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A GEOMORPHOLOGICAL AND ARCHEOLOGICAL ANALYSIS OF THE ARTHUR KILL-HOWLAND HOOK MARINE TERMINAL CHANNEL RICHMOND COUNTY, NEW YORK AND UNION COUNTY, NEW JERSEY

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A GEOMORPHOLOGICAL AND ARCHEOLOGICAL ANALYSIS OF THE ARTHUR KILL-HOWLAND HOOK MARINE TERMINAL CHANNEL RICHMOND COUNTY, NEW YORK AND UNION COUNTY, NEW JERSEY

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and

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ABSTRACT

John Milner Associates, Inc. (JMA) investigated available geomorphological and archeological data in connection with proposed improvements to the Arthur Kill-Howland Hook Marine Terminal Channel located in Richmond County, New York and Union County, New Jersey. The project area extends to the west and south from the confluence of the Arthur Kill Channel, Kill van Kull Channel, and Newark Bay, along the Arthur Kill for approximately three miles to Linden, New Jersey. Primary sources of data for this research consisted of geotechnical core-boring logs from the project area and historic maps of the region. In addition, archeological site files were examined in the repositories of the New York State Museum; the New York State Office of Parks, Recreation and Historic Preservation; the New Jersey State Museum; and the New Jersey Historic Preservation Office. The core-boring data, historic maps, and previous studies reveal a considerable amount of dredging activities within the Arthur Kill Channel, from the mid to late-nineteenth century to the present. These activities have resulted in low potential for the preservation of intact submerged Holocene surfaces within most of the project area. There is evidence that a small portion of the project area to the northeast of Shooters Island may contain potentially intact Holocene sediments. Therefore, it is possible that archeological deposits are present in this portion of the project area. If the proposed improvements to the Arthur Kill Channel cannot avoid potentially undisturbed Holocene sediments then it is recommended that the archeological sensitivity of the area be considered in the planning process. It is unlikely that additional dredging in the remainder of the project area will impact potentially significant archeological resources.

Copies of this report are on file at the U.S. Army Corps of Engineers, New York District; the New York State Office of Parks, Recreation and Historic Preservation; and the New Jersey Historic Preservation Office.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. INTRODUCTION

1.1 Purpose and Goals of the Investigation

John Milner Associates, Inc. (JMA) investigated available geomorphological and archeological data in connection with proposed improvements to the Arthur Kill-Howland Hook Marine Terminal Channel located in Richmond County, New York and Union County, New Jersey (Figure 1). This work was conducted in compliance with Federal statutes and regulations, including Section 106 of the National Historic Preservation Act as amended through 1992 and the Advisory Council on Historic Preservation Guidelines for the Protection of Cultural and Historic Properties (36 CFR Part 800).

Proposed improvements to the Arthur Kill-Howland Hook Marine Terminal Channel include deepening, widening, and selected realignment for navigational safety. This work was performed for The Greeley-Polhemus Group, Inc. on behalf of the U.S. Army Corps of Engineers (COE), New York District. The purpose of the investigation was to evaluate and synthesize existing information regarding the paleoenvironment, changes in coastline through the Holocene, and prehistoric cultural occupations in the area. The general goal of this research is to reconstruct the post-Pleistocene landscape vis-à-vis a shifting coastline and climatic changes. Specifically, the goal of this research is to reconstruct the developmental history of the Arthur Kill Channel through the Holocene and to correlate the potential for archeological residues to this history.

1.2 Description of the Project Area

The confluence of the Arthur Kill Channel, Kill van Kull Channel, and Newark Bay defines one end of the project area (Figure 1). The project area extends to the west and south along the Arthur Kill, approximately three miles to Linden, New Jersey. The Arthur Kill is a component of the New York Harbor Estuarine System, connecting Raritan Bay with Newark Bay (U.S. Army Corps of Engineers 1986:10). The area is currently characterized by industrial, commercial, and transportation-related activities. The massive movement of materials, merchandise, and people is reflected by the great density of such high-volume transportation networks as the various shipping channels/reaches, large roadways, railways, and airports. Newark International Airport is located just north of the project area.

1.3 Summary of Research and Recommendations

The Arthur Kill Channel is located near the terminal moraine of the Woodfordian glacial advance. Following the retreat of this glacier, approximately 19,000 years ago, sea level rose, gradually inundating river valleys and associated landforms. Many terrestrial landscapes available to Paleo-Indian, Early Archaic, and early Middle Archaic occupants of southeastern New York were submerged by the rising sea. Archeological residues of these early inhabitants may be preserved in submerged, buried, and intact Holocene sediments. As such, these submerged landscapes undoubtedly contain significant archeological resources. Submerged landscapes within the Arthur Kill Channel may consist of assorted glacial and postglacial deposits. Geotechnical core-boring data and information retrieved from historic maps, however, reveal a considerable amount of disturbances within the channel bed. Historic and recent dredging of the channel are the primary destructive agents of the Holocene sediments. A single core boring in the northeastern portion of the project area, near Shooters Island, indicates the potential for intact Holocene deposits. This information is congruent with earlier studies in the area. If intact Holocene sediments are present then there is potential for archeological deposits to be preserved in this portion of the project area.

Figure 1. Detail of *Elizabeth, N.J.-N.Y.* 7.5-minute quadrangle (USGS 1967, photorevised 1981) and *Arthur Kill, N.Y.-N.J.* 7.5-minute quadrangle (USGS 1966, photorevised 1981), showing project location.

If the proposed improvements to the Arthur Kill Channel cannot avoid potentially undisturbed Holocene sediments then it is recommended that the archeological sensitivity of the area be considered in the planning process. It is unlikely that additional dredging in the remainder of the project area will impact potentially significant archeological resources.

2. ENVIRONMENTAL AND CULTURAL CONTEXT

2.1 Environmental Setting

The Arthur Kill-Howland Hook Marine Terminal Channel project area is situated within the lowland section of the Northern Piedmont physiographic province (also called the Newark Lowlands), just west of the Atlantic Coastal Plain province and east of the Ridge and Valley province. The Newark Lowlands are characterized by a gently rolling surface underlain by sedimentary strata, which are broken up in places by diabase igneous rock ridges known as the Palisades Sill. The landforms within the Newark Lowlands generally slope down to the east (Isachsen 1991:139). The rock ridges are resistant to erosion and stream channels form in the soft beds of the Upper Triassic-aged red sandstone and shale lying between the ridges. The shales and sandstones are extensive throughout the Hackensack and Passaic Valleys north of the project area. The ridges tend to run northeast-southwest, thus the streams take this same general orientation. The Arthur Kill Channel exemplifies this pattern and empties into the Raritan Bay. The channel is approximately 21 km (13 mi.) long. Major tributaries of the Arthur Kill include the Rahway River, the Elizabeth River, and the Fresh Kills River.

The project area may contain a minor component of unconsolidated sandy and clayey Coastal Plain sediments of upper Cretaceous age (Fisher et al. 1976). Identified as the Raritan and Magothy Formations, these deposits would rest atop the older Triassic rocks. Soft and easily eroded, most Coastal Plain sediments would have been removed in the scouring action of the Wisconsinan glacier as it overran the Arthur Kill to emplace the Harbor Hill terminal Moraine nearly 23,000 year ago (Sirkin and Stuckenrath 1980).

Pleistocene and later events account for nearly all of the surficial terrain and deposits in southeastern New York. The Arthur Kill location was probably impacted by each of the major Pleistocene glacial advances, although in eradicating or reworking earlier deposits it is only the most recent advance that would be represented in the extant glacial features and landforms.

Much of eastern North America was uninhabitable during the late Pleistocene, owing to the presence of continental ice sheets. Late Wisconsinan glaciation peaked approximately 21,000 years ago (Dreimanis 1977:72, 74, Figure 2). After this time, the Laurentide Ice Sheet progressed through a series of retreats and advances until approximately 10,000 B.P., which marks the transition from the Pleistocene, or terminal Late Wisconsin, to the Holocene in the Great Lakes region (Dreimanis 1977:85). The Pleistocene/Holocene boundary is time-transgressive, and in southeastern North America occurs at ca. 12,500 years ago (Delcourt and Delcourt 1981:133). In other words, the Holocene epoch begins at different times in various parts of eastern North America, depending on deglaciation rates and proximity to the ice sheet.

Approximately 15 moraines have been identified for the Wisconsin glaciation in the lower Hudson Valley, Long Island, and Staten Island. Three major lobes of the final Wisconsinan advance (Woodfordian glacier) impacted Long Island. The Hudson-Champlain Lobe resulted in the Harbor Hill terminal Moraine, which traverses the northern portion of western Long Island and all of southern Staten Island, before arcing northwestward from the mouth of the Raritan River to the escarpment near Perth Amboy nearly 20 miles west of the Arthur Kill (Figure 2). As the Woodfordian glacier retreated from the Harbor Hill Moraine approximately 19,250 years ago (Averill et al. 1980), a number of proglacial lakes formed (Figure 3). Upland areas typically were

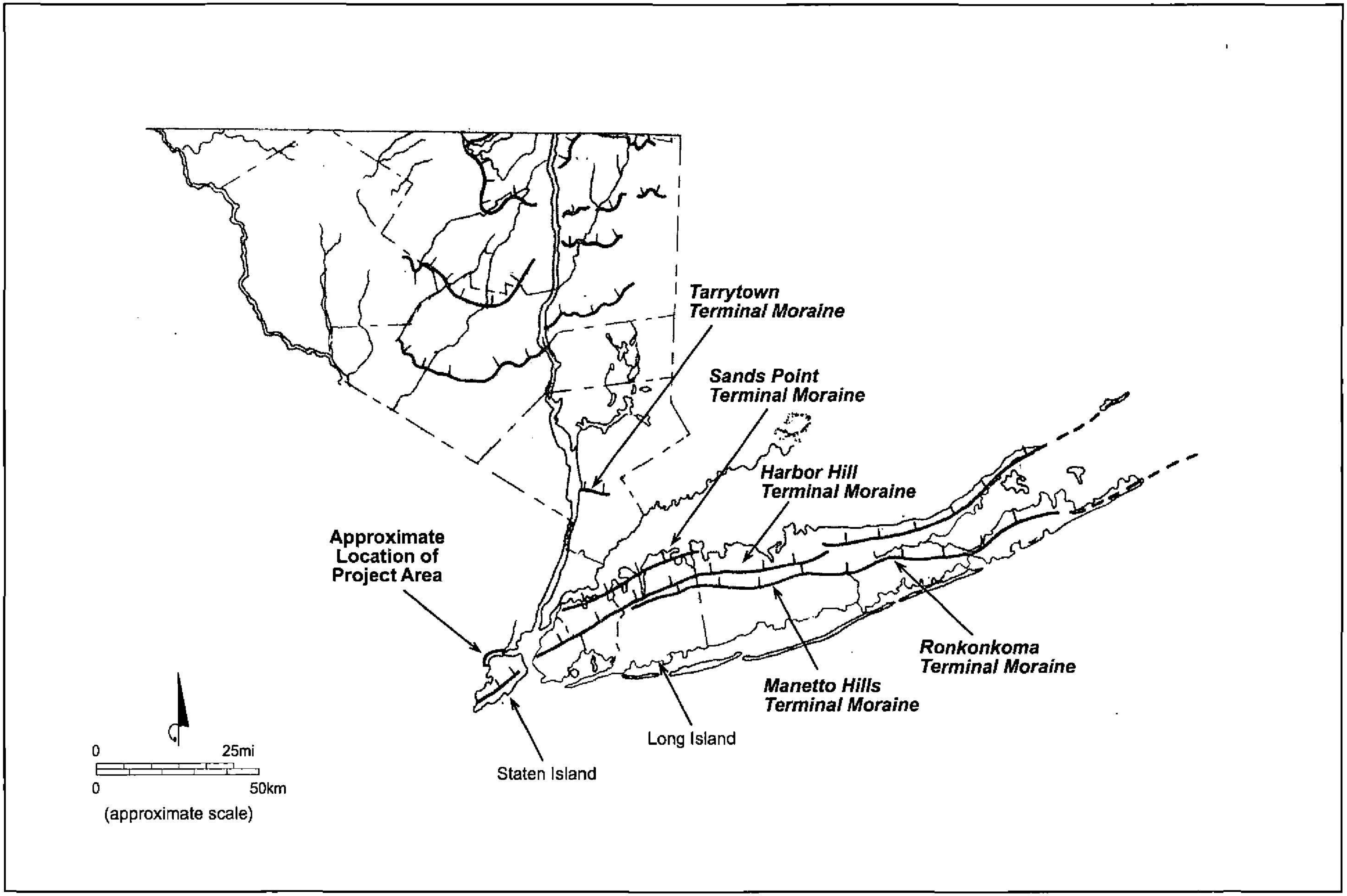

Figure 2. Approximate locations of the terminal moraines in the vicinity of the project area associated with the Woodfordian glacial advance (after Cadwell et al. 1989).

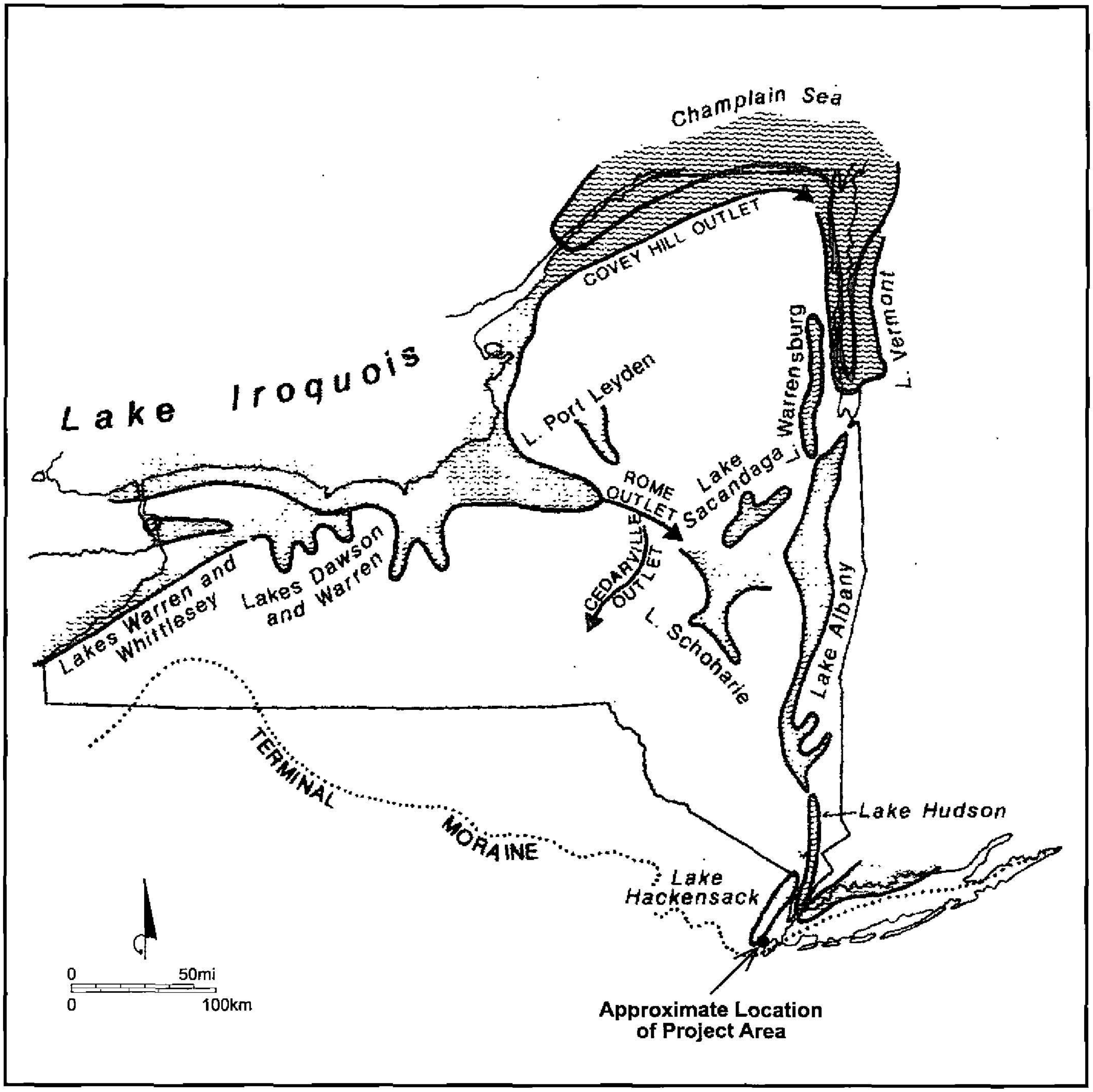

Figure 3. Map of New York showing the location of the terminal moraine and the Pleistocene lakes that formed as the Woodfordian glacier retreated. Arrows indicate the directions that the lakes drained (after Isachsen et al. 1991: Figure 12.23).

covered with thinner mantles of ice than lowland valley locations. As such, pockets of thick glacial ice remained in some valleys as the glacier retreated, becoming the basis for the proglacial lakes (Cadwell et al. 1989; Isachsen 1991).

The Harbor Hill Moraine is critical in the early post-glacial history of the Arthur Kill Channel. With the retreat of the Hudson-Champlain Lobe of the Woodfordian glacier the Harbor Hill Moraine served as a dam for glacial meltwaters and formed the southern conterminous boundary for Glacial Lakes Hackensack, Flushing, and Hudson. With continued retreat of this glacial lobe, Glacial Lake Albany formed in the mid and upper Hudson Valley (Cadwell et al. 1989).

Based on the thickness of varved lacustrine deposits, Lake Hackensack occupied the Hackensack Valley north of the present Arthur Kill location for some 3,000 years until its drainage about 16,000 years ago (Averill et al. 1980). Averill et al. (1980) suggest that drainage of the lake occurred catastrophically at that time, with torrents of water pouring through Sparkill Gap in the north and the breached Harbor Hill moraine (Arthur Kill and The Narrows) in the south. Lovegreen (1974) postulated a more gradual draining of the lake from approximately 12,000 to 13,000 B.P. With either scenario the Arthur Kill was established as a fluvial valley prior to human occupation of the region.

