EAST RIVER WATERFRONT ESPLANADE AND PIERS- OUTBOARD RESOURCES PHASE 1A ARCHAEOLOGICAL ASSESSMENT

CONTENTS

FIGURES

I. INTRODUCTION

The Lower Manhattan Development Corp. (LMDC) is the lead agency for the development of the proposed the East River Waterfront Esplanade and Piers Project. The East River Waterfront Esplanade and Piers project is intended to revitalize the East River waterfront by improving a two-mile-long, City-owned public open space connecting the Whitehall Ferry Terminal and Peter Minuit Plaza to the south with East River Park to the north. The existing esplanade would be enhanced, some new sections of esplanade would be created, and several piers would be renovated and redeveloped. For the purposes of this study, the Project Site or Area of Potential Effect (APE) runs along present South and Marginal Streets roughly from Whitehall Street adjacent to Battery Park, north and east to Jackson Street, along the East River shoreline of the Borough of Manhattan. The APE has been broken down into ten segments corresponding to discrete project elements, and the rough boundaries of the segments are described below:

1. Whitehall Street to the south side of Broad Street
2. Broad Street to Vietnam Veterans Plaza, on South and Marginal Streets
3. Broad Street through Old Slip, on Marginal Street and Outboard of Bulkhead
4. Old Slip to the North Side of Pier 15 between Fletcher and John Streets
5. Pier 15 and Adjacent Channels
6. Marginal Street between Beekman Street and Peck Slip, Pier 18, New Market Building, and the Proposed Marina[1]
7. North of Pier 15 (between Fletcher and John Streets) to Montgomery Street
8. Pier 35
9. Part of Pier 36, between Montgomery Street and Gouverneur Slip West
10. Pier 42

A more detailed depiction of the APE is found on Figures 1-4, which uses the current Sanborn insurance atlas as the base map. According to current plans, projected subsurface disturbance in the APE will generally be no greater than five feet below the current surface, with certain exceptions. The roadway area north of the Battery Maritime Building (BMB) to the Vietnam Veterans Plaza would require more substantial excavation to move the entrance to the Battery Park Underpass approximately 350 feet to the northeast, as well as for the potential relocation of a sewer outfall. The proposed pavilions to be constructed beneath the elevated FDR Drive would typically be constructed on concrete slab footings to a depth of not more than 3 feet, including utilities. Specific outboard locations—those on the river side of the existing bulkhead—such as Piers 15, 35, and 42, for example, would be affected by pile driving and/or dredging.

Due to the length of the project corridor, as well as the multi-phased components of the proposed improvements, a Programmatic Agreement (PA) is being established between the LMDC, the Advisory Council on Historic Preservation, and the New York State Historic Preservation Office (SHPO). The PA outlines the appropriate procedures for assessing the archaeological sensitivity of the APE. According to the PA, the "LMDC and the City will cooperate in the preparation of a 'Phase 1A' study that will examine the potential for archaeological resources to be present in the

[1] Within the East River Waterfront Esplanade and Piers EIS and the Programmatic Agreement, Pier 18 is referred to as the New Market Building Pier.

Archaeological APE. The Phase 1A study will consider the entire Archaeological APE, with the exception of two areas that would experience minimal disturbance (less than two feet in depth) for the Esplanade Project. These two areas are: the esplanade area that is outside the pavilions and South Street north of the Brooklyn Bridge. The Phase 1A study will be submitted to SHPO for review and approval." It is anticipated that the following phased approach to the required Documentary Study will conform to the PA so that the project can move forward and, at the same time, treat potential resources appropriately. Such studies may or may not indicate that further work, in the form of testing and/or monitoring during construction, will be required.

Historical Perspectives, Inc. has completed the Phase 1A study in compliance with the PA. The following documentary study of the proposed APE: 1) identifies categories of potential archaeological resources in the APE; 2) examines the construction history of the project site in order to determine the probability that any potential archaeological resources have survived post-depositional disturbances and remain in situ; and 3) determines whether additional study or testing regarding potentially-surviving archaeological resources is necessary.

This report, the initial Phase 1A task, covers the sections of the APE outboard of the bulkhead wall. It is our understanding that the City has already obtained certain permits necessary for this outboard work and would like to complete this analysis as soon as possible. The second Phase 1A task will focus on the portion of the APE that is south of the Brooklyn Bridge. The third Phase 1A task will cover the portion of the APE that is north of the Brooklyn Bridge.

Methodology

To build a picture of environment, land use, and disturbance to the APE through time, various public and private offices and institutions were contacted and collections researched. This includes not only published and unpublished archaeological and historical literature, but also newspaper articles, pamphlets, correspondence, maps, soil boring logs, photographs, and drawings. These contacts and their offices and institutions are given below.

Contacts

Vasanth Battu, Outside Projects Department, Metropolitan Transit Authority
Melanie Bower, Manager of Collections Access, Museum of the City of New York
Nancy Brighton, Archaeologist, United States Army Corps of Engineers
Norman J. Brouwer, Librarian Emeritus, South Street Seaport Museum
Kenneth Cobb, Assistant Commissioner, Department of Records, City of New York
Brian Cook, Topographic Bureau, Manhattan Borough President's Office
Diane Dallal, Technical Director for Archaeology, AKRF
Meghan A. Douris, Assistant General Counsel, New York City Department of Design and Construction
Simon Gelin, New York City Department of Environmental Protection
Jeffrey Katz, Section Chief, New York City Department of Design and Construction
Joshua Kraus, Project Manager, Lower Manhattan Borough Commissioner's Office, New York City Department of Transportation
Bill Lemke, URS

Matthew Monahan, Assistant Commissioner, Public Affairs, New York City Department of Design and Construction
Daniel Pagano, Archaeologist, New York City Landmarks Preservation Commission
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Lynn Rakos, Archaeologist, United States Army Corps of Engineers
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Suchi Sanagavarapu, New York City Department of Transportation
Vincent Soriano, Chief, BW&SO Mapping/Records, New York City Department of Environmental Protection
Rajen Udeshi, Principal Engineer, Outside Projects, CPM
Deborah Waters, Collections Information, Museum of the City of New York

Repositories

City Hall Library
Manhattan Community Board 1
Manhattan Borough President's Office, Topographic Division
Municipal Archives, Photographs–Department of Docks and Department of Ports and Trade; Manhattan Borough Presidents' Collection; New York City Mayors' Collection
New York City Department of City Planning
New-York Historical Society
New York Public Library (Humanities and Social Sciences Library)
New York Public Library (Science, Industry, and Business Library)

Online Resources

3dparks.wr.usgs.gov/nyc/index.html—"Geology of the New York Region," USGS
historicals.ncd.noaa.gov/historicals/histmap.asp—Office of the Coast Survey, Historical map and chart collection
rs6.loc.gov/ammem/browse—Library of Congress-American Memory
www.davidrumsey.com—David Rumsey Historical Map Collection
www.cooper.edu—"History Group EID101-D"
www.greenway.org—"East Coast Greenway-New York"
www.nycgovparks.org—"FDR Drive"
www.nycroads.com—"Franklin D. Roosevelt (East River) Drive
www.nylcv.org—"New York Waterfront Blueprint: Manhattan"
www.nottingham.ac.uk—"The 3Cities Project: JB Axelrod Essay"
www.oasisnyc.net/oasismap.htm—New York City Oasis (aerial photographs)

II. TOPOGRAPHY, PALEO-ENVIRONMENT, AND EXISTING CONDITIONS

A knowledge of Manhattan's geological history is essential for understanding the development and land-use history of both the project site and New York City. The island lies within the Hudson Valley region and is considered to be part of the New England Upland Physiographic Province (Schuberth 1968:10). The underlying geology is made up of "gneiss and mica schist with heavy, intercalated beds of coarse grained, dolomitic marble and thinner layers of serpentine" (Scharf 1886:6-7). The land surface in the metropolitan area was carved, scraped, and eroded by advancing and retreating glaciers during three known glacial periods. Before the final glacial retreat from the New York City area at the close of the Pleistocene (ca. 12,500 Before Present [BP]), melting ice formed a number of lakes in the valleys of the East, Hudson, and Hackensack Rivers, dammed by ice and glacially deposited moraines. Much of Manhattan Island, including the APE, was submerged beneath glacial Lake Flushing (USGS 2003).

When Lake Flushing drained as erosion ate through the moraine dams—probably through one or more massive flood events by 12,000 BP—Manhattan Island and the present channel of the East River, including the APE, were exposed as dry land. The release of meltwater during this same glacial retreat, however, also resulted in the rise of sea levels from about 400 feet below current levels 12,500 years ago, to about 10 feet below current levels between 4,000 and 2,600 years ago (Raber et al. 1984:10), flooding the APE. In short, the APE was exposed as dry land in ca. 12,000 BP, and then reflooded by ca. 2,600 BP as sea levels rose. For much of this period, the APE was not a shoreline location, and the channel of the East River was several miles distant.

Present Manhattan Island is marked by low hills, surrounded by estuaries and tidal straits, the remains of the channels of the Hudson, East, and Harlem Rivers, inundated by rising sea levels—part of an embayed section of the Coastal Plain.

Historical development has altered many of the topographic features which once characterized precontact Manhattan, and the current East River shoreline bears little resemblance to its condition during the early 17th century, when European colonization commenced. An examination of the Viele "Water Map," which charts the original shoreline of Manhattan, shows the APE submerged beneath the waters of the East River, with the project site lying between approximately 54 feet (Segment 7 between Frankfort Street and Catharine Slip) and 550 feet offshore from the pre-fill/pre-bulkheading shoreline (Viele 1865) (Figures 5, 6)

Intentional bulkheading and filling begun during the 17th century extended the shoreline to approximately its present location by the early 20th century (Sanborn 1928).

III. PRECONTACT PERIOD

The precontact period on Manhattan Island and in the surrounding area can be divided into three time periods, based on the precontact population's adaptations to changing environmental conditions. These periods are generally known as the Paleo-Indian (ca. 12,000 to ca. 10,000 BP), the Archaic (ca. 10,000 to ca. 2,700 BP), and the Woodland (ca. 2,700 to ca. 500 BP). These precontact periods are followed by the proto-historic and historical European Contact period, (beginning ca. 500 BP), which is distinguished from the precontact by the first Native American interactions with European trade goods, traders, trappers, fishermen, explorers and settlers.

Although the earliest evidence of humans in the New York City area appears during the Paleo-Indian period, approximately 12,500 years ago, and human occupation has continued into the present, there is no existing evidence of direct precontact occupation or exploitation of the APE. This is understandable, since the APE has been under water for approximately the last 2,600 years. As noted in the previous section, however, with the melting of the glacier at the end of the Wisconsin age and the draining of Lake Flushing, the APE would have been dry land available for exploitation by humans during the period from approximately 12,500 BP, when sea levels were 400 feet below current levels, until sometime between 4,000 and 2,600 BP, when glacial meltwater brought sea levels to 10 feet below current levels (Raber et al. 1984:10), flooding the APE. This time period corresponds roughly to the Paleo-Indian and Archaic culture periods.

The potential presence of submerged precontact sites far out on the continental shelf has been hypothesized for decades, and studies of near shore submerged sites were being published by the early 1960s (Emery and Edwards 1966). Unfortunately, the time, difficulty, and expense required to locate these sites, much less recover data, have resulted in the investigation of few submerged sites in this region. Ironically, our knowledge of precontact "coastal" adaptations, both in the New York City area and in other parts of the United States, is not generally based on sites that were coastal when they were formed, since the contemporary coast was many miles distant (Lewis 2000:528; Merwin, et al. 2003:46). Based only on terrestrial archaeology, we have an incomplete view of Archaic coastal adaptation, since few sites that were actually coastal have been investigated. Submerged archaeological sites from these periods would be extremely valuable because of the expected preservation of organic materials such as wood, plant fibers, and leather, which would survive in an underwater environment (Merwin et al. 2003:42, 51-52).

A review of available underwater archaeological literature regarding submerged site formation and the potential survival of submerged remains has proven somewhat inconclusive. There is no doubt that submerged archaeological sites do survive to a certain extent, and that certain data are preserved. This has been noted by archaeologists at submerged and partially-submerged sites around the world, including England, Denmark, Greece, Israel, South Africa, and Australia (Wilkinson and Murphy 1986; Stewart 1999:572-574; Merwin et al. 2003), as well as along the Gulf Coast of the United States (King 1981; Lewis 2000).

There is general agreement that rapid inundation increases the potential for a site's survival and integrity. Archaeologist George Bass noted in 1980 that gradual submergence "allows time for waves and currents to tear the site apart," while rapid submergence with a subsequent sediment cover "protects both the artifacts themselves and their spatial patterning from destruction by

water and marine organisms. Archaeologist David J. Stewart observed that the "pounding surf, [and] alternate periods of dryness and wetness" expected under conditions of slow inundation "can damage or destroy material, [and] even if artifacts are preserved, spatial context will be destroyed" (Stewart 1999:565).

Research along the Mississippi Gulf Coast conducted by Archaeologist R. Barry Lewis suggests that the submergence of low gradient and low energy (i.e., minimal wave and current action) shorelines, somewhat similar to those formerly in the APE, would have "tended to submerge rather than rework archaeological deposits." On the other hand, he also concludes that storm surges and storm tides are probably the most destructive agents on the Atlantic and Gulf Coasts (Lewis 2000:531, 536).

Based on data from a number of sites in the Eastern Mediterranean, Stewart agrees with Lewis' conclusions that archaeological sites on steep slopes tend to suffer more from inundation, since steep slopes become submerged more gradually than shallow ones,[2] and thus are exposed to direct tidal action for a longer period of time. Also, he observes that on steeply-sloping sites, artifacts erode out of their positions more easily and move farther downslope, away from their original positions. This migration is also affected by artifact size, shape, and weight. Israeli archaeologists have investigated a number of submerged coastal sites which exhibit some disturbance, but some artifacts are preserved in situ. One site, Athlit-Yam, a pre-pottery Neolithic (PPN) village (occupied ca. 8,100 to 7,500 BP), was found 300 to 400 m (984 to 1,312 feet) offshore in 8 to 12 m (26.2 to 39.4 feet) of water, on a shallow slope of approximately 2° to 3°. Numerous stone structures, hearths, at least one well, and a wealth of artifacts, including organic remains, were recovered. Spatial patterning was preserved to the extent that activity areas (lithics work area, animal butchering area, etc.) could be identified. It is not clear, however, whether spatial patterning *within* the activity areas was preserved (Stewart 1999:572, 583-584)

Of course, Paleo-Indian and Archaic period sites in the New York City region are somewhat less substantial than PPN villages. New York Harbor, the drowned estuary of the Hudson River, has long been hypothesized as an attractive place for precontact human activity, based in particular on the resources of the surrounding land, the number of precontact archaeological sites found on its present banks, and the small number of known sites dating to between 10,000 and 6,000 BP. The largest cache of stone artifacts from a precontact submerged site (more than 200), was recovered in 1994-1995 by beachcomber Helene Corcione, who combed through sand that had been dredged for a beach replenishment project and deposited on the Central New Jersey shore. The sand and the artifacts, which included 24 Archaic period points, some of which dated to the Early Archaic, came from a modern "borrow" area 3 km (1.86 miles) east of Sandy Hook. The artifacts were believed to have been in the upper 2 m (6.6 feet) of the sand stratum, buried beneath river sediment and muck. A survey of the area around the borrow location was conducted by the Stony Brook University Department of Anthropology in July/August 2003, and found water depths in the vicinity ranging from 14 to 20 m (45.9 to 65.6 feet) (Merwin et al. 2003:46-47).

Sea level curves constructed for New York Harbor by Paolo Pirazzoli in his 1991 *World Atlas of Holocene Sea Level Changes* indicate that offshore archaeological sites dating to 10,000 BP will

[2]Lewis' examples refer to slopes of 14° (steep) versus 2-3° (shallow).

be in water depths no greater than approximately 26 m (85.3 feet) below mean low water, and those from 6,000 BP will not be deeper than 14 m (45.9 feet) (cited in Merwin et al. 2003:46-47). These figures correspond roughly to the water depths from which Corcione's artifact cache originally dredged.

Although archaeologists contacted at the United States Army Corps of Engineers were not able to identify any studies of potential submerged precontact remains associated with Army Corps dredging projects in the waters around Manhattan (Lynn Rakos, personal communication with Cece Saunders, 2006; Nancy Brighton, personal communication with Sara F. Mascia, 2007), several studies for non-Army Corps projects have hypothesized the potential survival of submerged precontact and historical resources in and around New York Harbor. In 2004, the Cross Harbor Freight Movement DEIS assessed the precontact potential in a location quite similar to that of the APE—in and adjacent to the 65th Street Yard in the Bay Ridge section of Brooklyn—an area of drowned land, partially under water, and partially filled and developed with piers and bulkheading. The report concluded that:

> the channels along the Brooklyn waterfront have been subject to repeated dredging and maintenance during the 19th and 20th centuries, and construction of the piers and bulkheads along the waterfront also frequently involved dredging and deposition of large quantities of landfill. Due to the expected extent of disturbance associated with these actions, it is unlikely that any undisturbed prehistoric archaeological resources are present under the bulkheads or immediate off-shore areas of 65th Street Yard (NYCEDC 2004:7-14, 7-15, 7-16)

On a site north of the harbor, an attempt was made in 2002 to locate potential submerged precontact and historical resources prior to a dredging program planned for the upper Hudson River. This involved the collection of a series of 967 sediment cores. The preliminary analysis by the archaeologists reviewing the cores found that 122 of the cores contained historical archaeological deposits. No precontact period artifacts were recovered in any of the 967 Hudson River cores reviewed (URS 2003).

Potential Precontact Archaeological Resource Types

Since they would pre-date the inundation of the APE, potential precontact archaeological resources would be expected beneath river-deposited stratum, which are generally identified in soil borings as "mud" or "river mud," or "silt," but could also contain sand and clay. Mud and clay are expected as the predominant deposits in relatively still water, such as is found between piers and in slips. Sandy strata beneath the mud and clay would represent river deposits found in flowing river channels, i.e., predating pier construction. Beneath these deposits, a sandy, glacial till stratum would be expected, representing the former land surface of ca. 12,500 to 2,600 BP. This would be glacial till left behind by the Wisconsin glaciation (Figure 12). If this former land surface is undisturbed by river currents, tidal action, and historical dredging and construction, it would be expected in this stratum. The preinundation land surface would be buried more deeply the closer a location is to the present river channel. Soil boring logs show deposits of river mud in many parts of the APE, but this mud stratum varies in thickness and in depth depending on location and historical dredging.

Physical evidence of dredging or current/tidal activity that may have destroyed or severely impacted strata with precontact archaeological potential would include thin or missing till strata, such as locations where river mud sits directly atop rock or hard pan.

In Lower Manhattan, there have been no documented archaeological investigations of the preinundation land surface. The nearest contender is the 7 Hanover Square Site (south side of Old Slip, between Water and Pearl Streets, 2 blocks west of the APE), at which a layer of red sand was encountered beneath later river deposits. This was originally identified as the intertidal zone of Manhattan's early-17th-century beach. Examination and testing of the red sand under the direction of Steven Selwyn, Ph.D., however, concluded that it was not a "'beach' horizon" deposit, but sand redeposited *underwater* by river or stream currents. Furthermore, the red sand did not come from the most recent Wisconsin ice sheet of ca. 12,500 BP, the sands from which would have been of a yellowish cast, but represented the deposits of an earlier glaciation from ca. 40,000 BP (Rothschild and Pickman 1990:Appendix C).

A second consideration in determining precontact archaeological potential is an assessment of a location's attractiveness to precontact hunter foragers. The normal criteria for evaluation include a dry, sheltered, well-drained location, near a fresh water source, and near an area rich in game and useful plant resources. Given the extreme changes which have occurred to the environment since the period between 12,500 and 2,600 BP, it is nearly impossible to reconstruct the ancient environment of the APE. It is worthy of note that for most of this time period, the channel of the East River was as much as several miles distant from the APE, until rising sea levels flooded the estuary and eventually inundated the APE.

IV. HISTORICAL PERIOD

Historical Period Overview

Before being superseded by the Hudson River during the mid-19th century, the East River was the main port of entry into New York City. Its advantages included a gently sloping shoreline sheltered from strong winds, and a channel with an average depth of 50 feet, deep enough for 17th- to 18th-century ocean-going ships (Gratacap 1901:112). As ships gradually got larger during the 19th century, commerce shifted to the Hudson, until the vast majority of Manhattan's shipbourne trade entered the City via the Hudson River by the 20th century.

The importance of the East River shoreline is reflected by the placement of the New Amsterdam settlement there in the 1600s. Ships moored in the deep water off shore, and would be unloaded into smaller boats which would ferry the cargo to shore. The first wooden dock was built in 1647 at what is now Pearl and Broad Streets, and the shoreline was ordered stabilized with wooden sheetpile seawalls during the 1650s (Bone 1997:92-93).

The East River was the center of activity, and continued as such after the British conquest in 1664, and following the American Revolution. As trade and other ship-related industries expanded, and ships became larger, there was an ever greater need for facilities and storage space. As a result, piers, warehouses, and other facilities were constructed along the shoreline, and in order to keep pace with other ports, they were continuously expanded and modernized (Buttenwieser 1999:11-13). They also became more permanent, as the construction techniques of the 1600s and early 1700s—piles, plank platforms, timber sheet piling, and stone embankments—gave way to solid-based cribworks. The calm waters of the new basins and slips created by the new docks accumulated silt and debris, requiring the institution of regular dredging (Bone 1997:94-97).

Waterfront development also included the expansion of the Island of Manhattan into the East River. With the Dongan Charter of 1686, the City of New York received title to, among other things, all lands and water bodies on Manhattan extending to the low-water mark, and allowing the City to "fill, make up, lay out, use and build on" lands then under water. The city began selling water lots to private citizens, provided that the new owner fill and build the street and wharf along the low-water line. The Dongan Charter effectively extended Manhattan 200 feet into the East River, and the Montgomerie Charter of 1730 extended City boundaries from Whitehall to Corlears Hook, another 400 feet beyond the old low water mark. As commerce recovered from the British Occupation during the Revolution, the Outer Streets and Wharves Act of 1789 provided for the creation of South Street beyond the 1730 400-foot line. The Act also provided for greater regulation by the City of new development, including surveying straight streets (South Street) to facilitate commerce, and allowing the City to take action to fill in gaps at the private owners' expense, if necessary (Buttenwieser 1999:28-29, 39-40).

A comparison of maps from this period, namely a 1793 map by Goerck and Van Sheecburgh (South Street Seaport Museum Library) and the Taylor-Roberts Plan of 1797 (Cohen and Augustyn 1997:94-95) illustrates this problem, showing the jagged East River shoreline with crooked, irregular Front Street interrupted by numerous slips and watery areas between piers.

The 1797 map does show the earliest section of the new South Street, however, extending a grand total of three city blocks, from Whitehall Street to Broad Street, and Broad Street to Coenties Slip. North of Coenties Slip, the location of the future South Street is punctuated by numerous wharves jutting out into the East River as far north as Beekman Street.

The opening of the Erie Canal in 1825 provided further impetus to New York's commercial and physical expansion. By 1827, the Goodrich Map shows South Street open from Whitehall Street north to Roosevelt Street, broken only by Coenties Slip, Old Slip, Coffee House Slip (Wall Street), Burling Slip, and Peck Slip. After a seven-block break of East River wharves, South Street is again shown on the map, from Rutgers Street east to present Jackson Street, but this appears to be a projection, with the existing shoreline drawn in to the landward side of South Street (Cohen and Augustyn 1997:115).

By 1849, with the exception of Coenties Slip, South Street ran uninterrupted from Whitehall to Jackson Street (then Jackson Slip). The shoreline was punctuated with piers, beginning with Pier 2 at the foot of Whitehall Street, and ending with Pier 57 at Jackson Slip. Although generally straight along the landward side, mid-19th century South Street's pier and river edge was still jagged. Although a 70-foot street width was mandated, the width varied from a low of 61 feet to as much as 108 feet wide, although it was generally between 61 and 80 feet wide. This additional area is labelled "Marginal Street" in many 20th-century atlases. "Marginal bulkhead platforms were often constructed to permit vehicle and pedestrian traffic access to the bulkhead line;" in other words, these additional filled areas facilitated the functioning of the piers and wharves, and sometimes also hosted structures (Alvord 1849; Sanborn 1975; Historical Perspectives 1987:30).

Department of Docks—East River Bulkhead

Subsequent filling and construction activities during the 19th and early 20th centuries gradually expanded South Street (including unlabelled "Marginal Street" areas) to its approximate boundaries at present, creating a street generally 120 to 125 feet in width (Bromley 1921). The major innovation was the construction of the East and Hudson River bulkheads and associated structural systems begun in 1871 by the New York City Department of Docks. This initiative was partly in response to the run-down and squalid waterfront conditions that existed at the time, and New Yorkers' growing sense of, and pride in, their city as a center of world commerce. Design of the bulkhead was originally the responsibility of Civil War General George B. McClellan. The masonry-faced bulkheads and modern piers were to be the most up-to-date port facilities in existence, and were intentionally monumental to symbolize New York's international importance (Graham 1873; Bone 1997:99,102).

According to research conducted by AKRF, Inc. utilizing the archives of the South Street Seaport Museum, Department of Docks annual reports, and a structural conditions survey completed in 1989 by TAMS on behalf of the New York State Department of Transportation, the bulkhead within the APE was generally completed by ca. 1890. The section between Piers 35 to 42 (east of Rutgers Street through Montgomery Street), however, was not constructed until ca. 1910. The documentary record is somewhat incomplete. In some cases, dates of original construction are suggested by recorded dates of bulkhead damage and repair. The bulkhead north of the Brooklyn Bridge to Market Street, for example, was rebuilt in 1890 after being washed out by heavy tides.

Cartographic research indicates that the construction of new piers and the filling and expansion of Marginal Street behind the new bulkheads did not take place as soon as the new bulkheads were built, but were completed as late as the first decade of the 20th century. The 1891 Bromley real estate atlas does not record an expanded Marginal Street, and the piers are essentially the same as depicted in the 1885 Robinson atlas (Robinson 1885; Bromley 1891). More detailed maps from the collection of the South Street Seaport Museum Library (SSS 1903a; 1903b; 1907; 1910; 1911), showing bulkhead and pier facilities from 1903 to 1911, show an unwidened Marginal Street in the early 20th century.

For example, at Old Slip, the 1903 South Street Seaport Museum Library map (SSS 1903a - Figure 7) records a crib bulkhead ("CRIB B'H'D") at the foot of the filled-in slip, varying between 75 and 90 feet east of the landward side of South Street. Former Piers 11 and 13 are drawn in north and south of the slip. The bulkhead line is noted at 125 feet east of the landward side of South Street. Lest it be assumed that the 1903 map is simply out of date, two years later the 1905 Sanborn records a similar scenario, but with updated attributes. (Figure 8) There the "new" bulkhead line and proposed new piers are delineated with a dashed line, but former Pier 11 is still apparently functioning. Former Pier 12 remains as a stub, having been truncated to the new bulkhead line in preparation for the construction of new Pier 10.

The 1906 annual report of the Department of Docks notes expenditures for the construction of bulkhead walls and paving "new marginal street[s]" in all sections of the APE from Broad Street to Jackson Street. In the Old Slip section, from the upper part of Coenties Slip to just north of Wall Street (including the location discussed in the preceding paragraph), bulkhead expenditure was substantial ($248,596.07), especially in proportion to the total moneys ($371,875.54) already spent on the bulkhead there (Docks 1906:175-176), and the large volume of work corresponds to the projected bulkhead lines shown there in the 1905 Sanborn atlas (Sanborn 1905).

In other areas, such as the Broad Street to Coenties Slip section, where bulkhead wall and new pier construction had been authorized in December 1899 (Docks 1899:115, Map n.p.), the funds spent on the bulkhead wall in 1906 ($31,381.71) were a small part of the total expenditure on the bulkhead ($205,538.16), and suggest minor construction or even repairs. This is also apparent on the 1905 Sanborn Atlas, which shows no ongoing or projected construction in this area (Sanborn 1905).

As the maps also show (e.g., Sanborn 1905), even with completion of the new bulkhead, both old and new piers existed side by side. Old piers continued to earn revenue (Docks 1906:81) while the "old work" was gradually removed and new piers built (Docks 1899:82; 1906:175-181; 1914:172-175).

In summary, the monumental task of constructing new port facilities for the island of Manhattan did not end with the completion of the bulkhead wall. Filling and pier and street construction continued for many years after sections of the bulkhead were finished.

Potential Historical Archaeological Resource Types

Riverbottom Remains

These resources include discarded and lost cargo, and discarded material from shoreline activities. Prior to filling, the APE was part of the original harbor of Nieuw Amsterdam/New York, and potential for resources from this category would be expected within the strata of accumulated river muds, silts, and sands (Figure 12). For example, at 64 Pearl Street (between Broad Street and Coenties Slip, 3 blocks north of the APE), Archaeologists Rothschild and Pickman noted substantial numbers of late 17th-century artifacts in the stratum believed to have been the 17th-century East River bottom adjacent to an existing dock, and interpreted these as ship and shore discards and losses (Pickman and Rothschild 1981).

The nature of discarded remains is somewhat problematic, however, since they generally cannot be linked to any specific episode, person, household or business. Artifacts might be purposely dumped, or accidentally lost from either ship or shore activities, from businesses and households adjacent to the underwater location, or dumped clandestinely, and/or with collected refuse from other locations.

This is not to say that under certain circumstances the data provided by riverbottom remains cannot be valuable as a dating tool or for other avenues of research. In his archaeological study of excavated Cruger's Wharf (Old Slip and Water Street, 2 blocks west of the APE), Archaeologist Paul Huey noted a red sand stratum more than 25 feet below modern street level, which was identified as the original riverbottom, and two strata of riverbottom deposits representing the period between ca. 1650 and the construction of the wharf in ca. 1740. Huey not only used the artifacts to date the strata, but he was able to interpret the pieces of ships rigging, numerous whole bottles, ceramic vessels, shoes, and other complete objects as items lost or discarded overboard during normal shipping activities. From this data he attempted to reconstruct the changing trading patterns of New Amsterdam/New York during the 17th and 18th centuries (Huey 1984).

Sunken Vessels

Sunken vessels are perhaps the most complex and sensational of the artifact classes that have been recovered in the landfilled areas of Manhattan. Sometimes decrepit vessels simply sank at their moorings. An examination of the New York City Common Council minutes from the late-18th and early-19th centuries indicates that there were two general courses of action taken by the Council when a "hulk" was blocking the channel of a slip or wharf. Most references were either orders or payments for removal. In some cases in which the parties liable for the expenses were unknown, an official called the "Corporation Wharfinger" was ordered to take charge, as in the case of Whitehall Slip in 1790 (MCC 1917: I612), or in 1812 the "Superintendent of Repairs" (MCC 1917:VII 264, 601).

In 1784 there were two recorded instances in which payments were assigned to third parties for breaking up hulks to provide "fewel for the Poor" (MCC 1917:I 27; there are others, e.g. in 1824: XIII 790-791). A hulk was somewhat valuable for its constituent parts; agreements with the Council often specified that the remover receive the hulk *and* a cash payment, as in 1812 (MCC 1917:VII 237), and in 1788 at Albany pier (west side of Coenties Slip) (MCC 1917:I 402). The

seriousness with which obstructions to commerce were viewed is perhaps evidenced by the fines assessed for "incumbering" public slips, when those who bought the hulks did not remove them quickly enough, as was the case in 1824 (MCC 1917:XIII 790-791).

Considering the importance of the slips and wharfage to the commerce of the City, it is unlikely that a hulk would have entered the archaeological record based via "accidental" sinking or simple abandonment. A second method of disposing of such vessels, however, was to incorporate them into landfill by filling them with earth. In one 1786 case, a hulk sunk in Beekmans Slip was "partly on the Ground where the street is to be made" and "Cannot be raised." The Council's committee recommended "that the Hulk or wreck, lying in the slip be fill'd level with the street—That the petitioner be permitted to extend the street to the width of twenty feet at his own expence [sic]"[3] (MCC 1917: I 230-231). Apparently vessels were not the preferred method of landfill in every situation, since in an earlier incident at Beekmans Slip (1784), the Rhinelander family was threatened with prosecution and ordered to remove an "Old Hulk" from the slip so that it could be filled in (MCC 1917:I 52).

Along the former East and Hudson River shorelines, several examples of such vessels have been found by construction workers, and fewer excavated and/or recorded by archaeologists. Most notable among these was the hull of an early-18th century vessel found in the basement of 209 Water Street, later part of the South Street Seaport Museum, and the ca. 1720 ship excavated at 175 Water Street.

The ship excavated at the 175 Water Street site, unofficially dubbed the *Ronson* after the site developer, is of great historical significance, since it is not only an example of 18th-century landfill techniques, but also the only surviving example of a cargo vessel built during that period (Brouwer 1980; Hartgen 1992) and "a rare example of the eighteenth-century shipwrights' art" which is poorly documented (Rosloff 1986). Once it had outlived its usefulness, the 92-foot long, 25-foot wide vessel had been purposely sunk parallel to the shoreline and covered with fill. The bottom of the hull was found at 18 feet below grade (Bergoffen 2002). Analyses could not determine its country of origin, but based on the warm water shipworms embedded in the *Ronson's* pitch-and-horsehair sheathing, it may have plied the waters of the Caribbean (Rosloff 1986; Cantwell and Wall 2001) or possibly served in the tobacco trade along the coast of North Carolina.

Landfill Retaining Structures, Wharves, and Piers

Historic cribbing and bulkheads—devices for retaining fill—have been a subject of archaeological investigation for many decades (See e.g., Historic Sites Research 1978), and docks and wharves, some of which eventually functioned as landfill retainers, are known to have existed throughout the APE prior to the construction of present South and Marginal Streets.[4] All utilized similar construction techniques, which evolved from an almost vernacular tradition in the 17th and 18th centuries, to the recorded, standardized construction practices of the late 19th century.

[3]The location is presently Beekman Street between Water and Front Streets, outside the APE.
[4]Sunken ships, also used in this capacity, are discussed separately in the previous section.

According to Architect Kevin Bone (1997), a bulkhead wall is "a retaining wall along a waterfront, which shores up the embankment in order to stabilize it for the construction of wharves and piers." The term is believed to have originated with New York City engineers (Bone 1997:272). A wharf refers generally to a structure at which vessels unload cargo (Ibid. 277), although some sources distinguish between a marginal wharf, or quay, which is a parallel extension of the shoreline, and wharves which extend more or less perpendicular to the shoreline, usually called piers (Joseph et al. 2004:178-179).

Prior to the late 18th century, the chief method of land extension and wharf construction in the New York City area was by the creation of sheet-pile seawalls. Debarked logs of American white oak, sharpened to a point at one end and shaped at the head to accommodate a pile cap, would be driven side by side into the mud of the river floor with a log or stone drop hammer. They would then be anchored together with heavy horizontal wood planking secured to the outboard face of the piles. The planking would retain the fill which would be deposited on the landward side. Sheet piling was also employed in the construction of docks and wharves (Bone 1997:92-96), and according to a description written by Freeman Hunt in the April 3, 1840 edition of the *Merchants' Magazine and Commercial Review*, the practice continued well into the 19th century (Small 1941).

Other methods were developed for specific circumstances, such as shallowly-inundated building lots. At 7 Hanover Square, stone house foundations are believed to have been laid directly on the river bottom in ca. 1687-1697, in what was interpreted as the intertidal zone on the outboard side of present Pearl Street. The stone foundations not only supported the new houses, but also seem to have been employed to retain landfill (Cantwell and Wall 2001:236-237; Rothschild and Pickman 1990).

Sheet piling was also employed to surround riprap embankments, and combinations of piles, planks, stone embankments, and sheet piling were the dominant construction method to the time of the American Revolution. By the late 18th century, during the post-Revolutionary War rebuilding of Manhattan waterfront facilities, cribworks—wood-frame, "boxlike receptacles" with solid bottoms and open sides, filled with loose stone and sunk to river bottom—provided larger, sturdier supports for retaining walls and wharves, where pile-supported structures could not be built or proved unstable in the face of strong river currents and ice. The larger number of laborers available after ca. 1800 to man the required derricks and rigs made this type of construction more feasible. The river floor would be dredged, clearing mud and loose debris down to the bedrock or hardpan substratum. The crib bottom was fitted to the river floor's contours, and the cribwork was carefully filled with stone, mud, sand, and sometimes even concrete, and pinned to bottom. If the crib facing were constructed so tightly that earth alone could be used as the fill, it was called a "solid-filled crib" (Bone 1997:96-99; Joseph et al. 2004:178-179).

The more primitive construction form, using notched, unhewn logs, and larger fill cells, was known as a cobb[5] wharf, and the fill supposedly consisted entirely of stone (Joseph et al. 2004:179). Often the fill included other materials, such as ballast rock and coral, brush, and tree

[5]Cobb, or cob, may refer to a beating or spanking administered with a flat piece of wood, such as would make up the cribbing, or more likely, to the cobbles used in the fill.

stumps (Louis Berger 1990:V-3). Cobb construction, with its less accurate joints, was less durable and stable than cribwork (Bone 1997:96-99). The 1690s cobb structure excavated at the Barclays Bank Site (75 Wall Street, corner of Wall and Water Streets) was built with rough logs joined to form a series of 5-foot-square compartments. The structure was secured in place by pilings, and filled with rock and coral (Louis Berger 1983).

Data illuminating 18th- and 19th-century wharf construction practices in Lower Manhattan has been accumulating since the 1960s, as examples of cobb-type construction have been uncovered at a number of archaeological sites. Archaeological excavations conducted in 1969 on the site of Cruger's Wharf, at present Old Slip and Water Street (west of the APE), also uncovered part of a wharf of cobb construction, built in ca. 1740 (Huey 1984). The cobb components were encountered approximately 5 feet below the 1969 street surface, and extended an additional 17 feet down to what had been the ca. 1740 riverbottom. As the shoreline was extended from Water Street to Front Street by ca. 1765, fill placed on the landward side of the L-shaped wharf had "transformed" it into a retaining wall/bulkhead.

During the excavations for the Telco Block (site bounded by Water, Fulton, Front and John Streets, west of the APE) the tops of the wooden members of a mid-18th-century cobb wharf complex were consistently encountered at or below mean sea level, which was at approximately 5.5 feet below the curb, and an exposed section extended to 9.5 feet below mean sea level, to what was interpreted as the riverbottom. Deposits within the cobb wharf were stones, as would be expected. Lines of plank bulkheading were added as the wharves were incorporated into the shoreline system (Rockman, Harris, and Levin 1982:60, 64-68, Figures 3.10, 3.12).

The most complete study of such structures in Lower Manhattan took place at the Assay Office Site, on the block between Front and South Streets, and Wall Street and Gouverneur Lane, a block west of the APE. Plank bulkheads, as well as a cobb wharf complex dating to the 1790s, were unearthed beneath the basement floor levels of modern buildings. These represented multiple fill episodes, and were encountered in a fill stratum beginning approximately 8 to 13 feet below street level. Large logs of approximately 1 foot in diameter were used in the cobb frame, which from its base was 15 feet high. The 4-foot by 8-foot cells had well-built, split timber floors. The various wooden elements were attached to each other through carefully-prepared wooden joinery, and even some metal fasteners (Greenhouse 1984: 2, 3, 4, 10, 13-14; Louis Berger 1990:Fig. 4.2, IV 3,14-17; 1991; Cantwell and Wall 2001:230-233).

Predating the cobb wharves, a wharf type known as "block and bridge," was also uncovered at the Assay Office Site. In this case a series of wooden "blocks" 20 feet square and 40 feet apart (the blocks could also be masonry), and spanned by plank "bridges," had been constructed before the 1780s. This design allowed the river currents to pass through the pier and avoiding some of the buildup of mud and debris which occurred with solid wharves. As with many other piers, when the adjacent river was filled, the underwater spaces between the blocks was closed with planking, and like the adjacent cobb wharves, became part of a landfill retention system (Cantwell and Wall 2001:232-233). Cantwell and Wall note, in retrospect, that the sections of Cruger's Wharf and the wharf on Beekman Slip at the Telco Block were actually parts of block and bridge piers (Ibid.:325).

Only one excavation along the Hudson River has revealed the presence of wharves, in this case, a cobb-type construction. The wooden members were encountered during monitoring at Site 1 of the Washington Street Urban Renewal Area, and were dated to the late-18th and early-19th centuries. Although somewhat distant geographically from the APE, the remains are notable for providing valuable information on the joinery and fastenings employed on such constructions (Louis Berger 1987).

A grillage/raft type wharf employed construction techniques similar to that of a cobb wharf. As the name implies, it was a solid raft-like structure built of timbers laid as headers and stretchers, incorporating layers of stone. Additional "rafts" were built and stacked until the required height was reached. It would then be floated out to the intended location, filled with stones, and sunk (Joseph et al. 2004:179). Although more famous for the excavation of the *Ronson*, the 175 Water Street site (on the block surrounded by John, Fletcher, Water, and Front Streets, west of the APE) also uncovered wharf construction of this type, dating to ca. 1750 (Geismar 1983:117,203; Louis Berger 1990).

As was the case at the Assay Office Site, the remains of wharves and landfill devices may still survive beneath modern building foundations. Soil borings and test pits performed during a preliminary archaeological assessment of Block 97 (lots along the east and west sides of Front Street between Beekman Street and Peck Slip, west of the APE), in 2002, encountered wooden beams apparently belonging to cribbing or other landfill devices beneath building foundations on and extending below the current water table, which was encountered between 3 feet 8 inches and 5.5 feet below grade (Test Pit 1, 214 Front Street Block 97 Lot 37), and in fragments in all the soil borings (Bergoffen 2002:11-12). Monitoring was recommended in this case, but unlike the APE, these were building lots, not streetbeds.

During the 1870s, with the establishment of the New York City Department of Docks, East River piers and wharves were constructed following "modern" techniques, with a deck of wood or concrete atop wooden piles driven into the hard bottom in various combinations, often given greater stability by being driven through riprap or broken stone placed for that purpose (Greene 1917:28-33). A description of, and the impact of this construction on potential archaeological resources is provided later in this report.

