorded by the field team during excavation. Incorporated into the feature was a semi-circular metal ring that appeared to be fixed to the orlop deck planking with mortar. Brick rubble was also found both on top of and beneath the orlop deck and in limited other locations associated with the ship remnant. Bricks and mortar from these contexts were sampled, placed into plastic bags labeled with provenience information, and transported to the AKRF laboratory where they were washed and catalogued.

More than 20 whole red bricks and numerous brick fragments and mortar samples were recovered from the site. When cleaning the brick samples, the archaeologists were careful not to scrub visible ashy surficial residues off the bricks. Dr. Allan Gilbert of Fordham University, who is a recognized expert in historic brickmaking and who maintains an archive of historic bricks, visited the AKRF laboratory to offer preliminary input on the brick and mortar samples and to discuss plans for their further analysis. In addition to the preliminary analysis of the brick samples that is included in this report, limited documentary research was conducted with respect to the subject of shipboard hearths in attempt to gain insight into the construction and function of the brick feature and to place it into a historical context.

SOIL SAMPLES

Flotation of soils results in retrieval of a greater number of smaller artifacts (such as lead shot) and pieces of faunal (in particular bird and fish bones and fish scales) and floral (seeds and nuts) materials than are recovered during standard field excavations, which generally use ¼-inch mesh to screen excavated soils. The ship and its associated organic remains are exceptionally well preserved due to the site's water-saturated, stable, anaerobic environment located deep below the present street level.

During the flotation analysis, archaeobotanist Justine McKnight collected, cataloged, and analyzed the faunal and floral materials recovered during the flotation of the soil samples. The flotation analysis was completed by archaeobotanist Justine McKnight and the flotation report is included as **Appendix E**. Soil samples from the bow were not submitted for flotation analysis and are currently stored in the AKRF laboratory for potential analysis in the future. Further study of the plant macro-remains recovered from the site by researchers in the future may provide additional information regarding the ship's construction, provisioning, and ecological conditions in the vicinity of the project area beyond that which is presented in this report.

F. ARTIFACT/TIMBER STABILIZATION AND CONSERVATION

STABILIZATION AND TEMPORARY PRESERVATION OF SHIP TIMBERS

Wood recovered during archaeological investigations, particularly waterlogged timbers, requires specific conditions in order to best preserve its dimensional and structural integrity for both research and display purposes. The biggest causes of damage to archaeologically excavated timbers include: shrinkage and warping caused by uncontrolled drying; decomposition resulting from exposure to oxygen; crystallization of salts in the cellular structure of the wood, and macrobiological growth including insect and mold damage. In addition, improper conservation can result in further damage. For example, submersion in a watery environment is necessary for the preservation of the timber, but without proper treatment, can result in damage to associated metal artifacts (such as iron nails and metal fasteners). Proper conservation treatment is therefore needed to prevent damage and to carefully control the drying of the timbers for future analysis or preservation.

After removal of the stern of the ship remnant from the VSC Site, all of the individual ship elements were transported to the MAC Lab in St Leonard, Maryland for cleaning and stabilization. At the MAC Lab facility, staff—including head conservator Nichole Doub, MAC Lab Educator, Kathy Concannon, Dr. Riess, Ms. Fulton, and various assistants—unwrapped the timbers, and cleaned them of mud and soil. The timbers were then placed into tanks connected to a 600-gallon reverse osmosis water system which provided fresh, treated water for both the cleaning and storage of archaeological timbers. The Mac Lab conducted weekly chloride monitoring to measure salt levels for all of its projects as part of a regular desalination schedule. The staff at the Mac Lab introduced a chemical biocide and a corrosion inhibitor into the storage environment as an active prevention method to prevent infestations of mold or insects and to prevent the deterioration of the remaining iron components.

In April 2011, the timbers were re-packaged with foam and plastic sheeting and shipped to the CMAC lab at Texas A&M University in College Station, Texas. Under the leadership of Donny L. Hamilton, Ph.D., the Director of the Conservation Research Laboratory at CMAC, and Peter D. Fix, Ph.D., Research Associate and Assistant Director of the Conservation Research Laboratory, CMAC has taken temporary possession of the timbers and is continuing efforts to properly store and maintain the timbers. The CMAC facilities and staff have the expertise and equipment to allow for the appropriate maintenance and possibly the eventual preservation and reconstruction of historic vessels such as the WTC Ship. After their arrival at the CMAC lab, the timbers were individually assessed for damage caused during removal and the transfer from MAC Lab to Texas and placed on racks in large covered vats equipped with water filtration systems. CMAC has continued the use of bio-deterrents to prevent damage caused by mold and insects. CMAC staff continue to monitor the timbers to ensure their stability.

ARTIFACT/TIMBER CONSERVATION AND PRESERVATION

Artifact conservation services were provided by Cultural Preservation and Restoration, Inc. (CPR), of Blairstown, New Jersey. Representatives from CPR visited the VSC Site several days after the discovery of the WTC Ship. A pin test was completed that determined that the exterior portions of the ship remnant—which had been exposed to oxygen, heat, and direct sunlight for the first time in centuries—were considerably deteriorated (to a depth of approximately .25 inches) although the interior of the timbers were well-preserved. CPR recommended the construction of a canopy to shield the ship remnant from sunlight and also recommended that low-pressure hoses be used to maintain the moisture level within the waterlogged timbers.

In July 2010, CPR took custody of the timbers that had been removed at that time (including several courses of ceiling planking), the remnants of a wooden barrel (including lid, staves, and willow banding), and various other artifacts, including a 3-foot cast iron anchor that was recovered near the ship remnant. Additional artifacts, including wooden objects (tool handles, barrel bungs, scrub brush fragments, buttons, sheaves/trunnels, and a whittled or carved wood fragments), leather objects (fragments, complete and partial shoes, and a button), rope samples, metal artifacts (buttons, spoons, copper alloy eyelet, and a shoe buckle), and glass artifacts (a mirror fragment) were sent to CPR for conservation.

During the conservation process, the artifacts were mechanically cleaned. Metal artifacts were desalinated and treated with a corrosion inhibitor and an acrylic barrier coating. After cleaning, wet organic materials (e.g., rope and leather) were treated with glycerol or polyethylene glycol before being freeze-dried. Dry organic materials were stabilized and impregnated with acrylic resins. Conserved artifacts were documented through photography and the creation of a conservation record. All conservation work was completed in accordance with the *Code of Ethics and Guidelines for Practice, Documentation, and Treatment* as issued by the American Institute of Conservation (AIC).

G. ANALYSIS OF SHELLS, MARINE ORGANISMS, AND FAUNAL MATERIALS

Evidence of a variety of aquatic organisms was observed in association with the ship remnant. In some cases, shells and other remains of marine life were found on, within, or immediately adjacent to the vessel while in other cases, they were physically attached to it. Dozens of shell samples, including oysters, clams, gastropods, and horseshoe crabs, were transported to the AKRF laboratory, where they were carefully washed and processed. Where there appeared to be a potential for the remains to contain soft tissue or to degrade easily, samples were not washed and were instead placed in labeled plastic bags and refrigerated. Some shells remained physically attached to the ship timbers and were transported to the MAC Lab for stabilization. Those shells were analysis in tandem with the documentation and analysis of the ship timbers. The shells were left on the timbers, but were studied, identified, and catalogued.

AKRF's archaeologists and ecologists collaborated on the identification, processing, cataloguing, and analysis of these samples. An Inventory of Estuarine Biota, which includes the species, number, size, location, and description of each of the shell samples recovered during the investigation was created and has been included in the artifact inventory (Appendix B). Marine vegetation such as eelgrass fragments was also analyzed and is included in the inventory count; however, fish bones were analyzed separately as part of the analysis of the faunal remains recovered from the ship remnant (see below).

As part of the shell analysis, the locations from which the artifacts were collected were grouped into five provenience categories. These groupings were developed as a tool for identifying patterns in the locations of shells and marine organisms that could in turn yield insight into the depositional history of the ship remnant. The shell analysis was designed to identify each sample to the species level and to develop scenarios to explain how and when the shells came to be on the site. The analysis was also intended to result in a greater understanding of the riverside ecological environment of the Hudson River at the time of the vessel's working life and on the eve of the landfilling episode.

A sample of the ship remnant's sternpost, which was heavily damaged by shipworm infestation, was submitted to Dr. Kevin Eckelbarger, of the University of Maine. Dr. Eckelbarger provided a preliminarily identified of the species of shipworms that infested the ship remnant, which is summarized in this report.

Faunal (bone, both mammal and fish) identification and analyses can supply information about the consumption and use of animal products. Ms. Marie-Lorraine Pipes, who has extensive experience working with faunal collections from New York City, served as the faunal specialist for the ship remnant artifacts. Ms. Pipes analyzed the faunal collection associated with the ship remnant and created a catalog of the bones that identified the species of each. The index also made note of any identifiable features of the bones, such as evidence of butchering. The final report prepared by Ms. Pipes is included here as Appendix C and the faunal remains are included in the artifact inventory (**Appendix B**).

H. DOCUMENTARY, HISTORIC, AND CARTOGRAPHIC RESEARCH METHODOLOGY

In order to better understand the WTC Ship and its importance to the landfill that surrounded it, additional documentary research was completed. Various primary resources dating to the 18th and 19th centuries as well as secondary resources describing that period were examined to look for evidence of ships being sunk in the vicinity of the project site. These sources include the *Minutes of the Common Council of the City of New York*, I.N.P. Stokes' *Iconography of Manhattan Island* (1967), shipping records, ship registries, private business records, journals, historic wills, conveyance records, and historic newspapers, among other sources. Examples of ships being sunk or incorporated into the landfill in other areas of New

York City was researched to provide a comparative dataset. This research can potentially provide insight into the ship's identity, but can also help archaeologists to understand more about how ships were used for landfilling purposes in New York City in the 18th and 19th centuries.

As stated earlier, the location of the bow and the stern of the ship remnant were recorded by on-site surveyors. The location of the outer boundary of the hull was recorded as a series of x,y coordinates in the State Plane (1983) New York Long Island coordinate system, a standard coordinate system for geographic data in New York City. These were plotted using a Geographic Information System (GIS) software program,1 which allowed for the accurate mapping of the WTC Ship within the VSC Site and surrounding neighborhood.

More than 20 maps are discussed in **Chapter 3: Historic Context and Development of the Project Site**, and others were consulted during the investigation of the progression of landfill in the location where the ship was recovered. Five historic maps were selected to include as figures because of their accuracy and their ability to document the progression of landfill over time. Additional maps depicting general site conditions that are referenced in the chapter (e.g., the 1754-1755 Maerschalk, 1776 Ratzen, 1789 McComb, 1836 Colton, 1852 Dripps maps) were included in previous archaeological studies of the VSC Site that were prepared by AKRF and Historical Perspectives, Inc. The other referenced or reviewed maps did not depict the landfill on the project site, were inaccurate, or included redundant or irrelevant information and did not warrant inclusion in the report. As stated in the **Chapter 3** and the bibliography, most of the referenced maps are available within I.N.P. Stokes' Iconography of Manhattan Island (published between 1915 and 1928, reprinted in 1967), and in more recent works such as Manhattan in Maps by Paul E. Cohen and Robert T. Augustyn (1997). The majority of these maps are readily available in the collections and digital collections of numerous well-known institutions such as the New York Public Library, the Library of Congress, and David Rumsey Cartography Associates.

Once the WTC Ship was mapped, historic maps dating to the 18th and 19th century which depict the VSC Site and surrounding area were aligned to match the modern GIS base map, a process often referred to as geo-referencing. During map georeferencing, the historic map is analyzed in order to locate features that are clearly identifiable on both the historical scanned map and the modern GIS map. The best locations to use as common landmarks, or *control points*, are built features like street intersections that have not changed since the earliest maps, and that are spread out across the area of interest rather than clustered in one smaller area. Because these 18th- and 19th-Century maps were not created using modern, accurate survey techniques, it is virtually impossible to align them perfectly with modern geographic data. However, in long-developed areas like Lower Manhattan, historic street lines have remained fairly consistent. Therefore, the historic maps provide a good representation of the street grid and other built features that can be registered reasonably well, particularly for localized areas. A number of control points were identified in the historic maps showing the VSC Site, including the intersections of Broadway and Wall Street (in front of Trinity Church, also visible on the earliest maps), Maiden Lane and Nassau Street, and Church and Barclay (Barkley) Streets. These and similar locations were used to align the historical maps to the modern GIS map.

The geo-referenced maps were used as an aid in reconstructing the historic development of the project site.

ANALYSIS OF DEPOSITIONAL CONTEXT

Between February of 2009 and September 2011, archaeologists monitored construction at the VSC Site and documented some of the landfill-retaining structures (timber wharves, piers, bulkheads, etc.) that

[1] Esri ArcGIS

were observed in the landfill. A detailed description of these finds is included in a separate report prepared for PANYNJ by AKRF in 2012 (AKRF 2012a). Analysis of the ship's location within the broader network of landfill-retaining structures on the site has helped the archaeological team to understand how the area was filled and the ship's archaeological relationship with the traditional timber landfill retaining structures. In order to determine the ship remnant's location relative to the historic river bottom, soil borings completed by PANYNJ in 2005 were examined. As a result of this analysis, a generalized soil profile of the project site was created and the depths of the different stratigraphic levels identified in those borings were compared with the depths of the sections of the ship remnant. Elevations in the field were recorded using the PANYNJ vertical datum (with 0 being located 297.347 feet below mean sea level) and were converted to depths relative to mean sea level for the purposes of this report.

Chapter 3: Historic Context and Development of the Project Site

In order to better understand the ship remnant and its relationship to the landfill that surrounded it, various primary sources dating to the 18th and 19th centuries as well as secondary resources describing that period were examined. This research established the chronology of the site's development and identified the individuals who worked to create land along the waterfront in the location of the VSC Site, resulting in the incorporation of the ship remnant into the landfill. Examples of ships being sunk or incorporated into the landfill in other areas of New York City were also researched to provide data with which to compare the WTC Ship and its associated artifacts. The sources consulted during the preparation of this historical context are discussed in **Chapter 2, Section F: Documentary and Historic Research Methodology**.

A. HISTORY OF NEW YORK'S WATERFRONT

THE ESTABLISHMENT OF A DUTCH COLONY

The Dutch settlement of New Amsterdam was an ideal colonial town: a small, easily defensible outpost at the tip of Manhattan Island, situated at the confluence of the East and North (Hudson) Rivers and with one of the finest harbors in all of North America. The lower end of Manhattan was a prime location for the center of the new colony's economy, as its position on the Hudson River was perfectly suited for trade with both Europe and the rural parts of New Amsterdam, where trade in furs was rapidly developing. The colony "was created by trade and for trade and has never questioned its destiny" (Bank of Manhattan Company 1915: 5). The settlement was sustained by the import and export of goods traded with other colonies, Native Americans, and the Old World. As a result, New Amsterdam quickly became filled with people of diverse national origins and cultural traditions.

New Amsterdam functioned as the major center for commercial activity in the area spanning Fort Orange in Albany on the upper Hudson River to the Delaware Bay in the south. New Amsterdam's early shipping industry began circa 1610 and was largely focused on the transport of furs purchased from the Native Americans residing along the upper reaches of the Hudson River to the colony at the lower tip of Manhattan (Bank of Manhattan Company 1915). Regular shipping routes were established between Holland and New Amsterdam, which proved to be "highly profitable business ventures" as well as an excellent way to explore and document the new colony, leading to "notable discoveries" (ibid: 7).

In 1621, Dutch West India Company (WIC) was chartered to consolidate Dutch activities in the New World. In 1626, the Dutch famously purchased the Island of Manhattan from the local Native American tribe—the Munsee—for goods valuing sixty guilders. The Native Americans believed that land was for hunting and planting and did not share the European view that it could be owned in perpetuity. In exchange for furs, entrepreneurs and government officials supplied Native Americans with a wide range of goods. This municipal framework remained unchanged throughout the 17th century. In an era of speculation and opportunity, private traders converged on Manhattan after 1640, motivated by personal gain. They became dissatisfied with the WIC's administration and sought more reliable local protections. On February 2, 1653, New Amsterdam's municipal charter was officially proclaimed, establishing a city government similar in form and function to that of Amsterdam in Holland.

TRANSITION TO ENGLISH RULE

After the English conquest of New Amsterdam in 1664, the colony was renamed New York. As managed by the English, the colony began to grow as new trade networks were opened and old ones were expanded. Whereas the Dutch had primarily traded furs and other local goods from the port of New Amsterdam, the English focused on agricultural exports in the late 17th century, most notably flour (Albion 1967). An important aspect of this trade involved the transport of goods and passengers via the Hudson River between New York and the communities upriver. The colony grew steadily during the second half of the 17th century, although most of the development was concentrated at the tip of Manhattan and along the East River shoreline. In the mid-1680s, Peter Mesier constructed a house and windmill in the vicinity of Church Street between Liberty and Cortlandt Streets (Innes 1902). This was the first major development in the vicinity of the project site, although because major landfilling efforts along the Hudson River had not yet commenced, it was to the east of where the ship remnant was found.

Towards the end of the 17th century, the fur trade had diminished and with the British passage of the Bolting Act in 1678, New York obtained a "monopoly in bolting flour and in packing flour and biscuit for export" which "threw the export trade in breadstuffs into the hands of the millers and merchants of New York" (Bank of Manhattan Company 1915: 19). The number of ships in the Port of New York around that time was 18, however by 1694 that number rose to more than 160 (ibid). The increased trade brought about a similar increase in development and population in early New York. At the beginning of the 18th century, New York's expansion—fueled by the booming flour trade (ibid)—continued and the city of New York began to slowly stretch north of Wall Street, its previous boundary. This resulted in the need to transform Manhattan's naturally uneven terrain, and many hills were cut down and the resulting sediments used to fill in low-lying areas. Stabilizing the waterfront and making it more uniform became a priority at this time and landfilling along Manhattan's shoreline became increasingly common (discussed in greater detail below). This allowed for ships to come and go from the colony with greater efficiency, although the colony's maritime and trade industries remained focused on the East River.

HUDSON RIVER WATERFRONT DEVELOPMENT

Despite being less developed, the relatively few wharves and piers along the Hudson River were more important to the economy of the colony as a whole, as the Hudson was used to transport goods and people from Manhattan to the northern reaches of New York. This was especially important during the French and Indian War in the mid-18th century, when a pier at what was then the foot of Liberty Street (near what is now Greenwich Street) became "the general landing and starting place" where "enlistment soldiers, battoes[1], [and] provisions" were shipped from Manhattan to upstate New York (DeVoe 1862: 271). Because many provisions were shipped between Broadway Market (at Liberty Street and Broadway) and Fort Oswego, along the river to the north, in the early 1740s the market became known as "Oswego Market" and the docks at the foot of Liberty Street as the "Oswego Landing" (Stokes 1967). A thriving trade developed in New York, and ships left the city for the West Indies carrying "flour, corn, biscuit, timber, tuns, boards, flesh, fish, butter, and other provisions" and if they did not return to New York immediately, they would trade the West Indies goods with England and Holland (DeVoe 1862). On return trips from England, the holds of these vessels would be filled with coal as ballast, which would then be sold in New York (ibid). Other trade routes were more local: rice was imported from South Carolina, pelts were obtained from Native Americans upstate, lumber was shipped down the Hudson River, and wheat, flour, barley, corn, and other grains were brought over from New Jersey (ibid).

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[1] *Bateaux* were shallow, flat-bottomed transport vessels that were largely used on "rivers, bays, and lakes" although "the term…was also loosely applied to any rowboat" (Chapelle 1935: 54).

The Dongan Charter of 1680 had a profound effect upon the transformation of the waterfront. This charter permitted the city government to raise money by selling water, "or the right to build wharves and 'make land' out into the rivers between the low and high watermarks, a distance of 200 feet" (Cantwell and Wall 2001: 225). The Montgomery Charter of 1731 extended the range to 400 feet, well beyond the low water mark. Water lots were sold in the same manner as lots composed of solid ground, however, the new owners of these lots were charged with filling them in and with building wharves, piers, and/or bulkheads along the shore to prevent further erosion caused by the swift river currents. The construction of docks and piers at the ends of many of Manhattan's streets created slips, or landing places for ships, which were usually no more than one city block in length (Huey 1984).

CHANGES IN THE 18TH CENTURY

The British colony of New York continued to thrive through the mid- to late-18th century, although it was not as commercially successful as other American port cities, such as Boston, Charleston, and Philadelphia (Albion 1967). New York was a major trading location for British merchants across the ocean and it was the entry point and destination for many ships passing back and forth between the New and Old Worlds. Trade along the Hudson River began to increase during this time. Many ships traveling through the Port of New York in the 18th century were outfitted with guns and other arms as protection from a combination of dangers brought about by the circumstances of mid-18th century British wars. Most notable of these was the French and Indian War, which lasted from approximately 1754 to 1763, during which time the British fought an army of Frenchmen and Native Americans for control of North American colonies (Chappelle 1935). Throughout the 18th century, pirates and privateers were a common problem in the Port of New York, which combined with the on-going wars with the French and local Native Americans, made the harbor a dangerous place, forcing many of the ships passing through the area to carry weapons (Chappelle 1935 and Albion 1967).

By the late 18th century, the majority of New York's trade was conducted with the West Indies, although significant trade also occurred with Great Britain, other parts of Europe, and Africa (Albion 1967). The East River waterfront, already expanded through the addition of landfill, docks, wharves, and piers, was lined with shipyards. However, "little shipbuilding was done" and the New York City shipbuilding industry in the 18th century was considered to be "in a backward condition" relative to other colonies (Bank of Manhattan Company 1915: 30). During the 17th and 18th centuries, Philadelphia remained America's center of shipbuilding, with Philadelphia-built ships being sold all over the world, including to merchants in Europe and the West Indies and presumably to other colonies in North America (Gillingham, Bland, and Wilsonn 1932).

THE REVOLUTIONARY WAR

Tensions between American colonists and the British crown grew in the late-18th century. The colonists had grown increasingly independent from British commerce and were dissatisfied by what they viewed as oppressive taxation on the part of the British government. In 1776, the American colonists declared their independence from the British crown and the Revolutionary War ensued, with New York remaining a British stronghold until the war's end in 1783. During the course of the war, the British army occupied much of Manhattan and therefore many of its residents chose to flee the city rather than live alongside the army that had commandeered a large amount of personal property. Those that remained were loyal to the King of England, and the city became "the center of the British authority in America and there was much official business as well as lively Tory privateering" (Albion 1967: 6). The British military complex known as Fort George was located just a few blocks south of where the ship remnant was found.

During the course of the war, New York City's maritime industries suffered, with "her commerce and shipping…almost completely destroyed even to her fishing fleets" (Bank of Manhattan Company 1915: 32). The loss of trade with the British West Indies after the War ended also crippled the Port of New York (ibid). It was not until after the end of the War of 1812, that American commerce—the Port of New York in particular—surged and trade networks expanded, with the newly formed country opening up new trade routes and reestablishing itself in international trade. While the wars had disturbed New York's maritime industry more than many other cities, within a few years of the conflict's end, the city's shipping networks were reformed (Albion 1967). Americans developed new appetites for imports such as tea and porcelain. By the 1790s, merchants had established far-reaching networks for both domestic and foreign trade—reaching as far as China by the 1780s—and aided by a disruption of European trade caused by Old World wars (ibid). The East River waterfront maintained a prominent role in the shipping industry until the early-19th century, when the advent of steam-powered ships forced the focus of New York's trade economy to shift to the deeper waters of the Hudson River.

COASTLINE CHANGES IN THE 19TH CENTURY

Between 1815 and 1860, the waterfront in New York City was intensively developed, resulting in a surge of growth in the city's maritime and shipping industries and making it the most successful port in the country (Albion 1967). The opening of the Erie Canal in 1825 and the development of packet services to distant American and European ports led to expanded reciprocal trade between local merchants, the rest of the country, and the rest of the world. In the years preceding the American Civil War in the mid-19th century, "New York City handled two-thirds of America's imports, and dominated exports and passenger trade" (Novek 1992:24). This in turn attracted merchants to the waterfront areas, resulting in the establishment of one of the nation's most important commercial and shipping districts along the waterfront in Lower Manhattan.

As such, during the first half of the 19th century, significant efforts were made to fill in shallower waters and to construct new, more modern wharves and piers out into deeper waters. This was particularly true of the Hudson River, as New York's shipping industries had been re-focused there in part because technologically advanced steam ships were now too large for the East River piers. Steamships took over the lucrative fine cargo and passenger businesses which soon moved to the west side of Manhattan, as well. Throughout the late-19th and 20th centuries, the Hudson River was lined with piers and wharves. As the residential areas of the city had been slowly spreading northward during the mid- and late 19th century, Lower Manhattan remained the focus of New York's commercial endeavors.

The success of the waterfront and other business enterprises in the late 19th and early 20th centuries therefore helped to transform Lower Manhattan and the New York waterfront into a center of global trade and commerce. During the mid-20th century, the continued success and growth led to the replacement of smaller commercial and industrial institutions with large-scale developments to house business and financial enterprises, such as the World Trade Center and the Deutsche Bank Building, which were constructed on the VSC project site in the 1960s and 1970s. While the role of shipping and maritime trade in New York's economy has diminished somewhat in favor of finance and business, the commercial success of the modern Port of New York would not have been possible without the early development of the New York waterfront.

B. DEVELOPMENT OF THE PROJECT SITE

Before landfilling activities, the Hudson River shoreline ran to the east of the line of modern Greenwich Street, one block to the east of where the WTC Ship was discovered (see **Figure 3-1**). Landfilling along the Hudson River in the vicinity of the project site began at the turn of the 18th century and continued through the early 19th century (see **Figure 3-2**). By 1818, the entire VSC project site was composed of artificially constructed land.

Water lots along Greenwich Street in the vicinity of the VSC Site were granted to individual citizens in the late 17th and early 18th century. Soon after they were granted, the water lots were filled by “individuals with disparate interests [who] broadened their local residential and commercial holdings” through the creation of land (Buttenweiser 1987: 32). Those individuals included “John Rodman, dock owner, John Hutchins, proprietor of the Coffee House Hotel, and William Huddleston, founder of the Trinity School [who] added some fill and rudimentary docks” along the shoreline in the vicinity of the project site (ibid: 32). Huddleston and Rodman appear to have constructed slips at the ends of Liberty Street (called Crown Street until 1794) and Cedar Street (called Little Queen Street until 1794) near the low water mark (then located near Greenwich Street) by circa 1701 (Leake Papers 1826).

Peter Meiser—the previously mentioned windmill operator—was among a group of individuals that was granted water lots along the Hudson River in the vicinity of modern Block 54 at that time (Buttenweiser 1987). A map of early water lot maps published by the Department of Docks in 1873 depicts two water lot grants in the vicinity of the VSC Site: P.J. Messer’s (sic) 1699 land grant in the vicinity of modern Greenwich Street north of Liberty Street and an undated grant to William Huddleston covering the land between the high and low water marks south of what is now Liberty Street, covering a portion of modern Greenwich Street and a the northeast corner of what is now Block 54.

Historic conveyance records on file at the Manhattan Office of the City Register, New York City Department of Finance (see **Table 3-1**), show that deeds were recorded in 1704 and 1709 in which John Hutchins transferred property to Nicholas Bayard and John Burrow in three separate transactions (Liber 25, Page 198; Liber 25, Page 225; and Liber 26, Page 359). Bayard’s land—which extended as far west as the low water mark, then situated just west of what is now Greenwich Street (Liber 26, Page 359)—was eventually transferred to John Ellison, who is one of the first individuals to be associated with the development of the VSC Site, as discussed in greater detail below.

18TH CENTURY DEVELOPMENT TO THE EAST OF THE SITE: ELLISON’S DOCK AND THURMAN’S SLIP

John Ellison was an Englishman who came to America in 1688 (Ruttenber and Clark 1881). Some sources identify Ellison as a shipjoiner (Minutes of the Common Council [MCC] 1674-1776 VIII: 286) and others, including all conveyance records associated with him, as a sailmaker. However after his purchase of land along the Hudson River in the first years of the 1700s and the subsequent construction of a dock and store at the foot of Cedar Street, Ellison established himself as a merchant (Ruttenber and Clark 1881). It appears that Ellison took possession of property in the area circa 1702, although the deed confirming the transaction appears to have been recorded several years later. At that time, his land was in the vicinity of two slips, one each at the western ends of Liberty and Cedar Streets (Leake Papers 1826 and Liber 26, Page 359). Ellison had sloops built and soon established regular business trading with European settlers and Native Americans along the Hudson River, eventually leading to a regular shipping route running between his dock at the foot of Cedar Street and his son, Thomas Ellison’s property in New Windsor, New York (Ruttenber and Clark 1881).

Table 3-1
Early Conveyance Records for the VSC Site

Date	Date Recorded	Grantor	Grantee	Liber	Page	Location/ Remarks
-----	May 31, 1704	John Hutchins	Nicholas Bayard	25	198	Block 54, Not Lotted
-----	September 5, 1704	John Hutchins	John Burrow	25	225	Block 54, Not Lotted
June 22, 1703	September 14, 1709	John Hutchins* Nicholas Bayard*	Nicholas Bayard John Ellison	26	359	Block 54, Not Lotted; Assignment of Mortgage
-----	December 29, 1740	The City of New York	Petrus Rutgers	Water Lot Grant	-----	Block 54, part of north half
-----	December 29, 1742	The City of New York	Petrus Rutgers	Water Lot Grant	-----	Block 54, part of north half
-----	June 8, 1775	The City of New York	Adrian Rutgers	Water Lot Grant	----	Block 54, part of north half
March 26, 1763	April 11, 1763	John and Rachel Ellison	Robert Leake	36	311	Block 54, Lots 1 to 15 and 19
-----	August 1, 1763	The City of New York	Robert Leake	Water Lot Grant	----	Block 54, south half
July 4, 1775	June 28, 1787	Adrian Rutgers, Richard and Ann Sharpe, John M. and Helena Scott, and Benjamin Kissam	George Lindsay	44	279	Block 54, Lots 15 to 18¾
-----	February 10, 1804	The City of New York	George Lindsay	Water Lot Grant	----	Block 56, north half
-----	February 10, 1804	The City of New York	Bernardus Swartwout	Water Lot Grant	----	Block 56, south half
March 21, 1807	April 29, 1807	George and Elizabeth Lindsay	Alexander Campbell	76	158	Block 56, Lots 22 to 28
April 19, 1805	March 28, 1810	Bernardus Jr. and Mary Swartwout	Andrew Morrell	86	349	Block 56, Lots 15 to 21½
December 5, 1809	March 28, 1810	Andrew Morrell (Adms of)	William Ogden and John R. Murray	86	352	Block 56, Lots 16 to 21½
November 7, 1809	March 28, 1810	Alexander Campbell (exrs. and trus. of)	William Ogden and John R. Murray	86	357	Block 56, Lots 22 to 28

Notes: *Both sets of names are included within this conveyance in the index on file at the Manhattan Office of the City Register, however the original record does not appear to mention John Ellison.
Sources: Conveyance Libers on file at the Manhattan Office of the City Register, New York City Department of Finance.

A map of Manhattan created by James Lyne in 1730 (see **Figure 3-3**) identifies the pier at what was then the foot of Cedar Street as "Ellison's Dock." This dock was located to the east of where the WTC Ship was found at the approximate location of Greenwich Street, which had not yet been established. The dock was one of only four in the area and was located between two slips. The 1730 Lyne map shows that these piers stretched from the Hudson River shoreline in the vicinity of modern Cortlandt, Liberty, Cedar, and Thames Streets. In fact, Liberty, Cedar, and Thames Streets were the only streets in the area that stretched as far west as what was then the shore. The circa 1732 to 1735 map of New York drawn by an anonymous cartographer (sometimes referred to as "Mrs. Buchnerd's Plan," reproduced in Stokes 1967 and Augustyn and Cohen 1997) reverses the names of the adjacent Ellison's and Comfort's Wharves, suggesting that the latter was at the foot of Cedar Street, however this is inconsistent with other maps and documentary sources (Stokes 1967). That map does, however, label the shore of the Hudson River in the vicinity of the project site as a "fishing place."

The slip to the north of Ellison's dock between Liberty and Cortlandt Streets was known as Thurman's Slip (Stokes 1967). The slip was named for John Thurman, a wealthy baker who owned a great deal of property on Liberty Street in the area (DeVoe 1862). Thurman had been granted water lots in front of his property on Liberty Street to the north of the "Crown Street Slip"[1] (and therefore outside of the project site) and in 1735 requested another in order to build a market in the vicinity (ibid). In 1740 and 1742, the water lots making up what is now the northern half of Block 54 were granted to Petrus Rutgers, and it is assumed that the portion of the VSC Site south of Liberty Street was included within the slip until that time. Rutgers was among the individuals who signed a petition requesting the establishment of a market near Thurman's Slip, so he appears to have been living in the area before his water lot was granted (ibid).

The market was established to provide a landing place for the "great numbers of farmers and other persons from the Jersey side and up the North River…[who] frequently land (with their grain and other provisions for the market) at Thurman's Slip, which is a very convenient landing" (DeVoe 1862: 260). Thurman's Slip was "a great landing place for many years…for the market-boats of all sizes and on their arrival a great deal of trading in wood, provisions, &c. was transacted, which in a measure made it a market-place, although no market house was built, nor was it recognized by law" (ibid: 261). The slip formed between Ellison's and Comfort's Wharves, in the vicinity of modern Cedar and Thames Streets near Greenwich Street, was used mostly for the importation of hay and produce from the Hudson River Valley for sale in the market (Dunshee 1952).

The 1813 map created by David Grimm (reproduced in Stokes 1967 and Augustyn and Cohen 1997), drawn to reflect the mapmaker's memories of New York City between circa 1742 and 1744, depicts what was presumably Ellison's Dock on the shores of the Hudson River between Liberty and Cedar Streets. The dock was developed with two unidentified structures and a small slip was present along its northern side, at the foot of Cedar Street. This location was mentioned in the journal of Isaac Norris, who boarded a ship to Albany from Ellison's Dock in 1745 (Norris 1867). Interestingly, another pier called "Ellison's Wharf" is also depicted on the 1730 Lyne plan along the East River to the west of Beekman Street.

The circa 1755 map created by Francis Maerschlack depicts projected landfilling in the vicinity of the project site in addition to that which had already been completed by the time the map was created. It is the first map to depict the approximate lines of the future Greenwich, Washington, and West Streets, the construction of which was first proposed by the 1730 Montgomery Charter, but was not actually completed until many decades later. One of the first references to landfilling in this area was made in the *Minutes of the Common Council* in 1760, at which time the council granted permission for a stone wall to be constructed across the "Crown Street Slip," presumably for the purposes of filling it in (MCC 1674-1776 VI: 228).

The house, lot, wharf, and a water lot located on the North River and belonging to John Ellison were advertised for sale in the *New York Gazette and Weekly Post Boy* in July 1752. In March 1762, the New York Mercury advertised the sale of a home and lot (measuring 91 by 69.5 feet) at the foot of Liberty Street, fronting the slip as well as all the water lots associated with it. At that time, the home was occupied by a man named John Ellis and advertised as being "convenient for a baker, bolter, merchant, or tavern keeper."[2] One month later, the Common Council warned John Ellison, the grandson of the

[1] Few references using the name "Crown Street Slip" were identified through documentary research, dating to 1735 (DeVoe 1862), 1760 (MCC 1674-1776 VI: 228), and 1793 (MCC 1784-1831 II: 29 and 55). The name therefore appears to have been generically applied to the slip located at the foot of Crown Street at any given time and may not refer to one location in particular.

[2] While it is not clear if John Ellis and John Ellison were one and the same, it appears that the two surnames may have been used interchangeably. An advertisement from the *New York Gazette and Weekly Post-Boy* in September 1751 noted that Jonathan Higgins maintained a timber yard at "John Ellis's Slip." An advertisement from the same paper in August 1753 referenced Higgins again as the seller of a lot on Cedar Street "next to that of John Ellison."

previously mentioned John Ellison, a sailmaker who owned a home and lot of ground on the Hudson River, that unless he requested a water lot grant from the council in front of his home, it would be offered for public sale (MCC 1674-1776 VI: 289). Ellison was granted the lot one month later in June 1762 (MCC 1674-1776 VI: 292-293). In March 1763, the *Mercury* again ran an advertisement for the sale of Ellison's home, this time noting that the water lot was "sufficient for any small vessel to lye [sic] by the house."

Ellison's Dock also may have gone by the name, "Ellis's Slip." Advertisements published in the *New York Gazette* in August 1761 described a home for sale on Cedar Street near the Hudson River, fronting on Ellis's Slip. A *New York Gazette* advertisement from 1775 may refer to the pier as "Elliot's Slip." The *Minutes of the Common Council* note that in August 1788, a bulkhead was constructed across "Cortlandt and Ellis's Slips" (Stokes 1967). It is presumed that Cortlandt Slip was at the foot of Cortlandt Street, one block to the north of Liberty Street and the possible location of Ellis's Slip. As mentioned above, the Common Council Minutes note that in 1769, "Lambert Losie etc." were paid for "removing a wreck out of Ellises [sic] Slip" (MCC 1674-1776 VII: 157).

All references to Ellis's Slip may not refer to the VSC project location, however, as Samuel Ellis—for whom Ellis Island was named—also owned waterfront property on the Hudson River in the vicinity of Vesey and Barclay Streets. An advertisement in the *New York Packet* from 1785 announced Ellis' sale of Ellis Island, then known as Oyster Island, as well as a lot of ground "at the lower end of Queen Street, joining Lake's Wharf." Leake's wharf (discussed in greater detail below) was located along Cedar Street, so it is possible that this advertisement actually meant "Little Queen," the historic name of Cedar Street, rather than "Queen Street."

LEAKE'S WHARF AND THE BEGINNINGS OF CEDAR STREET

In 1763, John Ellison—the grandson of the previously mentioned John Ellison—and his wife leased a parcel of land on the Hudson River to the north of the slip at the foot of Cedar Street to a man named Robert Leake, presumably the very land that Ellison was trying to sell the year before (Leake Papers 1826). The original conveyance transferring the property to Leake describes the land, for which Leake paid a total of £1,050, as being "at the lower end of a street formerly called Ellison's Dock, now Little Queen Street" and indicates that the grant covered the southern half of what is now Block 54 (Liber 36, Page 311). To the north of this property was land owned by Petrus Rutgers' widow (ibid). The grant included all "buildings, stables, gardens, yards, [illegible] docks, wharfs [sic], ways, and water courses" associated with the property (Liber 36, Page 311). That same year, the colonial government granted a water lot to Robert Leake that was located near Ellison's Slip near Cedar Street (Leake Papers 1826).

Robert Leake (also spelled Leck or Lake) served as the British Commissary General for North America and moved to the city after the end of the French and Indian War (De Peyster 1888). Leake was a decorated military veteran who allegedly wore a silver plate on his head to cover a battle wound and who walked with a permanent limp as a result of a second wartime injury (*The New York Sun* 1882). Robert Leake died in November 1773, although during the decade in which he lived in New York City, he acquired a great deal of real estate (DePeyster 1888). At the time of his death, Leake owned a home on what is now Nassau Street, as well as "houses, storehouses, offices, and stables in the city; a farm at Belvue; two farms in New Jersey; an estate at Bidlington, in the county of Durham, England; lands at Pittstown, Albany County/a farm at Claverack; lands on the Mowhawk River; part of a tract in Tryon County; a right to lands in East Florida; and money in the Bank of England" (*The New York Sun* 1882: 5).

Leake appears to have played a part in the development of the waterfront in the vicinity of the project site during his ownership of the land. The map published by Bernard Ratzer in 1776 to depict Manhattan as it appeared circa 1766[1] shows that Liberty Street had been filled out to a point midway between modern Greenwich and Washington Streets, where it ended in a small slip bounded on the north and south by piers that stretched further out into the Hudson River (see **Figure 3-4**). Ratzer's map shows that Liberty Street had been filled out to a point midway between modern Greenwich and Washington Streets, where it ended in a small slip bounded on the north and south by piers that stretched further out into the Hudson River. It is not clear if this map reflects the construction of the stone wall that was ordered across the slip at the foot of Liberty Street by the Common Council in 1760.

The Ratzer map also indicates that Cedar Street was at that time filled out to a point just west of Greenwich Street, while an L-shaped pier just north of the line of Cedar Street extended into the river west of Washington Street. The new pier was in the location of the former Ellison's Wharf, however, while it is not known if it was constructed by Leake or Ellison, it was publicly known as "Commissary Leake's Dock." Perhaps coincidentally, the location where the WTC Ship was found appears to be aligned with the northern extension of the L-shaped dock. Leake owned stores near the wharf at the foot of Cedar Street, which may be depicted on some versions of the Ratzer map (*New York Gazette* 1772). Similar maps were created by French cartographer John Montresor in 1766 and 1775, although they do not appear to be as accurate as the Ratzer maps. The Montresor maps do not depict Leake's L-shaped wharf, although they do show that wharves were present in the area and that the shoreline in the vicinity of Liberty and Cedar Streets was one of the most developed sections of the Hudson River waterfront at that time.

After Robert Leake's death in 1773, his estate was inherited by his oldest son and heir, John George Leake. It has been suggested that Leake moved to New York from England after his father's death (Richardson 1846 and DePeyster 1888). However, it appears that Leake was already living in New York at the time of his father's passing and possibly arrived as early as 1767, when Robert Leake sent a letter to his sons John G. and Robert M. Leake regarding their upcoming journey to New York in which the father advised his sons to "behave on board ship that they may have nothing ill to say of you" (Leake 1767). John Leake appears to have been residing in a house on Chapel Street in 1771, although at least one other individual named John Leake also resided in New York around this time (*New York Mercury* 1771). A letter written to his brother Major Robert W. Leake in December 1773, suggests that John G. Leake was with his father when he died, after an "apoplectic…marched him into eternity" and in just "three hours transferred him from health to death" (Leake 1773).

While he had trained as a lawyer under James Duane, who was at one time Mayor of New York, John G. Leake's inheritance allowed him to spend his time managing his inherited estate rather than practicing law (*The New York Sun* 1886). During Leake's ownership in the years leading up to the American Revolution, the commercial importance of the docks in the vicinity of Leake's began to grow. His extensive land holdings and valuable waterfront property therefore allowed John G. Leake to amass a large fortune (Richardson 1846). A drawing of Lower Manhattan published in *The Atlantic Neptune* circa 1773 and reproduced in I.N.P. Stokes *Iconography of Manhattan Island* (originally published between 1915 and 1928) depicts the shoreline in the vicinity of the VSC Site, although it was drawn with a significant amount of artistic freedom. The image shows at least three neat wooden docks projecting into the Hudson River from the area near the VSC Site. While the drawing does not match the cartographic

[1] Numerous versions of this map exist, including one commonly referred to as the "Ratzen" map as a result of a spelling error on the original document.

record, it does give an impression of what the Hudson River waterfront was like at the time, with small and large ships alike traveling up the river and docking in the slips lining the shore.

LINDSAY'S WHARF AND THE BEGINNINGS OF LIBERTY STREET

As mentioned previously, conveyance records show that the northern half of modern Block 54—between Liberty and Cedar Streets—was granted to Petrus Rutgers, a prominent citizen of early New York, in 1740 and 1742. An ailing Rutgers prepared his will in 1745 and appears to have died shortly thereafter (New York Historical Society 1896). The property was inherited by his widow, Helena, but the extent to which it was developed during the mid-18th century is unclear. An advertisement published in the *New York Mercury* on January 14, 1754 promoted the sale of a portion of Rutgers' estate including two houses and lots with an adjacent wharf on the shore of the North River near "Oswego Street," another historic name for Liberty Street. If this was the property on the east half of the VSC Site, it does not appear to have been sold at this time (see Table 3-1).

A second advertisement for the sale of the Rutgers property near Liberty Street was published in the *New York Gazette* on January 10, 1774. At that time, three houses and lots, one vacant lot, a wharf, and a water lot on the North River near Thurman's market were offered for sale by Petrus Rutgers' son and sons-in-law, Adrian Rutgers, Richard Sharpe, John M. Scott, and Benjamin Kissam. The land was purchased by George Lindsay, an eminent stone-cutter who had emigrated from Scotland and was active in the Scotch Presbyterian Church on Cedar Street as well as in city government (MacBean 1922). In 1769, Lindsay created the first set of milestones for the city, which lined Broadway and indicated the distance from City Hall (Stokes 1967). An advertisement in the *New York Mercury* in August 1766 described the stone-cutting business of "Lindsay and Sharp" at the foot of Ellis's Slip, confirming Lindsay's presence in the vicinity of the project site long before he purchased land.

Lindsay purchased the property from Petrus Rutgers' heirs on July 4, 1775, however the deed confirming the sale was not recorded until 1787. The 12-year delay was likely the result of Lindsay's flight from New York City during the Revolutionary War, although it is not known where he went during that time (MacBean 1922). The conveyance record (Liber 44, Page 279) shows that Lindsay paid £400 for the property. The land was described in the conveyance record as being bounded to the southeast by a 40 foot-wide street (presumably an early incarnation of Greenwich Street), to the south by the wharf and water lot of Robert Leake, to the northeast by a 15-foot pier "now partly erected and soon after to be erected and built the whole length of the premises." This would suggest that Rutgers and his heirs never constructed a substantial pier near the foot of Liberty Street and that Lindsay was expected to continue the construction of the wharf. The circa 1755 Maerschalk map appears to confirm this, depicting far less development in the vicinity of the Rutgers property than was seen on Thurman's Dock to the north and Ellison's Dock to the south.

The deed stipulated that the pier to be completed by Lindsay should be extended to a distance 200 feet west of the low water mark, which was the same length as Leake's wharf to the south. This construction would have brought the wharf out past the approximate location of modern Washington Street. A small dock is depicted in this area on the 1776 Ratzer map (depicting the city circa 1766-1767), but the pier appears to be less substantial than those in the surrounding area, particularly Leake's Wharf. The expanded dock is depicted on the 1797 Taylor-Roberts map, which indicates that Lindsay's Wharf extended into the Hudson River west of Washington Street and that a small slip was present to the north, at the foot of Liberty Street.

CESSATION OF DEVELOPMENT DURING THE REVOLUTIONARY WAR

Landfilling efforts in the vicinity of the project site appear to have been slowed, if not entirely halted, during the Revolutionary War. It is unclear if Lindsay's Wharf was completed in the year between his purchase of the land and the start of the war or if work began again upon his return to the city circa 1784. John G. Leake, whose brother was a Major in the British army and who was likely a Loyalist, appears to have remained in the city throughout the course of the war. However, his loyalties to the British government do not appear to have been sufficiently strong that his land was confiscated during or after the war, as was his brother's property (DePeyser 1888).

The development of the project site during the time of the war is unclear. Two maps published circa 1782, the John Hills and British Headquarters Maps, depict the project site in a different manner. The 1782 Hills map depicts a block of wharves and piers extending west into the Hudson River from the approximate location of Greenwich Street, with a narrow slip near the foot of Liberty Street. This is somewhat similar to that seen on some versions of the 1776 Ratzer map and the 1776 map prepared by Samuel Holland, which is far less detailed. The circa 1782 British Headquarters map (and the 1900 facsimile of that map prepared by B.F. Stevens) depicts a uniform, rectangular block of wharves with several structures and no slip.

The changes to the wharves in the vicinity of the project site may have occurred as a result of a massive fire that swept through Lower Manhattan in 1776. A matter of weeks after British troops occupied New York in September 1776, a fire broke out at a tavern near Whitehall Slip, to the south of the project site (Schecter 2002). The fire raged through the city, destroying hundreds of buildings and inspiring looting throughout the city (ibid). An annotated version of the 1776 "Ratzen" map on file at the New York Public Library includes red shading to depict those areas that were affected by the fire. The block to the east of the VSC Site and a structure built on the wharf near the foot of Cedar Street, presumably Robert Leake's store, are all identified as having burned. It is therefore possible that there was some damage to the adjacent wharves as well, resulting in a need to rebuild or expand portions of the docks between the fire in 1776 and the creation of the maps in 1782.[1] However, it may simply just be the result of inaccurate cartography.

The fire caused a housing crisis, as displaced residents and incoming British troops alike had nowhere to stay (Schecter 2002). It is possible that Lindsay's property, which he vacated, was occupied by British troops at this time. The state of Leake's property in the project site during the Revolution is unknown. British troops likely maintained a significant presence in the area as the King's Wharf, where the arsenal and royal storehouses were located, was just two blocks to the north of the project site between Cortlandt and Fulton Streets (Dawson 1904). The ferry to Powle's Hook (Paulus Hook), a key link between Manhattan and New Jersey, was also near the foot of Cortlandt Street (ibid). The 1782 British Headquarters map depicts a battery in that area as well.

POST-WAR GROWTH

Following the war, as many British loyalists fled the city and American refugees began to return, the development of the Hudson River waterfront began to increase once again. In a span of less than 40 years following the end of the war, the VSC Site would be entirely filled, suggesting that developable land was being created along the waterfront at a rapid pace. The filling in of Block 56 represents the last phase of

[1] No traces of burned timbers or the burned remnants of landfill retaining structures were observed during the archaeological monitoring at the VSC site and dendrochronological analysis of some of the timbers making up the landfill retaining structures appear to pre-date the fire.

landfilling to affect the project site, and also the incorporation of the ship remnant into the adjacent land. Four individuals were involved in creating this landfill: George Lindsay, who owned the north half of Block 56, and John G. Leake, Barnardus Swartwout, Senior, and Barnardus Swartwout, Junior, whose land holdings made up the southern half of Block 56.

LANDFILLING IN THE NORTH HALF OF BLOCK 56

In 1784, George Lindsay announced his return to the city in the *New York Packet*. The article stated that he and his new business partner Thomas Brown had established their stone-cutting business at the foot of Liberty Street on the Hudson River, on the property he had purchased from Petrus Rutgers' heirs in 1775. The Common Council's Minutes note that in 1784, "George Lindsay [prayed] that some measures may be taken relating to dock at Thurmans's Slip," suggesting that he almost immediately began to make efforts to improve the waterfront, although no additional information was given at that time (MCC 1784-1831 I: 25).

By June 1785, the partnership of Brown and Lindsay had ended (*Independent Journal* 1785), although Brown continued to operate a stone business on Little Queen Street "near the City Tavern." George Lindsay, however, continued to work and reside on the project site. In 1786, he petitioned the Common Council for assistance because he wanted to construct a new home on his Liberty Street property; however he did not know where the front of the house should be placed because the streets had not yet been laid out (Stokes 1967). This may indicate that he resided on newly constructed waterfront land.

McComb's 1789 map of Manhattan—one of the first maps of the city produced after the war—depicts some development along the waterfront in the vicinity of the project site. The map does not suggest that a pier was located at the foot of Liberty Street (then located near Washington Street) at this time, although the map may not have been based on a proper survey, and its accuracy is therefore questionable. The map is the first to depict the beginning of Washington Street in this area. However, this does not appear to be accurate, as the Common Council ordered that the slip at the foot of Liberty Street be filled out to the western side of Washington Street between the lots of George Lindsay and John G. Leake in April 1793. In August 1793, a bulkhead was ordered across the "Crown Street Slip," presumably in connection with the landfilling proposed several months earlier (MCC 1784-1831 II: 29). However, this work does not appear to have occurred immediately.

In August 1795, George Lindsay requested permission to extend his wharf further out into the North River, a request that was denied by the Common Council (MCC 1784-1831 II: 168). However, the following week, he was granted permission to sink an additional block of landfill in front of his water lot on the river (MCC 1784-1831 II: 170). In 1795, the Common Council ordered that West Street finally be constructed, although it was not actually built in the vicinity of the project site until the early-19th century.