Stream flow through the Arthur Kill Valley subsequent to depletion of the glacial lake waters would have been considerably reduced, although tributaries draining portions of the Hackensack Valley and terrain of more local proximity are likely to have sustained a relatively high order fluvial system large enough to eventually produce alluvial landforms during the Holocene. Thus, in addition to nearby uplands formed by the Harbor Hill till, occupiable positions along the Arthur Kill are likely to have included stream terraces and floodplain levees. Poorly drained backswamps and low-lying floodplains supporting diverse biotic communities would have been present as well.

Climatic amelioration did not proceed steadily by the close of the Pleistocene. There is evidence for a glacial readvance in the Hudson Valley approximately 13,000 years ago, resulting in post-glacial Lake Norwood situated in the northern Hackensack Valley (Averill et al. 1980). A periglacial climate with park-tundra vegetation undoubtedly prevailed in the region until that time, with associated unstable land surfaces and minimal soil development (Sirkin 1967). With the advent of the Holocene and establishment of forest vegetation, more stable terrestrial conditions would have developed, thus allowing for weathering and soil development. Depending on deposit and landform ages, varying degrees of soil development would be expected on alluvial landscapes; strong soil development could be present in the uplands comprised of glacial till. Well-developed soils containing both fragipan and argillic subsoil horizons (fragiudults) have been mapped in upland till deposits approximately 1.5 miles west of the Arthur Kill in Union County, New Jersey (USDA in press). Owing to urban/industrial development, landscapes closer to the Arthur Kill are too severely disturbed to identify natural soils using the mapping techniques applied.

Carved by draining lake waters at the time of the Pleistocene/Holocene transition and stabilized early in the Holocene as a high-order stream system with both alluvial landforms and surrounding uplands, the Arthur Kill Valley potentially could have a record of human occupation spanning the Holocene. Human occupations would have ended late in the Holocene as the valley was inundated resulting from rising sea levels. The question therefore is not whether the valley was occupied prehistorically, but how much evidence of the occupations is still present.

Land areas formerly inhabitable along the Arthur Kill may now lie at elevations below sea level (Kardas and Larrabee 1976, 1980; Raber et al. 1996a, 1996b, 1996c). By the end of the Wisconsinan glaciation the Atlantic Ocean was up to 100 feet lower than its present level, and the coast line was as far as 100 miles east of the Arthur Kill Channel, near the edge of the continental shelf. Similar conditions have been proposed for other Mid-Atlantic locations, although Fletcher (1988) considered the Late Pleistocene sea to be as much as 75 m (246 ft.) lower than the modern level along the New Jersey coast. Investigators are in agreement that the rate of sea level rise has changed through the Holocene, with the most rapid rates of rise occurring early in the Holocene (Kraft et al. 1985). Before approximately 7,000 years ago the sea rose at rates of 8 to 10 mm/year; subsequently the rate of rise has decreased to about 1.25 mm/year (Fletcher 1988). By 4,000 B.P. the ocean was no more than 5 m (16 ft.) below its modern level, and perhaps as little as 1.5 m (5 ft.) of rise has occurred over the past 2,000 years.

Modern coastal and estuarine conditions were established in the vicinity of the Arthur Kill by approximately 2,000 years ago. This is substantiated by radiocarbon dates of marsh peats located near the Arthur Kill (Kardas and Larrabee 1980) and from the Hackensack Meadowlands (Averill et al. 1980). By this time the Arthur Kill had become a drowned valley, with alluvial landscapes and low-lying glacial till uplands submerged beneath brackish waters.

Initially, effects of marine transgression were introduced to the valley by approximately 5,000 to 6,000 years ago. Channel and valley bottom alluvial positions lying at the lowest elevations would have been the first to be affected, perhaps as early as 5,000 B.P., when sea level in New Jersey had risen to within about 11 m of its modern height (Fletcher 1988). The timing of tidal influences on the Arthur Kill Channel specifically was dependent on original valley relief, but if the outflow of glacial lake waters and later Holocene stream flows were able to carve the channel base to or near bedrock then a mid-Holocene date is likely. Further, prior to inundation of land surfaces, tidal influences on the main stem flow of the Arthur Kill would have resulted in brackish water. With rising tidal waters, sources of potable water would have been confined to the tributaries of the main channel, and the boundary between fresh and brackish water would have been in continuous retreat to increasingly higher elevations.

The rising Holocene sea has drowned many former land areas throughout southeastern New York; marine inundation may not always have been conducive to the preservation of land surfaces and associated cultural deposits (Kraft et al. 1983, 1985). With submergence, estuarine sediments were deposited over older surfaces. However, prior erosion by wave and current action, particularly on more sloping terrain, undoubtedly destroyed previous surfaces before they could be buried by these sediments. Finally, a long record of historic and recent dredging in the Arthur Kill Channel is likely to have severely truncated or removed entirely surfaces that formerly were preserved beneath a mantle of estuarine sediments.

The Arthur Kill project is located at the southern margin of the maximal extent of the Late Wisconsinan glaciation in this section of eastern North America. Approximately 18,000 years ago this area was characterized by frozen tundra bordering the Laurentide Ice Sheet (Delcourt and Delcourt 1981:Fig. 5). By 14,000 years ago climatic amelioration resulted in the northward retreat of the Laurentide Ice Sheet and corresponding expansion of different forest types, characterized by Parkland-Conifers and grass (Delcourt and Delcourt 1981:147; Dreimanis 1977; Sirkin 1967). At this time, the Arthur Kill area was situated within a glacial boreal forest, roughly 60 km south of the tundra (Davis 1969; Delcourt and Delcourt 1981; Sirkin 1977; Watts 1979).

By 10,000 years ago the ice sheet had retreated to the northern Great Lakes region, and the Arthur Kill location was within the northern portion of the Mixed Conifer-Northern Hardwood forests (Davis 1969; Delcourt and Delcourt 1981; Sirkin 1977; Watts 1979). Pollen isopoll maps for this time period indicate that the forests consisted of approximately 20 percent spruce trees, 50 percent pine trees, and 20 percent oak trees (Bernabo and Webb 1977:Fig. 7). Cool-temperate conditions prevailed in this portion of New York.

Estuarine and terrestrial environments of the Hudson River have undergone substantial changes over the 12,000 years, or more, of human occupations in the region. Warming post-Pleistocene climates led to the development of new forest types and wetland habitats. Rising sea levels progressively flooded older river valleys and created new estuarine environments. Major streams and their tributaries were greatly widened and deepened by the meltwater of the glaciers to the north (Isachsen 1991). Throughout the Holocene, most topographic positions situated adjacent to stream channels were at least somewhat modified by alluvial deposition and/or scouring, and upland settings were differentially eroded. Climatic changes and rising sea levels have greatly influenced the composition and distributions of animal and plant communities that provided subsistence resources for prehistoric hunting, gathering, and fishing peoples.

By 5,000 B.P. warming conditions resulted in expansion of deciduous forests, comprised of oaks and chestnuts in central Pennsylvania and south-central New York. New Jersey and southeastern New York were characterized primarily by Southeastern Evergreen Forests of oak, hickory, and southern pine (Delcourt and Delcourt 1981:Fig. 8; Watts 1979). By 4,000 B.P., pollen isopoll maps indicate that the Arthur Kill location was characterized by 50 percent oak pollen and 20 percent pine pollen (Bernabo and Webb 1977:Fig. 15).

2.2 Prehistoric Cultural Context

Eastern North American prehistory typically is divided into three major temporal categories: Paleo-Indian, Archaic, and Woodland. Each of these periods generally is associated with a suite of distinctive adaptive strategies. Archeologists use these cultural-historical constructs as a framework for discussing changes in sociocultural integration. The cultural history provides an important framework within which archeological research may proceed. It is important to note, however, that researchers disagree over many of the specifics concerning adaptations, cultural change, durations of periods, and continuities/discontinuities of particular lifeways. Therefore, the outline presented here is viewed as a broad model, specific details of which may change with ongoing research.

A large literature exists regarding Holocene lifeways and adaptations in eastern North America (e.g., Dincauze 1976; Keegan 1987; Neusius 1986; Phillips and Brown 1983; Ritchie and Funk 1973; Starbuck and Bolian 1980). The purpose of this section is to review relevant research in southeastern New York in general and in the vicinity of the Arthur Kill in particular.

Adaptations and lifeways of prehistoric groups are intimately connected to features of the landscape (Jochim 1976). Resources, travel, and habitation are important factors considered by groups when distributing themselves across the landscape. In addition, social considerations are evaluated by people and groups in decision making. This combination of social and physical requirements results in a cultural landscape that is unique in time and space.

Numerous archeological sites are reported for the Arthur Kill area in the early surveys performed by Skinner and Schrabisch (1913) and Cross (1941). However, descriptions of material culture are sketchy, precluding temporal assignments for artifacts, cultural occupations, and sites. In several cases, site place names presented in Skinner and Schrabisch (1913: 43-45) correspond to site names in the New York archeological site files.

2.2.1 Paleo-Indian Period (ca. 12,000-8,000 B.C.)

The earliest human occupations for the Americas fall into the Paleo-Indian period. Based on artifact assemblages, site locations, and ethnographic analogy, it has been inferred that Paleo-Indian groups were relatively small and highly mobile. Boreal forest-tundra conditions about 11,000 years ago supported such megafauna as mastodon, bison, caribou, Woodland musk ox, elk, and bear (Dincauze 1981; Fitting et al. 1966; Funk 1972; Gardner 1974; MacDonald 1968; Mason 1962; Ritchie and Funk 1973; Witthoft 1952).

In recent years, some investigators have chosen to group the Paleo-Indian and Early Archaic periods into a single cultural historical unit (e.g., Custer 1984; Gardner 1977). This procedure is based on environmental considerations and characteristics of the assemblages. Based on the Flint Run Paleo-Indian complex in the Middle Shenandoah Valley of northern Virginia, Gardner argued that Paleo-Indian and Early Archaic groups were part of the same adaptive system: "Both are essentially hunters, with a major shift in strategies from hunting emphasis to general foraging not occurring until the Middle Archaic, or post-8,000 B.P." (Gardner 1977:261). Stylistic changes in projectile points from Paleo-Indian to Early Archaic occurred, while other aspects of the associated assemblages are virtually the same (Broyles 1971; Gardner 1977:261; Turnbaugh 1977:79).

In studying Paleo-Indian occupations of the Hudson and Delaware Valleys, Eisenberg argued that the retreating Laurentide Ice Sheet resulted in "glacial disruptions," producing a patchy environment of "both coniferous and deciduous elements" (Eisenberg 1978:122). This observation is supported by palynological studies and the remains of animals adapted to a variety of settings. Based on site locations, Eisenberg suggests that Paleo-Indian groups were keyed into the resources associated with good-sized streams, lowland swamps, and upland deciduous forests (Eisenberg 1978:138).

The received wisdom concerning Paleo-Indian adaptations is that these people were narrowly focused in diet, which centered around the hunting of big game animals (e.g., Cleland 1976; Funk 1978; Stoltman 1978). Archeologists recently have questioned this assumption. In fact, many years ago James B. Griffin noted that

> there is no compelling reason to believe that early man was solely a carnivore or that his primary protein source was "big game." Most historically documented hunting groups obtained a sizable proportion of their food from vegetation. It is reasonable to assume that this was the case with prehistoric hunting groups in the Eastern United States (Griffin 1967:176).

A wider range of food resources appears to have been exploited by Paleo-Indians than traditionally believed. This is borne out by recently conducted studies (e.g., Dent and Kauffman 1985; Meltzer and Smith 1986; Moeller 1980).

The population density during the Paleo-Indian period apparently was very low. Few Paleo-Indian finds are reported for southeastern New York in general, and most consist of isolated finds by collectors (e.g., Saxon 1973). This view of Paleo-Indian population density is consistent with other parts of the Northeast and Mid-Atlantic regions (e.g., Snow 1980; Turner 1994). For the Delmarva region, Custer suggests two alternative settlement models to account for Paleo-Indian site locations (Custer 1989). The cyclical settlement model is based on Gardner's (1977) *Flint Run* research, in which groups move between two major settlement types: quarry-related base camps and other kinds of base camps. Around each of these settlement types is a constellation of specific ancillary smaller camps that are related functionally to the base camp or quarry base camp (Custer 1989: Figure 13). Group movement may have been determined by condition of the stone tool kit, selection criteria for lithic raw materials, and locations of satisfactory stone sources. Alternatively, the serial settlement model characterizes groups that selected lithic resources on an as-needed basis as they moved across the landscape (Custer 1989: 101-102). This settlement pattern may be more relevant for the following Archaic adaptations, when selection standards for stone materials were relaxed.

It is likely that coastal Paleo-Indian sites were submerged with rising sea level as the Laurentide ice sheet retreated. Port Mobil, located on the southwest coast of Staten Island, approximately four miles south of the project area, is a Paleo-Indian site with at least three horizontal components (Ritchie 1980:xvii-xviii). Approximately 20 fluted Clovis points and preforms were retrieved, fabricated from jasper, Normanskill flint, eastern Onondaga flint, and quartz (Kraft 1977; Ritchie 1980:xviii). Endscrapers, side scrapers, spokeshaves, gravers, and a variety of flake tools were recovered from the site. In addition, at least five fluted points have been recovered as isolated finds in the southwestern portion of Staten Island (Ritchie 1980:Figure 2). No clear associations have been identified between Paleo-Indian sites or artifacts and Pleistocene fauna, although Ritchie has intimated that the relatively high concentration of mastodon and fluted-point findspots (not in the same burial contexts) in southeastern New York is more than coincidental (Ritchie 1980:9-15; Ritchie and Funk 1973:6-7).

In contrast to specialized big game hunting practices, Paleo-Indian peoples of the Hudson Bay may have developed diversified hunting and gathering strategies. Northern hardwoods were replacing late Pleistocene Boreal spruce-fir forests through the Paleo-Indian period (Whitehead 1972). Riverine adaptations have been suggested by the recovery of fruits and fish remains at the Shawnee-Minisink site located along the upper Delaware River, Pennsylvania (McNett 1985).

2.2.2 Archaic Period (ca. 8000-1400 B.C.)

The Archaic period is divided into four subperiods, referred to as Early, Middle, Late, and Terminal. The beginning of the Early Archaic period (8000-6000 B.C.) is approximately coeval with the extinction of big game of the Late Glacial period. It is during this time period that the shift from Pleistocene climates and environments to essentially modern Holocene environments occurred.

Site locational and assemblage compositional information available for the Early Archaic Period suggests a continuation of the Paleo-Indian pattern. Dent (1991) and Evans (1985), however, argue that the early Early Archaic lithic assemblage from the Shawnee-Minisink site in the Upper Delaware Valley indicates "a shift toward more specialized procurement activities" (Dent 1991:133). They contrast this with a generalized procurement strategy of the earlier Paleo-Indian occupants of the site (Dent 1991:136-137).

In the southeastern United States, archeobotanical research indicates that hickory nuts and acorns were exploited as early as the Early and Middle Archaic Periods (Chapman and Shea 1981). Other plant resources were added to the menu in the Late Archaic Period. These include cucurbits, *Chenopodium* (Goosefoot), and *Phalaris* (Maygrass) (Chapman and Shea 1981). Evidence for nut processing is lacking in Early Archaic middens in southeastern New York, though this may be a sampling problem.

Early Archaic sites appear to be concentrated on terraces of large rivers and on the edges of upland swamps (Snow 1980). Changes in coastal plain geomorphology resulting from rising sea levels during the early and middle Holocene were crucial in creating landforms and topographic settings important for Early Archaic peoples (Kraft 1977). In particular, inland swamps developed as drowned river basins formed.

Several sites with Early Archaic components are known for Staten Island (Ritchie and Funk 1971). These are the H.F. Hollowell Site, the Old Place Site, the Ward's Point Site, and the Richmond Hill Site. H.F. Hollowell and Ward's Point are located near the town of Tottenville in the southern portion of the island. Old Place is situated along the east bank of the Arthur Kill, near the Goethals Bridge abutment. Richmond Hill is located on a gentle slope near the base of a hill in the central portion of Staten Island. A variety of artifacts are associated with the Staten Island Early Archaic occupations. Donald Hollowell and Albert Anderson, two avocational archeologists, excavated the Hollowell Site revealing numerous discontinuous occupations from the Early Archaic to Late Woodland periods. The lowest stratum of the site (Zone 4) yielded 24 projectile points, most of which have bifurcated bases and are attributed to the Kanawha Stemmed type. There are four possible Stanly Stemmed points, and one possible Eva point (Ritchie and Funk 1971:47, Figure 1). In addition, the Early Archaic assemblage from Hollowell includes endscrapers and side scrapers, some of which are spurred.

Ward's Point yielded three Kirk Stemmed points, four LeCroy Bifurcated Base points, 14 Kanawha Stemmed points, three untyped bifurcated-base points, four untyped broad stemmed points, one untyped broad side-notched point, and a thin corner-notched point. Included with the Early Archaic lithic assemblage are unifacial endscrapers, side scrapers, retouched flake tools, a graver, a spokeshave, drills, ovate bifaces, and *piecès esquillés* (Ritchie and Funk 1971:50-52).

Early Archaic artifacts recovered from the Old Place Site include Stanly Stemmed, LeCroy Bifurcated Base, and Kirk Corner-notched points (Ritchie and Funk 1971:49). Level 3 of the Richmond Hill site yielded one Hardaway Side-notched, a probably Kirk Stemmed, one LeCroy Bifurcated-base, a crude side-notched point, several Palmer Corner-notched projectile points, and a radiocarbon date from hearth charcoal of 7410 B.C.±120 (I-4929). Other artifacts recovered from the Early Archaic horizon at Richmond Hill include a variety of scrapers, trianguloid bifaces, sandstone choppers, hammerstones, and a possible celt blank (Ritchie and Funk 1971:54). Rising sea levels have probably inundated many Early Archaic sites that may have been adjacent to early Holocene rivers and nascent estuaries of the developing Hudson Bay.

