RESULTS OF GEOARCHAEOLOGICAL SOIL BORINGS AND PROPOSED PHASE IB ARCHAEOLOGICAL SURVEYS
Report #3

NEW JERSEY-NEW YORK EXPANSION PROJECT
STATEN ISLAND, NEW YORK

FERC Docket No. CP11-56-000
New York SHPO No. 09PR05949

Prepared for

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ATTACHMENTS

INTRODUCTION

Spectra Energy Corp (Spectra Energy) is proposing to expand its pipeline systems in the New Jersey-New York region to meet the immediate and future demand for natural gas in the largest United States metropolitan area. The New Jersey-New York Expansion Project (NJ-NY Project) will create a new transportation path for 800,000 decatherms per day (Dth/d) of natural gas from multiple receipt points on the Spectra Energy systems to new delivery points in New Jersey and New York. The Project consists of approximately 19.8 miles of multi-diameter pipeline, associated pipeline support facilities, and six new metering and regulating (M&R) stations. The proposed facilities are located in New Jersey, New York, and Connecticut (Figure 1).

Previous Investigations

The Public Archaeology Laboratory, Inc. (PAL) completed Phase IA archaeological overview surveys for the New York portion of the Project in August and December 2010 (Elquist et al. 2010a and b). Since that time additional Phase IA archaeological assessments have been conducted for pipeline route variations in the New York portion of the project (Elquist and Cherau 2011a, b, and c). The Phase IA archaeological assessment recommendations for the Project alignment and route variations include a program of geoarchaeological soil borings in sensitive areas where modern fill deposits associated with heavy industrialization and urbanization land uses have occurred. A total of 35 soil borings has been proposed to date for the archaeologically sensitive areas of the Staten Island portion of the Project pipeline route where subsurface soil conditions are unknown and/or considered too deep for conventional hand testing. Of these, two soil borings were completed in December 2010 (see separate PAL report, Cherau 2011) and 29 soil borings were completed from July to November 2011 and are the subject of the current report. PAL anticipates the completion of the four outstanding borings in the Staten Island portion of the project as landowner access permissions are obtained.

The ongoing goal of the soil borings program is to determine the presence and depth of ground disturbances, fill and/or marsh deposits, and of any sediments or buried landscapes containing potentially significant archaeological resources below these deposits. The Project area is dominated by industrial and commercial facilities, but the possibility remains that intact archaeological resources may be preserved within and below historically deposited fill. Additionally, large areas along the Project area of potential effect (APE) consist of former or current tidal marsh that may have been previously available for human occupation prior to marine transgression.

The following report presents the need for and scope of proposed Phase IB archaeological survey for four areas in the Staten Island portion of the project where the 29 soil borings were completed from July to November 2011. The proposed Phase IB archaeological survey methodologies have been formulated based on the results of these most recent geoarchaeological investigations that included the excavation and analysis of the 29 borings located on two different New York City (NYC) and New York State (NYS) properties (NYS Department of Environmental Conservation (NYSDEC); NYC Economic Development Corporation (NYCEDC) and in two city street right-of-ways (Western Avenue and Richmond Terrace) in Staten Island (Table 1) (Figure 2). The soil borings typically extended to a depth of 600 (cm) (19.7 feet [ft]), with isolated exceptions, and encountered complex stratigraphic sequences of fill, buried post-contact period surfaces, possible pre-contact period surfaces, and underlying natural unconsolidated geological deposits. The results of the geoarchaeological investigations for this portion of the Project were prepared by Georcheology Research Associates (GRA), under subcontract to PAL, the cultural resources consultants to Spectra Energy. The GRA report is provided as Attachment A.

Table 1. Archaeological Soil Borings Conducted from July to November 2011, Staten Island, New Jersey-New York Expansion Project.

Universal Boring Tracking Number	*Route Variation (where applicable)*	*Landowner Name*	*Date of Boring Completion*
RCH-2-ARC-1		NYSDEC Property	8/9/2011
RCH-2-ARC-2		NYSDEC Property	8/8/2011
RCH-2-ARC-3		NYSDEC Property	8/8/2011
RCH-2-ARC-4		NYSDEC Property	8/8/2011
RCH-4H-ARC-6.1	76	NYCDOT Property (Western Avenue)	10/20/2011
RCH-4H-ARC-7	76	NYCDOT Property (Western Avenue)	10/20/2011
RCH-4H-ARC-8	76	NYCDOT Property (Western Avenue)	10/21/2011
RCH-4H-ARC-9.1	76	NYCDOT Property (Western Avenue)	10/21/2011
RCH-4H-ARC-10	76	NYCDOT Property (Western Avenue)	10/21/2011
RCH-4H-ARC-11.1	76	NYCDOT Property (Western Avenue)	11/1/2011
RCH-4H-ARC-12	76	NYCDOT Property (Western Avenue)	10/27/2011
RCH-4H-ARC-13	76	NYCDOT Property (Western Avenue)	10/28/2011
RCH-4H-ARC-14	76	NYCDOT Property (Western Avenue)	10/24/2011
RCH-4H-ARC-15	76	NYCDOT Property (Western Avenue)	10/24/2011
RCH-4H-ARC-16	76	NYCDOT Property (Western Avenue)	10/31/2011
RCH-4H-ARC-17	76	NYCDOT Property (Western Avenue)	11/1/2011
RCH-5H-ARC-1	53	NYCDOT Property (Richmond Terrace)	10/20/2011
RCH-5H-ARC-2		NYCDOT Property (Richmond Terrace)	10/25/2011
RCH-5H-ARC-3		NYCDOT Property (Richmond Terrace)	10/25/2011

Universal Boring Tracking Number	***Route Variation (where applicable)***	***Landowner Name***	***Date of Boring Completion***
RCH-5H-ARC-4		NYCDOT Property (Richmond Terrace)	10/26/2011
RCH-5H-ARC-5		NYCDOT Property (Richmond Terrace)	10/26/2011
RCH-5H-ARC-6		NYCDOT Property (Richmond Terrace)	10/27/2011
RCH-5H-ARC-7		NYCDOT Property (Richmond Terrace)	10/27/2011
RCH-5H-ARC-8		NYCDOT Property (Richmond Terrace)	10/27/2011
RCH-6-ARC-1		NYCEDC Property	10/27/2011
RCH-6-ARC-2		NYCEDC Property	7/20/2011
RCH-6-ARC-3		NYCEDC Property	7/19/2011
RCH-6-ARC-4		NYCEDC Property	7/20/2011
RCH-6-ARC-5		NYCEDC Property	7/18/2011

PROJECT AREA OF POTENTIAL EFFECT (APE)

The APE is the "geographic area or areas within which an undertaking may directly or indirectly cause changes in the character of or use of historical properties, if any such properties exist" (36 CFR 800.16[d]). The APE is defined based upon the *potential* for effect, which may differ for aboveground resources (historic structures and landscapes) and subsurface resources (archaeological sites). The APE includes all areas where ground disturbances are proposed, where land use (i.e., traffic patterns, drainages, etc.) may change, or any locations from which the undertaking may be visible.

For archaeological resources associated with the pipeline component of the Project, the APE consists of any areas of ground disturbance for the proposed pipeline trench and associated temporary workspace. In general, the horizontal APE for the proposed pipeline trench is anticipated to be a maximum of 4.5 m (15 ft) at the top and 3 m (10 ft) wide at the bottom; the vertical APE for the proposed pipeline trench is 2.2 m (7 ft) below surface, except in areas where existing utilities are present or the pipeline needs to be deeper for road and railroad crossings or other landowner concerns. The proposed Phase IB testing methodology presented in this report encompasses the horizontal and vertical APE for the pipeline trench.

SCOPE AND AUTHORITY

The Spectra Energy NJ-NY Project requires approvals and permits from federal, state, and local entities. One of the primary Project approval requirements at the federal level is a Certificate of Public Convenience and Necessity under Section 7(c) of the Natural Gas Act issued by the Federal Energy

Regulatory Commission (FERC). Consequently, the Project is being reviewed under Section 106 of the National Historic Preservation Act (NHPA) of 1966, as amended. Prior to authorizing an undertaking (e.g., the issuance of a FERC approval or Certificate), Section 106 of the NHPA requires federal agencies, including the FERC, to take into account the effect of that undertaking on cultural resources listed or eligible for listing in the National Register of Historic Places (36 CFR §60). The agency must also afford the Advisory Council on Historic Preservation (ACHP) the opportunity to comment on the undertaking. The Section 106 process is coordinated at the state level by the State Historic Preservation Officer (SHPO), represented in New Jersey by the New Jersey Historic Preservation Office. The issuance of a federal agency certificate or approval depends, in part, on obtaining comments from the SHPO. In accordance with Section 106, FERC, as the lead federal agency for the Project, must consult with the New Jersey SHPO regarding the effects of the Project on historic properties.

The primary goals of cultural resource investigations conducted as part of the Section 106 review process are to:

- locate, document, and evaluate buildings, structures, objects, landscapes, and archaeological sites that are listed, or eligible for listing, in the National Register of Historic Places (National Register);

- assess potential impacts of the Project on those resources; and

- provide recommendations for subsequent treatment, if necessary, to assist with compliance with Section 106.

In addition to Section 106, the additional cultural resources investigation will be conducted for this portion of the Project in accordance with FERC's Office of Energy Project's *Guidelines for Reporting on Cultural Resources Investigations* (2002); the Secretary of the Interior's *Standards and Guidelines for Archaeology and Historic Preservation* (NPS, 48 Fed. Reg. 44716-42, Sept. 29, 1983); and the standards and guidelines set forth in *New Jersey Historic Preservation Office Guidelines for Phase I Archaeological Investigations: Identification of Archaeological Resources* (2004). Because of the sensitive nature of some of the material contained in this proposal, the covers and any applicable pages are labeled "CONTAINS PRIVILEGED INFORMATION – DO NOT RELEASE" in accordance with FERC guidelines and 36 CFR 800.11(c)(1).

RESULTS AND PHASE IB SURVEY RECOMMENDATIONS

The analysis and review of geoarchaeological soil borings have resulted in the identification of three pipeline route sections in Staten Island that contain archaeologically sensitive strata within the Project APE (Table 2). Phase IB subsurface testing investigations are recommended for these sensitive areas. Each pipeline section subjected to geoarchaeological soil borings is described in detail below.

NYSDEC Property (RCH-2-ARC-1, RCH-2-ARC-2, RCH-2-ARC-3, RCH-2-ARC-4)

Four geoarchaeological soil borings (RCH-2-ARC-1, RCH-2-ARC-2, RCH-2-ARC-3, RCH-2-ARC-4) were completed on NYSDEC property along the pipeline route from STA 257+80 to STA 248+00[1] , north of the Texas Eastern Transmission M&R 058 station and connecting utilities (Figures 3 and 4). This area crosses Bridge Creek, just north of the National Register eligible Old Place Neck archaeological site (OPRHP No. A08501.002971), identified and evaluated by PAL during hand and machine testing adjacent to the existing M&R 058 station in proposed pipeline route and work spaces (Elquist and Cherau 2011d). This area was assigned high archaeological sensitivity for both pre-contact and post-contact period resources. Pre-contact Native American archaeological resources are expected to be associated with the Old Place Neck Site dating from at least the Late Archaic through Contact periods. Post-contact period resources could include structural remains and artifact assemblages associated with documented seventeenth and eighteenth-century settlements and a nineteenth-century farmstead belonging to J. Carpenter (Elquist et al. 2010d:75-78). A post-contact period cultural component associated with the nineteenth-century Old Place Mill property was also identified within the Old Place Neck Site to the southwest.

The soil boring analysis determined the presence of archaeologically sensitive, intact paleosols underlying 100-150 centimeters (cm) (3.3-4.9 feet [ft]) of nonrecovered sediment in both RCH-2-ARC-1 and RCH-2-ARC-2 located on the south side of the reconfigured and historically straightened Bridge Creek channel. A radiocarbon date of 1500 ± 30 B.P. (Beta #309854) was obtained from the A-horizon organic sediment at 140 cm below surface (cmbs) (4.6 ft) in RCH-2-ARC-1. The archaeologically sensitive paleosols strata extend to approximately 275 cmbs (9.0 ft). RCH-2-ARC-3 and RCH-2-ARC-4 to the north of Bridge Creek channel contained near-continuous evidence of hydromorphic activity into the substrate. RCH-2-ARC-3 contained a series of A, B, and C top and subsoil horizons with mixed peats and silty-clay organic mats that extended from the ground surface to at least 400 cmbs (13.1 ft). RCH-2-ARC-4 contained discrete historic fill strata from ground surface to 190 cmbs (6.2 ft), underlain by a series of gleys to 350 cmbs (11.5 ft). Between 350 and 550 cmbs (11.5-18.0 ft) an overthickened A horizon seals a dense and moist organic mat that may represent a peat overlying the weathered Bw horizon. A radiocarbon date of 1700 ± 30 B.P. (Beta #309855) was obtained from this peat. A radiocarbon date of 2670 ± 30 B.P. (Beta #309856) was obtained from the AB-Bw interface present 150 cm (4.9 ft) below the peats. This core stratigraphy suggests that the Pleistocene/Holocene transition is only 30 cmbs (1 ft) below the late Holocene soil (GRA 2011: 21-23).

A Phase IB archaeological survey is recommended for the archaeologically sensitive strata identified through the soil boring analysis at this location. Given the depth of the sensitive archaeological strata that begin at approximately 100 cmbs (3.3 ft) and extend below the pipeline APE at approximately 214 cmbs (7 ft), machine-assisted trenches will be used. The high archaeological sensitivity section of proposed pipeline route at this location measures approximately 215 m (705 ft). Approximately eleven (11) trenches, each measuring 2.5 m (8 ft) wide by 4.5 m (15 ft) long (to accommodate the shoring box) will be placed at 15-m (49 ft) intervals within this work area (see Figures 3 and 4). The trenches will extend to at least 214 cm (7 ft) through the sensitive archaeological strata within the vertical pipeline trench APE. The testing methodology for machine-assisted trenches is described in more detail below under Fieldwork Methodology.

[1] Note that station numbers on the alignment sheets are discontinuous at some locations due to reroutes that have been incorporated since the original routing. At each point of discontinuity, an equation station is listed to indicate the difference between the original length and the reroute length through that segment.

NYCDOT PROPERTY – WESTERN AVENUE (RCH-4H-ARC-6.1, RCH-4H-ARC-7, RCH-4H-ARC-8, RCH-4H-ARC-9, RCH-4H-ARC-10, RCH-4H-ARC-11.1, RCH-4H-ARC-12, RCH-4H-ARC-13, RCH-4H-ARC-14, RCH-4H-ARC-15, RCH-4H-ARC-16, RCH-4H-ARC-17)

This segment of pipeline route follows Route Variation 76, which reflects a very minor deviation from the originally proposed route assessed in the Pre-filing report (Elquist et al. 2010a) and re-assessed in the Addendum #3 report (Elquist and Cherau 2011c). The Pre-filing route was largely contained within the Western Avenue roadbed, while the currently proposed route runs adjacent to the eastern edge of Western Avenue (Figures 5, 6, and 7). Twelve geoarchaeological borings were completed within the Western Avenue street right-of-way, which was offset 20 to 40 ft west of the pipeline's proposed centerline because the landowner, the Port Authority of New York and New Jersey, denied access to perform any subsurface investigations. This segment of pipeline route in and adjacent to Western Avenue was assigned high sensitivity for pre-contact resources given the presence of Archaic through Woodland finds associated with the Mariner's Harbor site area, artifact finds along Western Avenue/Site 8505, and deposits associated with the Bowman's Brook (NYSM 4594 and 7921) and Bowman's Brook North (A085-01-2364) sites to the north and east. This segment of route along Western Avenue north of the railroad crossing was assessed as having low sensitivity for any significant post-contact period resources (Elquist et al. 2010a: 81-82).

The twelve soil borings completed to date were placed within the street right-of-way that is elevated slightly (several feet) above the wetlands located approximately 1500 ft east of Western Avenue. The raised roadway may represent part of an original landform since there are no indications it was built on fill (Elquist et al. 2010a:78). All twelve cores placed within the street have similar stratigraphies that consist of relatively deep and recent fills overlying shoreline deposits. The fills extend from just under pavement to 88 cmbs (2.9 ft) at the southern end to 600 cmbs (19.7 ft) at the northern end of the Western Avenue survey area. The fill soils extend either to the limit of the probes (RCH-4H-ARC-15) at 600 cmbs (19.7 ft) or the interface with the Pleistocene shoreline that had been truncated by fill or at till matrices (GRA 2011:38). The shoreline sediments are underlain by fluvial sands and gravels at average depths of 500-600 cmbs (16.4-19.7 ft), except in RCH-4H-ARC-8 where a weak cambic soil was identified between 450-480 cmbs (14.8-15.7 ft) (GRA 2011:25). A radiocarbon date of 16,940 ± 70 B.P. was obtained from organic sediment (probable shoreline soil) at 465 cmbs (15.3 ft) in RCH-4H-ARC-8. This date is "consistent with regional chrono-stratigraphies and establishes the emergence of the Staten Island shoreline during the latter stages of the Wisconsinan" (GRA 2011:25). Two of the soil borings contained evidence of a possible paleosol: below 450 cm (14.8 ft) in RCH-4H-ARC-8 and from 200-230 cm (6.6-7.5 ft) in RCH-4H-ARC-13).