Subsurface Conditions: Soil Borings Review

Although soil borings are often useful in determining the extent of subsurface disturbance, in the case of the APE, they are of comparatively little utility beyond the confirmation of what is already known of the project area through documentary sources: that the APE is comprised of a thick stratum of fill which extends below the water table to what was once the East River floor; and that this fill, particularly that below the water table, will contain large rocks, as well as evidence of wood from cribbing and piles. Soil boring logs, unless they are created specifically with archaeological concerns in mind, do not generally provide the detail necessary to determine the difference between primary landfill and secondary fill, despite the fact that both documentary and archaeological evidence indicates the potential for the existence of a thin deposit of river silt between the two fill strata. Rock Data Maps provided by the New York City Department of Design and Construction (NYCDDC) record miscellaneous fill and the presence of wood/timber

and organic silt, but as already stated, do not differentiate substrata within the fill or provide the elevation of the water table (WPA 1965).

A soil profile based mainly on a program of 49 soil borings performed for the construction of the FDR Drive provides a more detailed subsurface view of the APE between Robert F. Wagner Sr. Place and Montgomery Street, although the locations of the borings within the APE are not precisely pinpointed (CNYDPW 1960). (See Appendix.) Again, although the fill and other strata are described in greater detail than in the Rock Data Maps, there is no differentiation of substrata within the fill, and the presence of timbers, riprap, and boulders are precisely what is to be expected in an area of filled riverbed punctuated by buried wooden piers, bulkheads, and cribbing. An additional set of soil borings with precise locations within part of the APE has been incorporated into the segment evaluations below (CNYDGS 1982), and included in the Appendix. As with the profile, although the confirmation of the presence of expected fill materials supports the documentary evidence, it does not provide data regarding disturbance. Simply put, disturbance to—and the archaeological integrity of—historical fill, pier, and wharf resources and the other categories of potential archaeological resources discussed above are unfortunately not discernable through soil borings.

On the other hand, soil boring logs should prove useful in determining the depth of fill strata, as well as the general elevations of river and glacial deposits. This data would provide help in identifying the potential precontact land surface which existed prior to inundation by rising sea levels after the last glacial retreat, i.e., if they have survived adverse impacts from tidal and current action, dredging, and construction disturbance.

Types of Recorded Subsurface Disturbance

Although many forms of subsurface disturbance have occurred with the APE, *documented* disturbance can be divided under several major headings.

Subway Tunnels

The current Sanborn records one subway tunnel passing beneath the outboard APE: the BMT Tunnel at Broad and Whitehall Streets. A second tunnel, at Rutgers Slip, is adjacent to the APE. These subaqueous tunnels, built by the shield tunneling method, were begun west of South Street, and by the time South Street was reached, were many feet below the current APE. For example, the Clark Street Tunnel shaft, constructed using this technique, was begun on Front Street and is already 54 feet below grade at South Street (Olmsted 1995). Therefore this construction should have had no impact on archaeological resources in the outboard APE.

Dredging

Dredging is a regular feature of port maintenance to remove accumulated mud and debris (artifacts) from channels and slips, and as a result, harbors and their channels are not generally environments conducive to the preservation of submerged archaeological sites (Stewart 1999:578). Contracts for dock, slip, and wharf maintenance farmed out by the New York City Common Council during the 17th and 18th centuries required the cleaning of "the said Dock, & slip in the Dock of all the Mudd & filth therein Soe deep as till they finde A sandy Bottom and During the said Lease shall soe Keep the same Clean" (4/13/1700, MCC 1905:I 104-105). The

Common Council usually specified cleaning to the "sandy Bottom" (5/26/1702 , Ibid.: I:191; 2/15/1705, Ibid.: I 294), or "A Sandy foundation" (12/9/1703, Ibid.: I 250). Logically, this would mean that each time a dock or slip was cleaned some of the river bottom beneath the river mud and silts would be impacted by the procedure. One study of a number of 19th-century ships which burned and/or sank at Manhattan docks concluded that all were either raised or removed, partly because of the pressure for usable dockspace (Historic Sites 1977).

Dredging activity was regularly recorded in the Department of Docks annual reports during the late-19th and early-20th centuries (e.g., Docks 1899:photos n.p.; 1937:15; Marine and Aviation 1950:14). According to the 1906 report, channels between the piers in the APE were dredged to varying depths between 26 and 35 feet below mean high water (Docks 1906:382-385). Furthermore, as old piers were removed and new piers constructed, dredging of the pier location consistently followed the removal of the "old works" and preceded the deposit of a new riprap foundation. Dredging reports also record the square yardage of "mud" and "crib" removed (Ibid.:175-181; 382-385).

Research by archaeologists Kardas and Larrabee concluded that between 1929 and 1976 the Army Corps of Engineers conducted at least 80 dredging and obstruction removal projects along the Manhattan riverfront. As test cases, the evidence regarding several well-known 19th-century wrecks which burned and/or sank at Manhattan docks were also examined, and all were either raised or removed to return the piers to revenue-producing status (Historic Sites 1977).

Dredging would most certainly have impacted archaeological resources on the riverbottom (and therefore below mean low water). In general, however, the impact of dredging upon potential archaeological resources, especially the most deeply buried precontact resources, is not precisely known, since the exact depths and frequency of the activity are not always recorded, particularly prior to the 20th century.

Pier Construction, Modernization, and Reconstruction

Manhattan's East River piers were constantly being updated and altered through time to meet the demands of more and larger vessels (Graham 1873). A comparison of historical maps shows major changes in the numbers and configuration of East River piers between 1891 and the 1910s, by which latter period the piers approximated their modern configuration. Some piers were removed and their locations became channels between enlarged piers; others were simply enlarged and renumbered (Viele 1865; Bromley 1891; Sanborn 1905; WPA 1936-1940) (e.g., Figures 8, 18).

The earliest piers that reached as far into the East River as the APE were recorded on maps from the closing years of the 18th century (Directory 1789; Taylor Roberts 1797; Commissioners 1811), corresponding to the reconstruction of New York City's pier facilities following the depredations of the Revolutionary War. As described earlier in this report, construction methods during that period entailed preliminary dredging, followed by construction utilizing combinations of piles and crib or cobb work.

Civil engineer Carleton Greene's 1917 treatise on the construction of "modern" (i.e., late-19th to early-20th century) American piers and wharves describes not only the driving of wooden piles,

but site preparation prior to pile-driving. This included measuring the depth of the "hard bottom" by means of wash borings and test piles, in order to determine the length of piles necessary. At the time, piles up to 60 feet in length were easily obtainable, and various species of pine were considered the most durable and economical. Lengths of 60 to 85 feet were difficult to come by, and the engineer would sometimes have to settle for inferior spruce. If piles greater than 85 feet were needed, splicing was necessary, although the availability of reasonably-priced fir piles of 110 feet in length, shipped from the Pacific Coast via the Panama Canal (completed in 1914) were anticipated (Greene 1917:28-33; Bone 1997:117).

Piles were generally driven down to rock or hardpan. Where the hard bottom was too deep to be reached, the pile was driven until the friction and cohesion between the mud/sand and the pile was so great that the pile could be driven in no deeper. Such conditions were frequently encountered along the Hudson shoreline, where "friction piles" had to be driven to depths of about 100 feet (Bone 1997:117).

Dredging was generally advised before testing. Greene noted an example from New York in which, prior to the driving of test piles, the center line of the pier was dredged to a depth of 15 feet, and 30 feet at the sides, although he does not provide the specific location. Where the water depth is not greater than 25 feet, Greene notes that "ordinary wooden piling" has a diameter of 14 to 16 inches. In deeper waters, or where the piles need additional support, riprap or broken stone not greater than 16 inches in any dimension, or round cobbles not greater than 6 inches in diameter are placed before the piles are driven (Greene 1917:28-33).

Greene reports that the New York City Department of Docks follows the principles he describes "with the greatest thoroughness." Specifically, once the slips alongside the piers were dredged, pine piles were driven in a combination of the "single-pile" and "double-pile" row systems. Transverse rows of single piles were placed 10 feet apart. Within the single-pile row the piles were spaced 6 feet apart from center to center. The outer three rows of piles were doubled, and the number of piles in each row were doubled, resulting in a spacing of 2.5 feet, with double rows spaced about 23 feet apart. Additional white oak piles would be placed as fenders at the outer corners of the pier (Greene 1917:34, 38, Figs.1, 2) (Figure 9).

The annual reports of the Department of Docks support Greene's outline of the construction process, as they record the expenditures involved in replacing existing old piers in five steps: "Removal of old work"; "Dredging"; "Rip-rap foundation"; "Pier proper"; and "Shed." Records of completed dredging programs record not only the volume of mud, but also the volume of "crib" removed from the channels (Docks 1906:175-181; 382-385).

In addition to the impacts of dredging for pier construction, the driving of thousands of piles throughout the outboard portion of the APE would have impacted potential archaeological resources which were then submerged, and now for the most part are below the water table.

Bulkhead Wall Construction

Civil Engineer Greene also describes the evolving building methods for the construction of the East and Hudson River bulkheads and associated structural systems inaugurated in 1871 by the

New York City Department of Docks (Bone 1997:99,102).[6] In the original bulkhead wall design of 1876, as well as modifications to 1899, the concrete and masonry bulkhead itself only extended about 15 feet below mean low water (Figures 10, 11). Because of the great depth of mud—in some places up to 170 feet deep—along the Manhattan shoreline, the bulkhead had to rest on piles, even though the piles could not extend to the hard bottom in all cases. According to Greene, the river mud was dredged "for a width of about 85 feet to a depth of 30 feet, more or less, depending on the consistency." According to Greene's schematic drawings, this width of dredging extended an equal distance on each side of the proposed bulkhead, therefore, approximately 42.5 feet out into the riverbed. Into that dredged surface the piles were driven, and the open spaces filled in with cobbles and riprap, to serve as a base and support for the concrete and masonry bulkhead (Greene 1917:88-94).

Where rock was not particularly deep, that is, about 40 feet or fewer below mean high water (mhw), or when the "hard bottom" was sufficient to keep the piles stationary without the addition of riprap, concrete was placed directly on the rock or atop the piles in the hard bottom. This still required the removal of mud, silt, sand, and clay through dredging so that the constructions could rest on the firm, relatively level surface. Greene's schematic drawings these bulkhead walls show greater horizontal impact on extending inland on landward side of the wall (greater than 25 to 30 feet), than that extending from the wall into the river (9 to 17 feet), although both are substantial (Greene 1917:62-65) (Figures 10, 11). Since dredging is not exactly a precise art, a conservative estimate of 20 feet for the minimum horizontal distance of impact will be employed in evaluation.

Outboard Segment Evaluations

Segment 3: Broad Street through Old Slip Outboard of the Bulkhead

The outboard sections of Segment 3 are limited to a narrow strip on the river side of the existing bulkhead, where the proposed esplanade would be extended out over the water, via a loop extending into the East River from the west line of Broad Street to approximately Vietnam Veterans Plaza (formerly Coenties Slip). This 20-foot wide structure will be referred to as the "Archipelago" (Figure 1). It is to be supported on new pilings driven into the riverbed outside the bulkhead. For the purposes of this discussion, this section of the APE will be arbitrarily defined as an area running 540 feet along the existing bulkhead from the line of the west side of Broad Street to the centerline of Vietnam Veterans Plaza, and extending between 0 and 105 feet from the current bulkhead. East of this Archipelago section, the area evaluated will extend between 0 and 25 feet from the river side of the bulkhead, beginning at the center line of Vietnam Veterans Plaza, and extending eastward to the west side of Old Slip.

Historical Period Usage

The outboard section of Segment 3 remained an unfilled and unbuilt upon section of the East River until ca.1800. Landfill, including wharves and piers, had not reached the outboard location by the time of the 1797 Taylor-Roberts Plan, which still shows open water there (Taylor-Roberts 1797). By the time of the 1811 Commissioners' Plan, fill activity in the vicinity had reached the

[6]For the historical background of the East and Hudson River bulkheads, see the discussion in the Historical Period Overview section of this report.

present roadbed of South Street, and eight piers are mapped extending from the shoreline through this outboard section of the APE. These were the two piers on the sides of Exchange Slip at the foot of Broad Street; three piers associated with Coenties Slip, one at the foot of each shore, and the third or "Middle Pier" extending through the center. Two piers stood adjacent to the foot of old Cuylers Alley or Lane, between present Coenties and Old Slips; and one extended from the western side of Old Slip, called Cruger's Wharf (Commissioners' Plan 1811). Given the approximate year of construction (c.1800), these wharves would most likely have been built utilizing cobb and/or crib construction techniques.

This situation remained substantially unchanged through ca. 1844 (USC&GS 1844). The 1849 detailed maps of East River wharves and piers by Michael Alvord show the piers of the early part of the century replaced with longer, more capacious constructions, yet in the same locations. In some cases the piers appear to have been lengthened, or in the process of being lengthened (Piers 8 through 11, east side of Coenties Slip through the west side of Old Slip) rather than replaced. It is likely that this change was not only in response to the increasing size of ships, but also to the encroachment on the piers by landfilling activities. Also by 1849, the East River piers were designated by official numbers, and the piers in this APE segment were numbered consecutively from 4 (along Broad Street) to 11 (on Old Slip) (Alvord 1849).

The next major development in this part of the APE was the construction of the modern bulkhead system begun in 1871 by the New York City Department of Docks. The bulkhead eventually defined the present landward boundary of this outboard segment of the APE. According to the Department's own 1873 map, the bulkhead project also involved substantial landfill, the demolition and removal of each of the existing piers within the APE, and the construction of new piers in slightly different locations following Department of Docks specifications[7] (Graham 1873).

By 1899, with work in progress on the new bulkhead from Broad Street to the east side of Coenties Slip, "Old [Pier] 4" and "Old 5" on the west and east sides of Broad Street had been removed, and "New 4" was under construction in the former channel between the two. "Old 6," along the west side of Coenties Slip was being replaced with "New 5;" while "Old 7" and "Old 8," at the center and on the east side of Coenties Slip, were simply being lengthened and renumbered as "New 6" and "New 7" (Bromley 1891; Docks 1899:115, Map n.p.). According to East River navigational charts, this task was completed to the center of Coenties Slip by 1903 (USC&GS 1906) (Figure 19).

Meanwhile, there was no indication of the timetable for the removal of the remaining old piers in this outboard section of the APE, i.e., "Old 9" and 10 near the foot of Cuylers Lane, and Old Pier 11 on the west side of Old Slip (Docks 1899:115, Map n.p.; USC&GS 1906) (Figure 19). These were still present in ca.1905 (Sanborn 1905, Figure 8), but the three piers were removed and replaced by New Pier 8 at the foot of Cuylers Lane, and New Pier 9 on the west side of Old Slip by the time the 1919 harbor chart was published. At that time the new bulkhead had been completed along the length of this part of the APE as well. Six piers extended from the bulkhead

[7]This has been described in more detail earlier in this report, in the Types of Recorded Subsurface Disturbance section, under the heading Pier Construction, Modernization, and Reconstruction.

through this outboard segment of the APE, Pier 4 at the foot of Broad Street; Piers 5, 6, and 7, at the west side, center, and east side of Coenties Slip; and Pier 8 at the foot of Cuylers Lane (USC&GS 1919; 1924).

With the decline of the East River waterfront, some of the piers fell out of use, were abandoned, and/or removed. On the 1959 harbor chart, Piers 5 and 7 (east and west sides of Coenties Slip) are outlined in dashed lines, and along with Pier 4 (foot of Broad Street) disappear by 1969. Pier 9 on the west side of Broad Street was demolished by 1959 and rebuilt west of the APE. A sunken wreck and an accumulation of river mud—signifying neglect through the cessation of dredging—is recorded in the eastern edge of this segment of the APE in both 1959 and 1969. By 1969, only two piers remain in this part of the APE, Pier 6, at the center of Coenties Slip, and functioning as a heliport; and Pier 8 at the foot of Cuylers Lane (USC&GS 1959; 1969). Pier 8 was truncated before 1979 (Figure 22), and based on an aerial photo was removed completely by 1996, although it still appears in truncated form on the 2000 chart. At present, only Pier 6 still stands in the APE (NOAA 1979, 2000; Oasis Map 1996; 2004).

Potential Archaeological Resources
This section of the APE Segment 3 is presently under water, and was never incorporated into the fast land of Manhattan Island during the historical period. Its land use history indicates archaeological potential for submerged precontact remains; 19th-century piers (from as early as ca.1800); and riverbottom deposits such as shore and ship discards (the last category does not include sunken ships or ships used as landfill). This archaeological potential, however, may have been negated by subsequent disturbance.

Disturbance
According to Rock Data Map soil boring logs dating from the 1930s, in this section of the APE the underlying rock stratum is fairly shallow, between approximately -22 feet (below mhw[8]) at the location of Pier 4 at the foot of Broad Street, and declining to about -38 feet at Pier 9 on the west side of Old Slip (WPA 1965 Sheet 1; See Appendix: Soil Borings 7, 8, 10-19, 29-31, 45-54, 221).

Following civil engineer Carleton Greene's description of bulkhead construction, this would mean that piles or even the foundations of the bulkhead itself would rest directly on rock. The preparation required to achieve a firm river bottom surface (rock or hard pan) for bulkhead construction would have necessitated the removal of mud, clay, and sand strata, which would include strata with archaeological potential, extending horizontally at least 20 feet riverward from the location of the proposed bulkhead wall (Greene 1917).

According to Greene, as well as the reports of the Department of Docks, with the construction of the new bulkhead, the old generation of piers (or at least the adjacent sections of these piers) was removed and the pier locations dredged to remove not only accumulated mud, but also the old piers' support structure. Preparations for the construction of the new piers involved further dredging, and subsequent to their completion, the channels between the piers were regularly dredged as part of normal maintenance (Docks 1906; Greene 1917).

[8] The elevation datum is mean high water, with mean low water at -4.85 feet.

Not only was dredging part of regularly performed maintenance, but dredging depths increased through time, as larger ships with deeper drafts became the norm, necessitating deeper docks and slips. The Harbor Commissioner's maps of 1857 provide the channel depths in the waters adjacent to the piers in the APE (Figure 13). They are considerably shallower than they were in the early 20th century, and particularly shallow as one neared the existing bulkhead and probably the piers on either side of the channel. In only one location was the depth of water greater than 9 feet, at the foot of Cuylers Lane, where it was 13 feet deep (Harbor Commissioner 1857). If, as is likely, these numbers refer to mean low water (mlw), the channel bottoms were less than 14 feet below mhw.

As recorded by the 1906 Department of Docks report, the channels and future pier locations between Whitehall and Old Slip were dredged to between 24.85 and 32.85 feet below mhw (Docks 1906:382-385), which would have impacted between 10 feet and more than 18 feet below the recorded 1857 bottom.

By the 1930s, however, the soil borings record sand/gravel/clay strata in this section of the APE with surfaces at a *higher* elevation (from Boring #14 -15.9 feet at Pier 5, to Boring #46 -23.9 feet at the eastern side of Coenties Slip) than the shallowest dredging depth. The locations in which the sand/gravel/clay strata occur at more than 25 feet below mhw (east of Coenties Slip), correspond to the areas in which dredging to 32.85 feet (below mhw) was prescribed. Only in one case, on the location of Pier 9, does the top of the sand/clay/gravel strata appear at a greater depth (Boring #54 -34.4 feet).

This scenario would suggest that roughly 10 to 18 feet or more of the 1857 river bottom was removed through dredging. Therefore, the sand/clay/gravel strata reported in more modern boring logs are largely modern, river-borne deposits, or at least strata disturbed and redeposited along the river side of the bulkhead during various construction and dredging episodes that took place in this part of the APE subsequent to the bulkhead's completion.

This would also account for the relative thinness of the sand/clay/gravel strata which lies below the river mud and above the rock stratum in much of this section of the APE. If it represents a combination of glacial deposits from the last Ice Age and sandy river deposits from the pre-pier period, it is surprisingly thin, generally less than 5 feet thick, and as little as 0.2 feet thick (Boring #16 at Pier 5). The places in which the sand/clay/gravel strata are from 5 to 11.3 feet thick tend to be beneath existing 20th-century piers, where the trapping effect of the piles and the difficulty of removal, as well as neglect, would make these accumulations an expected occurrence.

Potential Archaeological Sensitivity

Categories of potential archaeological remains for this section of the APE were submerged precontact remains, 19th-century piers, and riverbottom deposits from shore and ship discards. Documented dredging activity indicates that riverbottom deposits were systematically removed from these locations to facilitate the functioning of the East River piers and slips. Deep dredging was also the normal precursor of new pier and bulkhead construction during the late-19th and early-20th centuries. In many cases the shallow rock stratum in this section of the APE (less than 24.85 feet below mhw) would have meant that continual attempts to dredge to these depths

would have not only removed the river mud stratum, in which historical archaeological resources would be expected, but also severely impacted the sand/clay/gravel strata.

These sand/clay/gravel strata, between the river mud and rock, would be the expected location of the preinundation land surface, as well as the locus of precontact archaeological sensitivity, if undisturbed. Rather than in situ preinundation glacial materials, data suggests that these strata are a combination of both modern deposits and disturbed secondary deposits. As a result, they would no longer be archaeologically sensitive for precontact cultural materials.

Segment 5: Pier 15 and Adjacent Channels

APE Segment 5 lies completely outboard from the current bulkhead, between current Piers 14 and 16. A new Pier 15 will be reconstructed on the same location as the former Pier 15, the location of which is currently identified by several surviving piles. New Pier 15 will require the driving of new piles, but will have fewer piles than the existing pier, in order to enhance water flow and scouring for underwater habitats. To permit the berthing of ships, dredging to approximately 25 feet below mhw (20 feet below mlw) will be performed in the slips to the north and south of the Pier 15. For the purposes of this evaluation, the dredged area will include the pier slips extending south to Pier 14, in line with the south side of Maiden Lane, and in the north to Pier 16, east of the line of John Street.

Historical Period Usage

On the 1797 Taylor Roberts Plan, none of the piers or landfill adjacent to the Pier 15 segment extend beyond the west (inland) side of present South Street. Substantial land filling had occurred by the time of the 1811 Commissioners' Map. South Street had been opened, and three piers, the slips to the north and south of Pier 15, had been constructed between 1797 and 1811. These were along the south side of Maiden Lane, at the foot of Fletcher Street, and just south of John Street/Burling Slip (Commissioners 1811). From their period of construction, they were most likely built using cobb/cribb techniques, which is confirmed by the 1903 pier and dock map from the South Street Seaport Museum Library, which notes crib cell locations (SSS 1903a).

By the time of the 1849 Alvord pier and wharf maps, these three old piers were numbered 18, 19 and 20, respectively from south to north, and had each been lengthened by more than 100 feet to approximately 400 feet (Alvord 1849) (Figure 14). It is likely that this change was not only in response to the increasing size of ships, but also to the encroachment on the piers by landfilling activities.

The next major development in this part of the APE was the construction of the modern bulkhead system begun in 1871 by the New York City Department of Docks. The bulkhead eventually defined the present landward boundary from which Pier 15 extends. According to the Department's own 1873 map, the bulkhead project also involved substantial landfill, the demolition and removal of the old piers adjacent to the proposed new Pier 15, and the construction of the new piers following Department of Docks specifications[9] (Graham 1873). This work was still in progress in 1906 (Docks 1906:176,177).

[9]This has been described in more detail earlier in this report, in the Types of Recorded Subsurface Disturbance section, under the heading Pier Construction, Modernization, and Reconstruction.

The 1905 Sanborn atlas depicts current Pier 15 under construction, extending approximately 560 feet from the new bulkhead. In the eastern pier slip, Old Pier 20, a freight pier of the N.Y. & Texas Steamship Company Mallory Line, was still in service, almost abutting Pier 15 on the east. When completed, new Pier 15 was occupied by the same company. Old Pier 19 in the western pier slip had already been removed, and Old 18 at the edge of the western pier slip, had been removed and was being replaced by current Pier 14, which was under construction (Sanborn 1905). The Department of Docks annual report of 1906 records dredging operations in the western pier slip between present Piers 14 and 15, where 15,205 cubic yards of mud were removed in April 1906, to a depth of 32 feet below mhw (27 feet below mlw) (Docks 1906:228, 384).

To the east of new Pier 15, there were seven recorded dredgings performed during August and September of 1906, all related to the removal of "Pier Old 20." This flurry of activity seems to be due to the fact that the boundary line between the Department's Maiden Lane and Fulton Sections ran along the northern edge of Pier Old 20.[10] From the Old 20 location to new Pier 15, in the Maiden Lane Section, 8,377 cubic yards of mud were removed, as well as 10,819 cubic yards of crib from the old pier, leaving a slip with a depth of 26 feet below mhw (21 feet below mlw) (Docks 1906:384).

In the Fulton Section to the east of Old 20 (the eastern pier slip of the present APE), only 165 cubic yards of mud were removed, and 503 cubic yards of crib, also resulting in a slip with a depth of 26 feet below mhw (21 feet below mlw) (Docks 1906:384). Apparently crib from Old 20 had fallen into the Fulton Section, and less dredging for river mud was necessary, since Old 20 had been in operation and the slip maintained through at least 1905.

The 1919 nautical chart is the earliest available which depicts new Pier 15 alone, with old piers 18, 19, and 20 removed (USC&GS 1906; 1919). Pier 15 was operated by the United Fruit Company during the 1920s (Bromley 1921; Sanborn 1928), which apparently had 1-story buildings constructed on either side of the pier, parallel to South/Marginal Street, and extending 50 feet over the water beyond the bulkhead by the 1950s (Sanborn 1955; USC&GS 1959) Subsequent nautical charts through the year 2000 record the accumulation of river muds and silts in the channels on either side of the pier, suggesting that Pier 15 ceased to be an active pier, and the channels were left undredged (USC&GS 1969; NOAA 1979; 2000) (Figures 20, 22).

Potential Archaeological Resources

The Pier 15 section of the APE is presently under water, and contains several remaining piles of the former Pier 15, which mark its previous outlines. The location has never been incorporated into the fast land of Manhattan Island during the historical period. Its land use history indicates archaeological potential for submerged precontact remains and riverbottom deposits such as shore and ship discards (the last category does not include sunken ships or ships used as landfill). This archaeological potential, however, may have been negated by subsequent disturbance.

[10]Technically, the official boundary was the southern line of Burling Slip, which was the same as the northern edge of Pier Old 20.

Disturbance

According to Rock Data Map soil boring logs dating from the 1930s, in the underlying rock stratum beneath Pier 15 is fairly shallow, between approximately 34.9 feet below mhw[11] (Boring #276). Soil borings from the adjacent channels are quite different, however, with rock ranging from -143.5 to -167.6 feet (below mhw) (WPA 1965 Sheet 4; See Appendix: Soil Borings 24, 26, 27, 275, 276).

Following civil engineer Carleton Greene's descriptions of pier and bulkhead construction for locations in which a hard bottom was greater than 40 feet deep, preparation involved dredging to remove previous pier and bulkhead works, and the deposit of riprap or broken stone ("not greater than 16 inches in any dimension") to provide stiffening for wooden piles. Dredging and a "rip-rap foundation" for Pier 15, as well as adjacent Piers 14 and 16 are recorded in the 1906 Department of Docks report (Docks 1906:177,178). It is probable that the greater than 100-foot discrepancy between the depth of rock at Pier 15 and in the adjacent channels indicates the boring auger's encounter with the rock used in construction of the pier (Greene 1917).

There is no record of earlier piers on the present Pier 15 location, but to prepare the location for the deposit of stone and pile driving would have involved dredging, as noted in 1906. Soil boring #276, performed after the construction of the present pier, records the depth of water at 22 feet below mhw, with a stratum of river silt, sand and pebbles to 34.9 feet below mhw, where rock was encountered. The silt stratum is obviously a modern river accumulation, since the stratum beneath it is rock, and not any sort of sandy river bottom or glacial deposit.

Although channel depth on the Pier 15 location and in the pier slip to the west was between 14.5 to 21 feet below mhw in 1857 (Harbor Commissioner 1857) (Figure 14), by 1906 routine dredging specified a depth of approximately 32 feet below mhw (Docks 1906), and the 1906 navigational chart records the channel depths on the site of present Pier 15 at between 28 and 30 feet below mhw (USC&GS 1906) (Figure 20), also indicating that the silt stratum beginning at 22 to 28 feet below mhw in the 1930s is a post-construction accumulation.

Similarly, channel depths to the east of the Pier 15 location ranged from 12 to 29 feet below mhw in 1857 (Harbor Commissioner 1857) (Figure 14), where 1906 dredging records depths of 26 feet below mhw, indicating the mud stratum beginning at 15 to 17 feet below mhw is a post construction accumulation.

Due to the exceptionally deep bedrock in this area, dredging would necessarily have been deeper than the standard depth, and the rock, beginning at 34.9 feet below mhw, would have been placed to support the pier's deep piles. Without additional soil boring logs on the Pier 15 location, it is difficult to estimate the depth below -34.9 feet to which the dredging disturbance extends.

An additional disturbance to the Pier 15 segment location would have occurred adjacent to the modern bulkhead, built prior to the construction of Piers 14, 15, and 16. In this location where the bulkhead piles could not rest on the hard bottom due to its great depth, dredging to at least 30

[11] The elevation datum is mean high water, with mean low water at -4.85 feet.

feet, extending approximately 42.5 feet out into the riverbed prior to the driving of piles would have been performed (Greene 1917).

Strata greater than 30 feet below mhw on the location of Pier 15, as well as location of Old 18 and 19 in the western pier slip, and Old 20 in the eastern pier slip would have been further impacted by pile driving. For late 19th- and early 20th-century piers such as Pier 15, Greene notes that normal pile diameters were between 14 to 16 inches, and were driven in rows of varying configurations and spacings, depending on their location in the pier structure. This would rang from a maximum of 15 feet between double pile rows to as little as 5 feet between single pile rows.[12] The distance between piles within the row was even smaller (Green 1917).

Potential Archaeological Sensitivity
Categories of potential archaeological remains for this section of the APE were submerged precontact remains and riverbottom deposits from shore and ship discards. Documented dredging activity indicates that pre-20th century riverbottom deposits were removed from the Pier 15 segment location prior to the pier's construction, and therefore, the location would no longer be sensitive for this category of potential cultural materials. Because the only projected impact to the present pier slips is a proposed dredging to 25 feet below mhw in locations that were already dredged to a depth of 26 to 32 feet below mhw in 1906, no potentially sensitive strata would be impacted by this operation.

It is not clear to what depth beyond approximately 34.9 feet below mhw historical dredging operations have penetrated, and since dredging in adjacent channels has removed deposits to a similar depth, it is not clear to what depth the preinundation surface, which would have been potentially sensitive for precontact cultural remains, has been impacted by dredging. Dredging, however, is not the only modern impact in this part of the APE. Closely-spaced piles driven during pier construction would have severely perforated any surviving potential precontact remains, destroying their potential archaeological sensitivity. As a result, the Pier 15 location itself would no longer be archaeologically sensitive for precontact cultural materials. Proposed dredging operations in the present pier slips will not extend below depths already dredged during the 20th century, and therefore would not impact any theoretically surviving precontact cultural materials in these locations.

Segment 6: New Market Building, Pier 18, and Proposed Marina[13]
Segment 6 is an outboard location which lies beyond the present bulkhead from the line of Beekman Street to the line of Dover Street. The existing New Market Building will be demolished, and the existing Pier 18 will be reconstructed to enhance water flow and scouring for underwater habitats. A new structure will be built on the reconstructed pier. The proposed repair/reinforcement or reconstruction of the New Market Pier is anticipated to include the driving of new piles.

[12] This is calculated from Greene's measured drawing, which measures from the center line of the pile or pile cluster (Greene 1917:7).
[13] As noted above, Pier 18 is referred to as the New Market Building Pier within the East River Waterfront Esplanade and Piers EIS and the Programmatic Agreement.

To the north of the New Market Building and Pier 18 a new, approximately 97-slip marina is proposed, with a wave attenuator along the east side of the marina basin, and a breakwater constructed along the north side of the basin. Approximately 350 piles would be driven, to which the marina, wave attenuator, and breakwater would be attached.

Historical Period Usage

The outboard section of Segment 6 has been under the waters of the East River throughout the historical period. Prior to landfilling operations during the 18th century, the shoreline was along the eastern side of present Water Street, about two blocks to the west (Viele 1865) (Figure 5).

A comparison of historical maps shows no pier construction in Segment 6 until some time between 1797 (Taylor Roberts 1797) and 1811 (Commissioners 1811). The 1811 Commissioners Plan records the shoreline bulkhead on the riverside of present South Street, with no Marginal Street present. Five piers extended through the location of the New Market Building, present Pier 18, and the proposed marina. The East River Piers maps of 1849 identify the former piers as Pier 23, which was in the line of Beekman Street; Pier 24, about 70 feet south of the line of present Peck Slip; Pier 25, at the center line of Peck Slip; Pier 26, at the northern line of Peck Slip; and Pier 27, on the south side of the line of Dover Street (Alvord 1849) (Figure 15). Given the approximate year of construction (ca. 1800), these wharves would most likely have been built utilizing cobb and/or crib construction techniques. Pier and dock maps from 1903 in the collection of the South Street Seaport Library confirm this assessment, showing the piers supported on a series of crib cells (SSS 1903a; 1903b).

Plans for the construction of the new bulkhead by the Department of Docks, as detailed in the 1873 map, included the replacement of old Piers 23 through 27, with the proposed piers generally in the same locations (Graham 1873). But this did not take place immediately. New Pier 19 (replacing Pier 24 on the "lower side of Peck Slip") and new Pier 20 (replacing Old 25 and 26 at central and northern Peck Slip) were in use only by 1905. New Pier 18 (replacing Pier 23 at Beekman Street) was not completed until 1906, as described in the Department of Docks 1906 annual report, and bulkhead construction in this area was still in progress in 1906. Pier Old 27 was still in operation in 1905 (Sanborn 1905; Docks 1906:229). By the time of the 1919 harbor chart, the remaining old piers had been removed, the current bulkhead completed, and modern piers 18, 19, 20 and 21 had been completed through this segment of the APE (USC&GS 1919).

The area which presently hosts the New Market Building was empty of structures on the 1891 atlas (Bromley 1891), but in 1903 was labelled an "Oyster Basin." In that same year there was no Marginal Street, and a crib bulkhead was mapped along the southerly line of South Street, outside Segment 6 of the APE. A series of small, irregular structures, which seem to be shops or stalls, extended from the old bulkhead line out into Segment 6 and the oyster basin (SSS 1903b).

The 1906 Docks report notes a temporary platform built in 1906 in the APE between Piers 18 and 19 for the Fulton Market Fishmongers' Association (FMFA), where "the fish business is now temporarily carried on," while the FMFA awaited the completion of their new structure between Piers 17 and 18, outside the APE.[14] Meanwhile, the New York Wholesale Fish Dealers'

[14]This structure is a New York City Landmark, and is sometimes referred to as the "Tin Building."

Association (NYWFDA) had submitted plans for a two-story steel market on a new platform to be erected in the APE between Piers 18 and 19. This was the predecessor of the current New Market Building. Modern photographs of the present building and platform clearly show that it is built on piles (e.g., *New York Times* 2006). Another piscine organization, the New York Independent Fish Dealers' Association, was also granted a permit for a two-story steel shed (20 feet by 100 feet) abutting the west side of the NYWFDA structure, within the bulkhead, outside Segment 6 (Sanborn 1905; Docks 1906:229).

Harbor charts record little change to this arrangement through 1969 (USC&GS 1919; 1924; 1959; 1969), although by 1969 the accumulation of river deposits between Piers 18 and 19 in Segment 6 is recorded, suggesting lack of maintenance and disuse of the piers.

A platform was constructed in the outboard area between Piers 20 and 21 from Peck Slip to Dover Street between 1919 and 1924 ((USC&GS 1924), for structures relating to the B&O Railroad's use of its freight pier, Pier 20. This platform, which supported a 1-story structure and would have been constructed on piles, extended about 40 feet beyond the bulkhead (Sanborn 1928; Bromley 1921).

By the time of the 1979 chart, Piers 19, 20, and 21 from the north side of the New Market Building to Dover Street had been removed (Figure 22). With the reconstruction and reconfiguration of the South Street Seaport and Fulton Fish Market in 1983/1984, the channel between Piers 17 and 18 became the location of the Pier Pavilion of Pier 17 (White and Willensky 2000:35), and the current New Market Building occupied additional portions of Pier 18 and the slip east of Pier 18, as recorded in harbor charts by 1986 (NOAA 1982; 1984; 1986). Aside from the continued accumulation of river sediments adjacent to the New Market and pier, no further changes are recorded to Segment 6 of the APE in subsequent harbor charts and aerial photographs (NOAA 1990; 2000; Oasis 1996; 2004).

Potential Archaeological Resources

The outboard section of Segment 6 of the APE is presently under water, and contains the still-standing Pier 18 and the New Market Building. The outboard section was never incorporated into the fast land of Manhattan Island during the historical period. Its land use history indicates archaeological potential for submerged precontact remains and riverbottom deposits such as shore and ship discards (the last category does not include sunken ships or ships used as landfill). This archaeological potential, however, may have been negated by subsequent disturbance.

Disturbance—Pier 18

Soil borings conducted in and adjacent to the Segment 6 outboard locations in 1934 and 1950, subsequent to c.1906 bulkhead and pier construction, note extremely deep rock strata, generally between 144 and 178 feet below mhw (WPA 1965 Sheet 5:#1-7, #124, #126). Three exceptions (#1, #2, #3) encountered rock between 47 and 78 feet below mhw.

Following civil engineer Carleton Greene's description of pier construction, and of bulkhead construction for locations in which a hard bottom was greater than about 40 feet deep, preparation involved dredging to remove previous pier and bulkhead works, and the subsequent deposit of riprap or broken stone ("not greater than 16 inches in any dimension") to provide

stiffening for the wooden piles (Greene 1917). "Removal of old work" (i.e., old Piers 23 and 24), dredging and a "rip-rap foundation" for new Piers 18 and 19 is recorded as an expenditure in the 1906 Department of Docks report (Docks 1906:178).[15] It is probable that the approximately 70- to 100-foot discrepancy between the depth of rock in three boring logs from Segment 6 may have resulted from the boring auger's encounter with the rock used in construction of the bulkhead, especially since these three soil borings were performed along the modern bulkhead line.

Modern Pier 18 was built in approximately the same location as old Pier 23, although slightly to the east of the earlier pier. As a result, it occupied part of the channel between old Piers 23 and 24. In that location, the 1857 Harbor Commissioner's maps record pier slip depths between 15 and 33 feet below mhw, the depth generally increasing with distance from the bulkhead (Harbor Commissioner 1857) (Figure 15). By 1906, this had been deepened to between 21 and 38 feet (USC&GS 1906) (Figure 20), a removal of between 0 to 6 feet of the slip-bottom deposits. According to the 1906 Docks report, the slips between the piers in the outboard APE underwent routine dredging to depths between 26 and 35 feet below mhw, figures which fall neatly into the range recorded on the 1906 chart. This appears to be the standard range for East River pier slips up to that time (Docks 1906:382-385), and the shallower of the depths, 26 feet below mhw, is a conservative estimate for dredging depths in this section of the APE.

Additional disturbance from the removal of old Pier 23, and the construction of new Pier 18, would have further impacted this location. Following Carleton Greene's description of pier construction as a guideline for the construction of Pier 18, preparation involved dredging to remove previous pier and bulkhead works, and the subsequent deposit of riprap to provide stiffening for the wooden piles (Greene 1917). Department of Docks reports generally record expenditures for the "Removal of old work" and dredging of the specific locations of the old piers, which was then followed by additional dredging and a "rip-rap foundation" for the new piers (See e.g., Docks 1906:178-179).

Strata greater than the general slip depth of 26 feet below mhw would have been further impacted by pile driving. Greene notes that normal pile diameters were between 14 to 16 inches, and were driven in rows of varying configurations and spacings, depending on their location in the pier structure. This would range from a maximum of 15 feet between double pile rows to as little as 5 feet between single pile rows.[16] The distance between piles within the row was even smaller (Green 1917).

Disturbance—New Market Building

The New Market Building extends approximately 230 feet riverward beyond the modern bulkhead, and is partially on Pier 18 (covered in the previous paragraphs) and includes part of the former Pier 19 location in its northern corner.

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[15]Although one of the 1934 boring logs actually records 6 feet of rip-rap under Pier 18, the fact that there is no stratum of river deposits atop the rip-rap suggests it was not deposited in the construction of the pier 28 years earlier in ca. 1906 (WPA 1934 Sheet 5:#4).

[16] This is calculated from Greene's measured drawing, which measures from the center line of the pile or pile cluster (Greene 1917:7).

The 1857 Harbor Commissioner's maps records pier channel depths in Segment 6 at the location of the New Market Building (between old Piers 23 and 24, and east of old Pier 24) between 11 and 16 feet below mhw, with the south corner of the New Market Building location at 33 feet below mhw (Harbor Commissioner 1857) (Figure 15). By 1906, the depths were between 16 and 23 feet below mhw, with the south corner of the New Market Building location still at 33 feet below mhw (USC&GS 1906) (Figure 20). This indicates the removal of as much as 5 feet of the pier slip bottom deposits, and at the very least, regular dredging to maintain slip depth.

According to the 1906 Docks report, the slips between the piers in the outboard APE underwent routine dredging to depths between 26 and 35 feet below mhw. This appears to be the standard range for East River pier slips up to that time (Docks 1906:382-385), and the shallower of the depths, 26 feet below mhw, is a conservative estimate for dredging depths in this section of the APE. The shallower depths on the 1906 harbor chart may be accounted for by the location of the sounding abutting the bulkhead, where river mud would normally accumulate.

Using Carleton Greene's description of pier construction as a guideline for the construction of the platform for the present New Market Building (as well as the section of the Pier 19 location), preparation involved dredging to remove previous pier and bulkhead works, and the subsequent deposit of riprap or broken stone ("not greater than 16 inches in any dimension") to provide stiffening for the wooden piles (Greene 1917). "Removal of old work" (i.e., old Piers 23 and 24, which passed through the New Market Building site), dredging and a "rip-rap foundation" for new Pier 19 are recorded as expenditures in the 1906 Department of Docks report (Docks 1906:178).