Numerous researchers have observed that considerable changes occurred "in almost all aspects of the cultural system ... with the appearance of LeCroy-like points and the onset of the Middle Archaic" (Gardner 1977:258; also Custer 1984; Dincauze 1976; Snow 1980). Snow notes that additional ecological settings were occupied and more planned seasonal scheduling was practiced during the Middle Archaic compared to the Paleo-Indian and Early Archaic periods (Snow 1980:183). Concomitant with the increased range of habitats frequented by Middle Archaic groups is an increase in assemblage diversity. Celts, gouges, full-grooved axes, notched netsinkers, plummets, winged bannerstones (atlatl weights), and semilunar knives (ulus) are introduced into Middle Archaic tool assemblages (Dincauze 1976; Funk 1977; Gardner 1977; Snow 1980). The addition of groundstone implements to the tool kit suggests a more intensive use of plant resources than in earlier periods, presaging major developments in the Late Archaic. Meltzer and Smith observed however that "pestles, wooden mortars, and heavy-duty woodworking tools" have been recovered from Paleo-Indian and Early Archaic deposits (Meltzer and Smith 1986:18). The coastline was still considerably further to the east than at present, so many Middle Archaic sites are undoubtedly underwater.

Postulated Middle Archaic site types for eastern New York include quarries, quarry reduction locales, base camps, base camp maintenance stations, hunting/extractive camps, and individual hunting/fishing stations (Dincauze 1976; Funk 1976; Snow 1980). Groundstone tools may have also appeared during the Middle Archaic as part of what Dincauze (1976:140-142) has termed the Atlantic Slope Macrotradition.

The Late Archaic period (3000-1500 B.C.) reflects an increasingly expanded economic base, in which groups exploited the richness of the now-established oak-dominant forests of the region (Caldwell 1958). They depended on the procurement of white-tailed deer, elk, raccoon, and many smaller mammals, as well as birds, turtles, fish, and shellfish. Groups had "settled into" and were well-adapted to local settings. Territorial jostling by groups occupying major environmental zones has been suggested (Snow 1980:223-230). Late Archaic adaptations in central and eastern New York, southeastern New England, and the Mid-Atlantic region have variously been referred to as the Narrow Point and Mast Forest traditions (Tuck 1978; Snow 1980). In southeastern New York specifically the Late Archaic period is characterized by the Sylvan Lake complex (Funk 1976:247-254), represented by a variety of narrow stemmed and notched projectile points. In addition, this cultural complex is associated with notched bannerstones, netsinkers, whetstones, hammerstones, anvilstones, chipped-stone knives, endscrapers, side scrapers, drills, and antler flakers (Funk 1976: Table 33). The Rossville projectile point type is named after the Rossville site located in southwestern Staten Island, where a number of these lozenze-shaped points were originally retrieved and identified (Ritchie 1971:46; Skinner 1915).

The H.F. Hollowell Site, located in southern Staten Island, yielded several narrow stemmed points and a Vosberg-like projectile point at the base of Zone 3, overlying the Early Archaic horizon (Ritchie and Funk 1971:47). A number of Late Archaic projectile points were recovered from Zone 5 of the Ward's Point Site (Ritchie and Funk 1971:50). These include Orient Fishtail, Vosburg, and Sylvan Lake point types (Jacobson 1980; Ritchie and Funk 1971). Documented sites in the vicinity of the project area that yielded Late Archaic artifacts include Old Place, Old Place Amerindian Sites, Arlington Place, Bowman's Brook North, and Goodrich 11-1 (Tables 1 and 2).

By approximately 2500 B.C. the Broadspear Tradition appeared, possibly from the Southeast, and included Savannah River, Koens-Crispin, Snook Kill, Susquehanna, Perkiomen points, and near the end of the Late Archaic Orient-Drybrook "Fishtail" points and steatite bowls. The Terminal Archaic Period (ca. 1500-800 B.C.) marks the evolution of the Archaic system into new socioeconomic configurations. Sites and economic pursuits reveal a distinct riverine focus in conjunction with important technological innovations evidenced in the artifact assemblages. These include the use of soapstone vessels and the shift to broad-bladed projectile forms (Cook 1976; Turnbaugh 1975;

Table 1. Documented Sites in Vicinity of Project Area Listed in the New York State Museum and/or the New York State Office of Parks, Recreation and Historic Preservation.[a]

Site Name	Site No.[b]	Site No.[c]	USGS Quadrangle[d]	Topographic Setting	Cultural Association	Reference
Lakes Island	A085-01-0110		Arthur Kill	Confluence of Great Fresh Kills and Fresh Kills		Solecki 1977
Chelsea	A085-01-0135	746	Arthur Kill	Floodplain of Sawmill Creek	Grooved axes, 11 arrow points, burial ground.	Skinner 1903
Old Place	A085-01-0134	7215	Elizabeth	Marsh adjacent to Arthur Kill	Stanly/Neville, Snook Kill, Poplar Island, Bare Island projectile points. Winged bannerstone, endscraper. Narrow stemmed projectile points. Vinette I, Middle and Late Woodland pottery. Steatite sherds.	Ritchie 1980; Anderson 1964
Old Place Amerindian sites	A085-01-2366	7215	Elizabeth	Floodplain of Old Place Creek	Archaic, Transitional, Early Woodland, Late Woodland. Stanly Stemmed points, LeCroy Bifurcated Base point, Kirk Corner-notched point. C-14 date from charcoal: 5310 B.C. ± 140 (1-4070). Bare Island and Poplar Island projectile points. Vinette I and later pottery.	Ritchie and Funk 1971, 1973; Payne and Baumgardt 1986
Arlington Station	A085-01-0138	4593 (?), 730 (?)	Elizabeth	Knoll overlooking Newark Bay	"Algonkin pottery," scrapers, hammerstones, mortar, shell pits, grooved axes, celts	Skinner 1909
Arlington Place	A085-01-0139	729(?)	Elizabeth	Several knolls overlooking Newark Bay	Late Archaic through Woodland, Triangular points, Poplar and Bare Island points, Orient Fishtails, steatite sherds. Bannerstone. Grooved axe. Vinette I sherds.	Ritchie 1980
Bowman's Brook North	A085-01-2364	4594(?)	Elizabeth	Knoll overlooking Arthur Kill	Late Archaic to Late Woodland (?). Late Archaic stemmed point, broken triangular biface, village, cemetery. Algonkian pottery.	Payne and Baumgardt 1986; Skinner 1909; Kaeser 1970
Richmond Terrace	A085-01-2365		Elizabeth	Knoll overlooking Arthur Kill	Historic well, ca. 1845.	Payne and Baumgardt 1986
Haughwout House	A085-01-2367		Elizabeth	Floodplain of Old Place Creek	Ca. 1790 house site.	Payne and Baumgardt 1986
	A085-01-2368		Elizabeth	Floodplain of Old Place Creek	Remains of undated historic structure.	Payne and Baumgardt 1986
George Bowman	A085-01-2369		Elizabeth	Floodplain of Old Place Creek	Ca. 1790 house site.	Payne and Baumgardt 1986
	A085-01-2371		Elizabeth	Floodplain of Old Place Creek	Remains of historic outbuilding.	Payne and Baumgardt 1986
	A085-01-2373		Elizabeth	Floodplain of Old Place Creek	Remains of undated historic structure.	Payne and Baumgardt 1986

[a] Information reported here is taken from the archeological site files.
[b] New York State Office of Parks, Recreation and Historic Preservation site number.
[c] New York State Museum site number.
[d] 7.5-minute series.

Table 2. Documented Sites in Vicinity of Project Area Listed in the New York State Museum.[a]

Site Name	Site No.[b]	USGS Quadrangle[c]	Cultural Association	Reference
	8503	Arthur Kill	Camp.	NYSM files
	8504	Arthur Kill	Traces of occupation.	NYSM files
	8500	Arthur Kill	Camp.	NYSM files
	8501	Arthur Kill	Camp.	NYSM files
	4627	Arthur Kill	Camps.	NYSM files
	8502	Arthur Kill	Traces of occupation.	NYSM files
	8323	Arthur Kill	Relics.	NYSM files
	4599	Arthur Kill	Hamlets(?), midden traces. Scattered lodges, also shell heaps with pits... old shellfish drying heap.	NYSM files
	6976	Arthur Kill	Village.	NYSM files
	4602	Arthur Kill	Village, shell heap, arrowheads.	NYSM files
	4596	Arthur Kill	Late Archaic (?), Late Woodland, Historic. Plummet (?), grooved axes, Iroquois pottery, pipes, projectile points, steatite beads, incised clay beads, bannerstones, probable gunflints of jasper.	NYSM files
	7216	Elizabeth		Reported by A.C. Parker
	4595	Elizabeth	Village. Burials. Shell pits, fireplaces, large pits. Early historic pottery like Iroquoian, gunflints, lead bullets, pewter trade ring, trade pipes.	Reported by A.C. Parker
Gerties Knoll	731	Elizabeth		NYSM files
Arlington Avenue	728	Elizabeth	Concentration of material.	Skinner 1909
	8507	Elizabeth	Camp.	NYSM files
Goodrich 11-1	732	Elizabeth	Early through Late Archaic. Projectile points include Stanly Kirk complex.	NYSM files
	7812	Elizabeth		NYSM files
	7813	Elizabeth	Traces of occupation.	NYSM files
	8506	Elizabeth	Traces of occupation.	NYSM files
Ascension Church	733	Elizabeth	Woodland. Village and burial ground.	Skinner 1909
	4592	Elizabeth	Village, burials. Same as NYSM 733.	NYSM files

[a] Information reported here is taken from the New York State Museum archeological site files.

[b] New York State Museum site number.

[c] 7.5-minute series.

Witthoft 1953). Terminal Archaic occupations are represented in Old Place, Arlington Place, and possibly NYSM Site 4596 (Tables 1 and 2).

2.2.3 Woodland Period (ca. 1000 B.C.-European Contact)

The Woodland period is divided into three subperiods, referred to as Early, Middle, and Late. The Early (ca. 1000-0 B.C.) and Middle Woodland (ca. 0 B.C.-A.D. 1000) periods reveal profound changes from their Archaic antecedents throughout most of eastern North America. These periods are characterized by increasingly secure subsistence economies, in some places involving the practice of horticulture, and other cultural elaborations, such as long-distance trade and communication and the construction of earthen mounds for the burial of the dead.

The appearance of ceramic technology marks the onset of the Early Woodland period. In New York State, the Early Woodland period is roughly divided geographically into western (Meadowood [formerly called Point Peninsula 1]) and eastern (Middlesex) regions (Granger 1978; Funk 1976), although Snow argues that Middlesex represents "an Adena mortuary subsystem grafted onto the Meadowood cultural system" (Snow 1980:264). Meadowood projectile points are thin, of medium breadth, and side-notched (Ritchie 1971:35). Pottery of this period is called Vinette 1. Vinette 1 vessels have moderately thick straight-sided walls with conoidal-shaped bases, and coarse to medium-sized grit temper particles. Surface treatment is characterized by horizontal cord-markings on the interior and cord-markings in various directions on the exterior (Ritchie 1946, 1980:194). Simple grit-tempered tubular pipes are also characteristic of Vinette 1 pottery (Funk 1976:278; Ritchie 1980).

Based on projectile point and ceramic distributions, Early Woodland sites in eastern New York appear to be concentrated along the banks of large streams, reflecting a continuation of the previous Terminal Archaic settlement pattern. Documented sites in the vicinity of the Arthur Kill project area with Early Woodland components include Old Place, Old Place Amerindian sites, Arlington Place, and possibly Bowman's Brook North (Table 1).

Beginning with Fox Creek, there is a series of Middle Woodland phases for eastern New York, which reflects continuous and gradual changes (Funk 1976:287-297; Snow 1980:283). Greater sedentism during the Middle Woodland period is increasingly evident from the reliance on large storage pits and large ceramic vessels (Funk 1976:297). Funk (1976:292) suggests that Middle Woodland groups in eastern New York seem to be oriented to large streams, with special-activity camps located on high bluffs and along small inland streams. Characteristic artifacts include Fox Creek stemmed points (previously called Steubenville Stemmed points [Funk 1976:287-288]); Jack's Reef Corner-notched and Pentagonal points; Greene points; and shell-tempered pottery decorated with net, fabric, or cord impressions (Funk 1976:292; Snow 1980:281). Contrary to the upper Hudson Valley and central New York, there is no good evidence for the development of horticulture in the lower Hudson Valley or southeastern New York in general (Funk 1976; Snow 1980:287). Documented sites in the vicinity of the Arthur Kill project area with Middle Woodland components include Old Place and possibly Bowman's Brook North (Table 1).

The Late Woodland period (ca. A.D. 1000-European Contact) represents the culmination of economic and social trends of preceding periods for much of New York, including the middle and upper Hudson Valley. Sedentary lifestyles based on maize horticulture were the rule throughout the East, though numerous exceptions or special cases are known. Most groups were seasonally sedentary, and relied on horticulture and hunting and gathering to meet their subsistence needs. Late Woodland sites are most frequently situated near large streams, probably to take advantage of fertile soils for horticulture (Ritchie and Funk 1973). The relative importance of horticulture for these groups may be correlated with a de-emphasis on other previously used resource zones (Funk 1976). It may be that in the lower Hudson Valley region, the cultivation of maize was not practiced during the Late Woodland period (Ceci 1979). Projectile point types of this period in the Hudson Valley include triangular-shaped Levanna points and small isosceles triangular-shaped Madison points are rare (Funk 1976:301-302; Snow 1980:321). Late Woodland sites in the Hudson Valley were small and situated directly on the main river floodplain (Snow 1980:321-322), although Bowman's Brook, which is the type site for this Late Woodland phase is situated on a knoll overlooking the Arthur Kill Channel (Table 1) (Skinner 1909; Smith 1950). Bowmans Brook pottery is defined by two ware types. Bowmans Brook Stamped vessels are grit-tempered with connoidal bases and straight or out-flaring rims. Vessel surface treatment is characterized by cord-malleated exteriors, smoothed interiors, and cord-wrapped stick decorations in linear patterns (Ritchie 1980: 270). Bowmans Brook Incised pots frequently have restricted rims and are occasionally shell tempered. Exterior surfaces are smoothed and decorated with broad-line incisions, forming triangular or rectangular patterns around the rim and shoulder (Ritchie 1980: 270). The Bowmans Brook site yielded one dog and 10 human burials in two large pit features (Kaeser 1970). Other documented sites in the vicinity of the Arthur Kill project area with Late Woodland occupations include Old Place, Old Place Amerindian sites, Arlington Place, NYSM Site 4596, and possibly NYSM Sites 4595 and 733 (Tables 1 and 2).

2.2.4 *Summary*

Dramatic cultural changes occurred over the long period of human occupation in southeastern New York. Changing environments and new technologies may have led to stylistic changes among projectile points and ceramics that are central to our understanding of prehistoric cultural chronologies. Environmental and technological changes may have altered the primary subsistence resources exploited by prehistoric peoples, and prompted shifts in settlement patterns. These factors are relevant for the prehistoric occupations in the vicinity of the Arthur Kill Channel.

Clearly, shifts in settlement and mobility patterns can be demonstrated from the Archaic into the Woodland periods. As territorial sizes decreased and sedentism increased, perceptions of the landscape, resource zones, and specific resources undoubtedly changed as well. The proximity of critical resources to hunting stations, base camps, or villages certainly was an important factor in how specific resources were exploited vis-à-vis different mobility patterns. Groups that were relatively wide-ranging in territorial distributions and frequently on the move were likely to have spent more time and performed a greater range of activities at widely spaced yet important resource locations than groups that were more areally circumscribed. This relates to short and long-term requirements and anticipated needs. For instance, stone-tool-using groups that would be near known sources of quartz or chert only a few times during the year would most likely expend a considerable amount of energy at quarries producing finished or near-finished tools (e.g., preforms). Highly mobile groups will minimize the "baggage" that they need to transport by following this strategy. In contrast, groups who can visit quarries easily and on an as-needed basis may conduct limited later-stage tool production activities at quarries. Investigating characteristics of artifact assemblages in light of such issues will potentially inform on mobility strategies of the groups in question.

3. METHODS OF DATA COLLECTION AND ANALYSIS

The primary goal of this research is to synthesize and evaluate existing environmental and archeological data with regard to prehistoric adaptations and lifeways in the vicinity of the Arthur Kill Channel. The project area is situated within the Northern Piedmont physiographic province, just west of the Atlantic Coastal Plain.

Prior to postglacial inundation of the Arthur Kill Valley, a variety of landforms and habitats was available for human occupation and use. These include floodplains, stream terraces and benches, knolls, backwater swamps, and hills. Shooters Island, situated near the east end of the project area, was probably a knoll overlooking a former river approximately 5,000 years ago. The project area was close to Glacial Lake Hackensack during the Late Pleistocene (Figure 3). Within the Arthur Kill Valley, a number of paleotopographic settings that were inundated with rising sea level represent high-sensitive landforms for the presence of prehistoric resources. Previous research suggests that such settings were particularly attractive to Paleo-Indian and Early Archaic groups. Depending on the degree of historic or recent disturbances, stemming primarily from dredging activities, it is conceivable that potentially significant archeological sites are preserved in the sediments of the Arthur Kill Channel. One goal of the current research is to identify the potential for preserved submerged and buried archeological deposits within these sediments.

Data analyzed for geomorphological interpretations were gathered from two principal sources: (1) log data recorded for borings made in the Arthur Kill Channel by the U.S. Army Corps of Engineers in preparation for the planned channel deepening, and (2) maps and published reports offering pertinent topographic or environmental information relating to existing and past conditions. The core-boring data are the most directly applicable to the goals of the present study; the publications and maps were used to develop a set of expectations and an interpretative framework for the analysis of geomorphology and chronology of the Arthur Kill stratigraphy.

Archeological site files were investigated at the New York State Museum (Albany); the New York State Office of Parks, Recreation and Historic Preservation (Waterford); the New Jersey State Museum (Trenton); and the New Jersey Historic Preservation Office (Trenton). In addition, maps were obtained from the New York State Archives, the New York State Library, and the New York State Bureau of Land Management, Division of Land Utilization.

4. RESULTS

4.1 Core-boring Data

The Arthur Kill-Howland Hook Marine Terminal Channel project area was sampled by the COE with a series of core borings. These borings penetrated the sediments of the channel bottom in order to ascertain the bedrock elevation in 80 locations (Figure 4). These data were gathered specifically for the geotechnical aspects of the proposed channel deepening and relocation work.