In 1796, George Lindsay partnered with a man named George Knox, with whom he worked until Knox's death in 1804 (MacBean 1922). It is presumed that they continued to work near the project site, although an article published in December 1796 in the *Norwich Courier* details the attempted arson of the Lindsay and Knox stone cutting shed on "Washington, near Greenwich Street." Despite the fact that those two streets are parallel to each other, this may refer to the project site and indicate that Washington Street was already constructed. After Knox's death in 1804, Lindsay became business partners with a stonecutter named Alexander Campbell.

The 1797 Taylor Roberts map (see **Figure 3-5**) also depicts landfill in the area where the WTC Ship was found as well as the formal construction of Washington Street through the area. In 1797, the Common Council ordered that Washington Street be paved between the New Albany Basin (between Cedar and

Thames Streets, discussed below) and "Wilkins's Lot" (presumably the lot granted to Jacob Wilkins at the foot of Cortlandt Street in 1794), confirming that Washington Street was present by the late-1790s (MCC 1784-1831 II: 99).

The Taylor-Roberts map also shows that additional pier construction had taken place, extending the lines of Liberty and Cedar Streets further out into the Hudson River. The map shows that a small slip was located at the foot of Liberty Street (then located just west of Washington Street) and identifies Lindsay's Wharf to the south of the slip. As seen on the map, Lindsay's Wharf extended along the line of modern Liberty Street almost as far as modern West Street.

Numerous newspaper advertisements were published in the late-18th century that described some of the commercial and maritime activities that took place at the wharves at the foot of Liberty Street (see **Table 3-2**). At the end of the 18th century, the area had become a destination point for ships arriving from ports all over the world and a variety of goods were being sold from the docks on the project site. Few advertisements, however, refer to the dock at the end of Liberty Street as "Lindsay's Wharf."

In May 1799, George Lindsay ran an ad in the *Commercial Advertiser* requesting bids for "filling in with wholesome earth a dock of about 50 feet square situated at the foot of Liberty Street, N. River" (*Commercial Advertiser* 1799b). This followed an entry in the Minutes of the Common Council from April 1799 in which citizens lodged complaints about sunken (or not properly filled) lots at the slip at the foot of Liberty Street (MCC 1784-1831 II: 534). In August of that year, the city paid an unknown individual $250 for filling in the lower end of Liberty Street (MCC 1784-1831 II: 566). Although Lindsay already seems to have owned property in the area and started landfilling in the late-18th century, the water lot grant giving him custody of the location of the WTC Ship was not recorded until 1804, although such grants were often post-dated, like many other conveyances.

Table 3-2
18th Century Newspaper Advertisements Referencing Ships at Liberty Street

Date	Newspaper Name	Vessel Name	Summary of Advertisement
11/19/1795	*Daily Advertiser*	*Essex*	Ship to sail for Cowes in one week, seeking passengers; apply to the captain on board at the fork of Liberty Street.
10/27/1798	*Daily Advertiser*	*Two Friends* (American) *Triton* (Swedish Brig)	Lisbon and St. Ubes salt being sold from these two ships at the bottom of Liberty Street
2/2/1799	*Mercantile Advertiser*	*Franklin*	Ship arrived from Hamburg, E. Brush selling gin, lead, and German goods at the Liberty Street Wharf
11/7/1799	*Commercial Advertiser*	*The Sea-Horse*	Pilot-boat built Schooner, 8 months old for sale; armed with six guns, 2 twelve pound carronades, and small arms; laying at the Liberty Street wharf

The 1803 Mangin-Goerck map, which depicts both the existing conditions and proposed landfilling, depicts the project site in a similar manner as the 1797 Taylor-Roberts plan, although it suggests that the small slip at the foot of Liberty Street had been filled in by that time. The 1808 Longworth map depicts a large wharf called the "Liberty Street Dock" north of the foot of Liberty Street and a smaller unnamed dock projecting from the center of the block from the landfilled section west of Washington Street that is depicted on several earlier maps. As seen on that map, Block 56 was filled in almost halfway, while the unnamed pier likely extended as far as what would later become West Street, although the map's lack of accuracy makes this difficult to confirm. In 1804, the Common Council ordered additional distance between the lines of West and Washington Streets, increasing the distance between the two roads from 160 feet to 200 feet (MCC 1784-1831 II: 612).

In 1807, Lindsay sold the northern half of Block 56 to his business partner, Alexander Campbell for a sum of $12,500 (Liber 76, Page 158). George Lindsay does not appear to have had any further involvement with the project site or its development, and he died in 1826 at age 84 (MacBean 1922). Upon Campbell's death in 1809, the property was sold again. An advertisement in the *New York Commercial Advertiser* in November 1809 described the property as being bounded by Liberty Street to the north, Washington Street to the east, West Street to the west, and the property of Andrew Morrell to the south (discussed in greater detail below). The advertisement notes that Campbell's property, which made up the northern half of the block as well as water lots and wharfs to the west, had been surveyed and divided into 8 lots. In 1809, the land was sold by Campbell's estate to William Ogden and John R. Murray, who were business partners and brothers-in-law who were associated with the firm John Murray and Sons (Wilson 1948). Murray and Ogden had acquired the southern half of the block around the same time, as discussed below.

The conveyance record confirming the sale of the land to Ogden and Murray (Liber 86, Page 357) describes the property as "land and soil under water to be made land and gained out of the Hudson River," confirming that only the eastern portion of Block 56—including the location of the WTC Ship—was filled by this time. In 1811, the city declared the lower end of Liberty Street a nuisance because of the stagnant water that pooled there and they ordered a drain or gutter to be constructed from the intersection of Washington and Liberty Streets out to the river to divert excess water (MCC 1784-1831 VI: 628). It doesn't appear that the block was fully filled until circa 1817, the first year that the city collected taxes on the property (HPI 2003).

A survey of Block 56 was completed by City Surveyors Bridges and Poppleton in 1818 and published circa 1821, and is filed as Map 79 in the City Register's Office (see **Figure 3-6**). This map may have been prepared in anticipation of the division and sale of the lots making up the block in 1818 (*New York Daily Advertiser* 1818). As described by the Daily Advertiser, the sale included:

> *17 valuable lots of ground between Washington, West, Liberty, and Cedar Street…with the exception of one lot in the corner of Cedar and Washington Streets. On the premises there is now a valuable brick store, now in the possession of Messrs. John Murray & Sons, with other buildings.*

The map appears to depict both lot divisions, early structures, and the outlines of former wharves, including the unnamed wharf that was seen projecting from the center of the block in the 1808 Longworth map. Two buildings are depicted on the project site on that map: a small L-shaped structure at the southwest corner of Liberty and Washington Streets (on a property identified as "Lot 1"), and a large rectangular structure fronting on Liberty Street to the west of and perpendicular to the aforementioned unnamed wharf in the block's center. The former structure is identified as a shop in tax records from the early 1820s and the latter structure is described as a stable (HPI 2003).

In the years that followed the completion of this survey, Ogden and Murray appear to have gone bankrupt, and the Mechanics Bank sold the lots on Block 56 to various individuals in the late 1810s and early 1820s. The names of the individuals who purchased the lots are handwritten on the Bridges and Poppleton map, although no names are present on the lots on the western side of the site, suggesting that they were not yet settled enough to develop or sell.

LANDFILLING IN THE SOUTH HALF OF BLOCK 56

As discussed previously, John G. Leake owned a large wharf that extended into the Hudson River from the foot of what is now Cedar Street. However, Leake's Wharf appears to have occupied the streetbed only, and the south half of Block 56 was included within a water lot granted to Barnardus Swartwout in a conveyance dated 1804, but which was likely granted much earlier, and must have pre-dated Barnardus

Swartwout, Senior's death in 1794. Swartwout and his son were lumber and shipping merchants (Bayles 1859). The Swartwout family was living in New York City in 1761, when Barnardus Junior was born, although the family fled to Wappinger Creek, near Poughkeepsie in Dutchess County, New York after the British occupied New York City in 1776 (ibid). Both Swartwout and his son fought for the American army during the Revolutionary War, with Barnardus Senior rising to the rank of Captain and his son, who was only a teenager at the start of the war, to the rank of Ensign (Leggett 1865). A journal kept by Barnardus Junior during the war is now on file at the New York Historical Society. In a letter to his father after his enlistment, Barnardus Junior summed up his feelings by saying, "the regiment is for the trenches, and drums are bearing to arms so that I must leave you and take up my sword" (Swartwout 1781).

The family returned to New York City after the war, and the Messrs. Swartwout founded their business (Bayles 1859). In addition to their lumber and shipping enterprises, they also maintained a grocery store on Cedar Street near Leake's Wharf, which they opened in 1784 (*New York Packet* 1784b). Their firm, Swartwout & Son, owned many parcels of land along the Hudson River, the largest of which was immediately to the south of the project site south of Cedar Street.

The Swartwouts seem to have developed a business relationship with their Loyalist neighbor John G. Leake. While the nature of their involvement is unclear, Barnardus Swartwout, Junior and John G. Leake were both involved in the establishment of the New Albany Basin to the south of the project site (see below) and it appears that Leake loaned Swartwout money on more than one occasion. In 1796, Swartwout had assigned a mortgage to a group of individuals purchasing a tract of land in Clinton County, New York, which he then transferred to John G. Leake to cover a "large debt" (Caines 1805). Upon Leake's death in 1827, inventories of his estate[1] show that Barnardus Junior owed him money associated with the purchase of a different tract of land in Tarrytown, Westchester County, New York (Leake Papers 1827). In addition, Steuben Swartwout, Barnardus Junior's son, was also granted a mortgage by Leake in 1826 for the house and lot at 92 Cedar Street, which appears to have been east of Washington Street (Leake Papers 1827).

By 1786, shortly after the war, a "large" lumber yard was located on Leake's Wharf. That year, the *New York Packet* ran an advertisement seeking a new lessee. Subsequent documents suggest that the Messrs. Swartwout took control of the yard. In 1787, the Swartwouts asked the Common Council to grant them additional water lots in front of their property on the river, and although a more specific location is not given (MCC 1784-1831 I: 308). Barnardus Swartwout Junior would apply for additional water lots as far out as West Street in 1797, although once again, the exact location is not given in the council's records (MCC 1784-1831 II: 375).

The 1789 McComb map depicts only a small wharf in the vicinity of Leake's property on Cedar Street and a second small wharf is depicted near the Swartwout property at the foot of Thames Street. However, in February 1790, the *New York Daily Gazette* advertised the sale of lots at the foot of Cedar Street fronting on "the slip" to the west and Greenwich Street on the east, suggesting either that less landfilling had occurred or that Washington Street was not yet constructed and therefore not used as a landmark.

In 1791, a bulkhead was proposed across the slip at the foot of Cedar Street between Leake's Wharf and that of Barnardus Swartwout, to the south of the project site. According to the *Daily Gazette*, the bulkhead was to be 230 feet long, 10 feet wide at the bottom and 7 feet wide at the top, and with a "square-hawed"

[1] Leake died intestate and childless in 1827, and after his estate was escheated to the State of New York and used to found the Leake and Watts Orphan Asylum, a long battle over his estate ensued. As a result, the Leake Papers in the collection of the New York Historical Society contain numerous manuscripts describing his personal and real estate holdings.

front (1791). In 1792, both Leake and Swartwout were given permission to extend their piers out further into the river (MCC 1784-1831 VI: 702).

The efforts made by Leake and the Swartwouts in the early 1790s were influential in the establishment of the New Albany Basin, a large commercial slip and market place to the south of the project site. Leake's Wharf made up the northern edge of the basin, and Swartwout's Wharf at the foot of Thames Street formed its southern side. The basin was named after the original Albany Basin, which had been located at the tip of Manhattan earlier in the colony's history. The piers of the new basin were constructed between 1791 and 1796 (Stokes 1967). In 1793, the Common Council formally declared this area to be a good location for such a basin, and it was originally intended for the trade of bricks, lime, and hay (MCC 1784-1831 II: 13).

The New Albany Basin was a successful endeavor, and it attracted ship traffic and merchants, who began to set up their shops along the valuable real estate lining the basin's edges. As the northern boundary of the basin, Leake's Wharf became a popular place for ships to dock. Frequent newspaper advertisements from the late 18th century described the various ships that were docked at the wharf and the goods that were sold from the wharf. In many cases, the ships themselves were for sale (see **Table 3-3**).

Table 3-3
18th Century Newspaper Advertisements Referencing Leake's Wharf

Date	Newspaper Name	Vessel Name	Summary of Advertisement
7/15/1789	*Daily Advertiser*	*Hannah*	Sloop for sale at Leake's Wharf, 3 years old and suitable for river or coastal trade
10/17/1794	*Daily Advertiser*	*Amizade*	Ship arrived from Maderia, France, merchant Francis Baretto is selling 250 pipes of wine from his store on Leake's Wharf
6/22/1795	*Daily Advertiser*	*Goddess of Liberty*	Brig for sale at Lake's [sic] Wharf, nearly new, apply to Francis Baretto at no. 72 on the wharf
10/17/1795	*Daily Advertiser*	*Fanny*	Ship arrives from Glasgow with cargo of nails and oznabrigs
11/11/1795	*American Minerva*	*Eliza*	To land at Leake's Wharf with shipment of teneriffe wines for sale by LeRoy and Bayard on New Street
5/12/1796	*Daily Advertiser*	*Ellice*	Ship leaving for London from Lake's [sic] Wharf, seeking freight and passengers
12/2/1796	*Daily Advertiser*	*Milton*	Schooner leaving for St. Thomas and Curacao from Lake's Wharf at the north side of the New Albany Basin, seeking freight and passengers
12/12/1796	*Daily Advertiser*	*Milton*	Schooner offered for sale; advertised as new, well-built, and well-furnished

In 1794, John G. Leake hired a carpenter and a mason to construct "two new framed storehouses" on Leake's Wharf at the corner of Washington and Cedar Streets (Leake 1794). In May 1795, the *Daily Advertiser* ran an advertisement promoting the sale of these two new 3-story stores. The advertisement asked interested parties to apply at 44 Nassau Street, which historic directories confirm was John G. Leake's home. In February of 1798, the *Commercial Advertiser* promoted the lease of two stores at 74 and 75 Cedar Street at the corner of Washington Street north of the New Albany Basin. The advertisement was placed by Bernardus Swartwout, Junior, and noted that 75 Cedar Street was at that time being used as a ship chandlery.

In 1794, the Swartwouts had legal troubles involving their schooner, *Prince and Liberty*. The merchants were accused of violating an embargo by sending their ship to New Providence in the Bahamas. The Swartwouts argued that their ship had in fact been destined for Charleston, South Carolina, but had been diverted to the Bahamas because of bad weather. A judge ruled in their favor and returned the ship and its cargo, which had been confiscated, to the pair (*New York Daily Gazette* 1794). The pair owned many ships, however, and late-18th century newspapers contain numerous advertisements placed by one or both of the Swartwout men advertising ships for sale.

The New Albany Basin was in place through the early 20th century, while the slip to the north was filled in by circa 1818, as described above. In 1805, Barnardus Swartwout, Junior moved from New York City to Westchester County, New York (Bayles 1859). That year, he sold the lots making up the southern half of Block 56 to Andrew Morrell, a mason, for a sum of $16,000 (Liber 86, Page 349). The deed, which was not recorded until 1810, after Morrell had already died, described the tract as “land partly under water with buildings and improvements” (ibid). In 1809, Morell’s heirs sold the lots to Ogden and Murray, who had purchased the northern half of the block around the same time. The deed that documented that transaction, which was also not recorded until 1810, indicated that there was still an unfilled water lot on the property and that a store belonging to Morrell was present in the southeast corner of the site. Murray and Ogden held the land until it was confiscated after their financial troubles circa 1817. As described above, in 1818 the *Daily Advertiser* advertised the sale of the entire block except for one lot at the corner of Cedar and Washington Streets, which the Morrell family retained (HPI 2004).

The circa 1818 Bridges and Poppleton Survey prepared in advance of the sale of the 17 lots making up the block depicts three adjacent structures, each a different size, that were presumably those built by John G. Leake in 1795 and possibly expanded later by either the Swartwouts or Andrew Morrell. No other structures are depicted in the southern half of the block on that map. As with the northern half, the city began collecting taxes on the lots making up the southern half of the block in 1817 (HPI 2004). Initial tax records identify the building in the southeast corner as a shop.

THE HISTORY OF THE PROJECT SITE AFTER LANDFILLING

In 1830, Liberty and Cedar were among several streets that were widened that had “formerly threaded their sinuous courses between piles of rookeries, but are now enlarged and graced by splendid rows of stores and dwelling-houses” (Stokes 1967 V: 1690). By the mid-1830s, the rest of the streets in the area had also been adjusted, as seen on Colton’s 1836 map. The Dripps map of 1852 depicts the VSC Site as divided into lots and fully developed with structures. While the size and alignment of the small buildings situated over the location of the WTC Ship changed over the years, no maps dating from the late-19th century through the mid-20th century depict any significant alterations to the streetbeds during that time other than the installation of new utilities.

Historic building plans suggest that the structures that stood on Block 56 in the late-19th and early 20th centuries had basements that extended between 4 and 10 feet below the ground surface (HPI 2003). Records for at least two of these structures (historic Lots 16 and 26) show that when those locations were redeveloped in the late-19th and early-20th centuries, the foundations were laid on wood piles (ibid). Based on utility plans and archaeologists’ observations in the field during the construction of the VSC, the maximum depth of utilities in this area does not appear to have exceeded 10 to 15 feet below ground surface and the WTC Ship was therefore not affected by them. In addition, the widths of the project site streetbeds have remained largely consistent over time, with only minor fluctuations associated with project development.

In the 1960s, PANYNJ planned and constructed the WTC on an approximately 16-acre site that included the area bounded by Church Street, Liberty Street, Route 9A, and Vesey Street. As part of the construction of the WTC, deep excavation took place to create the “bathtub” foundation surrounded by the slurry walls bordering the site. The southernmost slurry wall of the original WTC bathtub is located along the northern line of Liberty Street.

Chapter 4: Summary of Maritime Archaeology and Ship Context

Maritime archaeologists study sites to recover information about our history not available elsewhere. This is especially true of vessels constructed before the mid-19th century, when written records and plans were not systematically prepared or preserved. In a maritime site, a ship or boat alone might answer many existing questions about the history of technology, economics, warfare, biology, and forestry. A vessel's contents can often provide information about its cargo, munitions, crew's belongings, vermin, stow-away seeds, etc. When interpreted, it allows archaeologists and maritime historians to meld the analyses of the artifacts with other historic data. As a result, scholars can often learn more about a vessel's historic milieu and sometimes particular historic events and people. The analysis and preservation of shipwrecks has been professionalized over the past few decades with the passing of the NHPA in 1966 and guidance concerning their evaluation has been provided by the National Park Service (NPS). This chapter includes a series of tables to provide a context for considering the uniqueness of the WTC Ship in both New York State and the colonial period in general nationwide. A final table provides a listing of regional museums and maritime organizations that have publically accessible collections of historic ships.

A. BRIEF HISTORY OF WOODEN SAILING SHIPS

The complex wooden hulls of the 18th and 19th centuries evolved after a long period of increasingly advanced ship construction. Prior to the 14th century, wooden hulls were built "shell first," with edge-fastened planking overlapping the planks below it and fastened with rivets. A small number of frames would have been added to these types of vessels to strengthen them further. Around the 1300s, European shipbuilders began constructing hulls using the "frame-first" principle. A complete skeletal framework of rib-like frames was constructed and the planks were attached to the frame, rather than to each other. For additional strength in seagoing vessels, a complete inner layer of planking known as the "ceiling" was added horizontally across the inner surface of the frames.

The timber frames required for these vessels were too substantial to be bent by steaming, and had to be cut from trees to the required shape. Since curved timber could not be found that would extend the full height from the keel to the bulwarks, the frames had to be made up of segments known as "futtocks." The futtocks were not attached to each other at the butts. In some hulls, frames were paired and fastened to each other with the meeting points of the butts staggered. In other hulls, like the WTC Ship, the futtocks were only attached to the outer planking and the ceiling. During this type of construction, the futtocks were erected and held in position by temporary wood "battens" until the planking was added. Once the planking was installed it was tightened up and made water tight by driving caulking—made of oakum (teased out hemp) and cotton—into the seams. The seams were finally sealed with tar, which might also be used over the entire hull below the waterline as a protection against worm damage. A discussion of the construction methodology and sequence used to build the WTC Ship is presented in **Chapter 6: Technical Analysis of the WTC Ship and Components**.

The European shift from shell-first to frame-first construction made possible vessels that could endure very long sea voyages, some lasting years. It was a major factor in the rise of the age of exploration and colonization. The other major factor was the adoption of sailing vessel rigs involving more than one mast. Additional masts allowed rigs that took greater advantage of the world's patterns of prevailing winds and by the 1700s, basic rigs had evolved. For centuries "fast hulls" were limited to oar propelled craft such as the galleys of the Mediterranean. Mariners in wind driven vessels accepted the fact that the length of their voyages would be determined by their luck with winds and weather. By the 1700s there were some efforts to make vessels faster through the shaping of the hull or modifications to the rig. The incentives were usually not strictly commercial. A faster vessel might be desirable to escape enemy vessels in wartime. Speed would also be desirable if engaging in illegal activities such as smuggling, piracy, and after efforts were made to suppress it, the slave trade. Real efforts to make purely cargo and passenger carrying sailing vessels faster began after peace returned to the seas in 1815 with the end of the Napoleonic Wars and the War of 1812. These efforts were stimulated by competition on the North Atlantic in the "packet ship" trade, the trade with China, and in the late 1840s the California Gold Rush.

A vessel square-rigged on three masts was called a ship. A vessel of two masts predominantly square-rigged was called a brig, or in some variations of the rig a snow or brigantine. A vessel of two masts predominantly rigged with fore and aft oriented sails was called a schooner. A sailing vessel with one mast, usually predominantly fore and aft rigged, was called a sloop. The WTC Ship has been identified as a sloop, specifically, a Hudson River Sloop, a class of vessel that was constructed specifically to travel along the shallow, rocky waters of the Hudson and similar rivers. Hudson River Sloops are a class of ships that had very beamy hulls that placed an emphasis on carrying a large cargo or a great amount of passengers rather than speed (Fontenoy 1994). The WTC Ship appears to fit with this class of ships as it also had a broad beam, shallow draft, and a mast that was stepped somewhere in the missing forward portion of the hull.[1]

B. HUDSON RIVER SLOOPS

Ships were essential to the colonies of New Amsterdam and New York during their early years, when the first settlers were still largely dependent on trade with the Old World for survival. However, very few ships, perhaps as little as 11, were present in New York Harbor during the 17th century (Fontenoy 1994). Throughout the American colonies, different shipbuilding strategies were used to create regional varieties of vessels that were perfectly suited for specific environmental conditions (Chappelle 1935). Shipyards were established along the East River waterfront in New Amsterdam by the mid-17th century (Bank of Manhattan Company 1915).

The earliest shipbuilders in New York were of Dutch origin, and some of the early vessels constructed were "sloeps," later Anglicized to "sloop" (Fontenoy 1994). Between the settlement of New Amsterdam and the end of the 18th century, a specific class of ship, the Hudson River Sloop, evolved to better navigate the waters of the Hudson River (ibid). These small, shallow vessels (usually no more than 60 feet in length) had large cargo holds and were therefore well-adapted to local trade up and down the Hudson River with the Native Americans living to the north (ibid). Early sloops were constructed with lee boards, more typical of Dutch ship construction, however, sloops were later built with center boards or "drop keels," which at the time was more common among English-built ships (Verplanck and Collyer 1908). These types of vessels became the predominant class of ship used in New York during the colonial period (Fontenoy 1994).

The Hudson River Sloop was "the forerunner in the establishment of the vast commerce of the Hudson" River (Verplanck and Collyer 1908: iii). Interestingly, sloops facilitated the development of New York's economy while environmental factors of the Hudson River inspired the development of the Hudson River

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[1] As described in Chapter 7, the ship's timbers appear to have grown in Philadelphia. Therefore, it is possible that the ship remnant was initially built for use in Philadelphia or New York, however, its construction typology is still consistent with that of the sloops built specifically for use on the Hudson River.

Sloop (ibid). Sloops rose in importance during the 18th century, when trade between the cities of Albany and New York intensified as both cities grew in size and population. Timber, flour, and furs were shipped south from Albany while manufactured goods were exported from New York City (Fontenoy 1994). Despite their relatively small size, sloops regularly sailed to the West Indies (Verplanck and Collyer 1908).

Smaller, unarmed sloops (approximately 50 feet in deck length) were typically used for local coastal trading while slightly larger armed sloops (up to 65 feet in length) were used for traveling over long distances, mostly to the West Indies (Fontenoy 1994). Early- to mid-18th century sloops were typically built of cedar or white oak, both of which were suitable for sailing along the sandy and rocky bottom of the Hudson River (ibid). Albany emerged as a center of shipbuilding at this time (ibid). Sloops were built in Philadelphia in the late-18th century, however, they were only a small fraction of the number of ships that were constructed there at the time. In 1793, the *New York Daily Advertiser* reported that only 1 of the 28 ships built in Philadelphia in 1791 was a sloop, as were just two of the 41 ships built there in 1792.

Hudson River Sloops were larger than the traditional sloops that preceded them so that they could carry heavy cargoes as well as larger cabins to accommodate more passengers (Fontenoy 1994). They also had a greater beam and a shallower hull to allow the ships to better navigate the River's rocks and shoals (ibid). While some sloops were owned by their captains, the majority were owned by wealthy landowners or merchants, manned by a hired crew and used mostly for endeavors associated with their owners' businesses (ibid).

Hudson River Sloops evolved again during the early 19th century, with more advanced hulls and rigging better suited to the changing economic environment of New York, which had transformed from "a frontier to a stable society based on well-established industries" (Fontenoy 1994: 45). During this time, the number of sloops sailing along the Hudson River increased significantly (ibid). Sloops remained steadily popular until the 1830s, when they were surpassed by steam boats, which, after they were technologically advanced enough, were faster and could carry more cargo (Verplanck and Collyer 1908).

One of the most remarkable journeys taken by a Hudson River Sloop was that of the *Experiment*, which was built in Albany and traveled to China in 1787 (Fontenoy 1995). One of the investors of the *Experiment*'s voyage was John G. Leake, who as discussed in Chapter 4, owned the wharf along the southern side of the block where the WTC Ship was found (ibid).

C. ARCHAEOLOGICALLY INVESTIGATED HISTORIC SHIPS

The WTC Ship is one of a small number of 18th century ships that have been identified, investigated, and recorded in New York State. **Table 4-1** provides research regarding maritime archaeology in the State of New York and includes collected information on the resource's discovery, time period, current location, designation, and type. As indicated in this table, only 22 historic vessels (two of which are comprised of a group of related vessels) have ever been professionally documented or partially documented in the State of New York. Of these, only nine vessels (or groups of vessels) have been State or Nation Register- (S/NR-) listed, two of which were also designated as National Historic Landmarks. Two other shipwrecks that have been investigated archaeologically have been determined S/NR-eligible. Out of this group of 17 historic vessels, only six have been partially or completely recovered.

Table 4-1
Vessels Investigated Archaeologically in New York State

Vessel Name	Location Found	Date Found	Date of Vessel	Current Location	Historic Designation	Type
*Princess Carolina (*the "Ronson Ship"*)*	175 Water Street, Manhattan	1982	circa 1720	Mariners' Museum, Newport News, VA (portion); additional remains *in situ*		Merchant ship, partially excavated
207-209 Water Street	207-209 Water Street, Manhattan	1978	Likely 18th c.	*In situ* (Below ground)		Portion of hull investigated in building basement
A. S. Parker	Hudson River, Mid-Hudson Valley	1993	19th c.		S/NR-Eligible	Schooner
Hudson River Sloop/ Schooner	Hudson River, Mid-Hudson Valley	1993	19th c.		S/NR-Eligible	Apparent Hudson River Sloop later refitted as schooner
St. Peter Great Lakes Schooner	Lake Ontario, Pultneyville		Built 1873, sunk 1898	*In situ* (Underwater)	S/NR-Listed	Great Lakes Schooner
Jefferson	Sacket's Harbor, Lake Ontario	1984	circa 1812, sunk circa 1820			US Navy brig, War of 1812 20-gun warship
HMS Culloden	Off Montauk, Long Island	1971	Built 1776, ran aground 1781	*In situ* (Underwater)	S/NR-Listed	Built in England, 74-gun ship of Royal Navy
Haldimand	Off Carleton Island, St. Lawrence River	1998	circa 1765	*In situ* (Underwater)	S/NR-Listed	British war ship
Lake Erie Schooner (*Caledonia?*)	Near Dunkirk, Lake Erie	circa 2005	circa 1812?	*In situ* (Underwater)		Schooner
Land Tortoise	Lake George	1990	1758	*In situ* (Underwater)	NHL; S/NR-Listed	Radeau, i.e. floating gun battery
Cadet	Near Bolton, Lake George	(Designated in 2002)	1893		S/NR-Listed	Steam launch
Forward	Lake George	circa 2008	1906, sank 1930s	*In situ* (Underwater)	S/NR-Listed	Motor launch
Wiawaka Bateaux	Lake George	1960s	Scuttled 1758	*In situ* (Underwater)	S/NR-Listed	French and Indian War, flat bottom boat
Champlain II	Westport, Lake Champlain	(Designated in 1997)	Built 1868, grounded 1875	approx. 35% intact, *In situ* (Underwater)	S/NR-Listed	Passenger side wheeler
Gunboat *Spitfire*	Lake Champlain	1997	circa 1776	*In situ* (Underwater)	NHL; S/NR-Listed	Benedict Arnold's Revolutionary War Gunboat
Philadelphia	Near Plattsburg, Lake Champlain	1935	circa 1776	Smithsonian Museum. Washington, DC		Gun boat; "oldest preserved American warship."
HMS *Boscawen*	Lake Champlain	1993	circa 1759	*In situ* (Underwater)		
U-2 Canal Boat	Hudson River, S. of Fort Edward	2009	1822-1825	*In situ* (Underwater)	S/NR-Eligible	Sailing canal boat
Ellis Island Vessels	New York Harbor	2010				
Canal Boat *Vergennes*	West Port, NY	1998	circa 1850	*In situ (Underwater)*	SR Listed/ NR Eligible	Canal boat
Ft. Montgomery Hulks	Ft. Montgomery, NY					
Lake Onondaga Maritime Historic District	Lake Onondaga, NY	2000s	Late 19th early 20th c.	*In situ (Underwater)*	SR Listed/ NR Eligible	Multiple

Note: This listing may not be all-inclusive.

A majority of the historic vessels that have been identified in New York State are located in Lake Champlain, Lake George, or Lake Ontario and were discovered in an underwater (rather than landfill) context. Several 18th-century vessels have been identified beneath the waters of Lake George and Lake Champlain, including a concentration of military vessels known as the "Wiawaka Bateaux" in Lake George. However, very few have been found in New York's major rivers, which were the focus of the region's earliest commerce. Two 18th-century ships have been identified at archaeological sites along the East River in Manhattan at 175 Water Street and 207-209 Water Street. On the Hudson River, two 19th-century schooners (one of which may have been a refitted former sloop) were investigated near Fort Montgomery in the mid-Hudson Valley. However, the WTC Ship recovered from the VSC Site appears to be the first 18th-century vessel investigated archaeologically in what was once the Hudson River.

If the WTC Ship is a merchant vessel, as research conducted to date has indicated, it is among the earliest of its function type found in New York. The vast majority of early vessels studied archaeologically in New York have been military vessels. The "Ronson" Ship at 175 Water Street (now known to be the *Princess Carolina* [Riess and Smith, in press]) is considered the earliest merchant vessel discovered in New York and dates to circa 1720. The remnants of the 18th-century ship discovered at 207-209 Water Street, portions of which are still *in situ*, have not been examined in sufficient detail to determine the vessel type or use. The Hudson River schooners identified near Fort Montgomery were tentatively dated to the mid-19th century. As a likely 18th-century merchant vessel, the WTC Ship found at the VSC Site represents one of a very rare ship type and it may be the earliest known Hudson River Sloop that has been found.

Table 4-2 provides summary information on Colonial-era ship archaeology across the United States, including the type of analysis conducted and the current status of the vessel. Of the roughly two dozen Colonial-era vessels ever professionally recorded nation-wide, only 12 were identified as merchant ships. About half of these ship discoveries have been either left in place or reburied.

Table 4-3 provides data on preserved ships in the collections of museums and maritime organizations in New York State and the general vicinity. This information was compiled from internet resources and personal contacts with curators, collection managers, conservators, and exhibit designers at pertinent repositories. It should be noted that table does not reflect how much of each ship was found and how much was analyzed or preserved. This table was created to identify possible repositories for the final disposition and/or display of the WTC Ship, to present various exhibit options, and to determine possible costs and issues pertinent to the storage/exhibition of the ship remnant.

Table 4-2
Colonial Vessels Documented and/or Excavated in North America

Name	Date	Vessel Type	Location	Type of Analysis	Current Status
Port Royal (*HMS Swan*?)	Pre-1692	British (merchant to 32-gun frigate)	Port Royal, Jamaica	Documentation and excavation	Not conserved; reburied *in situ*
Phips Shipwreck	1690s	British colonial military vessel	Anse aux Bouleaux, Quebec	Excavation	Not conserved; reburied *in situ*
Princess Carolina (the "Ronson Ship")	1720s	Merchant	Water Street, NYC	Limited excavation	Bow removed and conserved, in storage at the Mariner's Museum, additional remains *in situ*; Wooden model made
Rose Hill Shipwreck	1725-1750	Sloop	Northeast Cape Fear River, near Wilmington, NC	Documentation, no excavation	Not removed, currently *in situ*
Brown's Ferry Vessel	1740-1750	Ferry; colonial trader	Back River, South Carolina	Excavation, later documentation	Removed and conserved, currently at the Rice Museum; Wooden model made
Terence Bay Shipwreck	1750s	Schooner, possibly for fishing	Halifax, Nova Scotia	Limited excavation	Not removed, currently *in situ*
Quebec City's Bateaux	pre-1752	Bateaux (small transports)	Quebec City, Quebec	Documentation and excavation	Portions removed and conserved, current location unknown
Wiawaka Bateaux	c. 1758	Bateaux (small transports)	Lake George, NY	Excavation	Removed and conserved, at the Adirondack and NYS Museums
HMS Boscawen	1759-1760s	Colonial American sloop	Fort Ticonderoga dockyards, Lake Champlain	Excavation	Unknown
Machault	1760s	French frigate	Restigouche River	Excavation	Removed and conserved, location unknown; wooden model made
Town Point Vessel	1763-1781	British colonial trader	Pensacola, FL	Excavation	Not conserved; reburied *in situ*
Reader's Point Vessel	pre-1765	Colonial sloop	St. Ann's Bay, Jamaica	Excavation	Portions removed, unknown conservation
Betsy (44YO88)	1772-1781	British collier-brig	Yorktown, VA	Excavation	Unknown
The Otter Creek Shipwreck	post 1772	Schooner	Oriental, NC	Limited excavation	Not removed, currently *in situ*
Burroughs Wreck	c 1776	Merchant	Edenton, NC	Documentation, no excavation	Not conserved; reburied *in situ*
Philadelphia	c. 1776	Continental gun-boat	Plattsburg, Lake Champlain, NY	Excavation	Removed and conserved, currently at the Smithsonian, Washington, DC; wooden model made
Deadman's Island Shipwreck	1776-1781	British naval vessel	Pensacola Bay, FL	Excavation	Not conserved; reburied *in situ*
Cornwallis Cave Wreck	1776-1781	British naval (32-gun)	Yorktown, VA	Test trenches	Not conserved; reburied *in situ*
HMS Charon	1778-1781	British 44-gun ship	Yorktown, VA	Documentation	Not conserved; reburied *in situ*; wooden model made
Defence	c. 1779	Privateer	Penobscot Bay, ME	Documentation	Not removed, currently *in situ*.
Bermuda Collier	Pre-1796	British military collier	Chubbs Head Cut, Bermuda	Documentation, no excavation	Not removed, currently *in situ*.
Clydesdale Plantation Vessel	Late 18th c.	Sloop	Back River, Georgia	Excavation	Not conserved; reburied *in situ*
American Eagle	1814	American 20 gun-brig	Whitehall, NY	Excavation and Documentation	
Emanuel Point Shipwreck	1559	Spanish	Pensacola Bay, FL	Excavation	
Queen Anne's Revenge	1718		NC	Documentation (Excavation?)	
*La Atocha & *Various*	1622	Spanish (1622 Plate Fleet)	Florida Keys, FL	Salvage	
La Belle	1686	French	TX	Excavation	
Storm Wreck	18th C.			Documentation (Excavation?)	
Warwick	1619	English Cargo	Bermuda	Documentation (Excavation?)	
San Antonio	1621	Portuguese Nao	Bermuda	Documentation (Excavation?)	
Frenchman Wreck	circa1750			Documentation (Excavation?)	
Molasses Reef Wreck	Early 16th C.	Spanish	Biscayne Bay, FL	Documentation (Excavation?)	Earliest European vessel to be scientifically excavated
HMS *Fowey*	1748	British	Biscayne Bay, FL	Documentation (Excavation?)	
HMS *Fox**	1799	British Schooner	Dog Island, FL	Documentation (Excavation?)	
Henrietta Marie	1700		Florida Keys, FL	Documentation (Excavation?)	
HMS *Looe*	1744	British Frigate	Florida Keys, FL	Documentation (Excavation?)	
*Urca De Lima & *Various*	1715	Spanish (1715 Plate Fleet)	Florida Keys, FL	Documentation (Excavation?)	
Le Chameau	1725	French Man-of-War	Cape Breton Isl., Nova Scotia, Canada	Excavation	
**Various*	1733	Spanish (1733 Plate Fleet)	Florida Keys, FL		
Deadmans' Wreck	1763-1783	British Sloop of War	Santa Rosa County, FL	Documentation (Excavation?)	
Town Point Wreck	1763-1783		Santa Rosa County, FL		

Notes: The amount of each of these ships that was available for documentation or excavation (i.e., if the ship was fully intact or if only a portion was preserved) is unknown. This listing may not be all-inclusive.
*It is not known if this is a Colonial-era vessel or not.

Table 4-3
Preserved Ships in the Collections of Regional Museums and Maritime Organizations

Organization	Location	Type of Vessels	Date(s)	Vessel Types	Display Type	Focus
MUSEUMS IN NEW YORK STATE						
Adirondack Museum	Blue Mountain Lake, NY	Bateaux c.1758; many small-craft	18th–20th-c.	Transport; leisure	Dry exhibit & storage	Upstate New York
Cold Spring Harbor Maritime Museum	Cold Spring Harbor, NY	30' whaling boat	19th-c.	Whaling	Dry exhibit	Upstate New York
Hudson River Maritime Museum	Kingston, NY	Shad boat; life boat; lighthouse tender; ice yachts, the steam tug *Mathilda*; & the Hudson River Sloop *Clearwater,* seasonally	19th–20th-c.	Commerce, leisure, navigation, & military	Dry exhibit & floating	Hudson River
Long Island Maritime Museum	West Sayville, NY	1888 oyster sloop; 30 small craft; and ship models	19th– 20th-c.	Oystering, fishing, whaling, shipbuilding, & leisure	Dry exhibit & floating	Long Island
Museum of the City of New York	New York, NY	3 ship fragments; & ship models, including the Partial keel & bow of 18th c. vessel once thought to be Dutch trading ship *Tijger*	17th– 20th-c.	Military, transport, & merchant	Storage	New York City
National Maritime Historical Society	Peekskill, NY	English bow anchor c.1780–1810, found during WTC construction	18th– 19th-c.		No collections	National focus
New York Historical Society	New York, NY	Relic fragments from notable ships; ship models	19th– 20th-c.		Storage	New York City
New York State Museum	Albany, NY	Several bateaux; the *Tortise*, (underwater archaeology site)	18th–20th-c.	Military	In storage	NYC & Empire State component
Seaport Museum	New York, NY	11 floating vessels and several small wooden boats including: schooner, light ship, tugboats, freighter, 4-masted Barque, and full-rigged ship.	19th–20th-c.	Commerce & port	Storage & floating	NYC & seaport
Lake Champlain Maritime Museum	Vergennes, VT	2 full-sized replicas, several restored craft, & many small craft	18th–20th-c.	Military, merchant, transport	Storage, dry exhibit, & floating	Upstate New York
INSTITUTIONS OUTSIDE OF NEW YORK STATE						
Mariners' Museum	Newport News, VA	Collection includes remains of 3-masted wooden ship *Princess Carolina* (formerly the "Ronson Ship")	1720	Merchant	Preserved w/PEG; partial ship, in storage.	Global
Mystic Seaport	Mystic, CT	500 vessels; 4 designated Nat'l Historic Landmarks; numerous craft including whaleships, steamboats, canoes, kayaks, oyster & fishing boats, dinghies & pull-boats, rowing shells, etc.; ship models, & full-scale replicas	18th–20th-c.	All types	Storage, dry exhibit & floating	National Maritime focus
Nat'l Museum of American History	Washington, D.C.					National
U.S. Frigate Constellation	Baltimore, MD	Sloop of War; wooden	1854	Military	Floating	
USS Constitution	Boston, MA	3-masted frigate; wooden	1797	Military	Floating	

D. USE OF SHIPS AS LANDFILL-RETAINING STRUCTURES

During the wooden sailing ship period, a number of retired or derelict vessels—which were essentially ready-made landfill-retaining structures—were incorporated into the landfill surrounding Lower Manhattan. Some, lying parallel to the river, were intentionally sunk to form retaining walls holding in the fill. Others, already sunk and abandoned on the river bottom were too much trouble to remove, and were simply buried where they lay. In some cases, derelict vessels that were no longer sea-worthy were used as floating storage hulks. However, in June 1779, the city issued the following order:

All owners of hulks or old and dismantled vessels that lay in any of the slips or along the wharfs in the East River are hereby required immediately to remove the same to the Beach at the North River (*Royal Gazette* 1779: 1). Such hulks were banned in the East River as public nuisances that prevented the slips from functioning as intended (ibid). After this law was not complied with, a subsequent order was issued in July 1779 threatening the owners of hulks not removed from the city's slips with imprisonment (*The New York Gazette* 1779).

The minutes of the city's Common Council, its governing body during the 18th and early 19th centuries, include many references to ships or vessels that had sunk to the river bottom in the slips that lined the lower portion of Manhattan. However, most of these references refer to the removal of such wrecks, such as those at the old Albany Pier (near modern Coenties Slip) in 1784 (MCC 1784-1831 I: 80), 1785 (MCC 1784-1831 I: 190), 1788 (MCC 1784-1831 I: 401) and in Whitehall Slip in 1790 (MCC 1784-1831 I: 612). Another sunken wreck located at Beekman Slip was documented as having been incorporated into the landfill. In September 1790, a block of landfill was deposited over the wreck on the eastern side of the slip (MCC 1784-1831 I: 589). It is unclear if that is the same hulk in Beekman Slip that was ordered to be covered with fill in 1786 (MCC 1784-1831 I: 231). Interestingly, the Common Council Minutes note that in 1769, "Lambert Losie etc." were paid for "removing a wreck out of Ellises [sic] Slip" (MCC 1674-1776 VII: 157). No additional information could be obtained about the removal of a wrecked vessel from this location, however, it is possible that Ellis's Slip was situated in the vicinity of the project site (described in greater detail in Chapter 3). In addition, in 1724, the Council's minutes also make reference to breaking up the hulks of old ships to provide fuel for the poor (MCC 1674-1776 I: 27).

Buried vessels often survive in the landfill because, as with the VSC Site, later development on top of the landfill deposits had little impact on the buried hulls that lay buried on the historic river bottom far beneath them. The structures formerly located on the VSC Site were expected to have had basements of less than 10 feet in depth (HPI 2003). During the 20th century, the construction of large office buildings required much deeper basements and often subbasements for utilities and parking garages. During the 1960s, a boom in construction resulted in the discovery of several buried vessels, including some at the WTC Site to the north of where the WTC Ship was discovered. In 1916, during the construction of the No. 1 subway line, the remains of a portion of a wooden ship thought to be the Tijger, the fur trading ship captained by Adrian Block, were encountered beneath Greenwich Street near Dey Street, two blocks north and one block east of where the WTC Ship was located. Block's ship had burned in 1613 and was abandoned along the shoreline and was presumably incorporated in the landfill. The remains of the ship included "the badly charred keelson and three rib frames" made of oak as well as "a Dutch broad-headed axe, trade beads, clay pipes, a length of chain, a small cannon ball, and sherds of blue and white pottery" (Solecki 1974: 109).

The ship was found at a depth of approximately 20 feet below ground surface, underneath 9 feet of fill and 11 feet of silt from the river (Solecki 1974). During excavation for the construction of the WTC in the 1960s, archaeologists attempted to find the rest of the ship, but were unsuccessful. The archaeologists did recover an anchor dating to before 1790 near the former intersection of Cortlandt and Washington Street, one block to the north of the WTC Ship's location (ibid).

The remains of the ship that was thought to be the Tijger, now included in the collections of the Museum of the City of New York, were re-examined by Gerald A. de Weerdt, an expert on historic ships. De Weerst determined that they were not associated with the Tijger, and likely represented the remains of an 18th century vessel constructed by an English shipwright (de Weerdt 2005). While the ship was not the one that belonged to Adrian Block, the ship recovered from what is now the WTC Site in 1916 represents at least one other 18th century ship incorporated into the landfill in the vicinity of the VSC Site.

More recent examples of ships being found in Manhattan's landfill deposits include the bow of a small ship that was encountered during excavation at Old Slip, on the East River, in 1969 (Huey 1984). Another ship was found buried under a building at 209 Water Street in the South Street Seaport Historic District in 1978. The ship's historic importance was recognized but, because it was lying directly under a building dating to 1836, only limited recording could be completed and the ship could not be removed. Instead, it was left *in situ* and reburied under clean fill. Subsequently, in 1981 a remarkably intact 100-foot sailing vessel dating to the early 1700s was found in the construction site for a 30-story office tower at 175 Water Street. This ship, commonly known as the "Ronson Ship," which has since been identified as the *Princess Carolina*, was excavated and analyzed by Dr. Warren Riess (Riess and Smith, in press).

Chapter 5: Discovery and Archaeological Context of Ship Remnant

A. DISCOVERY, DOCUMENTATION, AND REMOVAL OF SHIP REMNANT

Under contract to PANYNJ, AKRF provided archaeological monitoring services during excavation activities at the VSC Site from late 2009 through mid-2011. During this long-term monitoring effort, AKRF collected information on a number of landfill-retaining structures. The results of the monitoring effort are discussed in AKRF 2012a.

DISCOVERY OF THE STERN OF THE SHIP REMNANT

On the morning of July 13, 2010, AKRF archaeologists observed what appeared to be the curved timbers of a ship while performing archaeological monitoring (see **Figures 5-1** and **5-2**). With the help of on-site construction workers from EE Cruz, AKRF archaeologists excavated the fill deposits covering the timbers by hand. Additional excavation revealed the intact remains of a portion of the hull of a ship. The AKRF archaeologists then consulted with Douglas Mackey, a Historic Preservation Program Analyst at SHPO and Amanda Sutphin, Director of Archaeology at LPC. AKRF continued to excavate the ship remnant using hand excavation methods through July 13 and 14, 2010 and Mr. Mackey and Ms. Sutphin visited the site.

As discussed in Chapter 1, AKRF called on the additional expertise of several more specialists in the field, including Norman Brouwer. On July 15, Mr. Brouwer visited the site and observed that the ship remnant was too fragile to move intact. He suggested that several steps be followed: (1) mapping the remains, (2) disassembling the ceiling planking—the top-most layer of the ship remnant's hull—to expose the rib-like timber frames that lay below for documentation, (3) removing the frames, and (4) documenting the hull's outer planks. He further suggested removing portions of the outer planks to expose the keel.

Excavation and documentation of the ship remnant continued through July 15 and July 16 in the manner recommended by Mr. Brouwer after first mapping the vessel *in situ*. Representatives from Corinthian Data Capture, LLC used three-dimensional laser-scanning technology to create a three-dimensional model of the exposed portion of the ship remnant (see **Figure 5-3a**). AKRF removed a portion of the ceiling planking and wrapped the removed timbers in plastic sheeting. To protect the rapidly drying timbers, hoses were used to keep the ship remnant wet and it was then covered with Geotech synthetic fabric to delay deterioration of the structure. Later, a protective awning was constructed over the ship remnant to shield it from direct sunlight.

Per the Emergency Mitigation Plan prepared by AKRF with input from LMDC, PANYNJ, SHPO, and LPC, AKRF assembled a team of experts and proceeded with the thorough documentation of the ship remnant *in situ*, the recovery of associated artifacts, and the careful removal of the individual timber elements comprising the ship remnant. This work was conducted by AKRF archaeologists and staff with the technical guidance of Principal Investigators Dr. Warren Riess and Carrie Atkins Fulton and with the continued assistance of EE Cruz and PANYNJ. Archaeological conservators from the MAC Lab were present to consult with on the removal of individual timber elements and to pack the timbers for transport and temporary storage at their facility in Maryland.

This phase of the field effort was conducted between July 26 and July 29, 2010. The duration of fieldwork each day was approximately 14 hours. EE Cruz made floodlights available so that work could continue after sunset. Throughout the documentation process, the archaeologists used hoses at low pressure as appropriate to clear mud and debris to expose the vessel timbers and to keep the timbers wet so as to preserve their condition. In addition, the stratigraphy, composition, and color of the soils comprising a portion of the pedestal underlying the ship remnant were noted and sketched.

Corinthian Data Capture, LLC returned to collect three-dimensional laser scans on two additional occasions to record each layer of the remains (see **Figure 5-3b** and **5-3c**).

DISCOVERY OF THE BOW OF THE SHIP REMNANT

After the discovery of the stern of the WTC Ship on the west half of the VSC Site, it was speculated that a portion of the ship's bow may be present on the east half of the project site. During the construction of the VSC, a temporary slurry wall was constructed in the vicinity of the former line of Washington Street to separate the west and east halves of the site. This wall—referred to as the "demising wall"—bisected the ship and the stern was encountered approximately 10 feet to the west of the wall. Excavation to the east of the wall began in early 2011, and all work in the anticipated location of the bow was monitored by AKRF archaeologists (see **Figure 5-4**).

In July 2011, excavation on the east half of the VSC Site had progressed to the anticipated depth of the ship remnant, which had been estimated using the data collected during the recovery of the stern. Markers were painted on the demising wall to alert the contractor to the presence of the ship (see Figure 5-4). While directing excavation in an attempt to locate the bow on the afternoon of July 29, 2011, AKRF archaeologists observed a portion of the stempost of the bow in close proximity to the demising wall. This timber was dislodged by the backhoe and transported to the AKRF laboratory for temporary storage in a large container filled with water. The area in the vicinity of the stempost was then cleared by hand to expose what remained of the bow, which measured approximately 3 feet by 6 feet.

On August 1 and 2, 2011, AKRF archaeologists, Warren Riess, and Kathleen Galligan completed the documentation and recovery of the fragments of the bow. Because the bow remains were fragmentary and significantly fewer timbers were present, a smaller crew was needed and it was not necessary to work into the evening. As with the stern, the archaeologists used hoses at low pressure as appropriate to clear mud and debris from the timbers of the bow and used plastic sheeting to protect the timbers and keep them wet. In addition, the stratigraphy, composition, and color of the soils surrounding the bow were noted and sketched. The bow fragments were documented through photographs and measured drawings.