Strata deeper than 26 feet below mhw on the New Market Building location would have been further impacted by pile driving. Greene notes that normal pile diameters were between 14 to 16 inches, and were driven in rows of varying configurations and spacings, depending on their location in the pier structure. This would range from a maximum of 15 feet between double pile rows to as little as 5 feet between single pile rows.[17] The distance between piles within the row was even less (Green 1917).

An additional disturbance to the New Market Building location would have occurred adjacent to the modern bulkhead, built prior to the New Market Building. In this location where the bulkhead piles could not rest on the hard bottom due to its great depth, dredging to a depth of at least 30 feet, extending approximately 42.5 feet out into the riverbed would have been performed prior to the driving of piles (Greene 1917). Unfortunately, the single soil boring on the site of the New Market Building was performed about 34 feet from the bulkhead, close enough for the upper strata to be impacted by bulkhead construction. The boring log, however, does record over 100 feet of sand/clay/gravel strata beginning at 37.9 feet below mhw, within which could be the preinundation land surface (WPA 1965 Sheet 5: #7)

Disturbance—Proposed Marina, Breakwater, and Wave Attenuator
The proposed marina section of Segment 6 extends north from the north side of Pier 18 and the New Market Building. It runs 425 feet northward measured from the New Market Building along

[17] This is calculated from Greene's measured drawing, which measures from the center line of the pile or pile cluster (Greene 1917:7).

the modern bulkhead, and a breakwater is proposed approximately 100 feet to the north of the northern end of the marina. From the bulkhead eastward, the marina would extend approximately 400 feet eastward into the river. In addition, a wave attenuator would be constructed approximately 100 feet east of the marina, parallel with the modern bulkhead.

Marina and Breakwater Location

This proposed location formerly hosted old Piers 24, 25, 26, and 27, all removed by the early 20th century and replaced by new Piers 18, 19, 20, and 21, which with the exception of Pier 18 have also been removed. The 1857 Harbor Commissioner's maps records pier channel depths here ranging from as shallow as 15 feet below mhw near the present bulkhead, increasing in depth to between 30 and 37 feet below mhw at the ends of the piers adjacent to the river channel itself (Figure 15).

By 1906, the depths were between 11 and 33 feet below mhw, which on comparison with some parts of the proposed marina/breakwater location are deeper than in 1857, and other sections shallower (USC&GS 1906) (Figure 20). This is somewhat unusual, since the trend through time was generally to widen and deepen pier slips to accommodate larger vessels.

It is probable that the depth soundings made for the 1906 harbor chart represent a period of neglect, since bulkhead work was being conducted here through 1905, and oddly, no routine dredging activity is recorded along this particular section of the East River as it is in the adjacent sections to the north and south (Docks 1906:229).

The soil borings available for this location, performed in 1934, also show the water in the slips to be fairly shallow (extending approximately 10 to 13 feet below mhw), but these soil borings were located beneath platforms close to the bulkhead, or abutting piers, where river mud is likely to collect. The only soil boring taken beyond the disturbance zone of bulkhead construction is #13, along the west side of Pier 21 (foot of Dover Street), which records a depth to river mud of 21.5 feet below mhw (WPA 1965 Sheet 5: #9, #12, #13, #15; Appendix).

According to the 1906 Docks report, however, the slips between the piers in the outboard APE underwent routine dredging to depths between 26 and 35 feet below mhw. This appears to be the standard range for East River pier slips up to that time (Docks 1906:382-385), and the shallower of the depths, 26 feet below mhw, is a conservative estimate for dredging depths in this section of the APE. The suspiciously uniform depth of the bottom of the river mud stratum, recorded in the soil borings at a very even depth of between 35.4 and 38.4 feet below mhw over a wide area, actually argues for the deeper dredging depth of 35 feet.

Additional disturbance from pier and wharf construction would have further impacted much of the proposed marina/breakwater location. Following Carleton Greene's description of pier construction as a guideline for the construction of Piers 18, 19, 20, and 21, preparation involved dredging to remove previous pier and bulkhead works, and the subsequent deposit of riprap to provide stiffening for the wooden piles (Greene 1917). Department of Docks reports record expenditures for the "Removal of old work" and dredging of the specific locations of old Piers 24, 25, 26, and 27, which was then followed by additional dredging and a "rip-rap foundation"

for new Piers 19, 20, and 21 (Docks 1906:178-179;1914:172). Deposits labeled "Gravel" immediately beneath the river mud may represent the riprap deposit, as in soil boring log #13.

Strata deeper than the 26 to 35 feet below mhw affected by the many dredging episodes in this location would have been further impacted by pile driving. Since the soil boring logs cited for this part of the APE record rock or bedrock between 86 and 143.4 feet below mhw, and Greene notes 60-foot piles as the norm, it is likely that disturbance due to pile driving is approximately that deep below mhw. Greene also notes that normal pile diameters were between 14 to 16 inches, and were driven in rows of varying configurations and spacings, depending on their location in the pier structure. This would range from a maximum of 15 feet between double pile rows to as little as 5 feet between single pile rows.[18] The distance between piles within the row was even less (Greene 1917).

An additional disturbance to the proposed marina and breakwater location would have occurred adjacent to the modern bulkhead. In this location where the bulkhead piles could not rest on the hard bottom due to its great depth, dredging to a depth of at least 30 feet, extending approximately 42.5 feet out into the riverbed, would have been performed prior to the driving of piles (Greene 1917). This depth also conforms roughly to the depth of the sand/gravel stratum which lies below the river mud in the soil borings (WPA Sheet 5:#9, #12, #15).

Wave Attenuator Location

The proposed location of the wave attenuator, approximately 100 feet east of the marina, is in what was formerly part of the East River shipping channel, prior to the extension of the pierhead line and the construction of modern piers 18 through 21 in the early 20th century.

Following published navigational charts, the channel has been deepened by four to eight feet since the mid-19th century, likely representing the results of dredging to accommodate ships of deeper draft. The 1844 survey recorded the channel depth at between 35 and 38 feet below mhw (USC&GS 1844); and in 1906 the harbor chart notes channel depth between 38 and 41 feet below mhw (USC&GS 1906) (Figure 20). The 1979 harbor charts records the water depth in the same location at between 42 and 44 feet below mhw (NOAA 1979) (Figure 22).

No soil borings are available for this location, although its distance from the end of the 19th century piers—approximately 150 feet—in addition to regular channel dredging, the deepening of the river channel itself during the 20th century, and the exposure to the currents of the open river, suggests that discards from ship and shore would not have accumulated here. This part of Segment 6 should not be considered potentially sensitive for that category of archaeological resources.

The evaluation of potential for submerged, precontact archaeological resources is more problematic. There is no available evidence with which to determine whether channel dredging would have impacted the preinundation surface which might have precontact archaeological potential. The depth of rock encountered in nearby soil borings in the pier slips, as well as the great thickness and variety of the sand, gravel, and clay strata, extend well below river channel

[18] This is calculated from Greene's measured drawing, which measures from the center line of the pile or pile cluster (Greene 1917:7).

depths of 42 to 44 feet below mhw (e.g. WPA 1965 Sheet 5: #2-7). It is worth iterating that the Archaic Period artifacts recovered in a dredging operation 1.86 miles east of Sandy Hook were found in the upper 6.6 feet of a sand stratum at water depths ranging from 45.9 to 65.6 feet (Merwin et al. 2003:46-47). This suggests that preinundation land surfaces, and therefore precontact archaeological potential may have survived approximately 1,100 feet off the historical shoreline of Manhattan, without impacts from historical period activities.

Although it is possible that deeply-submerged precontact remains may have survived the various dredging episodes, dredging is not the only modern impact in this part of the APE. Closely-spaced piles driven during pier construction would have severely perforated any surviving potential precontact remains, disrupting their spatial patterning and the preservation in situ of associations of materials from activity areas, thus destroying their potential archaeological sensitivity.

Potential Archaeological Sensitivity—Pier 18 and the New Market Building
Categories of potential archaeological remains for this section of the APE were submerged precontact remains and riverbottom deposits from shore and ship discards. It is probable that pre-20th-century riverbottom deposits and the glacial strata beneath them were impacted and/or removed during normal pier slip and shipping channel maintenance, as well as multiple dredging episodes associated with site preparation for the construction and removal old Piers 23 and 24, and the construction of the present bulkhead, the New Market Building platform, and new Piers 18 and 19. As a result, the Pier 18 and New Market Building section of the APE is not considered potentially sensitive for riverbottom remains.

Although it is possible that deeply-submerged precontact remains may have survived the various dredging episodes, dredging is not the only modern impact in this part of the APE. Closely-spaced piles driven during pier and New Market Building platform construction would have severely perforated any surviving potential precontact remains, disrupting their spatial patterning and the preservation in situ of associations of materials from activity areas, thus destroying their potential archaeological sensitivity.

Dredging is not the only modern impact in this part of the APE. Closely-spaced piles driven during pier, bulkhead, and platform construction would have severely perforated any surviving potential precontact remains, disrupting their spatial patterning and the preservation in situ of associations of materials from activity areas, thus destroying their potential archaeological sensitivity.

Potential Archaeological Sensitivity—Marina and Breakwater Location
Categories of potential archaeological remains for this section of the APE were submerged precontact remains and riverbottom deposits from shore and ship discards. It is probable that pre-20th-century riverbottom deposits and the glacial strata directly beneath them were impacted and/or removed to a depth of approximately 35 feet below mhw during normal pier slip maintenance, as well as site preparation for the construction and removal of old Piers 24, 25, 26, and 27, and the construction of the present bulkhead and new Piers 18, 19, 20, and 21.

In addition to multiple dredging episodes, the closely-spaced piles driven during pier, platform, and bulkhead construction would have severely perforated any surviving potential precontact remains, disrupting their spatial patterning and the preservation in situ of associations of materials from activity areas, thus destroying their potential archaeological sensitivity.

Potential Archaeological Sensitivity—Wave Attenuator Location
Given the deeply-buried nature of potential submerged precontact archaeological remains, and the lack of evidence of historical period disturbance impacts, it is possible that pre-inundation land surfaces may have survived in the proposed breakwater location, and that precontact archaeological remains, if they survived the impacts of river currents and tides during inundation, might still be present.

Plans for the wave attenuator are still in the conceptual phase, but it is envisioned that it may consist of a floating structure which is supported on guide piles. Dredging, in addition to the driving of piles, may also be required. If this is the case, areas of potential archaeological sensitivity for precontact resources would be impacted. See the "Conclusions" section of this report for recommendations.

Segment 8: Pier 35
Pier 35 lies between present Rutgers and Clinton Streets, west of the line of Jefferson Street, which formerly extended to South Street. The upland portion of Pier 35, which has sunk due to the failure of the relieving platform, may be replaced with the project.

Historical Period Usage
A comparison of historical maps shows no filling of the Pier 35 location during the historical period, and no construction directly on the location until the construction of Pier 35 itself in ca.1905. The original high water line was on present Cherry Street, two blocks to the north. The 1827 Goodrich map shows the shoreline expanded southward as far as Water Street, one block north of the Pier 35 section of the APE, and by the 1840s the bulkhead had been extended to include present South Street, with the future Pier 35 location serving as the channel between old Piers 45 and 46.

The Department of Docks' bulkhead construction program proposed the elimination of old Piers 45 and 46 and a new dock at the location of Pier 35 by 1873 (Graham 1873). Construction, however, had not still not taken place in 1905, when the Sanborn atlas records the two old piers in use by the New Haven & Hartford Railroad, and Pier 35 is drawn as a dotted outline only (Sanborn 1905). Work here is described as "in progress" in the 1906 Department of Docks report, with 1,237.92 feet of bulkhead still left to be completed (Docks 1906:201). The 1907 pier maps from the Department of Docks show no Pier 35, but also no new bulkhead or Marginal Street. The only expenditure for Pier 35 made by the Department of Docks through 1914 was $70.85 for plans for the pier (Docks 1914:174). The old "Crib Bulkhead," and the old piers remained in place (SSS 1907) until the late 1920s, when pier, bulkhead, and Marginal Street were finally completed (Bromley 1921; USG&GS 1924; Sanborn 1928).

Further eastward expansion of the pier along the riverside of Marginal Street took place during the 1950s (Sanborn 1955; USC&GS 1959), and the channel along the east side of the pier was

completely filled in as Pier 35 was linked with the adjacent piers to the east during the 1960s (USC&GS 1969). The changed configuration of Pier 35, as recorded in recent aerial photos (Oasis 1996; 2004), suggests that the pier surface was completely rebuilt by the 1990s.

Potential Archaeological Resources
The Pier 35 section of the APE is presently under water, and contains the still-standing Pier 35. It was never incorporated into the fast land of Manhattan Island during the historical period, nor were there any pre-20th-century piers on that location. Its land use history indicates archaeological potential for submerged precontact remains and riverbottom deposits such as shore and ship discards (the last category does not include sunken ships or ships used as landfill). This archaeological potential, however, may have been negated by subsequent disturbance.

Disturbance
There were no soil boring logs available for the Pier 35 section of the APE, although soil borings were conducted after bulkhead and Pier 35 construction (1934 and 1950) in the eastern and western pier channels adjacent to Pier 35, and to the north on Marginal Street on the landward side of the pier and bulkhead. The Marginal Street boring logs (WPA 1965: Sheet 11:#69-72) show extremely deep rock strata, ranging from 112 to 127 feet below mhw, while rock encountered in the channels along the bulkhead is substantially shallower, between 42 and 60 feet below mhw (Ibid.: #10, #12, #13).

Following civil engineer Carleton Greene's descriptions of pier construction, and of bulkhead construction for locations in which a hard bottom was greater than about 40 feet deep, preparation involved dredging to remove previous pier and bulkhead works, and the deposit of riprap or broken stone ("not greater than 16 inches in any dimension") to provide stiffening for the pier's wooden piles. Dredging and a "rip-rap foundation" for adjacent Piers 34 and 36 is recorded in the 1906 Department of Docks report (Docks 1906:181), and such work would have been necessary to remove old Pier 45, which abutted the new Pier 35 location on the west. It is most probable that the approximately 60-foot discrepancy between the depth of rock on the Marginal Street side of Pier 35 and in the adjacent channels indicates the boring auger's encounter with the rock used in construction of the pier and bulkhead (Greene 1917). This interpretation would lead to the conclusion that the mud and varied sand/clay/gravel strata encountered in the same water borings are 20th-century, post-pier and post-bulkhead construction deposits.

The remaining data neither supports nor disproves this scenario. Prior to the construction of present Pier 35 in the 1920s, the location was part of the pier channel immediately abutting old Pier 45. The 1857 Harbor Commissioner's map records channel depths at the borings' specific location of approximately 28 feet below mhw (Harbor Commissioner 1857) (Figure 16). The river mud in the 20th-century soil boring logs is 8 to 13 feet deeper, between 36 and 41 feet below mhw (WPA 1965 Sheet 11: #10, #12, #13). This could indicate that the river mud present in the 20th century borings is a modern deposit, or it could mean that the bottom 8 to 13 feet of the mud was deposited during the 19th century, and the sandy/gravel/clay strata below it represent part of the natural riverbottom and preinundation surface.

Furthermore, the soil borings performed in Marginal Street and those in the water adjacent to the present pier are very close to the bulkhead, and probably only reveal disturbance related to bulkhead construction. Unfortunately, since there are no soil boring logs available for the Pier 35 location itself, it must be assumed that potentially sensitive strata deeper than 28 feet below mhw survived channel dredging and dredging in preparation for the construction of Pier 35.

Nevertheless, those strata greater than 28 feet below mhw, would have been further impacted by pile driving for Pier 35. Greene notes that normal pile diameters were between 14 to 16 inches, and were driven in rows of varying configurations and spacings, depending on their location in the pier structure. This would range from a maximum of 15 feet between double pile rows to as little as 5 feet between single pile rows.[19] The distance between piles within the row was even less (Green 1917) (Figure 9).

Potential Archaeological Sensitivity
Categories of potential archaeological remains for this section of the APE were submerged precontact remains and riverbottom deposits from shore and ship discards. It is probable that pre-20th-century riverbottom deposits and the glacial strata beneath them were impacted and/or removed during site preparation for Pier 35 construction. Data from soil boring logs and information regarding channel depths and dredging activity regarding impacts to these potentially sensitive strata are inconclusive.

Dredging is not the only modern impact in this part of the APE. Closely-spaced piles driven during pier and bulkhead construction would have severely perforated any surviving potential precontact remains, disrupting their spatial patterning and the preservation in situ of associations of materials from activity areas, thus destroying their potential archaeological sensitivity.

If a stratum of riverbottom deposits containing 19th-century shore and ship discards has survived construction activity at the Pier 35 location, it too has been perforated by hundreds of piles. Unlike precontact archaeological sites, riverbottom remains are deposited in multiple, unrelated episodes, in much the same way a garbage midden is created. If the spatial patterning of the artifacts is disrupted, the research value of the deposits is not lost. Therefore, although the random removal of artifacts by historical pile driving perforation may have adversely affected this resource, it would not have eliminated the archaeological potential of riverbottom deposits. As a result, this section of the APE should be considered potentially sensitive for riverbottom remains. See the "Conclusions" section of this report for recommendations.

Segments 9 and 10: Pier 42—Proposed Cove and Beach
Segments 9 and 10 of the APE occupy present Pier 42, which is roughly rectangular, and runs along the river side of the bulkhead for approximately 710 feet, from approximately 100 feet east of the Montgomery Street line to approximately 160 feet west of Jackson Street (Figure 4). The pier extends approximately 145 feet southward into the East River. The proposed project will require the removal of the existing piershed structure on Pier 42, the reinforcement of the pier itself, and the importation of sand to be placed on the pier to create a beach. The westernmost section of Pier 42, approximately west of the line of Gouverneur Slip West, will be

[19] This is calculated from Greene's measured drawing, which measures from the center line of the pile or pile cluster (Greene 1917:7).

demolished—decking and existing piles will be removed—to create a small cove for the temporary mooring of small boats.

Historical Period Usage

A comparison of historical maps shows the early-17th-century shoreline of Manhattan adjacent to this section of the APE meandering between present Front and South Streets, about 150 feet north of current Pier 42 (Figure 6). Given the distance of Segments 9 and 10 from the heart of the early 19th-century city, landfilling and the construction of piers and wharves lagged behind other sections of the APE. South Street east of Montgomery Street is drawn in as a future construction on the 1836 Colton map of the city, but the streetbed was still unfilled and underwater into the 1840s (Colton 1836; Cohen and Augustyn 1997:119), when the segment between Montgomery Street and Gouveneur Slip was filled and opened, and the earliest piers constructed through Segments 9 and 10 of the APE (USCG&S 1844). The first piers can be identified as old Piers 51 and 52[20] on the west and east sides of Gouverneur Slip, respectively (Dripps 1851). Built during the 1840s, old Piers 51 and 52 may be examples of piers constructed on wooden piles. The detailed pier maps from the collection of the South Street Seaport Museum Library record no crib cells on these piers as they do for numerous other piers, although the piers may have been rebuilt during the late 19th century (SSS 1910).

By 1851, South Street had been opened along the entire length of Segments 9 and 10, from Montgomery Street almost to Jackson Street, but development still proceeded slowly. Old Pier 51, which served the "Ferry to Hudson Avenue," and later to Bridge Street in Brooklyn, and old Pier 51, both of which passed through Segment 10 (Alvord 1849; Dripps 1851) remained the only piers in this section of the APE until the early 1860s (Harbor Commissioner 1857; New Map 1860) (Figure 17), when a short municipal pier was built at the center line of Gouverneur Slip, and later labelled Pier "51½" (Bromley 1879).

The adjacent piers to the west, outside the APE, were taken over by the N.Y., New Haven & Hartford Railroad Company by the 1870s. The Railroad increased its wharf space by building a platform on piles with an iron shed between old Piers 50 and 51, abutting the north side of APE Segment 9 (Bromley 1879; SSS 1910). The company then expanded to old Pier 51 within the APE by 1891. Old Pier 51½ was removed, and the Railroad built a platform on piles in its place, also hosting a shed, between old Piers 51 and 52, and abutting the northern edge of Segment 10 (Bromley 1891; SSS 1910) (Figure 18).

The Department of Docks' bulkhead construction program proposed the elimination of old Piers 51 and 52, and the construction of four new piers in their place by 1873 (Graham 1873). Construction of the new piers had still not taken place in 1905, when the Sanborn atlas records the old Piers 51 and 52 still in use by the N.Y., New Haven & Hartford Railroad. The atlas, however, also outlines proposed new Piers 40, 41, 42, and 43, and the new bulkhead (Sanborn 1905) (Figure 18). The Department of Docks' 1906 report notes only expenditures for "Plans for improving" and the purchase of "Wharf property" in this section of the East River shore, and the condemnation of old Piers 51 and 52 and the old bulkhead (Docks 1906:181, 215). As late as 1914, no bulkhead or pier work had been done in this area (Docks 1914:175). The 1919 harbor

[20]The Dripps map labels the same piers 50 and 51(Dripps 1851).

charts show the new piers completed by that year, although the current bulkhead does not appear in its finished state until 1924. New Pier 40 occupied Segment 9, while new Piers 41, 42, and 43 cut through Segment 10, and new Pier 44 abutted Segment 10 to the east (USC&GS 1919; 1924) (Figure 18).

During the 1960s, the new piers were removed, and with the construction of present Pier 42, which forms Segments 9 and 10, the pier slips were also eliminated (USC&GS 1959; 1968) (Figure 23).

Potential Archaeological Resources
Segments 9 and 10 of the APE are presently under water, and contain the still-standing Pier 42. The location was never incorporated into the fast land of Manhattan Island during the historical period. Its land use history indicates archaeological potential for submerged precontact remains and riverbottom deposits such as shore and ship discards (the last category does not include sunken ships or ships used as landfill). This archaeological potential, however, may have been negated by subsequent disturbance.

Disturbance
This location formerly hosted old Piers 51, 51½, and 52, all removed by the second decade of the 20th century and replaced by new Piers 40, 41, 42, and 43, which have also been removed. The 1857 Harbor Commissioner's maps records pier channel depths here ranging from 19 feet below mhw near the present bulkhead, increasing in depth to between 23 and 36 feet below mhw at the southern edge of present Pier 42 (Figure 17).

By 1906, the slip depths were between 11 and 14 feet below mhw near the modern bulkhead, and 19 to 40 feet below mhw along the southern edge of present Pier 42. On comparison with the depth soundings of 1857, many of the northern sections of this part of the APE appear to have filled with mud, this possibly due to the fact that several platforms had been built out from the shoreline since 1857, and the piles from the platforms trapped river mud and prevented thorough dredging of the slips (USC&GS 1906) (Figure 21).

The soil borings available for this location, performed in 1934, also show the water in the slips to be fairly shallow (extending approximately 11.4 to 14.9 feet below mhw), but these soil borings were located beneath then-existing piers, close to the bulkhead, or abutting piers, where river mud is likely to collect (WPA 1965 Sheet 11: #43-47. See Appendix)

According to the 1906 Docks report, however, the slips between the piers in the outboard APE underwent routine dredging to depths between 26 and 35 feet below mhw. This appears to be the standard range for East River pier slips up to that time (Docks 1906:382-385), and the shallower of the depths, 26 feet below mhw, is a conservative estimate for dredging depths in this section of the APE. The suspiciously uniform depth of the bottom of the river mud stratum, recorded in four of five soil borings, at a very even depth of between 35.9 and 38.9 feet below mhw over a wide area, actually argues for the deeper dredging depth of 35 feet. The fifth boring log (#47), taken on the site of Pier 41 (now Segment 10), records river mud only to 26.9 feet below mhw, corresponding to the shallower end of dredging depths. This would mean the mud accumulations in the APE represent 20th-century deposits.

Although it is apparent that the slips between new Piers 40-43 were not maintained at these dredging depths, it seems logical that at the time of their construction during the 1910s, site preparation involved dredging to between 26 and 35 feet below mhw. This would have impacted Segment 9, the location of Pier 40, and much of Segment 10. Using Carleton Greene's description of pier construction as a guideline for the construction of Piers 40, 41, 42, and 43, preparation involved dredging to remove previous pier and bulkhead works, and the subsequent deposit of riprap to provide stiffening for the wooden piles (Greene 1917). Deposits labeled "Gravel" and "Cobble" immediately beneath the river mud may represent the riprap deposit.

Strata deeper than the 26 to 35 feet below mhw affected by the many dredging episodes in this location would have been further impacted by pile driving. Since the soil boring logs cited for this part of the APE record rock or bedrock between 47.8 and 58.4 feet below mhw, and Greene notes 60-foot piles as the norm, disturbance due to pile driving would most certainly have extended through the clay/sand/gravel/cobble strata beneath the river mud so that the piles could rest on rock. Greene notes that normal pile diameters were between 14 to 16 inches, and were driven in rows of varying configurations and spacings, depending on their location in the pier structure. This would range from a maximum of 15 feet between double pile rows to as little as 5 feet between single pile rows.[21] The distance between piles within the row was even less (Greene 1917).

An additional disturbance to the Pier 42 location would have occurred from the construction of the present bulkhead. According to civil engineer Carleton Greene's description of bulkhead construction, and given the moderate depth of rock in Segments 9 and 10 (47.8 to 58.4 feet below mhw), this would mean that bulkhead piles would rest directly on rock. Bulkhead construction would have necessitated the removal of mud, clay, and sand strata, which would have included strata with archaeological potential, extending horizontally at least 20 feet riverward from the location of the proposed bulkhead wall (Greene 1917).

Potential Archaeological Sensitivity

Categories of potential archaeological remains for this section of the APE were submerged precontact remains and riverbottom deposits from shore and ship discards. It is probable that pre-20th-century riverbottom deposits and the glacial strata beneath them were impacted and removed during site preparation for the various and multiple episodes of pier and bulkhead construction which affected the entirety of both Segments 9 and 10 during the 19th and 20th centuries.

Dredging is not the only modern impact in this part of the APE. Closely-spaced piles driven during pier and bulkhead construction would have severely perforated any surviving potential precontact remains, disrupting their spatial patterning and the preservation in situ of associations of materials from activity areas, thus destroying their potential archaeological sensitivity.

Therefore, Segments 9 and 10 would not be considered sensitive for precontact or historical archaeological remains.

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[21] This is calculated from Greene's measured drawing, which measures from the center line of the pile or pile cluster (Greene 1917:7).

V. CONCLUSIONS AND RECOMMENDATIONS

According to both the Standards for Cultural Resource Investigations (1994, adopted by the New York State Historic Preservation Office [SHPO]) and the Guidelines for Archaeological Work in New York City (LPC 2002), the first level of evaluation for archaeological sensitivity is based on documentary evidence. The above report, based primarily on documentation of subsurface disturbance, has fulfilled this first level of evaluation for the outboard locations of the East River Waterfront Esplanade and Piers APE.

Because the outboard sections of the APE have never been incorporated into the fast land of Manhattan Island, and also because harbor maintenance and construction practice through the 20th century mitigated against the accumulation of wrecks and earlier pier works along the busy waterfront, the categories of potential archaeological remains were limited to riverbottom remains, i.e., materials thrown or lost either from the shore or a vessel; sunken vessels; and submerged precontact sites.

Riverbottom Remains

The conclusion of this report is that with the exception of Segment 8 (Pier 35), the outboard locations of the APE are not sensitive for ship and shore discards and losses, based on the evidence of dredging for both routine harbor maintenance and preparation for new pier and bulkhead construction. Furthermore, in all cases, the earlier slips and channels along the East River which occupied the outboard sections of the APE during the 19th century were deepened by the early 20th century, in order to serve ships of deeper draft, or in preparation for new bulkhead and pier construction. Since the target of this dredging was river "mud" in which the potential resources of this archaeological category would be expected, the dredging activity would have severely impacted the archaeological potential for riverbottom deposits, so that it should be considered not sensitive for this category of resources.

Segment 8 (Pier 35)
Segment 8 (Pier 35) is considered archaeologically sensitive for riverbottom deposits (ship and shore discards and losses). Although it has been affected by historical pile driving, since the very nature of this resource category is something like a land-based garbage midden—it is created through a series of many discrete and loosely related or unrelated episodes, and the artifacts do not necessarily derive their value from their spatial relationship to other materials in the deposit—the impacts of historical pile driving would not have had the same deleterious effect on archaeological sensitivity for riverbottom deposits as they would have had on sensitivity for precontact remains. Therefore, if a stratum of riverbottom deposits containing 19th-century shore and ship discards has survived regular dredging, it would not lose its archaeological integrity because of historical pile driving.

Further mitigation efforts are not recommended for Segment 8, however, because no additional impacts to riverbottom deposits are planned. Therefore, unless the proposed plans for Segment 8 are altered to include the removal of earlier piles and dredging, no additional study of or testing for this category of archaeological resources is recommended.

Sunken Vessels

As already noted in the discussion of sunken vessels as an archaeological resource category, given the importance of the slips and wharfage to the commerce of the City, it is unlikely that a vessel would have entered the archaeological record via sinking or simple abandonment in an outboard location. City authorities were vigilant to encumbrances to commerce. Only one late 20th-century wreck was noted in the APE (Segment 3) on the official harbor charts in 1959 and 1969, a result of the neglect of the East River waterfront in the 1960s, and that was removed, not appearing on subsequent charts (USC&GS 1959; 1969; 1979). Although vessels were incorporated into landfill, by definition the outboard locations have not been filled, and therefore such an example is not possible here. Therefore, no further study of or testing for this category of archaeological resources is recommended.

Precontact Archaeological Resources

All of the outboard locations in the APE have undergone regular and pre-construction dredging, as pier slips and shipping channels were maintained, cleaned, and deepened during the 19th and 20th centuries. This may have impacted potential submerged precontact resources in these parts of the APE, and in some segments this is certainly the case, since the glacial till-like strata on or in which pre-inundation precontact archaeological sites would be expected have been either eliminated or heavily-impacted by dredging.

With the exception of the possible wave attenuator location in Segment 6, all the outboard locations of the APE have also been impacted by the driving of piles. There is no doubt that the thousands of piles driven for pier and bulkhead construction have passed through strata which would have been considered potentially sensitive for precontact archaeological remains. As described above, precontact archaeological sites have characteristics different from the midden-like riverbottom remains category. The preservation of spatial patterning is an important consideration, not only in the identification of site activity areas, but in determining the relationship of the materials within these activity areas. Given a precontact archaeological site perforated by hundred of 14- to 16-inch piles, it is difficult to imagine this information might survive, even if it had survived the forces of tides and currents as it was inundated during the precontact period.

Segment 6: Wave Attenuator Location
Although the East River channel here had been increased in depth since the 19th century, there is no history of pile driving or any other construction in the portion of Section 6 where a breakwater may be constructed. Given the deepest recorded water depths of 42 to 44 feet below mhw (NOAA 1979) (Figure 23), and estimates that precontact sites from 10,000 years BP would be found at depths no greater than approximately 90 feet (below mhw) (Merwin et al. 2003:46-47), the possibility of submerged and deeply buried former land surfaces which might contain precontact remains cannot be ruled out, providing these archaeological resources survived currents and tidal action at the time of inundation.

Based on the data presented in this report, it is recommended that when soil borings for design and construction purposes are planned for the wave attenuator location, that the program be

designed with the input of a professional archaeologist. Following the completion of these soil borings, the logs and technical notes should be reviewed by a professional archaeologist for evidence of a potential precontact living surface, as evidenced by the presence of a distinct layer of peat or buried soil matrix, and for the presence of artifacts or large concentrations of shell. As cited earlier in this report, similar testing for submerged precontact *and* historical sites was performed in the Upper Hudson River, although no precontact material was found in any of the borings completed (URS 2003).

After the soil boring logs are analyzed by an archaeologist, if no evidence of potentially sensitive strata are found, then no further archaeological research or testing would be indicated. If the Segment 6 wave attenuator location's precontact archaeological potential sensitivity is corroborated by the soil borings data, however, then a subsequent phase of archaeological study may be indicated.

As noted in the Introduction, the review of the Phase 1A technical report, which will include a Soil Borings Appendix, is to be conducted by SHPO. As established in the PA, "subsequent to the review of the Phase 1A by SHPO, LMDC and the City will cooperate in the preparation of a protocol ("Archaeology Monitoring and Testing Protocol") to define which portions of the Archaeological APE would be monitored during construction or would undergo Phase 1B field testing prior to construction, depending on the nature of the potential resources identified in the Phase 1A and the extent of construction that would take place in specific locations. The protocol will include an assessment of the feasibility and utility of monitoring versus field testing for all potentially sensitive archaeological areas that would be affected by the Esplanade Project. The protocol will also outline any areas to receive monitoring or field testing and will set forth the methodology."

VI. BIBLIOGRAPHY

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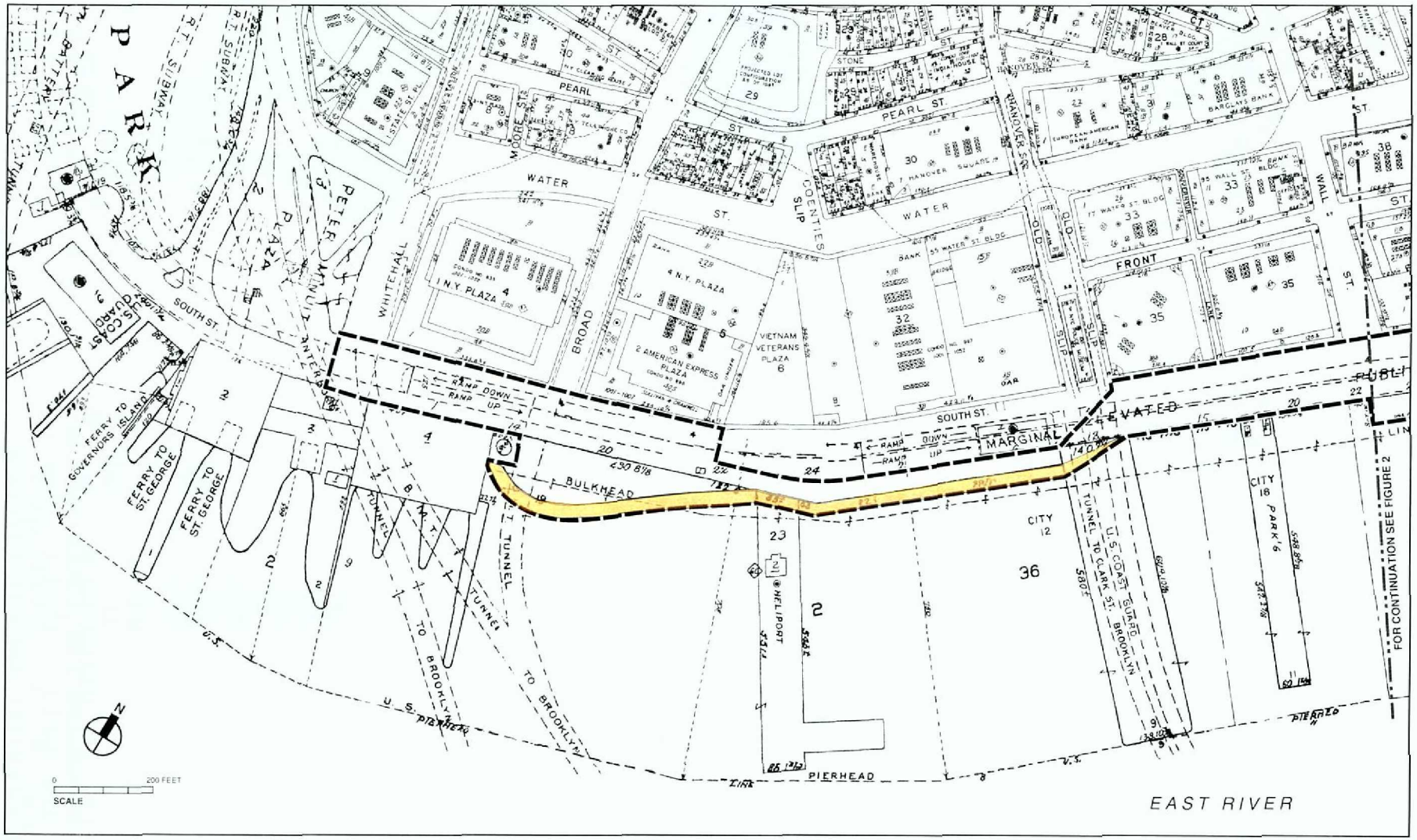
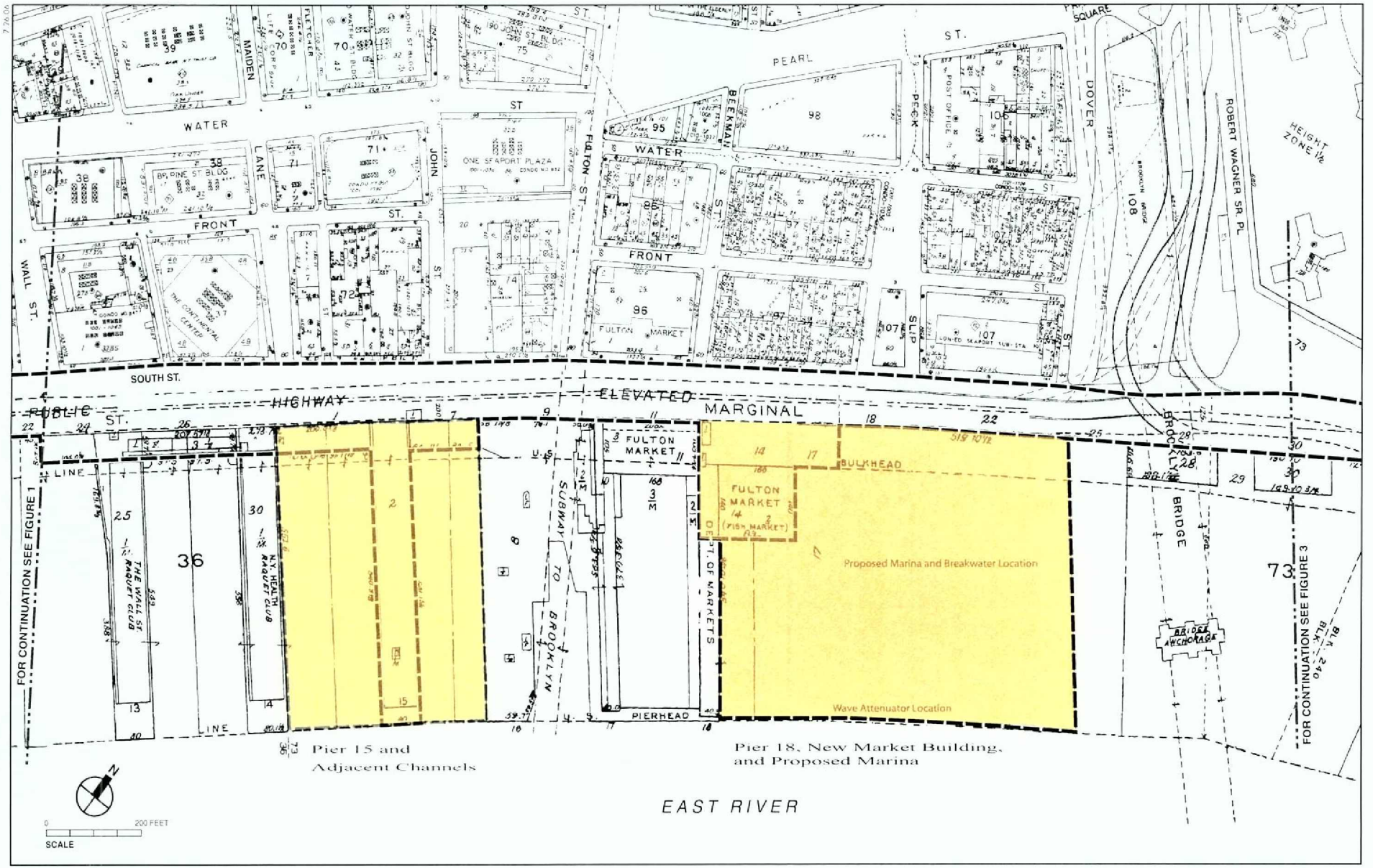


LEGEND

- - - - -	Area of Potential Effect
▭	Broad Street through Old Slip Outboard of the Bulkhead

EAST RIVER Waterfront Esplanade and Piers

FIGURE 1: Current Sanborn Map (Battery Park to Wall Street)