Analyses of the boring log data indicate that the existing stratigraphy within the Arthur Kill channel is comprised of three major components. These are characterized by a nearly ubiquitous upper layer of estuarine deposits, an underlying sheet of glacial or alluvial sediments, and basal bedrock of Triassic shale. Estuarine sediments range in thickness from approximately .3 to 3.7 m (1 to 12 ft.), and generally average about 2.1 m (7 ft.). These sediments are generally silty in texture, with black to dark gray colors derived from abundant concentrations of organic matter. Similar deposits are common along much of the Mid-Atlantic coastline, where brackish tidal waters are formed in the blending of riverine and oceanic waters. Estuarine deposits may be found in waters as deep as the Arthur Kill Channel, as well as in shallow settings where tidal marshes or mud flats are present.

Shallow water estuarine deposits in the vicinity of the project area are exemplified by the mud flats west of Shooters Island, a vast area east of Elizabethport, and extensive soil mapping units of Organic Substratum Udorthents (USDA in press) occupying filled shoreline and stream valley positions just west of the Arthur Kill in Union County, New Jersey. Historic to Late Holocene in age, these materials were laid down in estuaries formed subsequent to the submergence of former land areas. The aquatic conditions in which they accumulated and their recent age preclude these sediments from containing intact archeological deposits.

Bedrock underlies the entire project corridor, and its surface gently undulates from an elevational high of slightly less than 12.2 m (40 ft.) below mean low water to a low of somewhat over 15.2 m (50 ft.) below mean low water. This 3-m (10-ft.) range constitutes a narrow elevational bracket for the full 5-km (3.1-mi.) stretch of the project area; even at locations exhibiting the greatest local relief, the slope of the bedrock surface is subdued. For example, the 2.1-m (7-ft.) drop in elevation over the 152-m (500-ft.) distance between Borings AK95-9 and AK95-14 represents a slope of only 1.5 percent. In a few locations, gradients approach 3 percent, but all bedrock slopes are so slight that if encountered on a terrestrial landform they would be considered nearly level. Interestingly, nearly level to gently sloping terrain is characteristic of most modern landscapes within Triassic Lowland physiographic regions of the east coast.

The bedrock elevational range between about 12 - 15 m (40 - 50 ft.) below mean low water represents a maximum low for the original base of the freshwater Arthur Kill. With a channel base lying at this elevation or higher, the Holocene sea level curve recently developed by Fletcher (1988) indicates that marine transgression would not have impacted the Arthur Kill waterway until about 6,000 years ago. This refutes the reconstructed setting of the Port Mobil Paleo-Indian site offered by Eisenberg (1978: 123, Figure 19) for a brackish Arthur Kill lying as low as 25 m (82 ft.) below its present level 10,500 to 12,000 years ago. Southern stretches of the channel may have been lower than in the north, but probably not as low as 25 m given the documented gradient in the area.

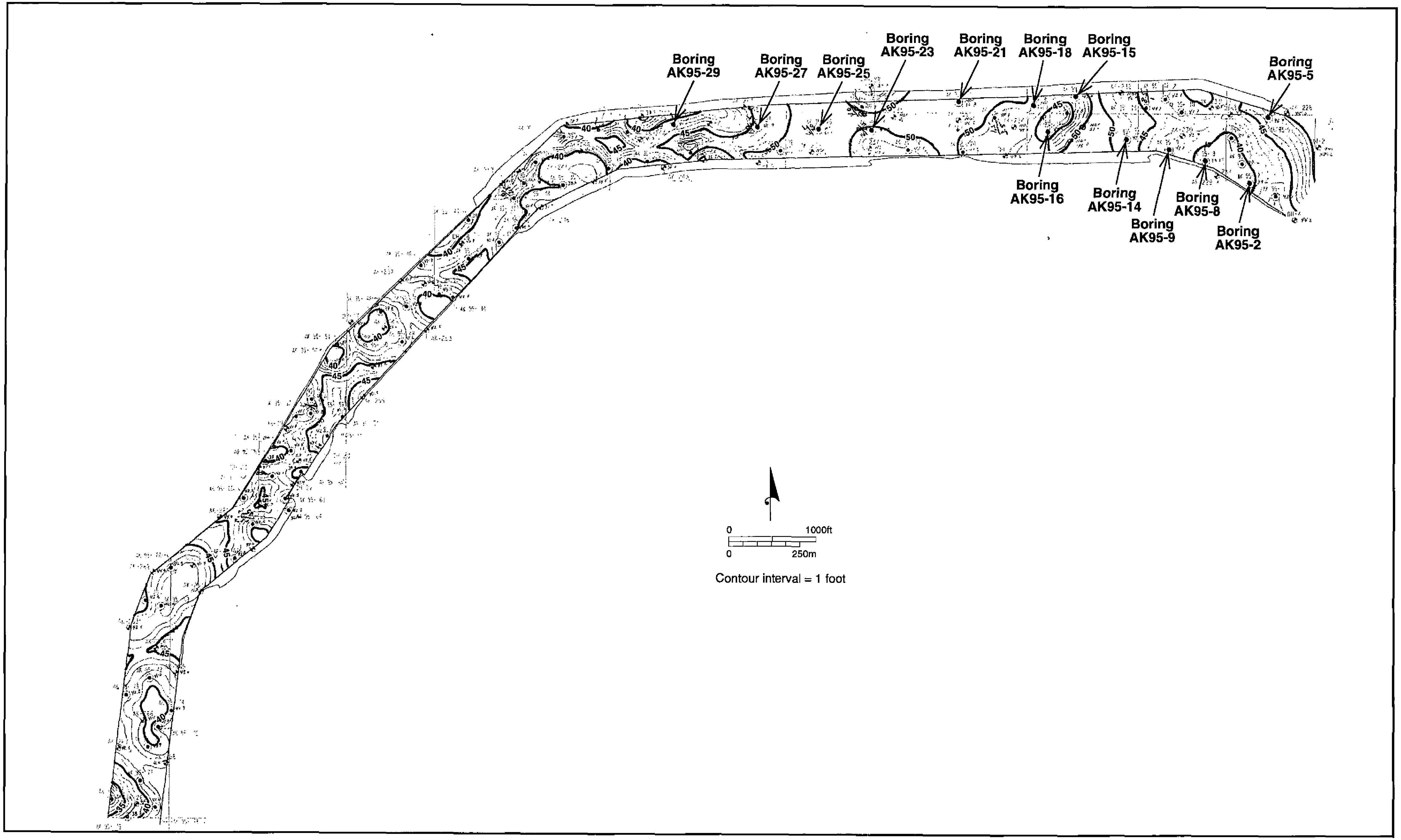

Figure 4. Arthur Kill project area showing the locations of core borings and the bedrock topography underlying the channel sediments. The core borings used in the stratigraphic reconstruction are indicated.

Submerged land surfaces with residual soils developed directly from the Triassic sedimentary rocks are not expected to be present in the Arthur Kill vicinity given the glacial and postglacial history for the region. These rocks were overrun and scoured by Pleistocene glaciers, and then buried to various degrees by the drift of retreating ice masses. Late Pleistocene sedimentation under lake waters impounded by the Harbor Hill terminal Moraine provided additional deposition in some areas, and wind-blown silts may have been laid down as a loessial mantle across many upland landscapes. During the Holocene, erosional dissection of the various Pleistocene deposits eventually could have re-exposed the Triassic rock, particularly along the main Arthur Kill Channel, however, alluvium of either bedload or floodplain/terrace origins should at least be present as a thin cap, even in the former channel courses.

Identifying Holocene alluvium is important for recognizing ancient landforms that may have been occupied in prehistory. Assuming that the Arthur Kill was formerly a high-order freshwater stream, a variety of alluvial settings with their associated depositional sequences potentially are represented in the now submerged stratigraphic columns of the valley. Very cobbly and gravelly deposits resting directly on bedrock may mark former stream channels, and fine-sandy to silty sediments overlying the cobbles would be consistent with vertical terrace accretion atop former bedload deposits. More silty or fine-textured strata may reflect lower floodplain or backswamp positions.

Interpreting the layer of mixed loamy to fine-textured or gravelly deposits lying between the Triassic bedrock and the estuarine sediments was the main focus in the analysis of the boring log data. It is difficult to establish a precise origin for this material given the great number of potential sources, as well as the distances between and alignment of boring locations. Glacial and postglacial deposits ranging from texturally mixed tills to sandy or gravelly outwash and even silty to clayey lacustrine sediments could readily account for all of the described stratigraphic patterns, without considering erosion, alluvial deposition, or soil development during the Holocene. In addition, detailed stratigraphic and geomorphic relationships for identifying potential alluvial landform sequences cannot be generated owing to the great distances between core borings. More tightly spaced borings (30-60 m [100-200 ft.]) situated along transects perpendicular to the Arthur Kill Channel and extending beyond its edges would provide a more complete valley profile with better prospects for establishing the context of the former stream channel within the continuum of possible alluvial and upland landforms than what is currently possible.

Whether the variable deposits situated between the upper estuarine sediments and the basal bedrock are Pleistocene or Holocene in age, these materials constitute the only strata with any potential for containing intact archeological residues. They are present mainly along the east-west leg of the channel, and for the most part disappear west and south of Boring AK95-27, where with few exceptions the recent estuarine sediments rest directly on bedrock. The almost complete absence of these Pleistocene or Holocene deposits throughout much of the channel corridor suggests that earlier dredging efforts have resulted in their removal; even where the deposits are still present the prospects of intact formerly inhabitable land surfaces are remote. Natural erosional processes accompanying the marine transgression and the historic/recent dredging of the channel conspired to minimize the potential for submerged and preserved Holocene landforms. The nearly uniform basal depth for much of the estuarine mantle evinces earlier channel dredging that consistently reached to approximately 12.2 m (40 ft.) below mean low water (Figure 5). The absence of pre-estuarine deposits capping bedrock eminences at or higher than this elevation supports the identification of earlier dredging to 40 feet. These observations are congruent with conclusions derived by Kardas and Larrabee regarding the dredging history of the Kill van Kull

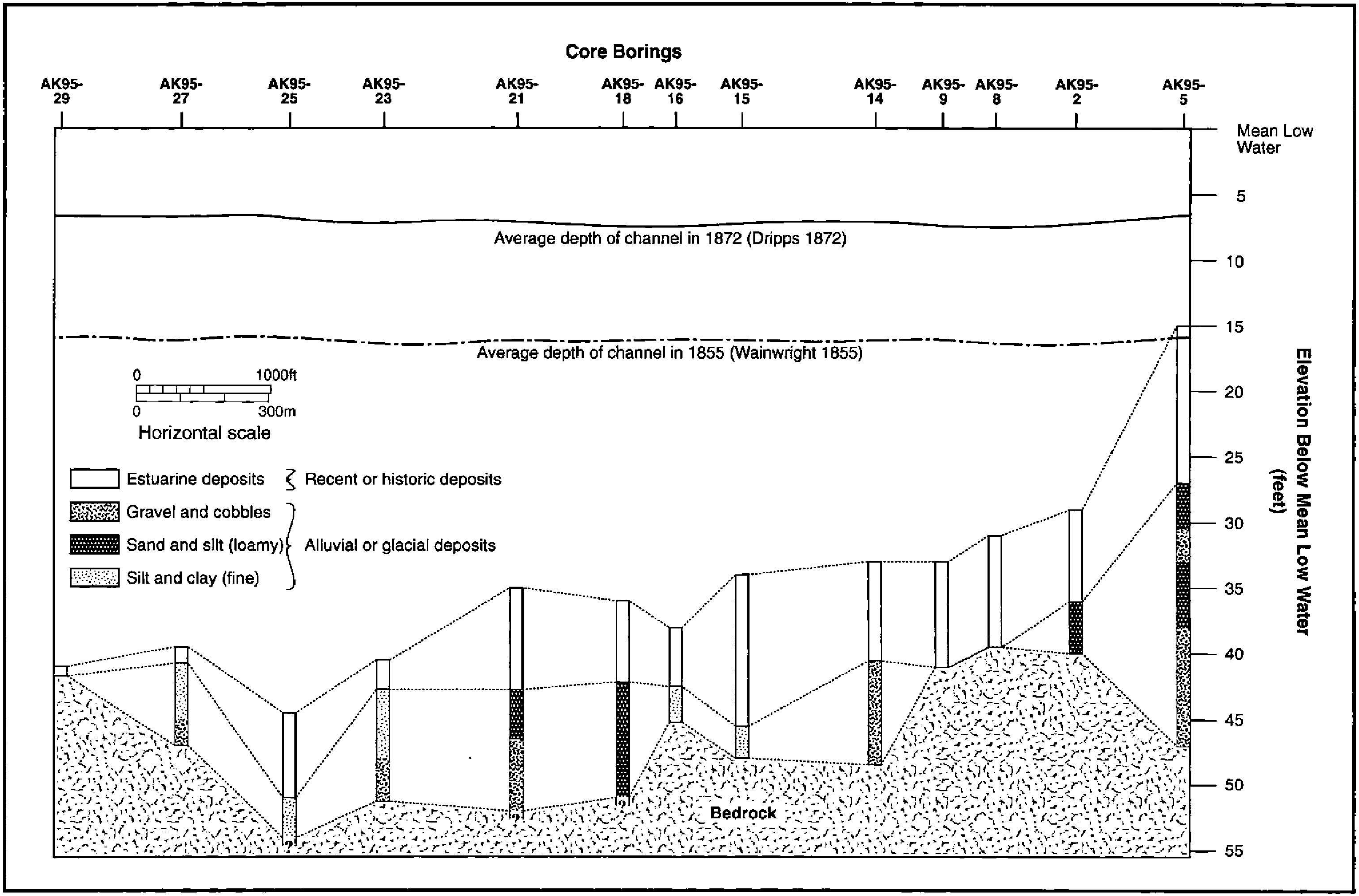

Figure 5. Stratigraphic profile along the east-west leg of the Arthur Kill Channel based on core-boring data.

Channel and Newark Bay (Kardas and Larrabee 1976: 33-36, 44, 1980: 12). A geotechnical core-boring investigation of the Arthur Kill Sediments and bedrock was conducted from the southern terminus of the current project area to Carteret, New Jersey, a distance of approximately 6.4 km (4 mi.) (Alpine Ocean Seismic Survey 1987). The results of that study are consistent with the core-boring data generated in the present project; recent to historic estuarine deposits directly overlie bedrock.

Boring logs suggesting widespread dredging truncations to approximately 40 feet or more may be contrasted to the stratigraphy of Boring AK95-5, located near the channel edge, just north of Shooters Island (Figures 1 and 4). This core boring contains pre-estuarine deposits rising to within 8.2 m (27 ft.) of mean low water. Even this elevation for pre-estuarine deposits, however, may not reflect an untruncated column. If indeed this single core boring represents an undisturbed column, then the rates of Holocene sea level rise impose temporal constraints on the potential for archeological deposits. The rising sea reached an elevation of approximately 8.2 m (27 ft.) below present mean low water between ca. 4,000 to 5,000 years ago (Fletcher 1988), thus archeological deposits more recent than the Late Archaic period would not be expected in this area. Under these conditions, later cultural residues would be restricted to inhabitable positions along retreating Late Holocene shorelines considerably removed from the original Arthur Kill Channel. Other researchers have indicated the potential for undisturbed submerged archeological deposits in the vicinity of Shooters Island (Kardas and Larrabee 1976: 44, 1980: 12; Rockman and Rothschild 1979; U.S. Army Corps of Engineers 1986: 27, 108). Alternatively, the stratigraphy displayed in Boring AK95-5 represents a truncated column, and that pre-estuarine deposits formerly occurred at a higher elevation, thus precluding the potential for any prehistoric deposits. There is administrative documentation that dredging to depths of 3.7 - 6.7 m (12 - 22 ft.) was conducted at the east end of Shooters Island Basin in 1920, although it is not clear whether this was within the current project area (Dredging Permit 1917). The U.S. Army Corps of Engineers (1986) Feasibility Report indicates that a small portion of the shallow area within the project area, "immediately north of the Shooters Island dike," may have escaped dredging activities (U.S. Army Corps of Engineers 1986: 27).

4.2 Map and Bathymetric Analyses

Further insights into the extent of historic modifications to the Arthur Kill are gleaned through comparisons of modern conditions with those depicted in earlier maps showing historic shorelines and bathymetric soundings. Maps produced during the eighteenth and nineteenth centuries demonstrate substantial differences from modern conditions both in the topography of landscapes adjacent to the Arthur Kill as well as in the bathymetric contours of open water areas (Bache 1856; Beers 1874, 1887; Bogart 1880; Dripps 1872; Office of the Surveyor General ca. 1750, 1797; Joint Boundary Commission of New York and New Jersey 1888; Robinson 1898; Wainwright 1855). As late as 1887, broad stretches of poorly drained, presumably tidal-marsh terrain were present on both the New Jersey and Staten Island sides of the Arthur Kill (Beers 1887). On Staten Island, south of Howland Hook, tidal marshes with networks of meandering creeks and guts are shown to have extended well over 915 m (3,000 ft.) to the east of open water. These marshes are no longer present; the former marsh surface originally would have been at or about the level of high tide, although modern topographic maps for the area reveal surface elevations of 3 m (10 ft.) or more above mean sea level (Figure 1). Similar conditions resulting from historic or recent filling of the marshes occur in New Jersey and large areas of filled marsh soils have been identified as Udorthents with organic substrata in Union County (USDA in press). Shooters Island is capped by approximately 2 - 4 m (6 - 13 ft.) of fill (Rockman and Rothschild 1979: 18-19).

The former tidal marsh areas and other shallow water estuarine positions are of considerable interest for the present study. Unlike the open water portions of the Arthur Kill, these positions are more likely to have been spared erosion by tidal and wave actions. The marshes and mud flats may mark the locations of former terrestrial landscapes, where slopes were sufficiently flat to enable estuarine sedimentation and the development of protective marsh vegetation to keep pace with the rate of submergence. Through gradual accretion, a mantle of estuarine sediments are likely to have amassed atop preserved Holocene or Pleistocene strata, particularly in low-lying areas well removed from eroding shorelines. Although low-lying landscapes situated some distance from paleo-shorelines offer good prospects for the preservation of submerged or buried surfaces, their remoteness from sources of fresh water represents diminished appeal for human occupation.