The soil boring analysis suggests that limited intact Holocene soil sediments could be present beneath the thick historic road fills, as evidenced in two of the soil borings found to contain possible paleosols (RCH-4H-ARC-8 and RCH-4H-ARC-13). These thin Holocene sediments could contain deeply stratified pre-contact period resources (GRA 2011:38). However, the current pipeline trench APE will be located approximately 10-20 ft east of the eastern edge of Western Avenue on Port Authority Property (former Proctor and Gamble Port Ivory Plant), which is 20 to 40 ft east of the series of soil borings recently completed within the Western Avenue right-of-way. Additional soil borings are therefore proposed for the new off-street pipeline alignment (Route Variation 76) pending permission by the Port Authority of New York and New Jersey. Until these additional soil borings are completed, Route Variation 76 along the east side of Western Avenue is still assigned high sensitivity for pre-contact period resources, and could also be sensitive for intact post-contact period resources in pre-modern fill deposits and A-horizon strata (see Figures 5, 6, and 7).

NYCDOT PROPERTY – RICHMOND TERRACE (RCH-5H-ARC-1, RCH-5H-ARC-2, RCH-5H-ARC-3, RCH-5H-ARC-4, RCH-5H-ARC-5, RCH-5H-ARC-6, RCH-5H-ARC-7, RCH-5H-ARC-8)

Eight geoarchaeological borings were completed within the Richmond Terrace street right-of-way, which includes an approximately 0.05 mile section of Route Variation 53. The remainder of this section of pipeline route follows within the Richmond Terrace street right-of-way per the December 2010 filing route (Figure 8). One soil boring, RCH-5H-ARC-1, lies outside of the current project APE at the north end of Western Avenue in Richmond Terrace. The other seven borings are within the current project APE[2]. This area was assigned high pre-contact period archaeological sensitivity during both the pre-filing and filing archaeological assessments. No post-contact period sensitivity was assigned because of an absence of documented historic structures and disturbances within the existing roadbed including underground utility easements (Elquist et al. 2010a and 2010b).

The four western borings (RCH-5H-ARC-1 through RCH-5H-ARC-4) in the Richmond Terrace right-of-way contain historic/modern fill from just under pavement to the limit of the soil borings, which varied from 176 cmbs (5.7 ft) in RCH-5H-ARC-1 to 600 cmbs (19.7 ft) in RCH-5H-ARC-4. The fill deposits in RCH-5H-ARC-2 appeared to be somewhat discrete, and possibly sensitive given the close proximity of the Richmond Terrace Historic Archaeological Site, which consists of the buried ruins of a residence predating 1845 (Elquist et al. 2010b:86; GRA 2011:29). While the fill did not offer "indications of unique degraded properties at this location", additional investigation was recommended to "follow out patterns of fill distribution that may be linked to the Richmond Terrace Historic Site" (GRA 2011:38).

The eastern four borings (RCH-5H-ARC-5 through RCH-5H-ARC-8) contain shallower fill deposits (150-473 cmbs) (4.9-15.5 ft), underlain by relatively thick buried A and B horizon soils, and Pleistocene shoreline and fluvial deposits. In RCH-5H-ARC-5 these buried intact soils are present from 250-570 cmbs (8.2-18.7 ft); in RCH-5H-ARC-6 from 207-378 cmbs (6.8-12.4 ft); in RCH-5H-ARC-7 from 520-600 cmbs (17-19.7 ft); and in RCH-5H-ARC-8 from 150-600 cmbs (4.9-19.7 ft). Of these only two, RCH-5H-ARC-5 and RCH-5H-ARC-6 contain evidence for potential Holocene soils between fill and Pleistocene sediment complexes (GRA 2011:29, 39).

A Phase IB archaeological survey is recommended for the archaeologically sensitive strata identified through the soil boring analysis in Richmond Terrace. The vertical pipeline APE in Richmond Terrace could extend to 245 cmbs (8 ft) or deeper because of the presence of utilities. Given the presence of asphalt pavement and underground utilities and the depth of the sensitive pre-contact strata that begin at 207 cmbs (6.8 ft), machine-assisted trenches will be used. The high sensitivity area associated with RCH-5H-ARC-2 measures approximately 30.5 m (100 ft) and the high sensitivity area associated with RCH-5H-ARC-5 and RCH-5H-ARC-6 measures approximately 99 m (325 ft). Approximately seven (7) trenches, each measuring 2.5 m (8 ft) wide by 4.5 m (15 ft) long (to accommodate the shoring box) will be placed at 15-m (49 ft) intervals within this work area (see Figure 8). The trenches will extend to at least 245 cmbs (8 ft) through the sensitive archaeological strata within the vertical pipeline trench APE. The testing methodology for machine-assisted trenches is described in more detail below under Fieldwork Methodology.

[2] RCH-5H-ARC-3 was shifted east toward RCH-5H-ARC-4 because of in-field logistical constraints (e.g., underground utilities, etc.).

NYCEDC PROPERTY (RCH-6-ARC-1, RCH-6-ARC-2, RCH-6-ARC-3, RCH-6-ARC-4, RCH-6-ARC-5)

Five geoarchaeological borings were completed on NYCEDC Property north of Richmond Terrace and southwest of the shoreline of the Kill Van Kull (Figures 8 and 9). This area was assigned a high sensitivity for pre-contact period resources associated with the previously documented Bowman's Brook and Bowman's Brook North sites, dated to the Archaic and Woodland periods, and including human burials. Moderate post-contact period sensitivity was also assigned based on the documented potential for Revolutionary War period human remains according to a 1926 report by Skinner (Elquist et al. 2010b:90). RCH-6-ARC-1 contained fill soils from ground surface to 181 cmbs (5.9 ft). The fill was underlain by an intact 200 cm (6.6 ft) thick basal soil that appears to have formed on top of shoreline sands and may be of terminal Pleistocene or Early Holocene age (GRA 2011:31). RCH-6-ARC-2 contained fill soils from ground surface to 279 cmbs (9.1 ft), underlain by mixed fill and estuarine and fluvial deposits that extend well below the vertical pipeline APE to 600 cm (19.7 ft). Cinders and iron concretions were present in the fill from 250-279 cmbs (8.2-9.1 ft). RCH-6-ARC-3 contained fill from just under pavement to 391 cmbs (12.8 ft), underlain by estuarine sediments well below the vertical pipeline APE to 600 cmbs (19.7 ft). The fill contained brick, wood, glass, ceramics, and cinders. RCH-6-ARC-4 contained fill from just under pavement to 372 cmbs (12.2 ft), underlain by estuarine and shoreline sediments well below the vertical pipeline APE to 600 cmbs (19.7 ft). The fill from 40-116 cmbs (1.3-3.8 ft) yielded brick fragments and cinders. RCH-6-ARC-5 contained fill from just under pavement to 290 cmbs (9.5 ft), underlain by estuarine, shoreline, and fluvial sediments that extend below the limit of the soil boring at 600 cmbs (19.7 ft). Cinders were present in the fill from 265-290 cmbs (8.7-9.5 ft) (GRA 2011).

The soil borings suggest the presence of intact Holocene soils that could contain pre-contact period cultural deposits, although these soils are for the most part deeply buried below the project pipeline vertical APE at 214 cmbs (7 ft). In one area, RCH-6-ARC-1, the Holocene soils possibly begin within the vertical APE beginning at 181 cmbs (5.9 ft). No Holocene soils, however, were identified at the far eastern end of the pipeline trench, closest to the river shoreline (RCH-6-ARC-5), where the proposed HDD entry point near STA 300+00 will extend from 0 to 60 ft below surface. In all cases, the soil borings indicated the presence of historic fill deposits within the vertical APE, some of which contain artifact assemblages including ceramics, glass, brick, and wood. This area north of Richmond Terrace is documented as having contained numerous nineteenth-century dwellings likely associated with "Sailors Row", as well as the potential for Revolutionary War burials.

A Phase IB archaeological survey is recommended for the archaeologically sensitive strata identified through the soil boring analysis in NYCEDC Property north of Richmond Terrace. Given the presence of asphalt pavement and the depth of the sensitive strata that extend to the limit of and below the pipeline APE at approximately 214 cmbs (7.0 ft), machine-assisted trenches will be used. The high sensitivity area measures approximately 290 m (950 ft). Approximately twelve (12) trenches, each measuring 2.5 m (8 ft) wide by 4.5 m (15 ft) long (to accommodate the shoring box) will be placed at 15-m (49 ft) intervals within this work area (see Figures 8 and 9). All of the trenches will extend to at least 214 cm (7.0 ft) through the sensitive archaeological strata within the vertical pipeline trench APE, although the eastern most trench may be deeper depending on the soil stratigraphy in the area of the proposed HDD entry point. The testing methodology for machine-assisted trenches is described in more detail below under Fieldwork Methodology.

TESTING METHODOLOGY

PAL's Phase IB archaeological survey testing methodology has been formulated according to the standards and guidelines set forth in the *Standards for Cultural Resource Investigations and the Curation of Archaeological Collections in New York State* (NYAC 1994); and *Landmarks Preservation Commission Guidelines for Archaeological Work in New York City* (LPC 2002).

The Phase IB archaeological field investigations will consist of subsurface testing in the form of machine-assisted trenches to locate and identify potentially significant belowground resources within the vertical APE of the pipeline trench. The exact on-the-ground placement and size of the machine-assisted trenches will need to be determined in the field at the time of the survey, pending any utilities issues with NY Dignet (which will be contacted prior to the fieldwork) and other ground surface or subsurface factors or obstructions that constrict the trench size and placement.

A combination of machine-assisted and shovel scraping techniques will be used to investigate the nature and integrity of any identified structural remains and cultural strata encountered in the trenches. All machine-excavated soils will be examined for cultural materials and a sample of these soils will be hand screened through ¼-inch hardware mesh. Any cultural material (or a representative sample) remaining in the screen and collected from the excavated unscreened soils will be bagged and tagged by trench and level. Soil stratigraphy will be recorded for each machine trench and plans and profiles will be measured and drawn. Cultural material and samples will be bagged and labeled with provenience information. Digital photographs will be taken of all trenching locations and any identified belowground cultural remains. All cultural remains will be mapped in plan using compass and tape measure onto current existing conditions topographic site plans. Measured detailed drawings (plans, cross sections) will be done for any identified structural remains in the trenches.

All trenches will be excavated in accordance with Occupational Health and Safety Administration (OSHA) regulations for benching, sloping, and/or mechanical shoring devices at depths that exceed 3-4 ft. Dewatering of the trenches will also be conducted as needed depending on the anticipated/actual depth of the water table at the time of the excavations. A site-specific HASP that specifies air monitoring and PPE including tyvek suits and ½ face respirators may be needed for the proposed archaeological investigations pending review of the environmental testing results for soil contaminant exceedances. PAL's Certified Industrial Hygienist (CIH) subconsultant, in consultation with the TRC environmental staff, will develop the necessary HASP, which will be reviewed by Spectra Energy's Environmental Health and Safety (EHS) group. Mobile lighting devices may also be needed for recordation in trenches below these depths.

Upon completion of testing and recordation, all archaeological trenches will be backfilled and restored to their original ground contour surface.

LABORATORY PROCESSING AND ANALYSES

All cultural materials recovered from the Project during the Phase IB field investigations will be returned to the PAL facility for laboratory processing and analyses. These activities will include:

- cleaning, identification, and cataloging of any recovered cultural materials;
- preliminary analysis of spatial distributions of cultural materials;

- map and graphics production.

CURATION

Any recovered cultural materials and related documentation (e.g., field forms and notes, maps, photographs, report) will be organized and stored in acid-free Hollinger boxes with box content lists and labels printed on acid-free paper. These boxes will be temporarily stored at PAL according to curation guidelines established by the Secretary of Interior Standards 36 CFR 79, and with *Standards for Cultural Resource Investigations and the Curation of Archaeological Collections in New York State* (NYAC 1994) and LPC guidelines (2002), and until such time as a permanent repository can be determined in consultation with the New York SHPO.

WORK PRODUCTS

Upon completion of the fieldwork, and laboratory processing and analysis, PAL will prepare Phase IB archaeological survey report(s). The reports will follow the guidelines established by FERC (2002) and the New York SHPO (2005) and the New York City LPC (2002). Draft copies of the report(s) will be submitted to appropriate agencies, Native American groups, and other consulting parties for review. The final report(s) will follow the draft review. Appropriate SHPO archaeological site forms will also be completed and submitted, if necessary.

PROJECT SCHEDULE

Fieldwork for the Phase IB archaeological investigations will take approximately 8 to 10 weeks, weather and logistics dependant, and can begin as soon as landowner permissions are obtained. Winter excavation protocols and procedures will be implemented including the use of shelters and heaters to ensure that archaeologically sensitive soil strata and features can be properly screened and recorded, and artifacts can be retrieved safely from non-frozen soils. Draft technical report(s) will be submitted within 45 days after the completion of the fieldwork.

PROJECT PERSONNEL

The archaeological investigations will be overseen by a Principal Investigator. The fieldwork will be supervised by a Project Archaeologist. All PAL project personnel meet the qualifications set by the National Park Service (36 CFR Part 66, Appendix C) and the NY SHPO.

REFERENCES CITED

Cherau, Suzanne G.

2011 Results of Geoarchaeological Soil Borings and Proposed Phase IB Archaeological Surveys, New Jersey-New York Expansion Project, Staten Island, New York and Linden, Bayonne, and Jersey City, New Jersey. PAL Report 2367.02, April 2011. Submitted to Spectra Energy Transmission, LLC, Jersey City, NJ.

Elquist, Ora, Suzanne Cherau, Nichole Gillis, and Gregory R. Dubell

2010a *Archaeological Overview Survey, Texas Eastern Transmission, LP, New Jersey-New York Expansion Project, Pre-Filing FERC Docket No. PF10-17-000, Staten Island, Manhattan, and Ramapo, New York.* PAL Inc. Report No. 2367.01, August 2010. Submitted to Spectra Energy Transmission, LLC, Jersey City, NJ.

2010b *Archaeological Overview Survey, Texas Eastern Transmission, LP, New Jersey-New York Expansion Project, FERC Docket #CP11-56-000, Staten Island, Manhattan, and Ramapo, New York.* PAL Report No. 2367.01B, December 2010. Submitted to Spectra Energy Transmission, LLC, Jersey City, NJ.

Elquist, Ora and Suzanne Cherau

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2011b *Archaeological Overview Survey, Addendum #2 to Technical Report, New Jersey-New York Expansion Project, Staten Island and Manhattan, New York.* Submitted by PAL, Inc. to Spectra Energy Transmission, LLC, Jersey City, NJ.

2011c *Archaeological Overview Survey, Addendum #3 to Technical Report, New Jersey-New York Expansion Project, Staten Island and Manhattan, New York.* Submitted by PAL, Inc. to Spectra Energy Transmission, LLC, Jersey City, NJ.

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Table 2. Summary Results and Phase IB Survey Recommendations for Completed Soil Borings, July to November 2011, Staten Island Portion of the NJ-NY Expansion Project.