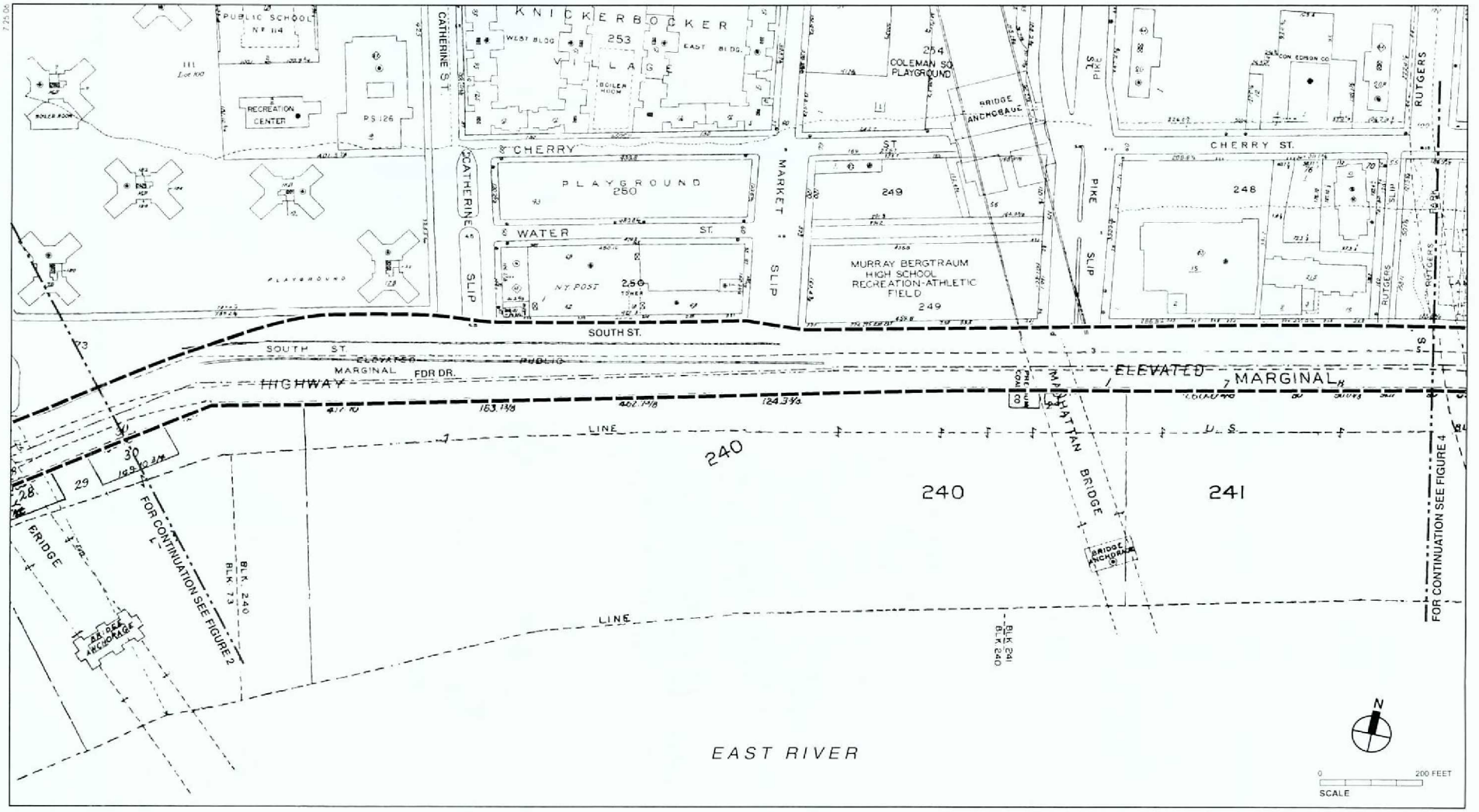


Area of Potential Effect

Pier 15 and Adjacent Channels, and Pier 18 with New Market Building and Proposed Marina

EAST RIVER Waterfront Esplanade and Piers

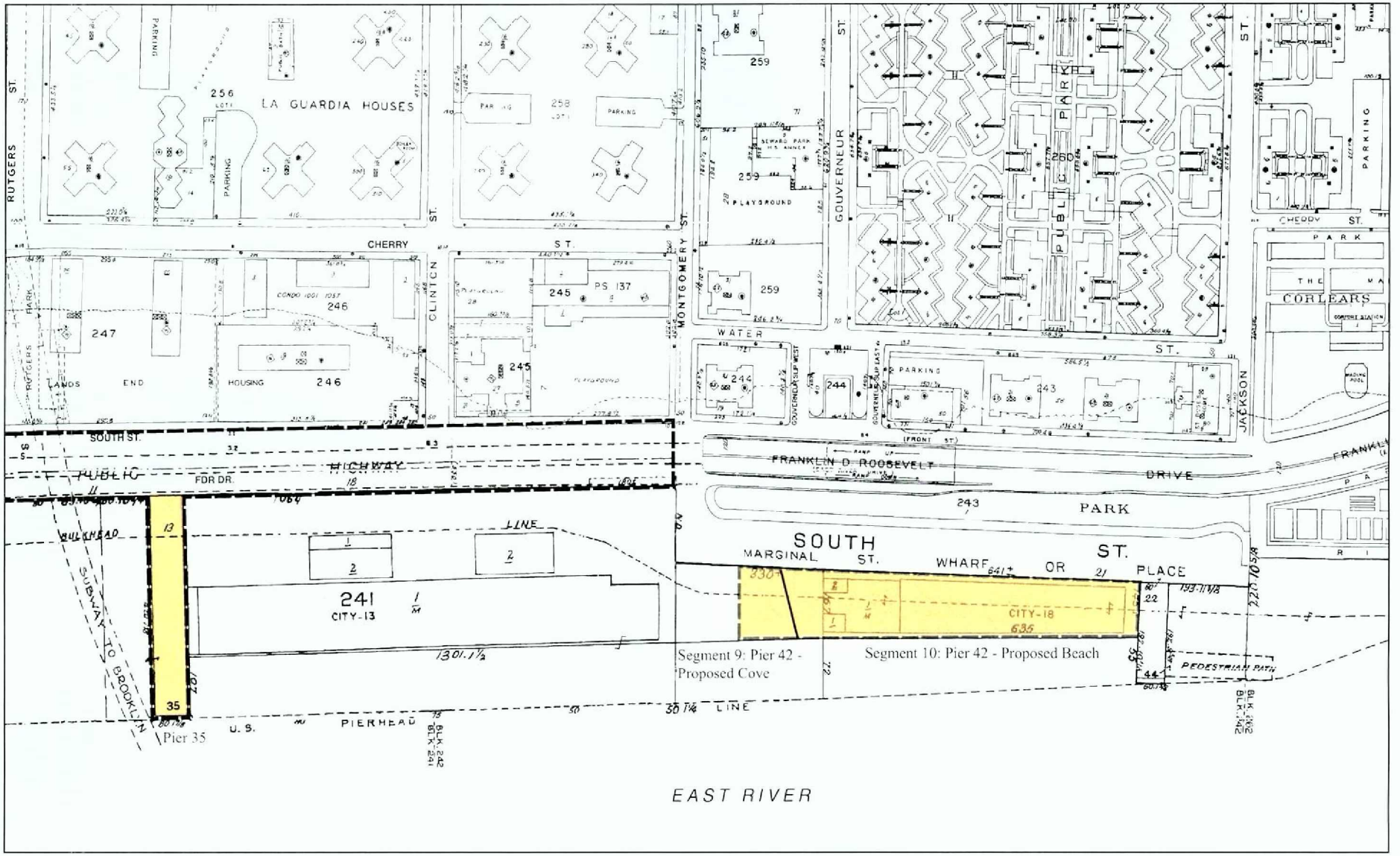
FIGURE 2: Current Sanborn Map (Wall Street to R. F. Wagner Place)



Area of Potential Effect

EAST RIVER Waterfront Esplanade and Piers

FIGURE 3: Current Sanborn Map (R. F. Wagner Place to Rutgers Street)

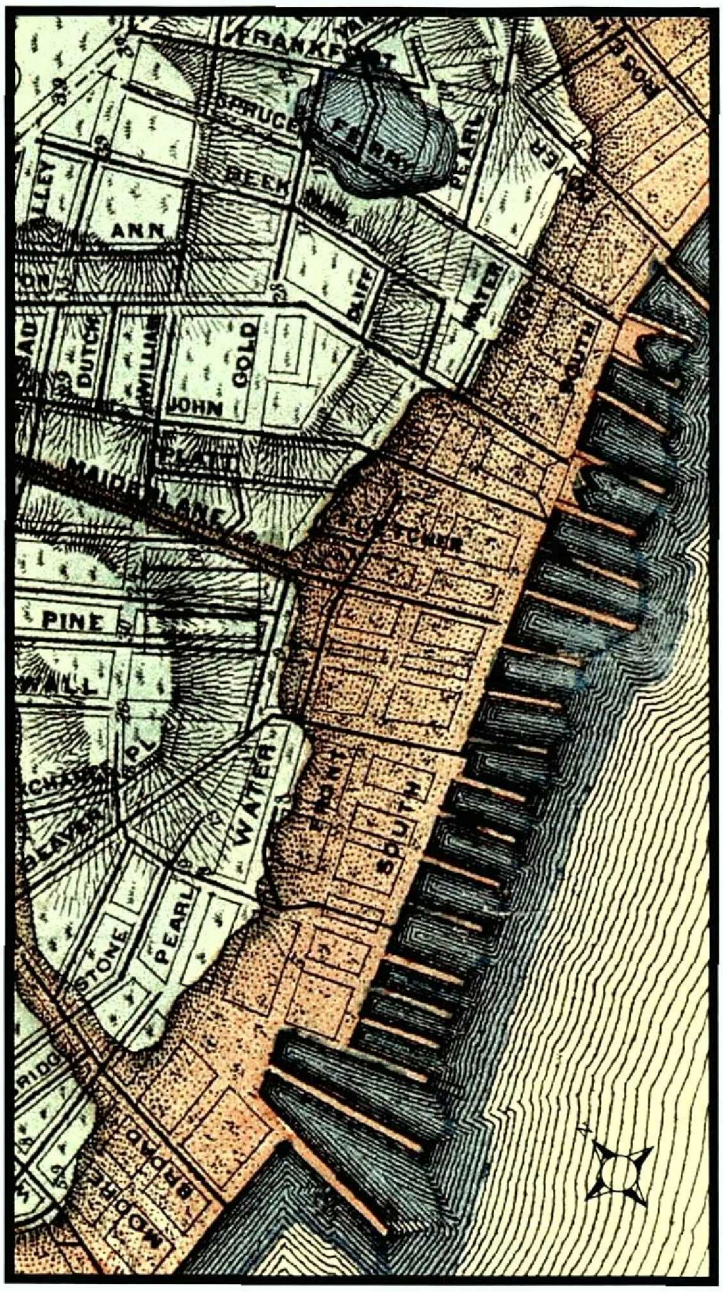


Area of Potential Effect

Piers 35 and 42

EAST RIVER Waterfront Esplanade and Piers

FIGURE 4: Current Sanborn Map (Rutgers Street to Jackson Street)



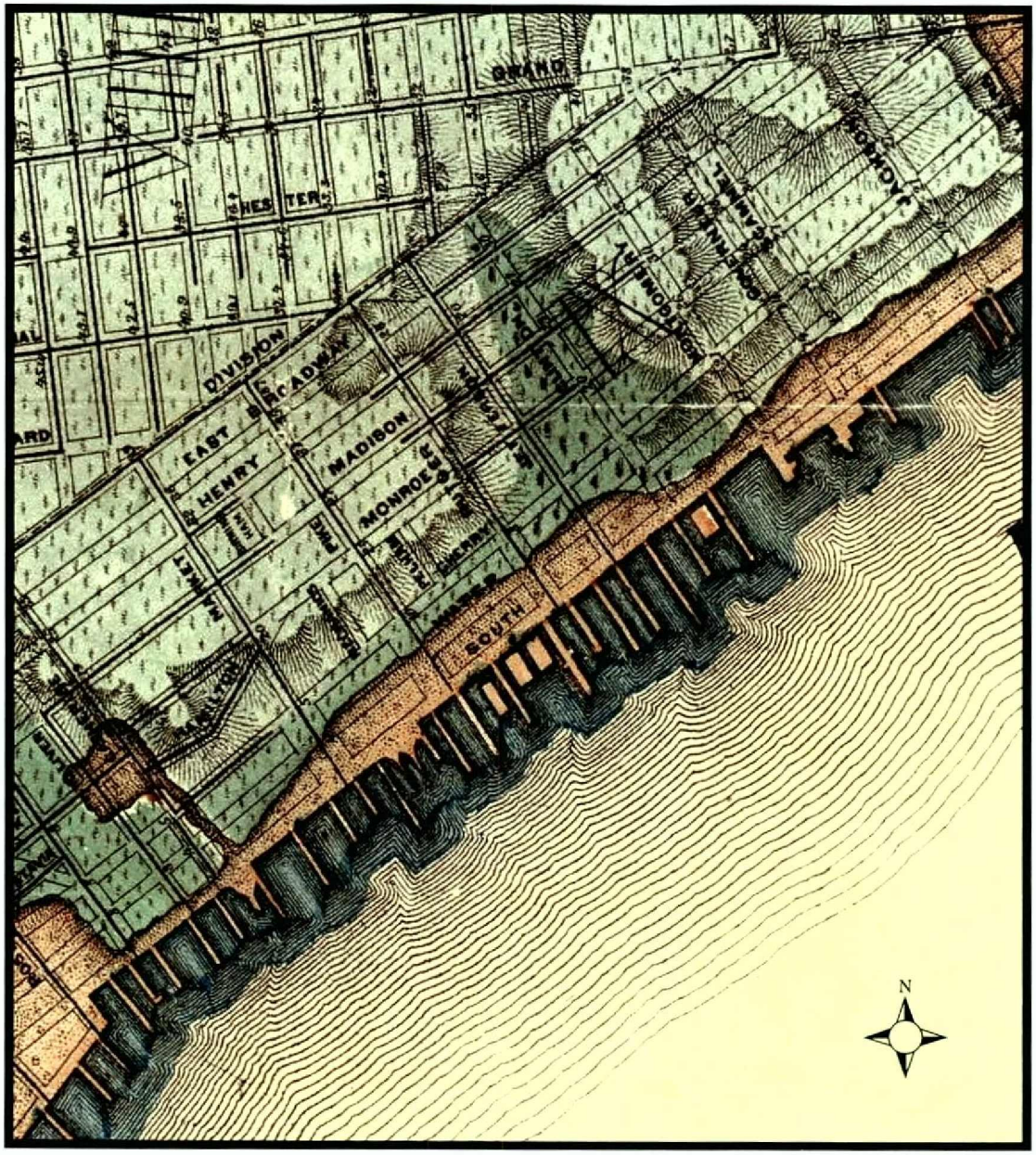
LEGEND

Green - Manhattan Island at the time of Contact Orange - Made land (17th to mid-19th centuries)

SOURCE: David Rumsey Historical Map Collection - www.davidrumsey.com

EAST RIVER Waterfront Esplanade and Piers

FIGURE 5: Viele, Topographic Map of the Island of New York, 1865
(Detail: Whitehall to Roosevelt Street)



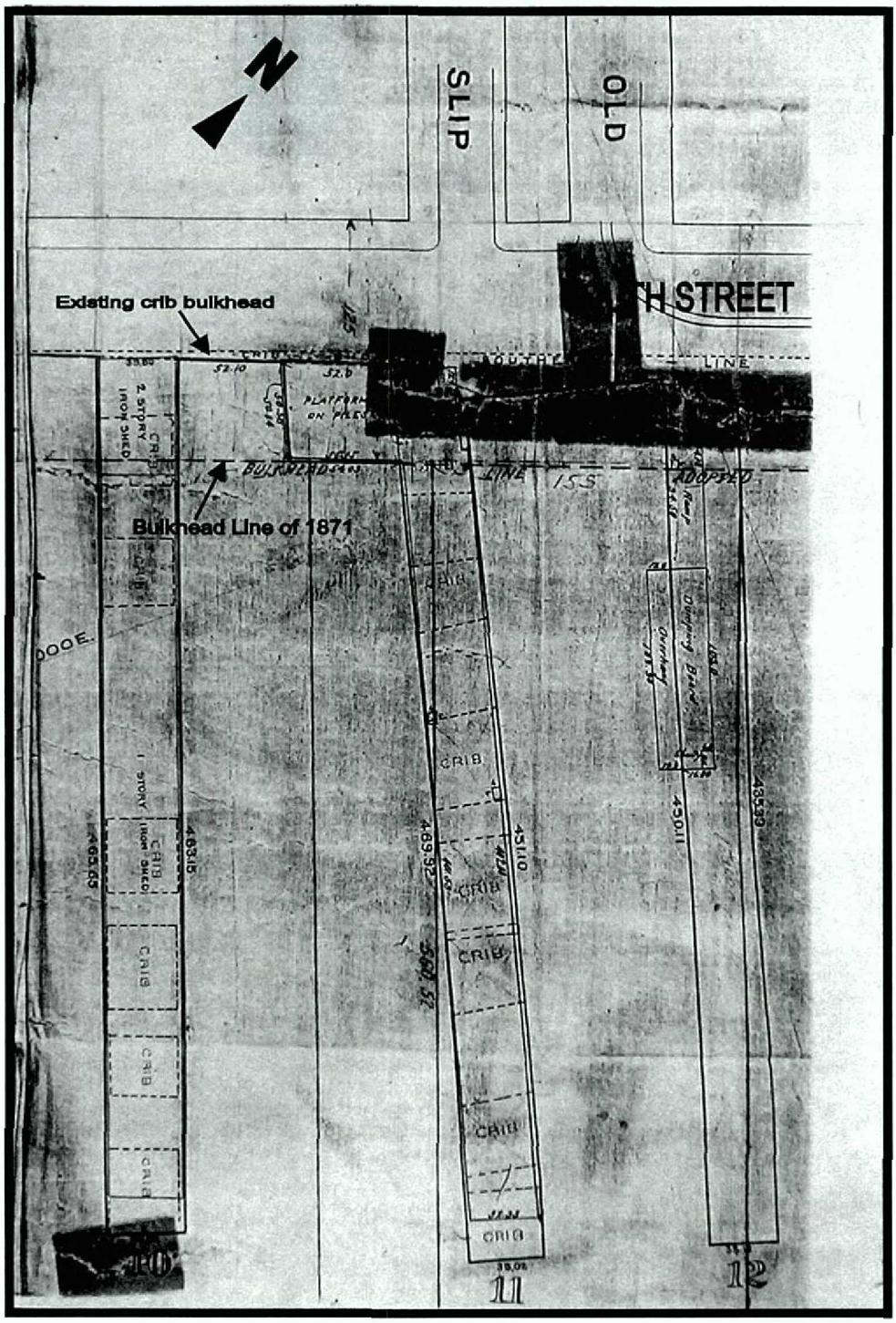
LEGEND

Green - Manhattan Island at the time of Contact
Orange - Made land (17th to mid-19th centuries)

SOURCE: David Rumsey Historical Map Collection - www.davidrumsey.com

EAST RIVER Waterfront Esplanade and Piers

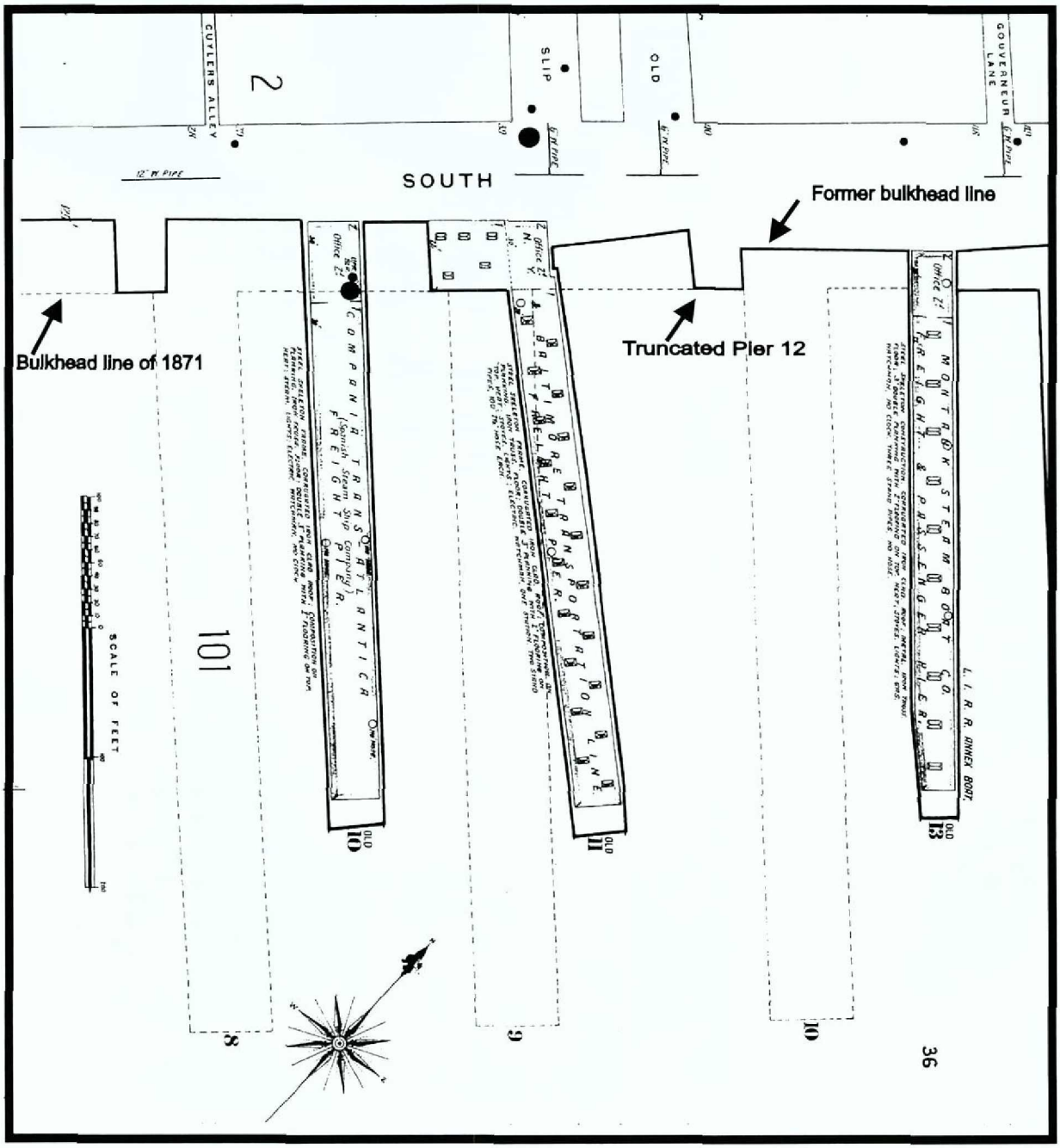
FIGURE 6: Viele, Topographic Map of the Island of New York, 1865
(Detail: Roosevelt Street to Jackson Street)



SOURCE: Department of Docks Pier Maps (SSS 1903a). Collection: South Street Seaport Museum Library

EAST RIVER Waterfront Esplanade and Piers

FIGURE 7: Dock Map, Old Slip to Fulton, ER., 1903



EAST RIVER Waterfront Esplanade and Piers

FIGURE 8: Sanborn, Atlas of the Borough of Manhattan, 1905
(Detail: Plate 102, South Street from Cuylers Alley to Gouverneur Lane, with Old Slip)

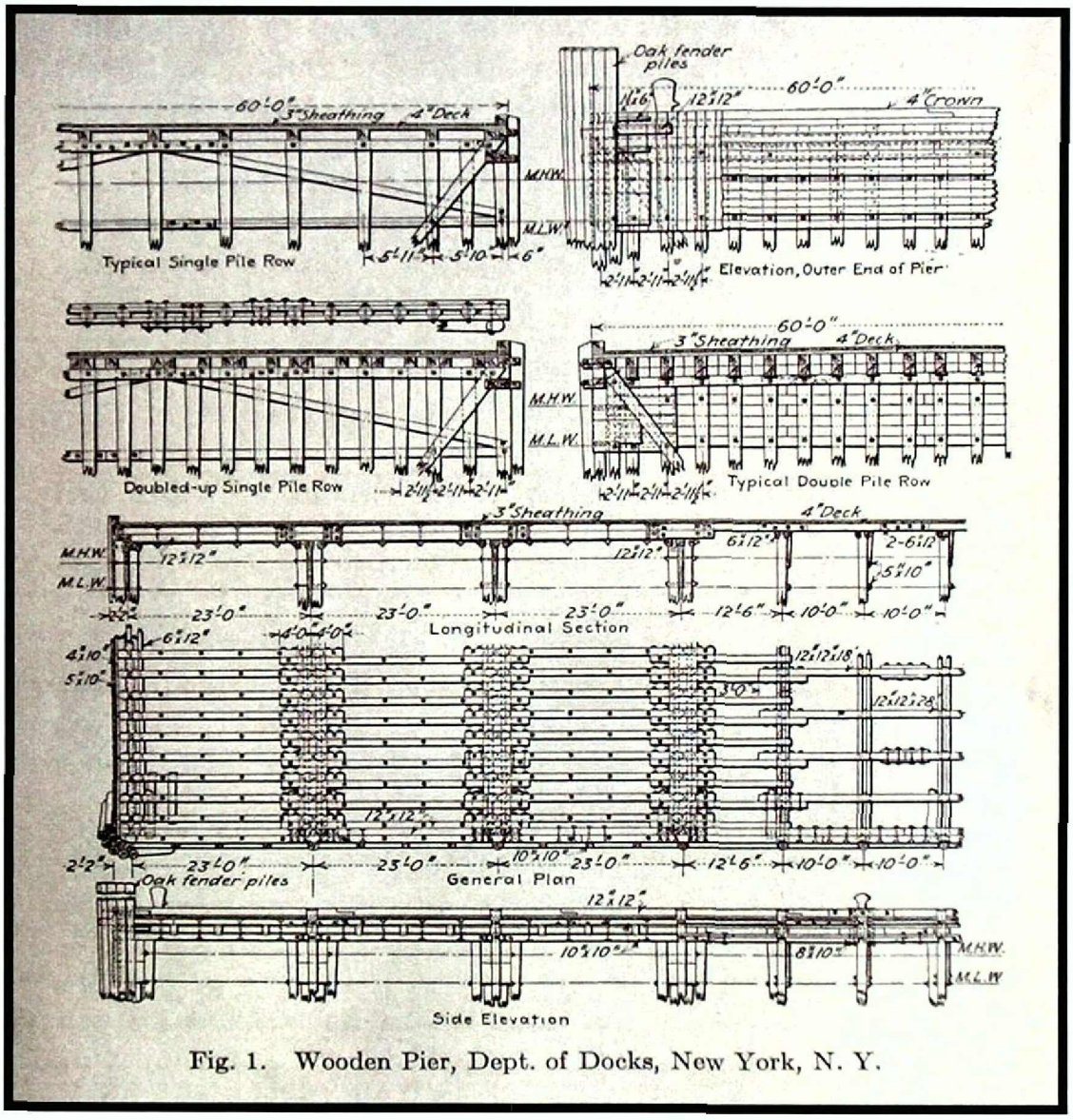


Fig. 1. Wooden Pier, Dept. of Docks, New York, N. Y.

SOURCE: Greene, *Wharves and Piers*, 1917

EAST RIVER Waterfront Esplanade and Piers

FIGURE 9: Wooden Pier, plan and elevations, 1917

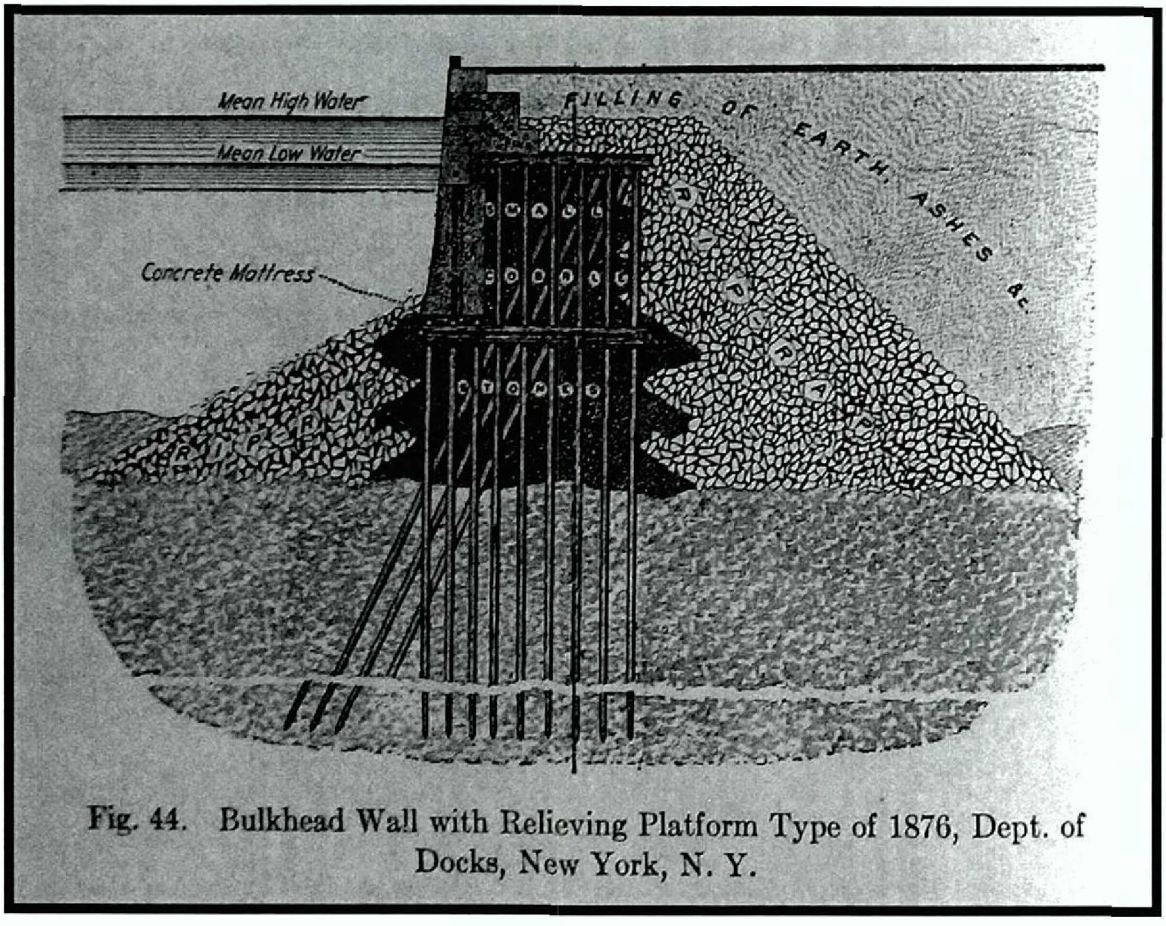


Fig. 44. Bulkhead Wall with Relieving Platform Type of 1876, Dept. of Docks, New York, N. Y.

SOURCE: Greene, *Wharves and Piers,* 1917

EAST RIVER Waterfront Esplanade and Piers

FIGURE 10: Bulkhead Wall, Type of 1876

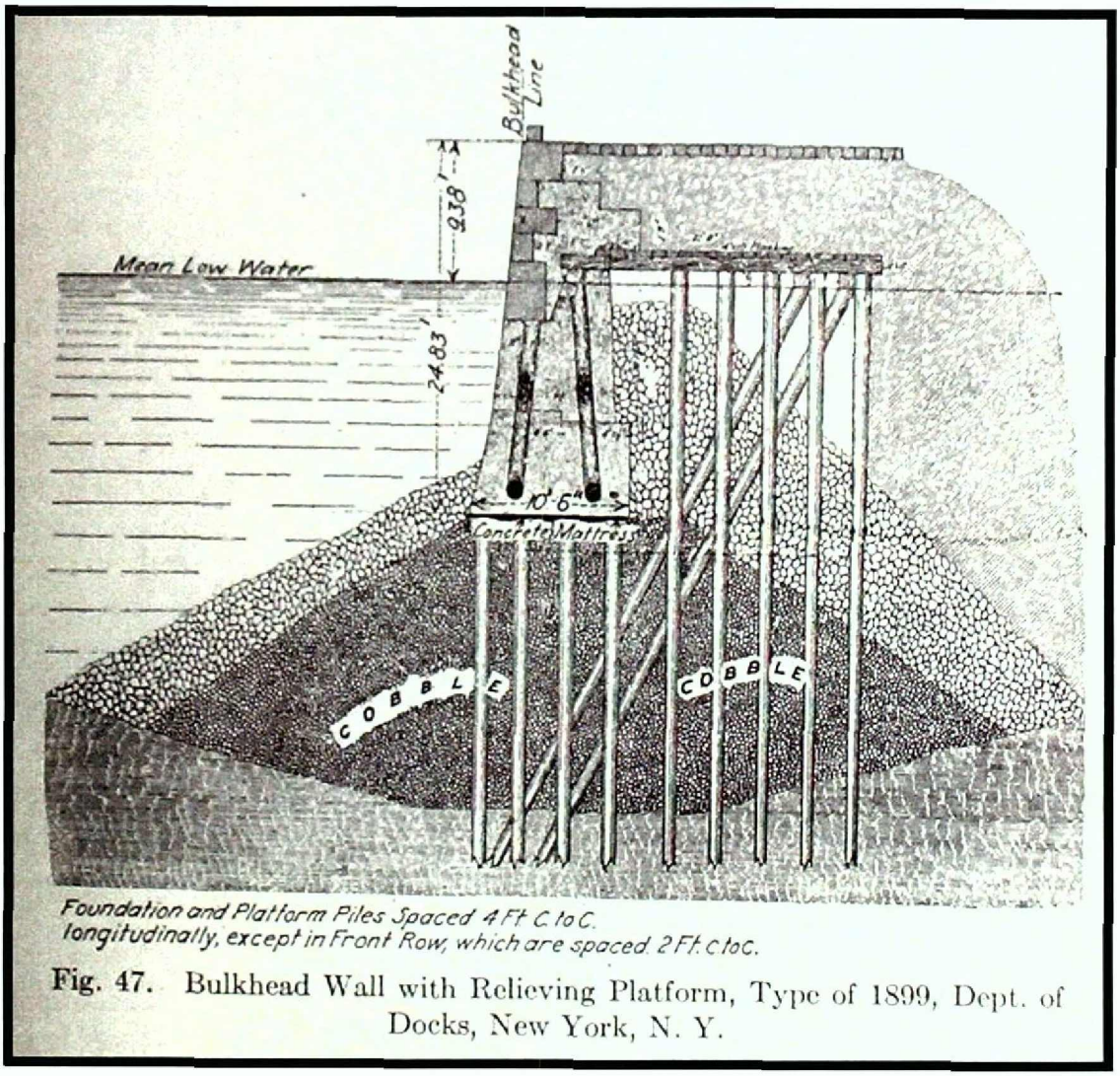
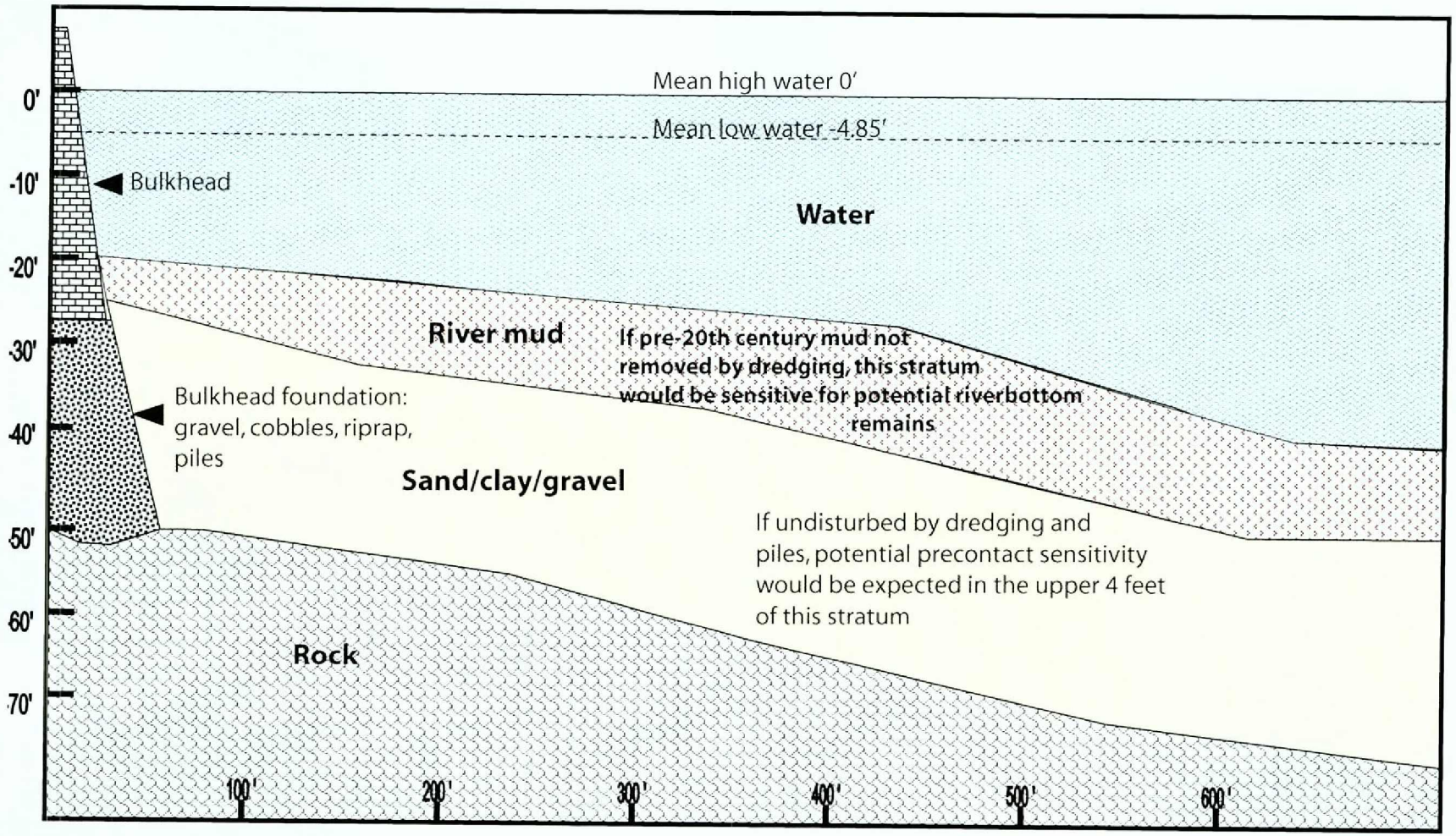


Fig. 47. Bulkhead Wall with Relieving Platform, Type of 1899, Dept. of Docks, New York, N. Y.

SOURCE: Greene, *Wharves and Piers*, 1917

EAST RIVER Waterfront Esplanade and Piers

FIGURE 11: Bulkhead Wall, Type of 1899

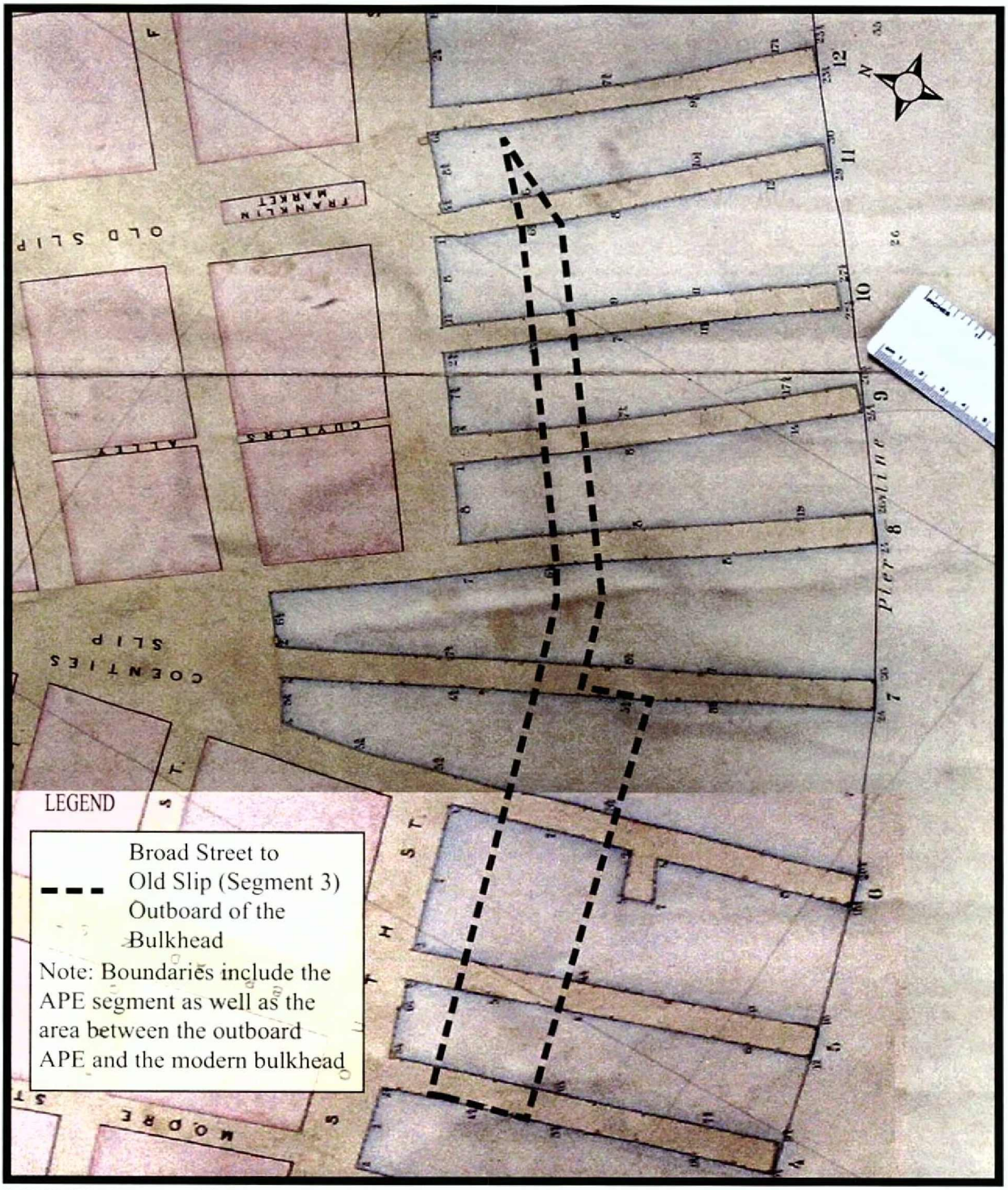


LEGEND

This profile is a ***generalized*** graphic depiction of the Outboard APE, based on the sources cited in this report, in particular: soil boring logs (WPA 1965), bulkhead plans (Greene 1917). Depths of strata vary among the outboard segments.