B. ARCHAEOLOGICAL CONTEXT OF SHIP REMNANT

The WTC Ship was recovered within and beneath landfill deposits approximately one city block (200 feet) west of Manhattan's original shoreline at Greenwich Street. The WTC Ship was oriented east-west near the center of the VSC Site and its eastern end (the bow) was located beneath the former line of Washington Street and its western end (the aft section, including the stern) was within the northern half of Block 56 (in an area that corresponds with historic Lot 28). Portions of the ship were destroyed by the 3-foot-wide demising wall, a temporary slurry wall constructed from the ground surface in early 2010 as part of site excavations, and an associated 10-foot-wide trench on its west side, which was excavated to construct tieback panels to support the demising wall (discussed further below). The small section of the bow was approximately aligned with the stern, and therefore while some disturbance occurred as a result of the construction of the demising wall, the bow appears to have been discovered in its original context, in relation to the stern, and appears to have been only slightly dislocated or moved (see Figure 1-3).

The approximately 32-foot-long stern was separated from the demising wall by the 10-foot trench and the approximately 3-foot-long bow was situated adjacent to the eastern face of the demising wall (see Figure 1-3). Therefore, in total, an approximately 35-foot section of the WTC Ship was examined *in situ* across a total distance of 45 feet. The ship remains were very likely intact along the entire 45-foot span until disturbed by construction of the trench. The upper, non-extant portions of the ship appear to have decomposed or were possibly removed before the ship sank and was buried beneath the landfill and were not destroyed by construction activity. The WTC Ship was encountered at an angle and the stern was found at a lower elevation than the bow. The top of the bow was found at 11.3 feet below mean sea level (approximately 16 feet below ground surface or the equivalent); the top of the eastern end of the aft section was at 14.4 feet below mean sea level (approximately 19 feet below ground surface), and the stern was 17.3 feet below mean sea level (approximately 22 feet below ground surface, see **Figure 5-5**).

Excavation of the approximately 200-foot trench adjacent to the demising wall that destroyed a 10-foot portion of the ship remnant was monitored by an archaeologist but proceeded rapidly during the day before the discovery of the ship. Upper portions of this area were also disturbed several months earlier during pre-trenching and clamshell excavation associated with construction of the demising wall. Timbers associated with disturbed landfill-retaining structures were observed in the area, including a feature that was documented during the evening hours the day before the ship was discovered (AKRF 2012a), but ship remains were not observed. The loss of the 10-foot portion of the ship can partially be explained by two factors: 1) the monitoring archaeologist was expecting to observe the remains of landfill-retaining structures, as earlier documentary studies did not identify the site as sensitive for ships; and 2) a very large quantity of timbers and wood associated with excavated landfill-retaining structures was present in this area, making the identification of relatively small numbers of ship timbers more difficult. It is expected that the discovery of the WTC Ship will lead to greater awareness of the presence of this type of resource in future archaeological monitoring projects in landfill contexts.

Several types of analyses were completed in order to determine how, why, and when the WTC Ship was deposited on the floor of the Hudson River. This included an examination of the soils above and immediately below the vessel, the landfill retaining structures observed adjacent to the ship remnant, and the marine life that grew on and near the vessel. The results of these analyses were combined to generate hypotheses regarding the WTC Ship's incorporation into the landfill making up modern Washington Street and Block 56.

ANALYSIS OF DEPOSITIONAL CONTEXT

In their 2003 Phase 1A study of the VSC Site, HPI generated a typical geological profile of the area based on data obtained from soil borings conducted during different periods in the 20th century (most dated to the 1960s and 1970s, during the construction of the WTC, the West Side Highway, and Battery Park City). That profile included five general levels: 1) historic and modern fill (15 to 20 feet thick); 2) silt representing the original floor of the Hudson River (7 to 30 feet thick); 3) coarse sand representing the original pre-river ground surface (5 to 10 feet thick); 4) decomposing rock, gravel, or boulders (5 to 25 feet thick); and, finally, 5) bedrock. Because the depth of the river naturally increased to the west of Greenwich Street, the depths of each of these levels also increased. A natural bay may have at one time been present in the vicinity of the project site north of Cedar Street (HPI 2004).

A series of soil boring samples taken in the vicinity of the project site by PANYNJ in 2005 reflected a profile similar to that described above. A series of seven almost-linear borings (Borings 533, 571, 578, 579, 580, 581, and 582) along the approximate line of Liberty Street was examined in order to determine the stratigraphic levels that made up the VSC Site. As not all of the soil borings included all the stratigraphic levels described above or contained some ambiguities, for the purposes of this analysis, the soil borings were divided into four general stratigraphic levels: landfill, silty river bottom, pre-river ground surface, and decomposing bedrock and bedrock (see Figure 5-5).

In general, the original river bottom appears to have consistently sloped down to the west, although some small peaks and valleys are noticeable in some levels.[1] As such, the fill deposits are thicker—more than 30 feet below ground surface—closer to West Street than they are near Greenwich Street, where the fill is less than 18 feet in depth. No soil borings were completed within the exact location of the ship remnant during the 2005 boring program, however two borings were located to the northwest (Boring 533) and southwest (Boring 577A). Both borings suggest that the river bottom was likely located beneath 23 to 24 feet of fill, therefore placing it at an elevation of 278 or 279 using the vertical datum established for the site by PANYNJ (assuming a ground surface elevation at 302).[2] The elevation of the river bottom increased to the east, towards the location where the ship remnant was found near Washington Street and the original shoreline at Greenwich Street.

Based on the stratigraphic levels visible in soil borings, it therefore appears that the WTC Ship was resting directly on the historic river bottom. While *in situ*, the WTC Ship was at an incline that appears to be consistent with the slope of the original river bottom. As described above, the lowest point of the vessel, near the base of the sternpost, was about 20 feet below sea level. The amidships (eastern) portion of the WTC Ship, approximately 32 feet to the east of the sternpost, was about 14 feet below sea level. What remained of the bow, located approximately 45 feet east of the sternpost, was encountered at about 11.5 feet below sea level, over 8 feet higher than the western end of the vessel.

During the documentation and recovery of the ship remnant, the soils surrounding it were excavated to allow for the drainage of water from the ship remnant and across the entire VSC Site, where limited work was continuing. As a result, the ship remnant was situated on an approximately 4-foot-tall soil pedestal extending above the adjacent area during the archaeological investigation. The pedestal was made up of mottled very dark grayish-brown (Munsell Soil Chart color 10YR3/1 with streaks of 10YR3/2) dense silty clay with thin, alternating bands of brown (10YR4/3) fine silty sand with pebbles and small shells (see **Figure 5-6**). The thin bands of silty sand with shells and pebbles may represent soils deposited as part of the tidal movement of the river.

RELATIONSHIP OF THE WTC SHIP TO ADJACENT LANDFILL

As discussed in greater detail in **Chapter 7**, the fill materials above the vessel included a variety of historic artifacts, as did the river bottom sediments beneath the ship remnant. For the purposes of the artifact analysis, three general contexts were used to classify the artifacts recovered during the investigation of the ship remnant: (1) Landfill, representing items deposited on the site during the landfilling episode that buried the vessel in the late-18th century; (2) Ship, referring to objects found contained within the frames of the vessel that do not appear to have originated in the landfill; and (3) River Bottom, representing those artifacts that were present beneath the vessel and appear to have been deposited before the ship remnant. Additional contexts were used for the analysis of objects of ambiguous origin, which could not be assigned to one of these three categories.

Additional artifacts and several small logs were observed directly beneath the ship remains, which are presumed to have been discarded and deposited on the river bottom when the project site was still an

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[1] This may be the result of some past disturbance (i.e., dredging of the river bottom or basement excavation). For example, Boring 580, which indicates the presence of more than 30 feet of fill material is in the vicinity of the former vault to the north of the Deutsche Bank Building near the former intersection of Washington and Liberty Streets.

[2] The PANYNJ vertical datum is 297.347 feet below mean sea level.

active slip in the mid- to late-18th century. It is possible that the small logs, several of which were found perpendicular to the keel, were used as rollers to move the WTC Ship or other ships from the shore to the water. However, the ship was discovered at an elevation that would have originally been beneath several feet of water, making the use of rollers at this location impractical. Other objects found on the river bottom included numerous fragments of a half-quart-sized redware mug, the nearly complete skeleton of a bay anchovy, and many fragments of a single horse cranium. These artifacts appear to represent refuse deposited on the floor of the Hudson River, likely by local residents or individuals aboard the many ships that were docked in the slip that formerly occupied Block 56. The WTC Ship was deposited on the river bottom, likely resulting in the fracture of the redware mug and horse cranium, and was subsequently covered with 15 to 20 feet of landfill deposits.

Landfill retaining timber structures were observed to the north and south of the WTC Ship during the initial discovery but were removed by heavy machinery immediately thereafter (see **Figure 5-7** for a photo and drawing of the substantial structure to the north). These structures were clearly not attached to the ship remnant but it is unclear if they were associated archaeologically. The southern edge of the landfill-retaining structure to the north terminated at the northwestern edge of the ship remnant and they are roughly perpendicular. There would appear to be three possible explanations for their location next to each other: 1) It is coincidental; 2) The timber structure was placed in this location to avoid the ship remains, which were visible to the team constructing the landfill; or 3) They were both placed in this location as part of the planned landfilling episode. Unfortunately, no evidence supporting any particular scenario was observed in the field during the brief period of time available before the landfill-retaining feature was removed.

ANALYSIS OF MARINE LIFE

The shells and other marine life remains recovered from the ship remnant and its surrounding context are a source of information regarding the chronology of events extending from the end of the vessel's active use as a sea worthy cargo vessel and its burial in a slip on the west side of lower Manhattan and the local marine environment at the time of the ship's burial.

The estuarine death assemblage (the marine species that had been previously living at the site before deposition of landfill) provides a window into the ecological context in which the vessel was abandoned. It also furnishes an opportunity to compare the species entombed on the site in the late 18th century to the species now common in New York Harbor. Though an active port, the Hudson River shoreline hosted a variety of species during the late-18th and early-19th centuries. The estuarine death assemblage represented by the organisms killed during landfilling activities includes an array of mollusk, crab, and gastropod species that appear to have once lived on the river bottom. A qualitative comparison between the estuarine death assemblage associated with the vessel and 1994/1998 United States Environmental Protection Agency (USEPA) Environmental Monitoring & Assessment Program (EMAP) data on the benthic (aquatic) invertebrate community assemblages throughout the New York Harbor Estuary suggest that the shoreline environment at the time of the landfilling event was not remarkably different than that of today. Some species (e.g., whelks and moon snails) are not represented in modern samples; however, it remains unclear whether the absence of these species reflects ecological changes in the estuary (i.e., pollution, etc.) or systematic under-sampling of these species in the EMAP program.

The analysis of the marine organisms associated with the vessel fell into two broad categories: (1) marine life archaeologically recovered as part of the initial excavation and recovery of the ship remnant and included in the general artifact collection; and (2) marine life physically attached to the ship's timbers, which were examined in the laboratory. Each category of analysis is presented in greater detail below.

AKRF archaeologists and ecologists collaborated on the identification and cataloging of the shells and other aquatic organism remains retrieved from the site as part of the artifact collection. An Inventory of Estuarine Biota, which includes the species, number, size, location, and description of each of the 342 shell samples recovered during the investigation, is included in the artifact catalog (see **Appendix B**). The specimens analyzed included the remains of oysters, clams, gastropods, crabs, barnacles, sponges, and other marine invertebrates. Marine vegetation such as eelgrass fragments was also analyzed and is included in the inventory count; however, fish bones were analyzed separately as part of the analysis of the faunal remains recovered from the ship remnant (see **Appendix C**).

As part of the shell analysis, the locations from which the artifacts were collected were grouped into five provenience categories: (1) soils immediately beneath the vessel; (2) on or immediately adjacent to the sternpost or hull exterior; (3) on top of the vessel; (4) within the vessel's frames; and (5) adjacent to the vessel or specific location unknown. A brief summary of the location groupings and shell types found within each is provided in **Table 5-1**.

Table 5-1
Summary of Shell Types Associated with Vessel by Location

Location Grouping	Shell Type Summary
Soils immediately beneath the vessel (River Bottom)	Hard Clam (*Mercenaria mercenaria*) Eastern Oyster (*Crassostrea virginica*) Mud Snail (*Ilynassa obsoleta*) Dwarf Surf Calm (*Mulinia lateralis*) Sponge (probably *Halichondria*) Mud Crab (probably *Neopanopeus sayi*) Softshell Clam (*Mya arenaria*) Blue Mussel (*Mytulis edulis*)
On or immediately adjacent to the sternpost or hull exterior	Shipworm (*Lyrodus pedicullatus*) Mud Snail (*Ilynassa obsoleta*) Blue Mussel (*Mytulis edulis*) Eastern Oyster (*Crassostrea virginica*) Barnacle (probably *Balanus*) Softshell Clam (*Mya arenaria*) Dwarf Surf Clam (*Mulinia lateralis*) Coffee Bean Snail (*Melampus bidentatus*) Hard Clam (*Mercenaria mercenaria*) Eelgrass (*Zostera marina*)
On top of the vessel	Sponge (probably *Halichondria*) Eastern Oyster (*Crassostrea virginica*)
Within the vessel's frames	Dwarf surf clam (*Mulina lateralis*) Mud Snail (*Ilynassa obsoleta*) Eastern Oyster (*Crassastrea virginica*) Hard Clam (*Mercenaria mercenaria*) Moon Snail (*Polinices duplicata*) Shipworm (*Lyrodus pedicellatus*) Horseshoe Crab (*Limulus polyphemus*) Oyster Drill (*Euplerua caudata*) Jingle Shell (*Anomia simplex*) Barnacle (probably *Balanus*) Blue Mussel (*Mytulis edulis*) Mud Crab (probably *Neopanopeus sayi*) Channeled Whelk (*Busycon canaliculatum*) Softshell Clam (*Mya arenaria*) Slipper Shell (*Crepidula fornicata*)
Adjacent to the vessel or specific location unknown	Eastern Oyster (*Crassastrea virginica*) Hard Clam (*Mercenaria mercenaria*) Mud Snail (*Ilyanassa obsoleta*) Horseshoe Crab (*Limulus polyphemus*) Blue Mussel (*Mytulis edulis*)

The location groupings were developed to allow for the identification of patterns in the locations of shells and marine organisms that could in turn yield insight into the depositional history of the ship remnant. It should be noted that Location Grouping 2 largely consisted of a dense accumulation of shells around the sternpost, most of which appeared to be physically attached to the sternpost or hull exterior. Oysters found in this context were clearly physically attached to the sternpost and outer planks of the ship. Oyster growth is largely contingent on environmental conditions, yet even at the slowest of rates, the sizes found on the ship remnant would suggest an oyster of at least 2 years of age (Kraeuter, et al. 2007). With the exception of oysters and barnacles, there was some ambiguity as to whether organisms such as snails and mussels found in this context had used the ship remnant as a substrate during their lives or were simply jumbled in the fill and sediments that happened to be in close proximity to the hull. The relative density of marine organism remains in this location suggested an intentional colony.

At least three distinct habitats are represented by the assemblage of marine organisms: (1) relatively deep water with a soft bottom, as indicated by infaunal species—species that burrow into the sea bed or other substrate, such as hard clams—and epifaunal species—which live on the surface of a substrate—such as channeled whelk; (2) hard substrates (e.g., vessel, wharf timbers, etc.) suitable for estuarine fouling communities (including jingle shells and oysters); and (3) shallow or intertidal flats (as indicated by mud snails and eelgrass) and/or salt marsh habitats (as indicated by coffee bean snails, which are obligate to vegetated salt marshes).

In all of the location groupings, most samples did not appear to be discarded food remains, but rather were free, living organisms in the near-shore environment that were entombed by the placement of landfill in the area. This is suggested both by the species represented—the majority of the species, such as mud crabs, horseshoe crabs, mud snails, and jingle shells are unlikely to be consumed as food in any historical context—and by the presence of bivalves such as clams and oysters with both of their valves intact (i.e., never opened for consumption). The species represented by the artifacts is therefore being considered as an estuarine death assemblage.

MARINE GROWTH COLLECTED FROM SHIP ELEMENTS

Evidence of marine life was found attached to the timbers of ship remnant's bow and stern sections once they had been cleaned and analyzed in the lab (MAC Lab and CMAC). Adult shipworms, barnacles, periwinkles, and oysters were identified on the timbers and planking of both the stern of the ship remnant (see **Table 5-2**) and the bow (see **Table 5-3**). On several outer planks in the stern, a layer of bryozoans (*Membranipora* sp.), small aquatic invertebrates, formed a lacy crust. Barnacles were observed on one frame and had also attached themselves to the outer planking from the garboard strake on up through those at the turn of the bilge.

Oysters about 1 inch in length were found on outer planking, the sternpost, and the keel. Larger 3 to 4-inch specimens grew on the outer plank PN 2-1, outer plank PN 12-3, and the largest on the sternpost. The larger sizes would suggest an oyster with a life span of at least 2 years.

Bryozoans were identified predominantly on the starboard outer planking in strakes 2 through 6, and were only present on two planks of the port side (PN 1-2 and PN 10-1). Juvenile periwinkles and mollusks were found on both starboard and port strakes 2 through 6.

Shipworm damage was observed on the outer planking, sternpost, aftmost section of the keel, and on the frames. The most severe shipworm damage was noted on the exposed upper portions of the frame remnants FN 5-0, FN 10-1, and 10-1/1. Shipworms are discussed in greater detail in **Chapter 6**.

Table 5-2
Marine Growth on Timbers in the Stern

Name	Artifact Number	Shipworm	Barnacle	Oyster	Bryozoan	Other
Port cant frame	FN 5-0	X	X			
Port futtock	FN 10-1 & 10-1/1	X				
Port outer plank	PN 1-2		X	X	X	
Port outer plank	PN 2-1			X (3-inch)		
Port outer plank	PN 3-1					Mollusks
Port outer plank	PN 3-2	X		X		
Port outer plank	PN 6-2	X		X		
Port outer plank	PN 6-3	X		X		
Port outer plank	PN 8-2		X	X		
Port outer plank	PN 8-3		X	X		
Port outer plank	PN 9-2	X		X		
Port outer plank	PN 10-1				X	
Port outer plank	PN 10-4	X				
Port outer plank	PN 10-5	X				
Port outer plank	PN 10-6	X				
Port outer plank	PN 11-2	X				
Port outer plank	PN 11-3	X		X		
Port outer plank	PN 11-4	X	X			
Port outer plank	PN 12-1	X				
Port outer plank	PN 12-2	X				
Port outer plank	PN 12-3	X		X (3.5-inch)		
Port outer plank	PN 12-4	X				
Port outer plank	PN 12-5	X				
Starboard outer plank	PS 1-1	X		X		
Starboard outer plank	PS 2-1			X		
Starboard outer plank	PS 2-2				X	
Starboard outer plank	PS 3-1		X		X	
Starboard outer plank	PS 3-2		X		X	Juvenile periwinkles
Starboard outer plank	PS 4-1	X			X	
Starboard outer plank	PS 4-2	X	X	X	X	
Starboard outer plank	PS 5-0	X				
Starboard outer plank	PS 5-1	X			X	
Starboard outer plank	PS 5-2			X	X	
Starboard outer plank	PS 5-3A	X				
Starboard outer plank	PS 6-1A	X				
Starboard outer plank	PS 6-3			X	X	
Starboard outer plank	PS 6-4		X	X		
Starboard outer plank	PS 7-1	X	X			
Starboard outer plank	PS 8-1	X	X			
Starboard outer plank	PS 9-1	X				
Sternpost	ST-1	X		X (4-inch)		
Sternpost	ST-2	X				
Keel	Keel A			X		
Keel	Keel B			X		
Keel	Keel D	X				

Table 5-3
Marine Growth on Timbers in the Bow

Name	Artifact Number	Shipworm	Barnacle	Oyster	Bryozoan	Other
Bow Ceiling Planking	BC1	X				
Bow Ceiling Planking	BC2	X				
Bow Ceiling Planking	BC3			X	X	
Bow Ceiling Planking	BC4	X				
Bow Ceiling Planking	BC5			X	X	
Bow Ceiling Planking	BC6	X		X		
Bow Ceiling Planking	BC7	X				
Stempost	A1	X				
Stempost	A2	X				
Stempost	Stem 1 and 2	X				
Bow Cant Frame	BF 1 and 1A	X			X	
Bow Cant Frame	BF 2	X				
Bow Cant Frame	BF 3				X	
Bow Cant Frame	BF 5	X				
Bow Cant Frame	BF 11 A and B	X				
Bow Cant Frame	BF 12	X				
Bow Outer planking	BOP 1	X				
Bow Outer planking	BOP 2 (2)	X				
Bow Outer planking	BOP 3 and 3-2	X				
Bow Outer planking	BOP 4	X				
Bow Outer planking	BOP 5B	X				
Bow Outer planking	BOP 6A	X				
Bow Outer planking	BOP Garboard	X				
Bow Outer planking	Bow Port Garboard	X				

The marine life on the small number of fragmented bow timbers differed from that on the aft section. In the bow area, marine growth was observed even on the internal timbers (see **Table 5-4**). Bryozoans, oysters, and shipworms were present on the outer planking, frames, and even ceiling planking in the fragmented bow portion.

The following is a summary of the marine life observed on the ship's timbers:

1. Ship worms were the most common type of marine life, followed by oyster, bryozoan, and barnacle.
2. At least 20 percent of all ship elements displayed evidence of marine life.
3. Elements recovered from the bow were six times more likely to have marine growth than those recovered from the stern.
4. While only 1 of the 14 cant frames from the stern displayed evidence of marine life (FN5-0 - both ship worm and barnacle) over half of the nine cant frames from the bow showed evidence of ship worms.
5. Five of the seven ceiling planks recovered from the bow showed signs of ship worm damage and a few had bryozoans or oyster but none of the 14 ceiling planks (some of which were several feet long) from the stern showed signs of marine life.

Table 5-4
Count and Percentage of Marine Life by Element by Ship Portion

Element by Ship Portion	Number of Elements	Shipworm		Barnacle		Oyster		Bryozoan	
		Count	Percent	Count	Percent	Count	Percent	Count	Percent
Stern									
Keel	1	1	100			1	100		
Keelson	1	none							
Sternpost	1	1	100			1	100		
Stern Knee	1	none							
Outer Planking--Port	12	6	50	3	25	8	67	2	17
Outer Planking--Starboard	9	7	78	5	56	5	56	5	56
Ceiling Planking--Port	6	none							
Ceiling Planking--Starboard	6	none							
Cant Frames--Port	8	1	13	1	13				
Cant Frames--Starboard	6	none							
Floor Frames	15	none							
Futtocks--Port	34	1	3						
Futtocks--Starboard	11	none							
Orlop Deck--Beams	3	none							
Orlop Deck--Planking	33	none							
Total Stern	**147**	**17**	**12**	**9**	**6**	**15**	**10**	**7**	**5**
Bow									
Apron	1	none							
Stempost	1	1	100						
Outer Planking--Starboard	7	7	100						
Ceiling Planking--Starboard	7	5	71			3	43	2	29
Cant Frames--Starboard	9	5	56					2	22
Cant Frames--Port	0	N/A							
Floor Frames	0	N/A							
Futtocks	0	N/A							
Total Bow	**25**	**18**	**72**			**3**	**12**	**4**	**16**
Totals	**172**	**35**	**20**	**9**	**5**	**18**	**10**	**11**	**6**

Chapter 6: Technical Analysis of the WTC Ship and Components

This chapter discusses the results of the technical analysis of the ship remnant. This analysis proceeds from a technical description of the ship's individual components and a discussion of the construction techniques to analyses of the shipworms that infested some of the ship's timbers, the identification of the wood species used to construct the ship, and the age of the timbers (determined through dendrochronological analysis). This chapter includes an examination of the possible galley hearth, a brick and iron feature found on the stern and concludes with a functional interpretation of the vessel and a comparison of selected metrical information on the WTC Ship to various other archaeologically investigated vessels. A glossary of ship terminology has been provided at the back of this report.

A. SHIP ANALYSIS

The ship remnant was composed of hundreds of individual timber elements and fragments. For the purposes of this analysis, these timber elements were categorized based on where on the vessel they were located: **bow** (the front/forward end of a vessel), **amidships** (the middle area of a vessel), and **stern** (the rear or aft portion of a vessel). Individual elements were further defined as to which side of the vessel they originated as **port** (the left side of a ship when facing the bow from the stern) or **starboard** (the right side of the ship). The descriptors **north** and **south** were also frequently used to describe the location of a ship element in relation to the ship's orientation while *in situ*. These elements varied by their placement and function on the ship and have been categorized into several groups or key ship elements.

To allow for the analysis of the timbers in a laboratory setting, a system of labeling was used to identify and categorize the timbers. As explained in **Chapter 3**, this labeling scheme followed a variation of the nomenclature outlined by J. Richard Steffy (1994). The preserved portion of the ship remnant included a keel, keelson, sternpost, stempost, stern knee, frames, outer planking, ceiling planking, and a small orlop deck (see **Table 6-1**).[1] The total preserved length of the aft section of the ship remnant was 32.5 feet, at its widest point it was 14.5 feet, and a depth along the sternpost to keel was 7.58 feet. The ship remnant was positioned with its stern to the west, its bow to the east, its port side to the north, and its starboard side to the south (see **Figure 6-1**). A greater number of timbers on the port side were extant while some timbers on the starboard side were not present and appear to have been lost at some point before the discovery of the ship remnant. An approximately 10-foot-long portion of the vessel was destroyed during the construction of the demising wall and by excavation adjacent to the wall for installation of tiebacks near amidships (the midpoint of the ship) (see Figure 6-1). On the east side of the demising wall, the bow section was heavily fragmented and had an approximate width of 3.75 feet, length of 2.25 feet, and a preserved depth of approximately 4.5 feet, measured along the stem fragment. What remained of the bow included several cant frames, part of the stempost, the apron, several pieces of ceiling planking, and some outer planking (see Table 6-1). Samples from the aft section of the ship remnant were analyzed by Dr. Robert Blanchette (see **Appendix F**) and summarized in the description of the hull remains below and are described in greater detail in **Section D** of this chapter.

[1] These terms are defined in a Glossary included in the back of this report.

Table 6-1
Scantling List for the Principal Timbers

Timber Element Name			Sided (inches)	Molded (inches)	Length (inches)	Number (*in situ*)
Keel			6.75	9.125	362	1 continuous
Keelson			10.5	6	159	1 continuous
Sternpost			5.75	11.5	86	1
Stempost			5.625	19.5	51.75	1
Stern Knee			19.25	24.5	81.75	1
Apron			9.5	8.5	26.5	1
Outer Planking	Stern--Port		9.5	1.5		12 strakes
	Stern--Starboard		9.5	1.5		9 strakes
	Bow--Port		-	-		-
	Bow--Starboard		4.5	1.5		7 strakes
Ceiling planking	Stern--Port		6.5	0.875		6 strakes
	Stern--Starboard		6.5	0.875		6 strakes
	Bow--Port		-	-		-
	Bow--Starboard		6	0.875		7 strakes
Frames	Cant	Stern	4.75	5		14
		Bow	4.75	5		9
	Floor	Stern	5.75	5.5		15
		Bow	-	-		-
	Futtock	Stern	4.5	5		45
		Bow	-	-		-
Orlop Deck	Beams		6	2		3
	Planking		6	0.75		19

Notes: The average sided and molded dimensions are listed for outer planking, ceiling planking, frames, and orlop deck. The maximum sided and molded dimensions are listed for the keel, keelson, sternpost, stempost, stern knee and apron. Length is only provided for keel, keelson, sternpost, stempost, stern knee and apron.

B. DESCRIPTION OF HULL COMPONENTS

KEEL

The keel was only preserved in the aft section and no evidence of the keel was observed in what remained of the bow. The keel was made from a single timber of Hickory (*Carya* sp.) and no joint was found in what was preserved. The keel was 6.75 inches wide (sided) and 9.725 inches thick (molded) near amidships and narrowed toward the stern to 5.25 inches sided and 5.25 inches molded.[1] The underside of the keel was heavily worn and there was no indication of a shoe present. Because of its length, the keel was broken into three pieces during removal to allow it to be transported to the laboratory facility. Before it was broken, the keel had a minimum overall *in situ* length of 30.17 feet. The eastern end of the keel (near amidships) was heavily splintered. The western (aftmost) part of the keel was heavily fragmented as a result of shipworm damage and much of it was lost. There was a 1.5 inch rabbet cut into the keel to receive the outer planking (see **Figure 6-2**). The rabbet increased and opened up toward the stern as the angle of the planking changed and eventually the notch disappeared.

[1] Because ship timbers curve and change orientation, the traditional nomenclatures of width and depth can be misleading and are generally replaced with terms of sided and molded. The term sided refers to the horizontal distance or the width across the surface of a timber, whereas molded refers to the vertical dimension or depth.

STERNPOST

Because of the significant damage to the sternpost as a result of the shipworm infestation, the sternpost split into two fragments (ST-2 and ST-1) before removal (see **Figure 6-6**). The lowest preserved fragment of the sternpost (ST-2) had a very distinguished construction modification to allow the sternpost to articulate with and receive the keel. There was a small iron stirrup in the underside of the sternpost with a projecting wooden tenon that secured the keel to the sternpost (see **Figure 6-3**). The wooden tenon was 5.25 inches from the aft face of the sternpost and projected down inside the stirrup by 2 inches. The tenon was 2 inches wide and 1.5 inches long. The iron stirrup was comprised of a cylindrical pin situated between two rectangular plates. The plates were 2.25 inches wide and 0.25 inches thick. The plates were at least 4 inches in length; however, concretions obscured the upper part of the plates and made it difficult to determine the exact length without damaging the remains. The cylindrical pin was 4 inches long and had a diameter of 0.75 inches.

The sternpost was made from White oak (*Quercus* sp.). ST-2 had a preserved length of 44 inches and ST-1 had a preserved length of 42 inches to give an overall preserved length of 86 inches, albeit there was heavy deterioration as a result of the shipworm damage. The base of ST-2 had a preserved thickness of 11.5 inches which narrowed toward the top. Additionally, the width of the sternpost was thinner and narrower near the base (ST-2) and widened towards the top (ST-1). The width near the forward face, which abutted the stern knee, was 5.75 inches, but the sternpost narrowed toward the aft face to 2.25 inches. The forward face of ST-2 had a 70-degree angle from horizontal. There was a 1-inch-deep rabbet on the forward face of the sternpost to receive the ends of the outer planking. The base of ST-1 was 10.25 inches molded, although this narrowed to 6 inches at the top. It was 5 inches sided at the base, and widened to 5.75 inches at the uppermost preserved edge. A Roman numeral “V” was carved into the port face of ST-1, which was likely used as a lading or draught mark. The mark was observed 14.5 inches above the base of ST-1 (see **Figure 6-4**). A draught mark designates the distance between the waterline and the bottom of the keel, and indeed, the bottom of this mark was identified 64.25 inches from the bottom of the preserved keel. No other marks were visible on the starboard side of ST-1 or anywhere on ST-2.

The sternpost also had evidence of rudder attachments, including at least two iron straps and a circular gudgeon. On ST-2, the gudgeon was 2.25 inches wide and 0.25 inches thick. The circular opening of the gudgeon measured 2 inches in diameter. The gudgeon was situated 6.25 inches above the base of the outer part of the sternpost. The straps stretched from the gudgeon to the sternpost, and then continued on to connect to the outer planking (PN 2-2). The straps were 2.75 inches wide and 0.25 inches thick. The longest preserved iron strap was 38 inches in length. The strap was located 11.25 inches above the base of the forward face of the sternpost. A second pair of iron straps was preserved at the base of ST-1, which would have been about 42.5 inches higher than the strap observed on ST-2. The gudgeon on ST-1 was not completely preserved, but it left an impression at the location where it joined the straps and was encrusted with heavy oyster growth. Although much of the upper iron strap was not preserved, there were impressions of the gudgeon straps on the outside of the outer planking (PN 3-2, PN 8-3, and PS 6-4).

STEMPOST AND APRON

The stempost broke into four main fragments (Stem 1, Stem 2, A1, and A2), all of which were heavily damaged by shipworms. The topmost segment was comprised of two timbers that had been bolted together: the stempost (Stem 1) and apron (Stem 2; see **Figure 6-5**). The apron (Stem 2) was attached to the inner face of the stempost in order to provide additional support for the outer planking as it curved into it. The preserved length of the apron was 26.5 inches and it was 8.5 inches molded and 9.5 inches sided. A large spike connected the fragment of the apron to the stempost (Stem 1). Stem 1 was a maximum of 31 inches in length and was 10.5 inches sided and 6.5 inches molded. Stem 1 featured a 1.5-inch rabbet cut into its aft face to receive the ends of the outer planking. Part of a draught mark in the form of a Roman numeral "II" was preserved on the starboard face, about 16.5 inches from the bottom of Stem 1. However, since the forward face of Stem 1 had been partially destroyed, only half of the draught mark remained (see Figure 6-5). The mark indicates that this location was two feet above the bottom of the keel, thus placing the bow fragment in context with the rest of the ship remnant.

Fragments A1 and A2 were encountered just below Stem 1. Fragment A2 was a smaller triangular section of the forward face of the stempost. It was 13 inches long, 8 inches molded, and 4 inches sided. Fragment A1 was connected to the aft part of Stem 1 and preserved part of the rabbet that received the outer planking. Additionally, an iron spike protruded through the widest part of the fragment, the head of which was visible on the forward face. The preserved remains of both A1 and A2 were 19 inches in length.

STERN KNEE

The stern knee—which was broken into three fragments (AP1, AP2, and AP3)—sat on top of the keel and rested against the sternpost. This knee made from white oak (*Quercus* sp.) served to strengthen one of the weakest parts of the hull at the point where the planks narrowed and came together into the sternpost and keel (see **Figure 6-6**). Weighing just under 600 pounds, this piece of compass timber pulled together the sternpost, keel, and outer planking at the stern of the vessel. The aft face of the stern knee formed a 110-degree angle from horizontal to fit against the 70-degree angle of the sternpost (ST-2). Nails were driven in through the sternpost and outer planking to connect them to the stern knee. Iron pins in the stern knee had diameters ranging between 0.75 inches and 1.25 inches.

The aft face of the stern knee, which articulated with sternpost, was 2.625 inches wide at the base and the width increased to 4 inches at the uppermost preserved part of the face (see **Figure 6-7**). The underside of the stern knee was rounded to fit the curve of the hull. The face that sat atop the keel was 2.625 inches wide near the sternpost and increased in width to 9.125 inches toward the forward end. Near the upper part of the top face of the stern knee, the preserved width was 11.125 inches. The width flared out toward the bottom part of the top face to 19.25 inches and then narrowed again to 17.25 inches.

To further integrate the stern knee with the rest of the hull, a notch was cut in the forward part of the stern knee to receive the final floor timber frame that transversed the hull (FNFS 9-0). This notch was 3.375 inches to 4.5 inches (aft to forward) deep and 6.75 inches to 7.625 inches (bottom to top) wide. The notch easily received the floor timber (FNFS 9-0), which was 5.5 inches wide (sided) and 5.5 inches thick (molded).

Forward of this notch, the stern knee continued for a length of 12.875 inches and was 12.625 inches thick before another notch was encountered. This 5-inch notch continued to the forward end of the stern knee for a distance of 11.75 inches. The floor timber FNFS 10 was positioned at the forward end of the stern knee. The preserved length of the stern knee along the keel was 81.75 inches on the starboard side and 80.5 inches on the port side. The preserved height along the sternpost was 38.375 inches on the starboard side and 36.25 inches on the port side. However, the upper portion of the stern knee was heavily fragmented and broke apart into several fragments (AP1, AP2, and AP3) during the removal of the stern knee.

KEELSON

The keelson, also hewn from white oak (*Quercus* sp.), sat atop the floor timbers to provide additional longitudinal support to the vessel (see **Figure 6-8**). As it was not specifically notched to fit over the floor timbers, the underside showed impressions where the frames had been located. There were only four iron bolts attaching it to the floor timbers. Narrowing toward the stern, the keelson had a molded thickness of 5 inches near the stern and 6 inches toward amidships, and it had a sided width of 7 inches near the stern and 10.5 inches near amidships. The keelson was fragmented and splintered near the forward (eastern) end and had an overall length of 159 inches. In what remained, there was no indication of a mast step, suggesting that if a mast were present, it would have been stepped farther forward.

FRAMES

Frames were preserved in both the bow and stern sections, however, only heavily fragmented cant frames remained in the bow. Several frames from the aft section that were analyzed were a species of white oak (*Quercus* sp.) (see Appendix F). In the stern, the framing pattern consisted of eight cant frames on the port and six extant cant frames on the starboard before the first floor timber (FNFS 9-0). Forward of the cant frames in the stern, the floor timbers that traversed the keel alternated with futtocks and additional futtocks were added above the floor timbers (see **Figure 6-9**). The futtocks were fastened only to the outer planking and were not fastened to the floor timbers. As such, space between the futtocks and floor timbers varied (see **Table 6-2**). Some timbers abutted the next (i.e., FNFS 10-0 and FS 10-2 and FNFS 14-0 and FN 14-1) while others were separated by as much as 8 inches (i.e., FN 10-1 and FNFS 11-0). While the floor timbers were generally perpendicular across the keel, the angle of the futtocks relative to the keel varied and were not as regularly spaced nor orthogonal. It appeared that attention was not given to the symmetry of the frames during the ship's construction.

Table 6-2
Frame Dimensions--Stern

Frame Number	Width (in)	Thickness (in)	Length (in)	Space forward (in)
FNFS 9	5.5	5.5	98	5.5
FN 9-1	5.25	5.25	85.5	2
FS 9-2	5	5	44.5	13.25
FN 9-3	2	4	5.75	1.5
FN 9-5	2.5	1.5	10.5	1.75
FNFS 10	5.75	5.5	103.5	0
FN 10-1 & 10-1/1	5.75	4.25	89	8
FS 10-2	6.5	5.25	46.5	7
FN 10-5	6.25	4.75	23	2.25
FNFS 11	5.75	6	113.75	3.5
FN 11-1	6.5	4.75	76.5	2.75
FS 11-2	5.5	5.5	41	0
FN 11-3/1	4.5	4	10	5.5
FN 11-3	4.25	4.25	31	1/8
FN 11-5	4	2.75	14.5	2.75
FNFS 12	4.5	5.25	110.5	8 (N),3.25 (S)
FN 12-1	4.75	5	75	2.5
FS 12-2	5	5	41	4.25
FN 12-3	5	3	27	5.25
FN 12-3/1	5.75	3.5	13	3.5
FS 12-4	5	4	15.5	NR
FN 12-5	4	4	16	1.75
FNFS 13	4.75	5.5	110.5	3 (N), 8 (S)
FN 13-1	5.5	5.5	78.75	3.5
FS 13-2	6.25	4.75	58	1.75
FN 13-3/1	3.25	4	10	1.25
FN 13-3	4.5	4	42	2.75
FNFS 14	5	4.75	127	0
FN 14-1	5.5	5.5	41	7
FS 14-2	6	5.25	51	6.75

Table 6-2 (cont'd)
Frame Dimensions--Stern

Frame Number	Width (in)	Thickness (in)	Length (in)	Space forward (in)
FN 14-3	4.5	3.25	25.75	2.5
FN 14-5	4	4.25	25	3.75
FN 14-7	5.5	4.5	47	.75
FNFS 15	6	6	131.5	3.5 (N), 2.25 (S)
FN 15-1	4	6	81	5.75
FS 15-2	4	5	46	6.75
FN 15-3	4.25	4.5	34.5	3.75
FN 15-5	4	4	17.25	0
FNFS 16	5.75	6	133.25	2 (N), 8.25 (S)
FN 16-1	5	5	64	1.75
FN 16-3	8.25	5.5	59.5	26
FNFS 17	5.75	5.25	102.5	3.75
FN 17-1	5	5	68	3/4
FN 17-3	6.75	4	36.5	NR
FNFS 18	6	6	99.75	2.5
FN 18-1	4	5.5	61	3.5
FN 18-3	4.5	4	32	NR
FN 18-5	4.5	4.75	37.5	NR
FNFS 19	6.25	6.25	90	2.5
FN 19-1	6.5	6	82.5	NR
FS 19-2	5.75	5.75	65	NR
FN 19-3	5.5	6	18	NR
FNFS 20	5.75	6.25	139	NR
FN 20-1	5.75	5.25	76	NR
FS 20-2	5.75	6.25	70.5	NR
FNFS 21	6	6	138	NR
FN 21-1	5	5 3/8	81	NR
FS 21-2	4.5	6	32	NR
FNFS 22	6	6 3/8	143	NR
FN 22-1	5.25	4.5	80	NR
FN 22-3	4.5	4.5	11	NR
FNFS 23	5.5	5.5	131	NR
FN 23-1	5 1/8	5	73	---

Notes: All measurements are the maximum preserved dimensions. Space forward was measured to the next timber. NR = "not recordable."

CANT FRAMES

In the bow, fragments of nine cant frames were recovered. The frames were closely spaced and appeared to fan out from the stempost (see **Figure 6-10**). Because of the position of the ship remnant relative to the demising wall, the frames were not preserved on the port side of the bow. The longest cant frame recovered during the removal of the bow measured 31.625 inches in length. The sided dimension of the frames ranged from 3 to 8.25 inches and the molded dimension ranged from 1.75 to 6 inches (see **Table 6-3**).

Table 6-3
Cant Frames--Bow

Cant Frame Number	Sided (in)	Molded (in)	Length (in)
BF 0	3	2.5	8
BF 1	4.5	5	29.5
BF 1(A)	4.5	1.75	6
BF 2	5 1/8	6	31 5/8
BF 3	5.5	5	30
BF 4	4.25	4.5	17.5
BF 5	7.25	4	15.75
BF 11 A	8.25	3	7.75
BF 11 B	4.25	2	4
BF 12	4.75	4	12
BF F	4	1.75	22.5

In the stern, the cant frames were very closely spaced at the bottom near the keel. On the port side, there was a distance of 5.5 inches between FN 7-0 and FN 8-0, 9.5 inches between FN 6-0 and FN 7-0, and 8 inches between FN 5-0 and FN 6-0 (see Figure 6-9). However, at the distal end of the cant frames of the stern, distances between frames ranged from 7.5 inches (between FN 1-0 and FN 2-0) to as much as 16 inches (between FN 5-0 and FN 6-0). The cant frames on the starboard side were not as well-preserved and were fractured. There were two empty spaces on the starboard side, possibly marking the locations where cant frames had once been. The sided dimensions of the cant frames ranged between 3.25 inches and 6.5 inches and the molded dimensions measured between 3.5 inches and 6 inches (see **Table 6-4**). One frame (F0) was aligned with the sternpost and likely served to reinforce the sternpost as an inner sternpost or sternson. A copper coin was found under this frame during the cleaning process at the MAC Lab.

Table 6-4
Cant Frames--Stern

Cant Frame Number	Maximum Width (in)	Average Thickness (in)	Preserved Length (in)	Space to Next Frame (in)
F 0	5.5	3.5	20.5	10 (FN1), 9.5 (FS1)
FN 1	4	5	50.5	7.5
FS 1	5.25	5	49.5	18.5
FN 2	5.25	6	65	9.5
FN 3	4.75	5.5	75	9
FN 4	3.75	4	48	4*
FS 4-1 and FS 4-2	6	6	87	14*
FN 5	5.75	n/a	97	16
FS 5 and FS 5-1	5	4	64	3*
FN 6	6.5	5.5	86	15
FS 6	6.25	5.75	42.5	13
FS 6-1	4	3.5	19.5	n/a
FN 7	6.5	5.25	84	11.5
FN 8	5.25	5.25	87	2.5*
FS 8	3.25	5.25	45	7.75
Notes: Spaces to the next frame are measured at the top unless noted. * Measured at proximal end.				

FLOOR TIMBERS

There were fifteen preserved floor timbers (designated in Table 6-2 with “FNFS”). The aftmost (westernmost) floor timber (FNFS 9-0) had the most pronounced curvature, indicative of the changing hull in the stern section in order to close the vessel (see **Figure 6-11A**). The curvature of a vessel’s frames is indicative of their placement within the hull; for example, the frames near the stern of a flat bottomed vessel would be more curved than those amidships to allow for the frames in the stern to close the vessel into the sternpost. The ship remnant's floor timbers FNFS 20-0, FNFS 21-0, FNFS 22-0, FNFS 23-0 were generally straight with little curvature indicating that they were nearing amidships (see **Figure 6-11B**). Similarly, the floor timbers tended to increase in length toward amidships. The longest floor timber had a preserved length of 143 inches (FNFS 22-0). The sided dimension ranged from 4.5 inches to 6.25 inches with an average of 5.75 inches. The molded dimension ranged from 4.75 inches to 6.375 inches with an average of 5.5 inches.

One iron drift pin was inserted into the center of each floor timber to connect it to the keel. Although most of these were broken, the pin in FNFS 23-0 was mis-hit and protruded from the bottom of the frame by 9.5 inches (see **Figure 6-12A**). The total preserved length of that pin was 15.25 inches and its diameter was 0.625 inches.

The floor timbers forward of and including FNFS 12-0 featured notches ranging in depth between 0.125 and 1 inch to fit over the keel (see **Table 6-5**). This notch was 12.5 to 14.5 inches wide, which was more than 5 inches wider than the 6.75-inch wide keel. Concretion was preserved on six of the floor timbers to indicate the position of the keel and it usually extended to fill the wide notch beyond the actual keel width. In addition to concretion in the area between the notch and the keel there were wood fillers, such as one piece of wood measuring 0.0625 inches in width in FNFS 21-0 and a circular filler plug 0.5 inches wide in FNFS 15-0 (see **Figure 6-12B**).

The other faces of the frames also had distinguishing marks, including tool marks on the frame timbers showing where they had been cut and shaped. Additionally, impressions of the keelson were visible on the upper face of several of the floor timbers. On the side of one timber (FNFS 14-0), three nails had been hammered into the side. These nails were located 3 inches, 4 inches, and 5.25 inches above the bottom of the frame. Timber FNFS 19-0 had a nail from the outer planking that angled through its side. Frame FNFS 23-0 also had two marks cut into the aft face that corresponded to the location of the keel (see Figure 6-12A).

Table 6-5
Floor Timbers

Floor Number	Keel Notch Depth (in)	Keel Notch Width (in)	Keelson Width (in)
FNFS 09-0	none	none	none
FNFS 10-0	none	none	none
FNFS 11-0	none	none	10.25
FNFS 12-0	0.5 to 0.75	13.25 (7)	12
FNFS 13-0	0.25	12.5 (10)	None
FNFS 14-0	0.75	NR	10^
FNFS 15-0	0.5	12.75 (10.125)	12
FNFS 16-0	NR	13.25 (6.75)	13
FNFS 17-0	0.75	13.25	None
FNFS 18-0	0.625 to 0.75	13.25	None
FNFS 19-0	0.125 to 1	14.5	None
FNFS 20-0	0.25 to 0.75	12.5	None
FNFS 21-0	0.25 to 0.5	13 (6.75)	None
FNFS 22-0	0.25 to 0.75	14	One mark
FNFS 23-0	0.5	13.25 (7.25)*	12

Notes: The floor timbers were notched for the keel but they were much wider than the actual keel impression. There was a visible keelson impression on only several floor timbers.
NR = "not recordable"
^ there was an additional impression at 16 inches in width
* marks on side of frame align with the keel

FUTTOCKS

The floor timbers, which transversed the keel, alternated with futtocks, which did not articulate with the keel. In general, a set of two futtocks, one on the starboard and one on the port, were preserved within the ship remnant in addition to the floor timber for each corresponding frame. The inner end of the futtocks varied in distance from the keelson between 4 inches and 9 inches. The longest preserved futtock (FN 10 1) was 89 inches in length. The sided dimensions also varied between 2 inches and 8.25 inches, as did the molded dimensions between 1.5 inches and 6.375 inches (see Table 6-5). The futtocks tapered toward their proximal ends. Nails connected the outer planking and ceiling planking to the futtocks, however, the futtocks were generally not connected to the floor timbers. There were several nails that pierced the sides of the frames: a nail in FS 19-2 was mis-hit from the outer planking; a nail transfixed the side of FS 10-2 and two nails pierced the forward side of port futtock FN 23-1.

OUTER PLANKING

The outer planking in the remnants of both the bow and the stern varied in thickness from 1 inch to 1.875 inches and it averaged 1.5 inches (see **Figure 6-13**). Seven different strakes were preserved in the bow section (see **Table 6-6**). Because of the heavy shipworm damage, the fragments were extremely friable. The longest fragment (BOP 1) was 21.5 inches in length and sided dimensions ranged between 3 and 8.25 inches.

In the stern, the width of the planking ranged from 1.5 inches to 14.5 inches and narrowed toward the stern (see **Table 6-7**). Stealer strakes, such as PN 5-1, were used to aid in this narrowing (see **Figure 6-14**). The planks terminated at the rabbet that was cut into the sternpost. The convex curvature seen in this planking defines the stern as a round tuck stern. A round tuck stern is one in which the planking comes into the sternpost at an angle (a square tuck stern is typified by planking that is perpendicular to the sternpost).

Table 6-6
Outer Planking—Bow

Plank Name	No. of Fragments	Sided (in)	Molded (in)	Length (in)
BOP Garboard	4	4.25	1.75	10.25
BOP 1	1	8.25	1.75	21.5
BOP 2	5	5	1.75	14
BOP 2-2 and 2-3	2	4	1.75	12.5
BOP 3	7	5.5	1.5	15
BOP 3-2	7	4	1.875	10
BOP 4	3	4.5	1	16
BOP 5A	7	7.5	1	9.5
BOP 5B	1	6	1.75	12.25
BOP 6A	5	3	1.5	6.5
Notes: All measurements are the maximum preserved dimensions.				

Table 6-7
Outer Planking—Stern

Plank Name	No. of Fragments	Width (in)	Thickness (in)	Length (in)
PN 1-1	2	11.25	1.5	54
PN 1-2	2	11	1.5	190.75
PS 1-1	4	12.25	1.5	314
PN 2-1	2	13.5	1.5	223
PN 2-2	1	13.5	1.5	107
PS 2-1	1	14.5	1.625	195
PS 2-2	2	14.5	1.5	108
PN 3-1	1	11.5	1.75	155.5
PN 3-2	3	10.75	1.25	177.5
PS 3-1	1	13.75	1.75	99.5
PS 3-2	3	13.5	1.875	226.5
PN 4-1	1	10.75	1.25	130.5
PN 4-2	1	10.5	1.5	185
PS 4-1	1	12.75	1.5	74.5
PS 4-2	6	1.5 (min)	1.5	191
PN 5-1	1	4	1.5	196
PS 5-0	1	9	1.5	24.5
PS 5-1	2	10.25	1.5	65
PS 5-2	1	10	1.5	128.75
PS 5-3	2	11.75	1.5	94
PN 6-1	1	10	1.75	61
PN 6-2	2	10.75	1.5	220
PN 6-3	1	11	1.5	100
PS 6-1	2	5.75	1.5	28
PS 6-2	2	6.5	1.5	75
PS 6-3	2	10	1.5	100
PS 6-4	1	11	1.5	39.25
PN 7-1	1	9.25	1.25	116
PN 7-2	3	9.25	1.25	275
PS 7-1	2	10	1.5	73.5
PN 8-1	1	9	1.5	146
PN 8-2	2	8.75	1.25	191.5
PN 8-3	1	9.5	1.625	54.5
PS 8-1	2	10.75	1.25	50.25
PN 9-1	2	8.5	1.25	165
PN 9-2	4	9.75	1.5	151
PN 9-3	1	10.5	1.5	51.5
PS 9-1	1	4.5	1	23.75
PN 10-1	1	4.5	1.25	46
PN 10-2	1	9.25	1.5	50.25
PN 10-3	1	2.75	1.375	50
PN 10-4	1	9.75	1.5	189
PN 10-5	2	9	1.5	24
PN 10-6	1	9.5	1.25	34.5
PN 11-1	1	9.5	1.375	97
PN 11-2	1	10	1.5	98
PN 11-3	3	9.75	1.5	42
PN 11-4	3	12	1.5	34
PN 12-1 and 12-2	3	4.5	1.5	24.5
PN 12-3	1	9	1.5	39.25
PN 12-4	1	9.5	1.5	7.5
PN 12-5	1	8.25	1.5	9.25

Notes: All measurements are the maximum preserved dimensions unless otherwise noted.