Differences between modern and historic maps demonstrate substantial changes in shoreline locations. By 1856, continuous shoreline bulkheading was in place along both sides of the Arthur Kill, although in the intervening century bulkhead positions have shifted. At the channel bend near Howland Hook and for several thousand feet south of the confluence with the Elizabeth River, the 1856 map shows the width of the Arthur Kill between bulkheads to be generally constant at about 168 m (550 ft.). Currently, widths along the same stretch range from about 183 m (600 ft.) near Howland Hook to as much as 259 m (850 ft.) approximately 457 m (1,500 ft.) south of the Elizabeth River. Thus, the bulkheads have been relocated in some areas to widen the channel, encompassing as much as 76 m (250 ft.) of former marsh lands. Bulkhead relocations were undoubtedly performed in conjunction with dredging activity, indicating that destruction of previous landforms by dredging was not limited to waterways but extended horizontally across the landscape as well.

While the boring logs provide current bathymetric and stratigraphic measurements that reflect a history of deep dredging, historic map data illustrate a nearly universal coastal process, which in such shipping channels as the Arthur Kill, would necessitate dredging efforts even without the progressive development of larger and deeper draft vessels. The 1855 map of the channel displays depths ranging from about 5 m (16 ft.) in the east-west leg to slightly under 6 m (20 ft.) in the north-south leg. By 1872, channel depths had decreased to approximately 2.5 m (8 ft.) in the east-west reach and 5 m (16 ft.) in the north-south reach, evincing rapid siltation of the channel (Figure 6). Accelerated rates of sedimentation have plagued east coast harbors throughout historic and recent times; this is well represented in the historic bathymetric data for the Arthur Kill Channel. Historic siltation may have already degraded the channel prior to 1855, possibly necessitating dredging activities in the early nineteenth century.

The bathymetric data partially document major historic changes in the Arthur Kill, however, they are of limited use in establishing the original level of pre-estuarine deposits. Channel depth readings record the top of existing estuarine sediments; they cannot determine the total thickness of estuarine deposits nor discriminate between those of Late Holocene or historic age. Comparing the modern and historic maps in conjunction with the core-boring logs for the east-west leg of the Arthur Kill, it is apparent that if recent dredging efforts have reached to approximately 12 m (40 ft.), then an average of 7 m (24 ft.) of material has been removed and partially redeposited below the 5-m (16-ft.) channel depth of 1855. This constitutes a considerable amount of material that may have extended below the base of estuarine sediments to eradicate earlier Holocene or Pleistocene surfaces. Given the core-boring data and the multiple episodes of channel widening/deepening, the search for submerged/buried former terrestrial surfaces would be more successful in the areas of filled tidal marshes located adjacent to the current Arthur Kill Channel.

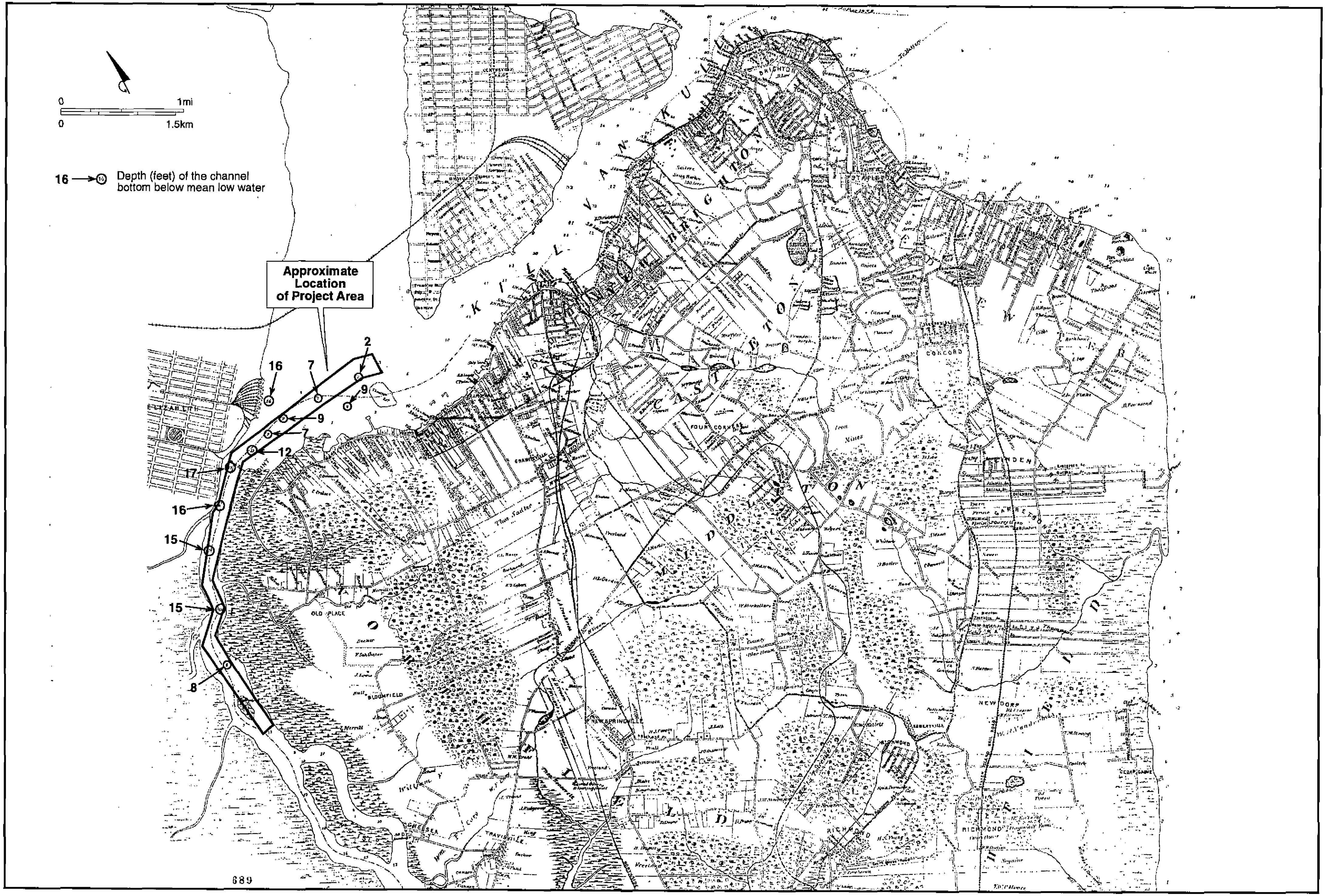

Figure 6. Approximate location of the project area on the Dripps (1872) map. Note the depths of the Arthur Kill Channel.

5. SUMMARY AND RECOMMENDATIONS

5.1 Summary

The Arthur Kill Valley most likely developed as a result of a breach in the Harbor Hill terminal Moraine by waters draining from Glacial Lake Hackensack approximately 16,000 years ago. Supported by later stream flow from the Hackensack Valley and other tributary systems, the Arthur Kill was probably a high-order stream, along which alluvial landforms developed. Established well before the arrival of human populations to eastern North America, the Arthur Kill Valley supported a diverse riverine environment, with numerous floral and faunal habitats. Originally situated at 23 m (75 ft.) or more above the Late Pleistocene sea level, the valley would not have been affected by the rising sea until the mid-Holocene. Initial effects of the sea level rise would have been the introduction of brackish water to the main river channel; with the ever rising tidal waters, landscapes adjacent to the channel were progressively inundated. Depending on the elevation of the original Arthur Kill valley bottom, submergence of the lowest landscapes may have begun as early as 5,000 years ago. The present shoreline was in place approximately 2,000 years ago.

Submerged landscapes situated along the Arthur Kill Channel may consist of assorted glacial and post-glacial deposits and Holocene alluvium. Such deposits resting atop Triassic shale bedrock and buried by a mantle of young estuarine sediments were identified in a number of core borings primarily within the east-west arm of the channel. The specific origins of these deposits could not be determined from the core-boring descriptions, although their presence does allow for the possibility of prehistoric cultural remains. Existing data, however, suggest that the potential is low for intact archeological deposits, a product of two major factors: (1) natural erosion of former land surfaces undoubtedly occurred with inundation, and (2) severe truncation of Holocene sediments resulted from historic and recent dredging activities.

Throughout most of the north-south arm of the channel, the presence of historic estuarine deposits resting directly on Triassic-aged bedrock indicates the removal of pre-estuarine (Holocene) deposits by dredging. Further, a relatively level bottom for estuarine sediments at approximately 12.2 m (40 ft.) below mean low water in the east-west stretch of the channel reflects a single dredging episode. Boring AK95-5, located near the edge of the channel, just north of Shooters Island, revealed a thick column of pre-estuarine deposits at a depth of 8 m (27 ft.) below mean low water. Of all the locations sampled by core borings, the area in the vicinity of Boring AK95-5 represents the greatest potential for intact Holocene sediments. Therefore, it is possible that archeological deposits are present in this portion of the project area. This finding corresponds to earlier studies regarding the potential for intact archeological deposits within the project area (Kardas and Larrabee 1976: 44, 1980: 12; Rockman and Rothschild 1979; U.S. Army Corps of Engineers 1986: 27, 108). The boring log data, however, are not sufficiently detailed to allow for the identification of submerged land surfaces; it is likely that some truncation of this column has also occurred.

Historical map and bathymetric data demonstrate significant changes in the shorelines and channel of the Arthur Kill. Broad tidal marsh areas originally extensive along the Arthur Kill are now buried beneath fill that is generally 3 m (10 ft.) or more in thickness. These buried marshes and other shallow estuarine positions situated outside of the modified Arthur Kill Channel represent the most likely contexts for preserved and submerged paleo-landforms. Historic modifications in the deeper portions of the channel minimize the potential for intact Holocene deposits. Bulkheaded shorelines have shifted since the mid-nineteenth century, and channel depths have changed considerably, owing to accelerated historic sedimentation and to dredging. Comparing nineteenth century and recent channel depths indicates that up to 7.3 m (24 ft.) of sediments have been removed in some locations. Much of this material certainly represents recent estuarine deposits, although older Holocene and even Pleistocene sediments were probably impacted as well.

5.2 Recommendations

The potential is low for the preservation of intact submerged Holocene (pre-estuarine) surfaces within the majority of the Arthur Kill-Howland Hook Marine Terminal Channel project area. Natural erosional processes accompanying postglacial submergence conspired with historic and recent dredging activities to severely impact the Holocene and Pleistocene sediments. Isolated locations along the channel periphery may have been disturbed to a lesser degree, thus perhaps increasing the potential for Holocene archeological deposits. Out of 80 core borings generated in the present project, one revealed substantial deposits of Holocene or Pleistocene age (Boring AK95-5). Based on these findings, it is recommended that the archeological sensitivity in the vicinity of Core Boring AK95-5 be considered if the proposed channel improvements cannot avoid the area.

Widely spaced core borings were distributed along the length and width of the project corridor. More tightly spaced observations, at 30-60-m (100-200-ft.) intervals, and aligned as a series of transects perpendicular to the channel length would provide a better database for assessing the paleogeography and pre-estuarine stratigraphy of the former freshwater Arthur Kill Valley. To construct a useful valley profile, these transects should extend well beyond the current channel margins, preferably intercepting the adjacent former marsh area. The core borings should be taken under the supervision of a soil scientist/geomorphologist, who also makes the descriptions of the recovered sediments.

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APPENDIX I:

CORE-BORING LOGS USED FOR THE STRATIGRAPHIC PROFILE OF THE ARTHUR KILL CHANNEL

HOLE NO. AK95-2

JOB NO.

REPORT ON SUBSURFACE EXPLORATION

DATE 10/24/95

GROUND ELEVATION MSL [✓ MLW] BASE 28.6

SHEET 1 OF 1

LOCATION 2,141,278
660,220

PROJECT Arta

UNIT Explorer

GROUNDWATER OBSERVATIONS:

	DURING DRILLING	SUBSEQUENT TO DRILLING				REMARKS
DATE						
DEPTH						
CASING AT						
TIME						
ELAPSED TIME						

☐ LIQUID INTRODUCED DURING DRILLING AT ________ FEET ☐ NO GROUNDWATER ENCOUNTERED ☐ NO READINGS

EXPLORATION LOG:

28.6
MLW

ELEVATION	DEPTH	CASING BLOWS	SAMPLE OR PROBE BLOWS	SAMPLE/RUN NO. (FOOTNOTE 1)	SOIL AND ROCK CLASSIFICATION - DESCRIPTION DEPTHS OF CHANGE UNIFIED SOIL CLASSIFICATION (FOOTNOTES 2 & 3)	LEGEND	SOIL SAMPLING AND ROCK CORING DATA CHARACTERISTICS UNUSUAL CONDITIONS REMARKS (FOOTNOTE 4)
29.6	1		W O		Dark gray to black		Petrol Odor
30.6	2		R		Clayey SILT, trace		
31.6	3				Sand (MH-CH)		
32.6	4						
33.6	5						
34.6	6						
35.6	7						
36.6	8				36.6		
37.6	9		7 18		Red-brown SAND and		
38.6	10		22 26		SILT, little Gravel (SM-ML)		
39.6	11		38 62	39.6			39.6 - 42.1
40.6	12				Gray to black SHALE-Siltstone with bands		€1 Cut 2.5'
41.6	13			42.1	of claystone. ~~Hard~~		Rec 1.9'
42.6	14				and unweathered. Near		42.1 - 45.1
43.6	15				vertical fractures.		€2 Cut 3' Rec. 3'
44.6	16						
45.6	17				TD 45.1		

SAMPLE STORAGE/CORE BOX NUMBER

HOLE NO. AK95-5	JOB NO.	REPORT ON SUBSURFACE EXPLORATION	DATE 10/25/95
GROUND ELEVATION MSL [✓ MLW] BASE 15.1			SHEET 1 OF 2
LOCATION 2,141,478 660,961		PROJECT Arthur Kill 95	UNIT COE Explorer

GROUNDWATER OBSERVATIONS:

	DURING DRILLING	SUBSEQUENT TO DRILLING				REMARKS
DATE						
DEPTH						
CASING AT						
TIME						
ELAPSED TIME						

☐ LIQUID INTRODUCED DURING DRILLING AT ______ FEET ☐ NO GROUNDWATER ENCOUNTERED ☐ NO READINGS

EXPLORATION LOG:

	ELEVATION	DEPTH	CASING BLOWS	SAMPLE OR PROBE BLOWS	SAMPLE/RUN NO. (FOOTNOTE 1)	SOIL AND ROCK CLASSIFICATION - DESCRIPTION — DEPTHS OF CHANGE — UNIFIED SOIL CLASSIFICATION (FOOTNOTES 2 & 3)	LEGEND	SOIL SAMPLING AND ROCK CORING DATA CHARACTERISTICS UNUSUAL CONDITIONS REMARKS (FOOTNOTE 4)
—15.1	16.'	1		W		Gray, Silty Clay,		
	17.'	2		R	S1	trace Fine Sand (ML)		
	18.'	3		↓		slightly organic		
CO30	19.'	4		W				
	20.'	5		O				
	21.'	6		H	S2	A/A		
	22.'	7		↓				
	23.'	8						
CO-35	24.'	9		W				
	25.'	10		O H	S3	A/A		
	26.'	11						
	27.'	12					27.1	
	28.'	13						
CO-40	29.'	14		4 4	S4	Red-brown SAND, Some Silt, tr. Gravel		
	30.'	15		5		(SM)		
	31.'	16					30.6	
	32.'	17		☒	S5	Cored through cobbles & bolders in		
	33.'	18		☒		~~[illegible]~~	32.6 33.1	
CO-45	34.'	19		18 14	S6	Red-brown Silt with little to some SAND and		SAND AND Gravel FLOATING IN A SILT/CLAY MATRIX
	35.'	20		18.		[illegible]		

SAMPLE STORAGE/CORE BOX NUMBER

HOLE NO. AK95-5	JOB NO.	REPORT ON SUBSURFACE EXPLORATION	DATE 10/25/95
GROUND ELEVATION MSL MLW BASE 15.1			SHEET 2 OF 2
LOCATION 2,141,478 660,961	PROJECT		UNIT COE Explorer

GROUNDWATER OBSERVATIONS:

	DURING DRILLING	SUBSEQUENT TO DRILLING				REMARKS
DATE						NWM-3T DIAMOND BIT
DEPTH						
CASING AT						
TIME						
ELAPSED TIME						

☐ LIQUID INTRODUCED DURING DRILLING AT ______ FEET ☐ NO GROUNDWATER ENCOUNTERED ☐ NO READINGS

EXPLORATION LOG:

	ELEVATION	DEPTH	CASING BLOWS	SAMPLE OR PROBE BLOWS	SAMPLE/RUN NO. (FOOTNOTE 1)	SOIL AND ROCK CLASSIFICATION - DESCRIPTION — DEPTHS OF CHANGE — UNIFIED SOIL CLASSIFICATION (FOOTNOTES 2 & 3)	LEGEND	SOIL SAMPLING AND ROCK CORING DATA CHARACTERISTICS UNUSUAL CONDITIONS REMARKS (FOOTNOTE 4)
	3.'	21						
	37.'	22		18 26 27	S7	Red-brown SILT, little to some Sand and Gravel (ML)		ROCK BIT REFUSAL AT 38.8'.
CO 50	38.'	23			WASH			
	39'	24					38.8'	
	40.'	25				GRAY SILTSTONE - UNWEATHERED, HARD (Bolder) Till		Pull-1 FROM 38.8' RUN 4.1' TO 42.9' REC. 1.8', C.L. 2.3'
	41.'	26					40.6'	
	42.'	27				CORE LOSS		%RQD = $\frac{1.1}{4.1}$ x100 = 26.8%
	43.'	28					42.9	% REC = 18/4.1 x100 = 43.9%
CO55	44'	29				Red, gray and green SANDSTONE and shale in cobbles. Matrix washed out (Till)	43.5	Pull-2 FROM 42.9', RUN 3.9' TO 46.8' REC 0.6' C.L. 3.3'
	45'	30						%RQD = 0
	46.'	31				CORE loss		%REC = $\frac{0.6}{3.9}$ x100 = 15.3%
	47'	32					46.8'	TOP ROCK
CO 60	48'	33				GRAY SANDSTONE - FINE GRAINED, UNWEATHERED, VERY HARD (Top Bedrock)		Pull-3 FROM 46.8 RUN 3.5' TO 50.3 REC 3.5'
	49'	34						%RQD = $\frac{2.1}{3.5}$ x100 = 60%
	50.'	35					50.3	% REC = 100%
	51'							

SAMPLE STORAGE/CORE BOX NUMBER

HOLE NO. AK95-8

JOB NO.