EAST RIVER Waterfront Esplanade and Piers

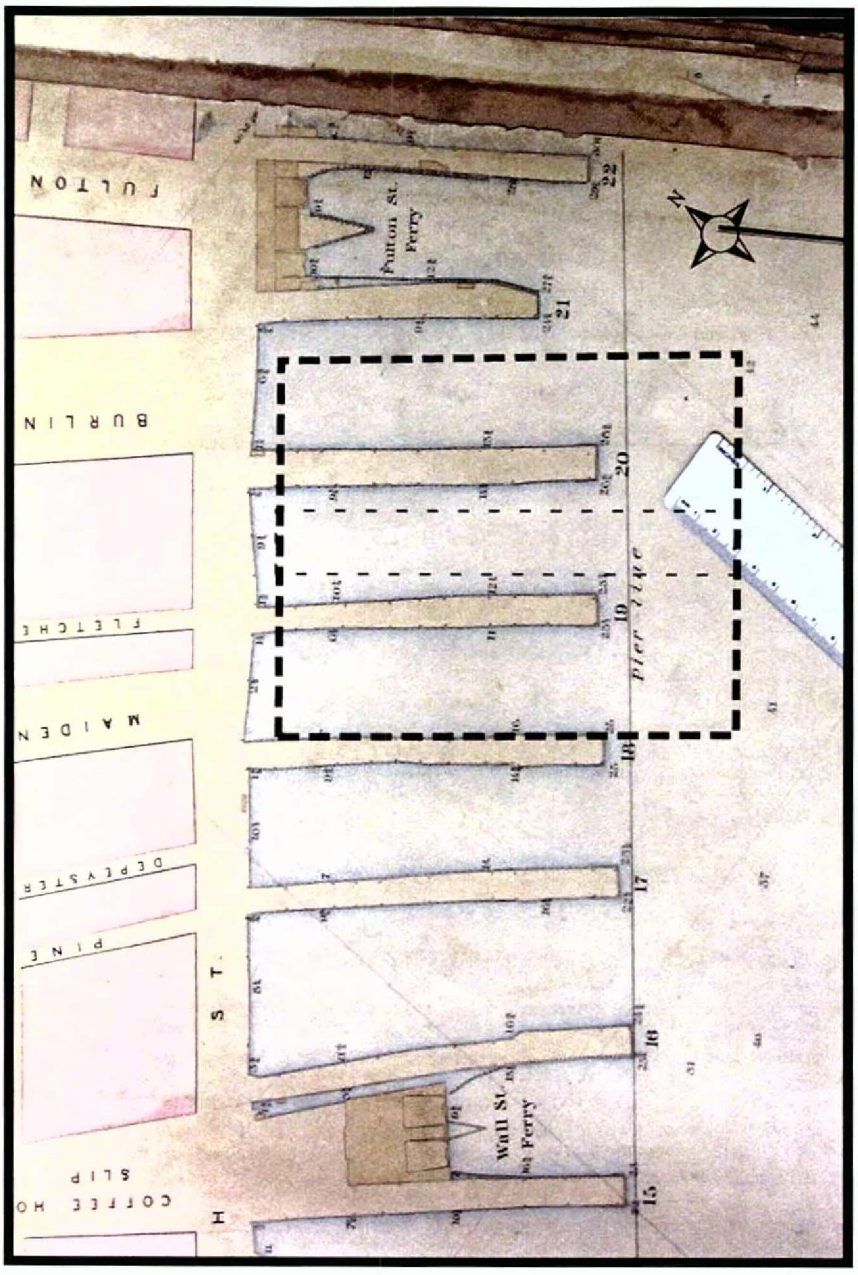
FIGURE 12: Generalized Profile of Approximate Outboard Resource Depths



SOURCE: Topographic Bureau, Manhattan Borough President's Office

EAST RIVER Waterfront Esplanade and Piers

FIGURE 13: Harbor Commissioner's Map, Broad Street to Old Slip, 1857



LEGEND

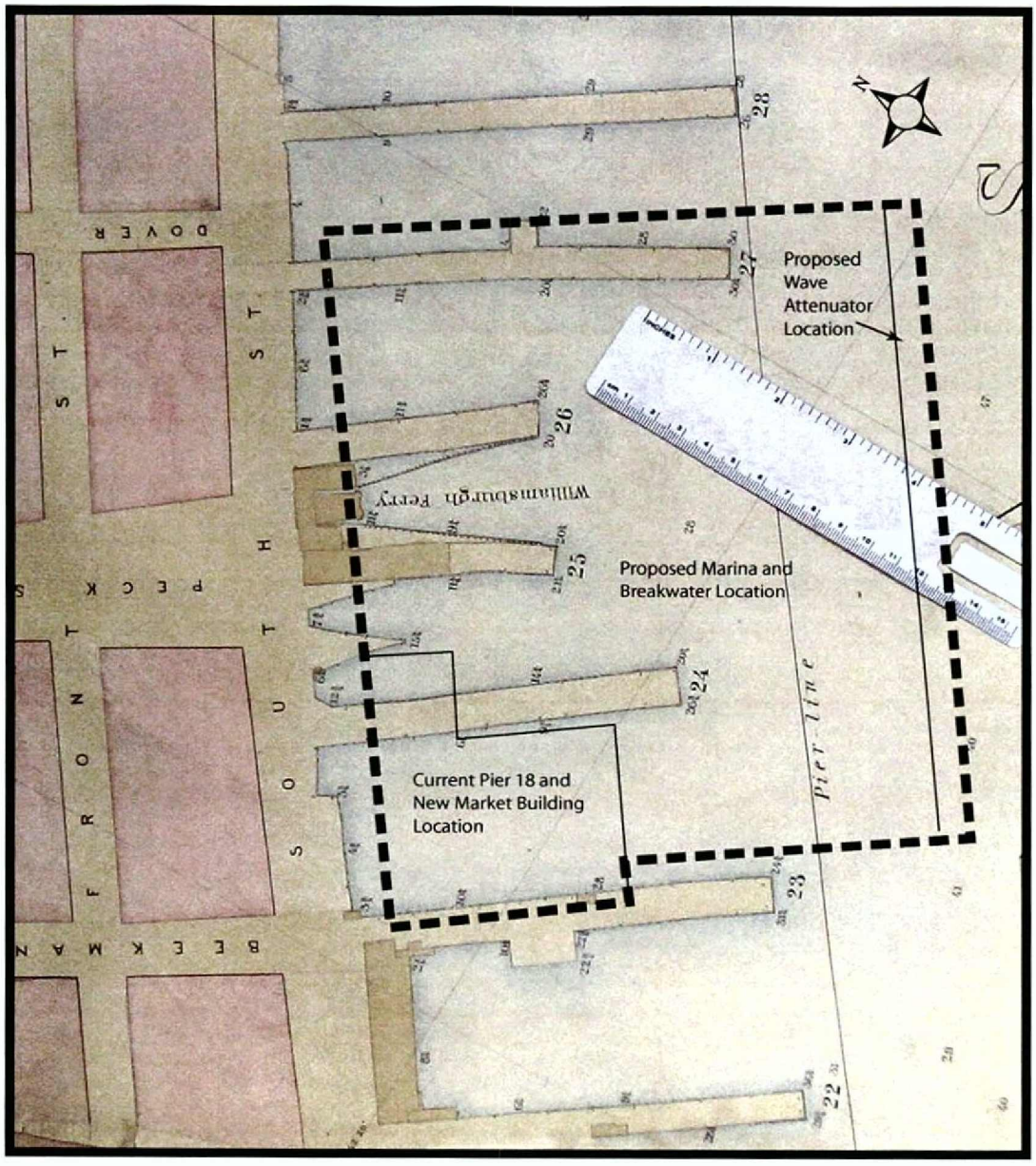
Pier 15 and Adjacent Channels location

Location of former Pier 15

SOURCE: *Topographic Bureau, Manhattan Borough President's Office*

EAST RIVER Waterfront Esplanade and Piers

FIGURE 14: Harbor Commissioner's Map, Coffee House Slip to Fulton Street, 1857



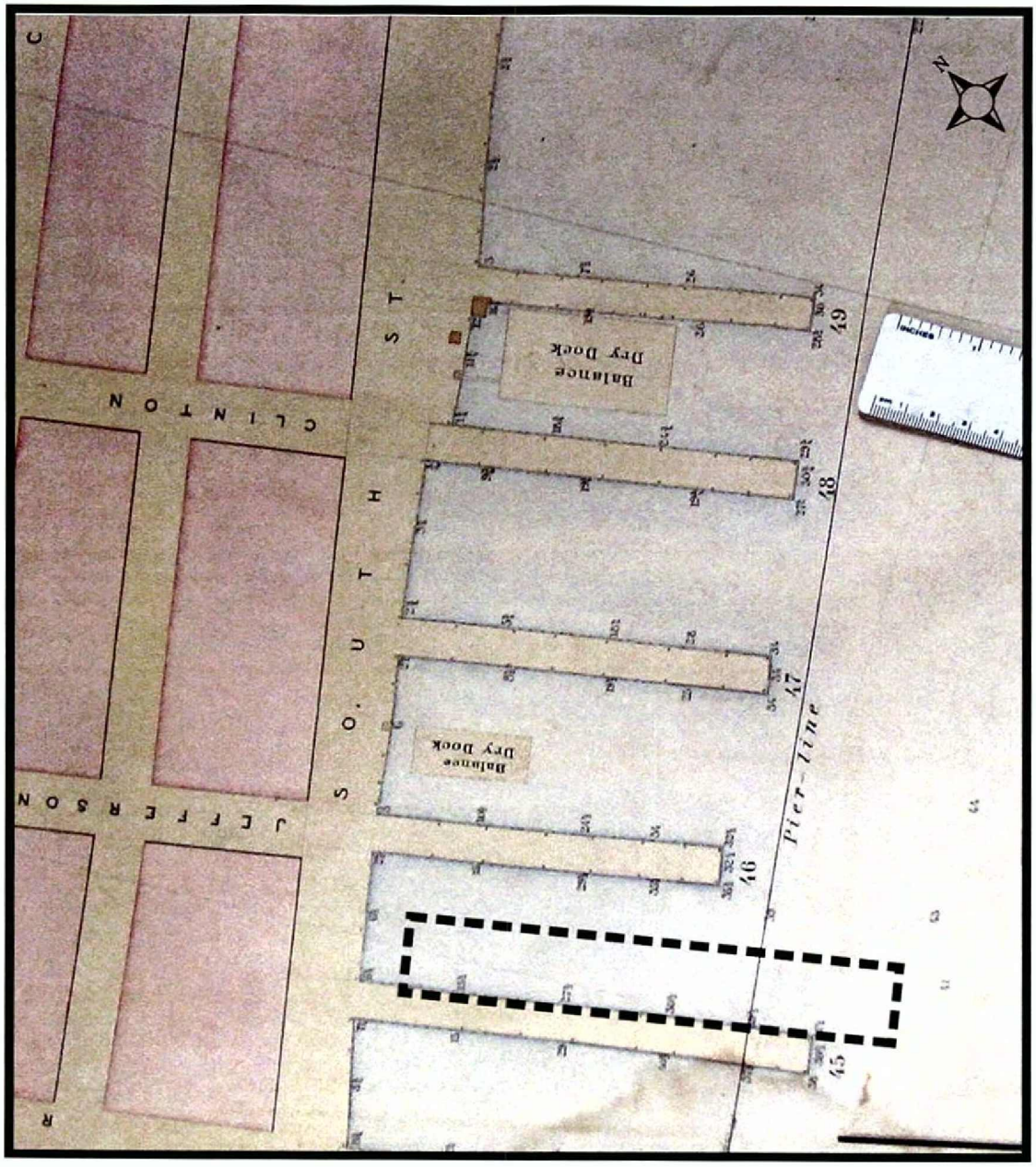
LEGEND

Pier 18 and New Market Building location,
Proposed Marina, Breakwater and Wave Attenuator location

SOURCE: *Topographic Bureau, Manhattan Borough President's Office*

EAST RIVER Waterfront Esplanade and Piers

FIGURE 15: Harbor Commissioner's Map, Beekman Street to Dover Street, 1857



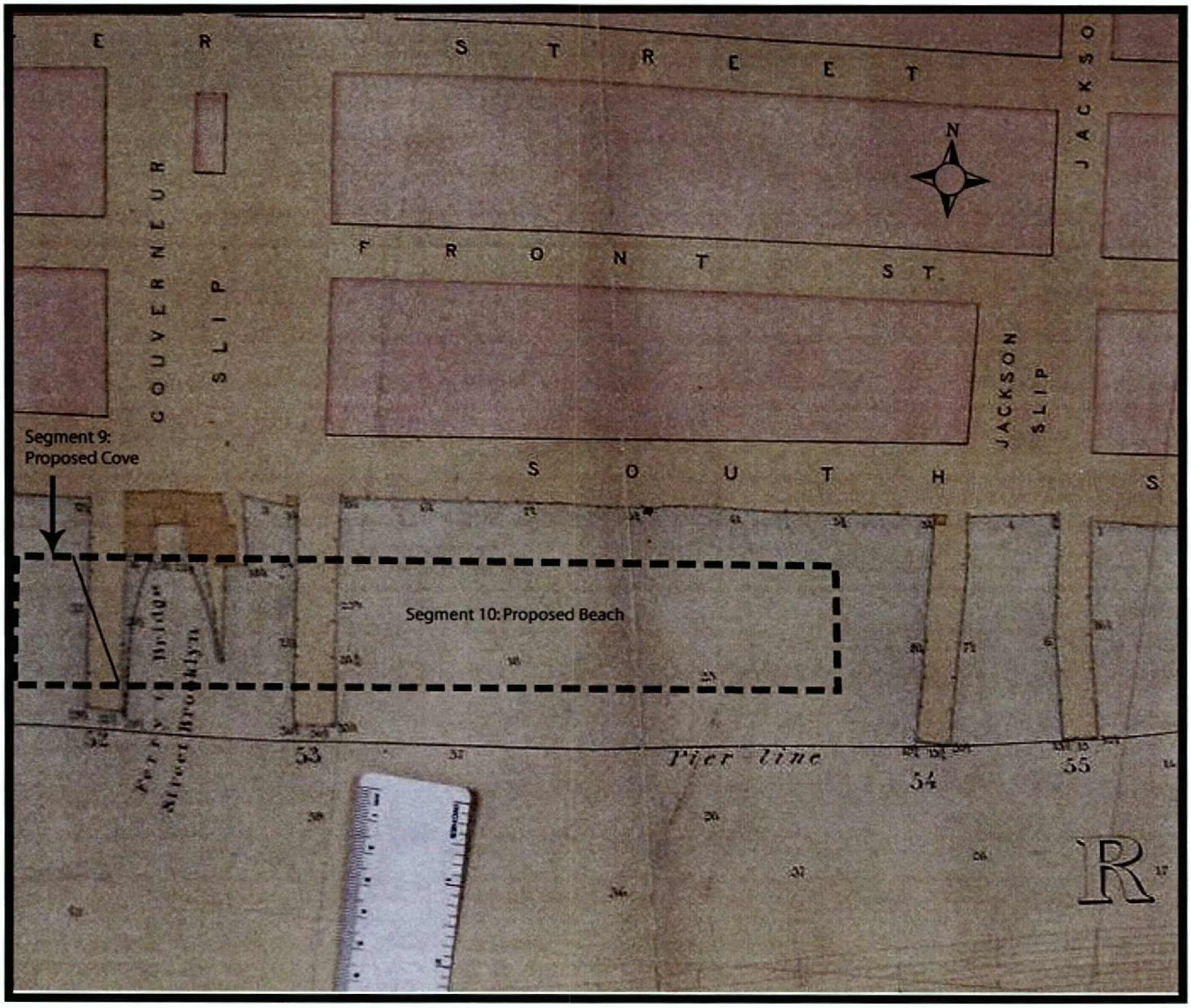
LEGEND

Current Pier 35 location

SOURCE: *Topographic Bureau, Manhattan Borough President's Office*

EAST RIVER Waterfront Esplanade and Piers

FIGURE 16: Harbor Commissioner's Map, Rutgers Street to Clinton Street, 1857



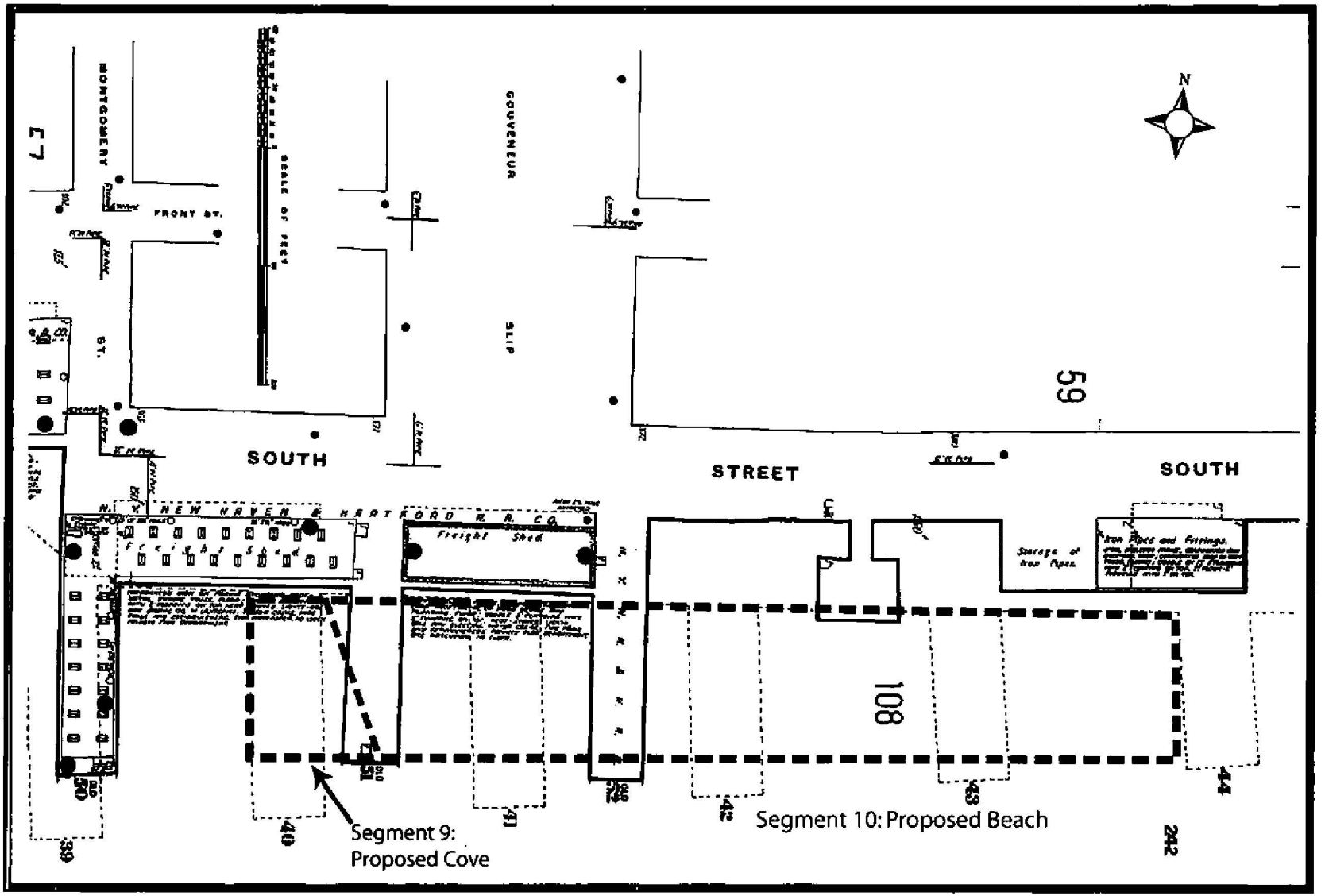
LEGEND

Current Pier 42 location

SOURCE: *Topographic Bureau, Manhattan Borough President's Office*

EAST RIVER Waterfront Esplanade and Piers

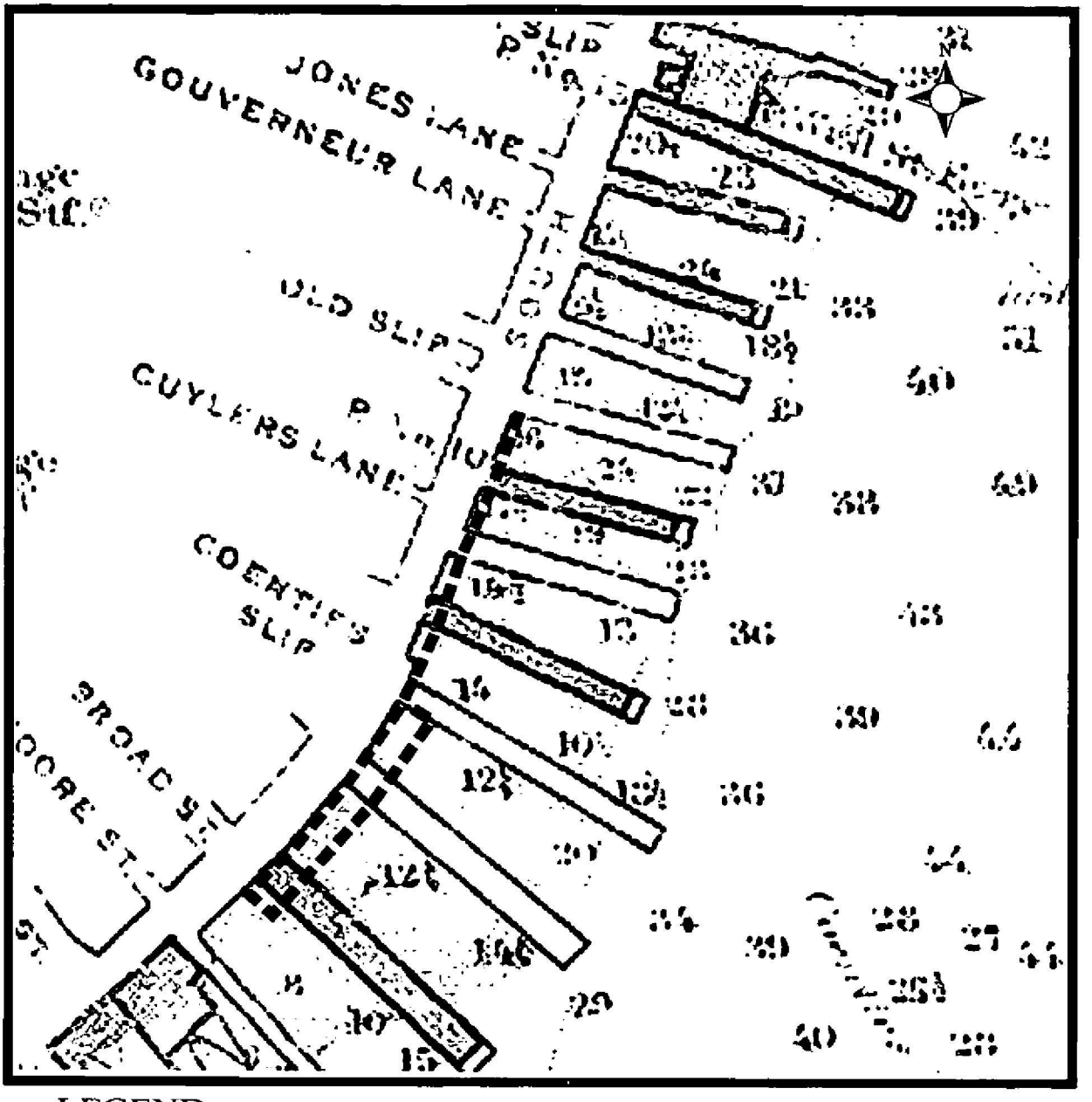
FIGURE 17: Harbor Commissioner's Map, Gouverneur Slip to Jackson Street, 1857



Current Pier 42 location

EAST RIVER Waterfront Esplanade and Piers

FIGURE 18: Sanborn, Atlas of the Borough of Manhattan, 1905
(Detail: Plates 108 and 109, Mongomery Street to Jackson Street)



LEGEND

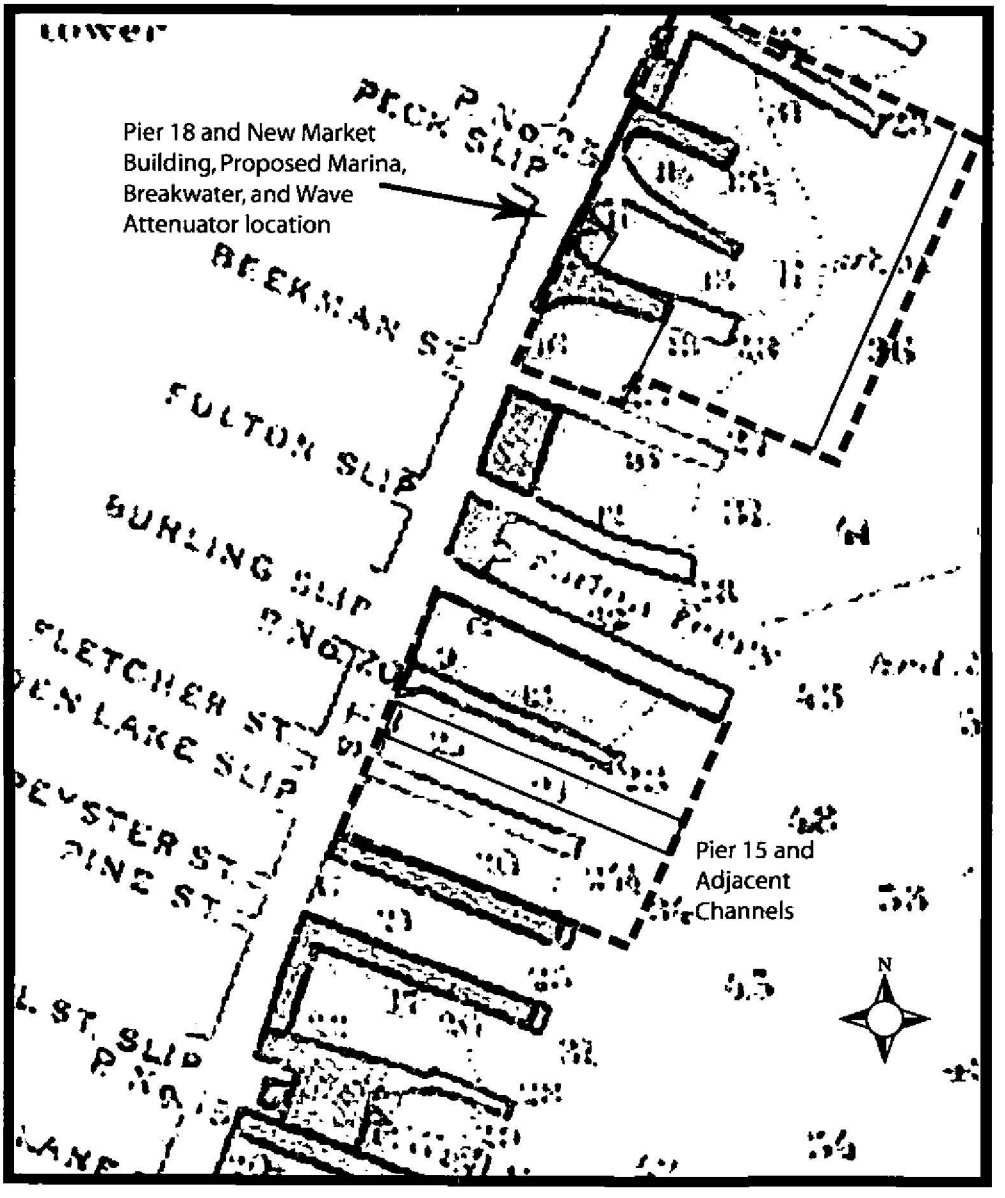
Broad Street to Old Slip (Segment 3) Outboard of the Bulkhead

Note: Boundaries include the APE segment as well as the area between the outboard APE and the modern bulkhead

SOURCE: Office of the Coast Survey, Historical Map and Chart Collection, historicals.ncd.noaa.gov/historicals/histmap.asp

EAST RIVER Waterfront Esplanade and Piers

FIGURE 19: Hudson and East Rivers from West 67th Street to Blackwells Island, 1906 (Detail: Whitehall to Wall Street)



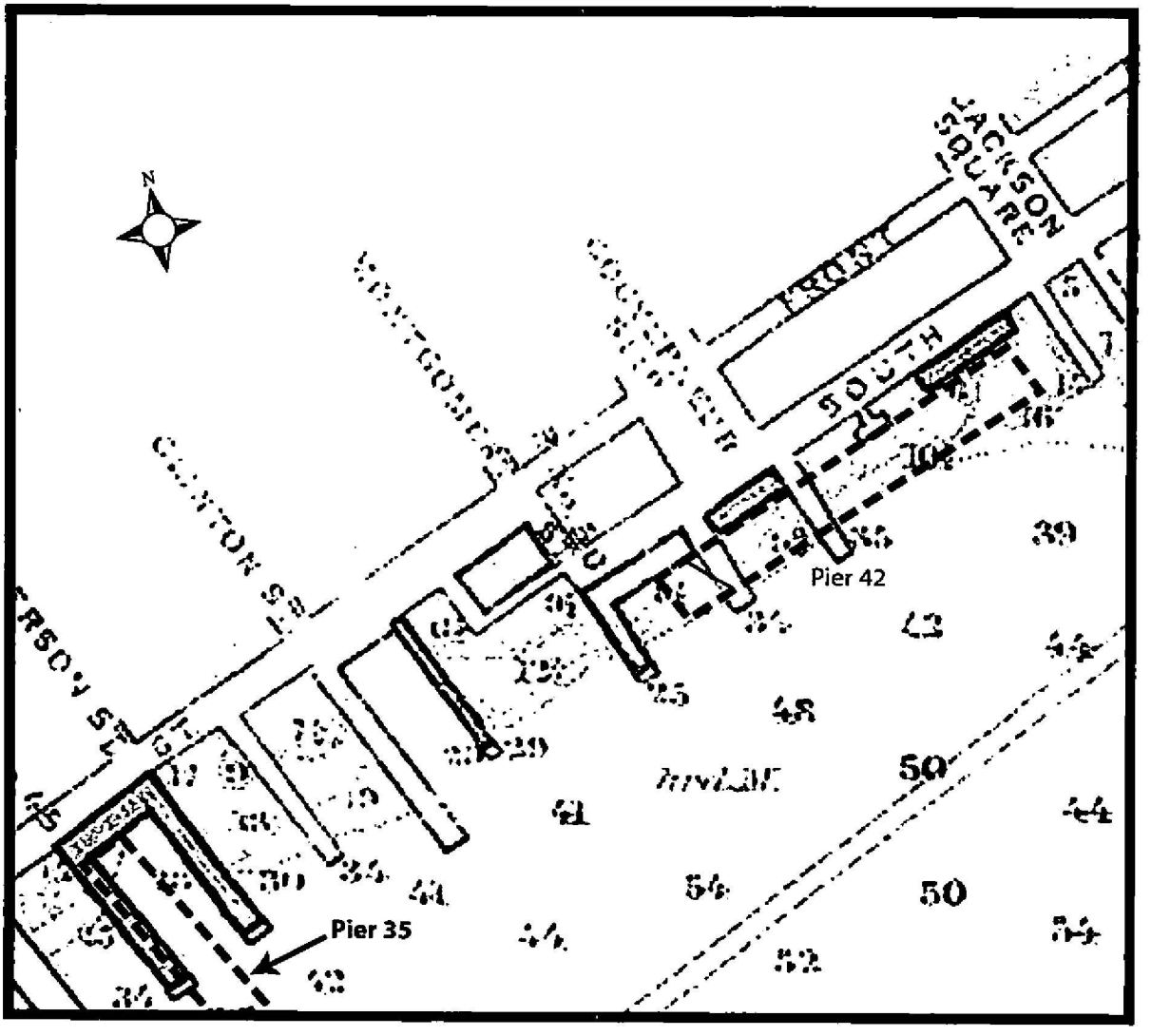
LEGEND

- - - -	Pier 15 and Adjacent Channels (Segment 5) and Pier 18 and New Market Building, Proposed Marina, Breakwater, and Wave Attenuator location (Part of Segment 6)

SOURCE: Office of the Coast Survey, Historical Map and Chart Collection, historicals.ncd.noaa.gov/historicals/histmap.asp

EAST RIVER Waterfront Esplanade and Piers

FIGURE 20: Hudson and East Rivers from West 67th Street to Blackwells Island, 1906 (Detail: Maiden Lane to Dover Street)



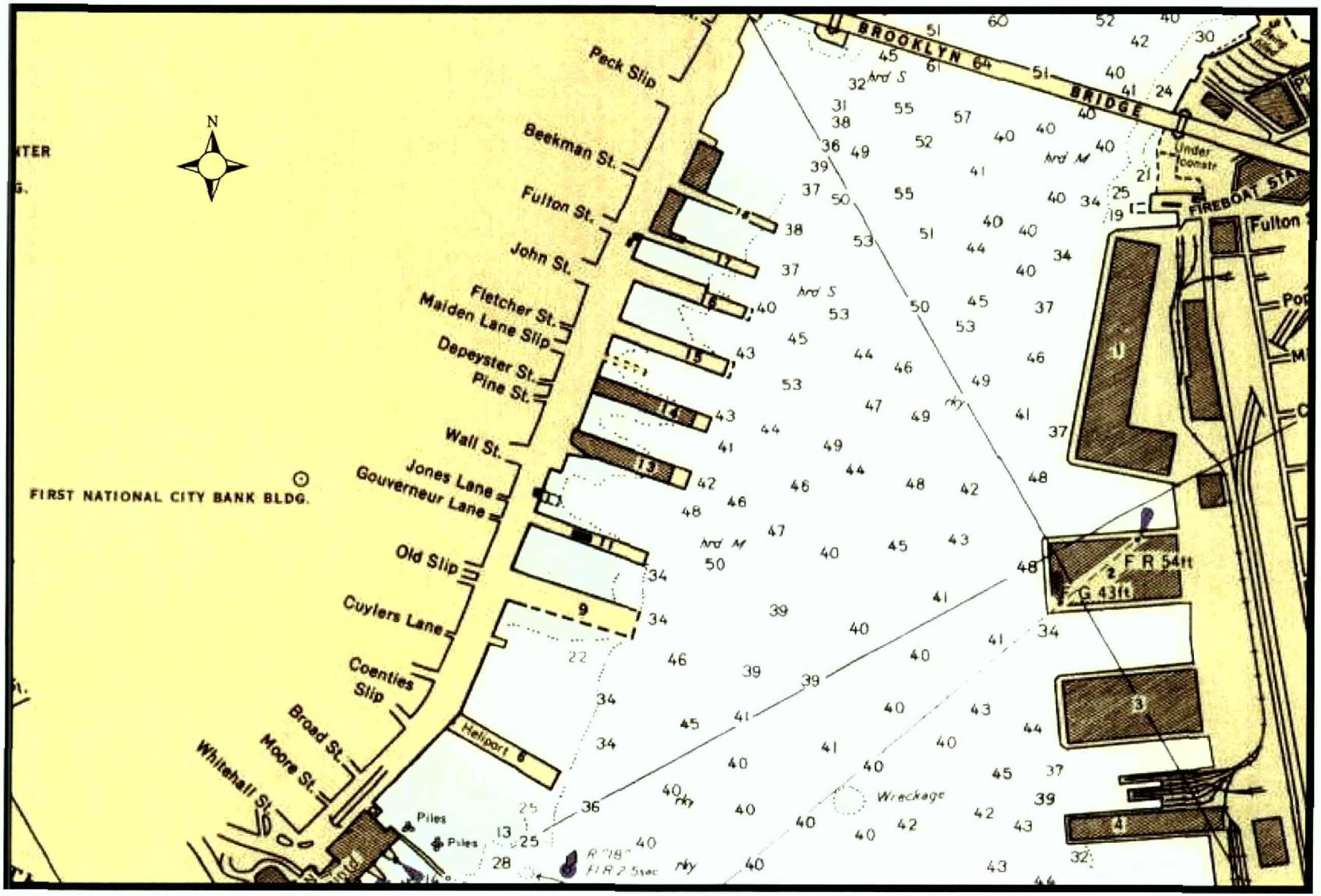
LEGEND

- - - - -	Pier 35 (Segment 8), and Pier 42: Proposed Cove (Segment 9) and Beach (Segment 10)

SOURCE: Office of the Coast Survey, Historical Map and Chart Collection, historicals.ncd.noaa.gov/historicals/histmap.asp

EAST RIVER Waterfront Esplanade and Piers

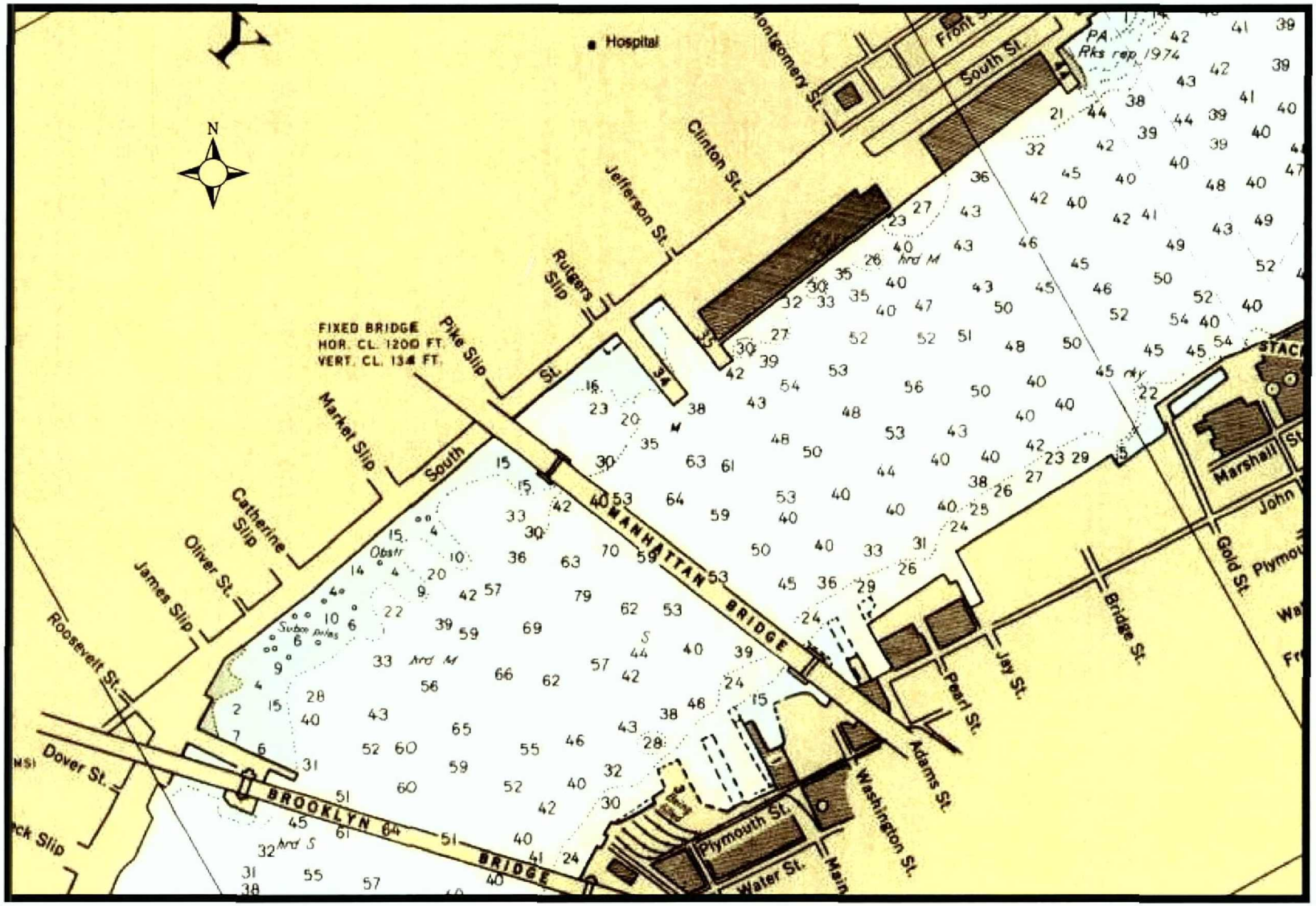
FIGURE 21: Hudson and East Rivers from West 67th Street to Blackwells Island, 1906 (Detail: Jefferson to Jackson Streets)



SOURCE: Office of the Coast Survey, Historical Map and Chart Collection, historicals.ncd.noaa.gov/historicals/histmap.asp

EAST RIVER Waterfront Esplanade and Piers

FIGURE 22: Hudson and East Rivers, Governors Island to 67th Street, 1979
(Detail: Battery to Brooklyn Bridge)



SOURCE: Office of the Coast Survey, Historical Map and Chart Collection, historicals.ncd.noaa.gov/historicals/histmap.asp