One outer plank (PS 1-1) spanned the entire length of the remnant and was 314 inches (26.17 feet) long. The other strakes were formed by up to four individual planks or plank fragments. The outer planking seemed to have been heavily repaired during the vessel's period of use. Timbers PN 10-3, PS 3-1, PN 11-2B, and PN 7-2 were filler pieces that were added after the construction of the vessel. Plank PN 3-1 featured a hole that was made by an unidentified truncated vertical spruce timber (SN-1). SN-1 was 13.375 inches long and had and 6 inches sided by 6.5 inches molded (see **Figure 6-15**). This timber had a rounded bottom. The hole observed in plank PN 3-1 was not cut into the planking, but was instead punched through when SN-1 was pushed downward by an unknown force. Because this timber rested on the planking and ultimately weakened the outer plank PN3-1, it seems unlikely to have been part of the original structure.

The garboard strake (formed by PS 1-1, PN 1-1, and PN 1-2) had a 1.5-inch beveled edge to fit into the rabbet of the keel. The edges of the planks were caulked with oakum up to 0.25 inch thick. Oakum was usually made from rope that had been unwound and picked apart before the fibers were rolled and driven into seams in order to waterproof them. The ends of the planking were attached to each frame with three nails and generally two nails were driven into the plank to attach it to each frame. The nails for the outer planking were approximately 3.5 inches in length and were 0.5 inches square. There were a few trunnels observed in the outer planking, but these did not seem to be used for fastening the outer planking to the frames (this is discussed in greater detail below).

CEILING PLANKING

Fragments of ceiling planking were found in both the bow (see **Figure 6-16**) and the stern (see **Figure 6-17;** note that planks are depicted as if flattened onto a two-dimensional plane). Overall, the ceiling planking generally had a uniform thickness of 0.875 inches, although it ranged between 0.375 inches and 1.25 inches. In the bow, the longest fragment was 18.25 inches and sided dimensions ranged from 3.75 to 6.5 inches (see **Table 6-8**). As it was the uppermost surface of the ship remnant and was therefore exposed to destructive forces, the ceiling planking was heavily fragmented. There were seven strakes on the starboard side of the bow. Any remnants of the ceiling planking on the port side of the bow were not extant during the recovery of the ship remnant.

Table 6-8
Ceiling Planking—Bow

Plank Name	Sided (in)	Molded (in)	Length (in)
BC 1	3.75	0.75	6
BC 2	6	0.375 to 0.875	18.25
BC 3	5.75	0.875	18
BC 4	6.5	1.25	12
BC 5	4.5	0.75	10.25
BC 6	5	0.875	9
BC 7	4	0.875	8.5
Notes: All measurements are the maximum preserved dimensions.			

For the stern, the widths of the ceiling planking ranged between 1.75 inches and 15.5 inches. The longest plank was made up of fragments CN 4/6 and 4/7, which had a combined length of 142.75 inches (see **Table 6-9**). The ceiling planking was made from several species including white oak (*Quercus* sp.), pine (*Pinus* sp.), and spruce (*Picea* sp.), as determined by Dr. Robert Blanchette (see Appendix F). The nails for the ceiling planking measured 0.375 by 0.375 inches and were tapered. The ceiling planking was not caulked between the strakes. A hole measuring 3.75 inches square was cut into CN 4/7, perhaps the former location of a bilge pump (see **Figure 6-17**). Several of the planks along the keelson did not contain nails or nail holes (e.g., CS 0, CS 1/1, CS 1/4, CN 1/2, CN 1/5, CN 1/6), which suggests that these boards could have been limber planks that were lifted and removed to access the bilge water.

Table 6-9
Ceiling Planking—Stern

Plank Name	Sided (in)	Molded (in)	Length (in)
C0-1	8	2 .125	42
C0-2	5	1	36
CS 0	6.5	0.875	16.5
CN 1 Q/1	5.75	0.875	18.25
CN 1 Q/2	4.75	1.25	9.5
CN 1/1	5.5	0.75	33
CN 1/2	5	0.875	20
CN 1/3	9.5	0.5	21
CN 1/4	3.25	0.5	5.25
CN 1/4A	3.75	0.625	3.5
CN 1/5	4.25	1.125	29.5
CN 1/6	4.25	1	41.75
CN 1/7	4.5	1	29
CN 1/8	3.875	1	19.375
CS 1/1A	5	1	6
CS 1/1 and 1/2	4	1	46.5
CS 1/3	3.5	1	8.5
CS 1/4	3.75	1	19.25
CN 2/1	5.5	1	32.25
CN 2/2	1.875	0.875	5
CN 2/3	1.75	1	17.75
CN 2/4	2.5	1.125	17.5
CN 2/5	9	0.75	34.75
CN 2/6	3.75	0.75	18.75
CN 2/7	4.5	0.875	16.5
CN 2/8 and CN 2/9	6	.75	34.5
CN 2/10	2.25	0.875	10
CN 2/11	3.75	0.875	11.75
CN 2/12	5.5	0.875	10.5
CN 2/13	8	1	42.5
CN 2/14	7	1.125	19
CN 2Q1	5	1	10.25
CN 2Q2	4.125	1	10.25
CN 2Q3	3.75	1	16.5
CN 2Q4	3.75	1	6.75
CN 2Q5	6.25	0.875	10.5
CS 2/1	5.25	0.875	8
CS 2/2	5	1	11.25
CS 2/3	5	0.75	4.5
CS 2/4	4	1	6.5
CS 2/5	8.5	0.875	32.5
CS 2/6	6.5	1	7
CS 2/7	4.75	1	7
CS 2/8	7	1	12
CS 2/9	2	1	6.25
CS 2/10	2.25	1	5.75
CS 2/11	3.5	1	7
CS 2/12	8	1	12.5
CS 2/13	7.75	1	7.25
CS 2/14	8	1	13.75
CS 2/15	7	0.875	13.25
CS 2/16	3.5	0.875	20
CN 3/1	7	0.875	19
CN 3/2	9.5	0.875	65.5
CN 3/3	6.25	0.75	43

Table 6-9 (cont'd)
Ceiling Planking—Stern

Plank Name	Sided (in)	Molded (in)	Length (in)
CN 3/4	6.25	0.875	22
CN 3/5	6	0.75	32.5
CN 3/6	13	1	114.5
CN 3/7	4.5	0.75	8
CN 3/8 and CN 3/9	5.5	0.875	66.5
CN 3/10 and 3/10A	15.5	0.875	103
CS 3/1	7.5	1	19
CS 3/2 and 3/3 & 3/4	7	1	76
CS 3/5	10	1	62
CS 3/6	7	1	27
CS 3/7 and CS 3/8	7.75	1	108
CS 3/9	8	1	21
CS 3/14	3	1	9.5
CN 4/1 to CN 4/5	11.25	1	86.25
CN 4/6	11.25	1	122.25
CN 4/7	8.75	1	20.5
CN 4/8	7	1	21
CN 4/8A	3	0.5	16.375
CN 4/9	3.75	1	22.875
CS 4/1	6.5	0.875	46
CS 4/2	4.75	0.875	37
CS 4/3	9.25	1	100.75
CS 4/4	3	1	21.75
CS 4/6	3	1	5.5
CN 5/1 to CN 5/10	11.75	1	99
CN 5/11	11	1	58.75
CS 5/1	7	1	32.75
CS 5/2	5.5	0.625	27.25
CS 5/3	6	1	33.25
CS 5/4	6.25	0.875	35.5
CS 5/5	10.25	1	74
CS 5/6	5	1	27
CN 6/1 to CN 6/5	13	1.875	30.75
CS 6/1	2.5	1	16.5
CS Q16	7.5	1	34.5
CS Q17	4.75	0.375	21.5
CS Q18	4.5	0.875	10.5
CQ 18	7	1	17
Notes: All measurements are the maximum preserved dimensions.			

ORLOP DECK

The orlop deck is a short, low deck above the hull at the stern of the ship. Although it was collapsed, the orlop deck was the only elevated deck surface identified on the ship remnant. The orlop deck was made up of the planking that made up the floor of the deck and deck beams, or support timbers mounted across the ship, perpendicular to the keel ("athwartships"). The deck had dimensions of approximately 12 feet at its longest and 7.67 feet at its broadest (see **Figure 6-18**). Three fractured beams spanned the breadth (see **Table 6-10** and Figure 6-18). Four 5.25-inch-wide timber fragments represented deck beam 1 (ODB 1/1, 1/2, 1/3, and 1/4) for a combined length of 87.25 inches. Four 6.5-inch-wide timber fragments comprised deck beam 2 (ODB 2/1, 2/2, 2/3/, and 2/4) for a reconstructed length of 80.25 inches. Deck beam 3 was represented by two 6-inch-wide timber fragments (ODB 3/1 and 3/2) for a reconstructed length of 31 inches. The preserved thickness of the three beams varied. The ends of ODB 1/1, 2/1, and 3/2 were tapered and there was an impression on the underside of ODB 2/1 as if it had been resting on an unknown object.

Table 6-10
Orlop Deck Beams

Beam Number	Sided (in)	Molded (in)	Length (in)
ODB 1/1	5.25	3	43.75
ODB 1/2	5.25	2.5	21.25
ODB 1/3	5.25	2.5	4.5
ODB 1/4	5	1	22.25
ODB 2/1	6.5	1 3/8	8.75
ODB 2/2	6.5	2 3/8	28.5
ODB 2/3	6	2.5	33.5
ODB 2/4	6.75	1.5	9.5
ODB 3/1	6	2.5	12.5
ODB 3/2	6	2 7/8	18.5
Notes: All measurements are the maximum preserved dimensions.			

The orlop planking was heavily fragmented and scattered toward the center of the deck (see Figure 6-18). The weight of the overlying fills likely weakened it and the operation of heavy equipment in this area before discovery of the ship probably affected the orlop deck more than other better supported portions of the ship. In addition, the orlop deck was exposed to the elements longer than any other portion of the ship. The planking varied in thickness from 0.375 to 1 inch and had an average thickness of 0.75 inches (see **Table 6-11**). The edges of planks OP 1/1 to 1/3 and OP 9/1 tapered on their undersides, where they fit against the hull of the ship. The nail pattern in the planking suggests that each corner of the plank was attached to the beam with one small tack. The tacks that held the planking to the beams measured 0.25 by 0.125 inches. Some of the nails in the planking were placed in areas without any beams and some of the nails in the beams did not connect with the planking (see **Figure 6-19**). The deck beams were fashioned from white oak (*Quercus* sp.) and the planking from spruce (*Picea* sp.), as determined by Dr. Robert Blanchette (see **Appendix F**).

UNPROVENIENCED TIMBERS

Several timbers were recovered during the archaeological investigation that were no longer *in situ*, but appear to have belonged to the ship remnant. For the bow, these timbers were labeled according to their location as either north or south relative to the stempost. For the stern, timbers labeled “Z” and “BZ” were documented and removed prior to the full excavation of the ship remnant and therefore were not individually labeled in the field. Additionally, some diagnostic timbers were found outside of the ship or were loose within the fill and these timbers were labeled as “Out.” The Out timbers were sequentially numbered according to the order of discovery. Hypothesized designations based upon nail patterns and impressions are included in **Table 6-12**.

Table 6-11
Orlop Deck Planking

Plank Name	Sided (in)	Molded (in)	Length (in)
OP 1/1, 1/2, and 1/3	11.25	0.75	41.5
OP 2/1	27	0.875	18.5
OP 2/2	6.5	0.5	25.25
OP 2/3	12.5	0.875	18.5
OP 2/4	5.25	0.75	27.75
OP 3/2	6	0.5	31
OP 3/1	6	0.75	25
OP 4/1	1.5	1	24
OP 4/2	5	0.375	28.5
OP 5/1	6.5	1	32
OP 6/1	6.875	1	23.375
OP 6/2	5.75	0.625	13.5
OP 7/1	12.5	0.875	21
OP 8/1	12	0.75	15
OP 8/2	12	0.625	40
OP 8/3	12	0.875	10
OP 9/1	10.5	0.75	33.25
OP 10	6	0.75	27
OP 11	4	0.875	37
OP 12 and 12/2	8.5	0.625	16
OP 13	5.625	0.75	14
OP 14	6.75	0.875	14.25
OP 15	5.875	0.75	16.25
OP 20/1 and 20/2	5.5	0.75	20.5
OP 21/1	2	0.5	18
OP 21/2	3	0.625	13
OP 21/3	1.25	0.5	13
OP 21/4	1.25	0.5	24.5
OP 22/1	4.5	0.375	13.5
OP 23/1	13	1	20.75
OP 23/2	7.75	1	17.5
OP 23/3	2.5	0.5	6.25
OP 23/4	3	0.5	8.25
Notes: All measurements are the maximum preserved dimensions.			

Table 6-12
List of Unprovenienced Timbers and their Possible Functions

Timber Name	Hypothesized Purpose	Timber Name	Hypothesized Purpose	Timber Name	Hypothesized Purpose
BZ 2-1	Ceiling planking	BZ 4-9	Ceiling planking	Out E	Unknown
BZ 2-2	Ceiling planking	BZ 4-10	Ceiling planking	Out F	Frame
BZ 2-3	Ceiling planking	BZ 5-1	Ceiling planking	Out G	Unknown
BZ 2-4	Ceiling planking	BZ 5-2	Ceiling planking	Out H	Outer planking
BZ 2-5	Ceiling planking	BZ 5-3	Ceiling planking	Out I	Outer planking
BZ 2-6	Ceiling planking	BZ 5-4	Ceiling planking	Out J	Unknown
BZ 2-7	Ceiling planking	BZ 5-5	Ceiling planking	Out K	Outer planking
BZ 2-8	Ceiling planking	BZ 5-6	Ceiling planking	Out L	Unknown
BZ 2-9	Ceiling planking	BZ 5-7	Ceiling planking	Out M	Unknown
BZ 2-10	Ceiling planking	BZ 5-8	Ceiling planking	Out N	Outer planking
BZ 2-11	Ceiling planking	BZ 5-9	Ceiling planking	Out P	Outer planking
BZ 2-12	Ceiling planking	BZ 5-10	Ceiling planking	Out Q	Ceiling planking
BZ 2-13	Ceiling planking	BZ 5-11	Ceiling planking	Out R	Unknown
BZ 2-14	Ceiling planking	BZ 5-12	Ceiling planking	Out S	Unknown
BZ 2-15	Ceiling planking	BZ 5-13	Ceiling planking	Out T	Unknown
BZ 2-16	Ceiling planking	BZ 5-14	Ceiling planking	Out U	Ceiling planking
BZ 2-17	Ceiling planking	BZ 6-1	Ceiling planking	Out W	Knee
BZ 3-1	Ceiling planking	BZ 6-2	Ceiling planking	Out X	Unknown
BZ 3-2	Ceiling planking	BZ 6-3	Ceiling planking	N. Side Unknown 1	Unknown
BZ 3-3	Ceiling planking	BZ 6-4	Ceiling planking	N. Side Unknown 2	Unknown
BZ 3-4	Ceiling planking	BZ 6-5	Ceiling planking	N. Side Unknown 3	Unknown
BZ 3-5	Ceiling planking	Untagged	Ceiling planking	N. Side Unknown 4	Unknown
BZ 3-6	Ceiling planking	Untagged	Ceiling planking	N. Side Unknown 5	Unknown
BZ 3-7	Ceiling planking	Out 1	Unknown	N. Side Unknown 6	Unknown
BZ 3-8	Ceiling planking	Out 2	Unknown	N. Side Unknown 7	Unknown
BZ 3-9	Ceiling planking	Out 3	Ceiling planking	N. Side Unknown 8	Unknown
BZ 3-10	Ceiling planking	Out 4	Ceiling planking	N. Side Unknown 9	Unknown
BZ 3-11	Ceiling planking	Out 5	Ceiling planking	N. Side Unknown 10	Unknown
BZ 3-12	Ceiling planking	Out 6	Ceiling planking	N. Side Unknown 11	Unknown
BZ 3-13	Ceiling planking	Out 7	Ceiling planking	N. Side Unknown 12	Unknown
BZ 3-14	Ceiling planking	Out 8	Possible Frame	N. Side Unknown 13	Unknown
BZ 4-1	Ceiling planking	Out 9	Unknown	S. Side Unknown 1	Unknown
BZ 4-2	Ceiling planking	Out 10	Unknown	S. Side Unknown 2	Unknown
BZ 4-3	Ceiling planking	Out 11	Unknown	S. Side Unknown 3	Unknown
BZ 4-4	Ceiling planking	Out 12	Unknown	Outside 1	Unknown
BZ 4-5	Ceiling planking	Out A	Frame	Outside 2	Unknown
BZ 4-6	Ceiling planking	Out B	Frame	Outside 3	Unknown
BZ 4-7	Ceiling planking	Out C	Beam		
BZ 4-8	Ceiling planking	Out D	Frame		

C. CONSTRUCTION TECHNIQUES

SHEATHING

There was no evidence of outer sheathing on the surface of the outer planking. It is possible that if outer sheathing was formerly present, the holes left by the nails that would have held the sheathing in place have since swelled shut and are no longer visible. However, the total lack of evidence of sheathing on any outer plank makes it unlikely that sheathing was ever present. Preserved hair and pitch were identified on the outer planking, which was apparently used to seal the hull in the place of sheathing. Preliminary microscopic studies of the hair suggest that at least one strand is human and contained a preserved louse, as shown in **Figure 6-20** (Pearson, personal communication October 21, 2010).[1] Despite the attempts of the ship's master to seal the hull, a layer of marine growth (including shipworms) was present on the ship's timbers (described in greater detail in **Chapter 7**) which resulted in significant damage to the timbers.

FASTENERS

Most of the fasteners on the WTC Ship were iron nails, as discussed in the above description of hull components. Iron pins in the stern knee had diameters ranging between 0.75 inches and 1.25 inches. The iron drift pin connecting floor timbers to keel had a length of 15.25 inches and a diameter of 0.625 inches. The nails for the ceiling and outer planking were approximately 3.5 inches in length and were 0.5 inches square. The tacks that held the planking to the beams measured 0.25 by 0.125 inches. The length was not attainable from the remains in the beams but would have likely had a minimum length of 1.5 inches.

However, the remnants of several trunnels were observed within the ship remnant. The trunnels were located on six frame timbers and three outer planks (see **Table 6-13**). It is possible that the frames with trunnels (FN 18-5, FN 5-0, FN 17-3, FN 16-3, Z1, and Z2) were recycled from older vessels because corresponding trunnels were not found either in the outer planking or in the ceiling planking associated with those frames. The three trunnels in the outer planking (PS 3-1, PN 3-1, PS 2-1) were located between frames. The trunnels, which were approximately 0.75 to 1 inch in diameter, do not seem to be plugs in the wood for knots. One trunnel, in PN 3-1, protrudes a distance of 0.0625 inches on the exterior of the hull and 2 inches into the interior. In most examples, only the trunnel holes remained, yet in those in which a trunnel was preserved, the trunnel was octagonal in cross section (see **Figure 6-21**).

Table 6-13
Wooden Fasteners

Name	Artifact Number	Number of Trunnel Remains		Wooden Plug/Nail
		Outer Planking	Ceiling Planking	
Port Futtock	FN 18-5	1		
Port Cant Frame	FN 5-0	2		
Port Futtock	FN 17-3	4	4	
Port Futtock	FN 16-3	5	6	
Starboard Outer Planking	PS 3-1	1*		
Starboard Outer Planking	PS 2-1	1*		1
Port Outer Planking	PN 3-1	1*		
Port Outer Planking	PN 2-1 (B)			1
Port Outer Planking	PN 9-1A			2
Port Outer Planking	PN 1			4
Notes: *between frames.				

Four pieces of outer planking contained wooden pieces that pierced the wood like nails or "coaks." A coak is a small wooden pin that could be added to the ends of timbers that were about to be joined in order to align or strengthen the joint. In planks PS 2-1, PN 2-1B, and PN 1, the coaks are in line with the iron nail pattern and often appear in place of the nails. Only in plank PN 9-1A do the coaks appear to be struck through knots.

[1] Hair deposits were found in several ship-related contexts and were embedded in caulking or tar-like materials on the vessel's timbers and within the frames. Ten separate hair deposits containing more than one strand of hair were collected during the investigation of the ship remnant. The hair containing the preserved louse was examined by Charlotte Pearson, Ph.D., a Cornell University-based archaeologist with experience in the analysis of hair and fiber, who identified the hair as human.

PROPOSED CONSTRUCTION SEQUENCE

It is possible that some of the frames with trunnels were recycled from an earlier vessel since trunnels were not used as fasteners in the rest of the ship remnant. The construction of the frames provides some information which can suggest the sequence of the WTC Ship's initial assembly (see **Figure 6-22**). In most cases, the floor timbers and futtocks were not connected. It appears that the floor timbers were used to provide support and create the curvature of the hull while the futtocks added interior support. The construction sequence likely started with the laying down of the keel. The sternpost and stempost would then have been added. Following that, the stern knee and apron would have been bolted into place and the frame timbers added over the keel. The keelson would then have been nailed on top of the frames. Three of the frames are possibly molds comprised of the first futtocks on each side nailed to the floor timbers FNFS 10, FNFS 14, and FNFS 20 since futtocks were abutting these floor timbers, as depicted on Figure 6-9. As molds, these frames could then be used to derive the curvature of other frames in between and with the extended height from the futtocks, the curve of the hull could be better visualized. Although it is possible the futtocks and frames were attached in these few examples, nails were visible only in the sides of FNFS 10 and FNFS 14 and the rest of the futtocks were not connected in any way to the floor timbers. With the floor timbers in place, the outer planking was nailed to the outer face of the frames, but only up to the top of the floor timbers, before the futtocks were inserted. Once the futtocks were attached, more outer planking was added, and this sequence was repeated until the upper extent of the WTC Ship was reached. The ceiling planking, orlop deck, and other interior structures would have been added last.

D. SHIPWORMS

Many of the timber elements of the WTC Ship were heavily damaged as a result of an infestation of *Teredo*, a mollusk more commonly known as "ship worms." As noted above, extensive shipworm damage was observed in the stern, and the outer planking, aftmost section of the keel, and frames were all affected. The damage was particularly notable in what remained of the sternpost and destabilized the timber, causing it to break in two during its removal, as discussed in **Chapter 5**.

Some shipworm species tend to be geographically specific, and therefore the identification of shipworm species can result in a determination of where a ship once sailed. A sample of the sternpost was analyzed by Kevin J. Eckelbarger, PhD., Professor of Marine Biology and Director of the Darling Marine Center at the University of Maine. In the small timber sample, Dr. Eckelbarger identified hundreds of well-preserved, calcified *Teredo* remains (Eckelbarger, personal communication, August 6, 2010). A single species, *Lyrodus pedicellatus*, was identified in the sample. This species is commonly found in the eastern Pacific and western Atlantic oceans and is native to warm waters with high salinity unlike those found in the New York City region. Because no shipworms local to the northeastern United States were identified in the sample, Dr. Eckelbarger hypothesized that the larvae may have infested the sternpost in the Caribbean, or a similar local, rather than in the waters off the coast of the United States.

E. SPECIES IDENTIFICATION AND DENDROCHRONOLOGICAL ANALYSIS

SPECIES IDENTIFICATION

Timber samples taken from various portions of the ship remnant were analyzed by Robert A. Blanchette, PhD, a Professor in the Department of Plant Pathology at the University of Minnesota. Dr. Blanchette determined that several wood types were used to construct the ship and that different wood species were used for different functions within the ship. Spruce, white oak, and hard pine were identified among the ceiling planks, spruce was used for the orlop deck planks and white oak for the orlop deck beams, the frames and stern knee were constructed of white oak, and the keel and keelson were made of hickory, a wood species native to North America. The complete list of samples analyzed by Dr. Blanchette is included in **Table 6-14** and Dr. Blanchette's report is included as **Appendix F**.

Table 6-14
Wood Species Identification

Sample Number	Element Type	Species type	Notes
CN 2/4	Ceiling plank	*Picea* sp. (Spruce)	
CN 4/4	Ceiling plank	*Quercus* sp. (White oak group)	
CN 1/7	Ceiling plank	*Pinus* sp. (Hard pine, southern or western species, not red pine.	
CS 1/3	Ceiling plank	*Quercus* sp. (White oak group)	
CN 1/1	Unknown	*Quercus* sp. (White oak group)	
OP 11	Orlop plank	*Picea* sp. (Spruce)	
OP 9/1	Orlop plank	*Picea* sp. (Spruce)	
SN-1	Unknown	*Picea* sp. (Spruce)	Soft sample
ODB 1/1	Orlop Deck Beam	*Quercus* sp. (White oak group)	
FN 5	Frame	*Quercus* sp. (White oak group)	
FNFS 21	Frame	*Quercus* sp. (White oak group)	Surface, hard timber
FN 7	Frame	*Quercus* sp. (White oak group)	Hard timber with soft spots
FS 10-2/1	frame	*Quercus* sp. (White oak group)	Deteriorating
Keelson	keelson	*Quercus* sp. (White oak group)	Surface
ST-2	sternpost	*Quercus* sp. (White oak group)	Interior
AP-3	stern knee	*Quercus* sp. (White oak group)	Surface
PS 3-2 B	outer plank	*Quercus* sp. (White oak group)	Interior
PN 8-2	outer plank	*Quercus* sp. (White oak group)	Surface
Keel A (East)	keel	*Carya* sp. (Hickory)	Surface
Keel B (West)	keel	*Carya* sp. (Hickory)	Interior

DENDROCHRONOLOGY

As discussed in **Chapter 2**, the dendrochronological analysis of timber samples collected from the stern of the ship remnant was conducted between August 2010 and May 2011 by the Tree Ring Lab at Columbia University's Lamont-Doherty Earth Observatory in Palisades, New York. The results of the analysis were presented in a report completed by the Tree Ring Lab dated May 2011 and entitled *Tree Ring Dating Results for World Trade Center Vessel Timbers, Lower Manhattan, New York City*. This document is included as **Appendix G** and its conclusions are summarized below. A list of the timber samples taken for dendrochronological analysis and the results of the analysis is provided in **Table 6-15**. Although there were some limitations to the dating due to the characteristics of the samples, the ship remnant frame samples did provide sufficient information to yield conclusive and meaningful results. As is explained in greater detail below, the analysis results indicate that the trees used to construct the frames of the WTC Ship were felled in the late 18th century and probably grew in the vicinity of Philadelphia, Pennsylvania. Reliable felling dates and growth locations for timbers other than the frames could not be determined with accuracy.

Table 6-15
Summary of Dendrochronology Results

Sample ID	Function	Species	First Identifiable Growth Year	Last Identifiable Growth Year	Notes
CN 1/1	Ceiling Plank	oak	1494	1650	Squared
CN 3-1	Ceiling Plank	oak	1662	1732	Squared
CN 3-10A	Ceiling Plank	oak	1542	1681	Squared
CN 5-1	Ceiling Plank	oak	-----	-----	No discernible rings; Not analyzed
CN 6-1	Ceiling Plank	oak	1644	1705	Squared
FS 9-2	Futtock	oak	1680	1743	Sapwood rings
FS 10-2	Futtock	oak	1689	1762	Sapwood rings
FN 11-1/1	Futtock	oak	No date	No date	Squared
FS 11-2	Futtock	oak	1571	1770	Sapwood rings
FS 12-2	Futtock	oak	1600	1723	Squared
FS 13-2	Futtock	oak	1688	1770	Sapwood rings
FN 15-1	Futtock	oak	1627	1769	Sapwood rings
FN 15-1/1	Futtock	oak	1662	1764	Sapwood rings
FS 15-2	Futtock	oak	1682	1770	Sapwood rings
FN 16-1	Futtock	oak	1663	1773	Sapwood rings
PS 1-1	Outer Plank	oak	1665	1716	Squared
PS 2-1	Outer Plank	oak	1602	1687	Squared
PN 2-1	Outer Plank	oak	1559	1685	Squared
Keel	Keel	hickory	1581	1724	Squared
Keelson	Keelson	oak	1639	1740	Squared
OUT 8	Unknown	oak	1641	1732	Sapwood rings
OUT W	Unknown	oak	1660	1721	
OUT ?	Unknown	oak	No date	No date	

Notes: All analyzed timbers were from the stern of the ship remnant.

Sources: Adapted from Columbia University's Lamont-Doherty Earth Observatory (2011); *Tree Ring Dating Results for World Trade Center Vessel Timbers, Lower Manhattan, New York City* (see **Appendix G**).

As seen in Table 6-15, a total of 23 samples from the ship remnant was analyzed by the Tree Ring Lab. All of the samples had been hewn square or otherwise reduced as part of the preparation of the timbers during the original construction of the ship. As a result, the outer surface of the timbers (i.e., the bark; also referred to as a "waney edge") was absent from all of the timber samples. When a waney edge is absent, the final (most recent) growth rings of the tree are also absent, making it impossible to identify the exact date that a tree was felled. Nine of the timber samples retained some sapwood, however. Sapwood is the outer series of rings in a tree's cross-section and is located just inside the bark. The sapwood surrounds what is known as the heartwood, or the inner series of rings at the core of the tree. Sapwood comprises the most recent series of rings, and thus represents the last years of the tree's life. Therefore, for timber samples that retained a significant amount of sapwood (as indicated in the "Notes" column in Table 6-15), the dates of the final growth rings can be reasonably considered to be within approximately twenty years of the trees' felling date. Thus, while the exact year that a tree was felled cannot be identified for samples retaining sapwood and no waney edge, a reliable felling date range within a ten- to twenty-year period can be conclusively assigned. Depending on how much sapwood survives on a given sample, the narrower the date range can be considered to be. For all samples lacking sapwood completely, the date of the last ring does not provide a reliable insight into the date on which the timber was actually felled, although it does provide a *terminus post quem* (TPQ) or a date before which the sample could not have been felled.

It should also be noted that typically samples with fewer than 100 growth rings are considered to yield less reliable data, since these samples have a higher likelihood of matching sequences in master chronologies but there is a lower likelihood that these matches are accurate. This is particularly true when there are no known factors that would limit the time period to which a certain sample could be dated, such as contextual indicators and/or documented history. Although some of the ship remnant samples had fewer than 100 rings, the Tree Ring Lab was able to maintain the reliability of the assemblage as a whole by formulating an average-annual radial growth chronology for all the ship remnant's oak samples. The chronology essentially matched the samples to each other and allowed the Tree Ring Lab to account for samples with fewer than 100 growth rings by fitting them into a longer growth series context common to all of the analyzed oak samples in the assemblage.

Of the nine samples that retained sapwood, one, OUT-8,[1] was a piece of wood found on the surface of the vessel, the function of which is uncertain. The last ring identified in OUT-8 was dated to 1732. The sample retained at least 15 sapwood rings, and because oak is unlikely to keep more than 20 rings of sapwood, it is likely that the felling date of tree from which the sample originated post-dated 1732 by only a few years. However, as stated, this date cannot be considered a reliable indicator for the construction date of the ship, since the timber was not necessarily part of the ship remnant or could have been recycled from an older vessel.

The remaining eight timber samples that retained sapwood were all taken from the oak frames of the ship remnant (FS 9-2, FS 10-2, FS 11-2, FS 12-2, FS 13-2 FS 15-2, FS 15-2, and FN 16-1). All of these samples exhibited relatively similar patterns. The timber sample for which the most conclusive date could be determined was FN 16-1, which had 111 rings and retained sapwood that appeared to suggest a close proximity to bark. Its outermost sapwood ring was dated to the year 1773. This date was the most recent of all of the eight frame samples that retained sapwood and provides the strongest available evidence for the date the timber was felled prior to the vessel's construction. Four of the other sapwood-retaining frame samples had a final extant growth ring that dated to 1770, while the remaining samples' final growth ring dated to 1769, 1764, 1762, and 1743.

The sample taken from the keel of the ship remnant was identified as hickory and was the only sample included in the analysis that was not oak. While this sample had 144 growth rings, it was hewn square and did not retain any sapwood. The master chronologies for hickory have not been sufficiently developed for comparison; therefore, the Tree Ring Lab used oak master chronologies to analyze the hickory sample. A correlation was found between the oak chronologies and the hickory sample, which allowed a provisional dating of the final extant growth ring on the keel to 1724. However, it should be noted that trees of different species may respond to climate in different ways and therefore, results using inter-species dating methods are not generally considered to be highly reliable. Hickory is not often used in dendrochronology and is found in only a few geographic areas in the world. Although hickory growing in the same geographical location as oak would be expected to have similar responses to environmental conditions as oak, the data to assess the reliability of interspecies dating between hickory and oak does not exist at this time. Furthermore, because no sapwood was present on the hickory sample, little insight can be gained with respect to the felling date of the timber used for the keel.

GEOGRAPHIC ORIGIN OF THE TIMBER SAMPLES

The tree ring analysis yielded several insights into where the trees from which the ship's timbers were constructed originated. This in turn may provide greater insight into the ship's construction. First, comparison of all 19 dated oak samples taken from the vessel indicated such a strong correlation or interannual agreement between samples as to suggest that all of the samples grew in the same geographic location, possibly the same grove of trees.

[1] As described above, timber samples labeled "Out" were apparently diagnostic, vessel-related timbers that were found outside of the ship or were loose within the fill.

As noted above, an average-annual radial growth chronology was formulated for the ship remnant's oak samples by the staff of the Tree Ring Lab. This average annual radial growth chronology reduced the individual variability in the oak samples that would have resulted from factors other than climate. As such, the average annual radial growth chronology is a more effective tool for comparisons of the assemblage with master chronologies from various regions than any one sample. The average annual radial growth chronology was compared to master chronologies from various regions, including Southern New York State, New Jersey, and Eastern Pennsylvania in order to determine which region presented the closest match to the samples from the ship remnant. The closest correlation was found with the Philadelphia, Eastern Pennsylvania, and Southern New Jersey master chronologies. The correlation between the samples and these chronologies was considered to be highly significant. Correlation between the samples and the Hudson River Valley and Northern New Jersey master chronologies did not correlate as closely as those associated with the regions to the south. Within the set of southern chronologies, the most compelling correlation appeared to be the Philadelphia master chronology, suggesting that the timber used to build the ship very likely grew in the Philadelphia area.

The Tree Ring Lab used various methods of statistical analysis to assess how closely the samples correlated with the master chronologies. A t-statistic (or test-statistic) quantifies the extent to which an estimated parameter departs from its standard error. As described in greater detail in the report included in Appendix G, a t-statistic of 3.5 has a 1 in 1,000 chance of being incorrect. In identifying the t-statistics for dendrochronological samples analyzed as part of this project, t-statistics of 3.5 or higher can reasonably be considered to be reliable. Sample FN 16-1, discussed above, had a t-statistic of 3.7 against the Eastern Pennsylvania master chronology and a t-statistic of 4.0 against the Philadelphia master chronology, providing compelling evidence of a connection between the sample and this geographical area. The average-annual radial growth chronology for the entire ship remnant oak sample assemblage showed still higher statistical correlations between the Eastern Pennsylvania master chronology (a t-statistic of 6.3) and the Philadelphia master chronology (a t-statistic of 6.3). In summary, the correlation between the oak timbers in the assemblage and Eastern Pennsylvania/ Philadelphia area was considered extremely reliable.

POSSIBLE INTERPRETATIONS OF THE RESULTS

The dendrochronological analysis of the ship remnant timbers has yielded several important insights into the WTC Ship's history. None of the ship remnant samples retained a waney edge and therefore no precise felling dates could be identified. However, due to the presence of sapwood on many of the frame samples, final growth rings dated to the 1760s and early 1770s can reliably be considered to be only ten to twenty years prior to the trees' felling. The strongest evidence for a felling date came from one frame sample whose sapwood indicated proximity to bark and whose last ring date, 1773, was the latest of all the last ring dates. Based on this evidence, it appears reasonable to assume that the trees were felled within a few years after 1773 and that the vessel may have been constructed relatively shortly thereafter. Depending on how long the timber was seasoned or stored prior to the vessel's construction, the ship may have been built in the late 1770s or in the 1780s. One sample, OUT-8, originated from a tree felled in the 1730s. The origin of the sample within the ship remnant is uncertain; therefore, any attempt to explain the earlier date of the sample must be speculative. If the timber functioned as a frame, as appeared to be the case, it may represent the reuse of a timber from an earlier vessel. However, it is also possible that the timber was not an integral part of the ship remnant and is not directly related to the construction history of the ship remnant.

The tree ring analysis also concluded that a strong correlation between the oak samples from the ship remnant suggests that the trees from which they came were likely growing in the same specific location in the Philadelphia area. If the ship was constructed from timbers that originated in a single grove of trees, it could be interpreted as supporting a hypothesis put forth by maritime historian Norman Brouwer, who stated that based on certain idiosyncratic aspects of the vessel's construction, it may have been built at a small rural shipyard rather than a large, established and well-financed shipyard. A small shipyard may have been more likely to take limited timber stock from a single geographic location for the construction of a vessel.

The implications of this historical correlation with Philadelphia, including the possibility that the ship may have been constructed in the Philadelphia area and intended for use in that region, are issues for further research and consideration.

F. INVESTIGATION OF POTENTIAL GALLEY HEARTH

A brick feature located on the orlop deck of the stern of the ship remnant was documented by the field team during excavation (see **Figure 6-23A**). This brick structural remnant may represent a hearth feature that served the ship's galley. *The two primary functions of a galley hearth would have been cooking food and generating heat.* Only a few bricks associated with the structure appear to have been *in situ* during the archaeological investigation of the stern. These were in an apparently square configuration and held in place with mortar in the center of the eastern portion of the orlop deck. Incorporated into the feature was a semi-circular metal ring that appeared to be fixed to the deck with mortar (see **Figure 6-23B**). A small section of the orlop deck planking was missing in the center of the metal ring. This appears to have been intentionally cut, possibly in association with the construction of the brick feature. A small, roughly square metal plate was located immediately atop this aperture; although it is not certain if this plate was in its original location.

Bricks and brick fragments were also found both on top of and beneath the orlop deck and in limited locations elsewhere on or adjacent to the ship remnant. More than 20 whole red bricks and numerous brick fragments and mortar samples were recovered from the ship remnant or its immediate vicinity during the documentation and recovery of the stern. As discussed in **Chapter 2**, Dr. Allan Gilbert of Fordham University completed a preliminary examination of the brick and mortar samples. While he did not perform a complete examination or a thorough analysis of the brick samples, Dr. Gilbert was able to make several observations regarding the bricks and mortar.

PRELIMINARY VISUAL INSPECTION OF THE BRICK AND MORTAR SAMPLES

Dr. Gilbert observed that with few exceptions, all of the bricks recovered during the investigation of the stern appeared to have been similar in size, shape, and color. Dr. Gilbert hypothesized that the bricks were likely produced by the same brickmaker, possibly as part of a single batch. The bricks were red in color with small streaks and deposits of yellow clay. Geographical locations containing yellow clay deposits are somewhat limited; therefore, the presence of yellow clay may help to identify a geographical region of origin for the bricks. While yellow clay suitable for brickmaking is located in limited parts of New Jersey, smaller deposits—such as those that streak the red bricks recovered from the ship remnant—can probably be found over a wider geographic area. If undertaken in the future, additional laboratory analysis of the composition of the brick samples could yield meaningful insights into the geographic origin of the bricks, as well as the period in which they were made.

Based on the preliminary visual analysis completed by Dr. Gilbert, both the bricks and the mortar appear to be consistent with an 18th century production period. The brick samples in the assemblage appear to be well-made by 18th century standards in that the size of each brick appears consistent and the shape relatively crisply defined with straight, uniform edges and sides. Dr. Gilbert also noted that some of the brick samples had a slightly discolored and glazed appearance. Known as "arch bricks," these would have been closest to the heat source during initial firing of the bricks.

In general, good quality bricks such as these were likely used to build hearths aboard ships, because sturdy construction would have been necessary to prevent the structure from destabilizing with the movement of the ship through water. Furthermore, the high risk of fire aboard a wood vessel would have made tight construction of chimneys a priority. Some bricks contained evidence of burning or charring. The char marks were limited to certain faces of the bricks, suggesting that some of the bricks were exposed to fire as part of a shipboard structure, supporting the hypothesis that the brick structure was a hearth. Dr. Gilbert observed an ashy residue that was still extant on the exterior of some of the bricks. Laboratory analysis of this material in the future might reveal the type of fuel (i.e. wood, coal, etc.) used within the hearth.

At least two distinct types of mortar were represented among mortar samples recovered from the vessel. All of the samples were composed primarily of lime and sand and some contained inclusions of hair. A detailed laboratory analysis of the composition of the mortar and comparison of the mortar to other shipboard examples of mortar use from various periods and geographic locations was outside of the scope of the present study and is recommended as a possible avenue for future research.

GALLEY HEARTHS ON 18TH CENTURY SHIPS

Limited documentary research was conducted to determine whether the brick feature encountered on the ship remnant was consistent with other period hearth examples. Period descriptions of 18th century galley hearths, particularly on sloops and other smaller vessels, are virtually nonexistent, and recent literature describing these features—which is based largely on archaeological evidence—appears to be extremely limited. In *The Global Schooner: Origins, Development, Design, and Construction, 1695-1845*, Karl Marquart (2003: 21) writes:

> *No specific information can be found on the galleys or cabooses of small vessels. All pictorial evidence, which in itself is vague, relates to much larger ships than schooners.*

Several recent books written about English warship construction in the 17th through 19th centuries (i.e. Goodwin 1987 and Lavery 1987) discuss the construction of hearths and stoves in some detail. However, the applicability of this information to smaller vessels in North America is not clear. However, there does appear to be an overall pattern of shipboard hearth construction between the 17th and 19th centuries. Earlier and/or cruder examples were made up of a simple brick fireplace over which cooking pots were hung while later, more sophisticated examples consist of a so-called "iron firehearth" consisting of a metal stove.

Maritime historian Peter Goodwin writes that between the mid-17th and mid-19th centuries the characteristics of galley hearths changed substantially as a result of several innovations that occurred largely in response to attempts to reduce the risk of fire aboard ship. As stated by Goodwin, "over the years the construction changed from a brick-built hearth to a self-contained iron stove" (Goodwin 1987:160). The earliest firehearths were located "low down in the vessel's hold" (ibid). By the 18th century, it was apparently more common—particularly on larger ships—to locate the hearth further forward toward the bow of the ship, often just below the forecastle[1] (Goodwin 1987:162).

[1] The portion of a ship's upper deck near the bow.

BRICK FIREHEARTHS

The most basic type of early brick firehearth was suitable only for boiling, rather than grilling or baking. According to historian Brian Lavery, even the most basic early hearths required a large number of bricks, and because the bricks were subject to so much movement aboard ship, the decks on which they rested had to be "carefully kneed" (Lavery 1987: 197). Galley hearths often required the construction of "additional carlings and pillars [that] were placed below to give support" to accommodate "the additional weight of the firehearth or stove and the brick" (Goodwin 1987: 162). Archaeological evidence has shown that the Swedish ship *Vasa* (a large naval ship built in 1628) had a simple brick-lined compartment in the middle of the orlop deck above which a swinging pot would have been suspended. This arrangement is apparently emblematic of the early and comparatively simple brick firehearth. Another example of a brick firehearth is found on the late-18th-century gun vessel *Wasp*, which Goodwin illustrates as a square-plan brick structure built atop a small brick base and oak "locating planks" (Goodwin 1987: 162). The feature, which contains an integral brick firebox, is surmounted by a metal canopy and flue (ibid).

In other brick firehearth examples, the feature consists of a brick hearth and a metal container or "kettle" for the food above it. Lavery (1987: 197) describes this arrangement:

> *Bricks were placed all around the pit, enclosing the kettles (except for their tops), leaving an opening on one side. This was closed by an iron door, which was hinged, and could be bolted shut. Horizontal pipes ran through the brickwork, forward of the kettle. The ash pit also had an opening in the top to allow the smoke to escape through a funnel. Several layers of brick were placed under the ash pit, to keep the fire away from the wood of the deck.*

On the *Defence*, a Revolutionary War privateer that was excavated in 1975, a brick firehearth was found on a small deck behind the foremast.[1] This feature consisted of a square-plan brick structure built to accommodate a square metal cauldron with rounded corners divided into two compartments by a partition (Switzer 1975).

IRON FIREHEARTHS

Iron firehearths were first introduced in the second quarter of the 18th century in part because the weight of the brickwork used in traditional hearths was "overloading and straining some of the small sloops" (Lavery 1987: 197). Iron firehearths were standard among larger English vessels by the third quarter of the 18th century. The Brodie stove, patented in the 1780s, became a particularly widespread version of the technology, particularly in the British Royal Navy in the late-18th and early-19th century. According to maritime historian Karl Marquardt (2005:27), "it can be assumed that US frigates also used either the Brodie stove or a similar fire hearth around the same time."

Stoves are relatively well understood due to the survival of period literature—including Brodie's stove patent documentation—and as a result of the archaeological investigations of several vessels with intact stoves. The features were typically upright rectangular iron boxes with an opening in the front and a metal hood and flue above; the stove accommodated a firebox and cooking apparatus. One example of an iron firehearth with a Brodie-style stove was located on the warship *Sovereign*. This example also had a duct in the bottom of the hearth so that stale air from below would be drawn up the flue of the stove, ventilating the lower portions of the ship (Goodwin 1987: 162).

[1] The mast closest to the bow.

GALLEY CHIMNEY

A galley chimney, which provided a means for ventilation, was typically composed of two parts, both of which were usually metal (often copper) or wood lined with metal (Lavery 1987: 200). The lower part of the chimney was affixed to the stove and conveyed the smoke to the deck immediately above the stove. The second segment of chimney extended a short distance above the upper deck to discharge the smoke into the air. The lower part of the chimney was typically conical or, in the case of iron firehearths, in the shape of a pyramid (ibid).

THE BRICK STRUCTURE FROM THE SHIP REMNANT

The brick feature found on the orlop deck of the ship remnant appears to represent the base of the original structure of which it was a part. This is evidenced by the fact that only a few bricks appeared to be *in situ* and because many dislocated bricks were found around the feature and beneath the orlop deck. This fact, combined with the scant historical documentation of period shipboard hearths, makes it difficult to determine the exact identity of the brick feature. However, based on the physical characteristics of what remained of the feature, it appears very likely that the feature was part of the ship's galley hearth.

It appears that the feature was a brick firehearth rather than an iron firehearth or stove. Although iron firehearths may have had brick bases to protect the underlying planks from fire, the bricks found on the ship remnant showed evidence of direct contact with fire, suggesting that they were likely part of a structure that incorporated a brick firebox. The purpose of the metal ring and plate in the center of the brick base and the apparent aperture within it is not clear, however, it may have been part of an ash pit, or simply a stabilizing aspect of the hearth's construction.

The WTC Ship's hearth may have been a structure similar to that found on the previously mentioned ship, *Defence*, which had a central opening to accommodate a metal cauldron or kettle. The loose bricks found beneath the orlop deck may have been part of the hearth that became dislocated. It is also possible that those bricks served as supports for the orlop deck, which bore the weight of the brick hearth.

G. FUNCTIONAL INTERPRETATIONS

The construction details of the WTC Ship provide some indications as to its use. The timbers showed evidence of heavy use, as evidenced by the many repairs visible in the outer planking, frames, and perhaps even the ceiling planking. As stated above, the outer planking showed evidence of numerous repairs and timbers PN 10-3, PS 3-1, PN 11-2B, and PN 7-2 represent filler pieces that likely replaced the original planks. Finally, while most of the ceiling planking was white oak, there were several planks made of spruce or pine, most of which were near the keelson. These pieces may represent replacement planks that took the place of the original white oak floor planks, which may have rotted during the period of the ship's use.

Because the ship had a very rounded stern with flat floors, it is likely that the ship was constructed for the transportation of cargo. The features observed in the WTC Ship's timbers would have maximized the amount of cargo space but would also have increased the amount of drag on the vessel. These characteristics paired with the vessel's shallow keel indicate that the ship was suited more for sailing in protected shallow waters rather than the open ocean. The shallow keel, rounded stern, and a mast stepped aft of the bow by approximately one-third of the overall length would have made the ship prone to lateral drift, thus confining it to rivers and estuaries such as the Hudson River However, with a few modifications—such as a leeboard and high bulwarks to give the ship greater freeboard to weather the seas—the ship could have been outfitted for ocean transport, as were many similar vessels at that time (Fontenoy 1994: 38). Indeed, the presence of a southern latitude shipworm species would suggest that the ship did sail into warmer waters. It is likely that the hard use of the vessel contributed to the need for multiple repairs and resulted in the ultimate demise of the vessel. **Figure 6-24** provides a profile view of the WTC Ship (note that the ship is depicted as level in Figure 24A).

H. COMPARATIVE ANALYSIS

As described in **Chapter 4**, the ship appears to have dimensions consistent with a class of ship known as a sloop and may represent a Hudson River Sloop.[1] The term "Hudson River Sloop" refers to a type of sloop that had been built in New York with variations in hull form between the 18th and 19th centuries and had the ability to handle the sailing conditions of the Hudson River (Fontenoy 1994). As noted, narratives refer only to the type of ship as a 'sloop' (Fontenoy 1994: 34, 40-41). Like the WTC Ship, Hudson River Sloops had very beamy hulls that placed an emphasis on carrying a large cargo or a great amount of passengers rather than speed (Fontenoy 1994). At the beginning of the 19th century, the beamy hull of the Hudson River Sloop was modified to a deeper hull with more deadrise to reflect the increasing importance of speedy transport in passengers up and down the river (Fontenoy 1994: 45-60). The construction of the WTC Ship appears similar to that of a sloop as it also had a broad beam, shallow draft, and could have had a mast stepped aft of the bow by approximately one-third of the overall length, which would have been in the section of the remnant destroyed by the demising wall. While several 18th century ships, including several sloops, have been described in historical accounts, few have been excavated (see **Chapter 4**) thus permitting little analysis, especially for the classification as a Hudson River Sloop. The following discussion is a brief comparison of the WTC Ship to several of those previously excavated ships which are similar in dimension and type (see **Table 6-16**). The vessels included in this comparative analysis include the Clydesdale Plantation vessel, the Readers Point vessel, the Rose Hill vessel, the *Boscawen*, and the Yorktown wreck 44YO88. All but the *Boscawen* transported cargo; the *Boscawen* is included for comparison because it was sloop rigged.

CLYDESDALE PLANTATION VESSEL

The WTC Ship seems to have similarities in construction to the mid-18th century Clydesdale Plantation vessel, which also had unjoined futtocks and floor timbers (Hocker 1992: 16). The Clydesdale Plantation vessel was about 45 feet in length and therefore slightly smaller than the WTC Ship, but it has been hypothesized that this vessel was rigged similarly to the northern sloops with the mast stepped far forward (Hocker 1992: 15). However, the Clydesdale Plantation vessel used trunnels as fasteners in addition to iron nails and had a finer stern than the WTC Ship, which relied solely on iron nails for its construction and had a very wide stern.

[1] The Hudson River Sloop type has only been identified, however, from 18th century illustrations, brief narratives, and ship models.