REPORT ON SUBSURFACE EXPLORATION

DATE 10/24/95

SHEET 1 OF 1

GROUND ELEVATION -30.7' MSL [✓ MLW] BASE

LOCATION N 660,468 E 2140772

PROJECT ARTHUR KILL 95

UNIT COE "EXPLORER"

GROUNDWATER OBSERVATIONS:

	DURING DRILLING	SUBSEQUENT TO DRILLING			
DATE					
DEPTH					
CASING AT					
TIME					
ELAPSED TIME					

REMARKS

NWM-SC
DIAMOND BIT.

☐ LIQUID INTRODUCED DURING DRILLING AT ______ FEET ☐ NO GROUNDWATER ENCOUNTERED ☐ NO READINGS

EXPLORATION LOG:

30.7'

ELEVATION	DEPTH	CASING BLOWS	SAMPLE OR PROBE BLOWS	SAMPLE/RUN NO. (FOOTNOTE 1)	SOIL AND ROCK CLASSIFICATION - DESCRIPTION DEPTHS OF CHANGE UNIFIED SOIL CLASSIFICATION (FOOTNOTES 2 & 3)	LEGEND	SOIL SAMPLING AND ROCK CORING DATA CHARACTERISTICS UNUSUAL CONDITIONS REMARKS (FOOTNOTE 4)	SAMPLE STORAGE/CORE BOX NUMBER
31			W		DARK GRAY TO BLACK			
			O		CLAYEY SILT, TRACE OF			
32			R		FINE SAND (MH)			
33								
34								
35				①				
36								
37								
38							BOUNCING RODS	
39						39.5'	AT 39.5'	
40				395	GRAY SANDSTONE - FINE GRAINED, UNWEATHERED, VERY HARD.		PULL-1	
41					39.5'-41.0' FRAGMENTED		FROM 39.5' TO 42.6' RUN 3.1' REC. 2.1' C.L. 1.0'	
42					42.6-43.3 SLIGHTLY-WEATHERED.	41.6'		
43				426		42.6'		
44							PULL-2 FROM 42.6' TO 44.6' RUN 2.0' REC 2.4' C.G. 0.4'	
45				44.6		44.6		

HOLE NO. AK95-9	JOB NO.	**REPORT ON SUBSURFACE EXPLORATION**	DATE 10/26/95
GROUND ELEVATION MSL [✓ MLW] BASE			SHEET 1 OF 1
LOCATION N-660593 E-2140359		PROJECT ARTHUR KILL 95	UNIT COE "EXPLORER"

GROUNDWATER OBSERVATIONS:

	DURING DRILLING	SUBSEQUENT TO DRILLING				REMARKS
DATE						NWM-ST DIAMOND BIT
DEPTH						
CASING AT						
TIME						
ELAPSED TIME						

☐ LIQUID INTRODUCED DURING DRILLING AT ________ FEET ☐ NO GROUNDWATER ENCOUNTERED ☐ NO READINGS

EXPLORATION LOG:

32.6'

ELEVATION	DEPTH	CASING BLOWS	SAMPLE OR PROBE BLOWS	SAMPLE/RUN NO. (FOOTNOTE 1)	SOIL AND ROCK CLASSIFICATION - DESCRIPTION — DEPTHS OF CHANGE — UNIFIED SOIL CLASSIFICATION (FOOTNOTES 2 & 3)	LEGEND	SOIL SAMPLING AND ROCK CORING DATA — CHARACTERISTICS — UNUSUAL CONDITIONS — REMARKS (FOOTNOTE 4)	SAMPLE STORAGE/CORE BOX NUMBER
32			W		DARK BROWNISH GRAY TO BLACK CLAYEY SILT, TRACE OF FINE SAND (MH)			
33			O					
34			R					
35								
36				1				
37								
38								
39								
40								
41			100/0.4'	2	SOME SANDSTONE ROCK FRAGMENTS	40.7 41.1		
42					BROWNISH GRAY SILTSTONE, SLIGHTLY WEATHERED, HARD, FRAGMENTED AND INTENSELY JOINTED WITH VERTICAL AND HORIZONTAL OPENED SMOOTH JOINTS.		PULL-1 FROM 41.1 TO 45.3 RUN 4.2', REC 3.0', C.L. 1.2	
43						43.5'	%REC = $\frac{3.0}{4.2}$ x100 = 71.4%	
44					GRAY SANDSTONE, FINE TO MEDIUM-GRAINED, SLIGHTLY WEATHERED AND PITTED VERY HARD, FRAGMENTED WITH VERTICAL AND HORIZONTAL IRREGULAR BREAKS.	44.1'	%RQD = 0	
45					CORE LOSS	45.3'		
46								

HOLE NO. AK95-14	JOB NO.	**REPORT ON** **SUBSURFACE EXPLORATION**	DATE 10/26/95
GROUND ELEVATION MSL [✓ MLW] BASE 33.1			SHEET 1 OF
LOCATION N - 660706 E - 2139872		PROJECT ARTHUR Kill 95	UNIT C.O.E. "EXPLORER"

GROUNDWATER OBSERVATIONS:

	DURING DRILLING	SUBSEQUENT TO DRILLING				REMARKS
DATE						
DEPTH						
CASING AT						
TIME						
ELAPSED TIME						

☐ LIQUID INTRODUCED DURING DRILLING AT ______ FEET ☐ NO GROUNDWATER ENCOUNTERED ☐ NO READINGS

EXPLORATION LOG:

33.1'

ELEVATION	DEPTH	CASING BLOWS	SAMPLE OR PROBE BLOWS	SAMPLE/RUN NO. (FOOTNOTE 1)	SOIL AND ROCK CLASSIFICATION - DESCRIPTION — DEPTHS OF CHANGE — UNIFIED SOIL CLASSIFICATION (FOOTNOTES 2 & 3)	LEGEND	SOIL SAMPLING AND ROCK CORING DATA CHARACTERISTICS — UNUSUAL CONDITIONS — REMARKS (FOOTNOTE 4)	SAMPLE STORAGE/CORE BOX NUMBER
33								
34			W		Black Clayey SILT			
35			O R		tr. Fine Sand (MH)			
36								
37				①				
38								
39								
40						40.3		
41			100/.5		Red-Brown SILT, some Fine SAND (SM) Till	40.8	C1	
42							Cut 6.1 Ft	
43					Red, green and gray Sandstone and Shale		Rec. 1.2' cobbles and bolders	
44					cobbles + bolders in			
45					SILT/(CLAY MATRIX)			
46					(Till)			
47					47.5			
48							Top Rock 47.5	
49				47.9	Gray Green, fine grained, poros		C2 47.9-51.2	
50					SANDSTONE		Cut 3.2'	
51				51.2	51.2		Rec: 2.7' RQD 68%	

HOLE NO. AK95-15

JOB NO.

REPORT ON

SUBSURFACE EXPLORATION

DATE 10/26/95

GROUND ELEVATION MSL [✓ MLW] BASE 33.8

SHEET 1 OF 1

LOCATION 2,139,288
661,187

PROJECT Arthur Kill 95

UNIT COE Explorer

GROUNDWATER OBSERVATIONS:

	DURING DRILLING	SUBSEQUENT TO DRILLING				REMARKS
DATE						
DEPTH						
CASING AT						
TIME						
ELAPSED TIME						

☐ LIQUID INTRODUCED DURING DRILLING AT _______ FEET ☐ NO GROUNDWATER ENCOUNTERED ☐ NO READINGS

EXPLORATION LOG:

-33.8

ELEVATION	DEPTH	CASING BLOWS	SAMPLE OR PROBE BLOWS	SAMPLE/RUN NO. (FOOTNOTE 1)	SOIL AND ROCK CLASSIFICATION - DESCRIPTION — DEPTHS OF CHANGE — UNIFIED SOIL CLASSIFICATION (FOOTNOTES 2 & 3)	LEGEND	SOIL SAMPLING AND ROCK CORING DATA CHARACTERISTICS — UNUSUAL CONDITIONS — REMARKS (FOOTNOTE 4)
34	.2				33.8		
35	1.2		W O		Black, slightly organic, clayey SILT, trace fine SAND (MH)		Petrol odor
36	2.2		R				
37	3.2						
38	4.2						
39	5.2			(51)			
40	6.2						
41	7.2						
42	8.2						
43	9.2						
44	10.2				44.3		
45	11.2		100/.5	(52)	Red-brown, dense, dry, clayey SILT, trace SAND (ML)		
46	12.2		C O				
47	13.2		100/.3 C	(53)	47.0		
48	14.2		O 100/0	(54) 47.5	Red-brown SHALE, dense and unweathered. No open fractures.		(54) = Shale cuttings ← 1 Cut 3.0' Rec 3.0' RQD 90%
49	15.2						
50	16.2				50.5		
51				50.5	Total Depth		

SAMPLE STORAGE/CORE BOX NUMBER

HOLE NO. AK95-16	JOB NO.	**REPORT ON SUBSURFACE EXPLORATION**	DATE 10/28/95
GROUND ELEVATION MSL [✓ MLW] BASE 38.2			SHEET 1 OF 1
LOCATION 2138987 660788		PROJECT Antidar Hill 95	UNIT COE Explorer

GROUNDWATER OBSERVATIONS:

	DURING DRILLING	SUBSEQUENT TO DRILLING				REMARKS
DATE						
DEPTH						
CASING AT						
TIME						
ELAPSED TIME						

☐ LIQUID INTRODUCED DURING DRILLING AT ________ FEET ☐ NO GROUNDWATER ENCOUNTERED ☐ NO READINGS

EXPLORATION LOG:

38.2

ELEVATION	DEPTH	CASING BLOWS	SAMPLE OR PROBE BLOWS	SAMPLE/RUN NO. (FOOTNOTE 1)	SOIL AND ROCK CLASSIFICATION - DESCRIPTION DEPTHS OF CHANGE UNIFIED SOIL CLASSIFICATION (FOOTNOTES 2 & 3)	LEGEND	SOIL SAMPLING AND ROCK CORING DATA CHARACTERISTICS UNUSUAL CONDITIONS REMARKS (FOOTNOTE 4)	SAMPLE STORAGE/CORE BOX NUMBER
39			W		Black, slightly organic clayey SILT (MH)		Petrol (organic) odor	
40			O					
41			R	S1				
42						42.4'		
43			15		Red-brown, dense SILT and CLAY (ML-CL)			
44			100/3	S2		43.5	C1 44.2–47.6	
45			100/.2	44.2	Red-brown, SHALE, weathered. No fractures. (Bedrock)		CUT: 3.4'	
46							REC: ~~REC~~ 2.4'	
47							RQD: 17%	
48				47.4				
					TD 47.6			

HOLE NO.	JOB NO.		DATE
AK95-18		**REPORT ON SUBSURFACE EXPLORATION**	27 Oct 95 -
GROUND ELEVATION -36.5 MLW	MSL [✓ MLW] BASE		SHEET 1 OF 1
LOCATION N 661,080 E 2,138,819 -		PROJECT ARTHUR KILL	UNIT C.O.E. "EXPLORER"

GROUNDWATER OBSERVATIONS:

	DURING DRILLING	SUBSEQUENT TO DRILLING				REMARKS
DATE						
DEPTH						
CASING AT						
TIME						
ELAPSED TIME						

☐ LIQUID INTRODUCED DURING DRILLING AT _______ FEET ☐ NO GROUNDWATER ENCOUNTERED ☐ NO READINGS

EXPLORATION LOG:

36.0

ELEVATION	DEPTH	CASING BLOWS	SAMPLE OR PROBE BLOWS	SAMPLE/RUN NO. (FOOTNOTE 1)	SOIL AND ROCK CLASSIFICATION - DESCRIPTION — DEPTHS OF CHANGE — UNIFIED SOIL CLASSIFICATION (FOOTNOTES 2 & 3)	LEGEND	SOIL SAMPLING AND ROCK CORING DATA CHARACTERISTICS UNUSUAL CONDITIONS REMARKS (FOOTNOTE 4)	SAMPLE STORAGE/CORE BOX NUMBER
						36.5'		
37			W	①	BLACK CLAYEY SILT, TRACE OF FINE SAND. (MH)		SLIGHT PETRO ODOR	
38			O R					
39								
40								
41								
42						42.2'		
43			8 18	②	RED-BROWN FINE CLAYEY SAND, TRACE OF MICA, PARTIALLY INDURATED, (SC)			
44			19 16					
45			24 29	③				
46			16 50	④				
47			38 40					
48			100/0.8	⑤				
49			83 100/0.5	⑥		48.7'		

HOLE NO. AK-95-21

JOB NO.

GROUND ELEVATION -35.6' MSL [✓ MLW] BASE

LOCATION N-661120 E-2137960

REPORT ON SUBSURFACE EXPLORATION

PROJECT ArthurKILL 95

DATE 10/27/95

SHEET 1 OF 1

UNIT COE "Explorer"

GROUNDWATER OBSERVATIONS:

	DURING DRILLING	SUBSEQUENT TO DRILLING				REMARKS
DATE						NWM-ST DIAMOND BIT
DEPTH						
CASING AT						
TIME						
ELAPSED TIME						

☐ LIQUID INTRODUCED DURING DRILLING AT ______ FEET ☐ NO GROUNDWATER ENCOUNTERED ☐ NO READINGS

EXPLORATION LOG:

35.0'

ELEVATION	DEPTH	CASING BLOWS	SAMPLE OR PROBE BLOWS	SAMPLE/RUN NO. (FOOTNOTE 1)	SOIL AND ROCK CLASSIFICATION - DESCRIPTION DEPTHS OF CHANGE UNIFIED SOIL CLASSIFICATION (FOOTNOTES 2 & 3)	LEGEND	SOIL SAMPLING AND ROCK CORING DATA CHARACTERISTICS UNUSUAL CONDITIONS REMARKS (FOOTNOTE 4)
36			W		BOTTOM OF HARBOR	35.6	
37			0 R		BLACK CLAYEY SILT (MH)		PETRO ODOR
38							
39				①			
40							
41							
42							
43			9			42.7'	
44			16 21	②	REDDISH BROWN FINE CLAYEY SAND, PARTIALLY INDURATED SOME FINE TO COARSE GRAVEL		
45			13 21	③	(SC)		
46			24 8			45.7'	
47			10 14	④	Red-brown shale gravel silt/clay matrix SAND STONE - RED TO BROWN	47.2'	
48			16 100/0.1	⑤	FINE GRAINED, BADLY BROKEN. cobble / [illegible]	47.8	BEGAN CORING AT 47.8' WITH NWM-ST DIAMOND BIT.
49				(5H) 5	BOLDER TILL - RED-BROWN SHALE cobbles + greene [illegible]		
50					crystalline Igneous (GM)		C1 47.8-50.8
51				(51) 50.8	bolders measuring 1.5' in length. Bolders		Cut 3.0'
					and cobbles in a		Rec 2.4'
					Silt/Clay matrix.		
					Did not reach bedrock		

SAMPLE STORAGE/CORE BOX NUMBER

HOLE NO. AK95-23

JOB NO.