Universal Boring Tracking No.	***Pipeline Route Section***	***Alignment Sheets(s)***	***2010 Phase IA Sensitivity Assessment***	***Geoarchaeological/Geotechnical Summary Results***	***Recommendation***	***Phase IB Testing Strategy***
RCH-2-ARC-1 RCH-2-ARC-2 RCH-2-ARC-3 RCH-2-ARC-4	Staten Island, STA 257+80 to STA 248+00	LD-A-1020.1 LD-A-1021	High for pre- and post-contact resources	Archaeologically sensitive strata including intact A and B soil horizons and paleosols, below fill deposits. Sensitive strata begin approximately 100 cmbs (3.3 ft) and extend below the pipeline APE at 124 cmbs (7 ft)	Phase IB survey in 215 m (705 ft) of pipeline trench, NYCDEC Property	11 machine-assisted trenches at 15 m (49 ft) intervals
RCH-4H-ARC-6.1 RCH-4H-ARC-7 RCH-4H-ARC-8 RCH-4H-ARC-9 RCH-4H-ARC-10 RCH-4H-ARC-11.1 RCH-4H-ARC-12 RCH-4H-ARC-13 RCH-4H-ARC-14 RCH-4H-ARC-15 RCH-4H-ARC-16 RCH-4H-Arc-16	Staten Island, STA 253+50 to 278+50	LD-A-1021 LD-A-1022 LD-A-1023	High sensitivity for pre-contact resources; low sensitivity for post-contact resources within Western Avenue right-of-way	Thick historic/modern road fills, overlying limited intact Holocene soil sediments; current pipeline trench will be located 20-40 ft east of these soil borings outside of the street right-of-way and on the adjacent Port Authority Property (former Proctor and Gamble Port Ivory Plant)	Sensitive strata in horizontal APE outside of Western Avenue right-of-way; Phase IB survey pending completion of additional soil borings on Port Authority property	To be determined
RCH-5H-ARC-1	Staten Island, outside of current APE	LD-A-1024	High sensitivity for pre-contact resources; low sensitivity for post-contact resources within Richmond Terrace right-of-way	Modern fill deposits	Not in current project APE	None
RCH-5H-ARC-2	Staten Island, STA 280+00 to 281+00	LD-A-1024	High sensitivity for pre-contact resources; low to moderate sensitivity-near the documented Richmond Terrace Historic Archaeological Site within Richmond Terrace right-of-way	Potentially sensitive historic fill soils to 279 cmbs (9.1 ft)	Phase IB survey in 30.5 m (100 ft) of pipeline trench in Richmond Terrace	2 machine-assisted trenches at 15 m (49 ft) intervals
RCH-5H-ARC-3 RCH-5H-ARC-4	Staten Island, STA 281+00 to STA 284+25	LD-A-1024	High sensitivity for pre-contact resources; low sensitivity for post-contact resources within Richmond Terrace right-of-way	Deep historic/modern fill deposits that extend below the vertical pipeline APE at 245 cmbs (8 ft); no evidence of intact Holocene soils	No sensitive strata in vertical APE; no Phase IB survey	None
RCH-5H-ARC-5 RCH-5H-ARC-6	Staten Island, STA 284+25 to STA 287+50	LD-A-1024	High sensitivity for pre-contact resources; low sensitivity for post-contact resources within Richmond Terrace right-of-way	Buried intact A and B horizon soils, with evidence for potential Holocene soils beginning at 207 cmbs (6.8 ft) extending below the vertical APE at 245 cmbs (8+ ft)	Phase IB survey in 99 m (325 ft) of pipeline trench in Richmond Avenue	5 machine-assisted trenches at 15 m (49 ft) intervals
RCH-5H-ARC-7 RCH-5H-ARC-8	Staten Island, STA 287+50 to STA 291+00	LD-A-1024	High sensitivity for pre-contact resources; low sensitivity for post-contact resources within Richmond Terrace right-of-way	Deep historic/modern fill deposits that extend below the vertical pipeline APE at 245 cmbs (8+ ft); no evidence of intact Holocene soils	No sensitive strata in vertical APE; no Phase IB survey	None
RCH-6-ARC-1 RCH-6-ARC-2 RCH-6-ARC-3 RCH-6-ARC-4 RCH-6-ARC-5	Staten Island, STA 291+00 to STA 300+50	LD-A-1024 LD-A-1025	High sensitivity for pre-contact resources; moderate sensitivity for primarily Revolutionary War period human remains	Archaeological sensitive historic fill strata from ground surface within and extending below the vertical pipeline APE at 214 cmbs (7 ft); intact Holocene soils well below vertical APE except in area of proposed HDD entry point near STA 300+00	Phase IB survey in 290 m (950) ft of pipeline trench on NYCEDC Property	12 machine-assisted trenches at 15 m (49 ft) intervals

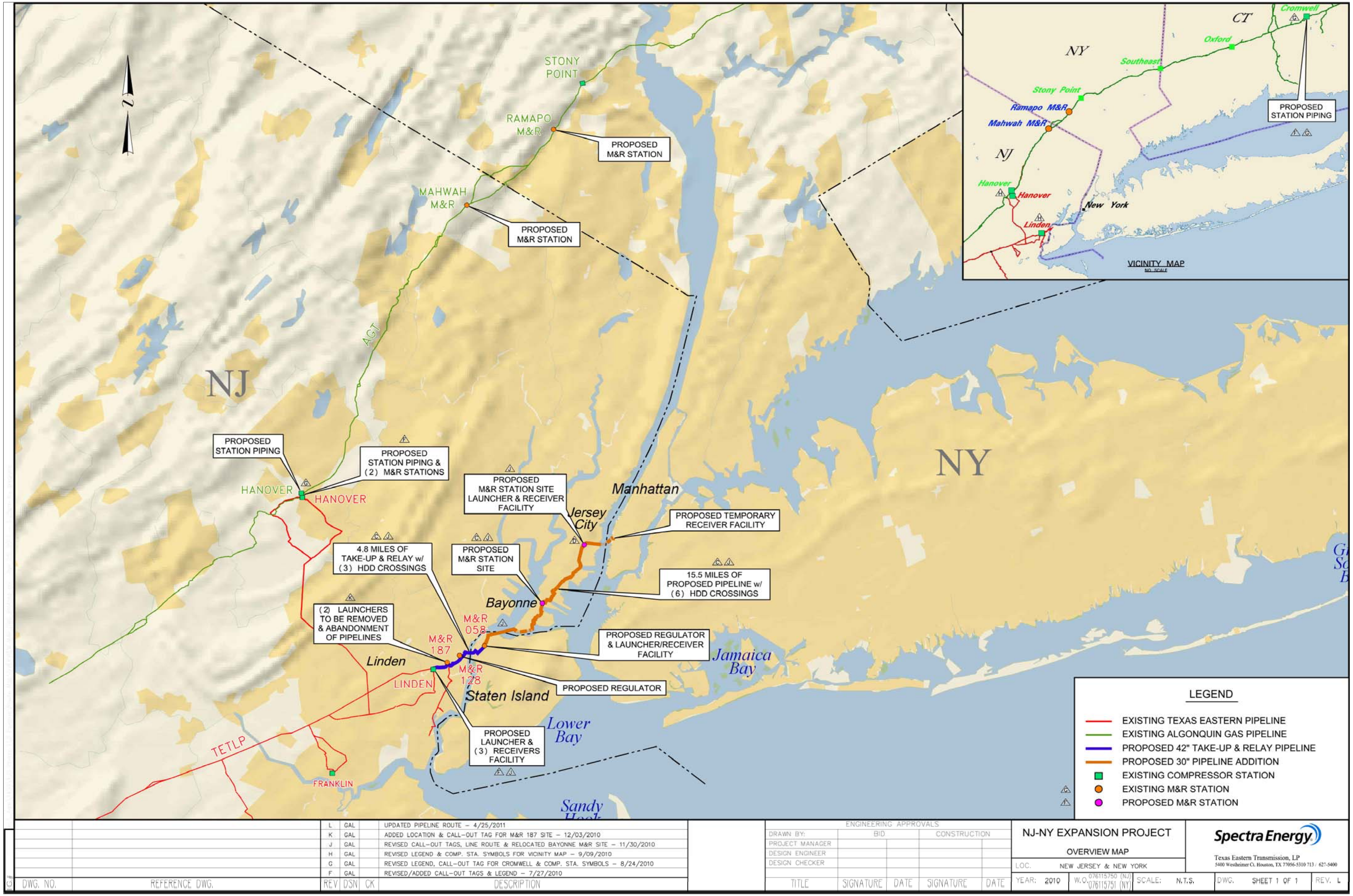


Figure 1. Overview map showing the various locations of the NJ-NY Project.

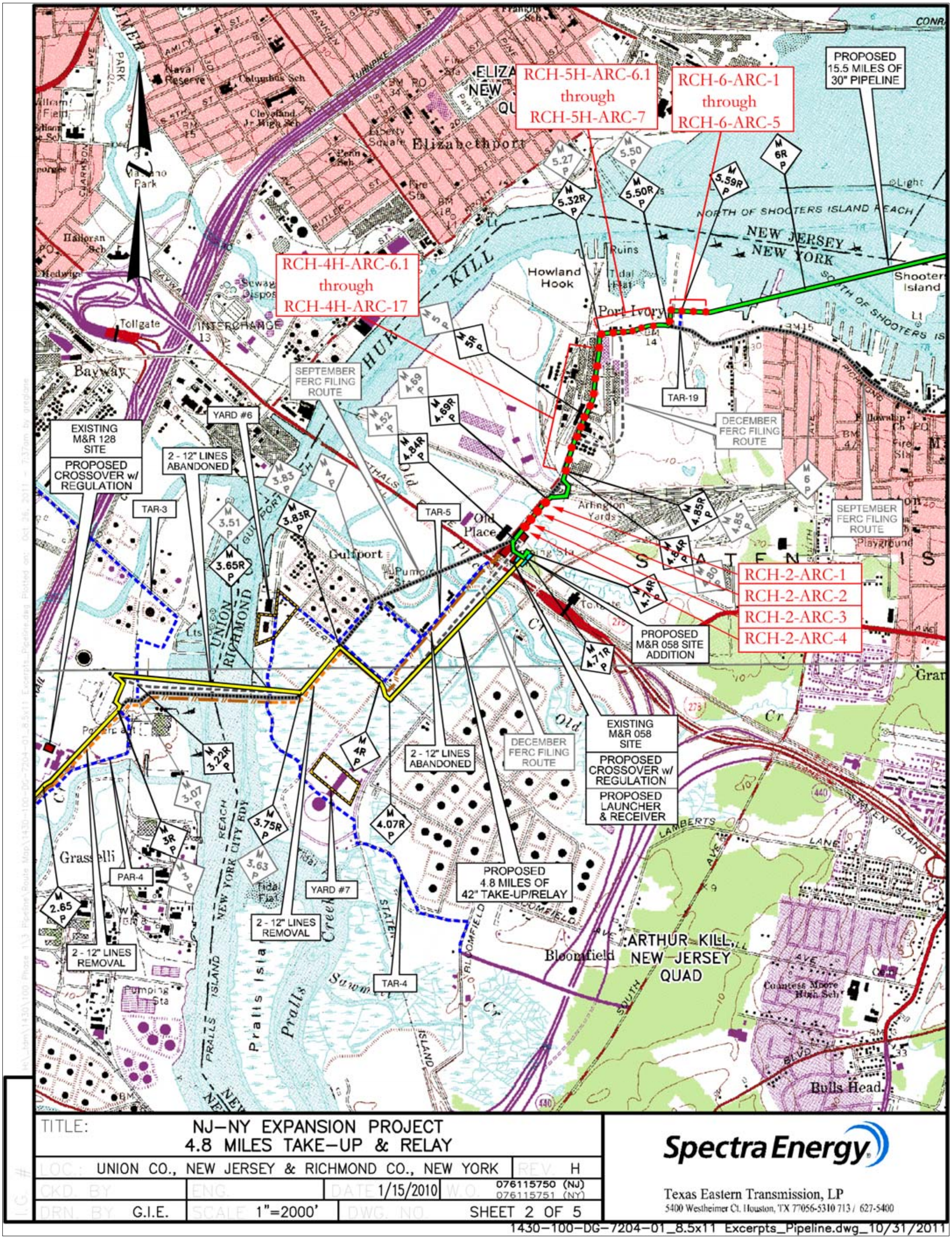


Figure 2. NJ-NY Project area, showing the location of geoarchaeological soil borings completed in Staten Island from July to November 2011 on the Elizabeth and Arthur Kill, NJ, USGS topographic quadrangles, 7.5 minute series.

RIGHT-OF-WAY					
TRACT NUMBERS	RCH-1	RCH-1.1	RCH-1	RCH-2	RCH-2S / RCH-2
RODDAGE	TEXAS EASTERN TRANSMISSION, LP 19.65 RODS	TEXAS EASTERN TRANSMISSION, LP 5.96 RODS	TEXAS EASTERN TRANSMISSION, LP 21.73 RODS	NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION 23.00 RODS	BRIDGE CREEK / NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION 5.48 RODS

SURVEY DATA

SURVEY COMPANY:

FIELD BOOK:

PAGES:

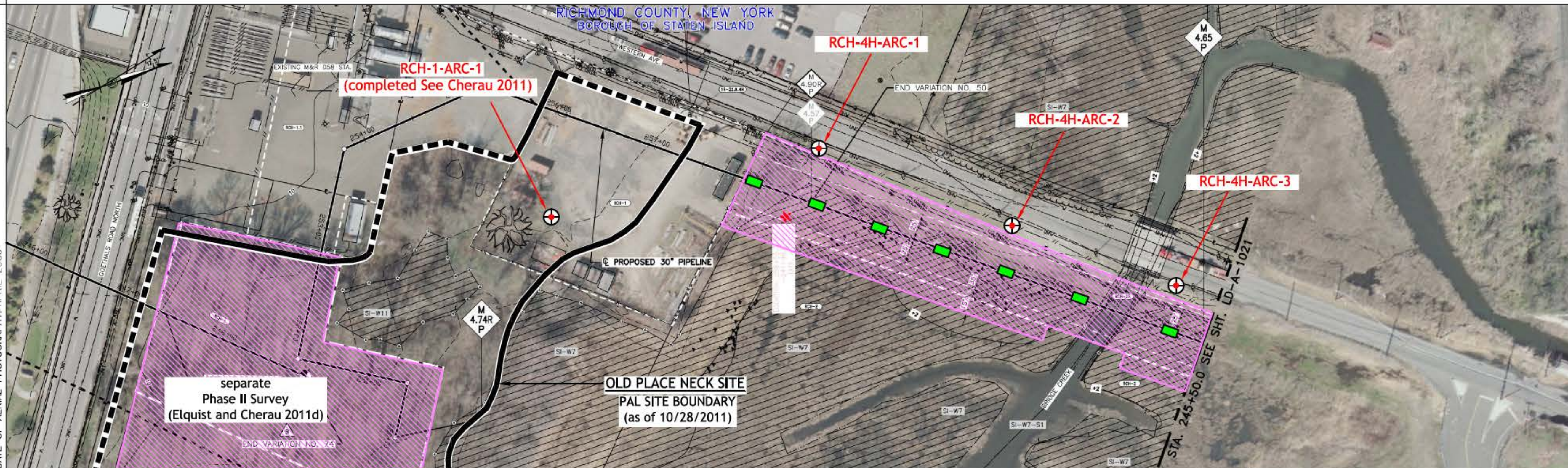
CLASS LOCATION

PIPE MATERIAL

ALIGNMENT DETAIL

PROPOSED PIPELINE
PREVIOUS FERC FILED ROUTE
EXIST. P/L W/OWNER NAME
PIPELINE TO BE REMOVED/ABANDONED
TEMP. WORKSPACE
PROPOSED PERMANENT EASEMENT
EXISTING EASEMENT
ADD. TEMP. WORKSPACE
YARD LOCATION
℄ STREAM / DITCH
DELINEATED WETLAND
APPROXIMATE WETLAND BOUNDARY
EDGE OF PAVEMENT
PERMANENT ACCESS ROAD (PAR) PAR 0.00
TEMPORARY ACCESS ROAD (TAR) TAR 0.00
CONTOUR MAJOR (EVERY 10') 20
CONTOUR AT +2 ELEV. +2
CONTOUR MINOR (EVERY 2')
TREE LINE
JERSEY BARRIER
PIPELINE MILEPOST
PROPERTY LINE
VERIFIED STORM DRAIN
UNCONFIRMED STORM DRAIN
VERIFIED UNDG. ELEC. CABLE
UNCONFIRMED UNDG. ELEC. CABLE
VERIFIED NAT. GAS LINE
UNCONFIRMED NAT. GAS LINE
VERIFIED SANITARY SEWER
UNCONFIRMED SANITARY SEWER
VERIFIED WATER LINE
UNCONFIRMED WATER LINE
VERIFIED STEAM LINE
UNCONFIRMED STEAM LINE
VERIFIED TELEPHONE CABLE
UNCONFIRMED TELEPHONE CABLE
VERIFIED UNDG. COM. CABLE
UNCONFIRMED UNDG. COM. CABLE
ELEC., WATER, SAN. SEWER, GAS, TELE. & STORM DRAIN MANHOLES
LIGHT POLE — UTILITY POLE
GAS VALVE — WATER VALVE
FIRE HYDRANT — TREE

DATE OF AERIAL PHOTOGRAPHY: APRIL 2009



ENVIRONMENTAL DATA

SI-W7 115.1' | SI-W7 185.1' | SI-W7-S1 BRIDGE CREEK 29.1' | SI-W7 77.6'

SITE SPECIFIC E & S

6 | 6 | 27 28 29 30 31 32 33 34 | 6

GENERAL E & S FIGURES

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34

PROFILE

SCALE:
HORIZONTAL: 1"=50'
VERTICAL: 1"=20'

THE LOCATION OF TRENCH PLUGS AND SLOPE BREAKERS ARE INTENDED TO BE USED AS A GUIDELINE ONLY. EXACT LOCATION TO BE DETERMINED IN THE FIELD AS DIRECTED BY THE CHIEF INSPECTOR.