Table 6-16
Comparative Analysis of Previously Excavated Ships

Vessel Characteristic	Vessel Name: WTC Ship	Clydesdale Plantation	Readers Point	Rose Hill	*Boscawen*	Yorktown wreck 44YO88
Date	late 18th century	1790s	mid-18th century	mid-18th century	1759	1772-1781
Length	~55 feet*	43.75 feet	56.5 feet	67 feet	70 feet	72 feet
Beam	14.5 feet#	15.42 feet	14.3 feet	22 feet	22 feet	23.6 feet
Keel Molded	9.125 inches	-----	10.875 inches	15 inches	14 inches	13.25 inches
Keel Sided	6.75 inches	-----	9.625 inches	8 inches	10.5 inches	14.4 inches
Keel Wood type	Hickory	Yellow pine	Maple	Maple	White oak	White Oak
Keelson Molded	6 inches	-----	10.875 inches	12 inches	6-10 inches	8.5-23 inches
Keelson Sided	10.5 inches	-----	9.625 inches	10 inches	10 inches	24.4 inches
Keelson Wood type	White Oak	pine	White Oak	White oak	White oak	Pine and Oak
Frame Molded	5 inches		10 inches	10.5 inches	7-12 inches	7-9 inches
Frame Sided	5 inches	-----	9.5 inches	11 inches	8.5-10 inches	9-10 inches
Frame Wood type	White Oak	Live Oak	White Oak	Beech & White Oak	White Oak	White Oak
Outer Planking Thickness	1.5 inches	-----	2 inches	2.4 inches	2 inches	2.25-2.5 inches
Outer Planking Wood Type	White Oak	Pine	White Oak	White Oak	White oak	white oak
Ceiling Planking Thickness	0.875 inches	-----	2 inches	2 inches	2 inches	2.5 inches
Ceiling Planking Wood	White Oak	Pine	White Oak	Red oak	White oak	White Oak
Fasteners	iron nails	iron, few trunnels	trunnels, iron	trunnels, iron	iron, trunnels	iron, trunnels
Sheathing	None	-----	0.25 inch oak	0.5 inch pine	-----	1.25 inch pine
Ship Type	Trader/Sloop	Coastal trader	West Indies or Inter-colonial	West Indies or inter-colonial	Warship	Collier/Transport

Notes: * Estimation based upon preserved remains from sternpost to the remains of stem, thus this number is likely an underestimate.
\# Width based on the *preserved* maximum beam. The actual maximum breadth, would likely have been closer to the upper deck, thus this number is likely an underestimate.

READER'S POINT SLOOP

Another 18th century sloop was excavated at Reader's Point in St. Ann's Bay, Jamaica, 56.5 feet in length, 14.3 feet in breadth, and about 100 ton displacement (Cook 1997: 47).[1] The keel for the Readers Point sloop shared a similar molded dimension of 10.875 inches but a sided dimension of 9.625 inches, which is much wider than the WTC Ship's keel. The Reader's Point sloop also had a similar rabbet cut 1.75 inches wide (Cook 1997). This keel was made from hard maple (*Acer* sp.), unlike the hickory keel of the WTC Ship, and there was no evidence of a false keel. This vessel had sacrificial planking on its port and starboard sides (about 0.25- inch-thick white oak) with a layer of pitch and hair between the planking (Cook 1997). While the WTC Ship preserved evidence of pitch and hair, there were no indications of sacrificial planking.

The Reader's Point vessel and the WTC Ship both contained a stern knee, used instead of a deadwood knee to reinforce the stern. The stern knee of the Reader's Point sloop was made of a single white oak timber fastened to the keel with two iron through-bolts and was 7.92 feet long; at the forward end it was 16.25 inches sided and 14 inches molded. It also had a groove cut in the top face for a floor in addition to two notches cut into each side to receive the futtocks. The stern knee of the WTC Ship did not have these notches for the futtocks but did have notches for the floor timber. The vertical length of the stern knee of the Reader's Point vessel was heavily eroded and only 24 inches survived (Cook 1997).

[1] Displacement is the weight of a vessel and its entire burden, or items carried on board.

The dimensions of the frames of the Reader's Point vessel, which average 9.5 inches sided and 10 inches molded, were much larger than those of the WTC Ship, but were similar in length with both vessels containing floors more than 11 feet in length near amidships (Cook 1997). The Reader's Point vessel had limber holes cut regularly into the bottoms of the floor timbers while the WTC Ship had only an enlarged keel notch. The limber holes would allow the bilge water to flow between the frames to collect in a location which could be easily pumped out. Cutting separate limber holes required more effort but ensured better fit between the frames and keel as well as better bilge water flow. The frames (including floors and futtocks) of the Reader's Point vessel were joined together with trunnels at nine locations, which functioned as molds to define the shape of the vessel. The frames were generally spaced closer together than on the WTC Ship and its futtocks began farther from the keel, at a distance of about 1 foot. The keelson of the Reader's Point Vessel was of a comparable size—10.875 inches sided and 9.625 inches molded—however, notches were cut into the underside of the keelson to receive several of the floor timbers (ibid). A mast step mortise was preserved on the keelson of that vessel that was located 18.21 feet from the bow (one-third of the length of the total hull remains). No mast step was found in the WTC Ship, and it is possible that, like the Reader's Point vessel, the mast could have had a similar step placement or one that was much farther forward.

The outer planking for the Reader's Point sloop was 2 inches in thickness, similar to that of the WTC Ship, but unlike the ship remnant, trunnels were used to attach the outer planking to the frames. Ceiling planking, also 2 inches thick, was attached to the Readers Point sloop with trunnels for the first three strakes of planking and iron nails for the remaining strakes of ceiling planking (Cook 1997: 56). This pattern differs from the WTC Ship, which had 1-inch thick ceiling planking that was attached with iron nails. The excavators of the Reader's Point vessel found evidence of heavy use and frequent repairs to the structure (ibid: 57). Although much of the timber used to construct the Reader's Point sloop was white oak, the starboard sister keelson[1] was made of hickory (*Carya* sp.), a wood species that is not usually used in hull construction, although it often used to make trunnels (Cook 1997: 53-54). Hickory was also used for the keel in the WTC Ship.

ROSE HILL SLOOP

The Rose Hill sloop, excavated near Wilmington, North Carolina, was 67 feet long and 22 feet in beam (Wilde-Ramsing, et al. 1992). At 8 inch sided and 15 inches molded, the keel for the Rose Hill sloop was much larger than that of the WTC Ship. The rudder of that vessel was found with two gudgeons and pintels, similar to what was preserved on the WTC Ship. Unlike the WTC Ship, the outer planking of the Rose Hill Sloop was attached to the frames with trunnels and there was sacrificial pine planking attached to the outside of the outer planking. The construction for the Rose Hill vessel also left very little space between frames. The frames of the Rose Hill vessel were 10.5 inches molded and 11 inches sided, which is much larger than those of the WTC Ship. Similar to the WTC Ship, the notch for the keel in the floor timbers was extended beyond the width of the keel to serve as limber holes for the bilge water.

BOSCAWEN

Although built for use on Lake Champlain during the French and Indian War in the mid-18th century, the *Boscawen* was a variation of the sloop type and measured approximately 70 feet in length and 22 feet in beam. Similar to the WTC Ship, the Boscawen's frames were unevenly spaced and the futtocks were not nailed to the floor timbers. The frames of the Boscawen were larger than those found on the WTC Ship and measured between 8.5 inches and 10 inches sided and 7 and 12 inches molded. The outer planking

[1] The sister keelson is an assistant keelson that reinforces the keelson near the mast step.

was 2 inches thick, similar to that of the WTC Ship. Like the Readers Point vessel, the *Boscawen* had a single mast stepped about one third of the length abaft the stem (Crisman 1985).

YORKTOWN WRECK 44YO88

The Yorktown wreck 44YO88 exhibits a very similar double-ended rounded construction, which otherwise is unique during the 18th century. Wreck 44YO88 was identified as the collier-brig Betsy built in 1772 and used in 1781 by British General Cornwallis to create a sunken barrier to prevent the passage of American ships during the Revolutionary War. In addition to having two masts, it was also larger than the WTC Ship at 72 feet in length and 23.6 feet in breadth (Morris 1991). Like the WTC Ship, this wreck also had Roman numerals carved into the sternpost to mark the draught.

CONCLUSIONS

While the WTC Ship displays construction techniques similar to several excavated 18th century vessels, the overall composition of these techniques are unique to the WTC Ship but consistent with details seen in other sloops. In the *Boscawen*, the Reader's Point Sloop and the Clydesdale Plantation sloop, the mast was stepped abaft the bow approximately one-third of the overall vessel length; while a mast stop was not present in the WTC Ship, this area where the mast step would be likely was also not preserved in the WTC Ship. Thus, it is likely that if a mast step had been present, it would have been in a location consistent with these other sloops. Additionally, the Clydesdale Plantation sloop, the naval sloop the *Boscawen*, and the WTC Ship all had similar frame construction in that the futtocks were not connected to the floor timbers as was common for ships of this period, as evidenced in the Reader's Point sloop. The stern knee of the WTC Ship also appeared to conceptually satisfy a similar purpose to that of the Reader's Point Vessel; in an area that usually has deadwood built up to fill out the narrow parts of a vessel's body and a knee to support the sternpost, the Reader's Point Vessel and WTC Ship satisfied these requirements in a single massive timber. While the stern knee of the Reader's Point Vessel had notches for the futtocks and that of WTC Ship had notches for floor timbers, the shipbuilders conceptually followed the same idea of further reinforcing the integration of this massive timber into the hull beyond the nails and through bolts.

Although based on a similar type, the WTC Ship, however, differs in many details. These unique construction details indicate that modifications were made to fit the ship's work environment and history. The planks are joined to the frames only with iron nails, thus omitting the older style fastening of trunnels. Perhaps this switch is indicative of access to an abundant supply of iron nails as would be fitting for the bustling trade environment of this New York region. With the unjoined floor timbers and futtocks, the shipbuilder may have used the available timber as a starting point, rather than working from frames prefabricated to specific lines. Thus, available timbers would have influenced dimensions of timbers and may have accounted for scantling dimensions, which were also much lighter than those belonging to any of the other vessels. The lighter scantling may also have increased the speed of the vessel. While changes to the sloop's overall hull design were noted in the early 19th century, these changes were based upon ship models and narratives; thus this use of lighter scantling in the late 18th century might have been a precursor to a hull change (Fontenoy 1994). Likewise, knowing the ship would have to travel shallow waters, such as those of the Hudson, meant the keel could have been shallow as well. Since the WTC vessel has only been preserved just to the turn of the bilge and with little known about the shape of the bow, these few remains will make reconstructing the ship's lines largely conjectural. However, future research could pursue attempts to compare the lines of the vessel to those taken from ship models in order to further refine the classification of the vessel. It is important to keep in mind that many of the construction techniques of the WTC Ship indicate a vessel built according to the constraints of a work environment and materials rather than according to lines from a model.

Chapter 7: Artifact Analysis

As described in **Chapter 2**, a pragmatic approach was taken in the examination and analysis of the artifact assemblage collected during the discovery, documentation, and removal of the ship remnant. The goal of this analysis was not to prepare a complete artifact catalogue but instead to collect sufficient information to justify the primary contexts assigned to each of the hundreds of proveniences generated in the field. The ultimate objective of the analysis was to identify a "ship context," that was limited to the artifacts associated with the ship remnant and its use rather than the surrounding landfill.

Although many additional artifacts were collected during the multi-year monitoring effort conducted at the VSC Site—reported separately (see AKRF 2012a)—this analysis primarily focusses on the approximately 7,474 artifacts collected from within and in the immediate vicinity of the vessel. This number is considered approximate due to the fragmentary nature of many of the artifacts, the collection of a number of "conglomerates" that contained numerous small finds that had adhered to each other, and samples made up of multiple smaller items (i.e., hair samples containing many individual strands of hair). Artifacts collected during monitoring elsewhere at the VSC Site are included in some of the tables in this chapter for comparative purposes. Not included in the tables or artifact counts presented in this chapter are the hundreds of ship elements and fasteners discussed in **Chapter 6: Technical Analysis of the WTC Ship and Components.**

This chapter begins with a basic description of the assemblage, with greater detail regarding some of the artifact categories or specific artifacts that provided particularly significant information or a greater amount of data (including Kitchen-related artifacts, Botanical Remains; Faunal Remains; Arms/Ordnance; Hair Samples; and Other Artifacts). The chapter then provides a discussion of analyses conducted to determine how ship-related artifacts may differ from those collected from either the surrounding landfill or the river bottom beneath the vessel. The spatial analysis section also includes consideration of the spatial distribution of artifacts within the vessel itself. An artifact inventory has been included as **Appendix B** and reports prepared by other team members containing specialized analyses of specific artifact collections (e.g., faunal remains and ordnance) have been provided as additional appendices. Appendix B also contains an index of field and lab provenience information.

A. GENERAL DESCRIPTION OF THE ARTIFACT ASSEMBLAGE

In total, approximately 7,474 artifacts were recovered during the discovery, documentation, and removal of the ship remnant. Of these, approximately 2,174 artifacts were recovered as either spot finds during the initial hand-clearing of the stern or through water screening of soils cleared from between the ship's timbers. In addition, eleven artifacts were later found during lab analysis and documentation of the individual elements. Finally, approximately 5,289 artifacts were collected through the flotation analysis of a small number of soil samples.

Only two soil samples were collected from non-ship contexts; therefore small finds and botanical remains are very likely underrepresented in the assemblage that is not associated with the ship itself. Furthermore, while most of the soil removed from within the ship's timbers was water screened, only a small quantity of the soil excavated from around, beneath, or on top of the vessel was screened. During the course of monitoring, collected artifacts were only sampled from the rest of the VSC Site when artifact collection was possible.[1] Therefore, it is assumed that larger artifact quantities and different percentages of artifact types from non-ship contexts would have been recovered had the collection strategies applied to the ship context been applied site-wide. No ship-related artifacts were collected from the fragmentary bow portion of the ship. Because of the degraded nature and small size of the bow fragments, the artifacts that were collected from that portion of the ship remnant have been treated as landfill finds.

Table 7-1 provides a general breakdown of the assemblage sorted by artifact group. An overwhelming majority of the artifacts was assigned to the Architectural group. However, this number has been greatly inflated by the nearly 5,000 small, non-carbonized wood fragments that were recovered during flotation analysis. Of the thousands of wood fragments that were found in the soil samples during the flotation analysis (excluded from the tables above), oak was the most prevalent, although spruce, pine, and hickory fragments were also identified. All of these wood species were present in the ship remnant's timbers and the majority of the small fragments recovered during the flotation analysis were likely associated with the vessel's timbers. These small fragments were likely introduced into the soils as the ship remnant was damaged during the landfilling process and/or as the ship remnant was removed from the site.

Table 7-1
Artifact Counts and Percentages by Group

Group	Total Count*	Percentage of Total
Activities	1,493	20
Architectural**	5,424	73
Arms	330	4
Clothing	19	<1
Furniture	5	<1
Kitchen	176	2
Personal	3	<1
Tobacco	22	<1
Unidentified	2	<1
Total	**7,474**	**100**

Notes: *Only includes artifacts recovered from vicinity of ship.
**This group includes substantial quantities of wood fragments collected through flotation.

The remaining tables in this chapter exclude these wood fragments, as the high counts would skew the data and obscure other patterns in the artifact assemblage. The artifact inventory presented in **Table 7-2** (not including non-carbonized wood) is organized by group and the five primary contexts established for the VSC Site artifact analysis: Landfill, Landfill/Ship, River Bottom, Ship, and Unknown. These contexts are described in **Chapter 2** and summarized in the following section of this chapter. Counts and percentages presented in the remainder of this chapter will generally refer to the smaller artifact counts presented in Table 7-2.

[1] As explained in AKRF 2012a, because of the nature of excavation throughout the VSC site as a whole, artifacts could only be collected in certain situations where it was safe for the archaeological team to examine excavated soils at close range.

Table 7-2
Artifact Counts and Percentages by Group by Primary Context

Group	Landfill**		Landfill/Ship		River Bottom		Ship		Unknown		Total	
	Count	Percent	Count	Percent	Count	Percent	Count	Percent	Count	Percent	Count	Percent
Activities	24	83	77	52	634	74	748	52	5	50	1,488	60
Architectural*	---	---	54	36	117	14	260	18	3	30	434	18
Arms	---	---	1	1	1	<1	327	23	1	10	330	13
Clothing	---	---	---	---	---	---	19	1	---	---	19	1
Furniture	2	7	2	1	1	<1	---	---	---	---	5	<1
Kitchen	---	---	14	9	99	12	62	4	1	10	176	7
Personal	---	---	---	---	---	<1	3	<1	---	---	3	<1
Tobacco	2	7	1	1	5	1	14	1	---	---	22	1
Unidentified	1	3	---	---	---	---	1	<1	---	---	2	<1
Totals	29	100	149	100	857	100	1,434	100	10	100	2,479	100

Notes:
*Does not include non-carbonized wood recovered during flotation analysis.
**Only includes artifacts collected from landfill in the immediate vicinity of the ship remnant.

KITCHEN-RELATED ARTIFACTS

In total, 176 artifacts belonging to the Kitchen group were recovered at the site, comprising about 7 percent of the collection. Kitchen-related artifacts consist of dishes, container glass, and tablewares and were largely made up of ceramic fragments (148). Only a handful of container glass fragments were identified among the assemblage. The majority of the recovered ceramics were red earthenwares (51.4 percent) and creamwares (16.9 percent). The remaining ceramics—all of which dated to the 18th century—were delft, Chinese export or Oriental porcelain, buff-bodied earthenware, stoneware, pearlware, and tin-glazed red earthenware (English faience) (see **Table 7-3**).

Table 7-3
Ceramics by Ware Type

Ware	Total
Creamware	25
Delft	3
Oriental Porcelain	6
Buff-Bodied Earthenware	10
Grey Salt-Glazed Stoneware	4
Red Earthenware	75
Unidentified	1
White Earthenware	2
White Salt-Glazed stoneware	10
Creamware/Whiteware	2
Gray/Buff-Bodied Stoneware	1
Porcelain	3
Earthenware	2
Stoneware	1
Pearlware	2
Tin-Glazed Red Earthenware	1
Total	**148**

BOTANICAL REMAINS

Soil samples were collected and a total of 12 samples were sent to archaeobotanist Justine McKnight for flotation and botanical analysis (see **Table 7-4** and **Appendix E**). Of the flotation samples, 92 percent contained archaeological plant remains, including a total of 145 seeds. The seeds represented a variety of growth environments: orchard tree fruits (e.g., cherry, peach and apple); vine fruits (e.g., grapes); garden produce (e.g., squash/melon and possibly cucumber); weeds (e.g., jimsonweed, cinquefoil, nightshade and poke); and wild edible fruits (e.g., elderberry and raspberry or blackberry).[1] Many of the botanical items found during flotation (e.g. peach and cherry pits, melon/squash seeds, and nuts) were identical to those collected by the archaeologists in the soils during water screening. However, the flotation analysis recovered a greater number of smaller objects (e.g., blackberry seeds and insect parts), thus providing a more detailed look at the flora and fauna associated with the site.

Table 7-4
Summary of Soil Samples Submitted for Flotation Analysis

Flotation Sample Number	Context	Location	Volume	Description	Samples retained for future soil chemical analysis
1	Ship	Beneath Orlop Deck	4.25 liters	Dense, dark gray clay and organic conglomerate	2
2	Ship	Between FN9 and FN10	1.5 liters	Organic conglomerate	2
3	Ship	Between FN2 and FN3	1.25 liters		2
4	Ship	Between FN7 and FN8	1.25 liters		2
5	Ship	Between FN17 and FN18	1.25 liters	Fibrous peat and organic conglomerate	2
6	Landfill	Adjacent to timber feature 7 within the VSC Site between slurry wall panels T-3 and T-4	2.25 liters	Control sample containing clay, leaves, and shell in an organic/peat conglomerate	2
7	Ship	Between FN14 and FN15	1.25 liters		2
8	Ship	Between FN22 and FN23	1.25 liters	Organic conglomerate	2
9	Ship	Around keel and stern knee	1 liter	Fine, oily sediment with petroleum odor	2
10	Ship	Between FN5 and FN6	0.025 liters	Small, oily sample	1
11	Ship	Associated with outer planking	1 liter	Two large wood fragments in an oily matrix	1
12	Ship	Beneath CS2/5	0.5 liters	Tar sample	2

Notes: Sample locations from Ship context are shown on **Figure 7-1**.
Sources: McKnight 2011 (see **Appendix E**).

In addition to the non-carbonized wood fragments referenced earlier, carbonized wood fragments not considered to have ever been part of the ship remnant were also recovered during the flotation analysis. The wood charcoal in the soil was derived predominantly from oak and, to a lesser extent, pine.

Most of the grasses found in the flotation samples have been found growing in disturbed environments such as garbage dumps or landfill sites (AKRF 2011 and 2012b). These include jimsonweed, which is poisonous and is believed to be carried by birds and spread in their droppings. It can lie dormant underground for years and germinates when the soil is disturbed. Jimsonweed is poisonous to livestock and is common on overgrazed pastures, barnyards, and waste land preferring rich soils (Cornell University 2012). Cinquefoil, another of the grasses observed in the flotation samples, adapts to a wide

[1] It is very difficult to differentiate between raspberry and blackberry seeds or between squash, melon, and cucumber seeds. For the purposes of this analysis, these distinctions were not made, although such differentiation could be completed with additional research in the future.

range of soils and is often used in landscaping. There is a marsh variety of this grass that typically grows in ponds or standing water.

FAUNAL REMAINS

More than 400 animal bones and bone fragments were recovered during the archaeological investigation of the ship remnant (see **Table 7-5**). The largest percentage of these (21 percent) was identified as cattle. Mammal was the most abundant class whereas fish and bird were found in almost equal but lesser quantities. More than half of the identified species were domesticated including mammals (i.e., cattle, goat, horse, pig, and sheep) and birds (i.e., chicken and turkey). While most of the faunal remains were distinct, unrelated elements (e.g., individual bones from various animals rather than complete or partial skeletons), a complete bay anchovy skeleton and numerous pieces of a highly fragmented horse skull were also recovered.

Table 7-5
Faunal Remains by Type

Type	Total
Bay Anchovy	75
Unidentified Bird	5
Cat	1
Cow	71
Chicken	5
Eastern Grey Squirrel	2
Unidentified Fish	10
Sheepshead	4
Goat	1
Horse	160
Large mammal	13
Medium mammal	47
Pig	17
Passenger Pigeon	1
Rat	1
Sheep	15
Small Mammal	6
Turtle	1
Turkey	1
Unidentified	11
Yellow Perch	1
Total	449

Notes: A large mammal is the size of a horse or cow; a medium mammal is the size of a sheep or goat; a small mammal is the size of a cat or rat.

Nearly all of the identified species within the assemblage were commonly consumed in New York City during the 18th century including all of the birds and fish, and most of the mammals. Undomesticated mammal species consisted of Eastern Grey Squirrel, cat, and rat and undomesticated birds consisted of passenger pigeon. Fish were represented by bay anchovy, sheepshead, and yellow perch and reptiles were represented by a turtle tibia.

All faunal elements were stained, though the color of the staining was inconsistent and ranged from brown to dark brown/black. The brown staining is thought to be the result of exposure to heat (low level burning). The dark brown-black staining is possibly the result of the tanning of hides and therefore represents an actual chemical transformation of the bone. The dark brown/black bone was found mostly ship remnant-related or adjacent contexts as opposed to the Landfill and River bottom contexts. Another possibility is that the bones were stained by the tannins in the oak planks of the ship remnant, however, further analysis would be necessary to determine if this was the source of the staining. If such analysis were to be complete, it could serve as a predictive marker for future landfill studies in order to determine the presence of potential ship remains in landfill deposits.

The majority of the mammal and bird bones that were recovered bear evidence of bone modification (i.e., slicing, chopping, cleaving, sawing, heat exposure, or staining). Of the bones that had been butchered, beef, pork (hams), and mutton (rack) cuts were most prevalent and were the remains of stew meats and roasts, with rump roasts being most popular. The large size of the beef cuts suggests that they were mainly generated by commercial establishments such as restaurants, taverns, and boarding houses. Smaller meat cuts were also present and might have been deposited into the landfill by the residents of local households. Some of the butchered bones could have been waste from meat consumed on the ship. Industrial waste associated with the food and butchering industry was represented by the skulls and foot elements of cattle and horse and by a goat horn core. Fish, turtle, and bird were infrequent within the assemblage, although all were locally available during the late-18th century. As such, most of the faunal remains could represent either household or commercial refuse. The visual appearance of the meat cuts was not consistent, possibly suggesting that they were generated by a variety of butchers using different techniques.

ARMS/ORDNANCE

Ordnance such as birdshot, buckshot, grapeshot, musket balls and a small cannon ball comprised approximately 13 percent of the artifact assemblage and yet provided a great deal of specialized data (see **Table 7-6**). These artifacts were analyzed by ordnance specialist Daniel Sivilich, President of the non-profit organization Battlefield Restoration & Archaeological Volunteer Organization (BRAVO). Mr. Sivilich determined that the collection of ordnance is unusual and unlike what would be expected on a colonial or early-American vessel. All but three of the artifacts identified as arms accessories or projectiles were recovered from the Ship context or in the immediate vicinity of the ship. The remaining three were birdshot recovered from the northwest portion of the VSC Site from the landfill. However, it should be noted that the soils removed from the ship were far more carefully examined than those of the rest of the construction site.

Table 7-6
Arms Accessories and Projectiles by Type by Ship-Vicinity Context

Artifact	Landfill*	Landfill/Ship	River Bottom	Ship	Unknown	Count
Belt or strap that was probably part of a carryall or ammunition carrying bag			1			1
Bird shot	3			251		254
Buck shot				10		10
Cannon ball				1		1
Cannon vent plate		1		1	1	3
Conglomerate				1		1
Grape shot				4		4
Gun spall				3		3
Musket ball				56		56
Total	**3**	**1**	**1**	**327**	**1**	**333**

Notes: *Includes 3 bird shot collected in the landfill at another location at the VSC Site, a significant distance from the ship

While some of the ordnance recovered from the ship remnant was probably used for hunting, much of the ordnance would likely have been used for defensive purposes, and merchant ships during the colonial period were usually armed (Chappelle 1935). The New Jersey Meadowlands, Barnegat Bay, and Raritan River area in particular were known to have been filled with pirates, and it is possible that during the ship's period of use, the ordnance was used for its defense. It is also possible that the WTC Ship was impressed by the British army during the Revolution and used to ferry troops and supplies to and from New York City. The only artifact that could be clearly associated with military activities was a button bearing the insignia of the British 52nd Regiment of Foot. Because the button was made of pewter, it would have been worn on the coat of a private from that regiment; an officer's button would have been made of silver. The button was found in the Amidships section of the stern between frames FN-10 and FN-14. The 52nd Regiment participated in the battles at Lexington and Concord, Bunker Hill, the Siege of Boston, the occupation of Philadelphia, and the retreat to Sandy Hook and New York and they were last stationed in New York in 1778 (Troiani 2001).

The lack of weapons such as cannon, muskets, rifles, pistols, swords, etc. strongly suggests that the ship was stripped of any usable materials before it sank. The scatter of the lead ordnance throughout the ship remnant suggests that this material was accidentally or intentionally discarded over time along with other miscellaneous items. The 52nd Regimental button might suggest that the ship remnant was used at some point during the Revolutionary War, most likely as a merchant vessel or maybe a personnel transport (Sivilich 2011). However, the button may not have been deposited by a member of the 52nd Regiment and could have been kept as a souvenir of the war or been part of a jacket worn second-hand and deposited years later.

HAIR DEPOSITS

Hair deposits were found in the following ship-related contexts: embedded in caulking or tar-like materials on vessel timber on or near vessel timbers; embedded in mortar associated with a brick feature on the ship; and within the vessel frame (loose strands and strands mingled with other artifacts in apparently incidental association). Ten separate hair deposits were catalogued from these three contexts, each deposit containing more than one strand of hair. For the purposes of this analysis, each hair sample (and the many individual strands within it) was counted as a single artifact.

OTHER ARTIFACTS

Artifacts from the Activities group (60 percent of the assemblage), including those related to various professions such as shoe-making and leather-working, cooking, and seafaring, were recovered during the archaeological investigation of the ship remnant. The Activities group also includes botanical and faunal material and coal and charcoal fragments that were found scattered throughout the site. Five artifacts from the Furniture Group (making up just a small fraction of the total artifact collection) were decorative furnishings such as flowerpots and delft tiles. Other bits of detritus found associated in and around the ship remnant included 22 fragments of white clay smoking pipes, representing 1 percent of the total assemblage. None of the pipe fragments contained a maker's mark, but analysis suggests they were made in England during the mid-to late-18th century and one bowl contained fluting and a floral motif suggestive of that time period. In addition to the bricks that made up the galley hearth, additional brick and mortar fragments were found elsewhere on the ship remnant and in the river bottom deposits, but no bricks were recovered from the landfill adjacent to the ship remnant, although many were observed in other portions of the VSC Site.

B. COMPARATIVE ANALYSIS

Before addressing the question of whether differences in the distribution of artifacts recovered from the ship can be identified, a preliminary step is establishing that the ship-context assemblage is distinct in comparison to the artifacts recovered from the surrounding landfill or underlying river bottom. Alternatively, if the three assemblages were determined to be essentially uniform, it would be unlikely that further analysis of the ship-context assemblage could address substantive research questions. In order to make this comparison, **Table 7-7** includes summary information regarding artifacts collected from other portions of the VSC Site during the multi-year monitoring effort (AKRF 2012a). This table presents artifact counts by *Type*, a variable that attempts to represent the primary activities and artifact classes represented by the assemblage.

Table 7-7
Artifact Counts and Percentages by Type by Context

	Landfill*		River Bottom		Ship		Totals	
Type	Count	Percent	Count	Percent	Count	Percent	Count	Percent
Arms Accessories /Projectiles	3	<1	1	<1	327	23	331	9
Block and tackle?	-----	-----	-----	-----	20	1	20	1
Ceramic (flower pot/chamber pot)	12	1	3	<1	-----	-----	15	<1
Construction Materials	52	4	109	13	87	6	248	7
Cooking/heating?****	36	3	15	2	238	17	289	8
Cordage	-----	-----	1	<1	5	<1	6	<1
Fastener	-----	-----	9	1	52	4	61	2
Food-related	395	29	310	36	279	19	984	27
Food storage/service	632	46	99	12	49	3	780	21
Local industry	12	1	1	-----	-----	-----	13	-----
Medicinal	4	<1	4	-----	-----	-----	8	-----
Natural	26	2	236	28	213	15	475	13
Personal item	42	3	5	1	20	1	67	2
Sewer pipe	1	<1	1	-----	-----	-----	2	<1
Ship part	1**	<1	1	-----	65	5	67	2
Shoe/clothing*****	54	4	67	8	37	3	158	4
Storage item	1***	<1	-----	-----	7	<1	8	<1
Tool	-----	-----	-----	-----	33	2	33	1
Unidentified	104	8	-----	-----	2	<1	106	<1
Totals	1,375	100	862	100	1,434	100	3,671	100

Notes:
*In this table Landfill counts include artifacts recovered from other areas of the VSC Site
**An anchor recovered 50-100 feet northwest of ship
***A wooden barrel recovered 50-100 feet northwest of ship
****Brick from hearth, coal, and charcoal
*****Shoe parts probably include waste materials from local manufacturing

Of immediate note is the observation that the artifact types *Arms Accessories, Block and tackle?* (wooden sheaves and blocks that may have been part of the ship's rigging), *Cordage* (rope), *Fasteners* (including trunnels and spikes), and of course *Ship part*, were most frequently recovered from the ship context, and rarely recovered from the other contexts. However, to make this comparison more objective, the quantities and percentages of the five most frequently recovered artifact types were compared for the three primary contexts included in Table 7-6: *Landfill, River Bottom*, and *Ship* (ambiguous contexts were not included in this analysis). The compared artifact types were *Construction Materials, Food related, Shoe/Clothing, Arms Accessories/Projectiles*, and *Food storage/service*. The Chi-square was used to determine whether the differences in the proportions of these artifact types suggested a random or statistically significant distribution resulting in the identification of a significant relationship (Chi-square-1263.17 with 8 degrees of freedom).

The following discussion contains summary information for each of the five established contexts—Ship, Landfill, Landfill/Ship, River Bottom, and Unknown—as well as for some of the artifact groups or specific finds.

SHIP

The 1,434 artifacts associated with the ship remnant (as summarized in Table 7-2) represent nine artifact groups—Activities, Architectural, Arms, Clothing, Furniture, Kitchen, Personal, Tobacco, and Unidentified—more than was encountered in any other context. The Activities group represents a wide range of artifacts including tools, ship parts, and various archaeobotanical remains. Architectural materials from this context included the bricks and mortar from the potential galley hearth (see **Chapter 6**), as well as nails, spikes, window glass, and wood fragments, all of which may have been part of the ship remnant at one time.

KITCHEN ARTIFACTS

A total of 62 artifacts from the Kitchen group was recovered from the ship remnant, representing 4 percent of the Ship context assemblage. These included four tableware utensils and utensil fragments were recovered from the Ship context, including one complete spoon and one spoon bowl without its handle (see **Figure 7-1**). Both spoons have long, narrow bowls of identical shape, but of different sizes: one measured 1.5 by 3 inches and the other 0.75 by 1.625 inches. The smaller spoon fragment was recovered during water screening of soils from the area near the stern knee. The larger, complete, spoon was made of a metal known as Britannia. The obverse of the handle was stamped "LONDON" and the front of the handle had an embossed decoration of sun rays at the top of the handle and dots in relief radiating down both of the handle's sides.

A third portion of a utensil, a small handle, was recovered near the Stern Knee and was discovered during flotation analysis. This handle featured the same embossed decoration on the handle. There was also a circular cartouche or hallmark imprinted below the rays, but the interior of the mark was rendered illegible by wear. While not enough of the handle was preserved to identify any other marks, the proportions of the handle fragment appear to be similar to those of the aforementioned small spoon bowl. They may therefore have been part of the same set of utensils, if not from the same spoon.

The fourth utensil fragment, another handle, was recovered between Frames FN 8 and FN 9 of the ship remnant. This utensil fragment appeared to have more iron in it than the other spoons and utensil fragments, which were made of Britannia. This handle had a square hallmark on its front, but because of its condition, it was not possible to determine which letter or mark is represented in the hallmark and therefore it could not be traced. While the handle was identical in shape and size to the two previously mentioned handles, it was undecorated and therefore may not be from the same set of utensils.

The Clothing category (representing 1 percent of the Ship's artifacts) consisted of buttons made of brass, wood, and leather, as well as a cufflink, a hook and eye, the finger of a leather glove, and a fine 18th century gilt shoe buckle. One was the previously mentioned pewter button that once belonged to a Private in the British 52nd Regiment of Foot.

Only three Personal artifacts were found during investigation of the ship remnant, all of which were found within the context of the Ship, near the stern within Analytical Units A and Stern Knee. These artifacts comprise two extremely worn objects which have been preliminarily identified as coins and a mirror fragment.

Ship-related faunal remains consisted of nearly 20 percent of the total faunal remains, most (34.5 percent) of which were identified as "medium mammal" (e.g., an animal the size of a sheep or a goat but which could not be identified as to species). Of the identifiable remains from the ship remnant, cattle was the most abundant.

BOTANICAL REMAINS

A total of 1,488 artifacts (60 percent of the total) were categorized in the Activities Group. These remains included fairly common seeds and pits such as cherry, peach, apple, orange, grape, a single coffee bean, blackberry/raspberry seeds, and seeds that may have come from squash, melon, and/or watermelon. In addition, various grasses and shrubs were present, including jimsonweed, cinquefoil and others, all of which are hardy species known to thrive in disturbed contexts such as garbage dumps and landfill sites, as described previously.

Raspberry/blackberry seeds and cherry pits were the most common seeds/pits recovered. Vine, orchard and garden seeds as well as nuts such as black walnut and pecan suggest the possibility that fruit, nut and vegetable products might have been important to the economy of the vessel. However, it is unclear if the recovered comestibles represent the remains of shipboard dining, the remains of produce hauled as cargo, or if they are simply part of the landfill that found its way between the planks of the ship remnant.

FAUNAL REMAINS

Faunal materials (mammal, bird, and fish bones) were also recovered during the archaeological investigation of the ship remnant (shells and other marine organisms are discussed in **Chapter 5**). These remains may have been deposited by butchers whose stands were located near the waterfront and whose waste-products were dumped into the river or used as landfill. The bones could also have been the remains of meals consumed aboard ship. As described above, butcher marks on the bones provide some clues as to the butchering methods that were employed, the cuts of meat consumed, and types of meat dishes (stews, roasts, etc.) served. A complete analysis of the faunal materials is included in **Appendix C**.

ARMS/ORDNANCE

Most of the ordnance recovered during the investigation of the ship remnant was located in the Ship context, not in the landfill or river bottom contexts. This included a single cannonball; a 4-pounder that was probably made of American iron, but was possibly created for a French-made cannon like those that were in use in America during the Revolutionary War (Sivilich 2011). Only a small number (3) of projectiles was recovered from the Landfill context in a location far removed from the ship remnant, strongly suggesting that the Ammunition recovered from the ship was associated with the operation of the ship and was not simply part of the landfill that had worked its way into the timbers (see Table 7-5).

Grapeshot, buckshot, musket balls, and birdshot are also present in the artifact assemblage. All musket balls (56 in total) had been cast in molds and had visible mold seams and/or sprue cuts, a characteristic of American ammunition (Sivilich 2011). At least two musket balls appear to have been fired and show evidence of having impacted a hard target. It is believed the musket balls and possibly the bird shot were used in small rifles known as fowling pieces which would have been used for procuring game. The musket balls were not of the size typically used for military ordinance. They range from 0.47 to 0.67 inches in diameter and could represent four different types of weapons. While the smaller sizes were probably used in smooth bore guns, one measured 0.67 inches in diameter. This is within the size range of musket balls compatible with the British Brown Bess (ibid). While this type of gun was typically used by the American army, it was also used by the 52nd Regiment of Foot, which is connected to the ship remnant via the pewter button recovered from the Amidships section of the stern (Murray, personal communication, October 18, 2011). Ten pieces of lead buckshot were recovered associated with the ship remnant. Typical military buckshot is 0.30 to 0.36 inches in diameter. The buckshot from the ship remnant was smaller and measured 0.20 to 0.26 inches in diameter which is more consistent with personal fowling or smooth bore muskets (Sivilich 2011).

In total, 251 pieces of birdshot were recovered during the ship investigation. The majority of the birdshot examined was not made using the shot tower method, which was a method of creating uniform, perfectly round lead shot that was invented by William Watts in 1782 (Sivilich 2011). The birdshot from the ship remnant is not perfectly round, nor does it appear to have been made in a mold. Sivilich (2011) conducted experiments during his analysis of the ordnance and determined that the birdshot recovered from the ship remnant was made using the "short drop method." With this method, lead is dropped from a lesser height into a vat of water, which cools and hardens the lead. Sivilich concluded that the birdshot was made using the Rupert method, which was invented in 1663 but used throughout the 18th century until the invention of the shot tower. Prince Rupert of Germany, who was also a soldier and scientist, invented an improved method for manufacturing lead shot in which molten lead is poured through a colander, creating molten lead droplets which are then dropped into water and cooled (ibid). With this method, shot of varying sizes can be made in greater quantities than by using the standard short drop method. Shot made by the Rupert method has a distinctive dimple and apple shape, identical to the shot found within the ship remnant (ibid).

In addition to its use in hunting, birdshot has also been linked to the quelling of uprisings. It is light in weight and generally not deadly when directed at people. Birdshot was found aboard slave ships such as the *Whydah* that went down off Cape Cod in 1717 and birdshot made by the Rupert method has been found on *Queen Anne's Revenge*, the former slave-ship captured by Blackbeard that sank off the coast of North Carolina in the early 18th century (North Carolina Department of Cultural Resources n.d.). Birdshot could have been kept aboard to quell mutinies, potential slave uprisings, or it could have been used as an anti-boarding weapon against pirates. Based on the presence of a toredo worms found in the ship timbers, the WTC Ship might have spent time in the Caribbean which was a stronghold for pirates as well as a destination for slave trading.

In addition to projectiles, three gun flints or spalls made of flint from Dover, England were included in the Ship's ordnance assemblage. This type of flint was used by both the British and American Armies for the production of gunflints, but the shape of the gunflint indicates it was made by the latter (Sivilich 2011). Also, in the collection were three sheets of lead (one recovered from ship, one recovered from the vicinity of the ship, and one from an unknown context) that are thought to be vent plates, also called cannon aprons. Lead sheets such as these would have been used to cover the breech of the cannon's touchhole (the opening where the canon's propellant is poured). In addition to the vent plates, a wooden spike overlaid with iron might be an example of an *cheval-de-frise*,[1] but it is more likely an iron-tipped piling.

LANDFILL

A variety of artifacts was recovered from the landfill situated on top of and adjacent to the ship remnant, all of which were from the Activities group. These items included anthracite coal, faunal and botanical remains, leather shoes and shoe fragments, a cast iron anchor, a piece of slag or clinker, and a portion of a wooden barrel or cask. Of the dozen animal bones collected from this context, nine were cattle and the remainder were medium mammal and pig. A large quantity of leather scraps and other detritus from shoe-making activities was found at the site, as were several nearly complete shoes. Coal was occasionally used as a fuel in New York City during the 18th century but it became very common only after the development of canal transportation early in the second quarter of the 19th century, which made Pennsylvania coal a cheap, readily available commodity (AKRF 2012b).

[1] A *cheval-de-frise* is a defensive fortification consisting of timber and spikes. *Cheveaux-de-frise* were used to impede cavalry on land and shipping at sea and a series of them were sunk in the Delaware and elsewhere to puncture the hulls of enemy ships.

One of the more interesting objects recovered from the landfill was the previously mentioned anchor, which was found during VSC construction excavation in the vicinity of, but not in direct relation to the ship remnant. The anchor appears to be cast iron and its shank and arms are flat sided and beveled which is consistent with methods of manufacture from circa 1760 into the early 1800s (McGowan, personal communication October 8, 2011). The shanks of anchors produced for the British Admiralty were typically embossed with a series of numbers to denote the anchor's weight. The anchor recovered from the VSC Site is similarly embossed, and the letter "W" at the foot of the shank suggests it came from the Woolwich dockyards in England (Brouwer, personal communication October 25, 2010). However, the embossed numbers, which appear to state either "61=0=7" or, if inverted, "1=0=19"—would suggest weights of either 6,107 or 119 pounds, neither of which is a realistic measurement for the object. Therefore, the true meaning of the numbers is currently unclear. However, after 1840, arrows were used instead of equal signs in these types of markings which suggests that the anchor predates 1840 (ibid).

LANDFILL/SHIP

A total of 149 artifacts was recovered from ambiguous deposits that may have been associated with either the landfill or the ship remnant. A dozen ceramics were found in the Landfill/Ship context, one quarter of which was creamware. Of the 12 bones that were recovered from this context, one was from a turkey—the only turkey bone recovered during the entire investigation—three were sheep, four from a small mammal, and four were cow bones, one of which had been gnawed on by a carnivore. A chestnut hull was also recovered from this context, the only representative of its kind recovered during the investigation. Many shoe fragments—including leather, heels, soles, seams and tongues—were present, along with a nearly complete shoe. A hunk of braided rope and a piece of a barrel lid were also recovered from this context, which could have been used either on the docks that surrounded the project site or aboard the ship.

RIVER BOTTOM

While relatively few artifacts were recovered from the landfill deposits during the investigation of the ship remnant, 857 objects were recovered from the river bottom deposits beneath the vessel. A large percentage of those artifacts consisted of bones, although this number was skewed by the collection of 154 fragments of a single shattered calvar portion of a horse's skull. The animal was 18 to 20 years old and had been killed with a poleaxe, also known as a killing axe, which were often used in a slaughter house (see Pipes [2011] in Appendix C). Botanical remains recovered from the river bottom were similar to those recovered from the ship remnant and included cherry and peach pits, as well as an orange pit and a coffee bean (see Appendix E).

The majority of the bones recovered during the investigation of the ship remnant were from the river bottom context. This count, however, is inflated by the high number of horse skull fragments probably from a single individual (154) and the recovery of the nearly-complete skeleton of a bay anchovy (75 fragments). If these are discounted, then the number of bones recovered from the River Bottom and the bone count from the ship remnant would be similar.

Ceramics collected from this context were predominated by a red earthenware pint mug with a handle that had broken into 56 mendable sherds. The quart-sized vessel was decorated in a motif known as "clouded ware" and appears to date to the late 18th century. It is believed to have been made by a New York or Philadelphia potter who was copying the English pottery popular at the time (Janowitz, personal communication, August 15, 2010). A white, salt-glazed chamber pot rim was also found. Although white salt-glazed stonewares began to be manufactured circa 1720, teawares that were the first to be manufactured in that style and more utilitarian wares became popular at a later date (Janowitz, personal communication, June 20, 2012). This chamber pot appears to have been made in England sometime after 1720 but before circa 1805 (Louis Berger & Associates 1995:19). The assemblage also included half of an Oriental Porcelain bowl decorated with a hand-painted blue dragon, although only the dragon's tail is present in what remains of this piece. Some experts insist it is a 17th century design and others believe it is of Southeast Asian origin, rather than Chinese *ching-te-chen*[1] origin (Janowitz, personal communication August 15, 2010). A similar artifact was found in a 19th century context at an archaeological site in Philadelphia although it is believed the saucer dated to a much earlier period (ibid).

UNKNOWN CONTEXT

Ten artifacts recovered during the investigation of the ship remnant could not be assigned to a particular context. The most unique of these was a nearly-complete shoe from an unknown context was collected by construction workers and given to the archaeologists. Referred to as the "*New York Times* Shoe" after a photograph of it was published in that newspaper, this shoe was found within the landfill at the same depth as the stern. Photographs of this shoe were sent to experts at Colonial Williamsburg, who suggested that the shoe dates from the 1790s to before 1820 and is an example of what shoemakers would consider fine work: a well-sewn shoe with many nice details (Povinelli, personal communication, September 7, 2010). The shoe experts made it clear that while second-hand shoes were common among sailors and there were no sumptuary laws to govern sailors' clothing choices. Particularly nice shoes were often patched, mended, handed-down, sold second-hand, and sometimes even found their way onto slaves' feet. While not extremely fine, this particular shoe is of a nice quality and would have been considered fashionable and could have been worn by a variety of individuals who may or may not have been involved in maritime activities (Saguto, personal communication September 4, 2010).

C. SPATIAL ANALYSIS OF SHIP ARTIFACTS

After establishing that non-random differences exist between the counts and percentages of artifact types recovered from the ship context and adjacent soils, an effort was made to identify artifact patterning within the ship itself. In order to begin to address this more substantive analysis the primary ship context was further divided into the following six categories, including three arbitrary analytical units and three ship-based Analytical Units (see **Chapter 2**):

- Western Portion of the Stern (indicated as "A" on Figure 7-1): Artifacts recovered from between the ceiling layer and outer planking, west of frame FNFS 10.
- Middle Portion of the Stern (indicated as "B" on Figure 7-1): Artifacts recovered from between the ceiling layer and outer planking, between frames FNFS 10 and FNFS 18.
- Eastern Portion of the Stern (indicated as "C" on Figure 7-1): Artifacts recovered from between the ceiling layer and outer planking, east of frame FNFS 18.
- Orlop Deck: Artifacts recovered from beneath the orlop deck and on top of the ceiling layer.
- Stern Knee: Artifacts recovered from the soils that accumulated around the stern knee on top of the outer planking.
- Unidentified Ship: Artifacts recovered from on top of the outer planking after all of the frames had been removed.

Comparison of the artifacts collected from each of these Analytical Units to each other, to the entire ship context, and to the other primary contexts may lead to the identification of similarities or differences. A

[1] Jingdezen, a city in china whose name is synonymous with ceramics, particularly porcelain.

breakdown of counts and percentages of artifact types for each ship context is presented in **Table 7-8** below.

Table 7-8
Counts and Percentages of Artifact Types by Ship Context

Artifact Type	Analytical Unit/Portion of Stern*						Orlop Deck		Stern Knee		Unidentified Ship		Total	
	Rear (A)		Middle (B)		Front (C)									
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Arms Accessories/ Projectiles	169	49	24	7	-----	-----	5	5	126	46	3	4	327	28
Block and tackle?	16	5	2	1	-----	-----	-----	-----	1	<1	1	1	20	2
Construction Materials	13	4	37	11	4	13	15	16	5	2	9	11	83	7
Cooking/heating?	69	20	101	30	-----	-----	58	63	6	2	4	5	238	21
Cordage	-----	-----	2	1	2	7	-----	-----	-----	-----	1	1	5	<1
Fastener	5	1	22	7	-----	-----	-----	-----	14	5	11	13	52	4
Food related	48	14	118	35	20	67	7	8	73	27	15	18	281	24
Food storage/service	10	3	11	3	-----	-----	3	3	12	4	13	16	49	4
Metal	-----	-----			-----	-----	-----	-----	-----	-----	1	1	1	<1
Personal item	7	2	5	1	-----	-----	1	1	3	1	2	2	18	2
Shoe/clothing	4	1	3	1	4	13	2	2	13	5	11	13	37	3
Storage item	-----	-----	2	1	-----	-----	-----	-----	5	2	-----	-----	7	1
Tool	1	<1	8	2	-----	-----	-----	-----	13	5	11	13	33	3
Toy	-----	-----	2	1	-----	-----	-----	-----	-----	-----	-----	-----	2	<1
Unidentified	-----	-----	1	<1	-----	-----	-----	-----	-----	-----	1	1	2	<1
Window Glass	3	1	-----	-----	-----	-----	1	1	-----	-----	-----	-----	4	<1
Total	**345**	**100**	**338**	**100**	**30**	**100**	**92**	**100**	**271**	**100**	**83**	**100**	**1159**	**100**

Notes: ***See Figure 7-1** for location of Areas A, B, and C

As stated in **Chapter 2**, the analysis and interpretation of spatial patterning within the ship remnant is beyond the scope of the present report. However, examination of Table 7-8 leads to the following general observations:

- The Stern Knee and A contexts yielded the greatest number of arms accessories/projectiles. That artifact type constituted the greatest percentage of the artifacts recovered from those two contexts. This may partly be a result of the accumulation over time of these small spherical objects in the portion of the ship remnant with the lowest elevation as opposed to an indication that these objects were more frequently used or stored in these areas.
- Great variability is indicated in the counts and percentages of artifact types between the arbitrarily identified Analytical Units A, B, and C. These areas were selected and defined in order to identify differences across the 32-foot length of the ship remnant's stern. If the forward portion of the stern (Analytical Units B and C) had served as its hold and the aft portion (A) was the location where the crew lived, differences between these areas would be expected. The most frequently recovered artifacts from Analytical Unit A were Arms Accessories/Projectiles (49 percent), Cooking/Heating (20 percent), and Food-Related (14 percent). For Analytical Unit B they were Food-Related (35 percent), Cooking/Heating (30 percent), and Construction Materials (11 percent). Finally, for Analytical Unit C, the most frequent types were Food-Related (67 percent) followed by Construction Materials and Shoe/clothing (both with 13 percent).
- A total of 67 percent of the artifacts collected from the Orlop Deck were identified as related to Cooking/Heating (58 artifacts), followed in frequency by Construction Materials (16 percent), and Food-Related (8 percent). Clearly, this distribution is a reflection of the assumption that the bricks

recovered from this area were part of a galley hearth, as described in greater detail in Chapter 6, Section G.