EAST RIVER Waterfront Esplanade and Piers

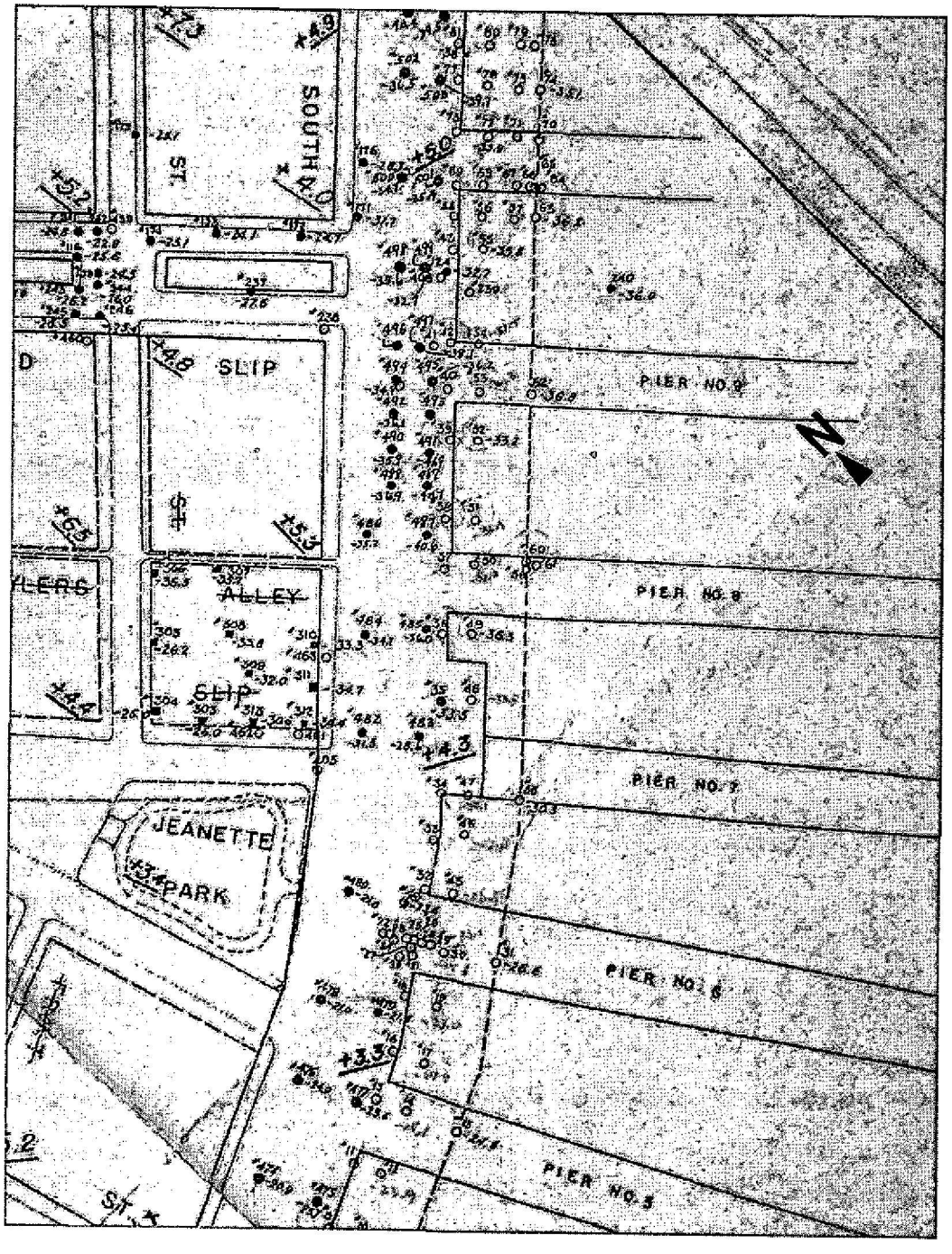
FIGURE 23: Hudson and East Rivers, Governors Island to 67th Street, 1979
(Detail: Maiden Lane to Jackson Street)

East River Waterfront Esplanade and Piers

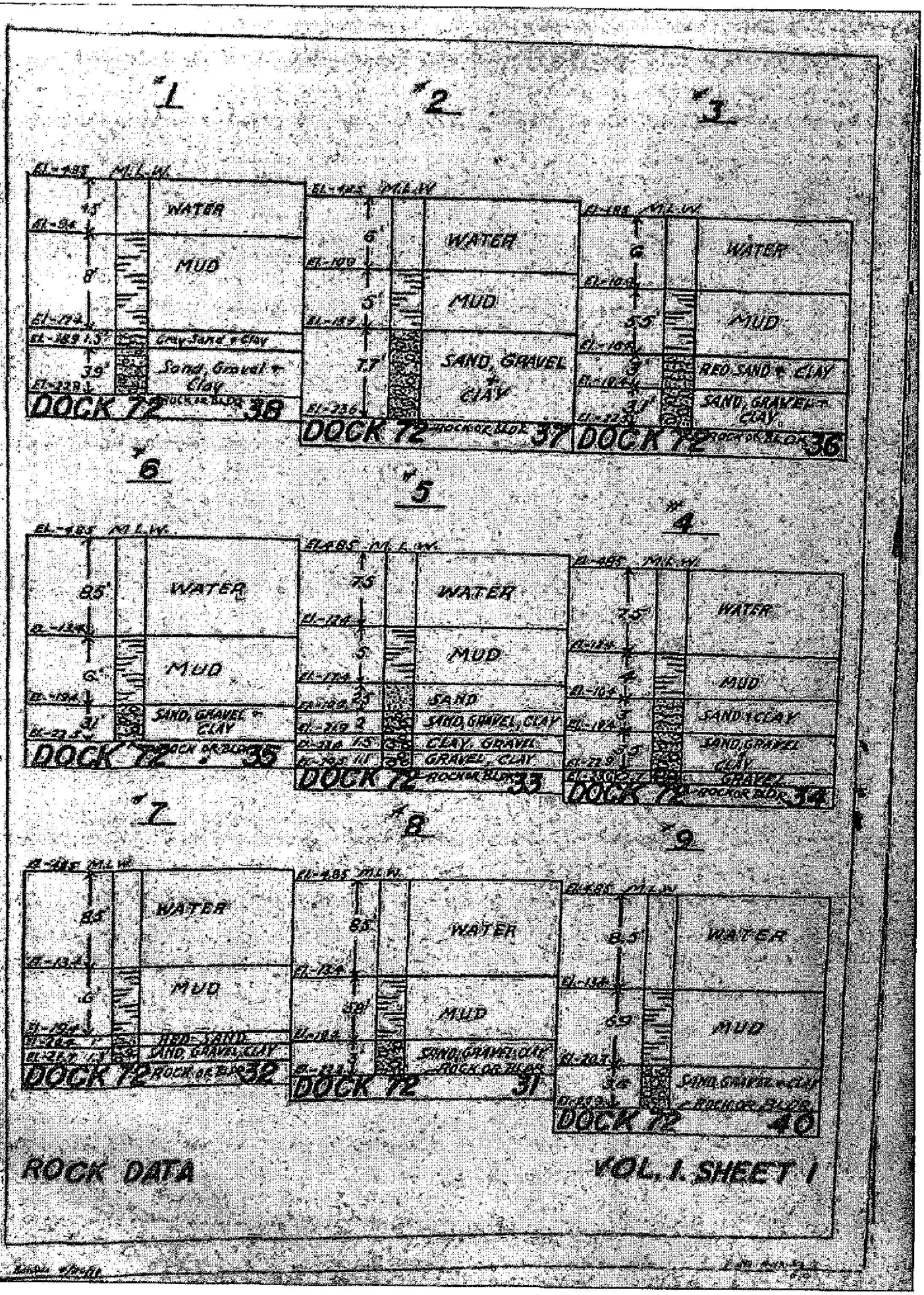
Outboard Resources Phase 1A

APPENDIX

Soil Boring Logs
and
Locational Maps

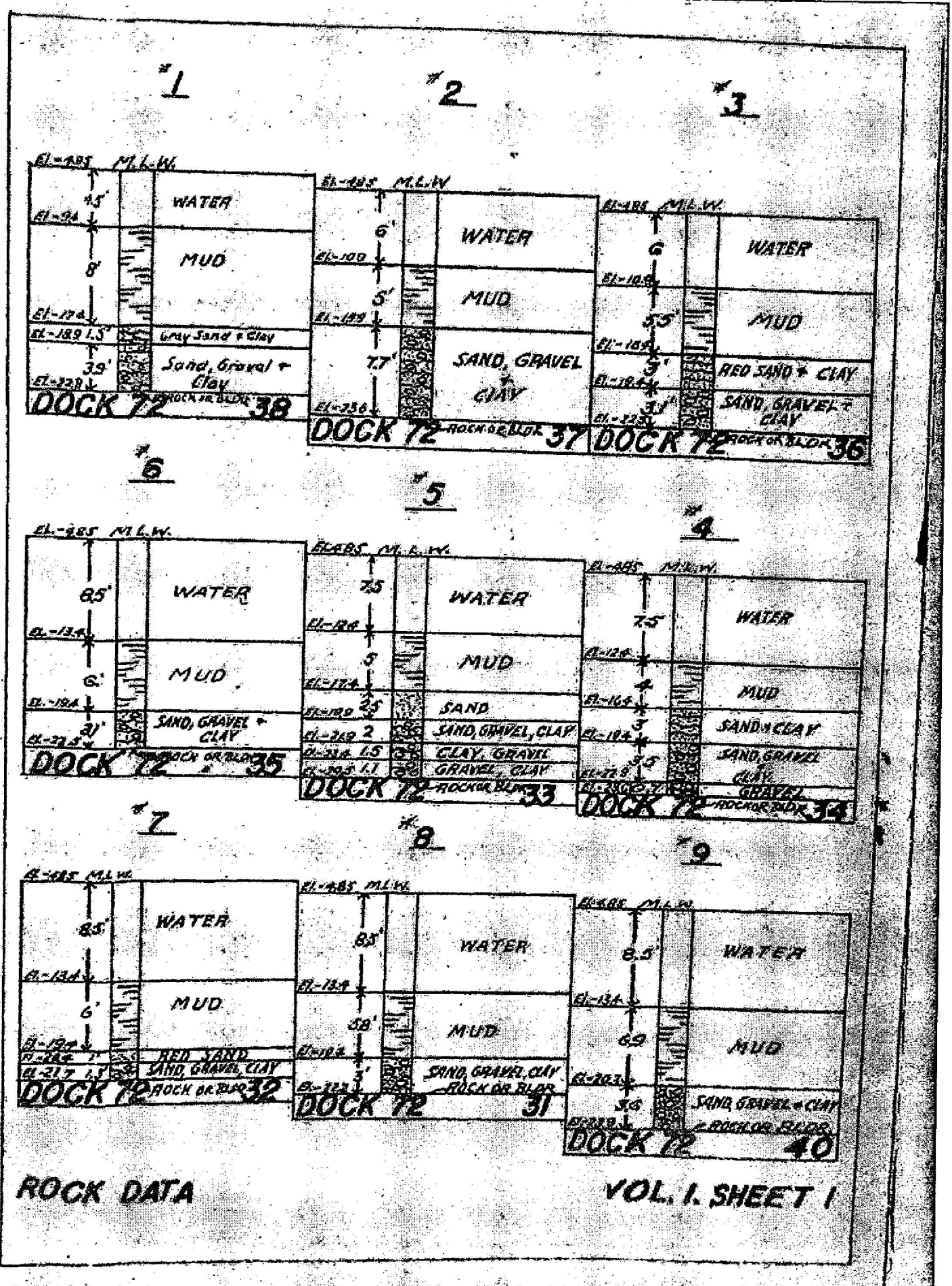


WPA Rock Data – Map Sheet 1b
(Volume 1, Sheet 1. Borough of Manhattan, Office of the President, 1937, revised)



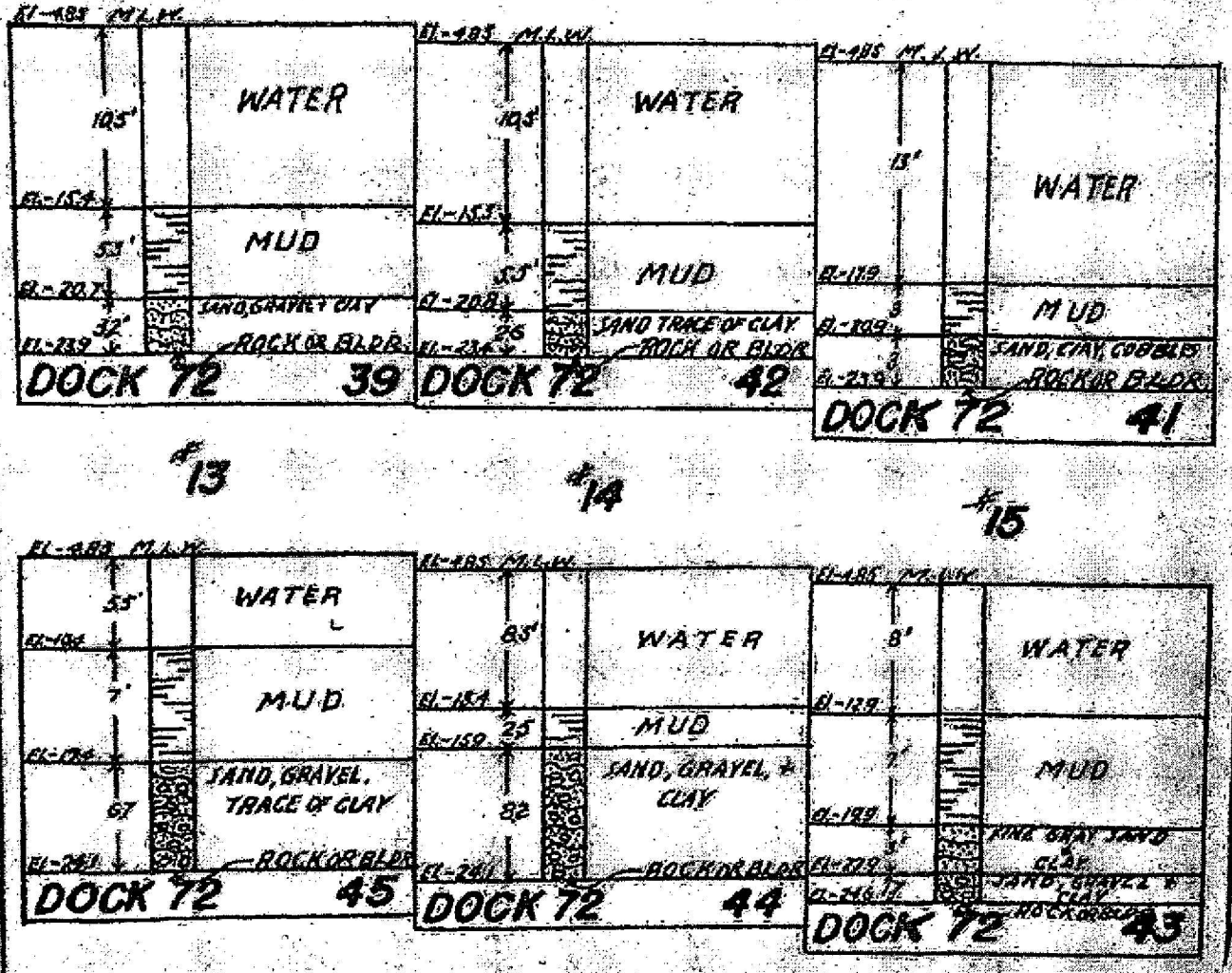
ROCK DATA

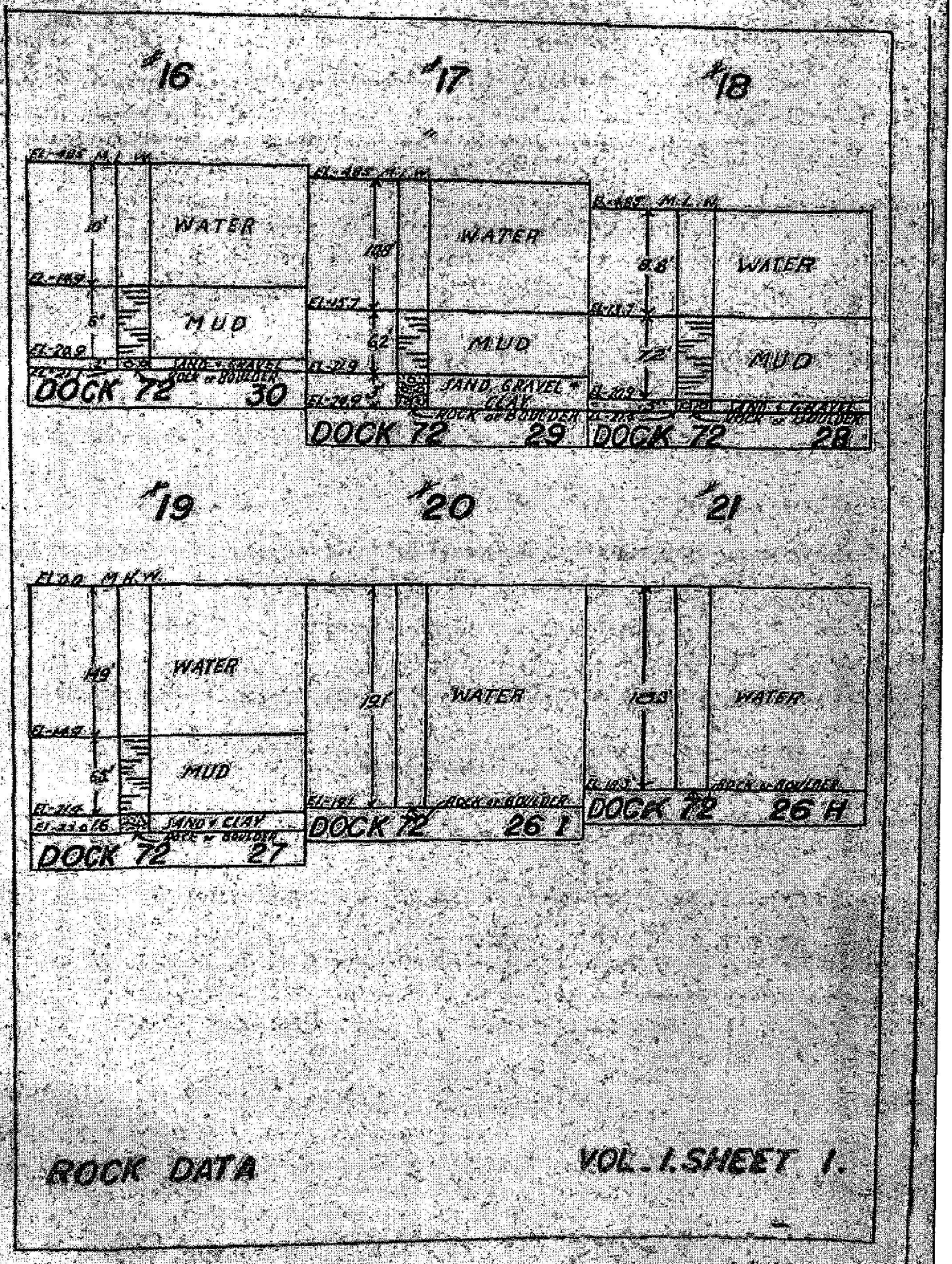
VOL. 1. SHEET 1


#1
#2
#3
El-4.85 M.L.W.
4.5'
El-9.4
WATER
8'
El-17.4
MUD
El-18.9 1.5'
Gray Sand + Clay
3.9'
El-22.8
Sand, Gravel + Clay
DOCK 72 ROCK OR BLDR 38
El-4.85 M.L.W.
6'
El-10.85
WATER
5'
El-14.9
MUD
7.7'
El-23.6
SAND, GRAVEL + CLAY
DOCK 72 ROCK OR BLDR 37
El-4.85 M.L.W.
6'
El-10.85
WATER
5.5'
El-16.4
MUD
3'
El-19.4
RED SAND + CLAY
3.1'
El-22.5
SAND, GRAVEL + CLAY
DOCK 72 ROCK OR BLDR 36
#6
#5
#4
El-4.85 M.L.W.
8.5'
El-13.4
WATER
6'
El-19.4
MUD
3.1'
El-22.5
SAND, GRAVEL + CLAY
DOCK 72 ROCK OR BLDR 35
El-4.85 M.L.W.
7.5
El-12.4
WATER
5'
El-17.4
MUD
2.5
El-19.9
SAND
2
El-21.9
SAND, GRAVEL, CLAY
1.5
El-23.4
CLAY, GRAVEL
1.1
El-24.5
GRAVEL, CLAY
DOCK 72 ROCK OR BLDR 33
El-4.85 M.L.W.
7.5'
El-12.4
WATER
4'
El-16.4
MUD
3'
El-19.4
SAND + CLAY
3.5'
El-22.9
SAND, GRAVEL + CLAY
GRAVEL
DOCK 72 ROCK OR BLDR 34
#7
#8
#9
El-4.85 M.L.W.
8.5'
El-13.4
WATER
6'
El-19.4
MUD
1'
El-20.4
RED SAND
1.3
El-21.7
SAND, GRAVEL, CLAY
DOCK 72 ROCK OR BLDR 32
El-4.85 M.L.W.
8.5'
El-13.4
WATER
5.8'
El-19.2
MUD
3'
El-22.2
SAND, GRAVEL, CLAY
ROCK OR BLDR
DOCK 72 31
El-4.85 M.L.W.
8.5'
El-13.4
WATER
6.9
El-20.3
MUD
3.6
El-23.9
SAND, GRAVEL + CLAY
+ ROCK OR BLDR
DOCK 72 40
ROCK DATA
VOL. I. SHEET 1

ROCK DATA

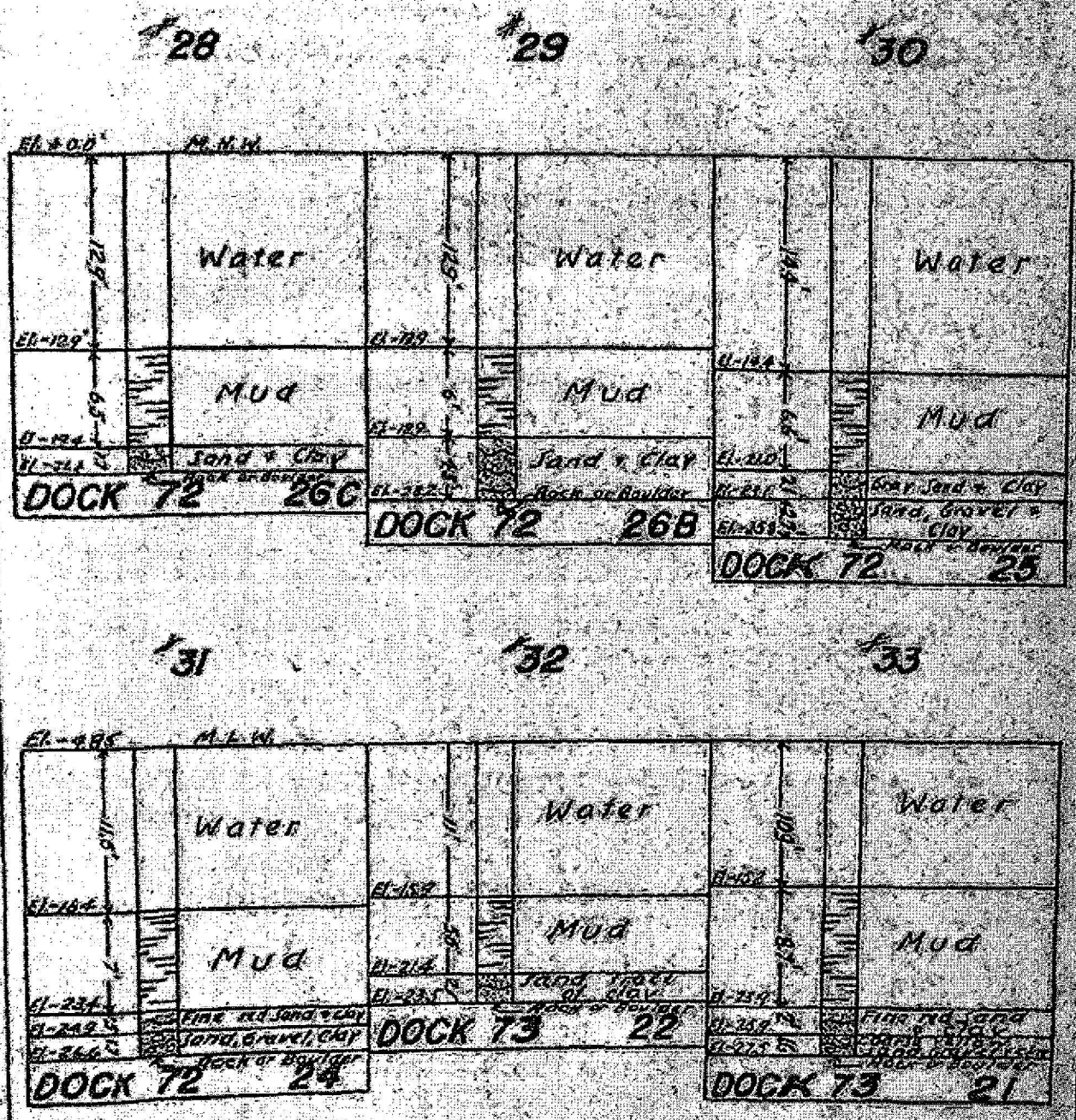
VOL. I. SHEET 1.

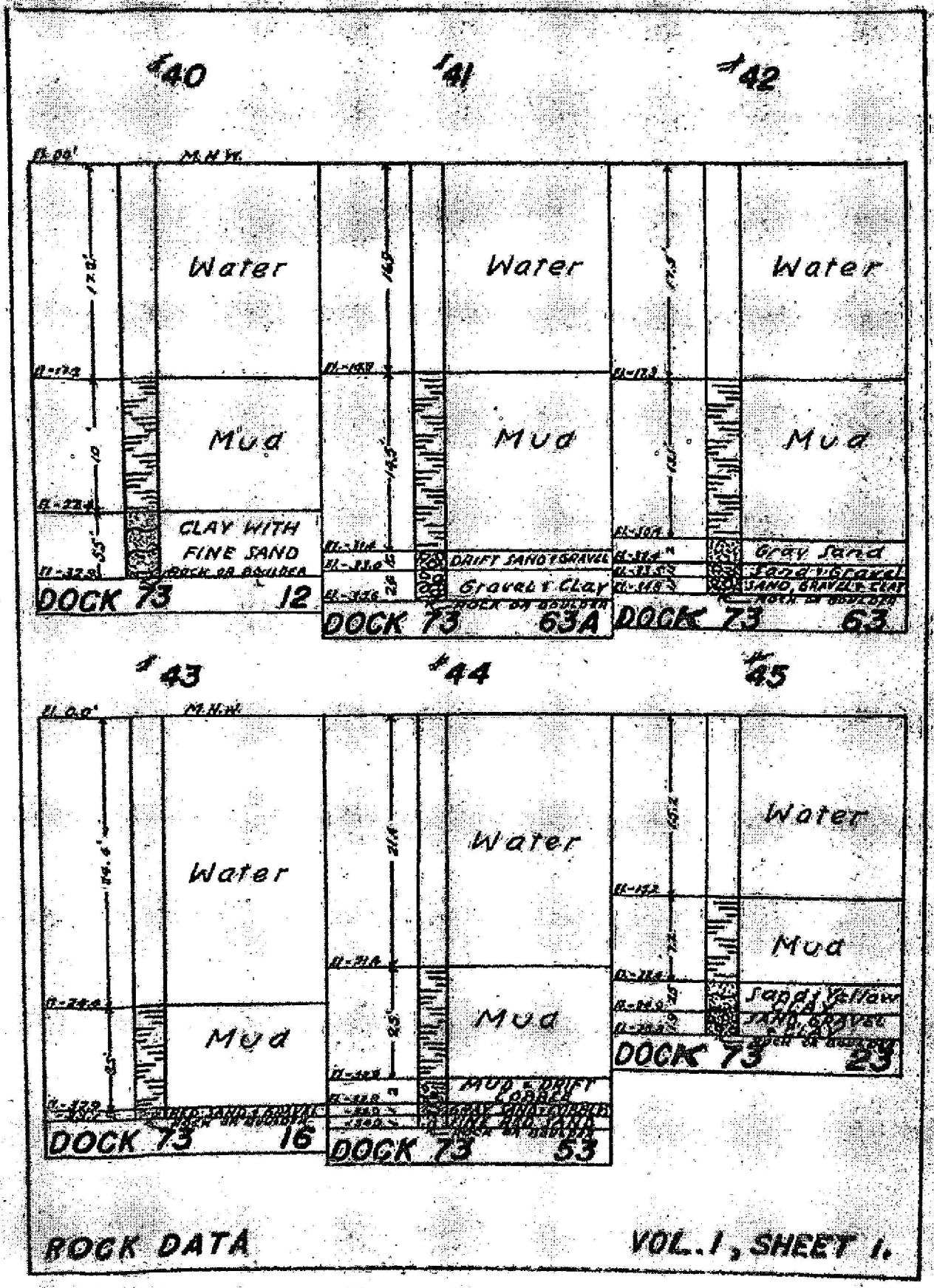


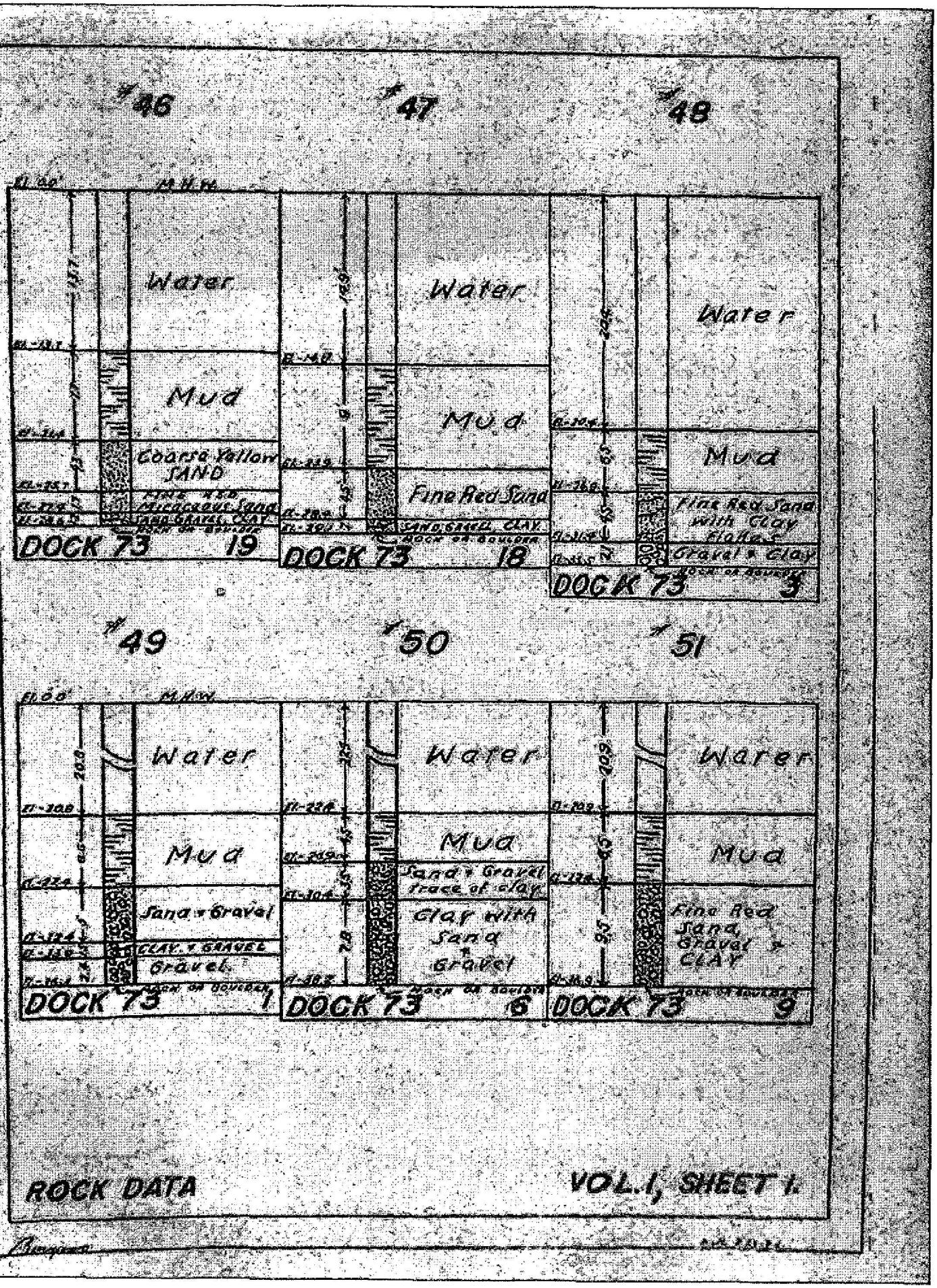


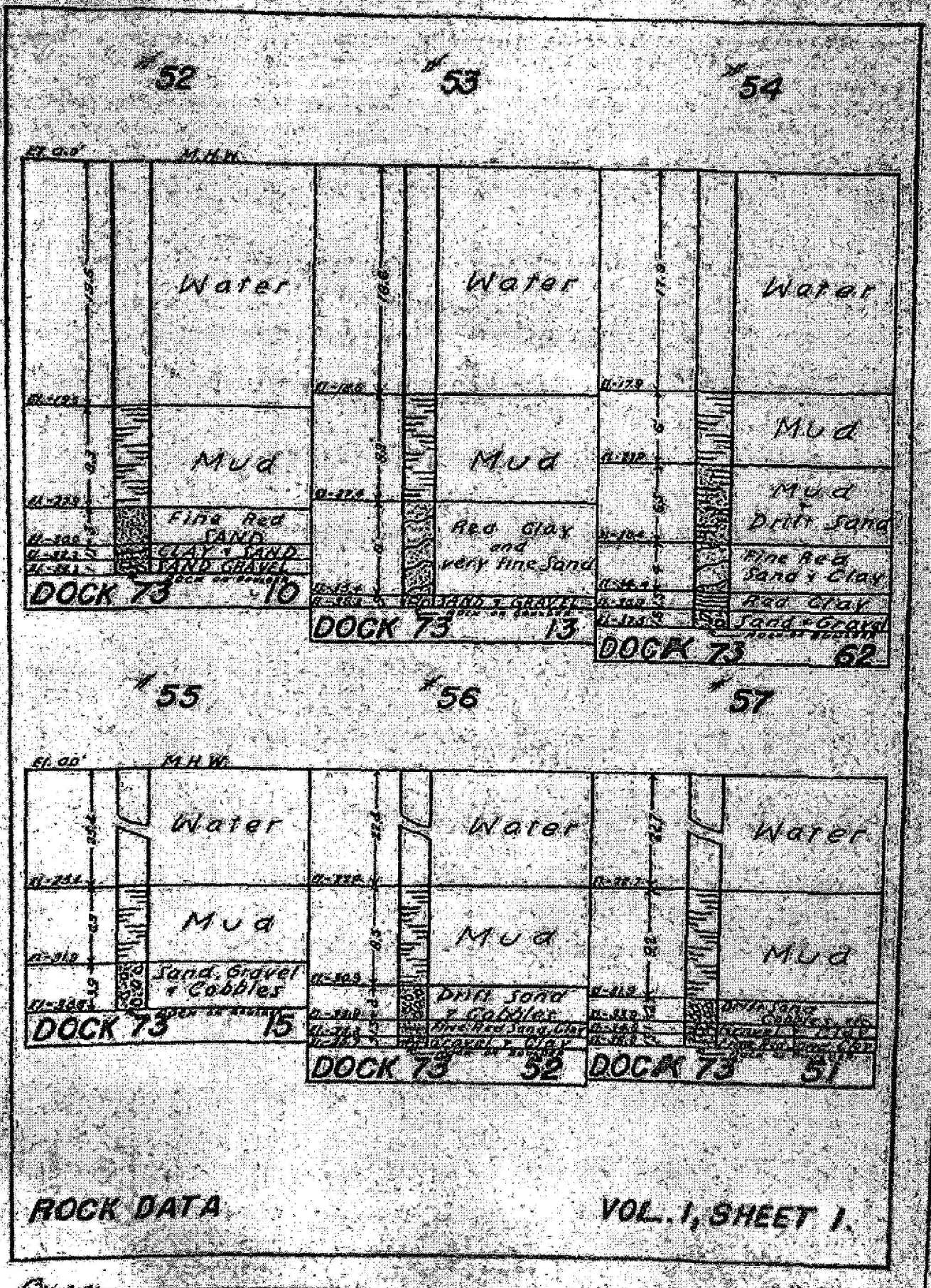
ROCK DATA

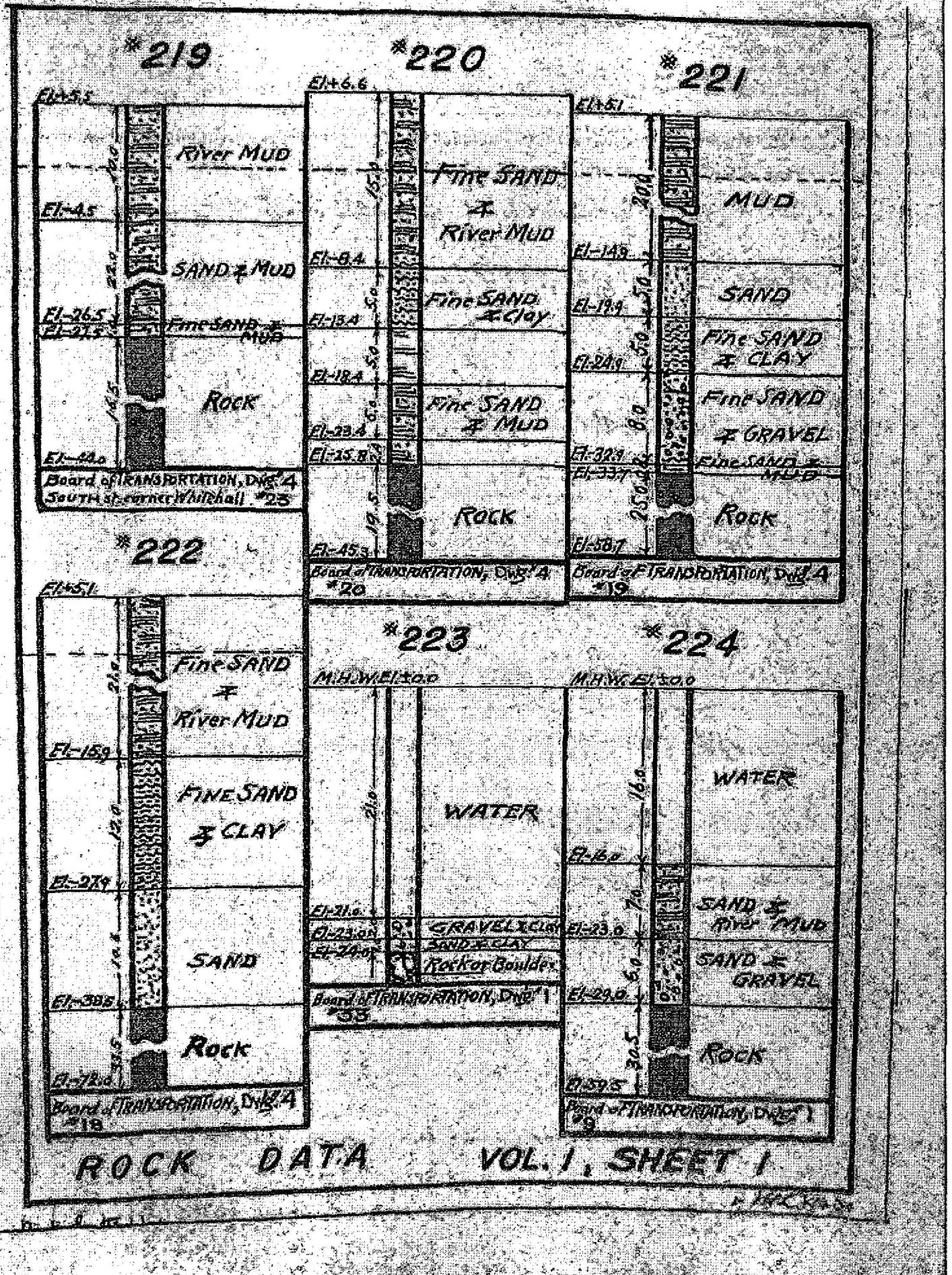
VOL. I. SHEET 1.

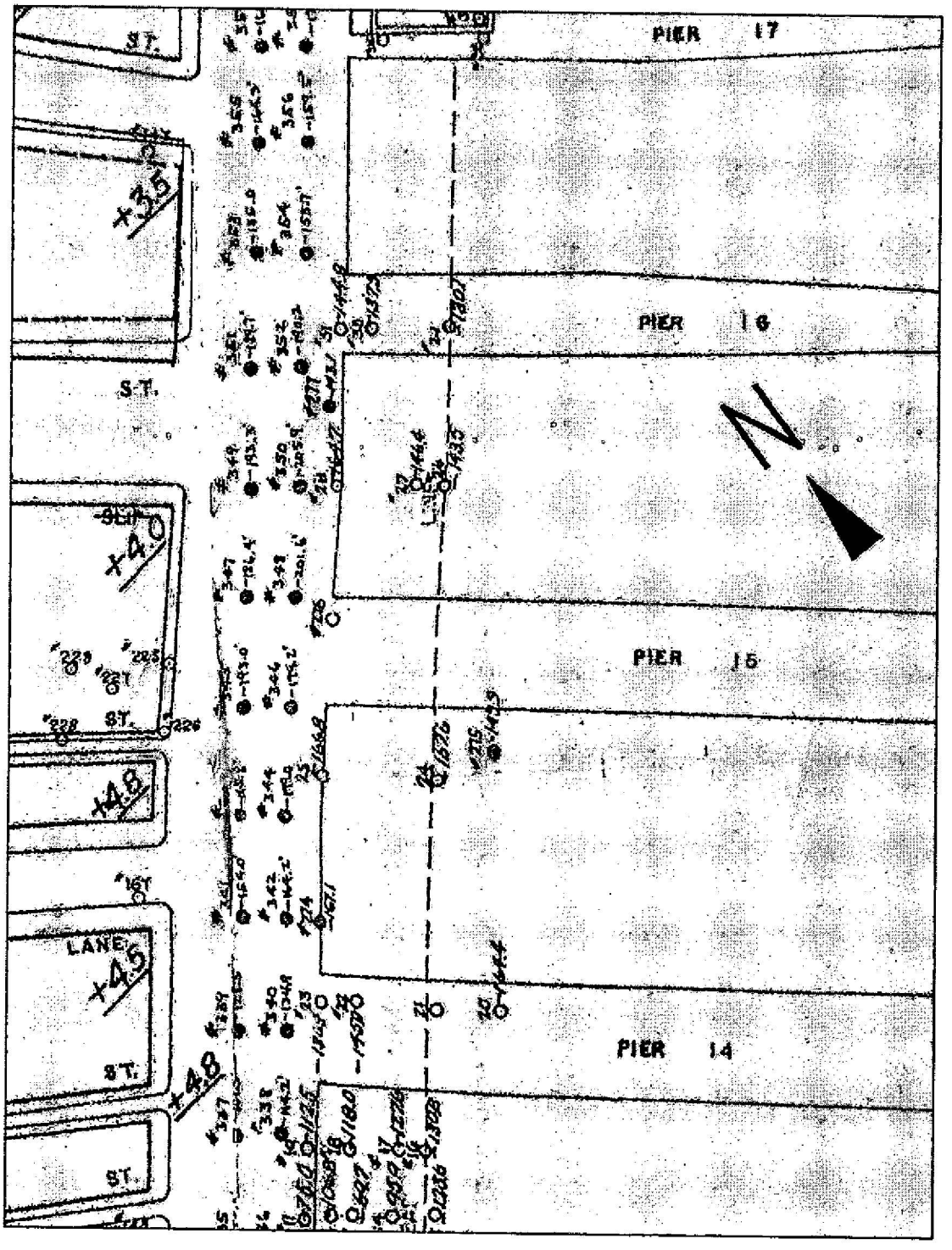

#28
#29
#30
El. ± 0.0' M.H.W.
Water
Mud
Sand + Clay
Rock or Boulder
DOCK 72 26C
DOCK 72 26B
Water
Mud
Sand + Clay
Rock or Boulder
Boul. Sand + Clay
Sand, Gravel + Clay
DOCK 72 25
#31
#32
#33
El. -4.85 M.L.W.
Water
Mud
Fine red Sand + Clay
Sand, Gravel, Clay
Rock or Boulder
DOCK 72 24
DOCK 73 22
Sand, trace of clay
DOCK 73 21
ROCK DATA
VOL. 1. SHEET 1.