FLUME PIPE AS REQUIRED

SLOPE BREAKERS/ARROW INDICATES DIRECTION

TRENCH PLUG

RIVER WEIGHT OR EQUIVALENT

SLOPE BREAKER & TRENCH PLUG SPACING

CODE	% SLOPE	SPACING
A	< 5%	NO STRUCTURE
B	5 – 15%	300 FT
C	15 – 30%	200 FT
D	> 30%	100 FT

% SLOPE

Source/Revision/Issue	Date
PAL modified: indicate archaeological sensitivity	12-16-11
Map data received from: Spectra Energy	11-01-11

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Project: NJ-NY Expansion

Date: December 2011

Figure 3

Proposed machine-assisted trench

Soil borings (symbol and number designation)

Archaeological Sensitivity

High

Moderate

Low

0 100 200ft
0 10 20 30 60m

PRIVILEGED INFORMATION - DO NOT RELEASE

REV	DRN	DATE	DESCRIPTION
A	GIE	10/01/11	ADDED ROUTE VARIATION NO. 74
A	GIE	10/01/11	ISSUED FOR FERC

DWG. NO. | DESCRIPTION — REFERENCE DRAWINGS | REVISIONS | ITEM NO. | DESCRIPTION | LN. FT. — MATERIALS

DRAWN BY: GIE
DRN. DATE: 07/22/11
CHECKED BY: GIE
CHK. DATE: 07/25/11

ENGINEERING APPROVALS — BID — CONSTRUCTION
TITLE | SIGNATURE | DATE | SIGNATURE | DATE

NJ-NY EXPANSION PROJECT
PROPOSED 30" PIPELINE
STA. 250+10.0 TO STA. 245+50.0
ALIGNMENT SHEET
LOC. RICHMOND COUNTY, NEW YORK

Spectra Energy
Texas Eastern Transmission, LP
5400 Westheimer Ct. Houston, TX 77056-5310 713 / 627-5400

YEAR: 2011 | W.O. 076115751 | SCALE: | DWG. LD-A-1020.1 | REV. A14

Figure 3. Revised archaeological sensitivity assessment for pipeline route at STA 257+80 to STA 245+50 and proposed Phase IB testing, NYSDEC Property, Staten Island, NY.

RIGHT-OF-WAY

TRACT NUMBERS
RODDAGE

RCH-2	RCH-3H	RCH-3	RCH-3R	RCH-1	RCH-4R	RCH-4	RCH-4H	RCH-4	RCH-4H
NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION	CITY OF NEW YORK	CITY OF NEW YORK	CONRAIL	PORT AUTHORITY NY AND NJ	PORT AUTHORITY NY AND NJ	PORT AUTHORITY NY AND NJ	WESTERN AVE.	PORT AUTHORITY NY AND NJ	WESTERN AVE.
14.43 RODS	3.03 RODS	19.37 RODS	2.68 RODS	14.56 RODS	5.37 RODS	3.93 RODS	13.08 RODS	0.65 RODS	6.48 RODS

SURVEY DATA

SURVEY COMPANY:
FIELD BOOK:
PAGES:

CLASS LOCATION

PIPE MATERIAL

ALIGNMENT DETAIL

PROPOSED PIPELINE
PREVIOUS FERC FILED ROUTE
EXIST. P/L W/OWNER NAME
PIPELINE TO BE REMOVED/ABANDONED
TMP. WORKSPACE
PROPOSED PERMANENT EASEMENT
EXISTING EASEMENT
ADD. TEMP. WORKSPACE
YARD LOCATION
℄ STREAM / DITCH
DELINEATED WETLAND
APPROXIMATE WETLAND BOUNDARY
EDGE OF PAVEMENT
PERMANENT ACCESS ROAD (PAR) PAR 0.00
TEMPORARY ACCESS ROAD (TAR) TAR 0.00
CONTOUR MAJOR (EVERY 10')
CONTOUR AT +2 ELEV.
CONTOUR MINOR (EVERY 2')
TREE LINE
JERSEY BARRIER
PIPELINE MILEPOST
PROPERTY LINE
VERIFIED STORM DRAIN
UNCONFIRMED STORM DRAIN
VERIFIED UNDG. ELEC. CABLE
UNCONFIRMED UNDG. ELEC. CABLE
VERIFIED NAT. GAS LINE
UNCONFIRMED NAT. GAS LINE
VERIFIED SANITARY SEWER
UNCONFIRMED SANITARY SEWER
VERIFIED WATER LINE
UNCONFIRMED WATER LINE
VERIFIED STEAM LINE
UNCONFIRMED STEAM LINE
VERIFIED TELEPHONE CABLE
UNCONFIRMED TELEPHONE CABLE
VERIFIED UNDG. COM. CABLE
UNCONFIRMED UNDG. COM. CABLE
ELEC., WATER, SAN. SEWER, GAS, TELE. & STORM DRAIN MANHOLES
LIGHT POLE / UTILITY POLE
GAS VALVE / WATER VALVE
FIRE HYDRANT / TREE

DATE OF AERIAL PHOTOGRAPHY: APRIL 2009

ENVIRONMENTAL DATA

SI-W7 150.7'
SI-W8 20.1'
UNNAMED CREEK 7.8'
SI-W8 11'
SI-SN2 5.8'
SI-SN3 13.9'

SITE SPECIFIC E & S

6 | 6 | 27 28 29 30 31 32 33 34 | 27 28 29 30 31 32 33 34

GENERAL E & S FIGURES

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34

PROFILE

SCALE:
HORIZONTAL: 1"=50'
VERTICAL: 1"=20'

THE LOCATION OF TRENCH PLUGS AND SLOPE BREAKERS ARE INTENDED TO LOCATION TO BE USED AS A GUIDELINE ONLY. EXACT LOCATION TO BE DETERMINED IN THE FIELD AS DIRECTED BY THE CHIEF INSPECTOR.

FLUME PIPE AS REQUIRED
SLOPE BREAKERS/ARROW INDICATES DIRECTION
TRENCH PLUG
RIVER WEIGHT OR EQUIVALENT

SLOPE BREAKER & TRENCH PLUG SPACING

CODE	% SLOPE	SPACING
A	< 5%	NO STRUCTURE
B	5 – 15%	300 FT
C	15 – 30%	200 FT
D	> 30%	100 FT

% SLOPE

Source/Revision/Issue	Date
PAL modified: indicate archaeological sensitivity	12-16-11
Map data received from: Spectra Energy	11-01-11

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Project: NJ-NY Expansion
Date: December 2011
Figure 4

PAL

Proposed machine-assisted trench

Proposed soil borings (symbol and number designation)

Archaeological Sensitivity

High
Moderate
Low

0 100 200ft
0 10 20 30 60m

PRIVILEGED INFORMATION - DO NOT RELEASE

DWG. NO.	DESCRIPTION	REV	DRN	DATE	DESCRIPTION
			GIE	10/01/11	ADDED ROUTE VARIATION NO. 76
			GIE	10/01/11	ADDED ROUTE VARIATION NO. 58
LD-A-1021A	SUPPLEMENTAL ALIGNMENT SHEET		GIE	10/01/11	ISSUED FOR FERC

REFERENCE DRAWINGS | REVISIONS | ITEM NO. | DESCRIPTION | LN. FT. | MATERIALS

DRAWN BY: GIE
DRN. DATE: 07/22/11
CHECKED BY: GIE
CHK. DATE: 07/25/11

ENGINEERING APPROVALS: BID | CONSTRUCTION
TITLE | SIGNATURE | DATE | SIGNATURE | DATE

NJ-NY EXPANSION PROJECT
PROPOSED 30" PIPELINE
STA. 245+50.0 TO STA. 257+00.0
ALIGNMENT SHEET
LOC. RICHMOND COUNTY, NEW YORK

Spectra Energy
Texas Eastern Transmission, LP
5400 Westheimer Ct. Houston, TX 77056-5310

YEAR: 2011 | W.O. 076115751 | SCALE: | DWG. LD-A-1021 | REV. A14

Figure 4. Revised archaeological sensitivity assessment for pipeline Route Variation 58, STA 245+50 to STA 248+00 and proposed Phase IB testing, NYSDEC Property, Staten Island, NY.

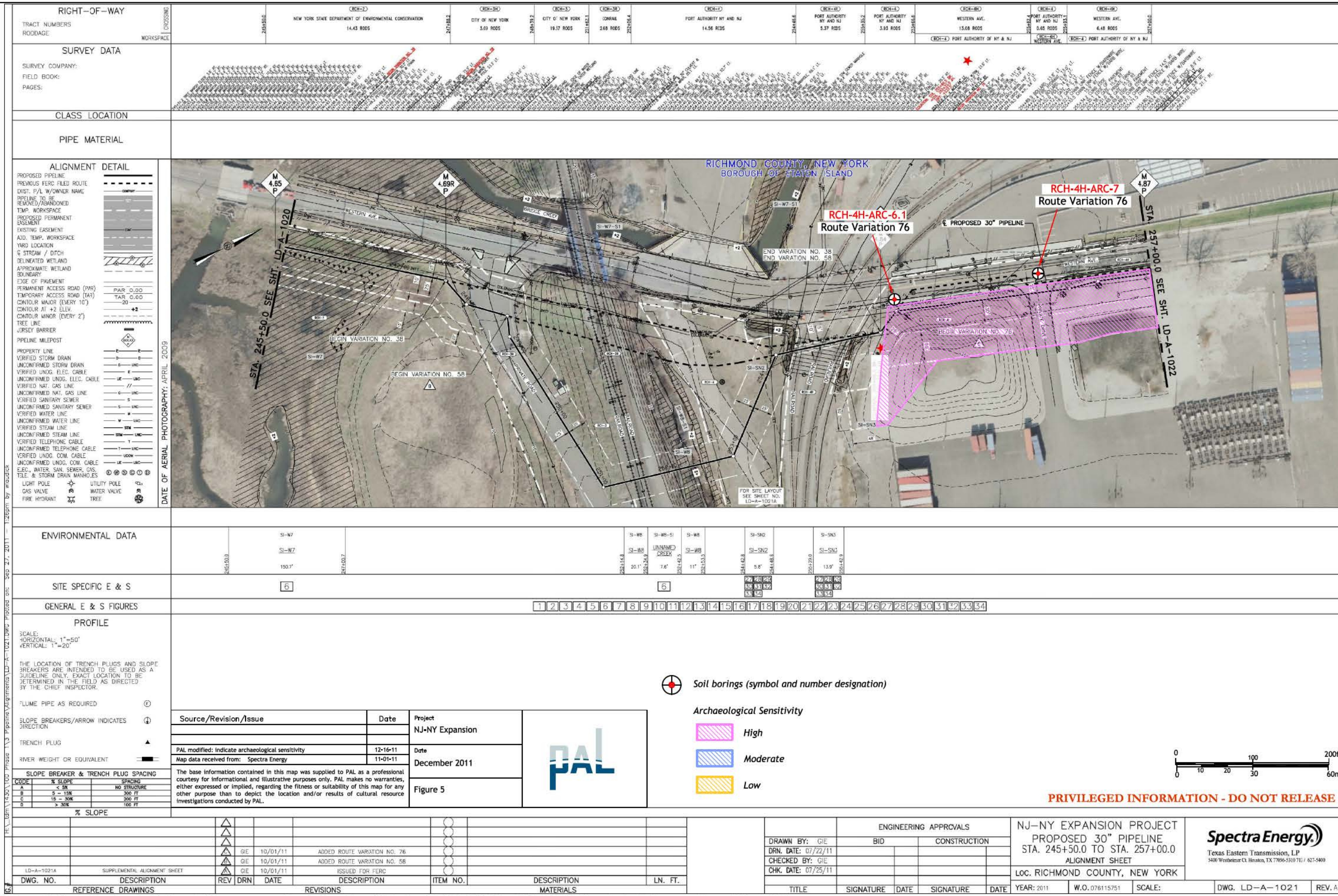


Figure 5. Revised archaeological sensitivity assessment for pipeline Route Variation 76, STA 253+50 to STA 257+00, Port Authority Property, Staten Island, NY.

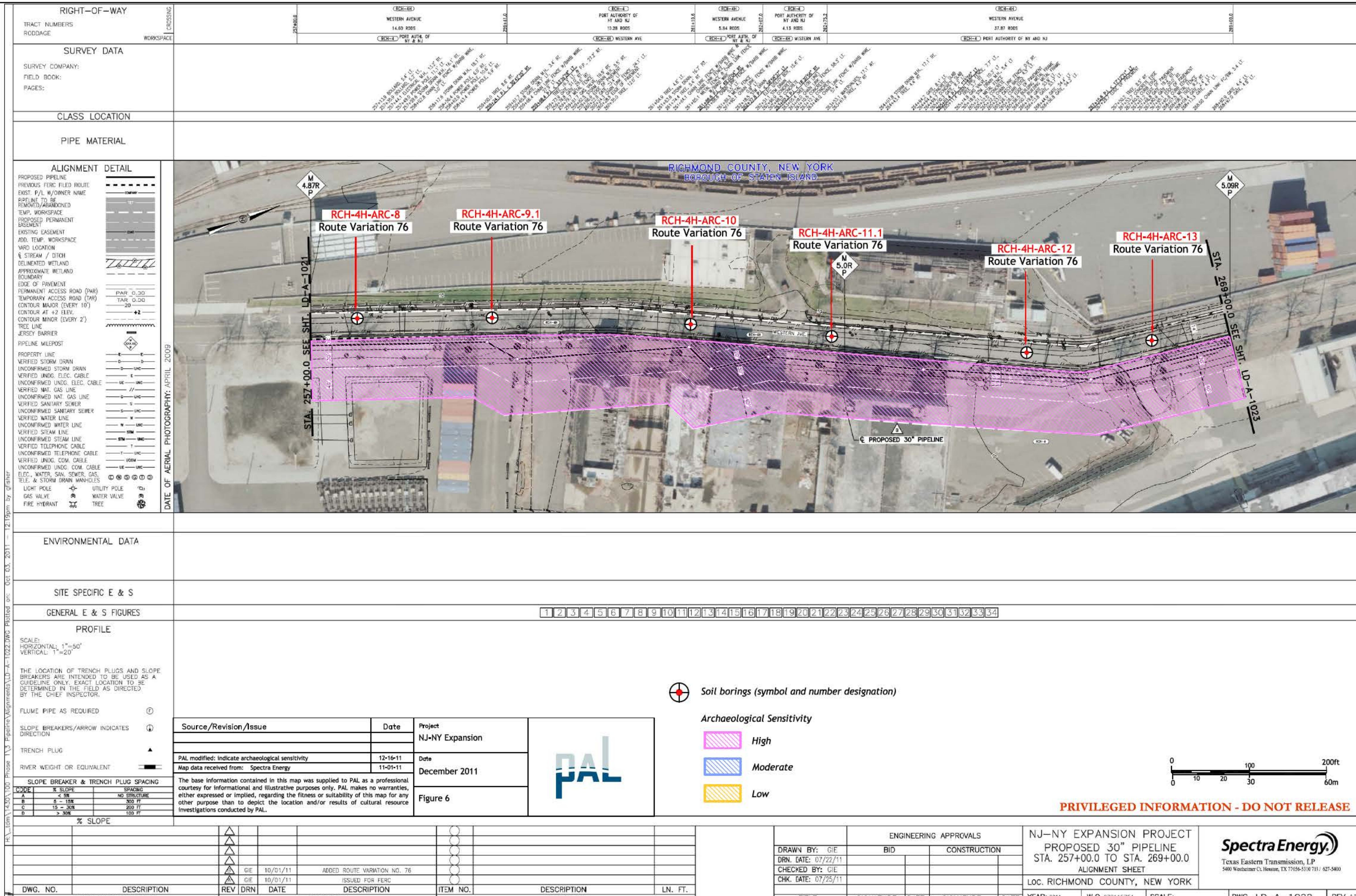


Figure 6. Revised archaeological sensitivity assessment for pipeline Route Variation 76, STA 257+00 to STA 269+00, Port Authority Property, Staten Island, NY.