The stark differences in artifact percentages of individual Analytical Units in comparison to the *Unidentified Ship* grouping and the totals observed as described above suggest that there is the potential for future analyses to yield substantive data about the artifacts recovered during the investigation of the ship remnant.

A. SYNTHESIS OF ANALYSES

SITE DEVELOPMENT

As discussed in **Chapter 3**, The WTC Ship appears to have been incorporated into the landfill making up Block 56 and Washington Street by the early 1790s. Prior to that time, the area had been an active waterway and was one of the busiest slips along the Hudson River. Three individuals are associated with the landfilling effort in the vicinity of the WTC Ship: (1) John G. Leake, who constructed and maintained the wharf to the south, in the vicinity of modern Cedar Street; (2) George Lindsay, who constructed and maintained the wharf to the north, along Liberty Street, and filled in the water lots on the north half of Block 56, including the location of the WTC Ship; and (3) Barnardus Swartwout Jr., who filled the water lots making up the south half of Block 56. The filling in of the Ship's location appears to have occurred in response to a development boom along the Hudson River that occurred after the American victory in the Revolutionary War. The block was entirely filled and partially developed by 1818.

SHIP CONSTRUCTION

The correlation between the growth rings of the timber samples from the ship remnant is sufficiently strong to suggest that the WTC Ship was built (at least partially) from timbers that grew in the same locality in the Philadelphia region and that were felled in the late-18th century, as described in **Chapter 6**. Depending on how long the timber was seasoned or stored prior to the vessel's construction, the ship may have been built between the late 1770s and the 1780s. Several different wood types were used to construct the ship, including spruce and pine (soft woods used for the internal planking), white oak (a hard wood used for the vessel's frames, deck beams, and some ceiling planks), and hickory (a durable wood that was used for the keel). The original intact vessel would likely have had a breadth of more than 20 feet and a length of 50 to 60 feet. The majority of the fasteners used to construct the WTC Ship were iron and few trunnels were observed. It is therefore possible that some of the frames with trunnels were recycled from an earlier vessel. Inconsistencies in the dates of the timbers as determined through dendrochronological analysis may also reflect the re-use of older timbers, however those inconsistencies may also be the result of loss of tree ring data as a result of the squaring of timbers.

The WTC Ship contained a brick feature that appears to represent the base of a former brick galley hearth, which would have been used by the ship's crew to cook food and generate warmth. The purpose of the metal ring and plate in the center of the brick base and the apparent aperture within it is not clear, however, it may have been part of an ash pit, or simply a stabilizing aspect of the hearth's construction. Loose bricks found beneath the orlop deck may have been part of the hearth that became dislocated or they may represent supports for the orlop deck that were installed to help the small deck bear the weight of the brick hearth.

In light of the unusual aspects of the ship's construction, it has been hypothesized that the ship was constructed in a small shipyard, likely in close proximity to where the trees grew. If the ship was constructed in the Philadelphia area, the center of America's shipbuilding industry in the 18th century, it is unknown if it was constructed for use in that region or for use elsewhere. The ship is consistent with the construction methodology of a class of ship known as the Hudson River Sloop. Like Hudson River Sloops, which were designed specifically to transport large cargoes and groups of passengers along the shallow, rocky waters of the Hudson River, the WTC Ship had a broad beam, shallow draft, and a mast that was stepped aft of the bow by approximately one-third of the ship's overall length.

Given its rounded stern and flat floors, it appears that the ship was constructed for the transportation of cargo. The ship remnant was constructed in a way that would have maximized the amount of cargo space but would also have increased the amount of drag on the vessel. Therefore, the WTC Ship was most likely used as a merchant trading vessel in shallow, protected waters—such as those along the coastal United States and/or Hudson River—and was not likely built as an ocean-going vessel. However, the shipworms that infested its timbers prove that the vessel went as far as the Caribbean, or a similar locale with warm, salty waters. The WTC Ship was subjected to hard use during its active period, and its keel was heavily worn, presumably from frequent landings. Many repairs were observed in its outer planking, frames, and ceiling planking. As timbers were damaged or rotted, they were replaced with new timbers or smaller filler pieces. It is therefore possible that it was constructed for use in a sheltered river environment, but was ultimately used to transport cargo to distances greater than those intended by the shipbuilder, resulting in significant wear and tear to the vessel.

If the ship was constructed in the 1770s or 1780s, as the dendrochronological analysis of its timbers would suggest, and incorporated into the landfill by the 1790s, the ship would therefore have experienced a very short period of active use, and was possibly only on the water for 10 to 20 years. It would appear that the years of hard use, frequent repairs, and significant shipworm infestation resulted in the ultimate demise of the vessel.

MARINE LIFE

It is unclear if the vessel went to the Caribbean frequently, or if its sole journey to that area resulted in the shipworm damage that brought about its ultimate demise. However, as described in **Chapter 5**, the evidence of marine life observed and collected during the ship's removal provides insight into the events that surrounded the deposition of the WTC Ship after it was no longer a sea-worthy vessel. The remains of marine organisms found both on and within the ship appear to indicate that the vessel sat in or near its present location (or in a similar location) and was partially submerged for at least two years before the land around it was filled in. Oysters and barnacles attached to the sternpost, planks, and keel provide compelling evidence that the ship's hull was exposed to the water of the lower Hudson River for some time prior to landfilling. Oysters, which do not tend to survive travel from one port to another due to their sensitivity to salinity, were found on the hull of the ship remnant, suggesting that the vessel was submerged in or near the site throughout the two- to three-year life span of the largest oysters that were collected.

There is no evidence that sacrificial layers, such as sheathing, that may once have protected the hull's exterior were present in the locations in which the mollusks were growing. The lack of these protective timbers appears to suggest that during that period when the mollusks were given the opportunity to grow on the vessel, the WTC Ship was either neglected, under repair, or abandoned. Similarly, relatively immobile species—such as clams found within the ship remnant's frames—suggest that the interior of the ship was sufficiently exposed to the open waters of the estuary that sediments could accumulate and that these species could recruit to the site and grow. Assuming that the clams did not infiltrate the vessel's framing during the landfilling process, the presence of these species suggests that the vessel was abandoned on the river bottom for a long enough period to allow the clams to reach maturity.

The pattern of bryozoan growth observed on the ship's timbers also contributes to the theory that all or portions of the ship remnant were submerged in water prior to landfilling. Bryozoans inhabit intertidal zones and can withstand some exposure to the air, but require periodic submersion in water to live. In the stern section of the ship remnant, bryozoan and oyster growth was generally limited to the outside of the outer planking, except where barnacle growth occurred on the upper proximal end of one of the cant frames (possibly as a result of water pooling around the bilge). The bow section of the ship remnant, however, exhibited bryozoan growth not only on the outer portions of the hull, but on the vessel frames and on the ceiling planking. This would suggest that these sections of the ship (the entirety of the bow fragment and the outer portion of the stern hull) would have to have been submerged or positioned at the intertidal zone to support this marine life.

SINKING OF THE WTC SHIP

As discussed in **Chapter 5**, he discrepancy between the bryozoan growth pattern on the bow and the stern of the ship may suggest that the bow of the ship remnant was more fully submerged than the stern (for example, the vessel was abandoned in shallow water with the bow angled upwards or the vessel was left at the shore with the bow pointed outward into the water). Alternatively, the entire vessel may have been submerged or partly submerged, but the bow was in a more fragmented condition and was therefore more susceptible to water infiltration and colonization by marine organisms. The presence of eelgrass, which lives only in shallow water, and the presence of coffee bean snails (Melampus bidentatus), which live exclusively in intertidal salt marsh habitats in Spartina-vegetated marshes, suggest that the uppermost portions of the stern of the ship may have been at or near the watermark at low tide.

It is possible that the vessel was used as a floating storage hulk at this time; its permanent placement along one of the docks in the vicinity of the VSC Site would have allowed for the growth of the marine organisms on and within its timbers. This possibility is consistent with historical documentation relating to New York harbor in the late 18th and early 19th centuries. As described in **Chapter 3**, numerous references to abandoned hulks in the slips along the Hudson and East Rivers can be found in the *Minutes of the Common Council*. Further, references to neglected and abandoned wharves and slips left to accumulate silt and refuse are also common, particularly during periods of economic downturn. The author John Lambert recorded his impressions of New York while touring the city between 1806 and 1808. Lambert described a bustling maritime center on his first trip to the New York wharves in 1806. When he returned the following spring, however, he found the pace of maritime commerce had abruptly declined and the waterfront had been largely abandoned as a result of the Embargo Act of 1807:

> *The port, indeed, was full of shipping; but they were dismantled and laid up…The streets near the water-side were almost deserted, the* grass had begun to grow upon the wharves…(Lambert 1814: 64-65 [emphasis in original]).

Although the vessel would have been abandoned prior to the period of economic downturn described by Lambert, the excerpt illustrates that even short-term neglect of localized waterfront infrastructure could result in an environment characterized by overgrown wharves and abandoned, dismantled ships.

ARTIFACT ANALYSIS

Analysis of the thousands of artifacts recovered during the discovery, documentation, and removal of the ship remnant has revealed a complex mosaic of activities representative of the vibrant local community, the landfill used to fill in the project site, and very likely information regarding the use and operation of the ship itself (see **Chapter 7**). Regarding

the local community, the artifacts recovered from the original river bottom included excess shoe parts likely discarded into the slip, a portion of a wooden barrel used to store or ship goods, an anchor, and butchered animal bones and horn cores. The fill itself contained a great variety of refuse likely discarded by the city's colonial residents at local dumps, dumps which were later used to fill in the slip as the developing city continued to grow westward, out into the waters of the Hudson River. Finally, from the partially sealed voids amongst the ship remnant's timbers, the field team recovered hundreds of pits, seeds, nuts, and animal bones that may have been consumed by the ship's crew or were the remains of cargo shipped up and down the Hudson or along the coast. Also recovered were arms accessories and projectiles likely used by the crew for hunting purposes or possibly to defend the ship from pirates. Of final note, the field team recovered tool handles, eating utensils, dishes, fragments of tobacco pipes, and even buttons, buckles, a cufflink, and the finger of a leather glove, all items that were the personal possessions of the ship's crew or passengers.

B. SIGNIFICANCE STATEMENT

The value of an archaeological site—by definition a unique, non-renewable, and irreplaceable resource—can be measured by the rarity of the site type, the importance of the information it can provide, and, more subjectively, the ability of the resource to provide a connection between the current residents of a geographic place and their historic predecessors. Historic ships are data-rich and highly complex structures that often span the disciplines of history, biology, chemistry, anthropology, economics, and engineering. They played a central role in the development of New York State and of New York City as a center of commerce and they helped the United States become a global economic power. However, of the many thousands of archaeological sites that have been excavated in New York State, including several hundred that have been listed on the State's Register of Historic Places, only a very small number of them are shipwrecks. In fact only a dozen Colonial-era merchant ships have ever been professionally recorded nationwide, one of which was the circa 1720 "Ronson Ship" discovered on Water Street, which is now known to be the *Princess Carolina* (Riess and Smith, in press).

The WTC Ship represents a combination of a very rare site type with a high research value that engaged the interest and curiosity of the public, partly due to its discovery near the WTC Site, a site of great significance as a symbol of New York City's importance in global trade. The WTC Ship is significant for its association with the rise in prominence of the Port of New York during the late 18th century, its association with the development of New York City's Hudson River shoreline, and for being the earliest documented example of a Hudson River Sloop, a ship type that emerged during the early 19th century as an important ship type on the Hudson River. The fact that the general public has expressed an interest in this discovery indicates that the *value* of the WTC Ship also includes its ability to convey to New York City residents and visitors an appreciation of the city's river-based mercantile past discovered at a place already infused with meaning and significance, a site where the LMDC and the Port Authority of New York and New Jersey are currently overseeing a major rebuilding effort.

As stated above, SHPO determined the WTC Ship eligible for listing on the State and National Registers of Historic Places (S/NR) as a shipwreck. Since the determination of eligibility, further documentary research and artifact analysis has provided a more detailed understanding of the importance of this ship remnant. This section considers the significance of the WTC Ship in comparison to the National Register criteria.

While the WTC Ship has lost some elements of integrity, it still possesses others to an important degree. Most importantly, the site where the WTC Ship was discovered has been continuously associated with trade and commerce for over 300 years; from its use as a small port in a young colony, to being the site of the World Trade Center, a location of world renown and symbolic of the United States' role in international trade and commerce, to its future use once reconstruction is completed. As a merchant vessel discovered beneath landfill, the WTC Ship conveys both the historic importance to New York of river-based trade and its dynamism and growth. These qualities would be enhanced by the preservation and reconstruction of the WTC Ship following appropriate standards.

The significance of a shipwreck possessing the appropriate aspects of integrity is based on a determination of its qualities, associations, and characteristics. Applying National Register criteria to a shipwreck requires establishing whether the vessel is:

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

The WTC Ship is significant in American history, architecture, engineering, and archaeology under Criteria A, C, and D for its association with the rise in prominence of the Port of New York during the late 18th century, its association with the development of New York City's Hudson River shoreline, and for possibly being the earliest professionally documented example of a Hudson River Sloop, a ship type that emerged as a very important type of vessel on the Hudson River during the early 19th century. In addition it may have been temporarily conscripted into service during the Revolutionary War and has the potential to yield information important to local and regional history.

CRITERION A – ASSOCIATION WITH EVENTS SIGNIFICANT TO THE BROAD PATTERNS OF NEW YORK HISTORY

The WTC Ship is considered significant under Criterion A in the areas of *Commerce*, *Engineering*, and possibly *Military*. The analysis of documentary records has the potential to enhance the significance of the WTC Ship as more information is collected concerning the ownership of the land in and around the location of the ship's discovery, the process of land reclamation, and possibly the port of construction of the remnant and its history.

COMMERCE

The WTC Ship was discovered in a former slip located in what was part of the Hudson River during the mid-to- late-18th century. Commerce and trade along the Hudson River played an integral role in the rise in prominence of the Port of New York and the dramatic development of New York City as a dominant commercial hub during the 19th century. The level of commercial activity steadily increased and eventually grew to handle two-thirds of America's imports, and dominated exports and passenger trade by the mid-19th century. Today the Port of New York is the third busiest port in the United States. As the WTC Ship appears to have been a merchant craft, it has historical value for its association with the development of commerce in the New York region during the late 18th century.

ENGINEERING

The WTC Ship's association with the historic development of New York City's Hudson River shoreline is based upon its discovery within fill deposited by the 1790s. Land-making had a crucial impact on the development of New York's burgeoning economy. After the end of the Revolutionary War, American commerce surged and trade networks expanded. By the 1790s, merchants had established far-reaching networks for both domestic and foreign trade. The East River waterfront maintained a prominent role in the shipping industry until the early-19th century, when the advent of steam-powered ships forced the focus of New York's trade economy to shift to the deeper waters of the Hudson River. Landfilling in the vicinity of the project site increased rapidly with this shift, and historic maps show that the project site was completely filled in and partially developed by 1818. As the shoreline was extended further out into the river, wharves, docks, and piers were buried in the landfill, forming the skeletal structure of the new ground.

The WTC Ship had a shallow draft with a particularly shallow keel but no retractable centerboard. For a sailing vessel, this would imply that it had a leeboard (or two), though the absence of the upper portions of the ship makes this impossible to confirm. This type of construction was part of the sailing tradition of both the English and Dutch and was typical of the Hudson River Sloops. These ships traveled up and down the Hudson River and along the American coast, even as far as the West Indies, where the timbers of the WTC Ship could have been infested with shipworms. During the early 19th century sloops emerged as the dominant vessel type on the Hudson River until gradually being displaced by the advent of steam-powered ships. As an apparently early form of the Hudson River Sloop, the WTC Ship is significant as a unique example of ship engineering and the adaptation of English and Dutch designs to the unique demands of the American coast and Hudson River and the regional economy.

MILITARY

There is limited evidence that the WTC Ship also had a brief association with the Revolutionary War. This evidence consists solely of two artifacts: a single military button from the coat of a British Regiment active in New York during the war; and one small cannon ball that is consistent with a standard used for French-made cannons. The French supplied the American army with military goods during the Revolutionary War. There were also two pieces of grape shot, one for a 3-pounder and the other for a 4-pounder gun. Both guns were manufactured for sea service but it is not known if they were used for military or mercantile defense. This association is perhaps further supported by its apparent construction and use between the 1770s and 1790s, during which time numerous American ships were conscripted for military service.

CRITERION C – EMBODIES DISTINCTIVE CHARACTERISTICS OF A TYPE, PERIOD, OR METHOD OF CONSTRUCTION

Under Criterion C, the WTC Ship is considered significant as a unique example of late 18th century merchant vessel construction in the categories of *Architecture* and *Engineering*. The handcrafted, vernacular design of the WTC Ship's individual elements is unique and cannot be easily placed into the existing knowledge base of ship design. This is partly due to the fact that so few ships from this period have ever been professionally documented and analyzed and that the builder/designers of non-naval ships during this time period rarely maintained documentary records of their work. The WTC Ship's significance under Criterion C was enhanced by the discovery of diagnostic portions of the ship's bow on the east side of the VSC Site.

At present, based on comparative analysis and discussions with a number of maritime archaeologists, the WTC Ship is thought to have been a single-decked vessel with an orlop deck below the living quarters at the stern of the hull. The original intact vessel would likely have had a breadth of more than 20 feet and a length of 50 to 60 feet. Based on the analysis conducted to date, it appears closest in shape to a Hudson River Sloop, a class of large, shallow-draft, single-masted vessels that carried goods and people throughout the Hudson River hinterlands. However, because only a portion of the ship was recovered, its identification as a Hudson River Sloop is only a hypothesis based on available information. The ship may in fact be another type and may have had any number of functions including ferrying supplies or people, possibly troops during the Revolutionary War, between Manhattan and New Jersey, or transporting goods and people up and down the Hudson River or to areas further south.

The WTC Ship's design likely reflects the needs of the owner to transport goods and/or people in the region and seemed to have prioritized hold space at the expense of crew comfort and sailing speed or stability. The fairly flat bottom of the WTC Ship combined with the lack of curvature of the frames around the stern contributes to the theory that the WTC Ship had only one deck. In addition, there is no evidence that the ship had more than one mast. The flattened bottom and wear marks on the keel suggest it may have been regularly brought ashore, perhaps to load and unload the vessel. Therefore, the WTC Ship is considered significant as an embodiment of a set of solutions to a distinctive situation for merchant ship use, design, and building during the late 18th century.

CRITERION D – YIELDS INFORMATION IMPORTANT TO HISTORY

The WTC Ship is considered significant under Criterion D for the informational value of the ship remains, the associated artifacts and samples, and their depositional context. Analysis of the ship remains and associated documentary evidence may ultimately help explain the broad issues of when, where, how, and for what purpose the WTC Ship was constructed. Analysis of the many artifacts recovered from within and in association with the WTC Ship, including those recovered through soil flotation, has the potential to yield important information on the ship’s function and the lives and consumption choices of its crew and/or passengers. Consideration of the materials used to construct the ship and fasten the pieces together also has the potential to provide important information regarding resource availability and decision making on the part of the builder. Finally, the archaeological context of the ship’s deposition could provide important information concerning the development of Manhattan’s Hudson River waterfront during the 18th and 19th centuries.

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Glossary of Ship Terminology

The following glossary provides brief definitions of the terminology used in this report. Terms in bold are defined elsewhere in the glossary.

Abaft: towards the **Stern**.

Aft: the rear of the vessel, closest to the **Stern**.

Amidships: the middle area of a vessel.

Apron: curved timber that reinforces the inner surface of the **Stem** at the ship's bow.

Athwartships: refers to the direction across the ship and perpendicular to the vessel's **Keel**.

Bateaux: shallow, flat-bottomed transport vessels.

Beamy: broad; used to describe the width of a hull.

Bilge Hole: a hole created in a **Ceiling Plank** near the **Keelson** to remove accumulated water.

Bilge: the area between the **Frames** where water is collected; also the area on which the ship would rest if grounded.

Bow: the front/forward end of a vessel.

Brig: a vessel with a **Foremast** and **Mainmast** that is **Square-rigged**.

Brigantine: a vessel with a square-rigged foremast and mainmast that carries a mainsail, fitted with a topmast, carrying a gaff-topsail.

Bulwarks: side of a vessel above its upper deck.

Canal Boat: a flat-bottomed vessel with rounded or pointed ends used for transportation along canals.

Cant Frame: a **Framing Timber** at an angle to the keel and centerline of the vessel found in the bow and stern.

Caulk: material inserted in the seams between a ship's timbers to create a water-tight seal.

Ceiling Planking: the top layer of the hull which would have served as its interior floor. These boards were added on top of the frames as internal planking to protect the cargo from the bilge water and the frames from the cargo.

Coak: a small wooden pin added to the ends of timbers that are about to be joined in order to align or strengthen a joint.

Collier: a cargo ship used to transport coal.

Draft: vertical distance from the water line to a vessel's lowest part.

Draught Mark: lines or marks—often representing numbers—carved into the **Sternpost** and/or **Stempost** to indicate the depth to which the ship was submerged as measured from the bottom of the **Keel**.

Drift Pin: cylindrical bolt with a head that is driven into a hole with a slightly smaller diameter.

Floor Timber: a **Framing Timber** that crosses and is fastened to the keel.

Fore: directional term referring to the area towards the **Bow** of a vessel.

Foremast: the forward **Mast** of the vessel.

Forward: directional term referring the area towards the **Bow** of a vessel.

Fouling: marine growth on the **Hull** of a vessel that can lead to damage if left untreated.

Frame or Framing Timber: sturdy, square, rib-like element that is perpendicular to the **Keel** and forms the structural support of the hull. There are several types of framing timbers: **Floor Timbers**, **Futtocks**, and **Cant Frames**.

Freeboard: distance between the upper deck and waterline of a vessel

Futtock: a **Framing Timber** that does not articulate with the keel.

Galley: the area of a vessel where food is prepared.

Galley Hearth: the oven or fireplace on a ship.

Garboard: the first line (or **Strake**) of the **Outer Planking** that joins into the K**eel**.

Gudgeon: a metal ring attached to the **Sternpost** usually held on by straps into which a **Pintle** would be inserted to hold a **Rudder** in place.

Gunboat: a small vessel with the primary purpose of carrying guns to fire upon targets.

Hold: the portion of a ship used for the storage of cargo.

Hull: the lowermost and outermost portion of a ship.

Joinery: woodworking techniques used to attach timbers (e.g., **Mortise** and **Tenon**).

Keel: the spine of a ship; the main longitudinal and lowest (bottom-most) structural element that runs along the center of the ship's length.

Keelson: a long timber running the length of the ship and situated above the frames to add strength and support to the structure of the ship; acts as an internal keel.

Launch: a smaller auxiliary boat intended to assist larger vessels.

Leeboard: timber or assembly of timbers mounted on the side of a hull and used to increase lateral resistance when sailing off wind.

Limber Board: **Ceiling Planking** next to the **Keelson** that could be removed to access the **Bilge**.

Limber Hole: Hole cut into the bottom surface of **Frames** near the **Keel** to allow water to drain into an area that can be easily pumped.

Living Area: the quarters inhabited by a ship's crew.

Mainmast: the principal **Mast** of a vessel; usually the second mast from **Forward** in a ship with two or more masts.

Mast: vertical timber from which rigging is hung.

Mast Step: a **Mortise** to receive the **Tenoned** heel of a **Mast**; a mast step could be as simple as a mortise cut into the top of a **Keelson** or cut into an assembly of blocks.

Merchant Vessel: a ship used for commercial or industrial (rather than military) purposes.

Molded: the vertical dimension or depth across the surface of a timber (opposite of **Sided**).

Mortise: a notch or groove into which a **Tenon** is inserted in order to join two timbers.

Oakum: a fiber teased out of hemp.

***Orlop Deck*:** a short, low deck above the hull at the ship's stern; made up of **Orlop Planking** and **Orlop Deck Beams**.

***Orlop Deck Beams*:** timbers mounted perpendicular to the keel to support the **Orlop Planking**.

***Orlop Planking*:** the timbers making up the floor of the **Orlop Deck.**

***Outer Planking*:** the exterior planks of the hull that would have been exposed to the water; also referred to just as "planking" or "the hull."

Pintle: a vertical pin.

Pitch: a tar-like material used to create a water-tight seal.

Port: the left side of a ship when facing the bow from the stern.

Privateer: an armed private ship given the license to attack enemy shipping.

***Rabbet*:** a notch or groove cut into a timber into which another timber can be inserted to form a tight join; usually cut into the **Keel**, **Stempost**, and **Sternpost**.

Rig: the arrangement of sails.

Rigging: the name given to all ropes on a vessel employed to support the masts and raise, lower, or fasten the sails.

***Room and Space*:** the distance from the **molded** edge of one **Frame** to the corresponding point on the next **Frame**. "Space" refers to the unoccupied distance between the two frames and "Room" is the area occupied by the frame.

Round-Tuck Stem: one in which the planking comes into the sternpost at an angle.

Rudder: timbers added to the **Stern** of the ship in order to aid in the steering of the vessel.

Scarfed: joined through notching.

Schooner: description applied to vessels of fore-and-aft rig of various sizes.

Sheathing: a thin covering of metal or wood placed on the outer hull to protect the hull from marine life or **Fouling**.

Shipworm: formally known as a *Teredo*, a mollusk that infests timber.

***Shoe*:** a temporary, sacrificial timber that was added to the underside of the **Keel** in order to protect it from damage.

***Sided*:** the horizontal distance or the width across the surface of a timber, whereas molded refers to the vertical dimension or depth (opposite of **Molded**).

Sloop: a broad, flat-bottomed vessel designed for the transportation of cargo; vessel with only one mast.

Snow: could refer to a type of **Brig** or **Sloop**; a two-masted, **square-rigged** vessel with a smaller triangular or square fore-and-aft rigged sail abaft the **mainmast.**

Square-Rigged: rigged with yards and square sails.

Square-tuck Stem: one in which the planking is perpendicular to the sternpost.

Starboard: the right side of the ship.

Stealer Strake: a short plank inserted between two lines of planking to increase the width; usually found near the bow or stern where the hull changes sharply.

***Stem*:** synonym for **Stempost**; also used to refer to the **Bow** section of a vessel.

Stempost:	upward curving timber(s) in the bow onto which the **Keel** is **scarfed** and to which the outer planking are joined; also referred to as "**Stem**."
Stern:	the rear or aft portion of a vessel.
Sternpost:	vertical or upward curving timber(s) that joins to the **Keel** and contains attachments for a **Rudder.**
Stern Knee:	a large, angular timber that reinforces the juncture of the **Sternpost** and **Keel**.
Stirrup:	in reference to a construction device, a U-shaped bar meant to receive and support another element.
Strake:	a line of planking running from bow to stern.
Tenon:	a timber ridge or protrusion inserted into a **Mortise** to join two timbers.
Trunnel:	a wooden peg used as a fastener to connect the wooden elements of a ship; also called a "treenail."
Wheeler:	also referred to as a paddle wheeler; a vessel powered by a steam engine that drives paddle wheels to move the vessel through the water.

Figures

7.2.13

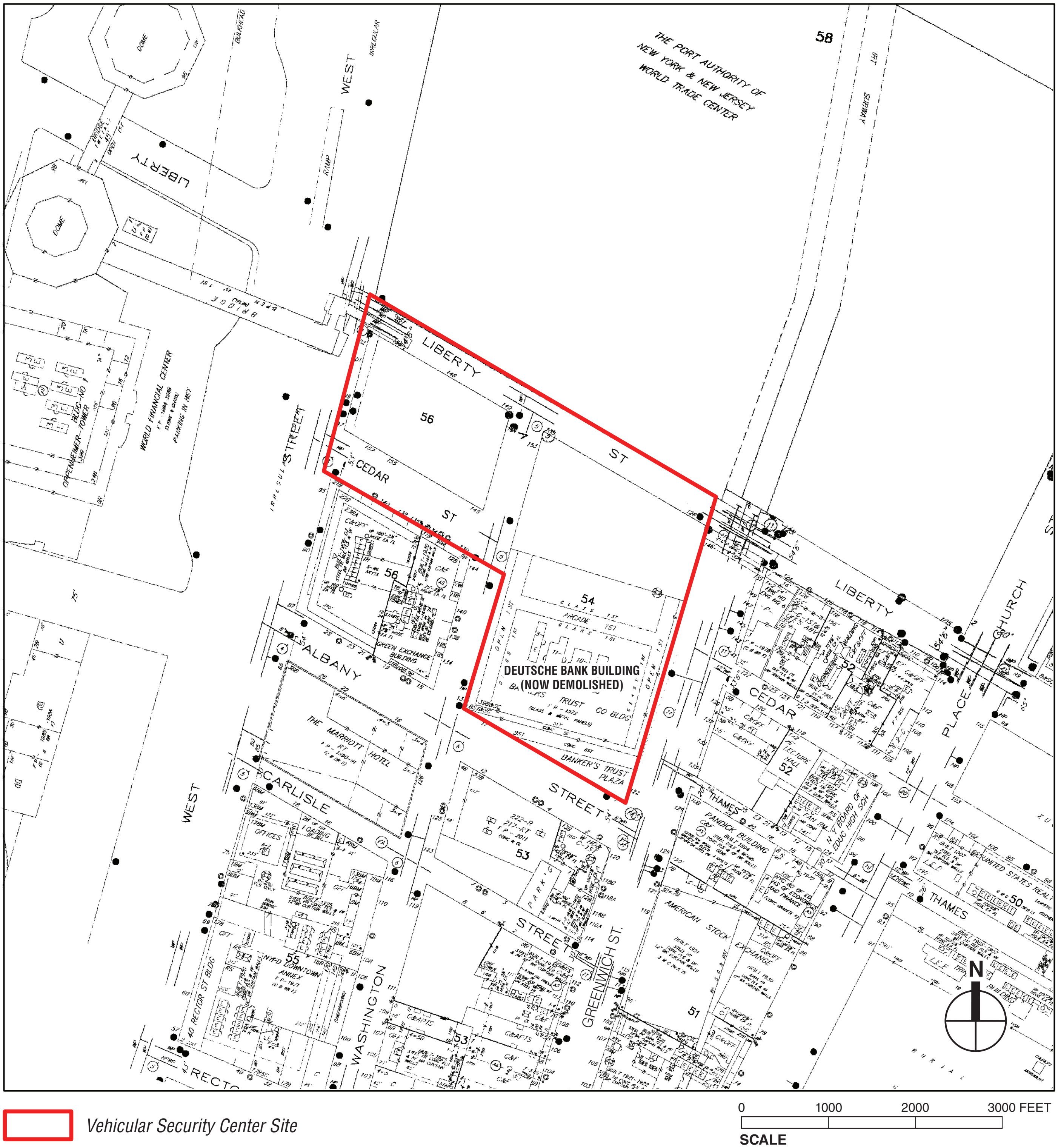
SOURCE: U.S. Topographic Map: ©2013 National Geographic Society

Vehicular Security Center Site

0 4000 FEET

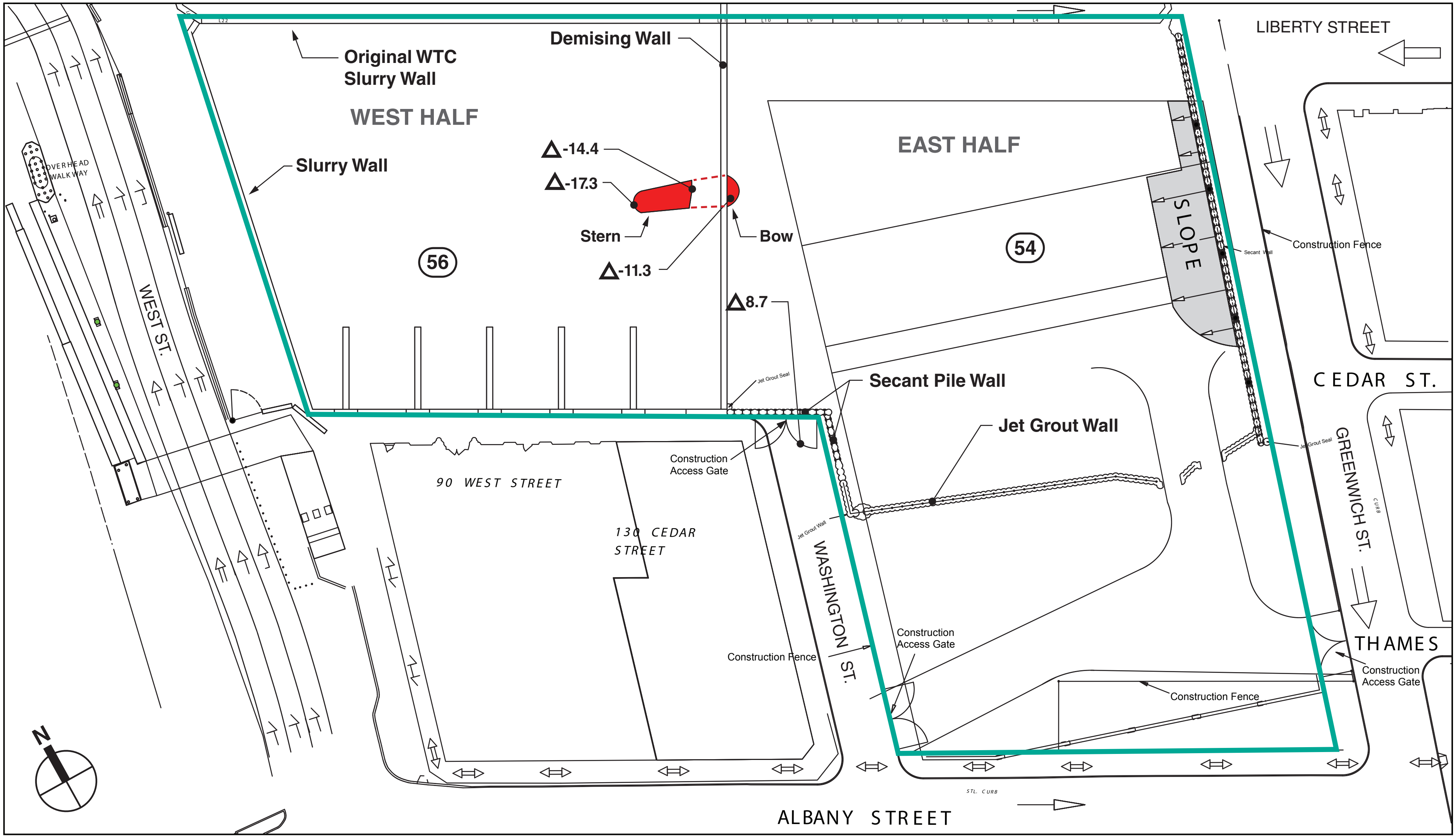
SCALE

Project Location
2013 USGS Topographic Map–
Jersey City and Brooklyn Quads
Figure 1-1



Vehicular Security Center Site

Sanborn Map, 2012
Figure 1-2



Vehicular Security Center Site

56 Block Number

△ Elevation in Feet Relative to Mean Sea Level

2011 VSC Site Plan Showing Location of Ship Remnant

Figure 1-3

Facing east showing Dr. Warren Riess and Carrie Atkins Fulton labeling ship elements in the stern and A. Michael Pappalardo carrying an artifact sample. The demising wall and horizontal tie back panel are 10 feet beyond the ship **A**

Example of labeling and photographic documentation of timber elements on the orlop deck **B**

Labeling and Photographic Documentation of the Ship Remnant

Figure 2-1

Facing east showing the recording of individual elements of the stern using standard field forms **A**

Facing south towards the west end of the ship under the protective awning showing the mapping of timber elements of the stern on large-format plans **B**

Recordation of Ship Remnant

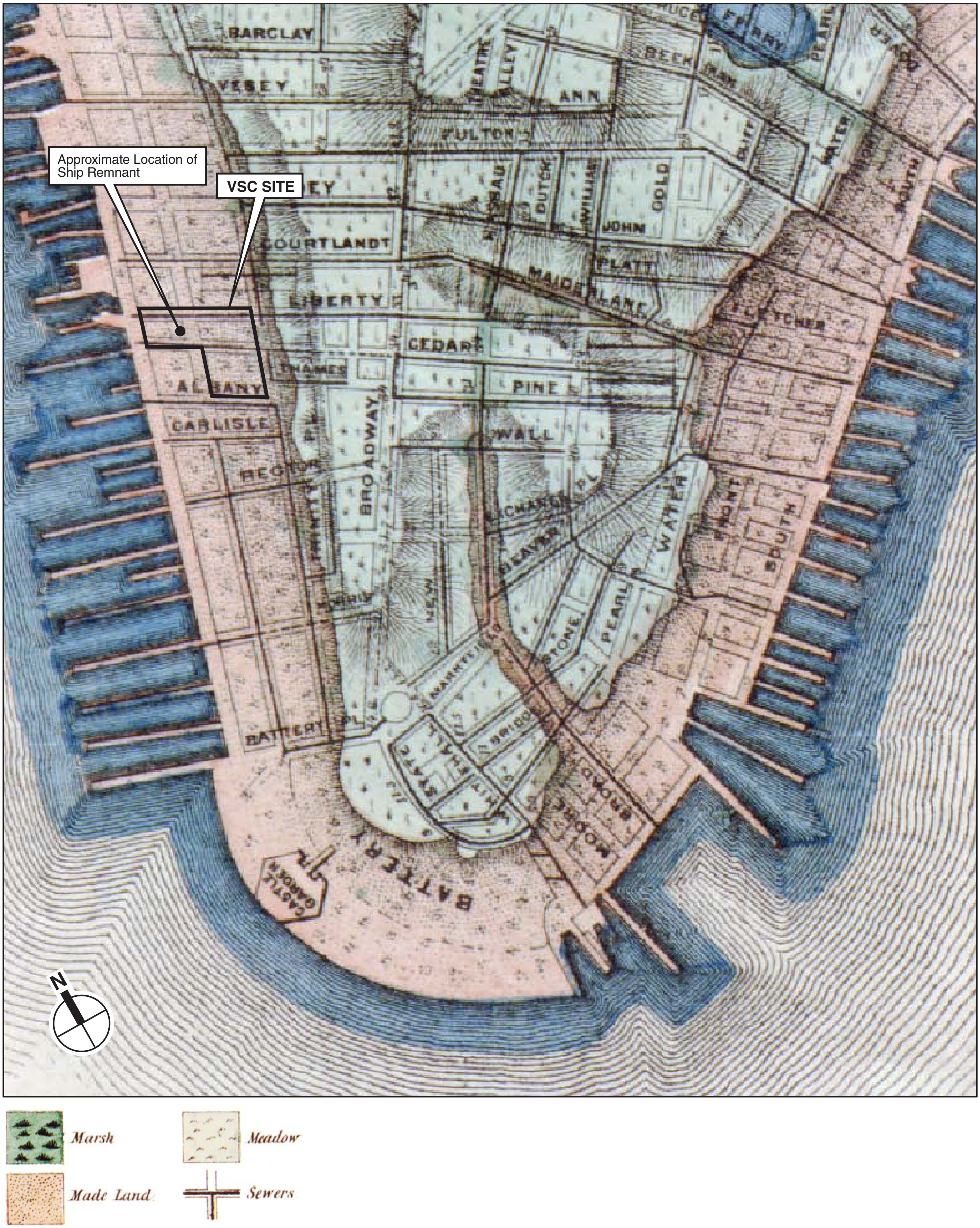
Figure 2-2

Conservators move fragile pieces on a plywood splint **A**

Stern timbers wrapped in foam and plastic sheeting are loaded onto wooden shelves in a shipping container **B**

Wrapping and Packaging the Ship Remnant after Removal

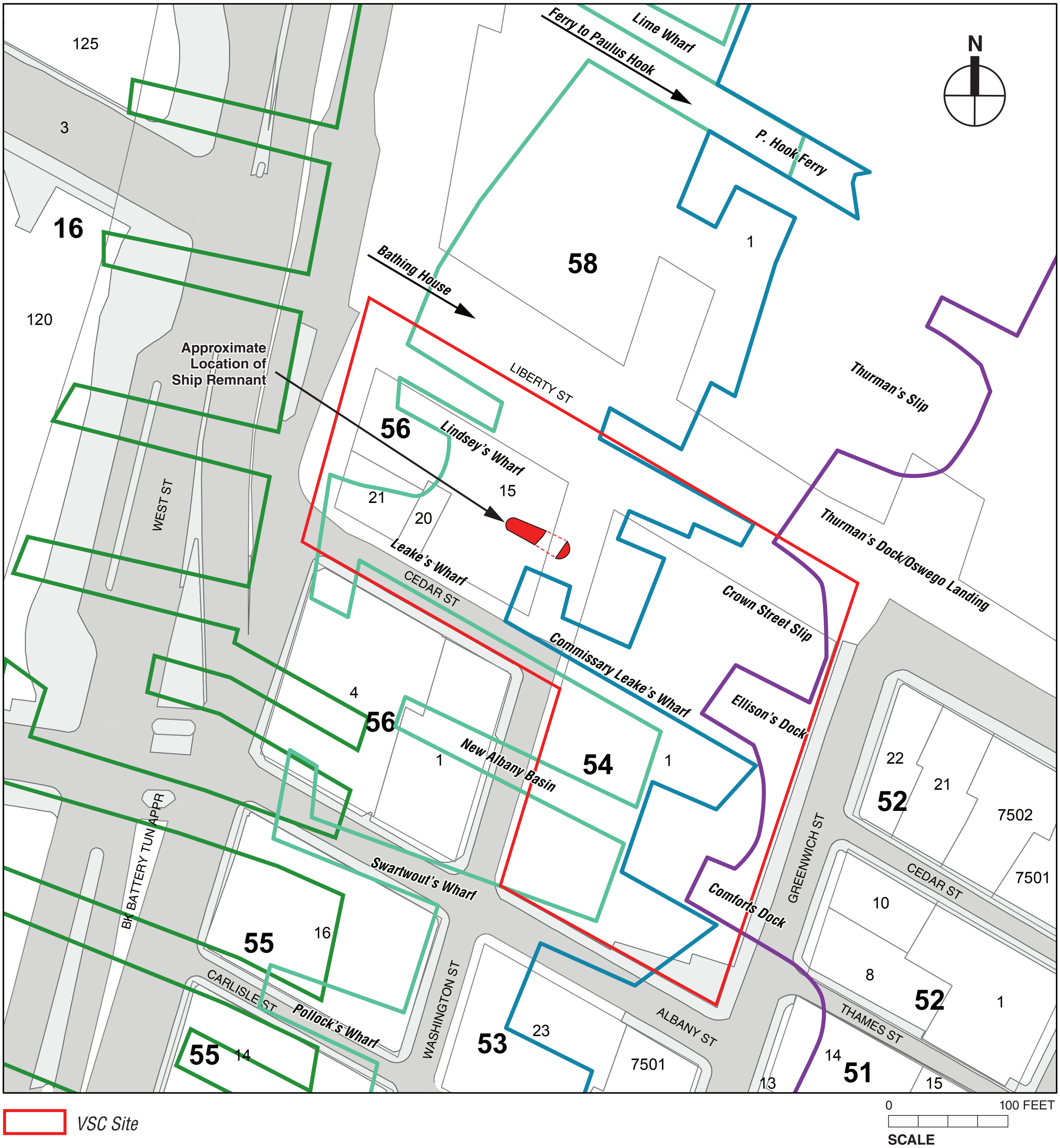
Figure 2-3



Sanitary and Topographical Map of the City and Island of New York. E. Viele, 1865

Figure 3-1

7.11.13



VSC Site

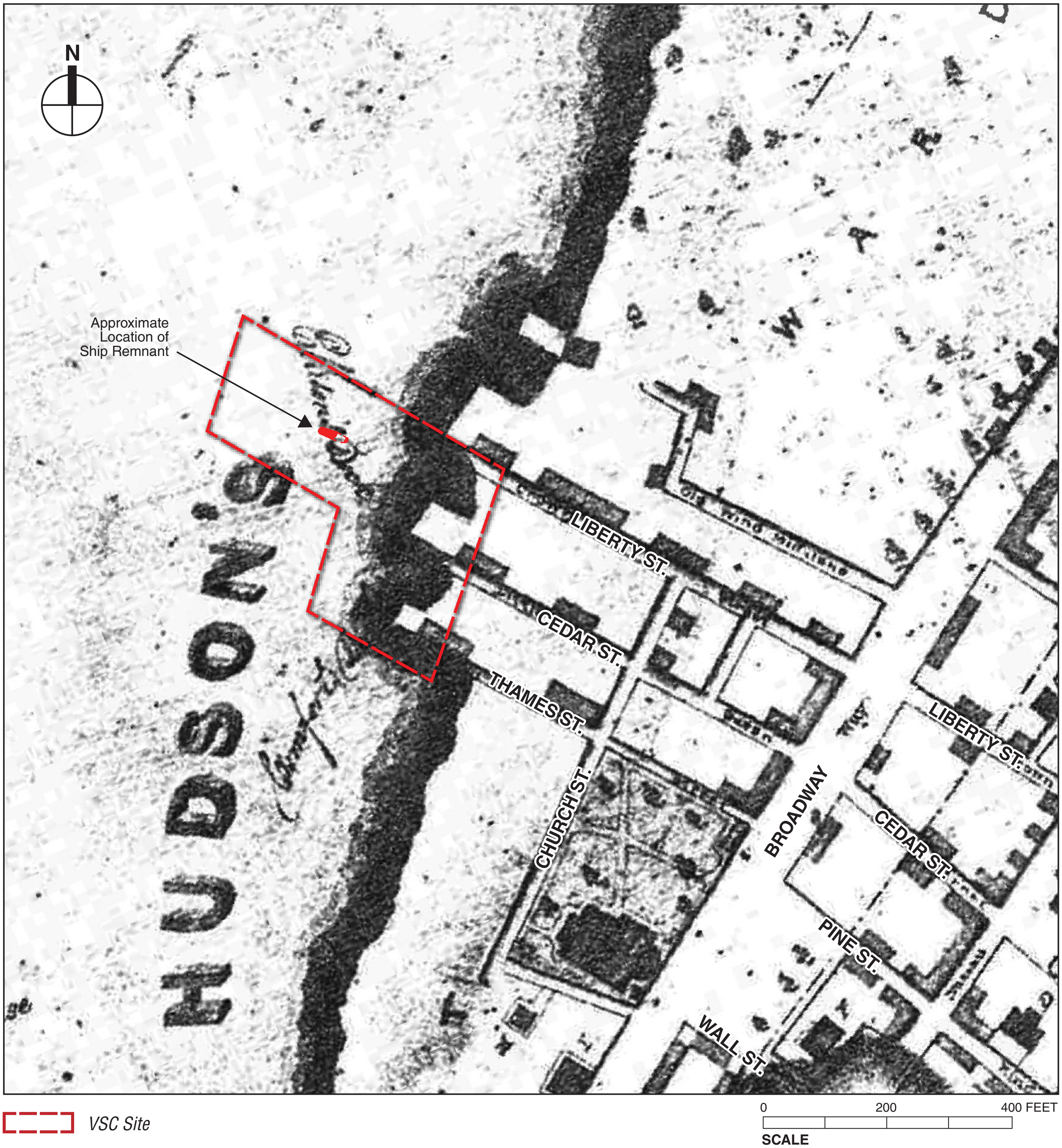
Shoreline in 1836 (Based on the 1836 Colton Map)

Shoreline in 1797 (Based on the 1797 Taylor-Roberts Map)

Shoreline in 1766 (Based on the 1776 Ratzer Map)

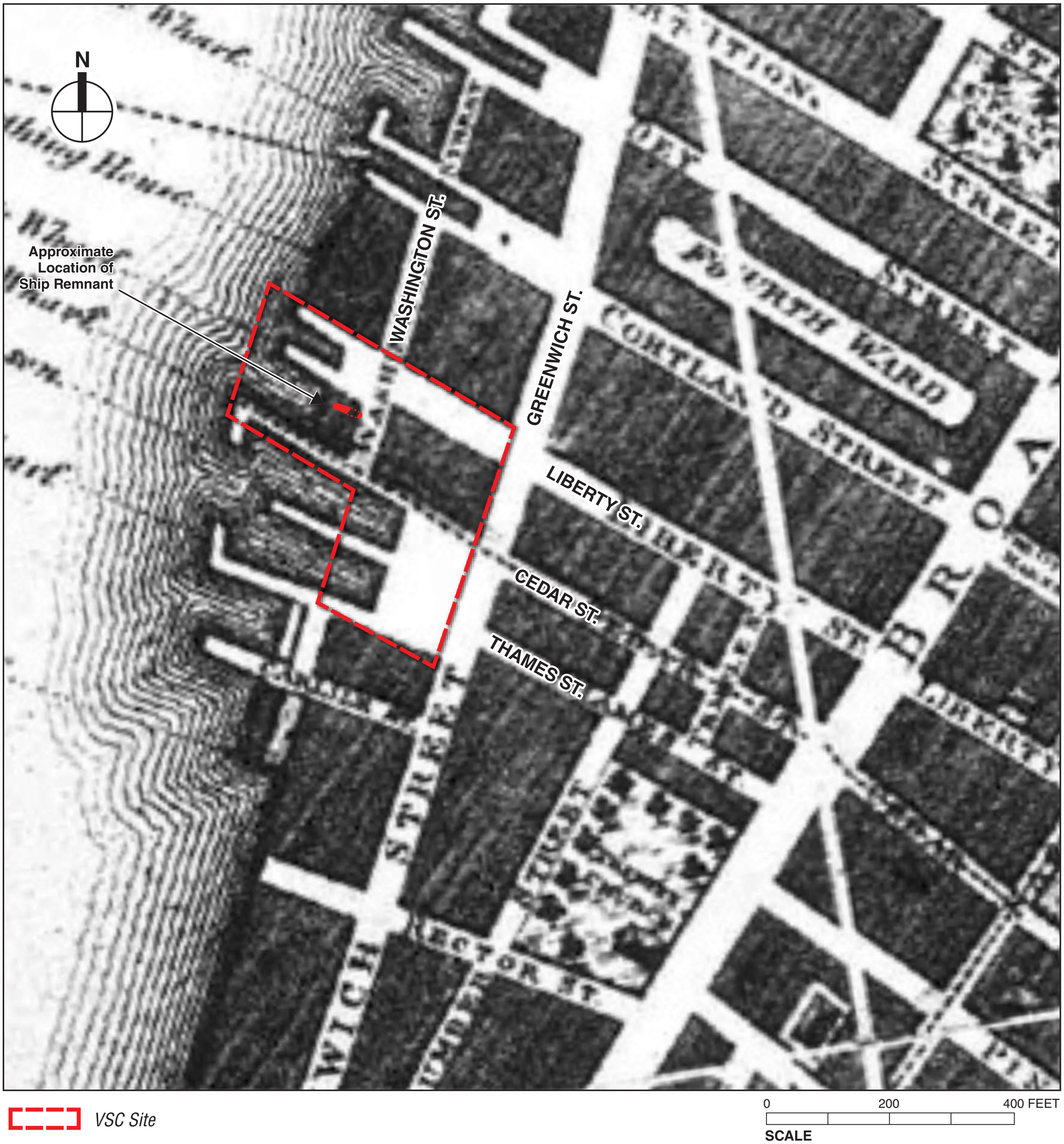
Shoreline in 1730 (Based on the 1730 Lyne Map)

Likely Landfill Progression from 1730 to 1836
Figure 3-2



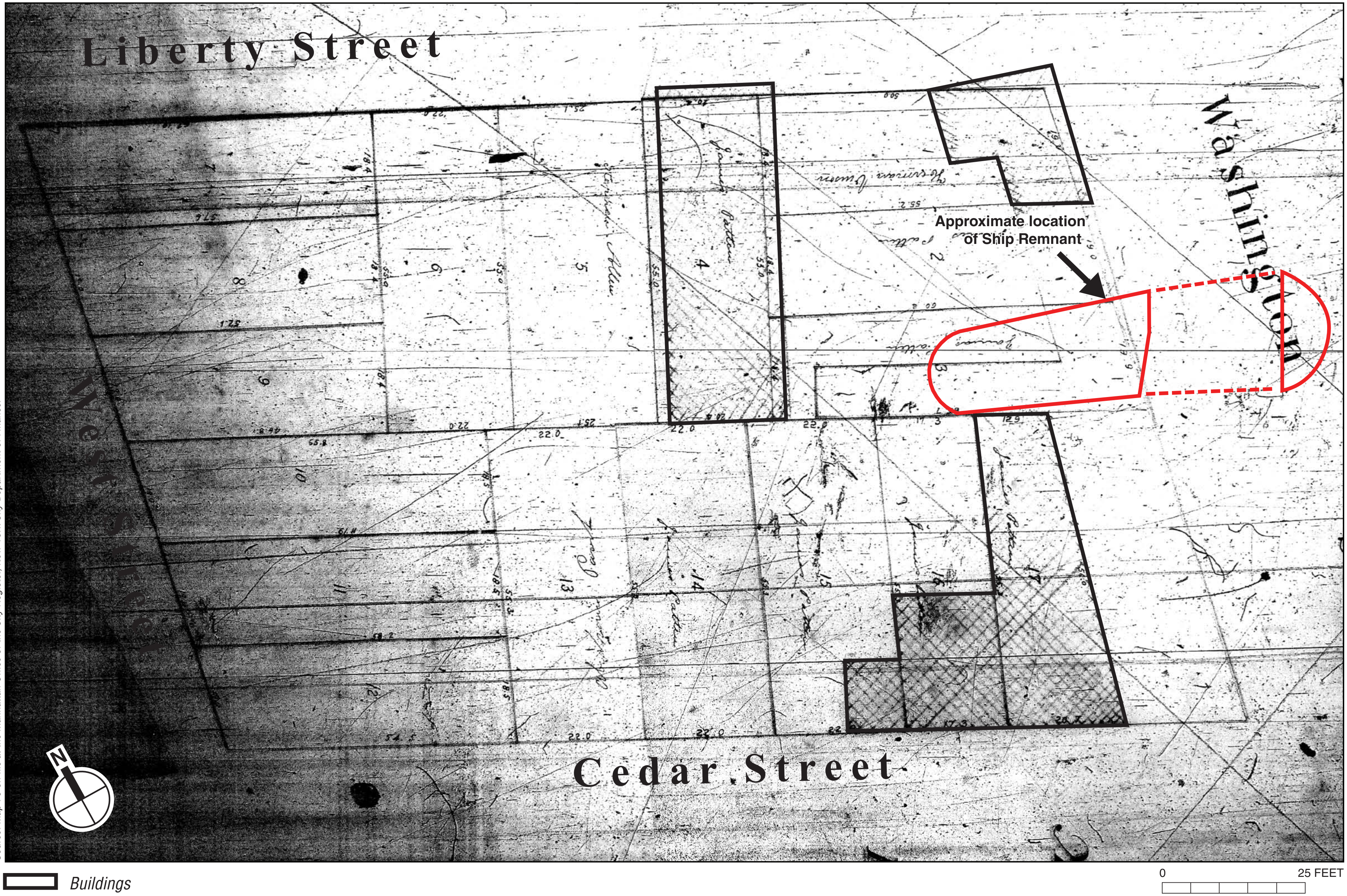
A Plan of the City of New York
J. Lyne, 1730
Figure 3-3

Plan of the City of New York
Surveyed in the Years 1766 & 1767
B. Ratzen, 1776
Figure 3-4



The Taylor - Roberts Plan, 1797

Figure 3-5



Source: Map 79 on file at the Manhattan Office of the City Register, New York City Department of Finance.