#40
#41
#42
Water
Mud
CLAY WITH FINE SAND
ROCK OR BOULDER
DOCK 73 12
Water
Mud
DRIFT SAND & GRAVEL
Gravel & Clay
ROCK OR BOULDER
DOCK 73 63A
Water
Mud
Gray Sand
Sand & Gravel
SAND, GRAVEL & CLAY
ROCK OR BOULDER
DOCK 73 63
#43
#44
#45
Water
Mud
DOCK 73 16
Water
Mud
MUD & DRIFT BOULDERS
DOCK 73 53
Water
Mud
Sandy Yellow Clay
SAND, GRAVEL & BOULDERS
DOCK 73 23
ROCK DATA
VOL. I, SHEET 1.

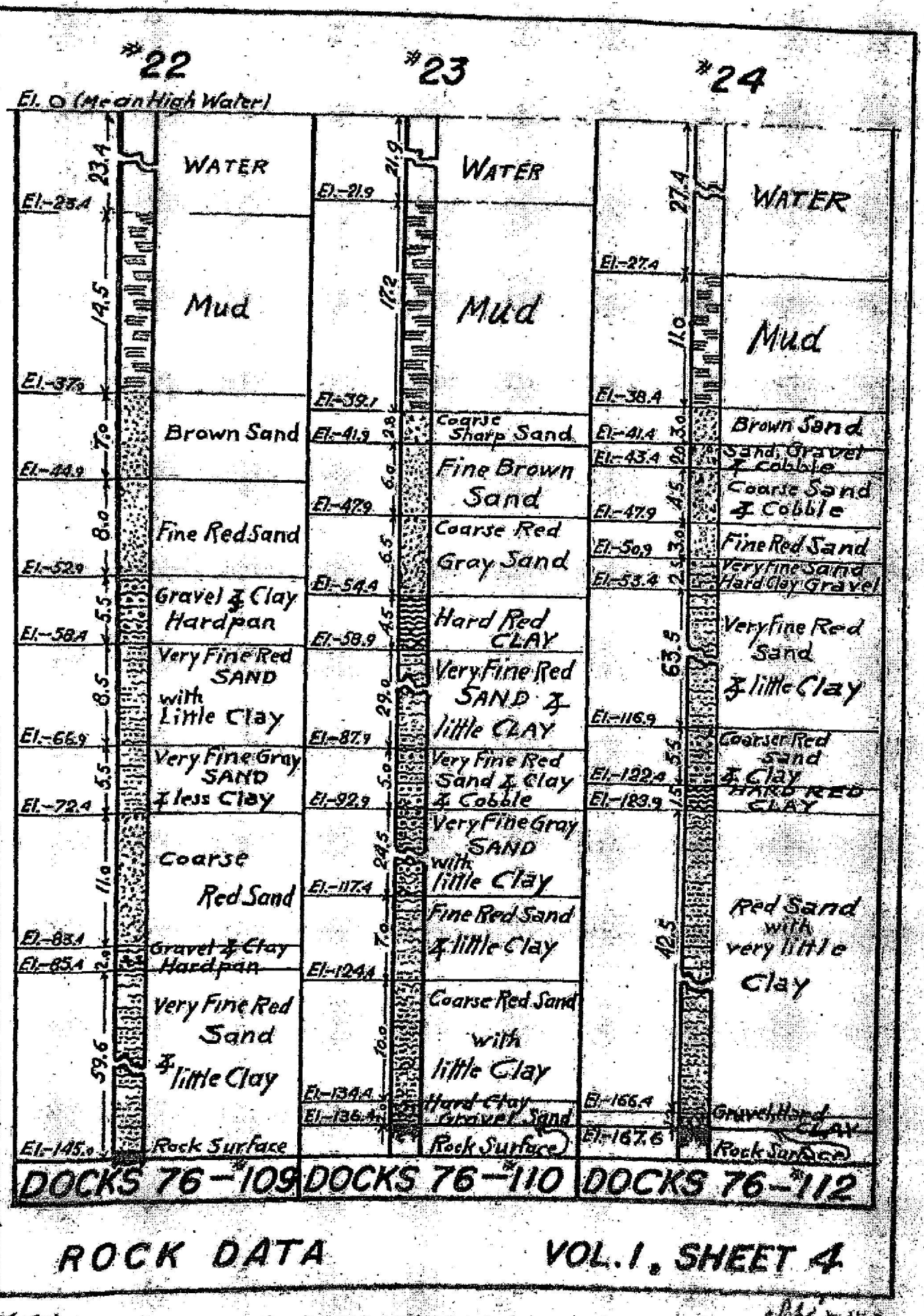

#46
#47
#48
El. 20'
M.H.W.
Water
Mud
Coarse Yellow SAND
Fine Red Sand
Mucky Sand
SAND GRAVEL CLAY
ROCK OR BOULDER
DOCK 73 19
DOCK 73 18
Water
Mud
Fine Red Sand with Clay flakes
Gravel & Clay
DOCK 73 3
#49
#50
#51
El. 0.0'
M.H.W.
Water
Mud
Sand & Gravel
CLAY & GRAVEL
Gravel
Sand & Gravel trace of clay
Clay with Sand & Gravel
Fine Red Sand, Gravel & CLAY
DOCK 73 1
DOCK 73 6
DOCK 73 9
ROCK DATA
VOL. 1, SHEET 1.


#52
#53
#54
El. 0.0'
M.H.W.
Water
Mud
Fine Red SAND
CLAY + SAND
SAND GRAVEL
DOCK 73 10
Water
Mud
Red Clay and very fine Sand
SAND + GRAVEL
DOCK 73 13
Water
Mud
Mud + Drift Sand
Fine Red Sand + Clay
Red Clay
Sand + Gravel
DOCK 73 62
#55
#56
#57
El. 0.0'
M.H.W.
Water
Mud
Sand, Gravel + Cobbles
DOCK 73 15
Water
Mud
Drift Sand + Cobbles
Fine Red Sand Clay
Gravel + Clay
DOCK 73 52
Water
Mud
Drift Sand Cobbles etc.
DOCK 73 51
ROCK DATA
VOL. 1, SHEET 1.

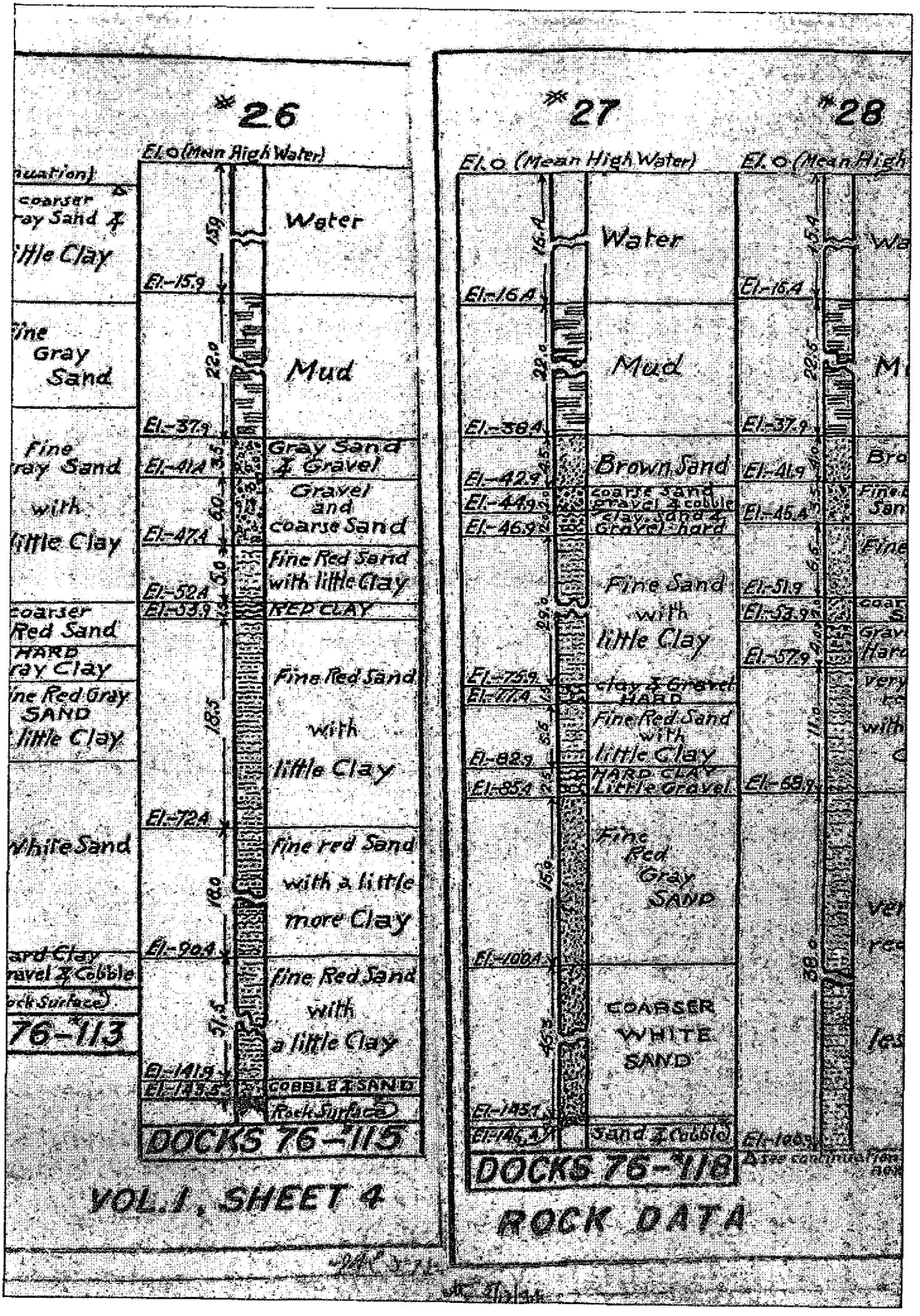

#219
El+5.5
River Mud
El-4.5
SAND & MUD
El-26.5
El-27.5
Fine SAND & Mud
ROCK
El-44.0
Board of TRANSPORTATION, Dwg. 4
SOUTH st. corner Whitehall #23
#220
El+6.6
Fine SAND & River Mud
El-8.4
Fine SAND & Clay
El-13.4
El-18.4
Fine SAND & MUD
El-23.4
El-25.8
ROCK
El-45.3
Board of TRANSPORTATION, Dwg. 4
#20
#221
El+5.1
MUD
El-14.9
SAND
El-19.9
Fine SAND & CLAY
El-29.9
Fine SAND & GRAVEL
El-32.9
El-33.7
Fine SAND & MUD
ROCK
El-58.7
Board of TRANSPORTATION, Dwg. 4
#19
#222
El+5.1
Fine SAND & River MUD
El-15.9
FINE SAND & CLAY
El-27.9
SAND
El-38.5
ROCK
El-72.0
Board of TRANSPORTATION, Dwg. 4
#18
#223
M.H.W. El +0.0
WATER
El-21.0
El-23.0±
GRAVEL & Clay
SAND & CLAY
El-24.0±
Rock or Boulders
Board of TRANSPORTATION, Dwg. 1
#38
#224
M.H.W. El +0.0
WATER
El-16.0
SAND & River MUD
El-23.0
SAND & GRAVEL
El-29.0
ROCK
El-59.5
Board of TRANSPORTATION, Dwg. 1
#9
ROCK DATA VOL. 1, SHEET 1

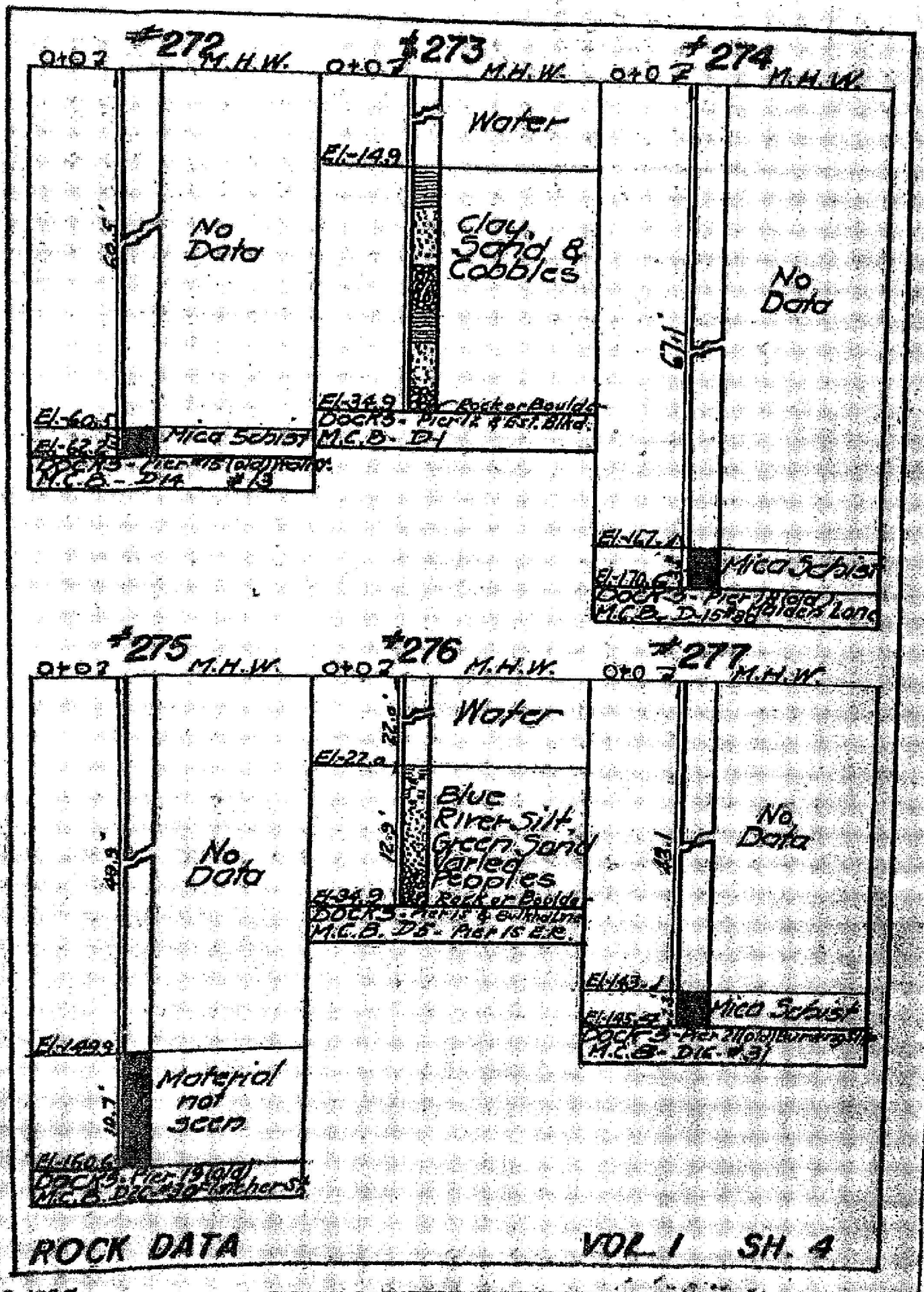


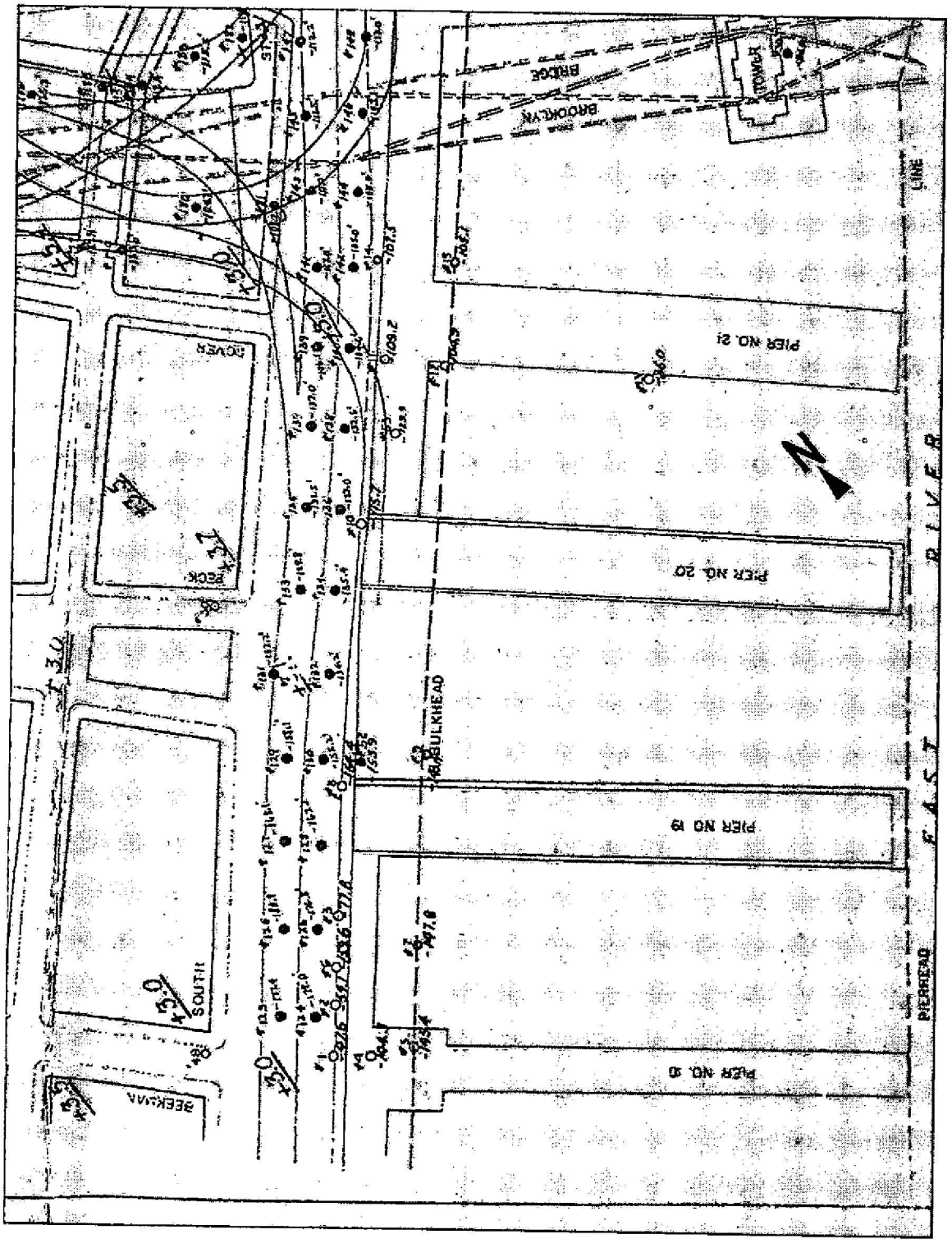
WPA Rock Data – Map Sheet 4
(Volume 1, Sheet 4. Borough of Manhattan, Office of the President, 1937, revised)



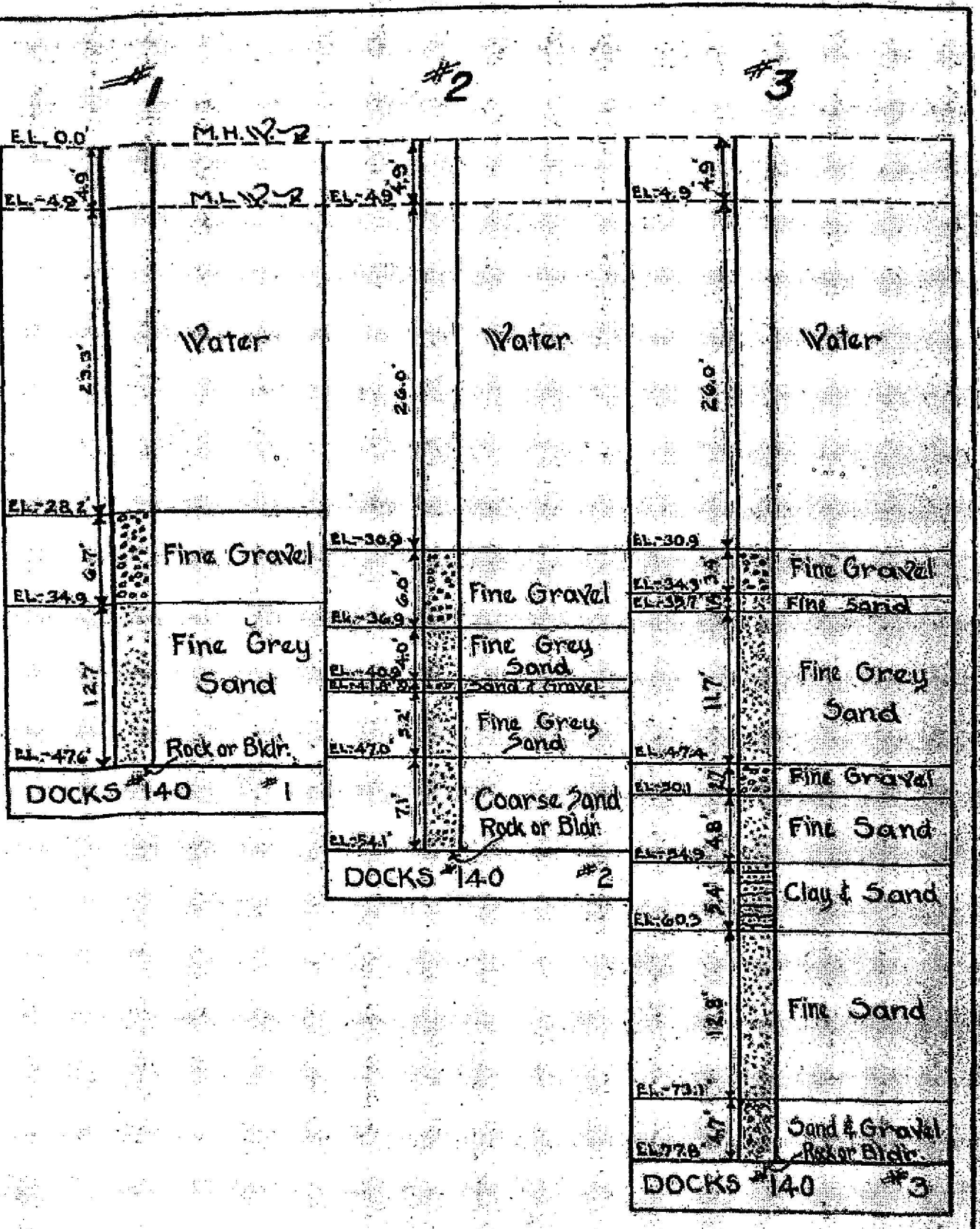
ROCK DATA VOL. I, SHEET 4


#26
El. 0 (Mean High Water)
Water
El.-15.9
15.9
Mud
22.0
El.-37.9
Gray Sand & Gravel
El.-41.4
3.5
Gravel and coarse Sand
40.1
El.-47.4
Fine Red Sand with little Clay
5.0
El.-52.4
RED CLAY
El.-53.9
Fine Red Sand with little Clay
18.5
El.-72.4
fine red Sand with a little more Clay
18.0
El.-90.4
fine Red Sand with a little Clay
51.5
El.-141.9
COBBLE & SAND
El.-145.5
Rock Surface
DOCKS 76-115
coarser Red Sand
HARD Gray Clay
Fine Red Gray SAND little Clay
White Sand
Hard Clay Gravel & Cobble
Rock Surface
76-113
Fine Gray Sand
Fine Gray Sand with little Clay
coarser & Gray Sand & little Clay
#27
El. 0 (Mean High Water)
Water
El.-16.4
16.4
Mud
22.0
El.-38.4
Brown Sand
El.-42.9
4.5
coarse Sand gravel & cobble
El.-44.9
2.0
Clay, sand & Gravel hard
El.-46.9
2.0
Fine Sand with little Clay
29.0
El.-75.9
clay & Gravel HARD
El.-77.4
1.5
Fine Red Sand with little Clay
3.6
El.-82.9
HARD CLAY Little Gravel
El.-85.4
2.5
Fine Red Gray SAND
15.0
El.-100.4
COARSER WHITE SAND
45.1
El.-145.1
Sand & Cobble
El.-146.4
1.3
DOCKS 76-118
#28
El. 0 (Mean High
Wa
El.-16.4
16.4
22.5
M
El.-37.9
Bro
El.-41.9
4.0
Fine
San
El.-45.4
3.5
Fine
El.-51.9
6.5
coar
S
Grav
Hard
El.-57.9
6.0
very
with
El.-68.9
11.0
ver
rec
36.0
les
El.-104.9
See continuation
nex
ROCK DATA
VOL. 1, SHEET 4


#272
M.H.W.
0+07
No Data
60.5'
El-60.5
El-62.2
Mica Schist
Dock 3 - Pier #15 (old) Section
M.C.B. - D14 #13
#273
M.H.W.
0+07
Water
El-14.9
Clay, Sand & Cobbles
El-34.9
Rock or Boulder
Dock 3 - Pier 12 & Est. Bldg.
M.C.B. - D-1
#274
M.H.W.
0+07
No Data
El-167.4
Mica Schist
El-170.6
Dock 3 - Pier 11 (old)
M.C.B. - D-15 & 16 Holden's Land
#275
M.H.W.
0+07
No Data
49.2'
El-149.9
Material not seen
19.7'
El-160.6
Dock 3 - Pier 19 (old)
M.C.B. D2C #30 Fletcher St
#276
M.H.W.
0+07
Water
22.0'
El-22.0
Blue River Silt, Green Sand Varied Peoples
12.9'
El-34.9
Rock or Boulder
Dock 3 - Pier 18 & Bulkheads
M.C.B. D8 - Pier 18 E.E.
#277
M.H.W.
0+07
No Data
49.1'
El-143.4
Mica Schist
El-145.4
Dock 3 - Pier 21 (old) Boarding St
M.C.B. - D1C #31
ROCK DATA
VOL. I SH. 4
LN 4-B-1938

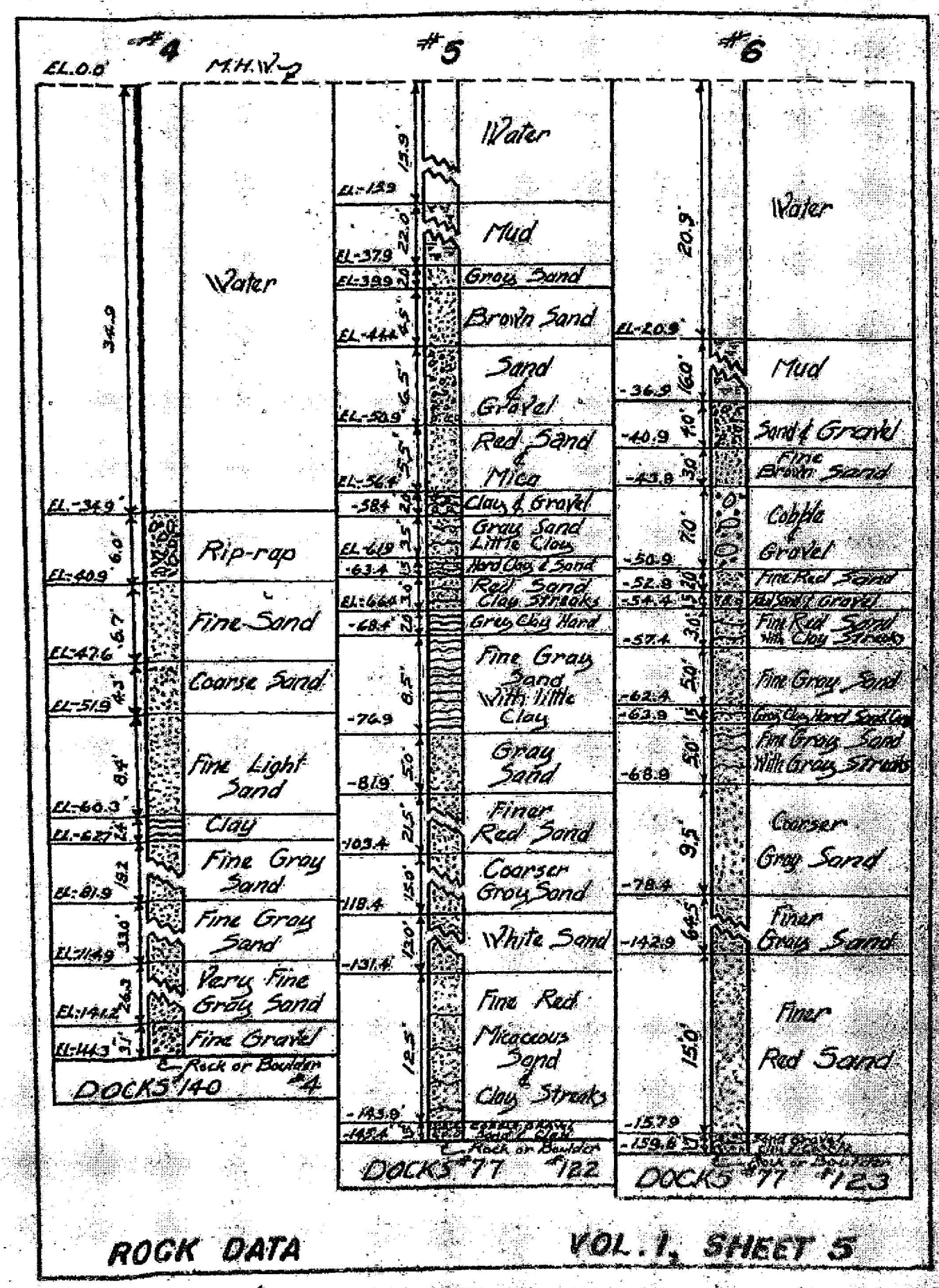


WPA Rock Data – Map Sheet 5
(Volume 1, Sheet 5. Borough of Manhattan, Office of the President, 1937, revised)

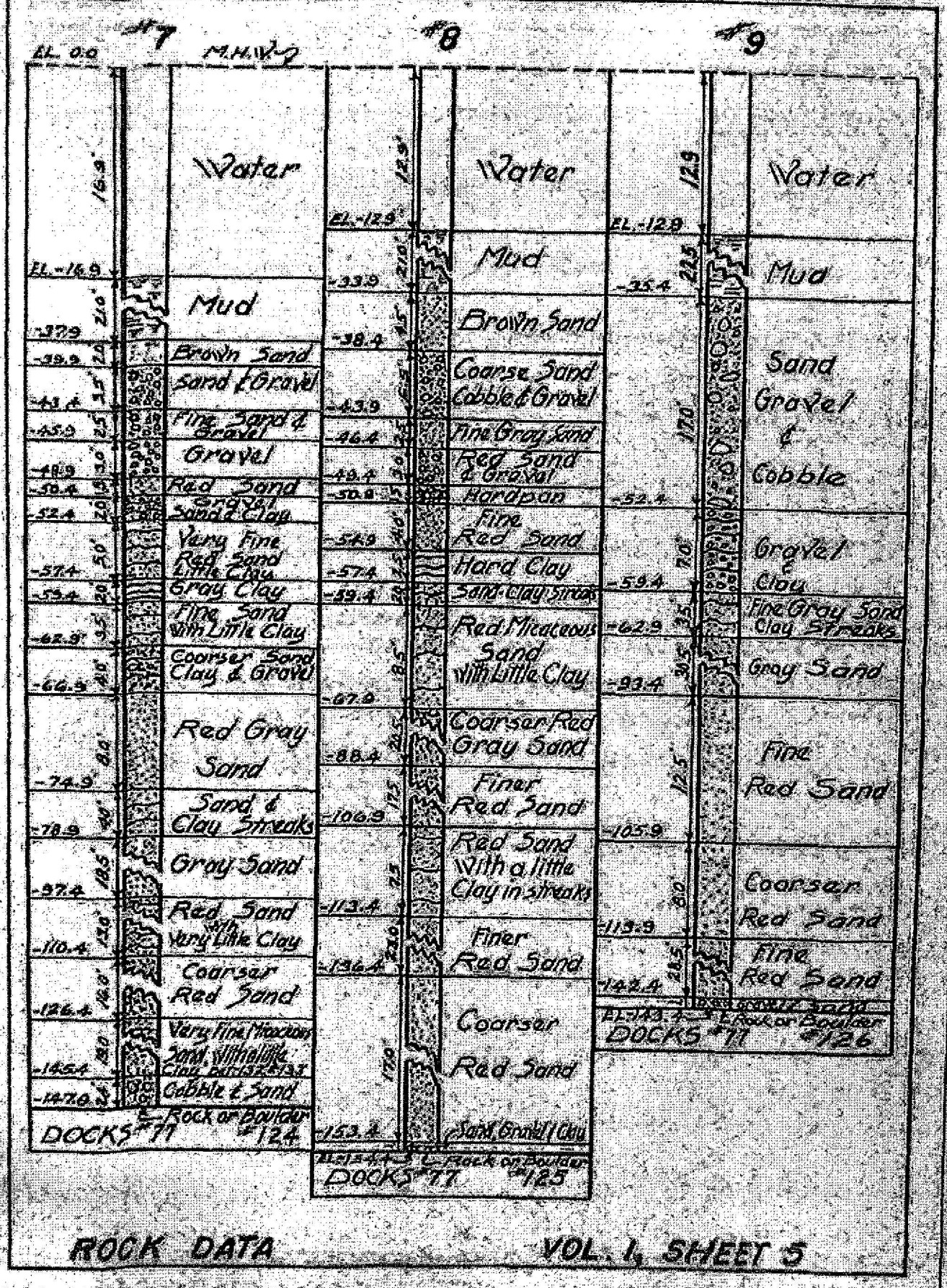


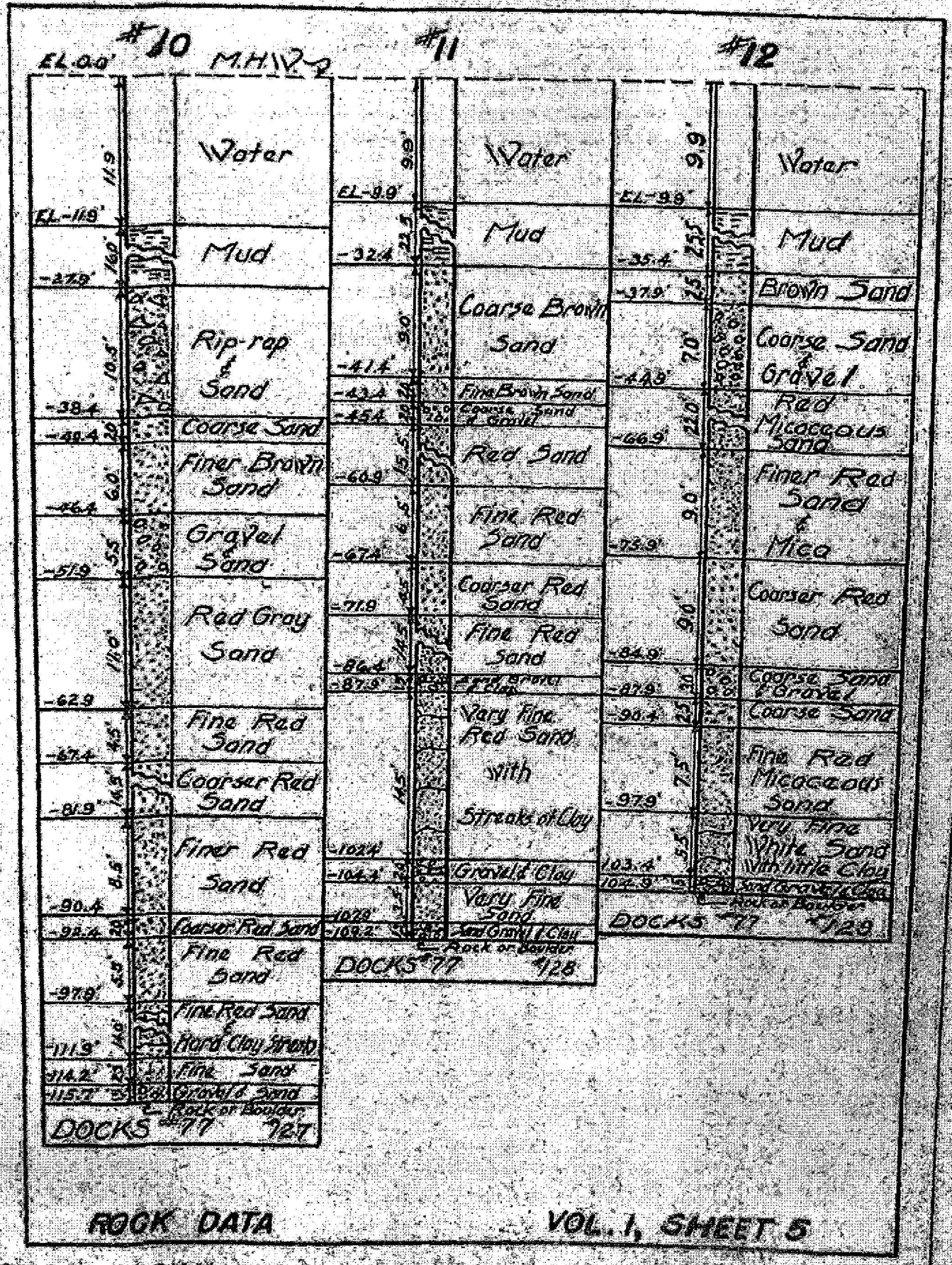
ROCK DATA VOL. I, SHEET 5

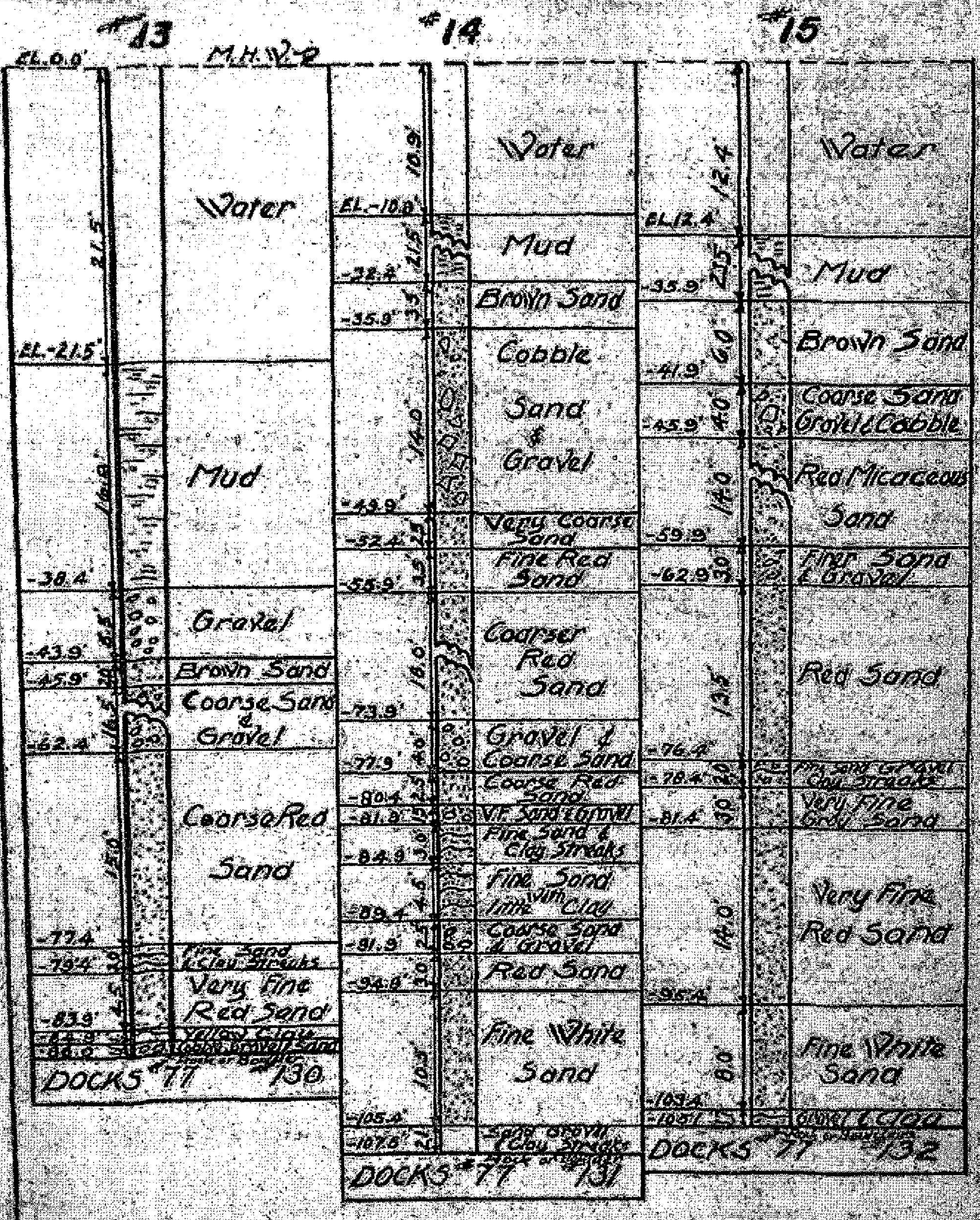
ian - 5-23-34 CKP 5-24-34 B-28-34



bmoh 6-21-34 - Begun 8-29-34 cmo


#7
EL. 0.0
M.H.W.-2
16.9'
Water
EL.-16.9
21.0'
Mud
-37.9
2.0'
Brown Sand
-39.9
3.5'
Sand & Gravel
-43.4
2.5'
Fine Sand & Gravel
-45.9
3.0'
Gravel
-48.9
1.5'
Red Sand
-50.4
2.0'
Gravel Sand & Clay
-52.4
5.0'
Very Fine Red Sand Little Clay
-57.4
2.0'
Gray Clay
-59.4
3.5'
Fine Sand With Little Clay
-62.9
4.0'
Coarser Sand Clay & Gravel
-66.9
8.0'
Red Gray Sand
-74.9
4.0'
Sand & Clay Streaks
-78.9
18.5'
Gray Sand
-97.4
12.0'
Red Sand With Very Little Clay
-110.4
16.0'
Coarser Red Sand
-126.4
18.0'
Very Fine Micaceous Sand, With Little Clay Partly Red
-144.4
3.0'
Cobble & Sand
-147.4
Rock or Boulder
DOCKS #77 #124
#8
12.9'
Water
EL.-12.9
21.0'
Mud
-33.9
4.5'
Brown Sand
-38.4
6.5'
Coarse Sand Cobble & Gravel
-43.9
2.5'
Fine Gray Sand
-46.4
3.0'
Red Sand & Gravel
-49.4
1.5'
Hardpan
-50.9
4.0'
Fine Red Sand
-54.9
2.5'
Hard Clay
-57.4
2.0'
Sand-Clay Streaks
-59.4
8.5'
Red Micaceous Sand With Little Clay
-67.9
4.5'
Coarser Red Gray Sand
-88.4
17.5'
Finer Red Sand
-106.9
7.5'
Red Sand With a little Clay in streaks
-113.4
23.0'
Finer Red Sand
-136.4
17.0'
Coarser Red Sand
-153.4
Sand, Gravel & Clay
EL.-154.4±
Rock or Boulder
DOCKS #77 #125
#9
12.9'
Water
EL.-12.9
22.5'
Mud
-35.4
17.0'
Sand Gravel & Cobble
-52.4
7.0'
Gravel & Clay
-59.4
3.5'
Fine Gray Sand Clay Streaks
-62.9
30.5'
Gray Sand
-93.4
12.5'
Fine Red Sand
-105.9
8.0'
Coarser Red Sand
-113.9
28.5'
Fine Red Sand
-142.4
Decomposed Rock
EL.-143.4±
Rock or Boulder
DOCKS #77 #126
ROCK DATA
VOL. I, SHEET 5