RIGHT-OF-WAY			
TRACT NUMBERS	RCH-4H WESTERN AVENUE	RCH-4 PORT AUTHORITY OF NY AND NJ	RCH-5H RICHMOND TERRACE
RODDAGE	4.09 RODS	51.39 RODS	10.90 RODS
WORKSPACE	RCH-4 PORT AUTHORITY OF NY & NJ	RCH-4H WESTERN AVENUE	

SURVEY DATA

SURVEY COMPANY:
FIELD BOOK:
PAGES:

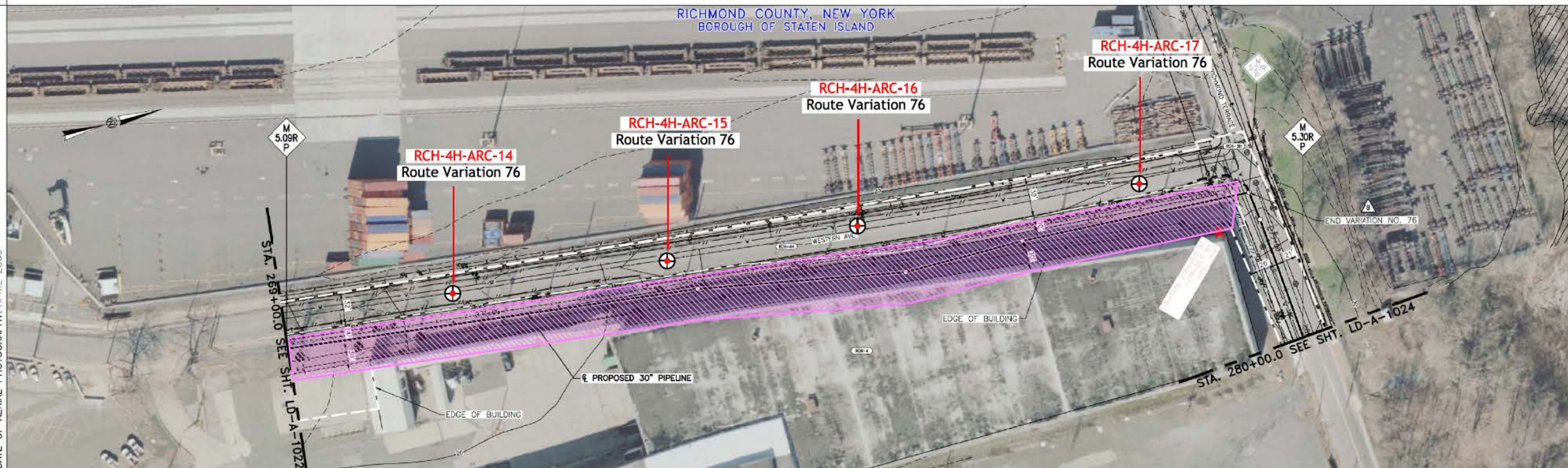
CLASS LOCATION

PIPE MATERIAL

ALIGNMENT DETAIL

PROPOSED PIPELINE
PREVIOUS FERC FILED ROUTE
EXIST. P/L W/OWNER NAME
PIPELINE TO BE REMOVED/ABANDONED
TEMP. WORKSPACE
PROPOSED PERMANENT EASEMENT
EXISTING EASEMENT
ADD. TEMP. WORKSPACE
YARD LOCATION
℄ STREAM / DITCH
DELINEATED WETLAND
APPROXIMATE WETLAND BOUNDARY
EDGE OF PAVEMENT
PERMANENT ACCESS ROAD (PAR) PAR 0.00
TEMPORARY ACCESS ROAD (TAR) TAR 0.00
CONTOUR MAJOR (EVERY 10') 20
CONTOUR AT +2 ELEV. +2
CONTOUR MINOR (EVERY 2')
TREE LINE
JERSEY BARRIER
PIPELINE MILEPOST
PROPERTY LINE
VERIFIED STORM DRAIN
UNCONFIRMED STORM DRAIN
VERIFIED UNDG. ELEC. CABLE
UNCONFIRMED UNDG. ELEC. CABLE
VERIFIED NAT. GAS LINE
UNCONFIRMED NAT. GAS LINE
VERIFIED SANITARY SEWER
UNCONFIRMED SANITARY SEWER
VERIFIED WATER LINE
UNCONFIRMED WATER LINE
VERIFIED STEAM LINE
UNCONFIRMED STEAM LINE
VERIFIED TELEPHONE CABLE
UNCONFIRMED TELEPHONE CABLE
VERIFIED UNDG. COM. CABLE
UNCONFIRMED UNDG. COM. CABLE
ELEC., WATER, SAN. SEWER, GAS, TELE. & STORM DRAIN MANHOLES
LIGHT POLE — UTILITY POLE
GAS VALVE — WATER VALVE
FIRE HYDRANT — TREE

DATE OF AERIAL PHOTOGRAPHY: APRIL 2009



ENVIRONMENTAL DATA

SITE SPECIFIC E & S

GENERAL E & S FIGURES 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34

PROFILE

SCALE:
HORIZONTAL: 1"=50'
VERTICAL: 1"=20'

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FLUME PIPE AS REQUIRED
SLOPE BREAKERS/ARROW INDICATES DIRECTION
TRENCH PLUG
RIVER WEIGHT OR EQUIVALENT

SLOPE BREAKER & TRENCH PLUG SPACING

CODE	% SLOPE	SPACING
A	< 5%	NO STRUCTURE
B	5 – 15%	300 FT
C	15 – 30%	200 FT
D	> 30%	100 FT

% SLOPE

Source/Revision/Issue	Date
PAL modified: indicate archaeological sensitivity	12-16-11
Map data received from: Spectra Energy	11-01-11

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Project
NJ-NY Expansion

Date
December 2011

Figure 7

PAL

Soil borings (symbol and number designation)

Archaeological Sensitivity

High
Moderate
Low

0 100 200ft
0 10 20 30 60m

PRIVILEGED INFORMATION - DO NOT RELEASE

DWG. NO.	DESCRIPTION	REV	DRN	DATE	DESCRIPTION	ITEM NO.	DESCRIPTION	LN. FT.
			GIE	10/01/11	ADDED ROUTE VARIATION NO. 76			
			GIE	10/01/11	ISSUED FOR FERC			
REFERENCE DRAWINGS		REVISIONS				MATERIALS		

	ENGINEERING APPROVALS			
DRAWN BY: GIE	BID		CONSTRUCTION	
DRN. DATE: 07/22/11				
CHECKED BY: GIE				
CHK. DATE: 07/25/11				
TITLE	SIGNATURE	DATE	SIGNATURE	DATE

NJ-NY EXPANSION PROJECT
PROPOSED 30" PIPELINE
STA. 269+00.0 TO STA. 280+00.0
ALIGNMENT SHEET
LOC. RICHMOND COUNTY, NEW YORK

YEAR: 2011 | W.O. 076115751 | SCALE: | DWG. LD-A-1023 | REV. A14

Spectra Energy
Texas Eastern Transmission, LP
5400 Westheimer Ct. Houston, TX 77056-5310 713 / 627-5400

Figure 7. Revised archaeological sensitivity assessment for pipeline Route Variation 76, STA 269+00 to STA 278+50, Port Authority Property, Staten Island, NY.

RIGHT-OF-WAY

TRACT NUMBERS
RODDAGE
CROSSING
WORKSPACE

RCH-5H
RICHMOND TERRACE
65.04 RODS

RCH-6
DCAS
7.68 RODS

SURVEY DATA

SURVEY COMPANY:
FIELD BOOK:
PAGES:

CLASS LOCATION

PIPE MATERIAL

ALIGNMENT DETAIL

PROPOSED PIPELINE
PREVIOUS FERC FILED ROUTE
EXIST. P/L W/OWNER NAME
PIPELINE TO BE REMOVED/ABANDONED
TEMP. WORKSPACE
PROPOSED PERMANENT EASEMENT
EXISTING EASEMENT
ADD. TEMP. WORKSPACE
YARD LOCATION
℄ STREAM / DITCH
DELINEATED WETLAND
APPROXIMATE WETLAND BOUNDARY
EDGE OF PAVEMENT
PERMANENT ACCESS ROAD (PAR) PAR 0.00
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CONTOUR MAJOR (EVERY 10')
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UNCONFIRMED SANITARY SEWER
VERIFIED WATER LINE
UNCONFIRMED WATER LINE
VERIFIED STEAM LINE
UNCONFIRMED STEAM LINE
VERIFIED TELEPHONE CABLE
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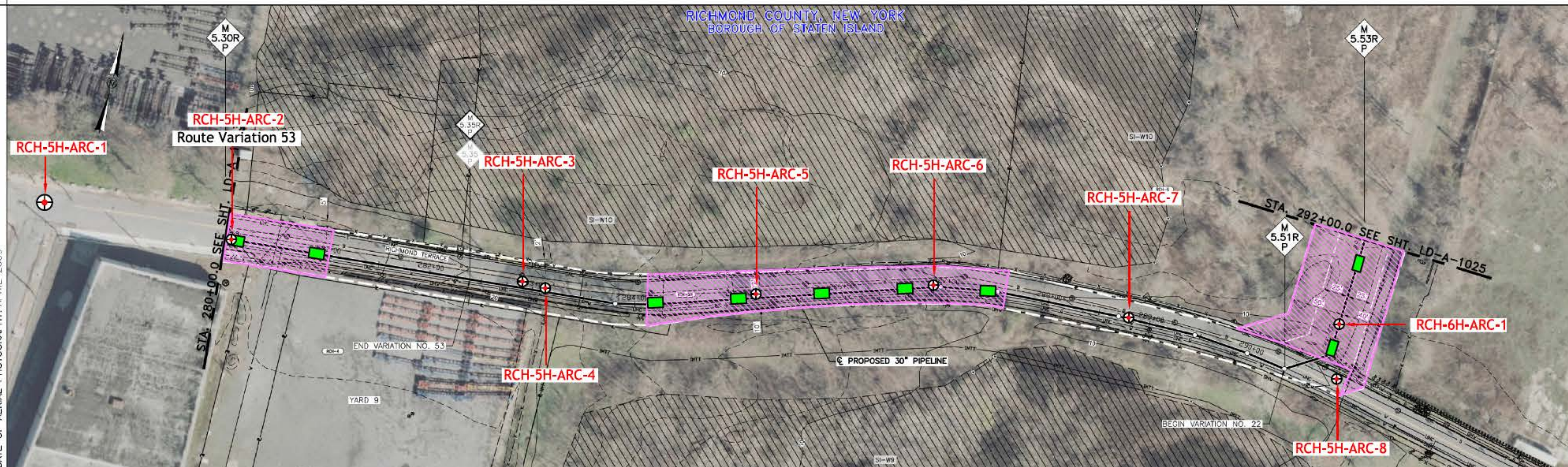
E.LEC., WATER, SAN. SEWER, GAS, TELE. & STORM DRAIN MANHOLES
LIGHT POLE
UTILITY POLE
GAS VALVE
WATER VALVE
FIRE HYDRANT
TREE

DATE OF AERIAL PHOTOGRAPHY: APRIL 2009



ENVIRONMENTAL DATA

SITE SPECIFIC E & S

GENERAL E & S FIGURES

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34

PROFILE

SCALE:
HORIZONTAL: 1"=50'
VERTICAL: 1"=20'

THE LOCATION OF TRENCH PLUGS AND SLOPE BREAKERS ARE INTENDED TO BE USED AS A GUIDELINE ONLY. EXACT LOCATION TO BE DETERMINED IN THE FIELD AS DIRECTED BY THE CHIEF INSPECTOR.

FLUME PIPE AS REQUIRED

SLOPE BREAKERS/ARROW INDICATES DIRECTION

TRENCH PLUG

RIVER WEIGHT OR EQUIVALENT

SLOPE BREAKER & TRENCH PLUG SPACING

CODE	% SLOPE	SPACING
A	< 5%	NO STRUCTURE
B	5 - 15%	300 FT
C	15 - 30%	200 FT
D	> 30%	100 FT

% SLOPE

Source/Revision/Issue	Date	
		Project NJ-NY Expansion
PAL modified: indicate archaeological sensitivity	12-16-11	Date December 2011
Map data received from: Spectra Energy	11-01-11	
The base information contained in this map was supplied to PAL as a professional courtesy for informational and illustrative purposes only. PAL makes no warranties, either expressed or implied, regarding the fitness or suitability of this map for any other purpose than to depict the location and/or results of cultural resource investigations conducted by PAL.		Figure 8

Proposed machine-assisted trench

Soil borings (symbol and number designation)

Archaeological Sensitivity

High

Moderate

Low

0 100 200ft
0 10 20 30 60m

PRIVILEGED INFORMATION - DO NOT RELEASE

DWG. NO.	DESCRIPTION	REV	DRN	DATE	DESCRIPTION	ITEM NO.	DESCRIPTION	LN. FT.
			GIE	10/01/11	ISSUED FOR FERC			
REFERENCE DRAWINGS		REVISIONS				MATERIALS		

ENGINEERING APPROVALS

	BID		CONSTRUCTION	
DRAWN BY: GIE				
DRN. DATE: 07/22/11				
CHECKED BY: GIE				
CHK. DATE: 07/25/11				
TITLE	SIGNATURE	DATE	SIGNATURE	DATE

NJ-NY EXPANSION PROJECT
PROPOSED 30" PIPELINE
STA. 280+00.0 TO STA. 292+00.0
ALIGNMENT SHEET
LOC. RICHMOND COUNTY, NEW YORK

Spectra Energy
Texas Eastern Transmission, LP
5400 Westheimer Ct. Houston, TX 77056-5310 713 / 627-5400

YEAR: 2011 | W.O. 076115751 | SCALE: | DWG. LD-A-1024 | REV. A14

Figure 8. Revised archaeological sensitivity assessment for pipeline route, STA 280+00 to STA 292+00 (includes section of Variation 53), Richmond Terrace and NYCEDC Property, Staten Island, NY.

RIGHT-OF-WAY

TRACT NUMBERS
RODDAGE

RCH-6	RCH-12S	RCH-7.2S	RCH-12S	RCH-7.2S	RCH-12S
DCAS	KILL VAN KULL, NY	MARINERS HARBOR YACHT CLUB, INC.	KILL VAN KULL, NY	MARINERS HARBOR YACHT CLUB, INC.	KILL VAN KULL, NY
68.21 RODS	4.70 RODS	0.59 RODS	7.13 RODS	0.53 RODS	3.70 RODS

SURVEY DATA

SURVEY COMPANY:
FIELD BOOK:
PAGES:

CLASS LOCATION

PIPE MATERIAL

ALIGNMENT DETAIL

PROPOSED PIPELINE
PREVIOUS FERC FILED ROUTE
EXIST. P/L W/OWNER NAME
PIPELINE TO BE REMOVED/ABANDONED
TEMP. WORKSPACE
PROPOSED PERMANENT EASEMENT
EXISTING EASEMENT
ADD. TEMP. WORKSPACE
YARD LOCATION
℄ STREAM / DITCH
DELINEATED WETLAND
APPROXIMATE WETLAND BOUNDARY
EDGE OF PAVEMENT
PERMANENT ACCESS ROAD (PAR)
TEMPORARY ACCESS ROAD (TAR)
CONTOUR MAJOR (EVERY 10')
CONTOUR AT +2 ELEV.
CONTOUR MINOR (EVERY 2')
TREE LINE
JERSEY BARRIER
PIPELINE MILEPOST
PROPERTY LINE
VERIFIED STORM DRAIN
UNCONFIRMED STORM DRAIN
VERIFIED UNDG. ELEC. CABLE
UNCONFIRMED UNDG. ELEC. CABLE
VERIFIED NAT. GAS LINE
UNCONFIRMED NAT. GAS LINE
VERIFIED SANITARY SEWER
UNCONFIRMED SANITARY SEWER
VERIFIED WATER LINE
UNCONFIRMED WATER LINE
VERIFIED STEAM LINE
UNCONFIRMED STEAM LINE
VERIFIED TELEPHONE CABLE
UNCONFIRMED TELEPHONE CABLE
VERIFIED UNDG. COM. CABLE
UNCONFIRMED UNDG. COM. CABLE
ELEC., WATER, SAN. SEWER, GAS, TELE. & STORM DRAIN MANHOLES
LIGHT POLE — UTILITY POLE
GAS VALVE — WATER VALVE
FIRE HYDRANT — TREE

DATE OF AERIAL PHOTOGRAPHY: APRIL 2009

ENVIRONMENTAL DATA

SI-W10	SI-W10	KILL VAN KULL
67.6'	229.2'	299.8'

SITE SPECIFIC E & S

FOR KILL VAN KULL HDD DETAIL DESIGN, REFER TO DWG. NO. LD-H-1030

GENERAL E & S FIGURES

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34

PROFILE

SCALE:
HORIZONTAL: 1"=50'
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Project
NJ-NY Expansion

Date
December 2011

Figure 9

PAL

Proposed machine-assisted trench

Soil borings (symbol and number designation)

Archaeological Sensitivity

High

Moderate

Low

0 100 200ft
0 10 20 30 60m

PRIVILEGED INFORMATION - DO NOT RELEASE

DWG. NO.	DESCRIPTION	REV	DRN	DATE	DESCRIPTION	ITEM NO.	DESCRIPTION	LN. FT.
			GIE	10/31/11	CHANGED WORKSPACE			
			GIE	10/01/11	CHANGED PROPERTY LINES			
			GIE	10/01/11	ISSUED FOR FERC			
REFERENCE DRAWINGS				REVISIONS			MATERIALS	

	ENGINEERING APPROVALS			
	BID		CONSTRUCTION	
DRAWN BY: GIE				
DRN. DATE: 07/22/11				
CHECKED BY: GIE				
CHK. DATE: 07/25/11				
TITLE	SIGNATURE	DATE	SIGNATURE	DATE

NJ-NY EXPANSION PROJECT
PROPOSED 30" PIPELINE
STA. 292+00.0 TO STA. 306+00.0
ALIGNMENT SHEET
LOC. RICHMOND COUNTY, NEW YORK

Spectra Energy
Texas Eastern Transmission, LP

YEAR: 2011 | W.O. 076115751 | SCALE: 1"=50' | DWG. LD-A-1025 | REV. A14

Figure 9. Revised archaeological sensitivity assessment for pipeline route, STA 292+00 to STA 300+00, NYCEDC Property, Staten Island, NY.