1818 Survey of Block 56 by W. Bridges and T.H. Poppleton

Figure 3-6

Molly McDonald conducting archaeological monitoring at 7:00 AM on July 13, 2010, the morning the ship remnant was first discovered. **A**

After discovery of the ship the overlying soils were removed by hand. A portion of the northern (port) side of the stern is visible on the left. **B**

Photographs of Archaeological Monitoring and Initial Discovery of Ship Remnant

Figure 5-1

Aerial view of the ship remnant and associated landfill after the excavation of the sides of the vessel. **A**

Close-up view of the northern (port) side of the stern after initial clearing and installation of temporary support beams. **B**

Photographs of Excavation of Ship Remnant

Figure 5-2

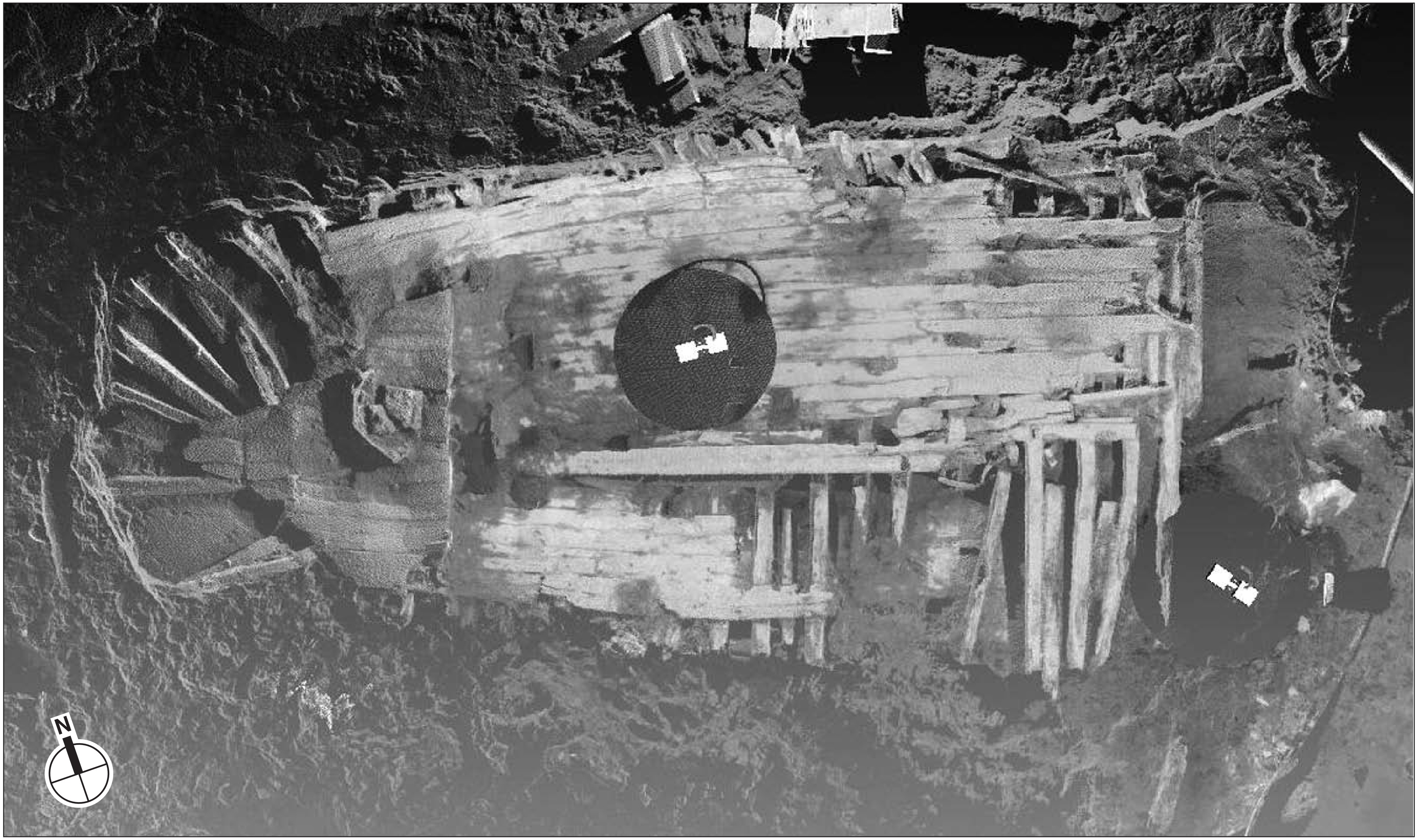


Image Credit: Corinthian Data Capture, LLC

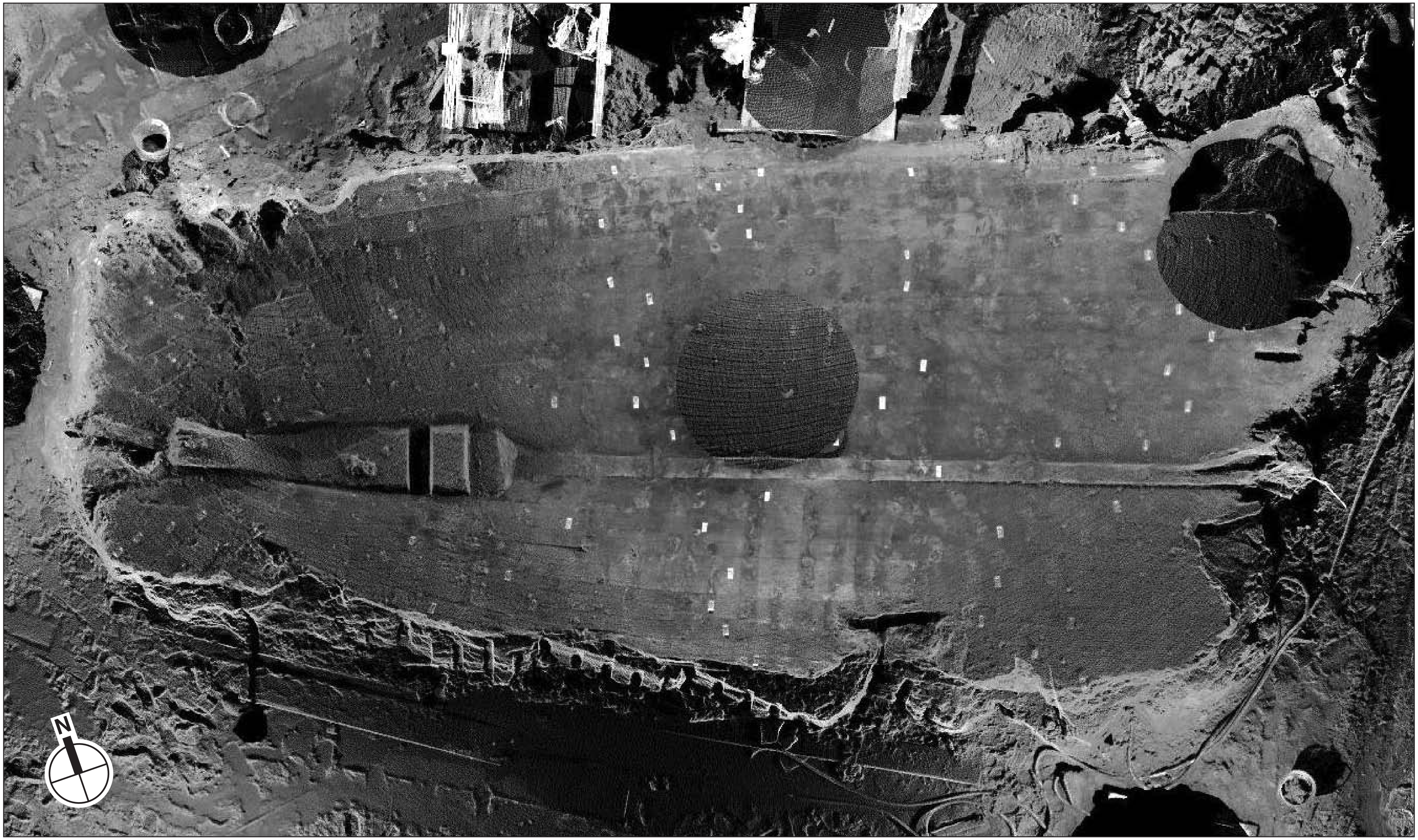
Laser Scan of Ceiling Planks and Orlop Deck (at Left)

Figure 5-3a

Image Credit: Corinthian Data Capture, LLC

Laser Scan of Frames of the Stern
Figure 5-3b

Image Credit: Corinthian Data Capture, LLC

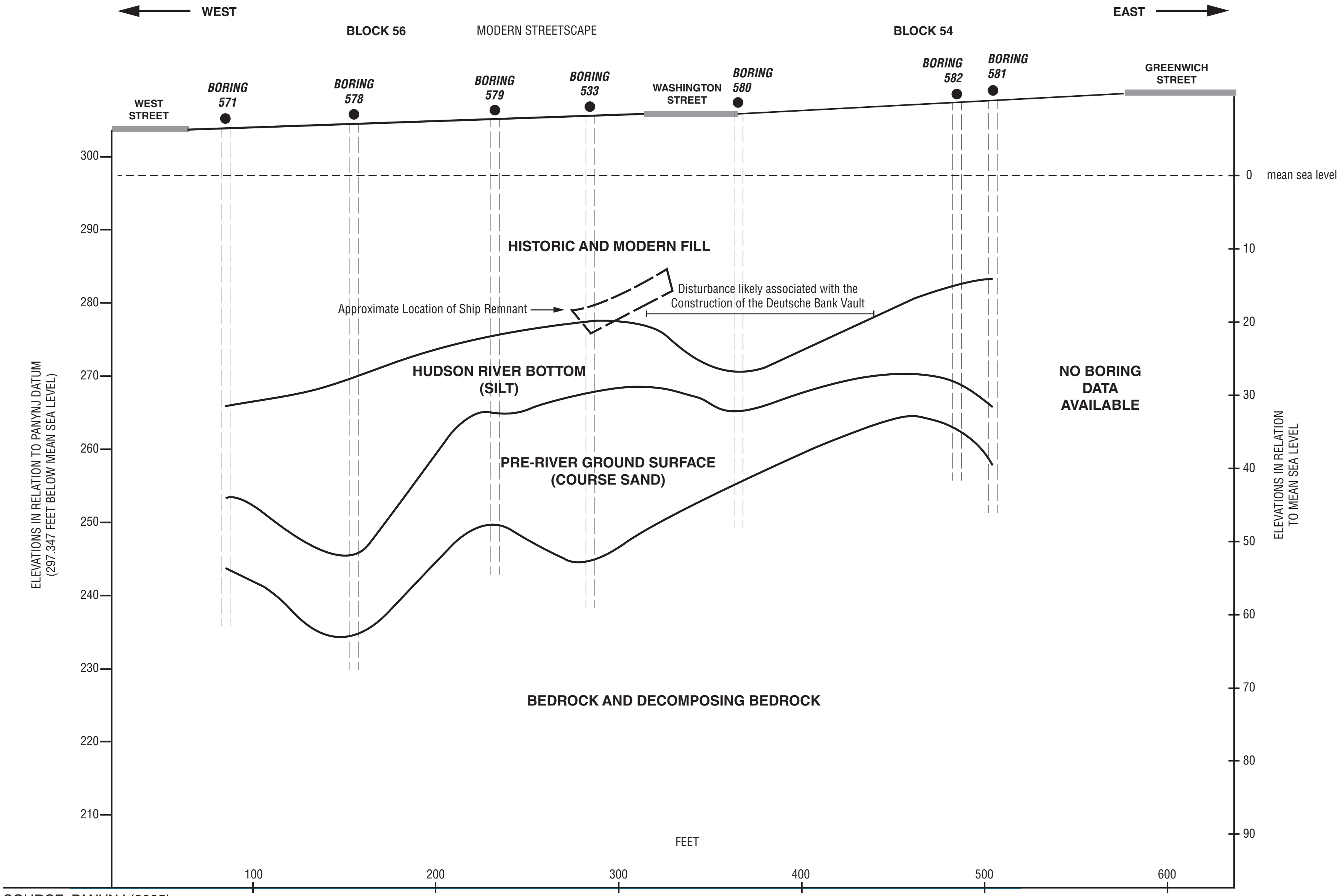


Laser Scan of the Outer Planking of the Stern
Figure 5-3c

Block 54, to the east of the demising wall during excavation in the location where the remains of the bow were anticipated. The demising wall was marked to alert the bakhoe operators to the possible presence of the bow. **A**

Dr. Warren Reiss and Kathleen Galligan investigating the exposed bow remains. **B**

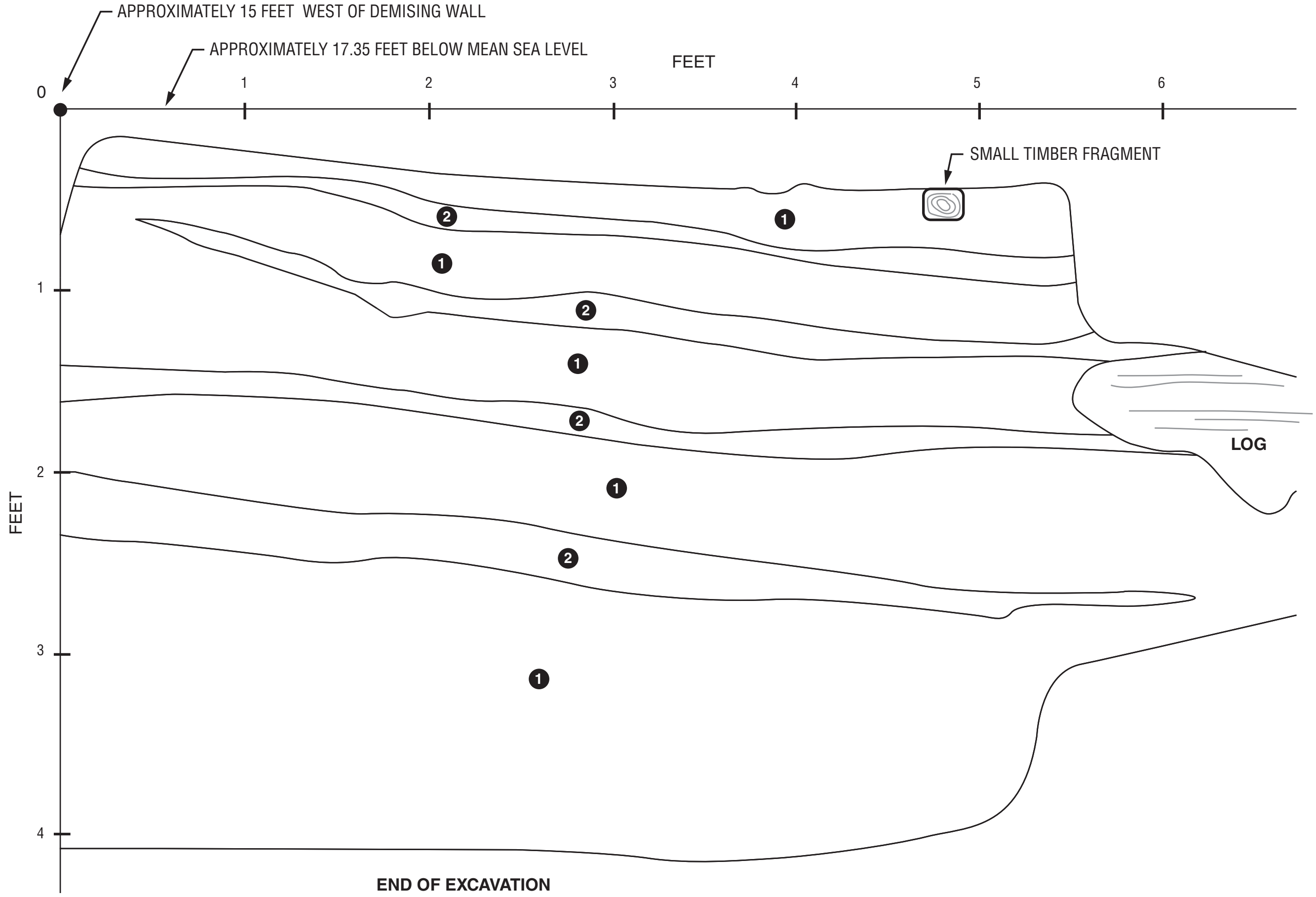
Photographs of Archaeological Monitoring and Discovery of Bow Remains



SOURCE: PANYNJ (2005)

NOTES: This profile was generated using selected soil boring logs. In some cases, soil levels observed in the borings have been combined. This profile therefore represents an estimate of what the general profile of the site may have looked like and has been simplified for the purposes of this analysis. Vertical and horizontal scale are different.

Soil Profile of Project Site Based on Soil Borings
Figure 5-5



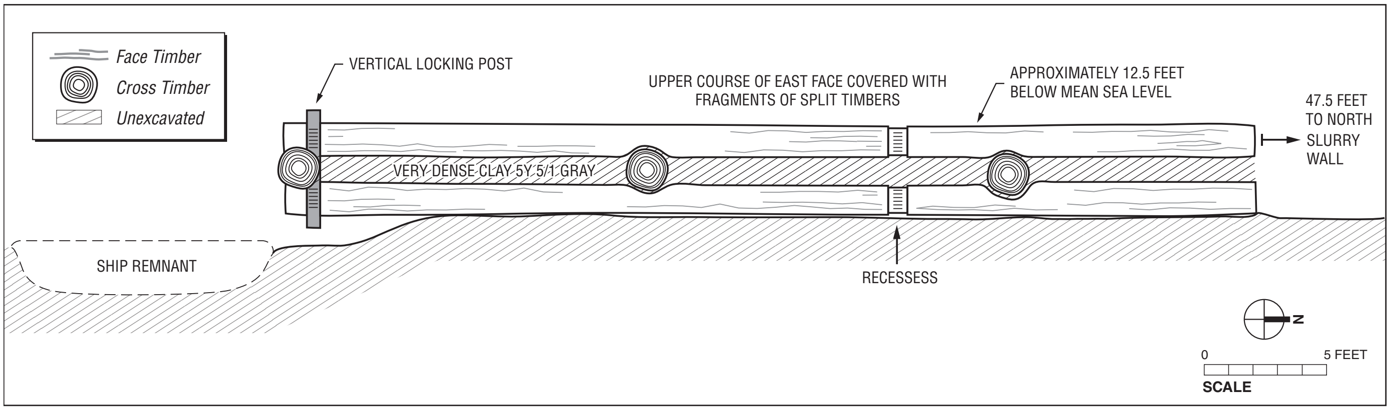
❶ 10YR 3/1 very dark gray dense silty clay mottled with 10YR 3/2 very dark grayish brown clay

❷ 10YR 4/3 brown fine silty sand with pebbles and small shells, streaked with lenses of soil 1

Profile drawing, north face of soil pedestal after removal of ship remnant **A**

Photograph of north face of soil pedestal after removal of ship remnant **B**

North Face of Soil Pedestal
After Removal of Ship Remnant
Figure 5-6

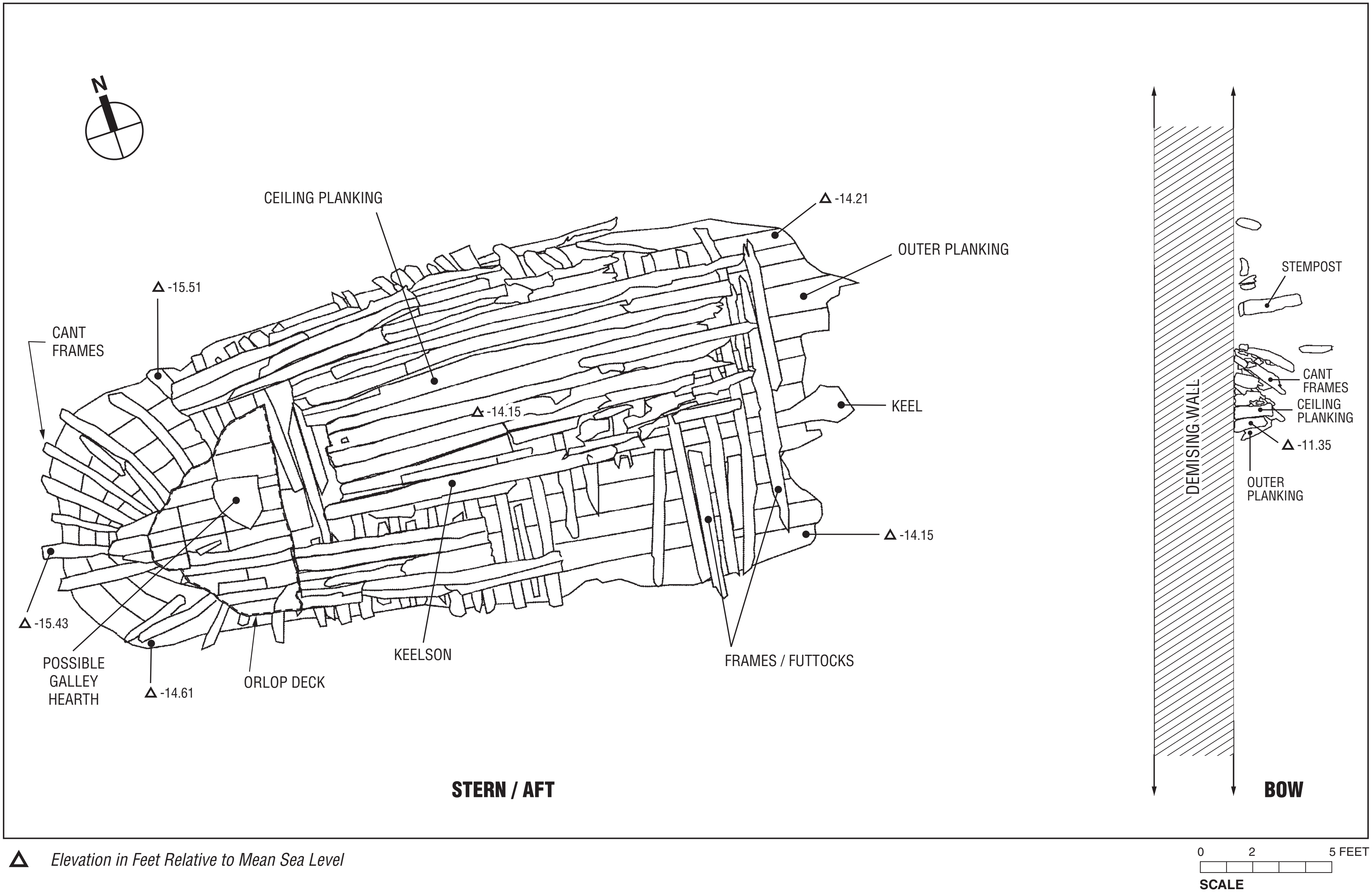


Profile drawing of east face of landfill retaining structure north of ship remnant **A**

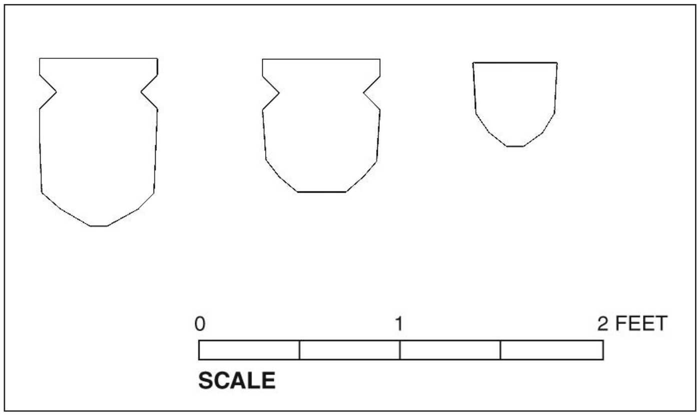
Facing north during removal of top course of landfill retaining structure north of ship remnant (in foreground). WTC slurry wall is in background and demising wall is to the right **B**

Location of Ship Remnant and Adjacent Timber Features

Figure 5-7



Plan View Drawing of Stern and Bow Portions of Ship Remnant
Figure 6-1



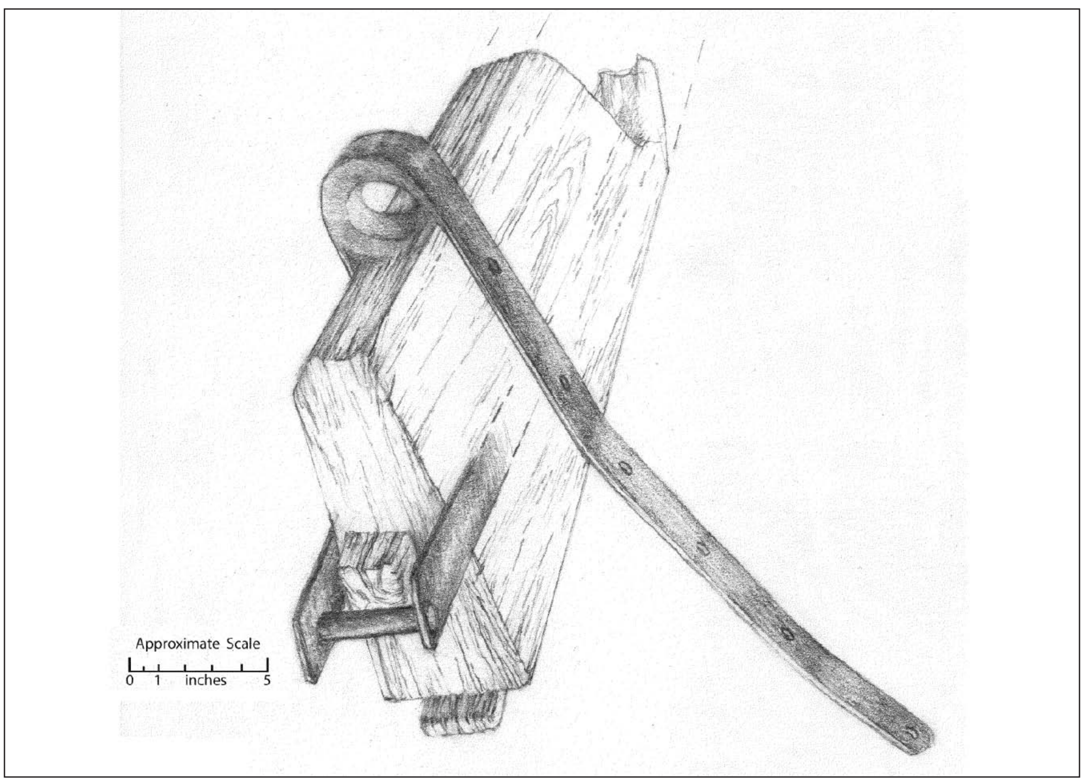
Cross sections of keel from near amidships (left) to stern (right) showing changes in rabbet **A**

West half of intentionally broken keel showing 1.5-inch-deep rabbet. Photograph by Drew Fulton **B**

Aft end of keel as observed in the field **C**

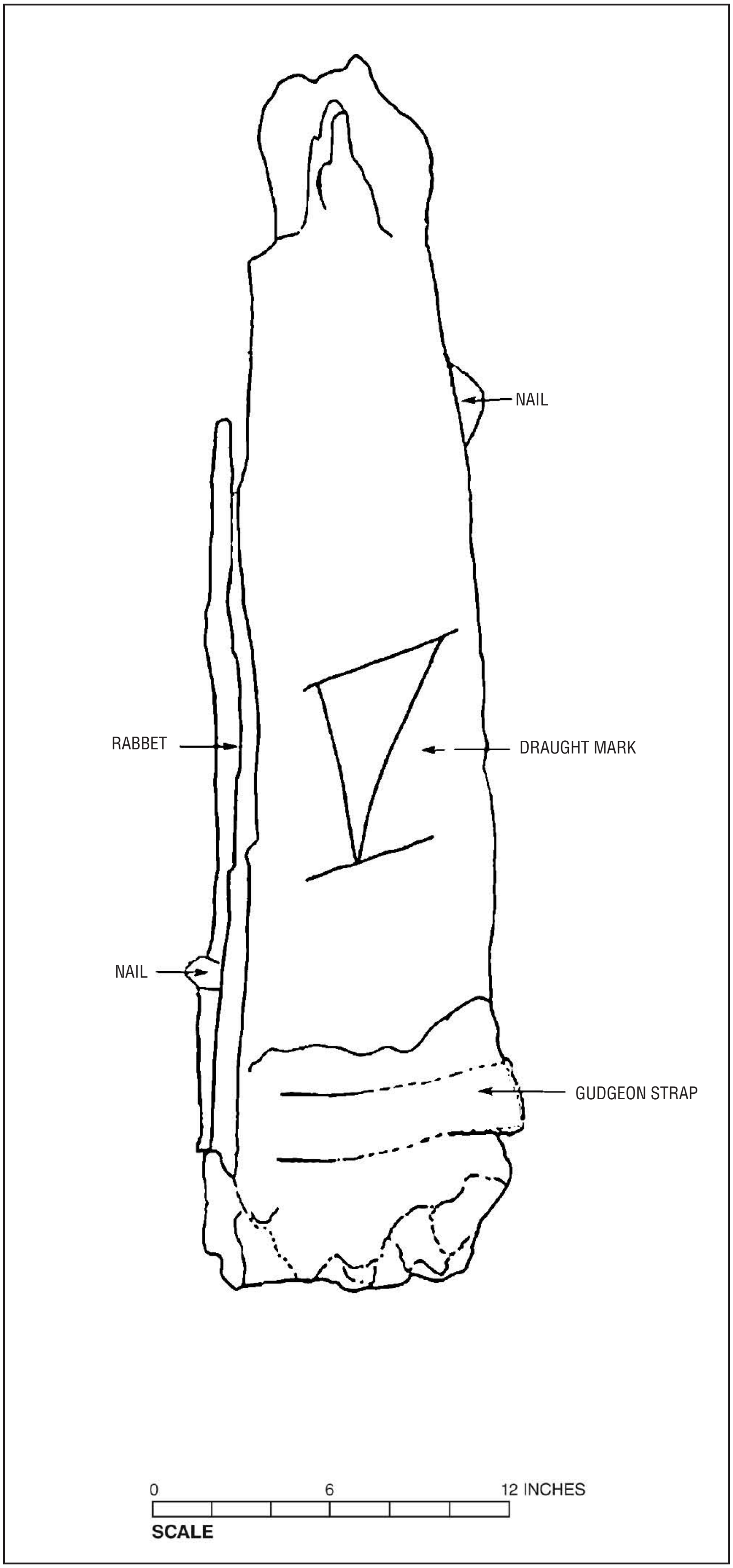
Images of Keel
Figure 6-2

Bottom of sternpost (ST2), which attached to the keel with a projecting wood tenon and iron stirrup. The forward face is to the left of the photograph. Photograph by Drew Fulton **A**



Artist's rendering of the bottom half of the sternpost by Kathleen Galligan. The circular gudgeon is located on the aft face of the sternpost **B**

Sternpost
Figure 6-3

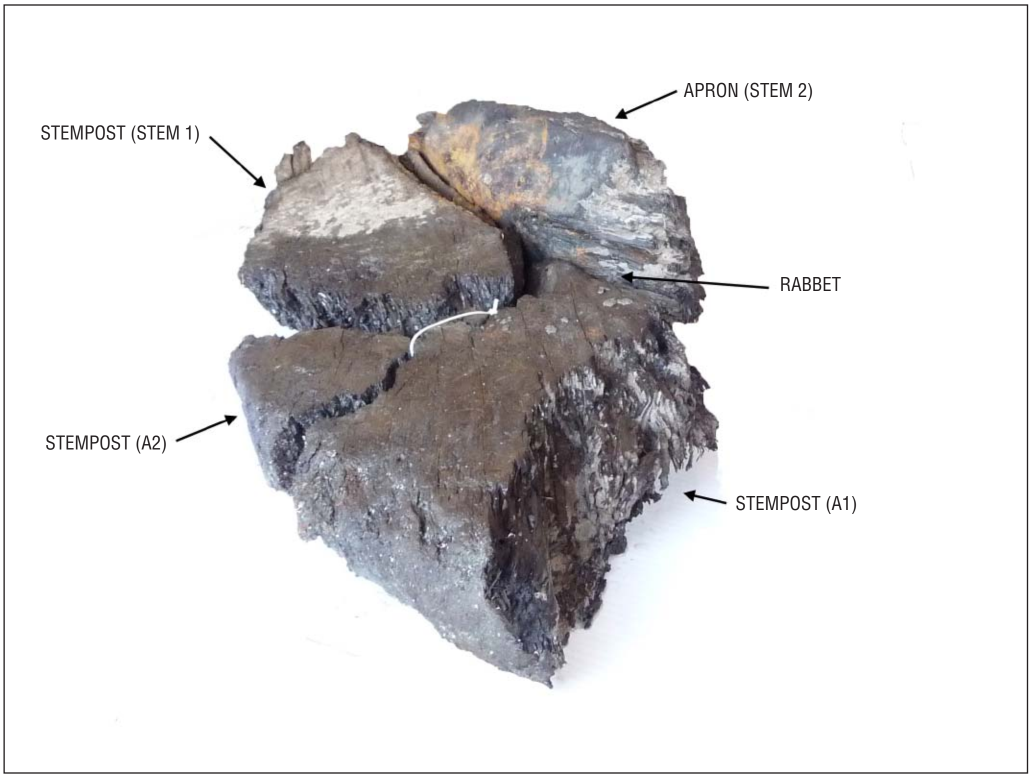


Tracing showing draught mark on port face of sternpost **A**

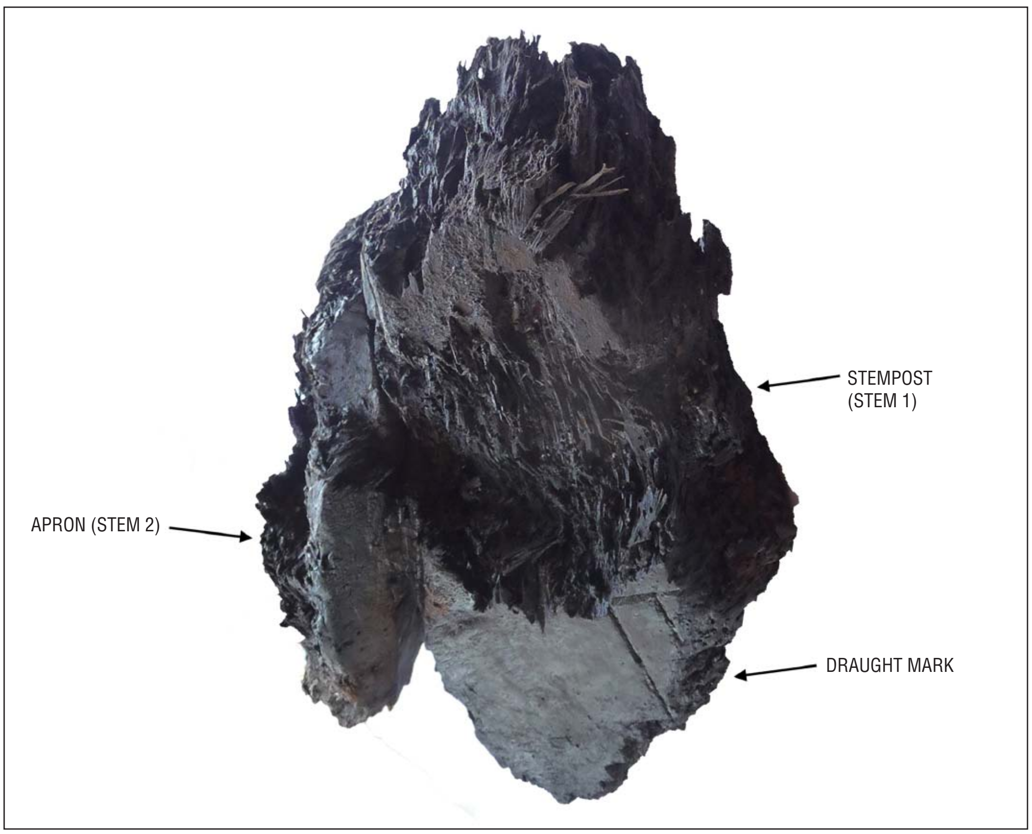
Photograph of draught mark on port face of sternpost **B**

Images of Sternpost

Figure 6-4



Stempost and apron viewed form the port side **A**

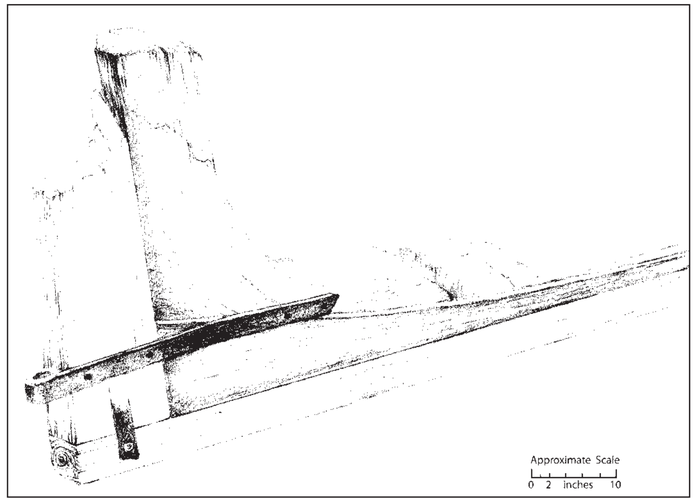


Stempost starboard draught mark (part of a Roman numeral II). The draught mark is at the base of the fragment that would have been connected to A2 **B**

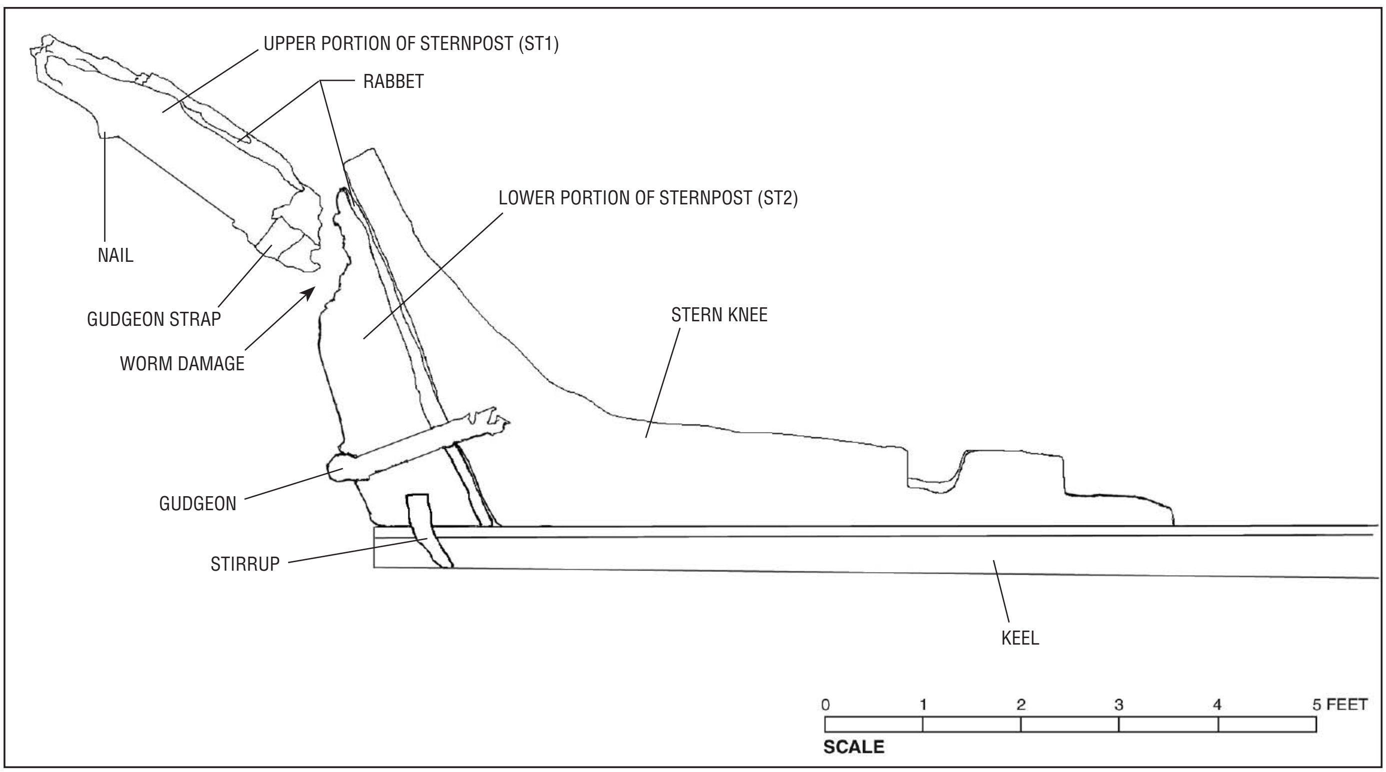
Images of Stempost

Figure 6-5

1 Stern knee as observed in field after removal of outer planking on starboard side (this photograph has been edited so that only the Ship Remnant is visible)



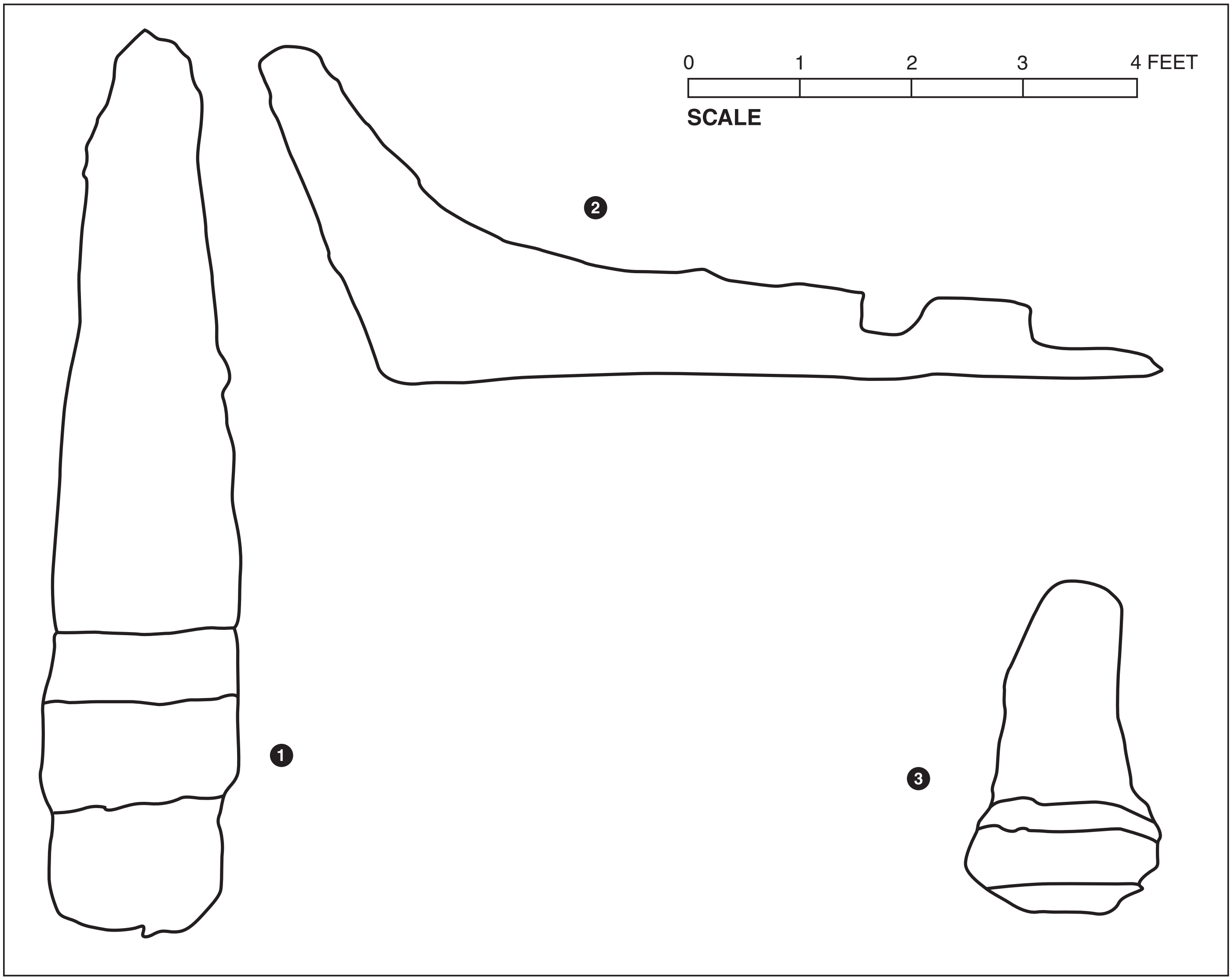
2 Artist's rendering of stern knee articulated with sternpost, keel, and outer planking. Drawing by Kathleen Galligan



3 Composite sketch of sternpost, stern knee, and keel

Images of Stern Knee Articulated with Sternpost and Aft Portions of Keel

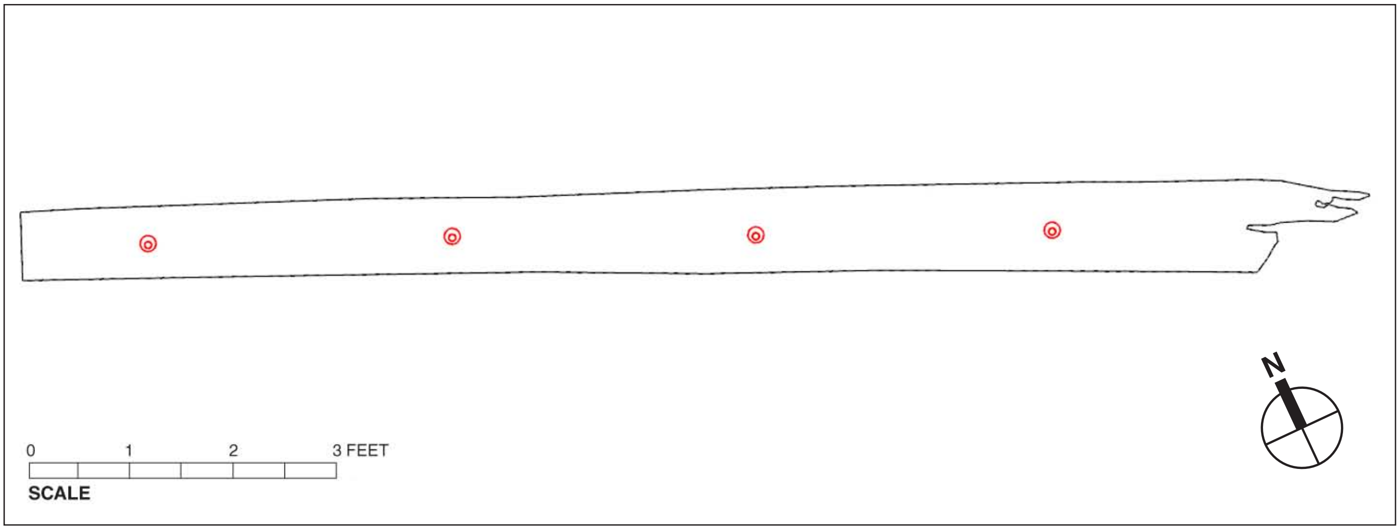
Figure 6-6



Top (1), starboard side (2), and forward side (3) views of stern knee. **4**
Images created using *Photo Modeler Scanner* and *Rhinorceros*