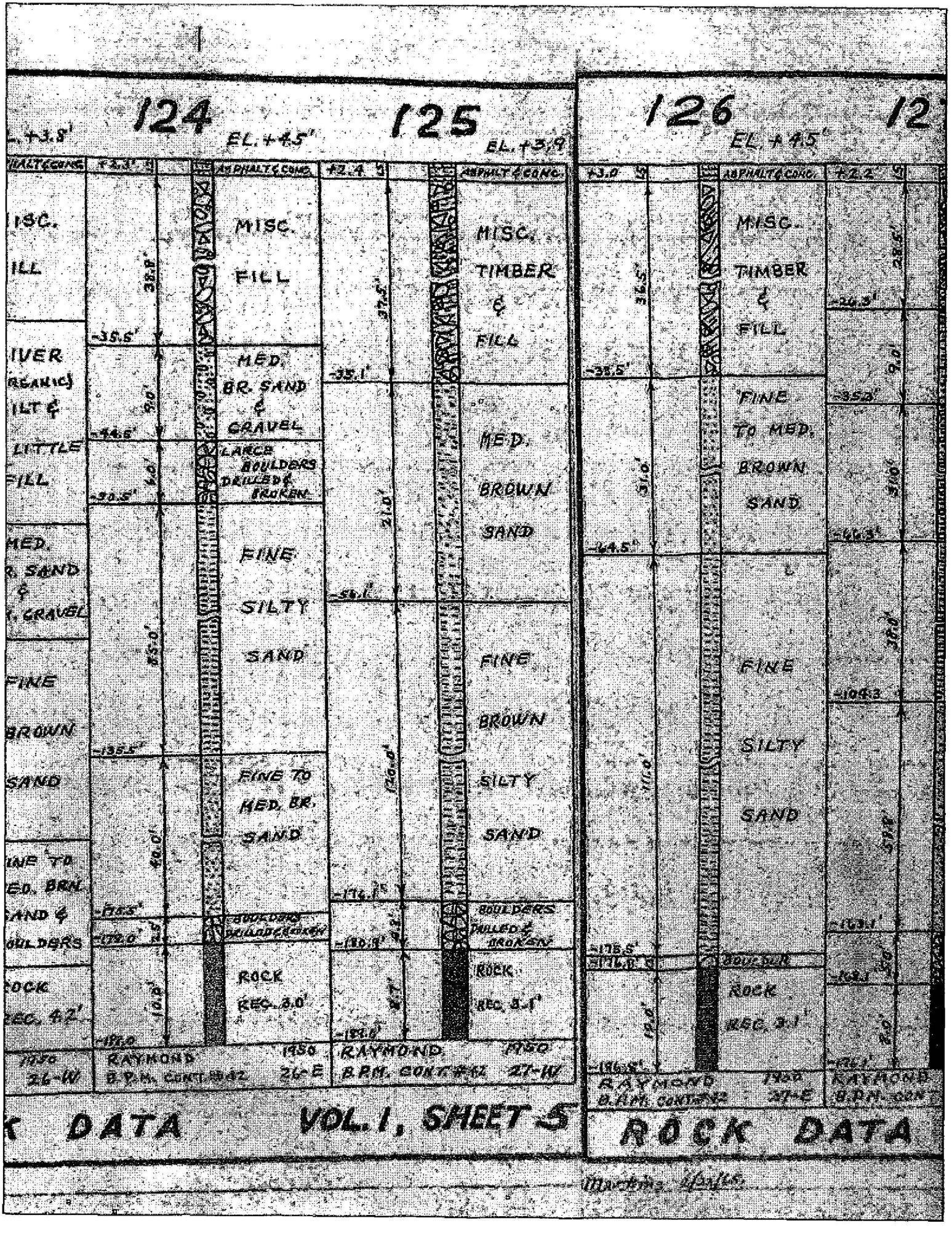

#10
EL 0.0'
M.H.W.
Water
11.9'
EL -11.9'
Mud
16.0'
-27.9'
Rip-rap & Sand
10.5'
-38.4'
Coarse Sand
2.0'
-40.4'
Finer Brown Sand
6.0'
-46.4'
Gravel & Sand
5.5'
-51.9'
Red Gray Sand
11.0'
-62.9'
Fine Red Sand
4.5'
-67.4'
Coarser Red Sand
14.5'
-81.9'
Finer Red Sand
8.5'
-90.4'
Coarser Red Sand
2.0'
-92.4'
Fine Red Sand
5.0'
-97.9'
Fine Red Sand & Hard Clay Streaks
14.0'
-111.9'
Fine Sand
2.0'
-113.9'
Gravel & Sand
1.8'
-115.7'
Rock or Boulder
DOCKS '77 '127
#11
Water
9.9'
EL -9.9'
Mud
22.5'
-32.4'
Coarse Brown Sand
9.0'
-41.4'
Fine Brown Sand
2.0'
-43.4'
Coarse & Gravel
2.0'
-45.4'
Red Sand
15.5'
-60.9'
Fine Red Sand
6.5'
-67.4'
Coarser Red Sand
4.5'
-71.9'
Fine Red Sand
14.5'
-86.4'
Hard Ground
1.5'
-87.9'
Very Fine Red Sand with Streaks of Clay
14.5'
-102.4'
Gravelly Clay
2.0'
-104.4'
Very Fine Sand
5.8'
-107.8'
Sand Gravel & Clay
1.4'
-109.2'
Rock or Boulder
DOCKS '77 '128
#12
Water
9.9'
EL -9.9'
Mud
25.5'
-35.4'
Brown Sand
2.5'
-37.9'
Coarse Sand & Gravel
7.0'
-44.9'
Red Micaceous Sand
22.0'
-66.9'
Finer Red Sand & Mica
9.0'
-75.9'
Coarser Red Sand
9.0'
-84.9'
Coarse Sand & Gravel
3.0'
-87.9'
Coarse Sand
2.5'
-90.4'
Fine Red Micaceous Sand
7.5'
-97.9'
Very Fine White Sand with little Clay
5.5'
103.4'
102.9'
Sand Gravel & Clay
Rock or Boulder
DOCKS '77 '129
ROCK DATA
VOL. 1, SHEET 5



ROCK DATA

VOL. I SHEET 5

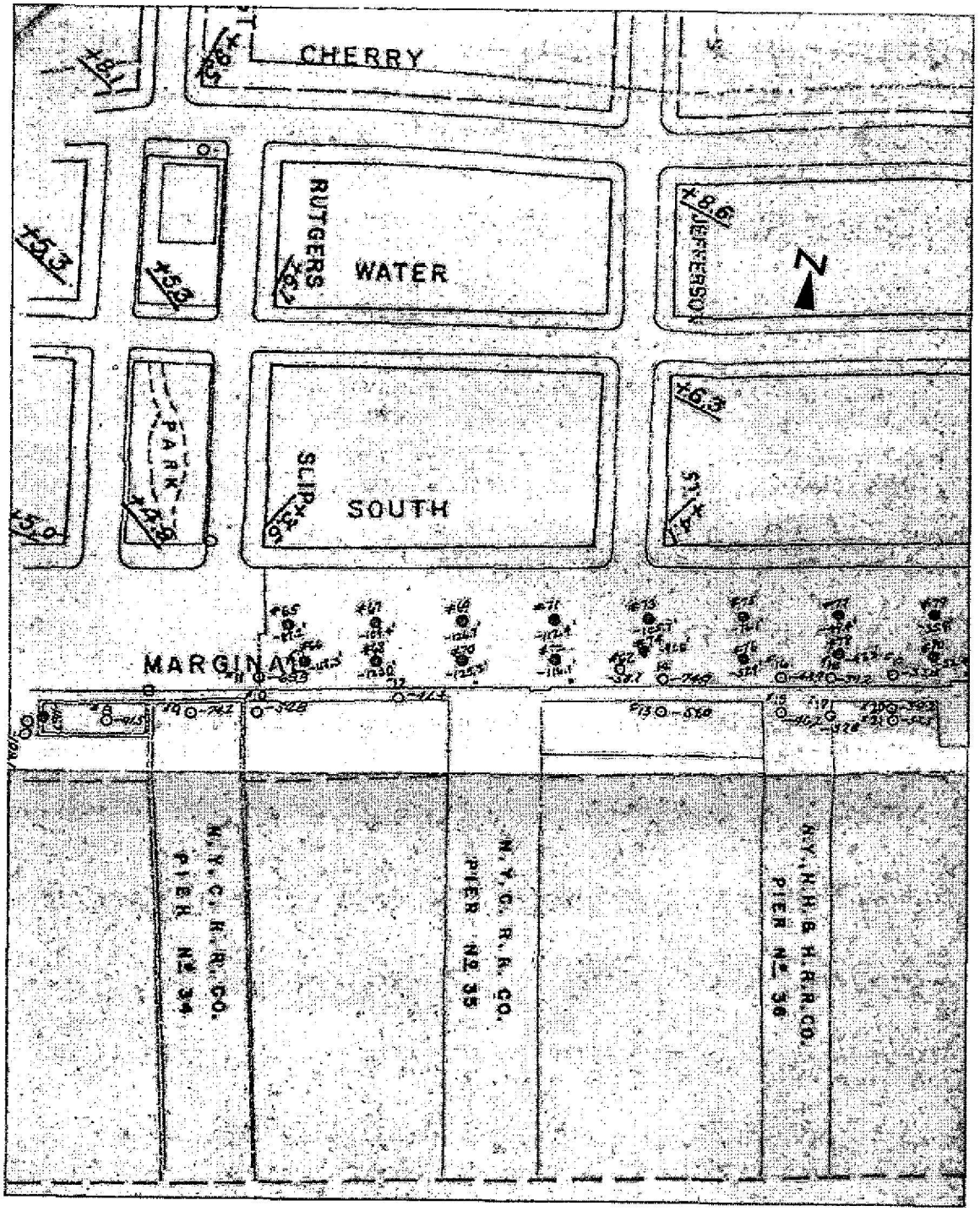
Liebman 6-13-38



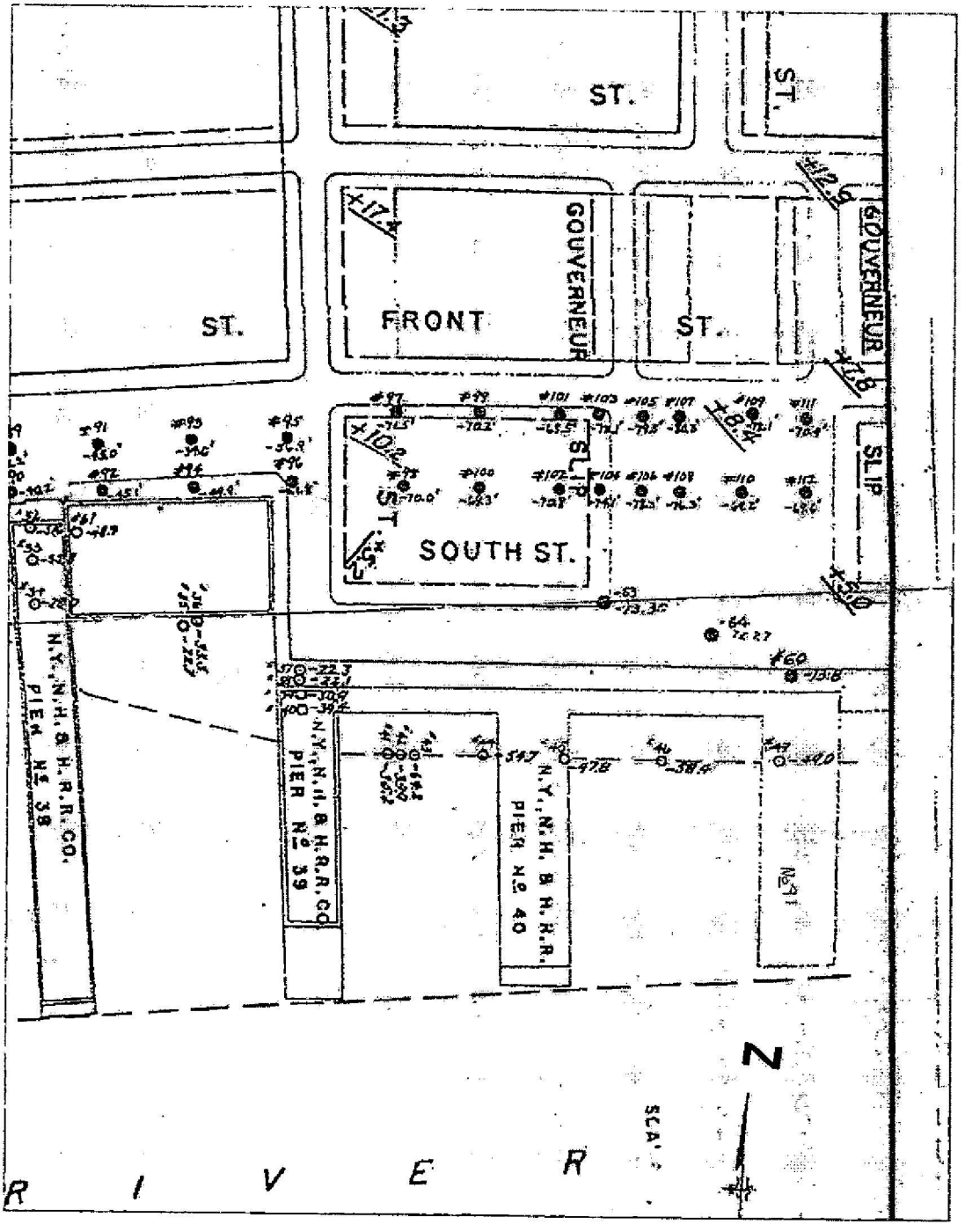
ROCK DATA VOL. 1, SHEET 5

ROCK DATA

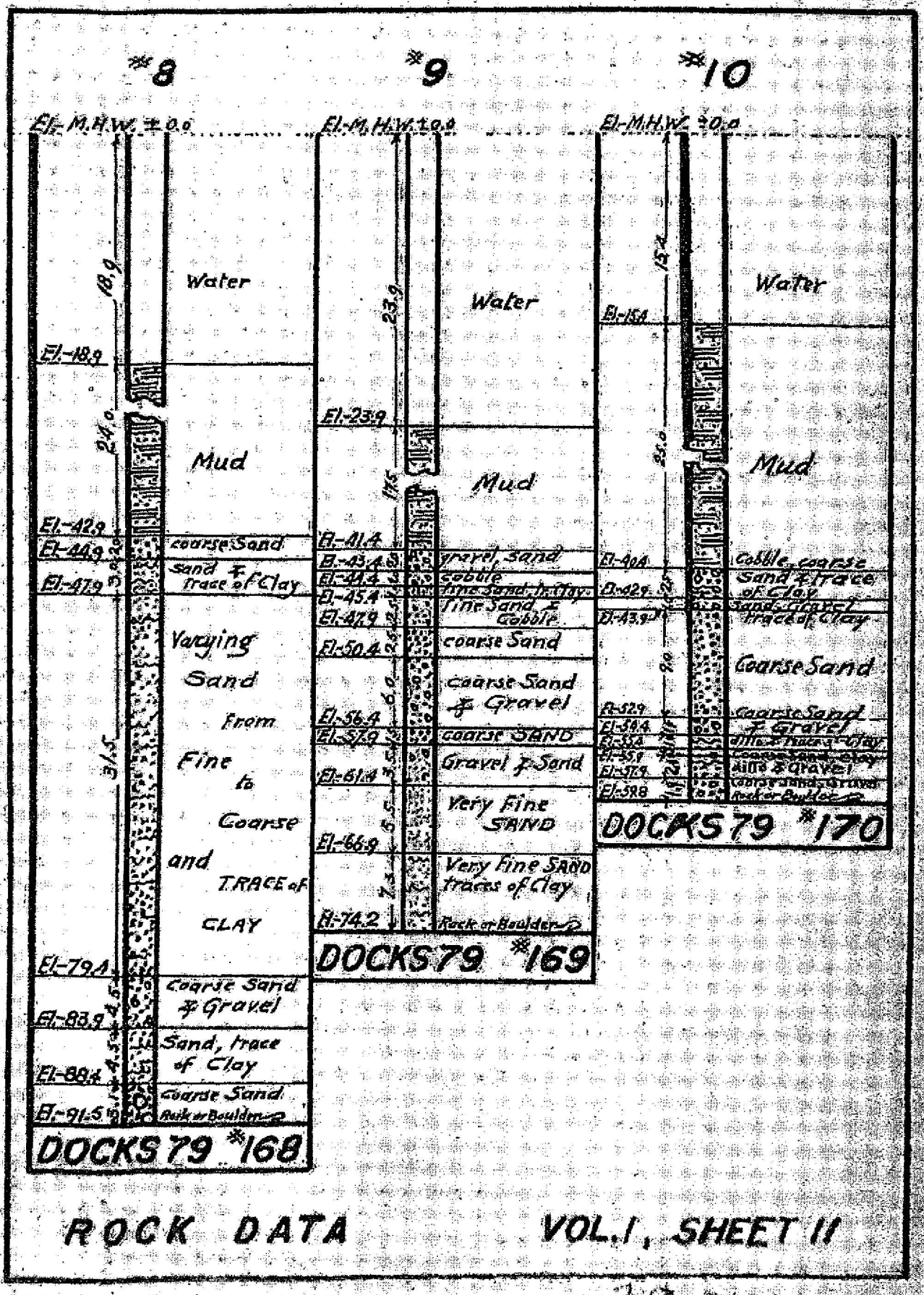
Martin's Upstate



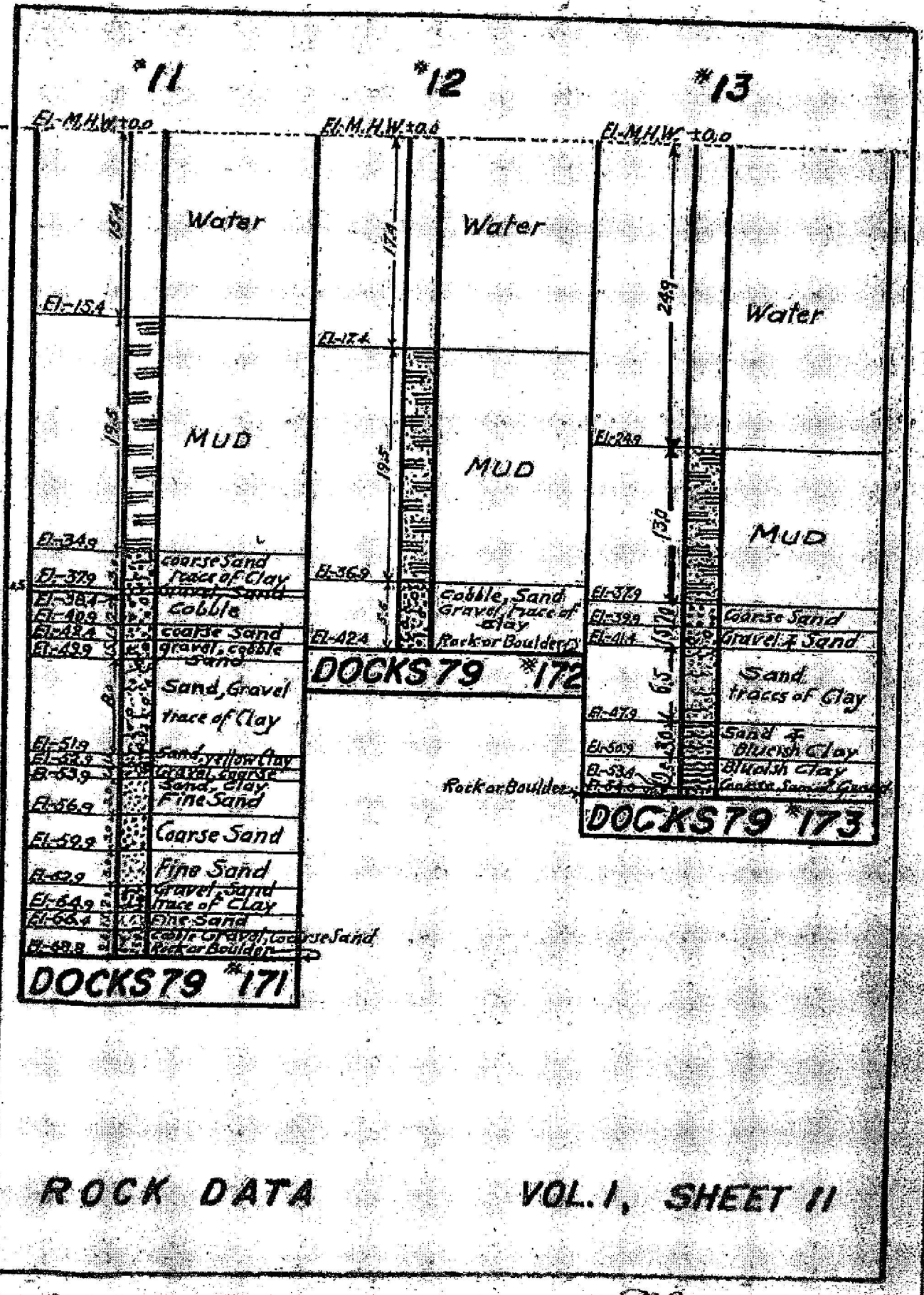
WPA Rock Data –I Map Sheet 11a
(Volume 1, Sheet 11. Borough of Manhattan, Office of the President, 1937, revised)

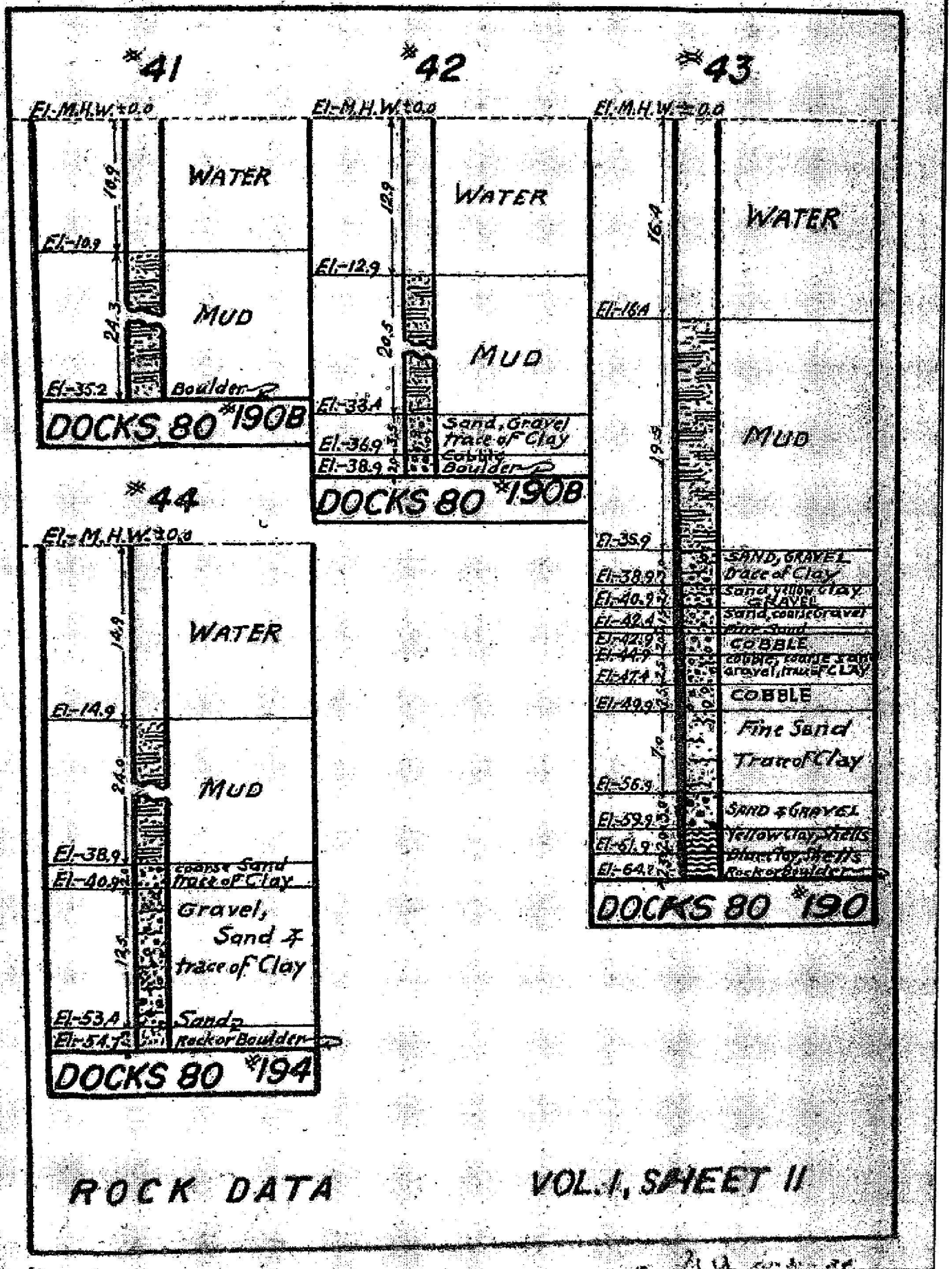


WPA Rock Data – Map Sheet 11b
(Volume 1, Sheet 11. Borough of Manhattan, Office of the President, 1937, revised)

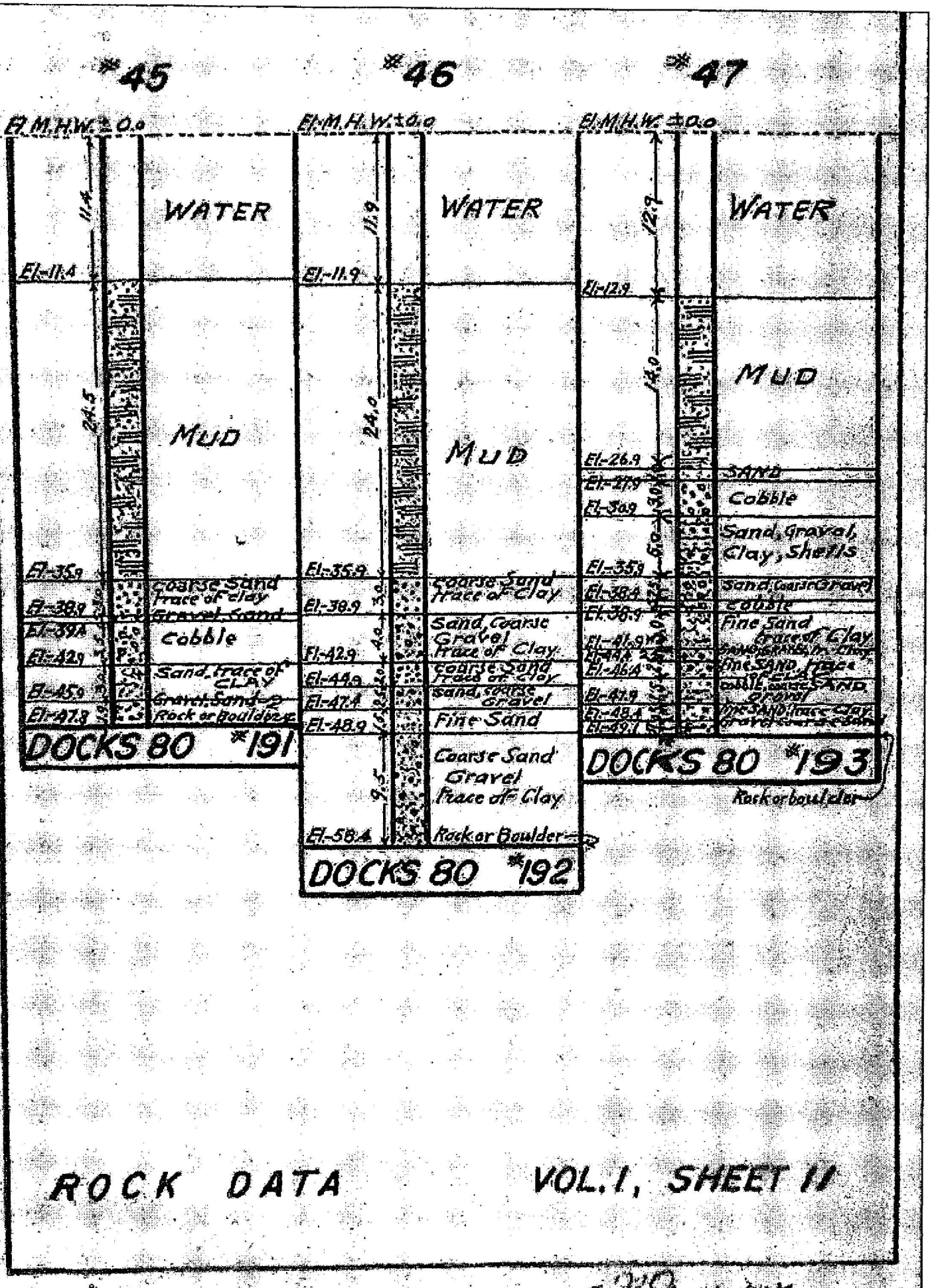


ROCK DATA VOL. I, SHEET 11

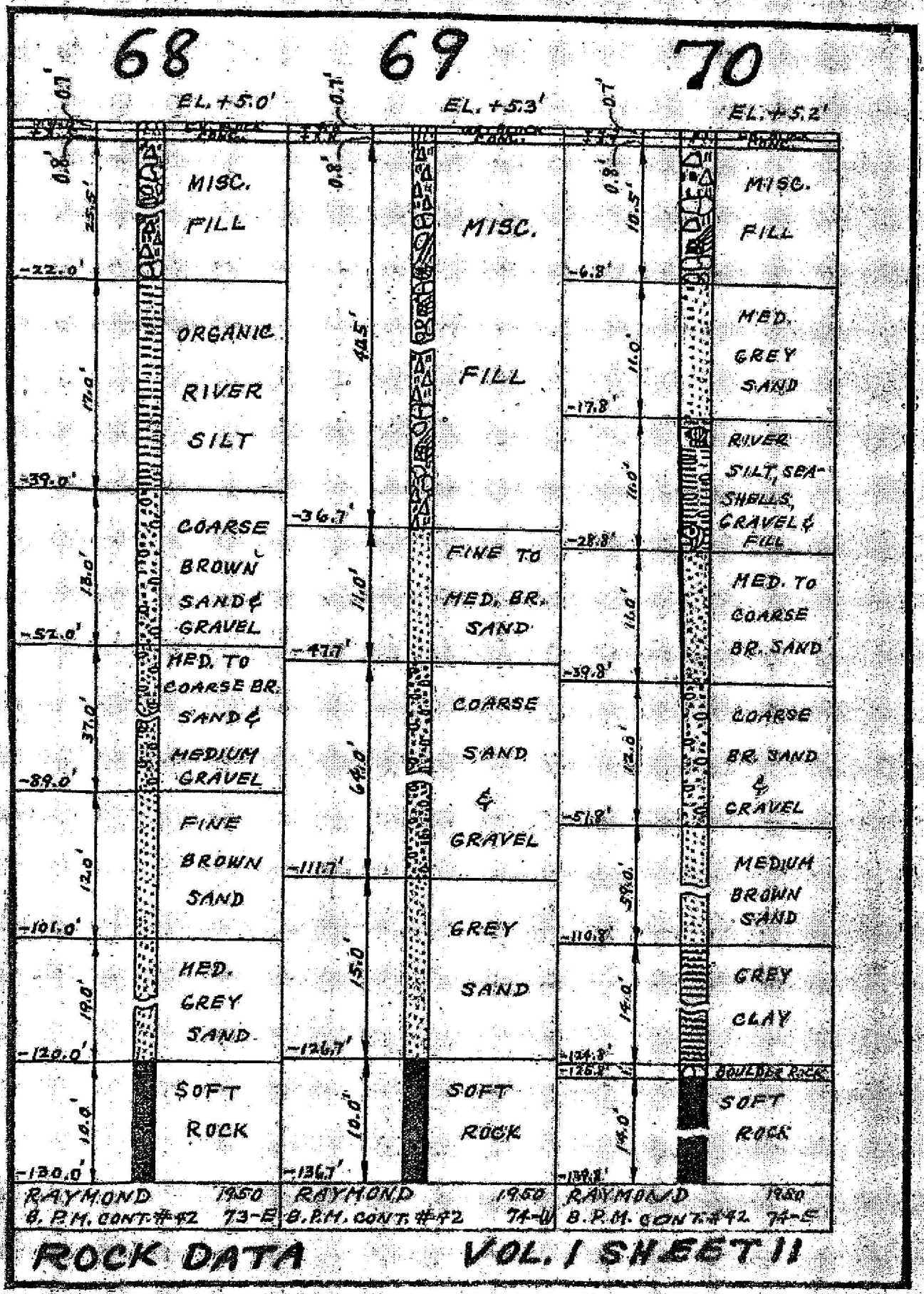

*11
*12
*13
El-M.H.W.+0.0
El-M.H.W.+0.6
El-M.H.W.+0.0
154
Water
El-15.4
195
MUD
El-34.9
El-37.9
45
El-38.4
El-40.9
El-43.4
El-43.9
coarse Sand trace of Clay
gravel, Sand cobble
coarse Sand
gravel, cobble Sand
Sand, Gravel trace of Clay
El-51.9
El-52.9
El-53.9
El-56.9
El-59.9
El-62.9
El-64.9
El-66.4
El-68.8
Sand, yellow Clay
Gravel, coarse Sand, Clay
Fine Sand
Coarse Sand
Fine Sand
Gravel, Sand trace of Clay
Fine Sand
coarse Gravel, Coarse Sand
Rock or Boulder
DOCKS 79 *171
174
Water
El-17.4
195
MUD
El-36.9
5.5
El-42.4
Cobble, Sand Gravel trace of Clay
Rock or Boulder(?)
DOCKS 79 *172
249
Water
El-28.9
139
MUD
El-37.9
El-39.9
El-41.4
6.5
El-47.9
El-50.9
El-53.4
El-54.0
Coarse Sand
Gravel & Sand
Sand, traces of Clay
Sand & Bluish Clay
Bluish Clay
Rock or Boulder
DOCKS 79 *173
ROCK DATA
VOL. I, SHEET 11



ROCK DATA VOL. I, SHEET II

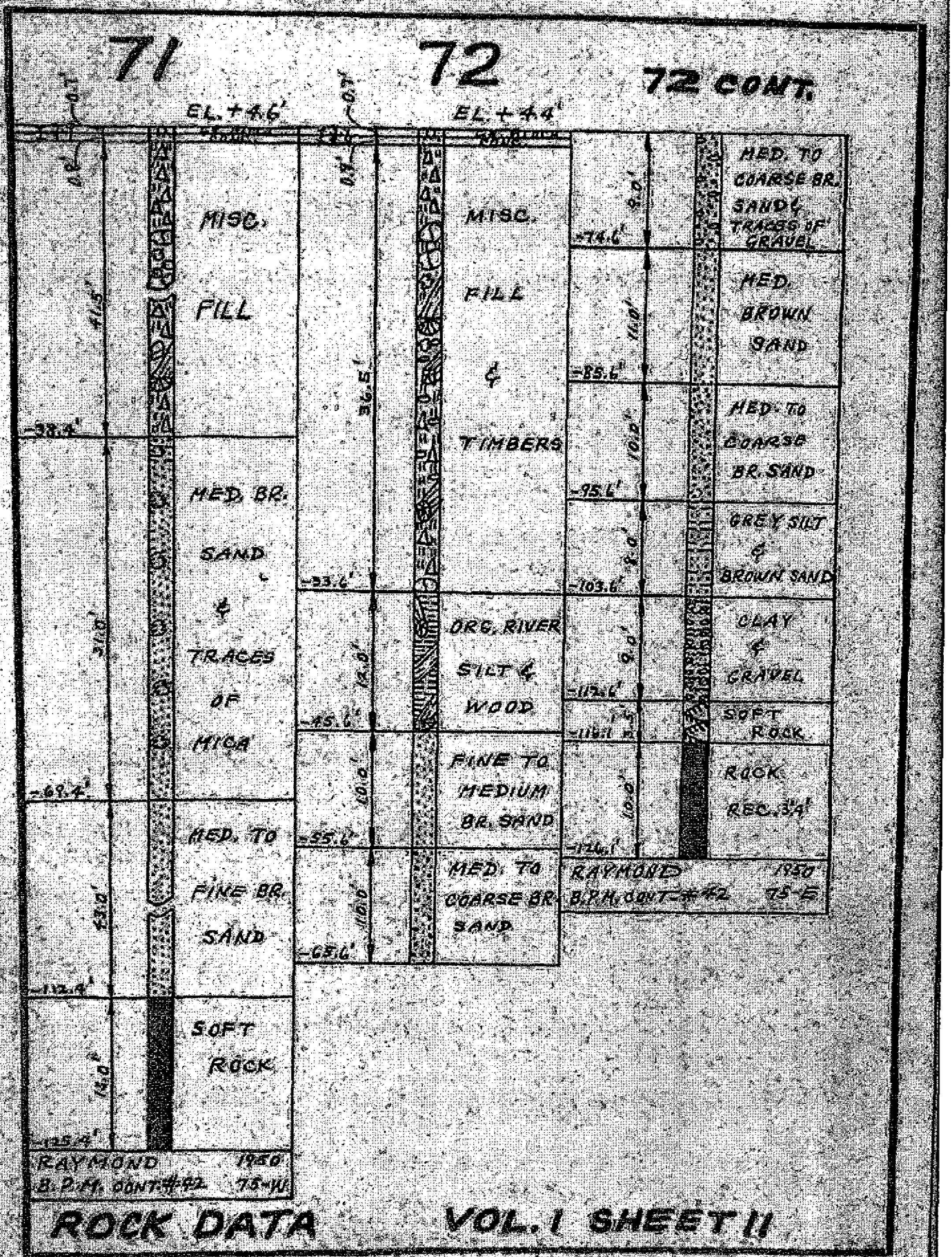


ROCK DATA VOL. 1, SHEET 11



ROCK DATA VOL. I SHEET II

Meetings 2/4/65


71
EL. +4.6'
MISC. FILL
41.5'
-38.4'
MED. BR. SAND & TRACES OF MICA
31.0'
-69.4'
MED. TO FINE BR. SAND
43.0'
-112.4'
SOFT ROCK
14.0'
-126.4'
RAYMOND B.P.M. CONT. #42
1950
T.S.-W.
72
EL. +4.4'
MISC. FILL & TIMBERS
36.5'
-33.6'
ORG. RIVER SILT & WOOD
12.0'
-45.6'
FINE TO MEDIUM BR. SAND
10.0'
-55.6'
MED. TO COARSE BR. SAND
10.0'
-65.6'
72 CONT.
MED. TO COARSE BR. SAND & TRACES OF GRAVEL
9.0'
-74.6'
MED. BROWN SAND
11.0'
-85.6'
MED. TO COARSE BR. SAND
10.0'
-95.6'
GREY SILT & BROWN SAND
8.0'
-103.6'
CLAY & GRAVEL
9.0'
-112.6'
SOFT ROCK
1'-6"
-114.1'
ROCK REC. 3'/4'
10.0'
-124.1'
RAYMOND B.P.M. CONT.-#42
1950
T.S.-E.
ROCK DATA
VOL. I SHEET II
Martino 4/6/65.