ATTACHMENT A

GEOARCHEOLOGY RESEARCH ASSOCIATES – SOIL BORING REPORT #3

PRELIMINARY REPORT:
"PRE-ANALYSIS" RESULTS OF GEOARCHAEOLOGICAL INVESTIGATIONS, PHASE 1A, NJ-NY EXPANSION PROJECT
ROUND 3, JULY-NOVEMBER 2011
STATEN ISLAND, RICHMOND COUNTY, NEW YORK

Prepared for:

Public Archaeology Lab
210 Lonsdale Ave
Pawtucket, Rhode Island 02860

Assembled by:

Geoarcheology Research Associates
92 Main Street
Suite 207
Yonkers, NY 10701

Joseph Schuldenrein, Ph.D.
Principal Investigator

with

Juan Urista, M.A.
Project Geoarcheologist

Johnathan Garland, M.Sc.
Project Geoarchaeologist

December 11, 2011

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1. INTRODUCTION

This report presents the preliminary results of field investigations conducted over the interval July-October, 2011 for the NJ-NY Expansion Project. Geoarcheology Research Associates (GRA) of Yonkers, New York was contracted by Public Archaeology Laboratory (PAL) of Pawtucket, Rhode Island to conduct a geoarchaeological study along a proposed pipeline corridor for Spectra Energy Transmission, LLC. This study presents a summary of a third round of fieldwork and preliminary results for the project area. A first round produced a comprehensive report of the first thirty-two (32) cores examined for geoarchaeological purposes (GRA, 2011a). The second round documented the findings of an additional fourteen (14) cores (GRA, 2011b). This present effort examines thirty (30) cores, of which twenty-nine (29) were freshly taken and a single probe (RCH-1-ARC-1) was reported on previously (GRA, 2011a). The latter core is included in this report because its location--on the southern end of the reported pipeline segment--is critical for interpretive purposes. As in the case of the earlier two reports, this document is a "pre-analysis" report that assembles the stratigraphy of subsurface deposits to the degree that technical field studies permit. The geoarchaeological study is being undertaken to develop a probability model for the Phase IB archaeological survey. By conducting a systematic survey involving comprehensive sub-surface exploration, GRA is providing a working schema of subsurface stratigraphic relations in this project's areas of potential effects (APE). The project impact area spans urban areas known for dense, complex, and deep archaeological and historical deposits.

The locations tested and reported herein are distributed exclusively in Staten Island (Richmond County), a borough of New York City. The pipeline route currently extends over 20.3 miles and the locales sampled in this third round of fieldwork were selected because they traverse terrain of potentially high archaeological sensitivity. For geographic purposes it was useful to group these test locations along a continuous length of line, running North-Northeast and then West-East over a span of approximately 1.13 miles (1.8 km), or about 5.6% of the extant length of line. The thirty (30) borings were excavated across five (5) properties in Richmond County, New York (Figure 1). Cores typically extended to a depth of 20 feet (610 cm), with isolated exceptions, and encountered complex stratigraphic sequences of fill, buried historical surfaces, possible prehistoric surfaces, and underlying natural unconsolidated geological deposits. A critical objective of the study was the identification of the range of Late Quaternary environments associated with the prehistoric and historic settings of potential and known sites along the length of line. In this connection, we report on the results of five (5) radiocarbon dates for four (4) particularly critical locations with significant potential for recovering information on prehistoric settlement and paleoenvironments.

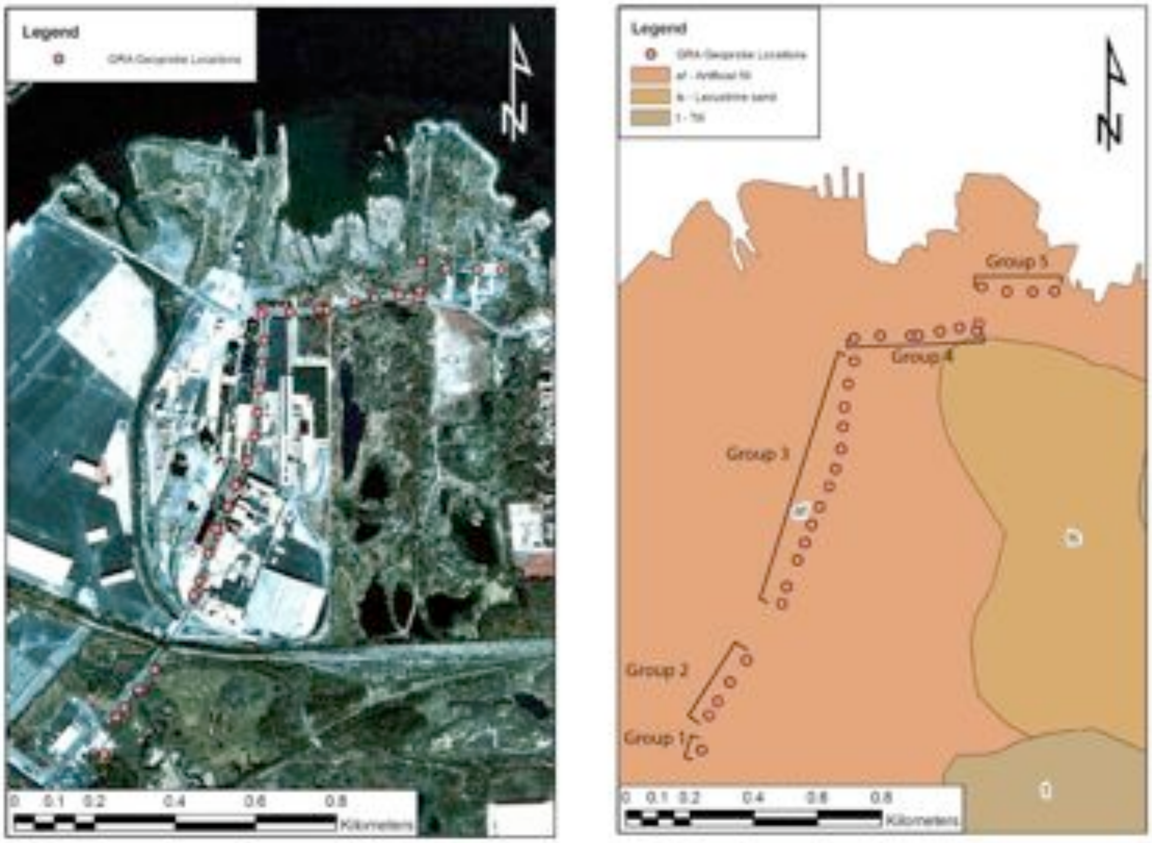

Figure 1. Aerial imagery alongside surficial geology map of project area with boring locations (Source: NYS Museum / NYS Geological Survey 1999).

This preliminary report presents baseline results of this initial investigation. A thorough overview of the geological setting of the region is presented, with a particular focus on landscape history along the project corridor. A methods section follows, which details both field and laboratory techniques. Particular attention is accorded to the interpretive potential of deep coring for the development of paleolandscape reconstructions and models of archaeological probability. The results are presented sequentially (property by property) along the currently proposed route.

Detailed sedimentological documentation for each core is presented in Appendix A along with photo mosaics of the opened cores. Results of the radiocarbon assay are presented in Appendix B. More generalized descriptions of the cores are detailed in the results chapter. Preliminary recommendations of the potential for buried archaeological deposits conclude the document.

Included in the recommendations is a protocol for specialized laboratory studies that should be undertaken in support of developing a paleolandscape model that underpins a robust model of archaeological sensitivity. It should be noted that no special analyses (with the exception of five radiocarbon dates) have been conducted to date. As such, the interpretations presented in this preliminary report lack refinements made possible by such analyses.

Finally, it is cautioned that the recommendations presented in this study represent follow up work that would enhance the interpretive potential for reconstructing paleo-environment, site formation histories, and the development of a model of buried site preservation. For this pipeline segment in particular, the possibility of formulating a comprehensive landscape history relevant to the Old Place Site, one of the most critical prehistoric sites in New York City, is facilitated by paleoenvironmental studies at the southern end of the alignment. That potential was partially confirmed in this study by the radiocarbon results (Appendix B). The results of this report and our earlier studies (GRA 2011a, 2011b) suggest that a comprehensive follow-up analysis design should be based on a representative sampling of the entire pipeline corridor to maximize information yield and to develop a scientifically sound and cost-effective mitigation strategy.

2. PROJECT GEOMORPHIC BACKGROUND

The entire proposed pipeline corridor, as well as the segment under consideration, is located along urbanized segments of near-shore, tidal, and offshore settings in Upper New York Bay in New Jersey and New York. The Late Quaternary landform history of the New York Bay is a function of bedrock geology and events associated with regional glacial history. The end of the Pleistocene (after 18,000 B.P.) is almost exclusively registered in the surface and subsurface deposits of the coast and near-shore settings of metropolitan New York City and adjacent New Jersey and New York. Variable accumulations of sediment record the region's history of glaciation and deglaciation and corresponding marine based submergence and emergence. Related terrestrial and marine histories reflect the dynamic balance along the glacial margins and shorelines over the course of the past million years.

Regional geological and paleoenvironmental studies are extensive. Relevant research has focused on bedrock geology (Isachsen et al. 1991; Schuberth 1968); late Pleistocene and (to a lesser degree) Holocene surficial deposits (Antevs 1925; Averill et al. 1980; Lovegreen 1974; Merguerian & Sanders 1994; Rampino & Sanders 1981; Reeds 1925, 1926; Salisbury 1902; Salisbury & Kummel, 1893; Sirkin 1986; Stanford 1997; Stanford 2010, Stanford & Harper 1991; Widmer 1964), as well as postglacial vegetation change (Peteet et al. 1990; Rue & Traverse 1997; Thieme et al. 1996) and sea level rise (Newman et al. 1969; Weiss 1974). More recently, there have been detailed studies of archeological preservation potential for the Holocene surficial deposits (GRA 1996a, 1996b; Schuldenrein 1995a, 1995b, 2000; Schuldenrein et al., 2007; Thieme & Schuldenrein 1996, 1998; Larsen et al., 2010) and estuarine sediments (GRA 1999; LaPorta et al. 1999; Wagner & Siegel 1997).

Physiography and Bedrock Geology

The Upper New York Bay is an estuary formed within a valley deepened and widened by the advance and retreat of the Laurentide continental ice sheet of the last Ice Age. Mesozoic-age Newark Group rocks underlie most of the New York Harbor region in New Jersey and extend up the west side of the Hudson River. The Palisades Sill of Triassic-age marks the western shore of the Hudson in the New York City area. The sill is an igneous intrusion into the Newark Group sedimentary rocks. These sedimentary rocks contrast with the Cambrian to Ordovician metamorphic rocks of the New York Group east of the Hudson River. Quaternary-age glacial deposits rest unconformably on the Newark Group sedimentary rocks as well as those of the New York Group.

Pleistocene Glaciation, Chronology, and Landform Development

The unique landscape configurations of the Upper New York Bay are attributable to large-scale geological processes of the last ice age. Until recently, only generic landscape chronologies served as a basis for geoarchaeologically-oriented cultural resources assessments (such as 3DI 1992). Currently, however, the combination of regional geologic mapping by the New Jersey Geological Survey (Stanford 1995, 2002 and, Stone et al. 2002), as well as older regional mapping by the New York State Geological Survey (Cadwell 1989), paleoenvironmental studies (e.g., Carbotte et al. 2004, Maenza-Gmelch, 1997), and geoarcheological investigations (e.g. Schuldenrein et al. 2007, Thieme 2003, Schuldenrein and Aiuvalasit 2011) provide a significantly more refined and chrono-stratigraphically accurate understanding of the late Quaternary geologic history and archeological potential of the Upper New York Bay.

Prior to the terminal Wisconsinan, glaciers advanced across the region at least twice during the Pleistocene (Stanford, 1997; Sirkin, 1986). Both Illinoisan, ca. 128,000-300,000 B.P. (radiocarbon years before present) and pre-Illinoisan, (> 300,000 B.P.) terminal moraines are mapped in northern New Jersey, and these ice advances may be represented by still earlier tills on Long Island (Rampino and Sanders, 1981; Merguerian and Sanders, 1994). Older tills have a "dirty" appearance and can be distinguished from late Wisconsinan deposits by the presence of unweathered mudstone, sandstone, and igneous rock clasts in the late Wisconsinan deposits (Stanford, 1997).

The Hudson-Mohawk Lobe of the latest or Wisconsinan ice sheet advanced to its Harbor Hill terminal moraine by 20,000 B.P. (Sirkin, 1986; Sirkin and Stuckenrath, 1980). The extensive and arcuate shaped Harbor Hills landform marks the final position of the ice advance, links Long Island with Staten Island, and is dated by postglacial radiocarbon dates from northwestern New Jersey of 19,340±695 B.P. in a bog on Jenny Jump Mountain (Stanford, 1997) and 18,570±250 B.P. in Francis Lake (Cotter, et al., 1986). Thieme and Schuldenrein (1998) obtained a similar date of 19,400±60 B.P. from a loamy sediment overlying glacial till along Penhorn Creek in the Hackensack Meadowlands.

During the later phases of the Pleistocene, the hydrography at the glacial margin was dynamic and resulted in a glaciolacustrine landscape that involved cyclic retreats and transgressions of linear lakes that approximated the morphologies of structural valleys. Lakes Passaic, Hackensack, Hudson, and Flushing variously occupied the terrain between Long Island and east-central New Jersey as well as the Hudson valley. In Newark Bay and the lower reaches of the Hackensack and Passaic River valleys, subsurface stratigraphy revealed uniform lake bed sequences beginning with deep, classically-varved pro-glacial sediments (Antevs, 1925; Lovegreen, 1974; Reeds, 1925, 1926; Salisbury, 1902; Salisbury and Kummel, 1893; Stanford, 1997; Stanford and Harper, 1991; Widmer, 1964). Reddish brown muds derived from Mesozoic-age Newark Group rocks form thicker winter layers, while more sandy sediment layers were deposited as the ice melted during the summer. The top of the glaciolacustrine sediment sequence is typically an unconformable contact from 12-30 feet below the present land surface in the Hackensack Meadowlands (Lovegreen, 1974). These same varved silts and clays fill the deeper parts of the incised Hudson valley and are overlain by riverine sands and gravel, which are, in turn, capped by thick marine estuarine muds.

Deglaciation of the Mohawk River lowland between 13,000 and 12,000 B.P. is a key event in the geologic history of the New York Harbor area. Proglacial Lake Iroquois, which occupied the Lake Ontario basin, subsequently drained directly to the Hudson

River valley via the Mohawk lowland and added to the volume of pro-glacial Lake Hudson. Researchers disagree on the mechanism, but an outlet through the Harbor Hill moraine at the Narrows was opened at about this same time, emptying Lake Hudson and forming the present Hudson River drainage pattern. Newman and his coauthors (Newman et al., 1969) noted that marine and brackish water filled the -27 m (-89 ft)-deep channel of the Hudson River at 12,500 +/- 600 B.P. (14,830 cal yrs B.P.) as evidenced by marine and brackish marine microfossils preserved at the base of organic silts beneath peat bogs at Iona Island. It is unclear as to whether the erosion of the outlet through the Harbor Hill moraine was gradual or catastrophic as recently proposed by Uchupi et al., (2001) and Thieler et al., (2007). Nevertheless, evidence suggests that flow from the Hudson River eroded a channel and valley across the exposed continental shelf to drain and deposit a delta on the outer shelf at a lowered sea level stand. Most challenging to our understanding of the Hudson River history is the lack of a clear explanation for a direct marine connection between contemporaneous sea level at the edge of the continental shelf and the upper Hudson River valley. More generally, we consider the shelf to have been sub-aerially exposed at this time. Differential isostatic adjustment of the earth's crust following deglaciation is the most reasonable explanation accounting for down-warping and depression of the crust beneath glacier ice in the north and commensurate uplift of the continental shelf, thereby raising sea level in line with the upper Hudson River channel. Evidence for differential uplift of the crust along the upper Hudson Valley (relative to the New York Harbor area) is based on historic tide gauge data by Fairbridge and Newman (1968), although the complete relationship remains unclear.