GROUND ELEVATION MSL [✓ MLW] BASE 40.5

LOCATION 2,136,979
660,795

REPORT ON
SUBSURFACE EXPLORATION

PROJECT

DATE 10/28/95

SHEET 1 OF 1

UNIT COE Explorer

GROUNDWATER OBSERVATIONS:

	DURING DRILLING	SUBSEQUENT TO DRILLING				REMARKS
DATE						
DEPTH						
CASING AT						
TIME						
ELAPSED TIME						

☐ LIQUID INTRODUCED DURING DRILLING AT ________ FEET ☐ NO GROUNDWATER ENCOUNTERED ☐ NO READINGS

SAMPLE STORAGE/CORE BOX NUMBER

EXPLORATION LOG:

40.5

ELEVATION	DEPTH	CASING BLOWS	SAMPLE OR PROBE BLOWS	SAMPLE/RUN NO. (FOOTNOTE 1)	SOIL AND ROCK CLASSIFICATION - DESCRIPTION DEPTHS OF CHANGE UNIFIED SOIL CLASSIFICATION (FOOTNOTES 2 & 3)	LEGEND	SOIL SAMPLING AND ROCK CORING DATA CHARACTERISTICS UNUSUAL CONDITIONS REMARKS (FOOTNOTE 4)
41	.5		W	S1	Black, slightly organic Clay and Silt (CH-MH)	40.5	
42	1.5		O R				
43	2.5		32			42.4	
44	3.5		30 25	S2	Red-brown SILT and Clay, little Sand and Gravel (ML-CL)		
45	4.5		45 35	S3			
46	5.5		30 37				
47	6.5		45 38	S4		47.0	
48	7.5		100/0	47.0	Pebbles and Cobbles in Silt/clay matrix (Till)		C1 47.0 → 50.3
49	8.5						Cut: 3.3'
50	9.5				Red-Brown, weathered SHALE (bedrock))	49.5	Rec: 1,2'
51.	10.5			50.3		50.3	

HOLE NO.	JOB NO.		DATE
AK95-25		**REPORT ON SUBSURFACE EXPLORATION**	10/29/95
GROUND ELEVATION MSL [✓ MLW] BASE 43.8			SHEET 1 OF 1
LOCATION 2,136,370 660,798		PROJECT Arthur Kill 95	UNIT COE Explorer

GROUNDWATER OBSERVATIONS:

	DURING DRILLING	SUBSEQUENT TO DRILLING				REMARKS
DATE						
DEPTH						
CASING AT						
TIME						
ELAPSED TIME						

☐ LIQUID INTRODUCED DURING DRILLING AT ________ FEET ☐ NO GROUNDWATER ENCOUNTERED ☐ NO READINGS

EXPLORATION LOG:

-43.8-

ELEVATION	DEPTH	CASING BLOWS	SAMPLE OR PROBE BLOWS	SAMPLE/RUN NO. (FOOTNOTE 1)	SOIL AND ROCK CLASSIFICATION - DESCRIPTION DEPTHS OF CHANGE UNIFIED SOIL CLASSIFICATION (FOOTNOTES 2 & 3)	LEGEND	SOIL SAMPLING AND ROCK CORING DATA CHARACTERISTICS UNUSUAL CONDITIONS REMARKS (FOOTNOTE 4)	SAMPLE STORAGE/CORE BOX NUMBER
44	.2		W			43.8		
45	1.2		O R		Black Clayey SILT (CH-MH)		strong Petrol (asphaltic) odor	
46	2.2		↓					
47	3.2							
48	4.2							
49	5.2							
50	6.2		↓			49.9	CO to 50.0	
51	7.2		4 7		Red-brown SILT and Clay, little Sand and Gravel			
52	8.2		11		(ML-CL)	51.5		

HOLE NO. AK95-27	JOB NO.	**REPORT ON** **SUBSURFACE EXPLORATION**	DATE 10/29/95
GROUND ELEVATION MSL [✓ MLW] BASE 39.6			SHEET 1 OF 1
LOCATION 2,135,675 660,819	PROJECT Arthur Kill 95		UNIT COE Explorer

GROUNDWATER OBSERVATIONS:

	DURING DRILLING	SUBSEQUENT TO DRILLING				REMARKS
DATE						
DEPTH						
CASING AT						
TIME						
ELAPSED TIME						

☐ LIQUID INTRODUCED DURING DRILLING AT ______ FEET ☐ NO GROUNDWATER ENCOUNTERED ☐ NO READINGS

EXPLORATION LOG:

39.6 -

ELEVATION	DEPTH	CASING BLOWS	SAMPLE OR PROBE BLOWS	SAMPLE/RUN NO. (FOOTNOTE 1)	SOIL AND ROCK CLASSIFICATION - DESCRIPTION — DEPTHS OF CHANGE — UNIFIED SOIL CLASSIFICATION (FOOTNOTES 2 & 3)	LEGEND	SOIL SAMPLING AND ROCK CORING DATA — CHARACTERISTICS — UNUSUAL CONDITIONS — REMARKS (FOOTNOTE 4)
40	.4					39.6	
41	1.4			S1	BLACK CLAYEY SILT (CH-MH)	40.7	Petrol Odor c/o to 41.0
42	2.4		10 11	S2	Red-brown SILT + CLAY. Some Sand + Gravel. (ML-CL)		
43	3.4		12 16				
44	4.4		17 20	S3			
45	5.4		25 50	S4	Red-brown SAND and Gravel, little Silt + Clay		
46	6.4		50		(SM-GM)	46.0	c/o to 46.0
47	7.4		100/3		Red-brown, dense SHALE (Bedrock)		C1 46.3 - 49.7 Cut: 3.4' Rec: 2.0', RQD: 61%
48	8.4						
49	9.4						
50	10.4			49.7			

SAMPLE STORAGE/CORE BOX NUMBER

HOLE NO. AK95-29	**JOB NO.**	**REPORT ON** **SUBSURFACE EXPLORATION**	**DATE** 8 Nov 95
GROUND ELEVATION 41.1 MSL [✓ MLW] BASE			**SHEET** 1 **OF** 1
LOCATION 2134725 660845		**PROJECT** ARTHUR- KILL	**UNIT** C.O.E EXPLORER

GROUNDWATER OBSERVATIONS:

	DURING DRILLING	SUBSEQUENT TO DRILLING				REMARKS
DATE						
DEPTH						
CASING AT						
TIME						
ELAPSED TIME						

☐ LIQUID INTRODUCED DURING DRILLING AT ______ FEET ☐ NO GROUNDWATER ENCOUNTERED ☐ NO READINGS

EXPLORATION LOG:

40

ELEVATION	DEPTH	CASING BLOWS	SAMPLE OR PROBE BLOWS	SAMPLE/RUN NO. (FOOTNOTE 1)	SOIL AND ROCK CLASSIFICATION - DESCRIPTION — DEPTHS OF CHANGE — UNIFIED SOIL CLASSIFICATION (FOOTNOTES 2 & 3)	LEGEND	SOIL SAMPLING AND ROCK CORING DATA CHARACTERISTICS UNUSUAL CONDITIONS REMARKS (FOOTNOTE 4)	SAMPLE STORAGE/CORE BOX NUMBER
41					WATER	41.1		
42			WOR 100/0.2		BROWN SILT, SOME FINE TO COARSE GRAVEL	41.6		
43					REDDISH BROWN SHALE, HARD, SLIGHTLY WEATHERED, FRAGMENTED		PULL 41.6' - 47.7' RUN 6.1' REC 5.3' REC 86.8% RQD = 28.6%	
44				C				
45				O				
46				R				
47				E				
48						47.1		
49								

APPENDIX II:

SCOPE OF WORK

Scope of Work
and
Request for Proposal
for
Geomorphological Study
Arthur Kill-Howland Hook Marine Terminal Channel
Richmond County, New York and Union County, New Jersey

I. Introduction

The U.S. Army Corps of Engineers, New York District (Corps), is currently preparing a re-evaluation report to identify a National Economic Development (NED) plan for the Arthur Kill-Howland Hook Marine Terminal Channel and to obtain authorization for the construction of the plan. The Corps feasibility report submitted in 1985 recommended improvements to the channel, which included deepening, widening and the selected realignment of the channel for navigational safety. The Federal statutes and regulations authorizing the Corps to undertake these responsibilities include Section 106 of the National Historic Preservation Act as amended through 1992 and the Advisory Council on Historic Preservation Guidelines for the Protection of Cultural and Historic Properties (36 CFR Part 800).

The purpose of these investigations is to review existing information in order to provide an analysis of coring data and previous research on the prehistoric archaeological potential of the area. The proposed investigations will involve a review of the subsurface exploration conducted as part of this and other projects and previous cultural resources reports, particularly those sections regarding the prehistory of the project area, for "scientific analysis and to 'reconstruct' climate and biota" (New Jersey Historic Preservation Office [NJHPO] letter dated February 3, 1982).

II. Project Background

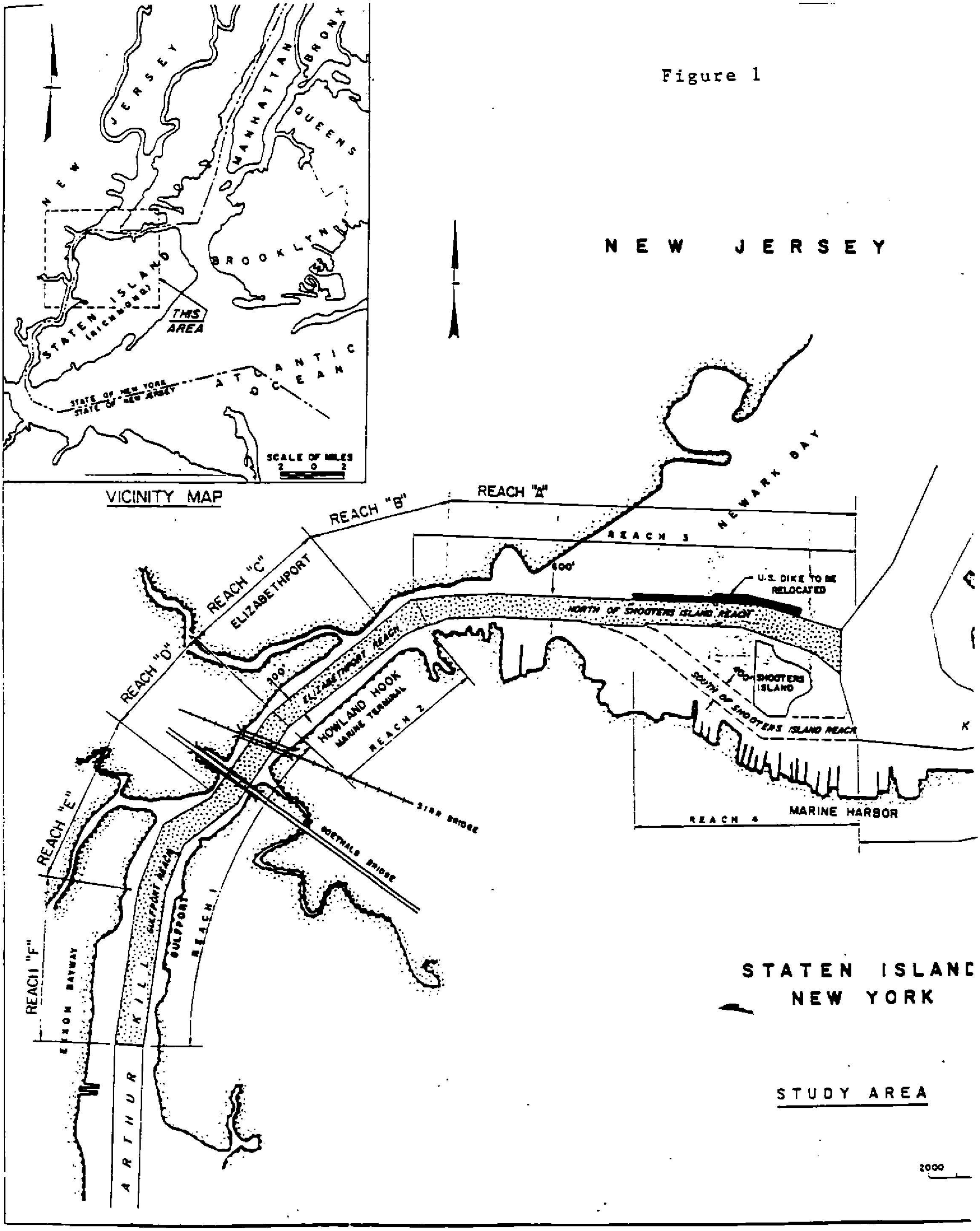
A. Project Location

The Arthur Kill-Howland Hook Marine Terminal Channel project area extends from the confluence of the Kill Van Kull Channel, Newark Bay Channel and the Arthur Kill Channel westward approximately three miles to approximately Linden, New Jersey (Figure 1). The waterway is used intensively as a navigation channel. One of New York City's most active marine terminals, Howland Hook, is located along the channel.

B. Project Plan

The Corps is planning to deepen and widen the Arthur Kill Channel. As currently proposed, the channel will be deepened from the existing 35 feet to 41 feet from the confluence with the Newark Bay and Kill Van Kull channels to the Howland Hook Marine Terminal, a

Figure 1


NEW JERSEY
MANHATTAN
BRONX
QUEENS
BROOKLYN
STATEN ISLAND (RICHMOND)
THIS AREA
ATLANTIC OCEAN
STATE OF NEW YORK
STATE OF NEW JERSEY
SCALE OF MILES
2 0 2
VICINITY MAP
NEW JERSEY
NEWARK BAY
REACH "A"
REACH "B"
REACH "C"
REACH "D"
REACH "E"
REACH "F"
ELIZABETHPORT
REACH 3
600'
U.S. DIKE TO BE RELOCATED
NORTH OF SHOOTERS ISLAND REACH
SOUTH OF SHOOTERS ISLAND REACH
SHOOTERS ISLAND
400'
ELIZABETHPORT REACH
300'
HOWLAND HOOK MARINE TERMINAL
REACH 2
SIRR BRIDGE
GOETHALS BRIDGE
REACH 4
MARINE HARBOR
K
EXXON BAYWAY
ARTHUR KILL
GULFPORT REACH
GULFPORT
REACH 1
STATEN ISLAND
NEW YORK
STUDY AREA
2000

distance of approximately 2.1 miles. The remaining section of the channel, from Howland Hook Marine Terminal to the Exxon Bayway and Gulfport, will be deepened to 40 feet. In addition to this deepening, portions of the channel will be shifted or widened to accommodate the use of this channel by deep draft vessels.

Prior to the preparation of the 1985 Feasibility report, a cultural resources investigation was conducted concerning the presence of potential significant prehistoric and historic cultural resources located within the project area and along nearby Shooters Island. The report highlighted two areas that may be potentially sensitive for the presence of prehistoric sites. These areas consisted of the area at the western edge Shooters Island that is mostly occupied by abandoned hulks in shallow areas and mudflats and the large mudflats to the north of the channel along the Union County, New Jersey shoreline. The report recommended that

> "available sub-bottom data be compiled, and if necessary seismic or other geophysical survey be performed, to develop a geophysical map of the two areas of shallow water. The results of these studies should be used to predict locations of greatest probability for prehistoric site presence and preservation. Finally, a program of archaeological sampling should be undertaken. This would involve the use of standard testing equipment, such as a truck mounted on a shallow draft scow to take piston-core samples into the sediments (Kardas and Larrabee 1980:52)."

In subsequent coordination with the NJHPO for the Shooters Island Area I, New York Harbor Collection and Removal of Drift Project and the Arthur Kill-Howland Hook Marine Terminal Study, the NJHPO provided the opinion that

> "prospecting for sites in the Newark Bay section of the project area is not a reasonable measure to protect prehistoric features in the Arthur Kill-Kill Van Kull junction, on the headland or peninsula of which Shooter's Island is the witness, or on the submerged flats and meadows between there and the Elizabethport shore...To prospect by coring or boring is expensive...and not a satisfactory way to find underwater sites (NJHPO letter dated February 3, 1982; see also NJHPO letter dated February 3, 1984 in Appendix 7, Feasibility Report, Draft June 1985).

The NJHPO suggested the data acquired in the

> "course of the technical studies for improvements in the New York Bays and neighboring waterways can be of value in the process of considering cultural resources, mainly prehistoric. Sub-bottom cores, logs, profile diagrams, maps and charts, will over the years permit constructing physiographic diagrams for the Late Glacial, Post-Glacial and Recent and provide material for scientific analysis to "reconstruct"

> climate and biota...The locations of the cores and their accompanying documents should be made known to the professional cultural resources community (NJHPO letter dated February 3, 1982).

The goal of this project will be to prepare a report that combines the existing coring data gathered as part of this project and neighboring studies with the research conducted on the prehistoric environment of the Arthur Kill and Kill Van Kull Channels to initiate the scientific analysis requested by the NJHPO. This study will serve to bring the coring data to the public and provide a start to the development of a database for this area.

III. Previous Research

A number of studies have been undertaken in the project area and the vicinity of the project area that should be reviewed. These reports contain most of the data that will be utilized for this project.

Alpine Ocean Seismic Survey, Inc.
1987 Draft Final Report: Subsurface Exploration in the Arthur Kill Extensions, Howland Hook to Carteret, New Jersey

Kardas, S. & E. Larrabee
1976 A Preliminary Archaeological Reconnaissance for Cultural Resources, Kill Van Kull and Newark Bay Channel Dredging Project.

1980 Cultural Resource Reconnaissance New York Harbor Collection and Removal of Drift Areas of Elizabeth, Union County, New Jersey.

1985 Cultural Resource Reconnaissance New York Harbor Collection and Removal of Drift Project, Bayonne Reach, Hudson County, New Jersey.

Raber Associates
1996a Reconnaissance Cultural Resources Investigations, Arthur Kill New Jersey Reach, Union and Middlesex Counties, New Jersey, New York Harbor and Collection and Removal of Drift Project, U.S. Army Corps of Engineers, New York District.

1996b Reconnaissance Cultural Resources Investigations, Arthur Kill New York Reach, Richmond County, New York, New York Harbor and Collection and Removal of Drift Project, U.S. Army Corps of Engineers, New York District.

1996c Reconnaissance Cultural Resources Investigations, Kill Van Kull New York Reach, Richmond County, New York, New York Harbor and Collection and Removal of Drift Project, U.S. Army Corps of Engineers, New York District.

Rockman, Diana DiZerega and Nan Rothschild
1979 A Preliminary Assessment of Cultural Resources on Shooters Island, Richmond County, New York and Hudson and Union Counties, New Jersey.

U.S. Army Corps of Engineers, New York District
1995 Report on Subsurface Exploration. Exploration Logs and Map.

1985 Feasibility Report: Navigation Study on Improvements to Existing Federal Navigation Channels.

Main Report and Environmental Impact Statement
Technical Appendices

1979 Shooters Island, New York and New Jersey: Report to Congress.

IV. Contractor Services and Required Investigations

A. The general services to be provided under this contract are those required to conduct research and prepare a report on the prehistoric environment of the Arthur Kill-Howland Hook Marine Terminal Channel project area.

B. The Contractor shall be responsible for conducting, in the manner prescribed, the work detailed below. Failure to fully meet the requirements of this scope of work may be cause for termination of work for default of the contract, or for an evaluation of unsatisfactory upon completion of the project.

C. This scope of work requires the completion of the following tasks:

Task 1 - Review Previous Research and Background Research

a. The Contractor shall review the documents referenced in Section III, "Previous Research" above, as well as the specific sources required by the New Jersey Historic Preservation Office (NJHPO; Appendix A).

b. The Contractor shall also conduct research to:

1. determine the prehistory of the project area and vicinity.

2. identify previously known cultural resources within the project area and vicinity.

3. outline pertinent research issues that may be associated with identified cultural resources.

4. research the geology, hydrology, etc. of the project area.

c. At a minimum, these objectives will be accomplished by conducting thorough review of New York State Historic Preservation Office (NYSHPO), NJHPO, New York State Museum and the New Jersey site files, local histories, and regional prehistoric research.

Task 2 - Data Analysis

The Contractor will assemble and collate all data collected for this study with the purpose of collating it in the preparation of the draft and final reports.

Task 3 - Report Preparation

The Contractor shall prepare interim, draft and final reports. The reports produced by a cultural resource investigation is of potential value not only for its specific recommendations but also as a reference document. To this end, the report must be a scholarly statement that can be used as a basis for any future cultural resources work. It must meet both the requirements for cultural resource protection and scientific standards of current research as defined in 36 CFR Part 800 and the Councils Handbook.