Images of Stern Knee

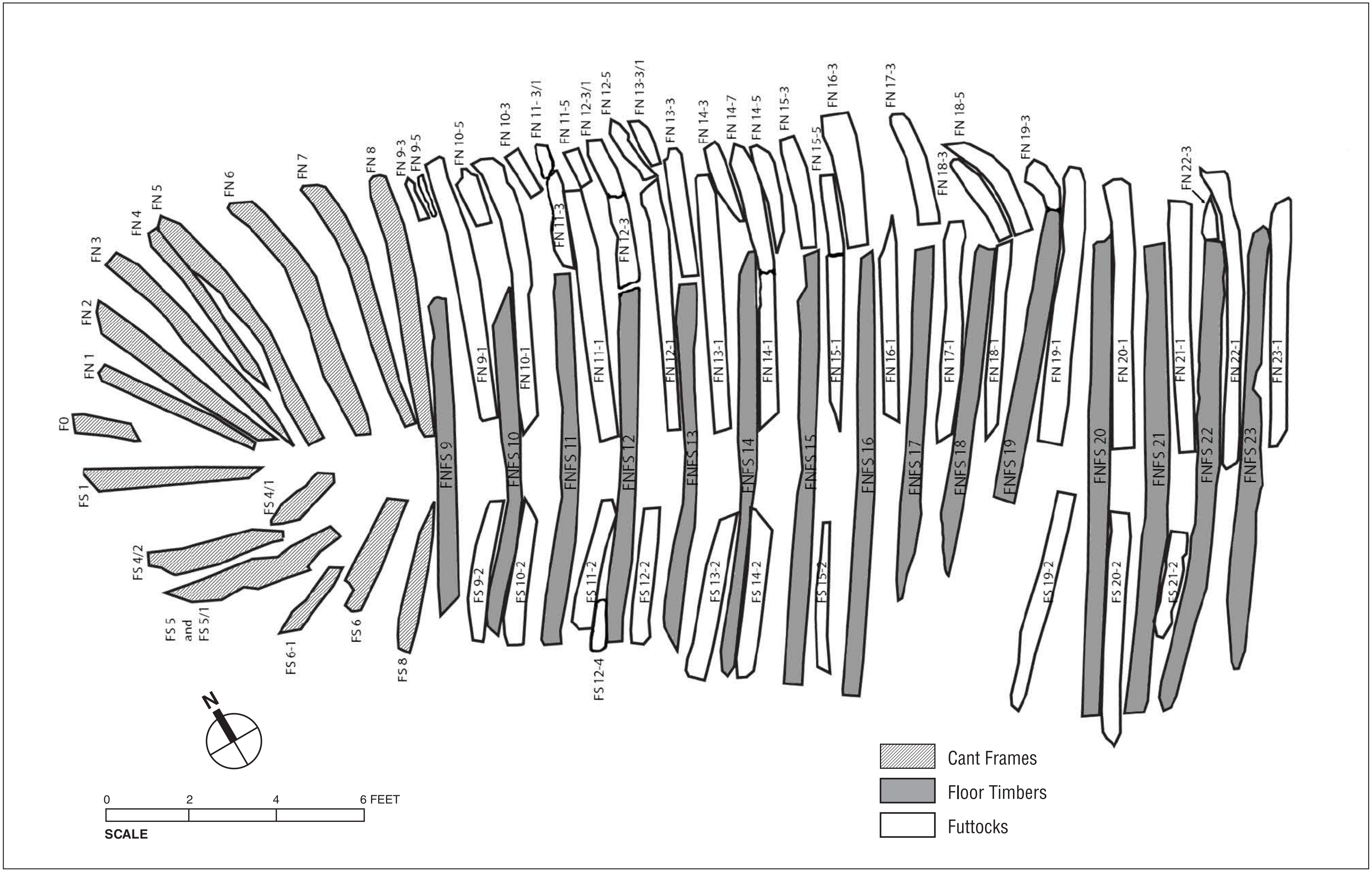
Figure 6-7



Schematic of top of keelson with nails marked in red. Image created using *Photo Modler Scanner* and *Rhinoceros* **A**

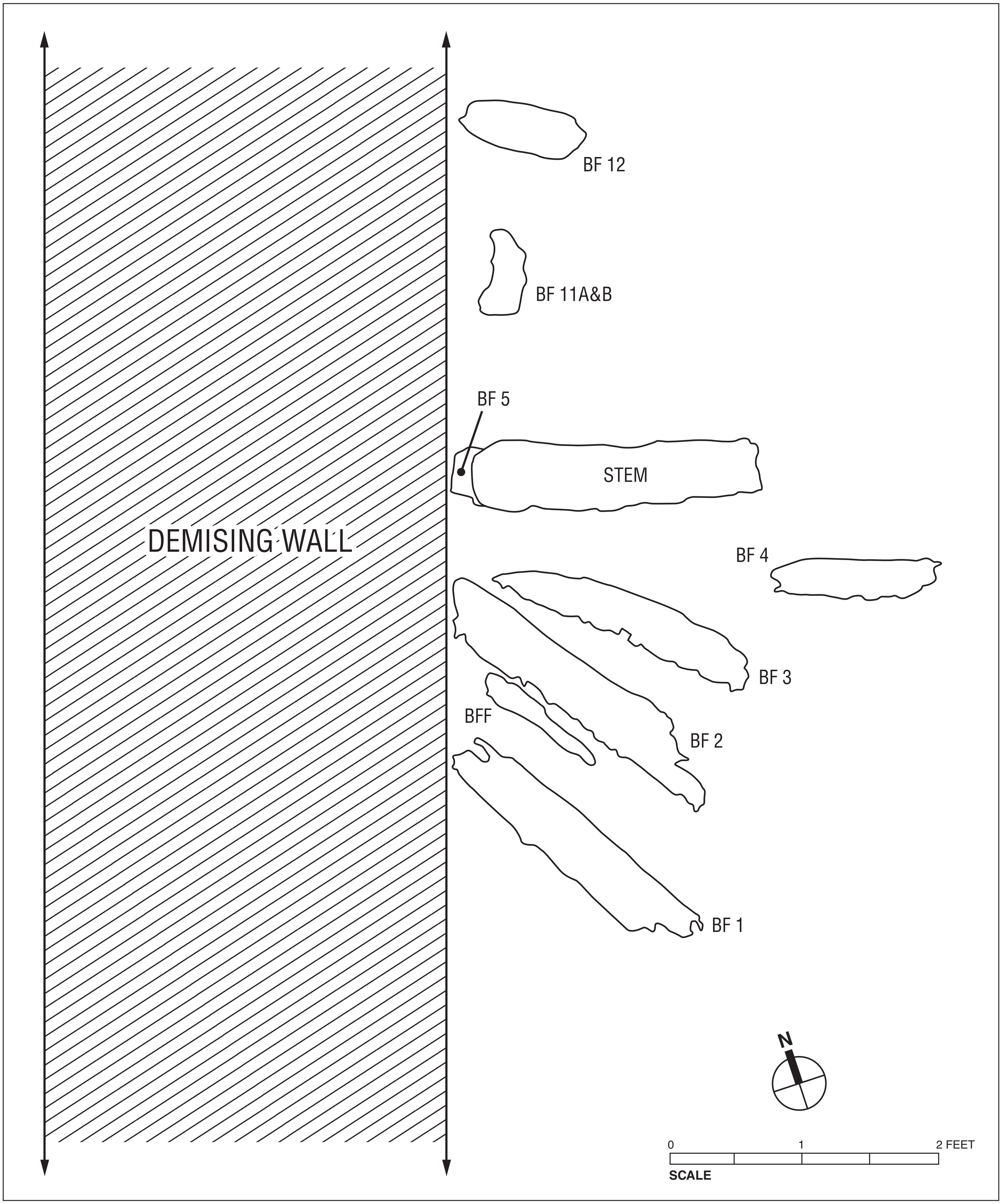
Photograph of keelson *in situ* after removal of ceiling planking. Photograph by Drew Fulton **B**

Images of Keelson
Figure 6-8



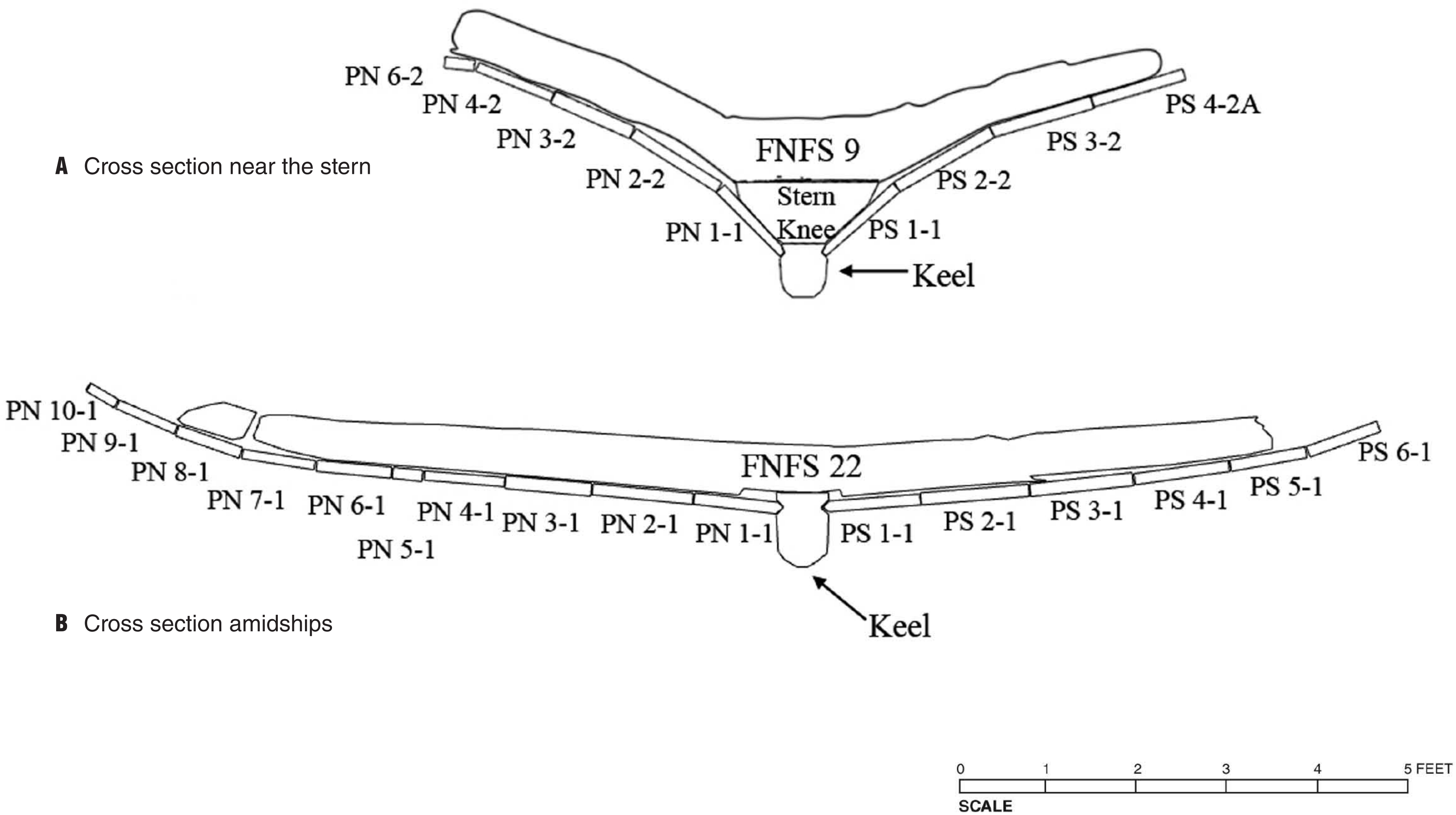
Plan View Drawing of
Frame Pattern of Stern

Figure 6-9



Plan View Drawing of Cant Frames of Bow

Figure 6-10



Cross Sections of Hull at Stern and Amidships

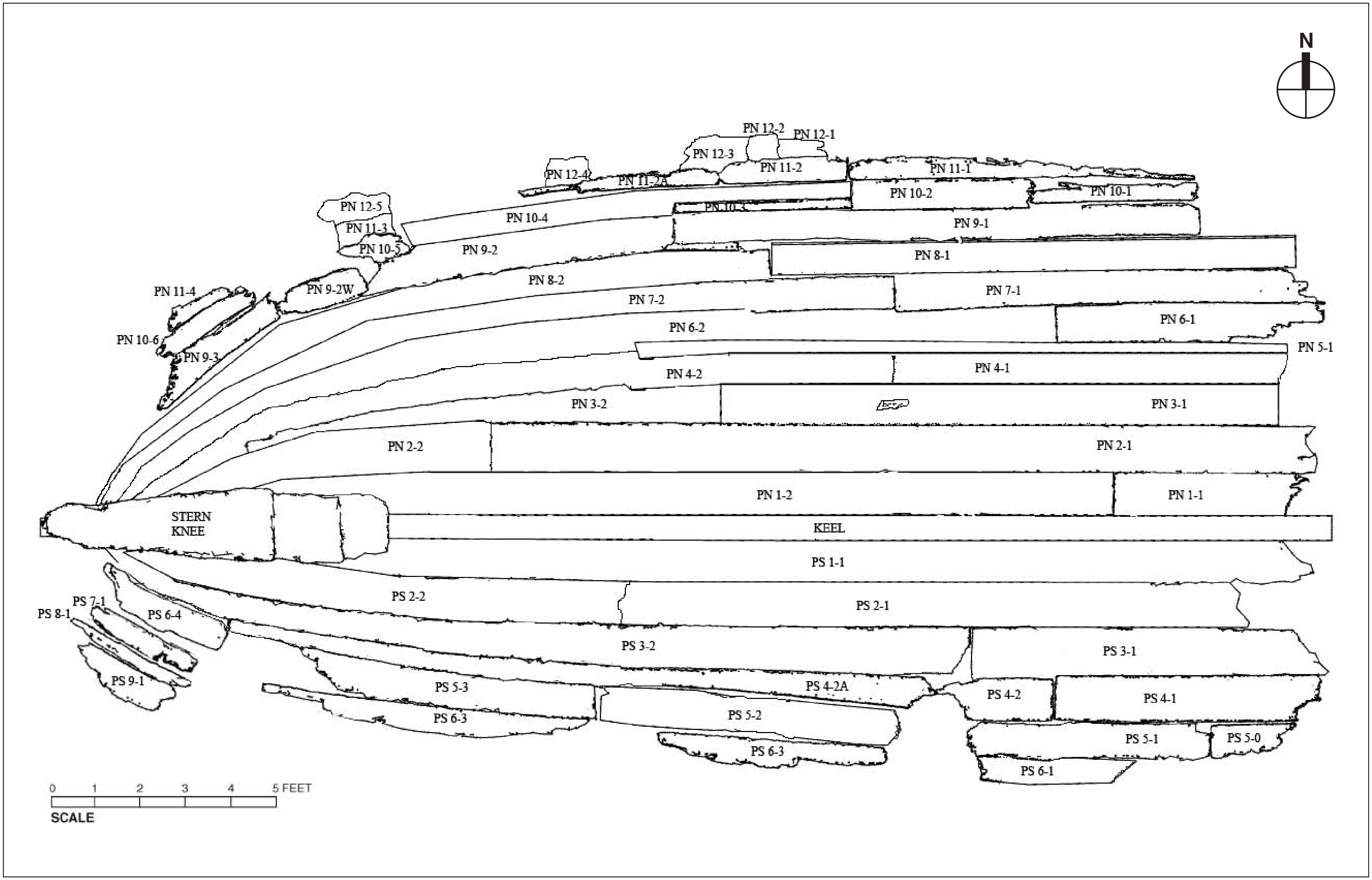
Figure 6-11

Frame FNFS 23-0 showing a mis-hit iron pin in center. Two marks on aft face of frame correspond to location of keel. Photograph by Drew Fulton **A**

Filler plug located under frame FNFS 15-0 **B**

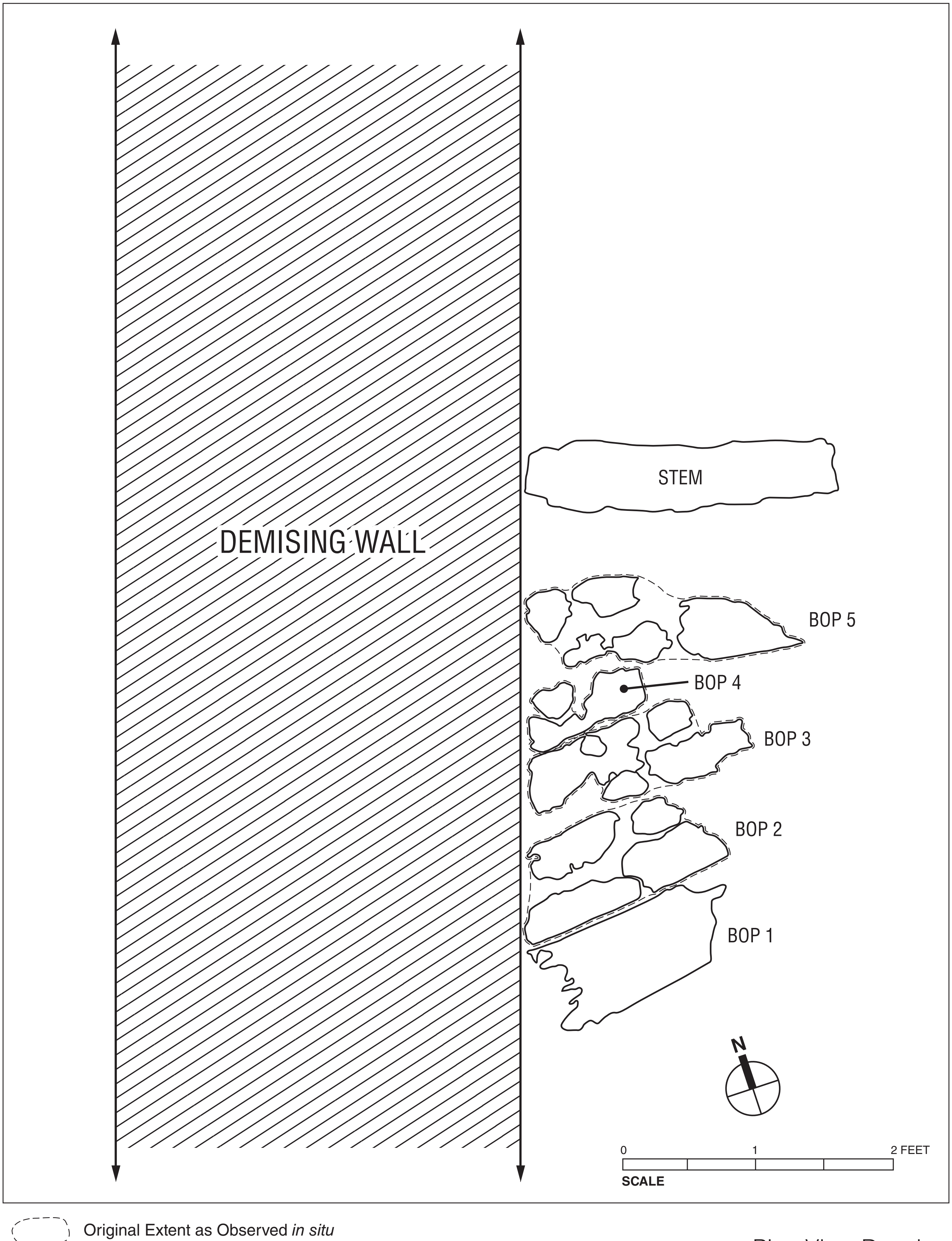
Images of Mis-hit Pin and Filler Plug in Frames

Figure 6-12

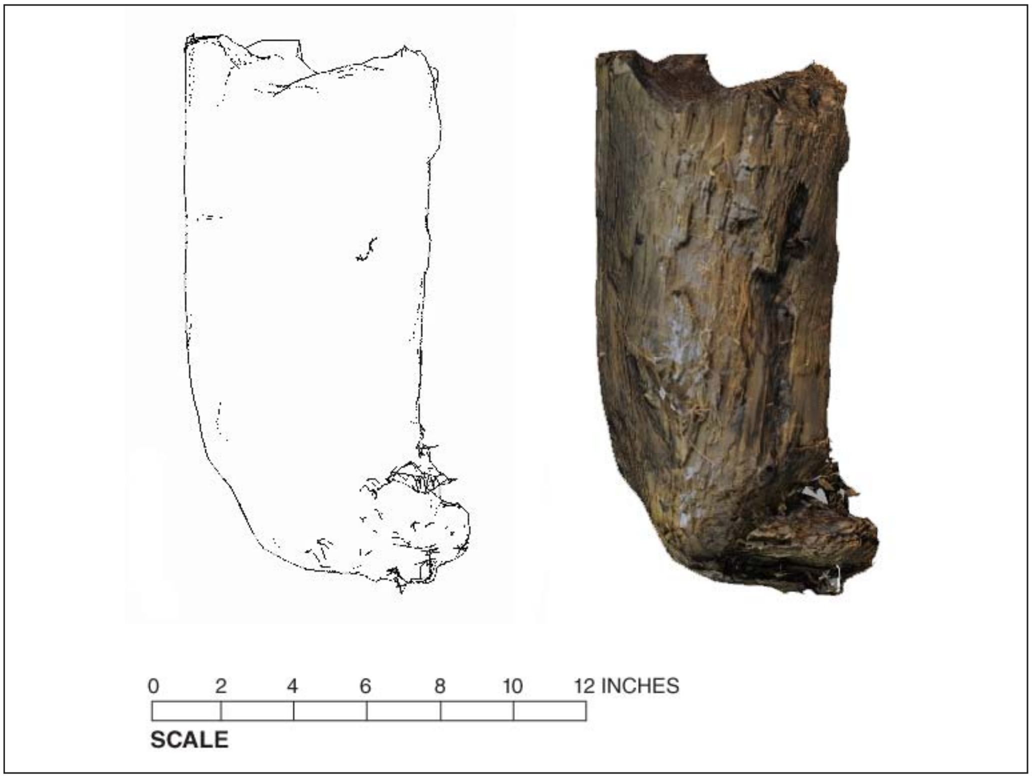


Plan View Drawing of Outer Planking of Stern

Figure 6-13



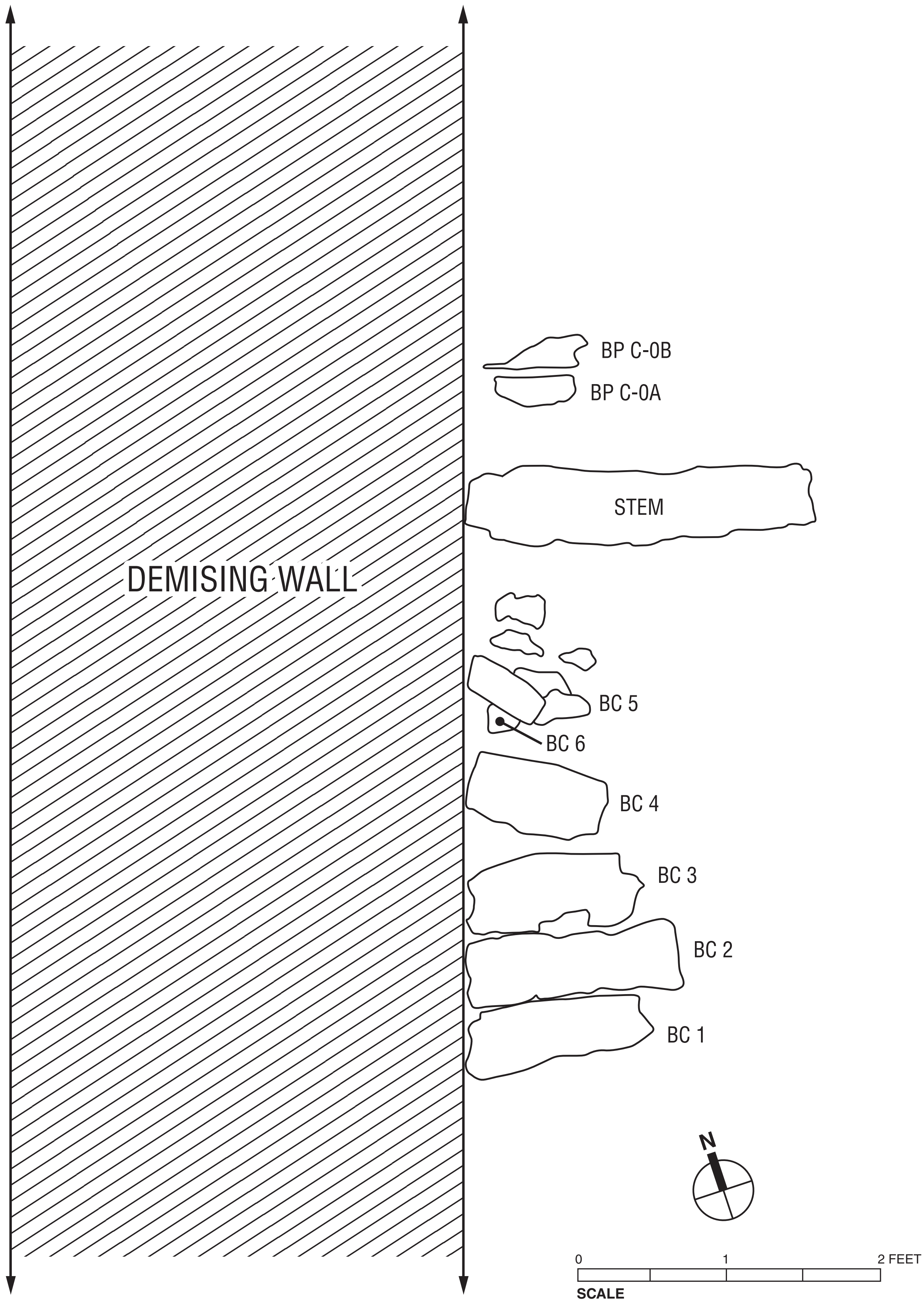
Plan View Drawing
of Outer Planking of Bow
Figure 6-14



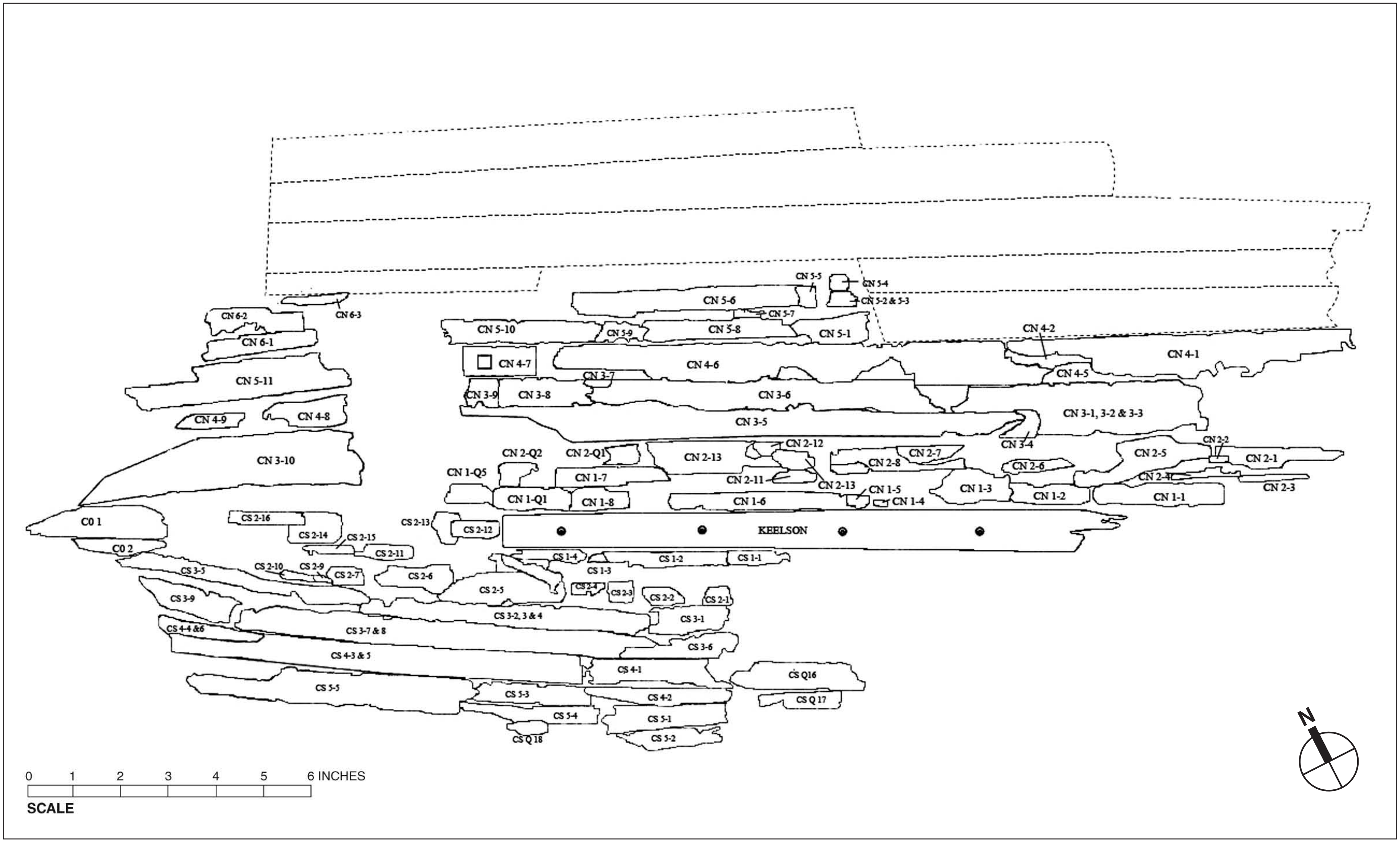
Photograph (right) and rendered view (left) of SN1, made using *PhotoModeler Scanner* and *Rhinoceros* **A**

Photograph of top of SN1 *in situ* with ceiling planking. Photograph by Kathleen Galligan **B**

Images of SN-1
Figure 6-15



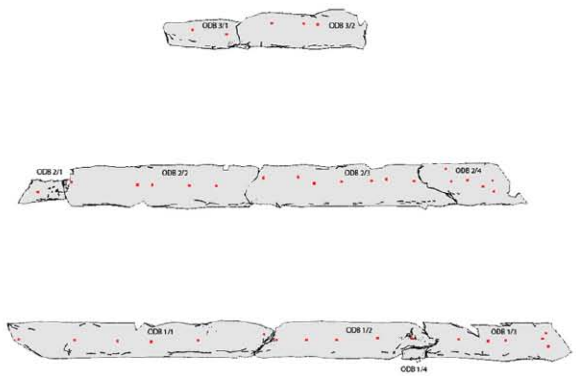
Plan View Drawing
of Ceiling Planking of Bow
Figure 6-16



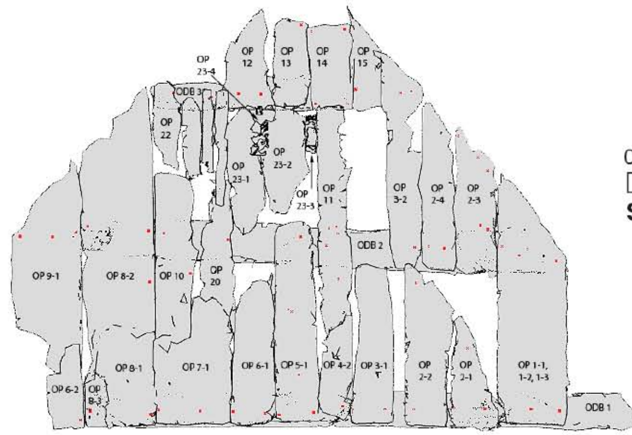
Ceiling Planks Removed Prior to Ship Remnant Documentation

Plan View of Ceiling Planking of Stern

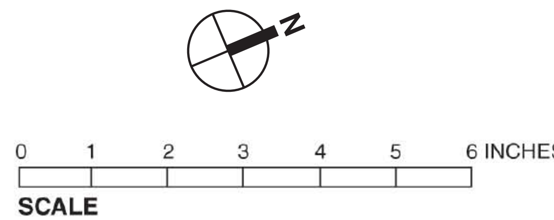
Figure 6-17

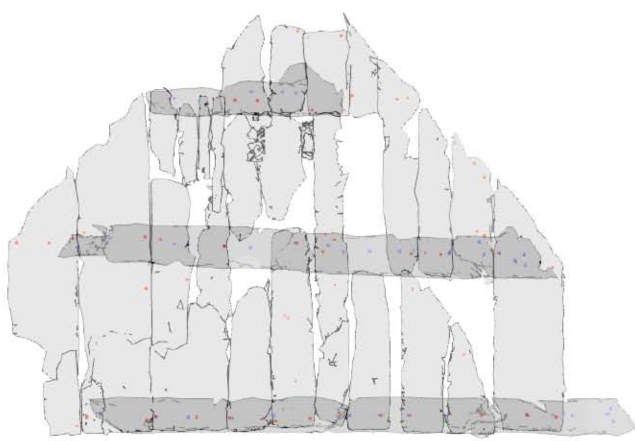


A The construction of deck beams of the orlop deck, viewed from the top. Red nails correspond to the orlop planking



B The construction of planking of the orlop deck, viwed from the top.



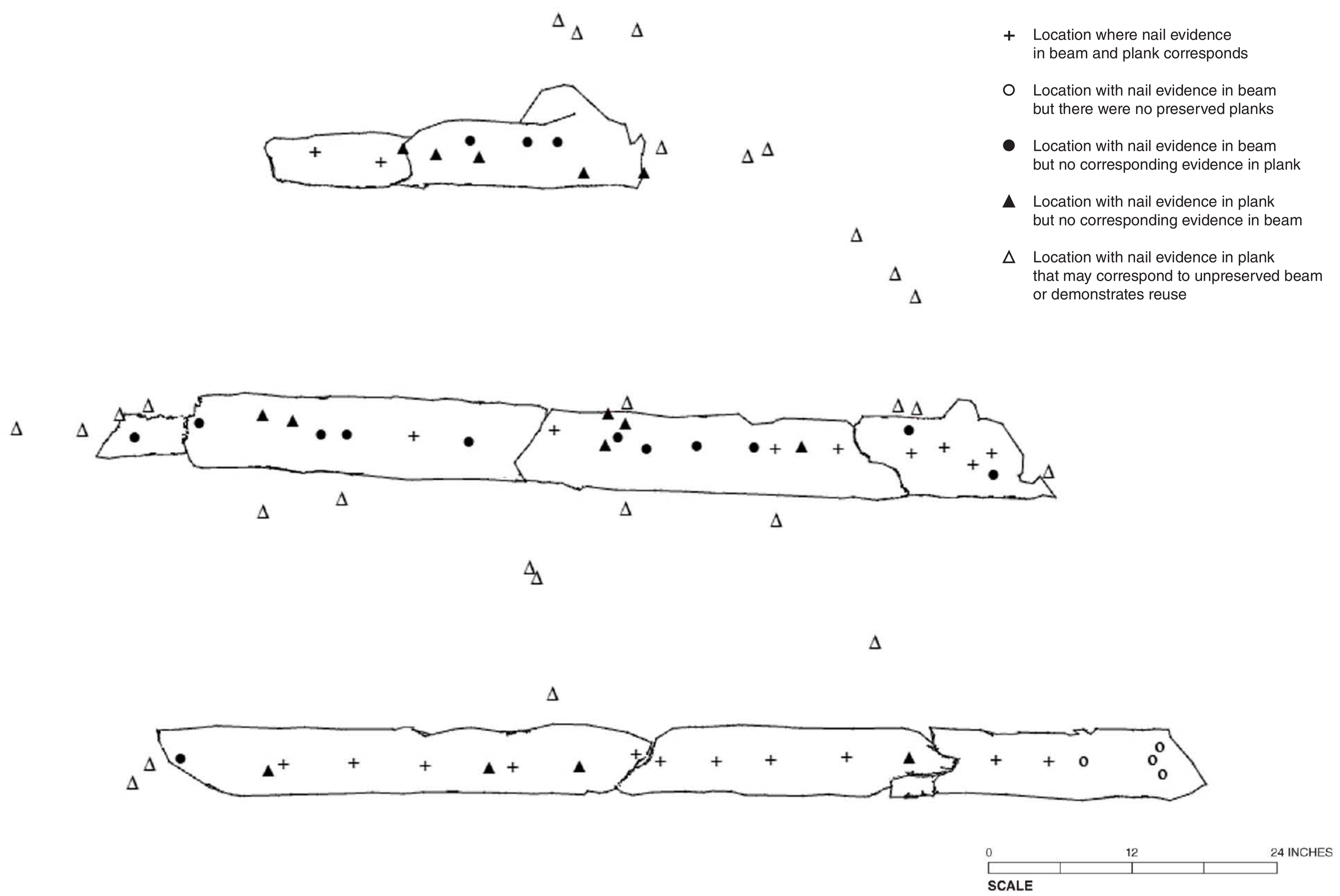


C Overlay of orlop planking over deck beams, viewed from the top. Blue nails correspond to the orlop deck beams.

D Rendered view of bottom of the orlop deck

Images of Orlop Deck

Figure 6-18



Plan View of Orlop Beams Indicating Nail Pattern

Figure 6-19

Human hair **A**

Louse **B**

Microscopic Images of Human Hair
and Louse Affixed to
Outside of Outer Planking
Figure 6-20

Trunnels to outer planking. Photograph by Drew Fulton **A**

Close-up view of an octagonal trunnel. Photograph by Drew Fulton **B**

Images of Frame FN 17-3

Figure 6-21

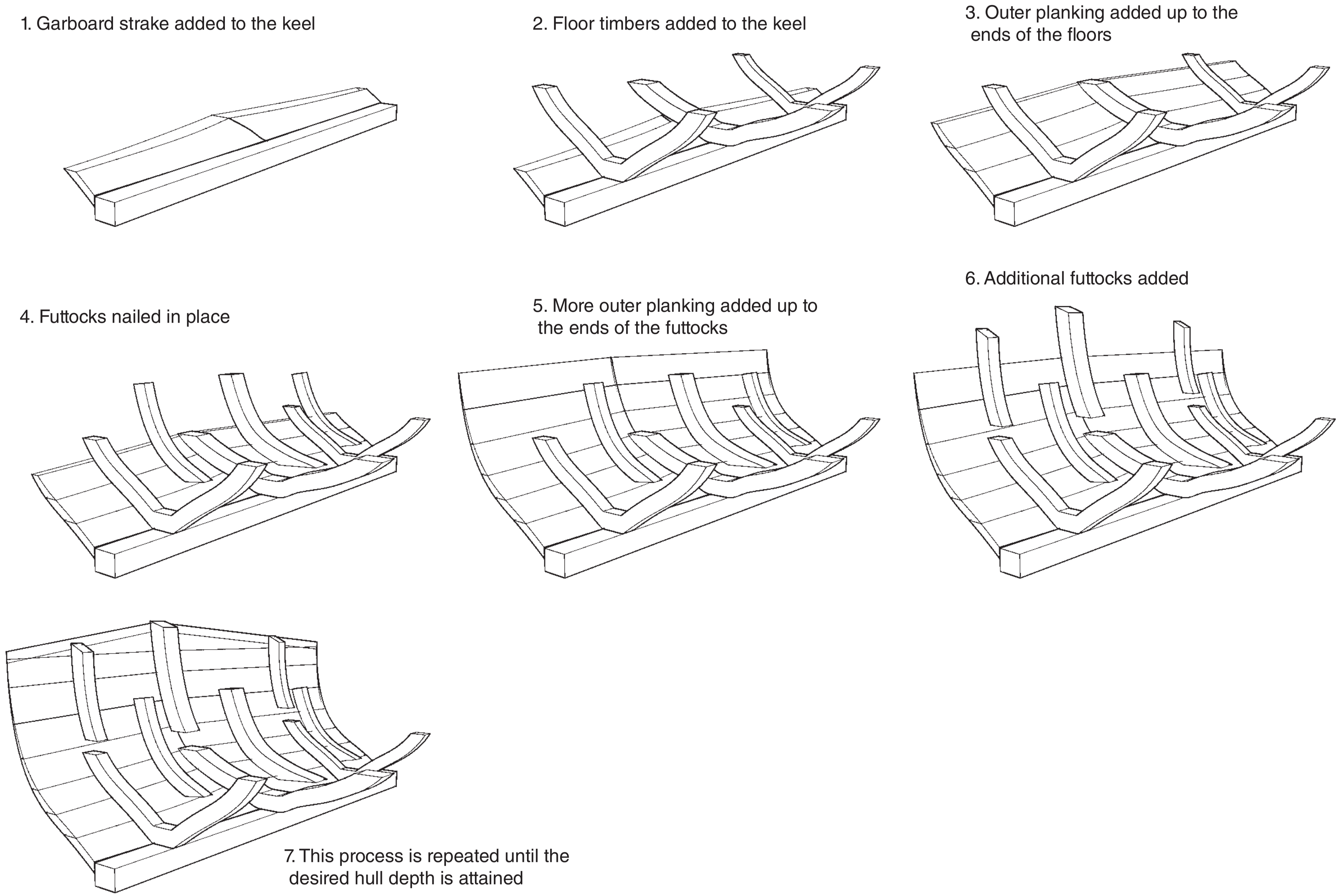


Diagram of Construction Sequence

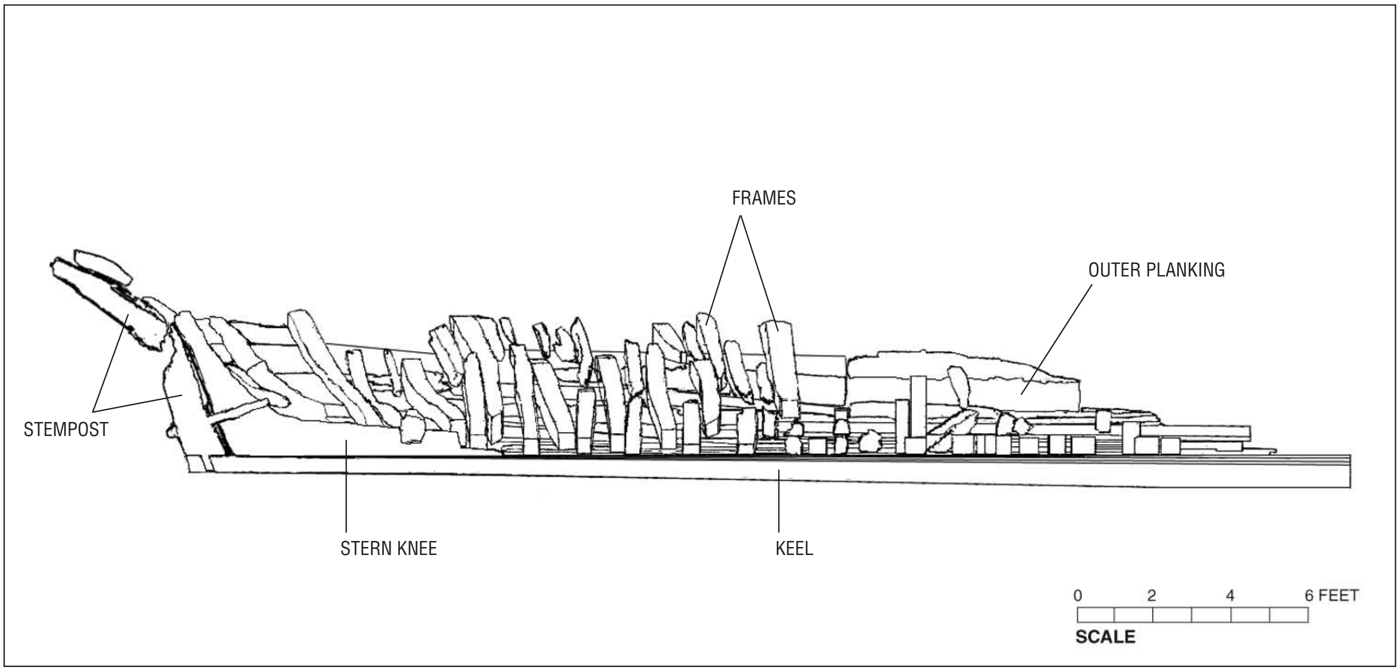
Figure 6-22

Facing west at stern of Ship Remnant, showing collapsed orlop deck and possible galley hearth **A**

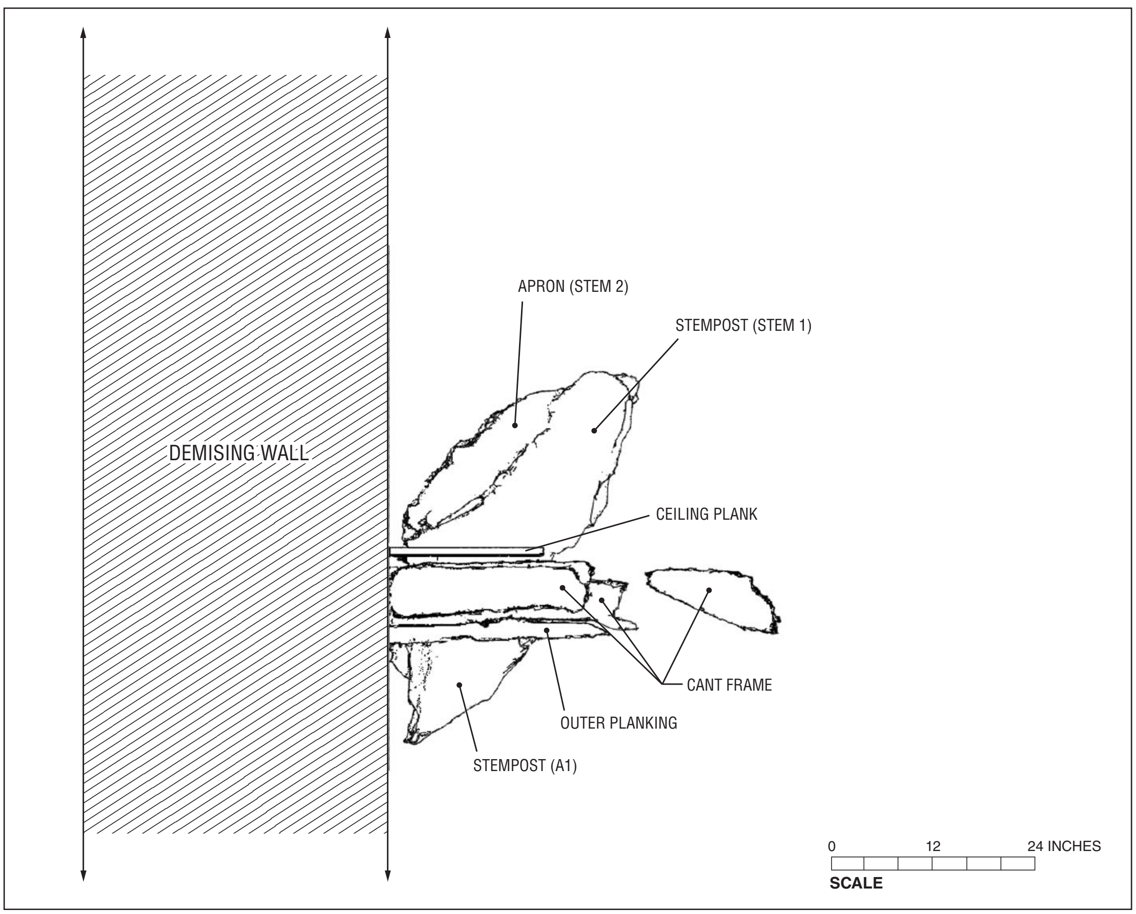
Metal feature in location of possible galley hearth on orlop deck **B**

Photographs of Possible Galley Hearth on Orlop Deck

Figure 6-23



Profile view of starboard side of stern at the keel **A**

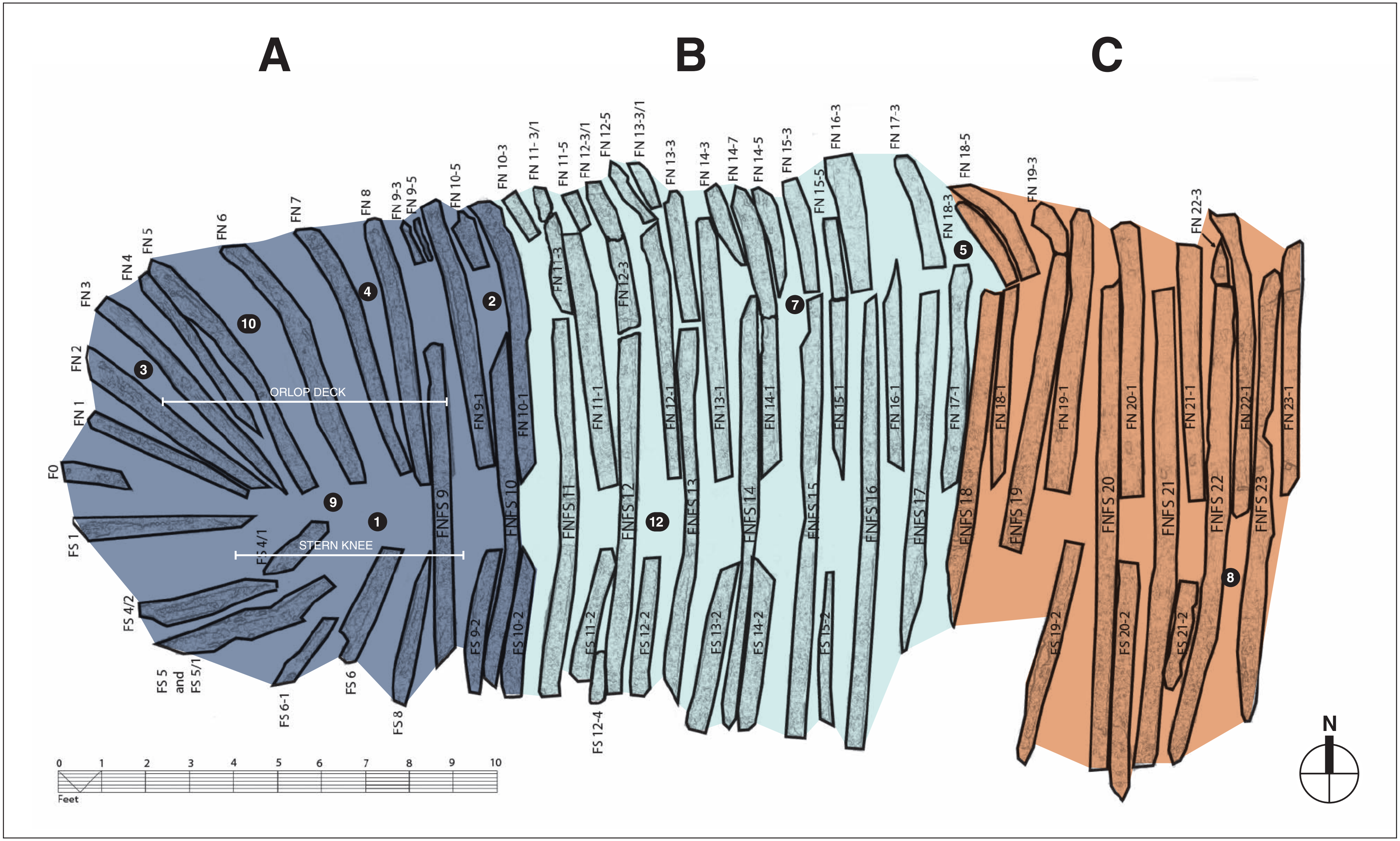


Profile view of starboard side of bow **B**

Profile Views of Stern and Bow

Figure 6-24

8.29.12



❶ Floation Sample Location and ID number

NOTE: Sample 6 was not within the Ship Remnant; samples 1 and 9 were at different depths within the vessel; and sample 11 was made up of sediments washed into the stern from other parts of the vessel during the archaeological investigation

Analytical Units for Ship-Related Artifacts

Figure 7-1

Appendices