The present study relies on an accurate record of relative sea level rise developed for the New York Harbor area by Schuldenrein et al. (2007) for determining the submerged locations of probable prehistoric human habitation areas in the Hudson River channel. That study proposed a model for archaeological sensitivity that would help guide plans to minimize impacts on cultural resources by future marine construction. The attendant construct for sea level rise (Figure 2) is derived from existing and newly reported radiocarbon analyses from nearby submerged environmental settings acquired during baseline New York Harbor and related GRA studies. GRA (Schuldenrein et al. 2007) presented a relative sea level history consistent with "far field" eustatic sea level studies (Fleming et al., 1998). We show a rapid rise in relative sea level at a rate of approximately 9 mm/yr (0.5 inches/yr) from at least 9000 cal yrs B.P. until about 8000 cal yrs B.P. when the rate of rise diminished to a consistent 1.5 – 1.6 mm/yr (0.06 inches/yr), from 7000 cal yrs B.P. until the present. This sea level model is consistent with studies by Bloom and Stuiver (1963) for the Connecticut shore; Redfield and Rubin (1964) for Barnstable, Massachusetts; Belknap and Kraft (1977); and Nikitina et al. (2000) for Delaware Bay as reexamined by Larsen and Clark (2006). Our new model (Figure 2) differs markedly from that presented by Newman et al., (1969) and is proposed herein as a more accurate construct.

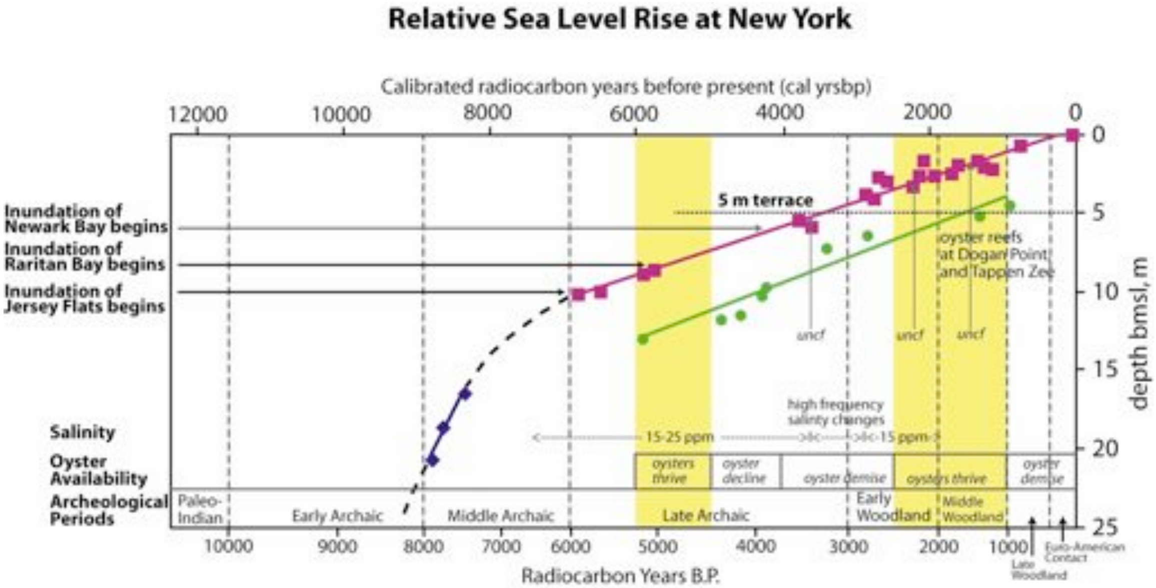

Figure 2. Sea level rise model for New York Harbor (from Schuldenrein et al. 2007).

In general terms, the new relative sea level model can be retrofitted to account for reflooding of the incised Hudson channel and Upper New York Bay as described by Thieler et al., (2007) for the Narrows at ca. 12,000 B.P. (13,875 cal yrs B.P.), as well as for the marine incursion of the upper Hudson Valley and consequent deposition of brackish estuarine sediments. It cannot, however, resolve the differential positions of the incised channel at the Narrows with the proposed delta at the edge of the continental shelf. We show progressive flooding of the main Hudson channel culminating in its present configuration. The area currently known as the New Jersey Flats was initially subject to inundation about 7,000 cal yrs B.P. Oyster reefs formed upriver at Tappan Zee at this time as well, and spread at successively shallower depths following the rising sea level (Carbotte et al., 2004). The latter record of oyster reef growth is consistent with sea level rise as demonstrated by the data points (in green) in Figure 2. The common depth range for the eastern oyster *Crassostrea virginica* is 8 to 24 feet (2.5-7.2 m). This explains the Tappan Zee oyster growth history which parallels but falls beneath our calculated and contemporaneous sea level curve. Marine water entered and progressively flooded Raritan Bay and Newark Bay about 6,000 cal yrs B.P. Marshes upstream from the present mouth of the Raritan River as well as the nearby Hackensack marshes became increasingly saline after 3,000 cal yrs B.P. and they subsequently evolved into salt marshes.

The estuaries and shorelines along the Upper Bay became the focus of historical Dutch settlement, and eventually blossomed into the sprawling metropolis of New York City. In general, the natural tidal zones and immediate near-shore settings through which the proposed pipeline corridor runs have been wholly reworked throughout the historic period and into the present day. The background literature review for this project conducted by PAL provides a thorough overview of the historical development of the project area with numerous archival maps that show the successive land use of the project area (Elquist et al., 2010a and 2010b).

Expected Geological Sequence within the Project Area

For the initial reports on the NJ-NY Expansion project (GRA 2011a, b) the assessment of the age and archaeological potential within the geological sequences drew extensively from the detailed surface geology maps of New Jersey (Stone et al., 2002). Those maps were most relevant because the line segments traversed, with a single minor exception, were confined to New Jersey. The present Staten Island segment is in New York State and the map of surface geology generated by the New York Geological Survey has developed slightly different mapping units. In general, however, the units and, more significantly, their antiquities are broadly correlative between the two states. For present purposes we draw directly from the digitized New York State surface geology map (NYGS 1989). This has been generated from two traditional mapping sources: first, the state-wide surface geology map (1:250,000 scale; Cadwell, 1989) and second, a traditional Quaternary map of the Hudson Quadrangle (4° x 6°) (Fullerton et al., 1992).

There are three surficial deposits mapped within the project alignment corridor, three of which are depicted in Figure 1 (per NYGS, 1999). A fourth, *Peat Muck* ("pm") is a Holocene to historic age *Swamp Deposit,* effectively a salt-marsh and estuarine matrix, that underlies or interdigitates with anthropogenic fill along most of the alignment. The *Artificial Fill* itself ("af" in Figure 1) is the most pervasive surface sediment in the impact zone, as detailed in our results section. The two other New York-based surficial units of relevance to the project are *Lacustrine Sands* ("ls"), and *Till* ("t"), both of late Pleistocene (glacial) age and formally mapped to the east and south of the core-testing alignment (Figure 1). Again, it is stressed that these units must be considered as fundamental basal sediments underlying most core locations, but they should not be used to infer either the age or composition of the sediments retrieved from individual cores. This is because of the pervasiveness of fill caps whose depth, composition, and lateral extent were not and could not have been mapped with requisite accuracy, despite the best efforts of the New York Geological Survey (1999).

In general the *Till* deposits represent deposition beneath the ice, with sediment sizes ranging from boulder to silt. They are described as "variably textured…..usually poorly sorted sand-rich diamict" (NYGS, 1999). Permeability of the matrices varies with compaction thicknesses ranging from 1 to 50 meters. As in New Jersey, till complexes are non-stratified. Basins carved out by glacial ice resulted in the hummocky to variably graded topography which gave rise to the succession of lakes that emerged after the glaciers retreated.

Lacustrine Sands are most typically encountered as well-sorted quartz sand complexes, often stratified and usually laid down in pro-glacial lakes. However, the sands may also have been accreted on remnant ice as a near-shore facies, or even near a sand source. Matrices are permeable and thicknesses are highly variable (2-20 meters).

Exceptions to classic lake basin sedimentation proliferated, with deltas registering on the margins of the previously described pro-glacial lakes. While the lake basins infilled with fine grained sediments, coarser deposits of sands and silts were laid down along the peripheries. Undifferentiated marine and lacustrine sand bodies have also been identified (NYGS 1999) as near shore deposits at or below the highest marine levels, where they may include fossil shells. In this connection finer grained sediments, silts and clays, may also proliferate along the margins of the pro-glacial lakes; the fines are often calcareous. Delta sediment bodies have been recognized as coarse to fine gravel and sand depositional strata, stratified and well-sorted along the ancient lake shoreline, again with variable thicknesses (3-15 m).

Finally, the *Swamp Deposits,* equivalent to the Salt-Marsh and Estuarine deposits utilized in the New Jersey reports (GRA 2011a, b; per Stone et al., 2002) are dominantly organic silts and sands in poorly drained reaches (along the coastal edge to the west). They are characteristically unoxidized, and will often overlie marl and lake silt with thickness of 2-10 m. It remains unclear as to whether or not these underlying “marl-type” complexes represent Holocene basins or, as is probably the case, they represent primary or reworked depositions of Pleistocene antiquity.

3. METHODS

Designated sampling intervals for baseline core placements were agreed upon by the State Historic Preservation Officer (SHPO) of New York. For New York the sampling interval was set at one test boring every 300 feet (90 m). An underlying hypothesis is that for any comparative study this interval should accommodate comprehensive project-wide reconstructions.

On the ground, spacing intervals had to be modified because of logistical concerns. In some cases boring locations were judgmentally re-spaced to evaluate settings and substrate associated with particular features, known locations of critical archaeological sites, and paleo-environmental settings that were both rich and varied, despite their burial beneath significant accumulations of fill. Among the primary archaeological sites in the area are the Old Place prehistoric locus, Bowman's Brook, and the Bowman's Brook North sites. Additional considerations included questions of representative sampling and in-field circumstances such as accessibility and presence of buried contaminants. In all cases of re-spacings, resolution was obtained through negotiations with Spectra Energy and PAL. The boring locations and precise placements were mapped by a team of surveyors contracted by Spectra Energy. Most in-field adjustments to boring proveniences resulted in locational modification of no more than 5-10 feet from the originally designated placements. Remote sensing for buried utilities or obstructions was conducted at testing localities by Spectra Subsurface Imaging, LLC of Latham, NY. Their surveys augmented background subsurface map reviews by utility companies, property owners, and utility identifications by the One-Call Service. Remote sensing provided an additional control delimiting the presence and orientation of subsurface utilities and features. For this segment of line, the total of thirty (30) cores emplaced along the 1.13 mile (1.8 km) traverse resulted in an average spacing of one (1) core per 200 feet (60 m), a sampling interval that exceeded minimal requirements by 33% and enhanced the effectiveness of the coring procedure substantially.

Subsurface excavation for the GRA study was performed by a Geoprobe™ boring device, operated by LAWES, Inc. of Center Moriches, NY. The Geoprobe™ is a hydraulically driven, mechanical track-mounted device that extracts cores that can be collected in stratigraphically intact sections within plastic sleeves (Figure 3). These sections are sealed in the field, collected, and described under controlled laboratory conditions at a later date.

Figure 3. Field collection of cores.

For this project, cores of approximately 2 ½ inch (6 cm) diameter were collected in 5 foot sections (152.4 cm) to depths of up to 20 feet (6.1 m) below ground surface. As in previous rounds of investigations, the upper 1-5 feet (0.3-1.5 m) of each boring was hand-cleared in order to verify absence of near-surface obstruction and to assess the potential for buried surfaces. Safety gear included the use of protective eye-wear, hard-hats, steel-toed boots, neoprene gloves, and reflective safety vests. A trained environmental geologist employed by TRC, Inc. took sediment samples for characterization of contaminants, and ran a photo ionization detection (PID) meter over the samples to test for volatile organic compounds. The in-field examinations of the cores were guided by health and safety procedures regulating the handling and collection of the cores.

All of the core sleeves were sealed in the field (Figure 4) and transported to GRA's lab facilities, where they were subsequently split, described, and sampled (Figure 5). The cores were described using standardized pedo- and litho-stratigraphic terminology (ISSC 1994; USDA 1994). Samples of historical artifacts as well as soil samples for possible age determinations by radiometric analysis were collected. Upon full documentation of the cores and sample collection, the discarded sediment and soil fractions were bulked in 55-gallon drums. Upon completion of the project the bulked samples are to be sampled and characterized for contaminants; they are ultimately transported to a disposal facility.

Figure 4. Core Samples

Finally, it should be noted that full recovery from each core segment was rarely achieved. This is typical, as highly variable conditions of the substrate can result in inadvertent sediment loss upon recovery. These conditions include the presence of an elevated water table, uniquely unconsolidated sediments, and dramatic changes in sediment texture. Based on GRA's general experience working with this technique (Schuldenrein 2006, 2007), as well as regional conditions, the team has developed a method for extrapolating both the thicknesses and depths of deposits.

Figure 5. Split core prepared for documentation and sampling under laboratory conditions.

4. PRELIMINARY RESULTS

The array of cores from this round of field investigations (July-November 2011) extends along three major segments as follows: (1) an initial alignment of 0.75 miles (1.2 km) running south to north-northeast along Western Avenue; (2) a central alignment of 0.25 miles (0.4 km) trending west to east along Richmond Terrace; the route then follows a dog-leg north and east to (3) a final west-east segment of 0.13 miles (0.2 km) traversing several properties (Figure 1).

The segments may be further subdivided into properties and then into ***groups*** on the basis of the uniformity of core-spacings, terrain breaks, and universal boring tracking number. Property ownership criteria are used for grouping cores, following the scheme utilized for the New Jersey studies (GRA 2011a, b). Following these grouping criteria, we have considered five (5) discrete core ***groups*** that span the entire alignment. The surface geology map shows that the alignment traverses a single surface geology unit, artificial fill ("af"; NYGS 1999), such that more refined, differentiated, and accurate terrain elements are visible directly on *Google Earth* imagery. Thus the individual ***groups*** and their attendant core distributions are depicted in Figures 6-10.

Lithostratigraphic descriptions of the individual cores with accompanying photographic documentation are presented in Appendix B.

Texas Eastern Transmission, LP (TETLP) Property – *Staten Island, NY*

(Group 1: RCH-1-ARC-1)

The initial geoarchaeological study reported on the results of this boring on the TETLP property (GRA 2011a). The core was collected within a fenced-in section of the property, east of Western Avenue (Figure 6). The location is in close proximity to the northern section of Old Place Creek. The study area contains both paved and graded dirt and gravel roads associated with the Texas Eastern Transmission M&R 058 station and connecting utilities. This area is also in the vicinity of Bridge Creek at the Goethals Pond complex. RCH-1-ARC-1 is approximately 660 ft. (0.201 km) due east of the Old Place Site, one of the oldest, best preserved stratified prehistoric sites in the Northeast (Ritchie and Funk 1971), with occupations ranging from Middle Archaic through Woodland. More recent archaeological assessments of the area suggest that jasper, chert, and argillite debitage recovered in the area between Goethals Bridge Road North to the west, Gulf Avenue to the south, and Western Avenue to the east are likely related to the Old Place Site or associated prehistoric complexes (HAA 1995; Louis Berger Group 2007: 83; PAL 2010).

Figure 6. Core for Texas Eastern Transmission, LP (TETLP) Property – *Staten Island, NY.*

Initial observations on the core identified four discrete historic fill units to a depth of 1.6 m, disrupted midway through the column by a potential artificial surface (Appendix A). The base of the fill has truncated a lower solum (BC horizon) that preserves portions of degraded vegetated mat. That solum was the only component of the profile that provided indications of a stable surface whose primary expression, in the form of a developed soil and buried surface would have been removed by land grading. Beneath the BC horizon the parent material is of fluvial origin. Downward coarsening quartz sands intergraded with gravels are suggestive of moderate to higher energy fluvial activity, related to a former medium order stream, possibly a flow line of Old Place Creek.

NRCS (2005) mapped soils have been assigned to the *Laguardia-Ebbets-Pavement and Buildings, Wet Substratum Complex* (NRCS 2005; PAL 2010). The *Laguardia-Ebbets Complex* consists of a mixture of natural soil minerals and construction debris over tidal marsh, with pavement and buildings covering up to eighty (80) percent of the surface.

The present investigations did not register any evidence for the marsh complex, although potential thicknesses of organic matrix could have been removed through relandscaping above the BC horizon interface at 1.6 m. This does not appear likely, given the absence of visible muck sediments that should be readily identifiable within any of the four (4) fill complexes if the landscaping involved local reworking of extant ground cover in the historic past.

The absence of marsh deposits is striking when considered in the context of descriptions of the prehistoric Old Place Site (Ritchie and Funk 1971). While the boundaries of the aboriginal locus are uncertain, the site is reportedly located on a strip of dry land bounded by marsh, in the immediate vicinity of Western Avenue between Old Place Creek to the south and the Staten Island Rail line to the north. It is possible that an older surface, possibly a moraine margin or even a later Holocene ridge overlooking the marsh depression, may have constituted the occupation landform. It is significant that previous testing locally determined that intact sediments are present approximately two (2) feet below the surface deposits (Louis Berger Group 2007, 69; PAL 2010, 77). While the present boring furnished unequivocal evidence for a deep artificial cap, the composition of that fill is consistent with a natural landform. Thus grading of that feature could account for an extensive expanse of historically recontoured terrain and would explain the absence of the diagnostic marsh sediments in a landscape where such deposits, even in secondary context, would be otherwise ubiquitous.