1. One copy of the interim report will be submitted to the Corps, according to the time schedule established in Section VI "Project Schedule", below. The interim report will provide a brief summary of the work conducted to date and the work yet to be completed. It shall present any preliminary results of the research.

2. Four copies of the draft report will be prepared and submitted to the Contracting Office according to the schedule established in Section VI "Project Schedule", below. The draft report will be reviewed by the Corps, the NJHPO and the NYSHPO. All comments of the reviewing agencies and will be transmitted to the Contractor prior to the submission of the final report.

3. Eight copies of the final report shall be submitted to the Contracting Office according to the schedule established below in Section VI "Project Schedule". The final report shall address all comments made on the draft report.

Task 4 - Project Management

The Contractor will be responsible for ensuring that all deliverables are provided on schedule and that all terms of this scope of work are satisfied.

V. Report Format and Content

A. The draft and final reports shall have the following characteristics:

1. The draft and final copies of the cultural resources report shall reflect and report on the work outlined in Section IV (Required Investigations) above.

They shall be suitable for publication and be prepared in a format reflecting contemporary organizational and illustrative standards of professional archaeological journals. The draft report will be revised to address all review comments.

2. The report produced by a cultural resources investigation is of potential value not only for its specific recommendations, but also as a reference document. To this end, the report must be a scholarly statement that can be used as a basis for any future cultural resources evaluation. It must meet both job requirements for cultural resources protection and scientific standards as defined in 36 CFR Part 800 and in the "The Treatment of Archeological Properties: A Handbook" (1980) published by the Advisory Council on Historic Preservation.

3. All interim, draft and final copies of the report shall reflect and report on the work required by this scope.

B. **PAGE SIZE AND FORMAT.** Each report shall be produced on 8 1/2" x 11" archivally stable paper, single spaced with double spacing between paragraphs. The printing of the text should be letter quality. All text pages, including figures, tables, plates and appendices must be consecutively numbered.

C. Two final copies of the report, both with original photographs, figures, etc., shall be submitted in a hard-covered binder suitable for shelving.

D. The **TITLE PAGE** of the report shall include the municipalities and counties incorporated by the project area, the author(s) including any contributor(s) The Principal Investigator should be identified and is required to sign the original copies of the report. If the report has been written by someone other than the contract Principal Investigator, then the cover of the publishable report must bear the inscription "*Prepared Under the Supervision of (NAME), Principal Investigator*". The Principal Investigator in this case must also sign the original copies of the report.

E. A **MANAGEMENT SUMMARY** or **ABSTRACT** shall appear before the **TABLE OF CONTENTS** and **LIST OF FIGURES**. It should include a brief project description including the location and size of the project area, the methods of data collection, the results of the study, evaluations and identification of impacts and recommendations. It should also include the location of where copies of the report are on file.

F. The **TABLE OF CONTENTS** will include a list of all figures, plates and tables presented in the report.

G. The **INTRODUCTION** will state the project's purpose and goals as defined by the scope of work and will include the applicable regulations for conducting this work and will contain a general statement of the work conducted and the recommendations proposed.

H. The **BACKGROUND RESEARCH** must be sufficient to provide a detailed description and evaluation of the prehistoric research of the project area. This section should include a summary of the existence of sites and a description of previous work conducted in the area. The following information should be presented and discussed:

1. the **ENVIRONMENTAL SETTING**, including topography, soils, hydrology and geology.

2. an **ANALYSIS** of paleoenvironment, present climate and current vegetation.

3. **PAST AND PRESENT LAND USES** and current conditions.

4. a **DISCUSSION** of prehistoric and historic culture history of project locale. This section should provide contexts for research questions, survey methods, etc.

5. a **REVIEW** of known sites, previous investigations and research in the project area and vicinity and information provided by local collectors and Archaeological Society of New Jersey local chapter members. Appendix A includes a list of standard references that must be consulted for all projects.

I. A **RESEARCH DESIGN** will outline the purpose of the investigation, basic assumptions about the location and type of cultural resources within the project area. The following shall also be included:

1. **RESEARCH OBJECTIVES** and **THEORETICAL CONTEXT** with reference to the NJHPO historic contexts (Appendix A).

2. specific **RESEARCH PROBLEMS** or questions.

3. **METHODS** to be employed to address the research objectives and questions.

4. a **DISCUSSION** of the expected results, including hypotheses to be tested.

J. A **METHODS** section, if applicable, shall include:

1. a **DESCRIPTION OF FIELD METHODS** employed, including rationale, discussion of biases and problems or obstacles encountered.

2. a **DEFINITION** of site used in the survey.

K. **RESULTS, INTERPRETATIONS AND RECOMMENDATIONS.** A discussion of the results in terms of the background cultural context, research design, goals and research problems with reference to the NJHPO historic contexts and potential research questions.

M. A **REFERENCES CITED** section will list all references and citations located within the text, including all figures, plates or maps, and within any appendices. All sources (persons consulted, maps, archival documentation, etc.) maybe listed together. This list must be in a format used by professional archaeological journals, such as *American Antiquity*.

N. **APPENDICES** shall include, but not be limited to:

1. a copy of all boring/subsurface exploration data used in the report.

2. the **QUALIFICATIONS** of the Principal Investigator and any other key personnel used.

3. the final **SCOPE OF WORK**.

O. **PHOTOGRAPHS** will be glossy black and white prints no smaller than 5" x 7". Photographic illustrations should be securely mounted by use of an archivally stable mounting medium. Photograph captions for site overviews must include direction or orientation. At a minimum, captions should identify feature or location, direction, photographer and date of exposure. **All photographs should be fully captioned on the reverse of the photograph in case they should be removed from the report**. Photographs should be counted as "Figures" in a single running series of illustrations, plates, etc.

P. **GRAPHIC PRESENTATION OF THE RESULTS.**

1. All pages, including graphic presentations, will be numbered sequentially.

2. All graphic presentations, including maps, charts and diagrams, shall be referred to as "Figures". All figures must be sequentially numbered and cited by number within the body of the text.

3. All figures, plates and tables should be incorporated into the text on the page following their citation. They should not be appended.

4. All tables shall have a number, title, appropriate explanatory notes and a source note.

5. All figures shall have a title block containing the name of the project, county and state.

6. All maps, including reproductions of historic maps, must include a north arrow, accurate bar scale, delineation of the project area, legend, map title and year of publication.

7. The report must include the project area accurately delineated on a U.S.G.S.

7.5' topographic map and a county soils survey map, if available for that area.

VI. Project Schedule

A. All reports should be submitted in a timely manner as stipulated below:

1. the interim report will be submitted to the Corps monthly with each invoice. The interim report shall discuss what work has been accomplished and what work has yet to be completed. It shall also state any problems the Contractor has encountered in conducting the work or contain requests for information.

2. the draft report will be submitted to the Corps not later than 15 July 1996. The draft report will be reviewed by the Corps, the NYSHPO and the NJHPO. One copy of the draft report will be returned to the Contractor with comments. The final report will address all comments provided with the draft report.

~~3. The final~~ report will be submitted to the Corps four (4) weeks after the Contractor receives the draft report with comments.

B. The number of copies for the interim, draft, and final reports will be submitted, according to the above schedule, as follows:

1. One copy of the interim report.

2. Four copies of the draft report; three of these copies will contain original photographs, if applicable.

3. Eight copies of the final report; one copies will be unbound and six copies, one of which will be the unbound copy, will contain original photographs, if applicable.

C. Scheduled completion date for the work specified in this scope is December 13, 1996.

VII. Additional Contract Requirements

A. Agencies, institutions, corporations, associations or individuals will be considered qualified when they meet the minimum criteria given below. As part of the supplemental documentation, a contract proposal and appendices to the draft and final report must include vitae for the **PRINCIPAL INVESTIGATOR** and **MAIN SUPERVISORY PERSONNEL** in support of their academic and experiential qualifications for the research, if these individuals were not included in the original contract proposal. The Principal Investigator must also be a qualified geomorphologist. Additional personnel should consist of an archaeologist that meets the qualifications presented below. Personnel must meet the minimum professional standards stated below:

1.. Archaeological Project Director or Principal Investigator (PI). Persons in charge of an archaeological project or research investigation contract, in addition to meeting the appropriate standards for archaeologist, must have a doctorate or equivalent level of professional experience as evidenced by a publication record that demonstrates experience in project formulation, execution, and technical monograph reporting. For this project, the Principal Investigator must also have experience in the geomorphology as outlined below. Suitable professional references may also be made available to obtain estimates regarding the adequacy of prior work. If prior projects were of a sort not ordinarily resulting in a publishable report, a narrative should be included detailing the proposed project director's previous experience along with references suitable for to obtain opinions regarding the adequacy of this earlier work.

2. Geomorphologist. Personnel hired for their special knowledge and expertise in geomorphology should have a Master's degree or better and experience and a publication record demonstrating a substantial contribution to the field through research.

3. Archaeologist. The minimum formal qualifications or individuals practicing archaeology as a profession area a B.A. or B.S. degree from an accredited college or university, followed by two years of graduate study with concentration in anthropology and specialization in archaeology during one of these programs, and at least two summer field schools or their equivalent under the supervision of an archaeologist of recognized competence. A Master's thesis or its equivalent in research and publications is highly recommended, as is the PhD degree. Individuals lacking such formal qualifications may present evidence of a publication record and references from archaeologists who do meet these references. In addition, the archaeologist should also have experience in the prehistoric archaeology of the southern New York - northern New Jersey area.

4. Standards for Consultants. Personnel hired or subcontracted for their special knowledge and expertise must carry academic and experiential qualifications in their own fields of competence. Such qualifications are to be documented by means of vitae attachments to the proposal or at a later time if the consultant has not been retained at the time of proposal.

B. Principal Investigators shall be responsible for the validity of the material presented in their reports. In the event of a controversy or court challenge, Principal Investigators shall be required to testify on behalf of the government in support of findings presented in their reports.

C. Neither the Contractor nor his representatives shall release any sketch, photograph, report or other data, or material of any nature obtained or prepared under this contract without the specific written approval of the Contracting Officer prior to the time of final acceptance by the government.

D. The Contractor shall furnish all labor, transportation, instruments, survey equipment, boats and other associated materials to perform the work required by this Scope of Work.

E. The Contractor shall return all copies of reports provided by the Corps when the final report is submitted.

VIII. Fiscal Arrangements

A. Partial payments of the total amount allocated will be dispersed upon the receipt of invoices. Invoices will be submitted with the interim report and with the draft report and will reflect the amount expended. The total amount of all monthly invoices shall not total more than 90% of the agreed work order amount. The remaining 10% of the agreed work order amount shall be paid upon the receipt and acceptance of the final report, all reports provided by the Corps, etc. and receipt of the final invoice. **No invoice payments will be made if it is does not include an accompanying interim or draft report.**

B. Invoice payments will be made pursuant to ~~the "Prompt~~ Payment" clause of the contract.

Appendix A
Standard References to be Consulted for Cultural Resources Reports State of New Jersey Historic Preservation Office

Chesler, Olga (editor)

1982 **The Paleo-Indian Period to the Present: A Review of Research Problems and Survey Priorities.** New Jersey Department of Environmental Protection, Division of Parks and Forestry, Office of New Jersey Heritage, Trenton.

1984 **Historic Preservation Planning in New Jersey: Selected Papers on the Identification, Evaluation, and Protection of Cultural Resources.** New Jersey Department of Environmental Protection, Division of Parks and Forestry, Office of New Jersey Heritage, Trenton.

Cross, Dorothy

1941 **Archaeology of New Jersey** Vol. I. Archaeological Society of New Jersey and New Jersey State Museum, Trenton.

New Jersey Department of Environmental Protection

1979-1985 **Annotated Bibliography: Cultural Resources Survey Reports Submitted to the New Jersey State Historic Preservation Officer.** 5 Vols. Division of Parks and Forestry, Office of New Jersey Heritage, Trenton. Reports submitted since 1985 are available for review at the HPO.

1990 **New Jersey and National Register of Historic Places as of December 31, 1988.** Division of Parks and Forestry, Historic Preservation Office, Trenton.

1994 **New Jersey and National Register of Historic Places, 1989-1992 Addendum.** Division of Parks and Forestry, Historic Preservation Office, Trenton.

New Jersey Pinelands Commission

1980 **New Jersey Pinelands Comprehensive Management Plan.** New Lisbon, New Jersey.

1991 **Pinelands Cultural Resources Management Plan for Historic Period Sites.** New Lisbon, New Jersey

Schrabisch, Max

1915 **Indian Habitations in Sussex County, New Jersey.** Bulletin No. 13. Geological Survey of New Jersey, Union Hill.

Standard References to be Consulted (cont'd)

1917 **Archaeology of Warren and Hunterdon Counties.** Bulletin No. 18 (Geologic Series) Reports of the Department of Conservation and Development, Trenton.

Skinner, Alanson and Max Schrabisch
1913 **A Preliminary Report of the Archaeological Survey of the State of New Jersey.** Bulletin No. 9. Geological Survey of New Jersey, Trenton.

Spier, Leslie
1915 **Indian Remains near Plainfield, Union County, and along the Lower Delaware Valley.** Bulletin No. 13. Geological Survey of New Jersey, Trenton.

NEW JERSEY HISTORIC PRESERVATION OFFICE, HISTORIC CONTEXTS

Under the National Historic Preservation Act, each State Historic Preservation Office is responsible for preparing and implementing a "comprehensive statewide historic preservation plan." A State Historic Preservation Plan is a concise document that describes a vision for historic preservation in the state as a whole and sets future direction for the State Historic Preservation Office. It provides direction and guidance for decision-making by addressing, at a general level, the state's full range of historic resources including objects, buildings, structures, districts, and archaeological sites. Information on historic resources used to develop and update the State Historic Preservation Plan is derived from a variety of sources including historic context documents, theme studies, resource inventories, and National Register nominations. Historic context documents are emphasized in developing and revising a State Plan.

As of December 1994, the New Jersey State Historic Preservation Office (HPO) is in the process of drafting its State Plan. However, a reference file of historic context documents has already been developed. Historic contexts enable considerations of historic properties in terms of chronological timeframes, cultural themes (or topics), and geographic areas. The historic context files in the HPO are organized mainly by chronological categories and cultural themes. The following chronological categories were proposed in 1988 and have been utilized quite consistently over the past six years:

1.	Paleo-Indian	11,500-8000 years ago
2.	Early Archaic	10,000-6000 years ago
3.	Late Archaic	6000-3000 years ago
4.	Early/Middle Woodland	3000-1200 years ago
5.	Late Woodland	1200 years ago-A.D. 1601
6.	European Intrusion	A.D. 1500-1700
7.	Initial Colonial Settlement	A.D. 1630-1775
8.	Early Industrialization, Urbanization, and Agricultural Development	A.D. 1750-1860
9.	Suburban Development	A.D. 1840-1940

10. Immigration and Agricultural, Industrial, Commercial, and Urban Expansion A.D. 1850-1910

11. Metropolitan New Jersey A.D. 1910-1945

12. Modern New Jersey A.D. 1945-present

The sections of the historic context files dealing with cultural themes or topics identify a variety of subjects. Examples include Afro-Americans in New Jersey, Maritime New Jersey, Military History, and Transportation. These and all other historic context files are open for updating and expansion. New topics can be added as needed.

The third aspect of historic contexts is spatial or geographic variation. Therefore, the historic context files also contain information regarding human use of New Jersey by geographic area. Considerations of geographic variations are found primarily within individual sections of the files dealing with specific time periods and themes/topics.

Preparers of archaeological reports are urged to become familiar with the historic context files. Ideally, these files should contain, or provide reference to, current information upon which a great deal of HPO planning and decision-making is based. Of particular concern to archaeological report writers, this decision-making includes evaluations of National Register eligibility for prehistoric and historic archaeological sites.

DRF/MLG:C:\WD\REPORTS

APPENDIX III:

QUALIFICATIONS OF THE INVESTIGATORS

Appendix III: Qualifications of the Investigators

Daniel P. Wagner, Ph.D.: Dr. Wagner obtained his Ph.D. in Soil Science from the University of Maryland, College Park in 1982. He has worked as a consulting pedologist throughout Eastern North America and Central America for over 20 years. As a regionally recognized expert in soil classification and genesis, he has participated in well over 900 projects applying soil-geomorphic principles to an array of land use considerations. Among the earliest of a now growing number of soil scientists actively involved in archeological investigations, Dr. Wagner has participated in some 150 cultural resource investigations distributed from Upper New York State to Georgia. Most of these studies involved paleogeographic analyses of prehistoric sites emphasizing Holocene depositional and weathering sequences as well as evolving environmental conditions. He has also worked on a number of historic sites interpreting landscape modifications for settings ranging in diversity from 18th century tidewater plantations to the core areas of major East Coast cities. Dr. Wagner has authored or co-authored 26 professional publications and has presented numerous papers at both professional soil science and archeological meetings. He is currently on the part-time faculty of Johns Hopkins University where he teaches an environmental soils course.

Peter E. Siegel, Ph.D.: Dr. Siegel received his Ph.D. in Anthropology from the State University of New York at Binghamton in 1992. He has over 20 years of experience in archeology in Eastern North America, the Caribbean, and Lowland South America. Most recently, he served as Project Director for the Centro de Investigaciones Indígenas de Puerto Rico's Maisabel Archaeological Project from 1985 to 1992. In the Northeast region, Dr. Siegel developed and applied a probabilistic sampling design for the Lower Chenango Valley in New York, served as Co-director of a Phase I archeological survey of selected areas of the F.E. Walter Dam project in Pennsylvania, and worked on numerous cultural resource investigations for the Public Archaeology Facility at SUNY-Binghamton. His areas of theoretical and methodological expertise include the analysis of complex societies, spatial analysis, lithic microwear analysis, quantitative methods, and the analysis of features. Regarding the latter topic, Dr. Siegel developed a quantitative method for analyzing feature morphology at a Late Woodland site on the Mississippi River in Illinois for his Master's thesis. He has edited one book, authored or co-authored more than 25 publications in professional journals, and presented numerous papers at professional meetings and seminars.