The Old Place Site also has a prominent historical component. Post-contact domestic sites dating from the 17th to the 20th century were located along the western side of Western Avenue (PAL 2010). Structures associates with the main buildings of these sites appear to have been located adjacent to the nearby Coca-Cola property, approximately 300 feet west of the proposed pipeline corridor. Previous archaeological testing and historical analysis has determined that all of these residential sites have a potential historical significance, and that these archaeological resources may be considered eligible for the National Register of Historic Places (Payne and Baumgardt 1986; PAL 2010).

Taken together, the geoarchaeological testing coupled with the background information converges on a high potential for archaeological recovery in fill sequences, intact subsoils, and underlying sandy deposits at this site (GRA 2011, Appendix A and Table 1). The background literature review from this study identified the potential for both historic and prehistoric archaeological materials in this area, and this core (RCH-1-ARC-1) supports this research (Elquist et al, 2010b: 76).

New York State Department of Environmental Conservation (NYSDEC) Property – Staten Island, NY

(Group 2: RCH-2-ARC-1, RCH-2-ARC-1, RCH-2-ARC-1, RCH-2-ARC-4)

GRA extracted four (4) cores along the lowermost northeast trending alignment east of Western Avenue. Cores were emplaced along the southeastern shoulder of the Western Avenue roadway in close proximity to the northern margins of Old Place Creek (Figure 7). The study area contains both paved and graded dirt and gravel roads associated with the Texas Eastern Transmission M&R 058 station and connecting utilities. This area is in the vicinity of Bridge Creek at the Goethals Pond Complex.

Figure 7. Cores along New York State Department of Environmental Conservation (NYSDEC) Property, East of Western Avenue – *Staten Island, NY.*

The midpoint of the four (4) cores of the RCH-2 core series is approximately 1000 ft. (0.305 km) north to north-east of the Old Place Site, which is, as noted earlier, one of the oldest, classically stratified prehistoric sites in the Northeast (Ritchie and Funk 1971), with occupations spanning over 8000 years of prehistory. In recent years a variety of raw materials associated with aboriginal sites—jasper, chert, and argillite debitage—have been recovered in the area between Goethals Bridge Road North to the west, Gulf Avenue to the south, and Western Avenue to the east. These finds are clearly linked to Old Place and contemporaneous prehistoric locales (HAA 1995; Louis Berger Group 2007: 83; PAL 2010).

The immediate site environment, both east and west of Western Avenue is marshy and the landforms immediately to the east of the core complex is an obvious slackwater basin with arcuate channel scars indicative of meandering (Figure 7). A reconfigured and historically straightened channel bisects Western Avenue between RCH-2-ARC-2 and RCH-2-ARC-3. As discussed, the substrate of the lowermost two cores are similar, preserving evidence of stable surfaces associated with formerly elevated terrain (similar to that noted for RCH-1-ARC-1), while the uppermost pair of cores feature sequences that are more directly linked to the marshy lower lying terrain.

The variability between the two core sets is striking, given their proximity to one another and minimal differences in contemporary surface topography. The two southernmost cores, RCH-2-ARC-1 and RCH-2-ARC-2 were nearly identical and featured intact paleosols beneath a topmost 1.0-1.5 m depth of sediment that was not recovered. RCH-2-ARC-1 preserved a complete A-E-Bt1-Bt2-C sola that extended for 2 m and registered an intact Argillic soil, replete with diagnostic cutans ("clay skins"), rubefied faces, silty-clay textures, and subangular blocky to angular blocky structures. An organic sediment date from the A-horizon (at 1.4 m below surface) provided a ^{14}C determination of 1500±30 BP (Beta-309854). The pedogenic signature for RCH-2-ARC-2 was more subdued, but apparently laterally continuous with the sequence RCH-2-ARC-1. It was a cambic profile and textures were considerably coarser (loamy sands) and structures ranged from massive to weak subangular blocky. Underlying parent materials in both cases extended for ±2-3 m and consisted of massive (loamy) sands that featured shell fragments and interdigited clay and silt lenses. These were provisionally interpreted as shoreline facies (of probable Pleistocene-age). The lowermost meter of sediment (to 6 m below surface) was a deeply rubefied (5YR 3/3) silty clay loam conforming to regional variants of the Rahway till, again of apparent Pleistocene antiquity.

The two northern cores, RCH-2-ARC-3 and RCH-2-ARC-4 preserved near-continuous evidence of hydromorphic activity well into the substrate. The former location featured a series of A-C horizons with mixed peats and silty-clay organic mats that extended from the surface to >4 m. Field descriptions are consistent with NRCS (2005) descriptions of soils belonging to the *Ipswich-Pawcatuck-Matanuck Mucky Peats*. These swamp deposits are underlain by gleyed loamy sands that probably represent a former shoreline facies that extended another 1 m in depth. The base of the sequence is a fluvial sand, whose reddish color may signify a reworked till.

The upper 3.5 m of RCH-2-ARC-4 consist of discrete historic fill episodes (to 1.9 m) capping a series of gleys. Intact hydromorphic soil matrices were in evidence, suggesting that regrading was not uniform and did not remove the original solum completely.

Between 3.5 and 5.5 m an overthickened A-horizon seals in a formerly intact, but weakly developed cambic soil. This dense and moist organic mat may represent a peat overlying the weathered Bw horizon. It signifies prevalent waterlogging subsequent to formation and then submergence of the stable surface. The peats furnished a ^{14}C determination of 1700±30 B.P. (Beta-309855), a date that may be consistent with a phase of waterlogging consistent with late Holocene sea level rise and the superposition of hydromorphic features over formerly well drained landform elements. The AB-Bw interface, 1.5 m beneath the peats, produced a date of 2670±30 B.P. (Beta-309856) (Appendix B). Taken together these dates may be representative of evidence for a significant late Holocene transition in the landscape as the buried late prehistoric surfaces were suddenly exposed to rising water tables. The core stratigraphy suggests that the Pleistocene/Holocene transition is only 0.3 m beneath the late Holocene soil. Older (Pleistocene) deposits at the base of RCH-2-ARC-4 are registered by a fluvial facies that signals resumption of stream flow immediately above the erosional surface of the till formations. Superficial fluvial accumulations at till unconformities were in evidence everywhere along this segment of pipeline at a depth of 6 m.

As noted, this section of the pipeline route is considered highly sensitive for the presence of archaeological resources related to prehistoric occupation and Contact Period settlement. The radiocarbon dates confirm these observations and provide chrono-stratigraphic context for at least the later aboriginal settlement phases of the Old Place Site (A085-01-0134 and A085-01-2366). Three (3) radiocarbon dates converge around the ubiquity of the pre-contact soil in the vicinity of the Old Place Site that extended from 2.7 to 1.5 kya, after which time a dynamic hydromorphic environment clearly took hold along the margins of the encroaching (landward) shoreline.

Related geoarchaeological studies in the vicinity show that the salt marsh adjacent to the Old Place Creek developed rapidly during the past 800-1000 years. Analysis of core sediments from this section of Staten Island appear to extend the longevity and duration of the former stable Holocene land surface to 2,500 - 3,000 B.P. and indicate that estuarine sedimentation and late Holocene fluvial erosion represent cyclical geomorphic events (GRA 1997; PAL 2010, 77-78).

New York City Department of Transportation (NYCDOT) Property – Western Avenue, Staten Island, NY

(Group 3: RCH-4H-ARC-6.1, RCH-4H-ARC-7, RCH-4H-ARC-8, RCH-4H-ARC-9.1, RCH-4H-ARC-10, RCH-4H-ARC-11.1, RCH-4H-ARC-12, RCH-4H-ARC-13, RCH-4H-ARC-14, RCH-4H-ARC-15, RCH-4H-ARC-16, RCH-4H-ARC-17)

GRA excavated and examined twelve (12) core probes along this reach of Western Avenue (Figure 8). Core alignments followed an offset of 20 to 40 feet west of the pipeline's proposed centerline. The offset deviated from the original alignment because the owner, the Port Authority of New York and New Jersey, denied Spectra access to perform any and all subsurface investigations.

Figure 8. Cores along New York City Department of Transportation (NYCDOT) Property, East of Western Avenue – *Staten Island, NY.*

The twelve (12) cores were taken along a 1,980 ft. (0.6 km) segment of the Western Avenue roadway north of the Bridge Creek wetlands restoration and the raised Staten Island Railroad rail bed. The wetlands lie on the order of 1500 feet (<0.5 km) east of Western Avenue. That street itself is elevated slightly (several feet) above the wetlands. This raised roadway may represent part of an original landform (PAL 2010, 78), as there are no indications that it was built on fill. Soils south of this location are mapped as *Ipswich-Pawcatuck-Matunuck* mucky peats, *Pavements and Buildings*, and wet sub stratum *Laguardia-Ebbets Complex* (NRCS 2005).

The twelve (12) extracted cores from the "RCH-4H" series revealed broadly similar, but generally less intricate stratigraphies than those to the south. Thus while the "RCH-1" and "RCH-2" sequences featured paleosols and estuarine facies between the historic fills and Pleistocene shoreline and till depositions, the typical "RCH-4H" succession was capped by relatively deep and recent fills that often rested unconformably on shoreline deposits. This was precisely the case for the following RCH-4H-ARC probes: 6.1, 7, 8, 9.1, 10, 11.1, 12, 16, and 17. An intervening 0.3 m thick organic matrix was noted in ARC-13, while ARC-14 and ARC-15 both contained fills that extended beyond the depths of the probes (>6 m). With a single exception the shoreline sediments were underlain by fluvial sands and gravels typically at net depths of 5-6 m. At ARC-8 a weak cambic soil was identified between 4.5 and 4.8 m.

The relatively straightforward stratigraphies called attention to the composition, thickness, and antiquity of the dominant shoreline facies for this portion of the alignment. Typically the matrices are 2-3 m thick and are typically loamy sands with occasional fine grained lenses and interdigitations. Colors are dominated by hues in the 10YR to 5YR ranges and uniquely narrow 4/3 values/chroma readings. These colorimetric readings implicate weathered (i.e., rubefied) shoreline deposits. Nearly all cores featured at least several strata that were populated by varying concentrations of shell fragments, typically in the 1-3 mm size grades. In some instances coarser clastic components (subrounded gravels, generally <20 mm) were identified. Taken together the facies identified as "Shoreline" conforms to the lithostratum designated by the NYSGS (1999) as "s", the undifferentiated marine and lacustrine sand, generally well sorted and in the fine to medium size grade….(it) is a near shore deposit, at or below the highest marine level…(it) may include fossil shells." The NYSGS is not definitive when assigning the deposition to a time frame, but regional reconstructions have established the facies as Pleistocene (dominantly) with deposition extending into the Holocene (see Stone et al, 2002). For this study a single organic sediment specimen was submitted for a radiocarbon assay. A result of ^{14}C 16,940±70 B.P. (Beta-309857) on a probable shoreline soil at RCH-4H-ARC-8 (4.65 m bgs) is consistent with regional chrono-stratigraphies and establishes the emergence of the Staten Island shoreline during the latter stages of the Wisconsinan.

The comprehensive nature of the RCH-4 sampling program, with extremely close interval spacings and repetitive stratigraphies the length of the alignment suggests that the sequences accurately reflect the local subsurface successions. Accordingly, these subsurface records point to intact Pleistocene marine and (possibly) lake chronologies bracketing limited intact Holocene soil-sediment packages beneath thick historic fills. Significantly, while the thinness of the Holocene sediments does not presage the presence of deeply stratified prehistoric sites, the depth and discrete composition of the historic fills offers indications that intact historic resources may proliferate along this portion of the alignment.

These stratigraphic observations notwithstanding, the prehistoric sensitivity along the alignment is well documented. Alanson Skinner's (1898-1909) study of the historic resources of Staten Island details the discovery of numerous historic artifacts, along or in the vicinity of Western Avenue, north of the Staten Island Railroad (Skinner 1898-1909, PAL 2010 79). Finds in this area have included prehistoric pottery and stone tools, such as grooved axes, jasper and argillite blades, scrapers, and projectile points of various lithic materials including argillite, quartz, and flint. These finds have been associated with the Archaic, Terminal Archaic, Woodland, and possibly the Contact Period as well. Such finds are likely associated with a previously recorded site: Site 8505 (NYSM site files), which is a pre-contact site broadly set between Richmond Terrace to the north and the Staten Island Railroad to the south.

The sampling area located along Western Avenue is also in close proximity to a known pre-contact site, the Mariner's Harbor Site (Boesch 1994, No 105 and STD-MH; PAL 2010, 79, 82). Additionally, the Bowmans Brook Site (NYSM 4594) is east of the sampling area within present-day Mariners Marsh Park. Mariners Marsh Park, south of Richmond Terrace, was also identified by Skinner (1909) as having extensive (late) prehistoric artifact complexes as well as human burials and possibly Native American agricultural fields. While the area has largely been disturbed during 20th century landscaping activities and industrialization, isolated intact tracts probably remain.

Finally, the portion of the route located south of Staten Island Rail is considered to have moderate sensitivity for 18th century resources related to Revolutionary War period skirmishes and burials. The area north of the railroad is considered to be highly sensitive for pre-contact resources and should be considered to have strong potential for post-contact period resources (PAL 2010, 81-82).

New York City Department of Transportation (NYCDOT) Property – *Richmond Terrace, Staten Island, NY*

(Group 4: RCH-5H-ARC-1, RCH-5H-ARC-2, RCH-5H-ARC-3, RCH-5H-ARC-4, RCH-5H-ARC-5, RCH-5H-ARC-6, RCH-5H-ARC-7, RCH-5H-ARC-8)

Eight (8) core borings were excavated into the substrate beneath the pavement along this linear stretch of Richmond Terrace (Figures 9a and 9b). Borings were taken along the centerline of the proposed alignment and within the area of potential effect. The Richmond Terrace roadway demarcates the northern boundary of Mariners Marsh.

Figure 9a. Cores along New York City Department of Transportation (NYCDOT) Property – ***Richmond Terrace, Staten Island, NY.***

Figure 9b. Cores along New York City Department of Transportation (NYCDOT) Property – *Richmond Terrace, Staten Island, NY*.

Historic maps dating to the 19th century indicate that the project area consisted of dry land abutting the tidal marsh and the Kill Van Kull shoreline to the north. Currently the tidal marsh offsets a minor inlet. Soils in this region have been mapped as *Inwood-Laguardia-Ebbets Complex* (see PAL 2010, NRCS 2005).

With the exception of core RCH-5H-ARC-8, all of the borings consisted of historic fill to the base of the excavations. RCH-5H-ARC probes 5, 6, and 7 reached Pleistocene deposits at depths of 5-6 m beneath the continuous fill covers. A visually compelling contact between the fill and a relatively thick buried soil was identified at RCH-5H-ARC-5. A ^{14}C determination of 117±0.3 pMC (Beta-309858) verified that "modern bomb carbon" percolated through the fill and provided a skewed determination for the soil. Nevertheless, the contaminated buried A-horizon capped a well developed Bt, with rubefied colors and subangular blocky structures at ca. 3.0 m. More generally, shoreline and fluviatile facies were largely recognized at the fill-interfaces. At RCH-5H-ARC-6 dense clays and inclined sand beds of apparent deltaic origin were recognized (associated with a lake-basin sediment complex). Probe ARC-8 registered a 4.5 m deep complex of near-shore deposits that fined downward. The upper portion consisted of clast supported sands and gravels. The gravel fraction disappeared midway through the complex and sands fined downward. The matrix is rubefied (5YR 4/3) and on textural, structural, and colorimetric grounds it is identical to the sediment bodies forming the basal shoreline features along the Western Avenue alignment (RCH-4H core series). The surficial geology map has projected that sediment unit as extending to the approximate location of RCH-5H-ARC-8 ("ls" as depicted on Figure 1) and the sub-surface sequence registered in the core confirms the surface mapping.

This portion of the alignment is bounded by numerous prehistoric and historic sites. The Bowman's Brook Site (NYSM 4594) is immediately to the south (near RCH-5H-ARCH-6) and the Bowman's Brook North Site (A085-01-2364) and the Richmond Terrace Historic Archaeological Site (A085-01-2365) are both due north of the alignment and possibly within the margins of the APE.

It is noteworthy that within the historic fills several cores preserved discrete fill accumulations, probably associated with single or localized events of re-grading. The Richmond Terrace Historic Archaeological Site is described as consisting of buried ruins of residences predating 1845 (PAL 2010, 86). Though there is little diagnostic evidence for development and occupation of this site, there are numerous slab foundations of early 19th century dwellings along the north side of Richmond Terrace. Furthermore these sites are in the vicinity of the project APE and should be considered potentially significant (PAL 2010; Payne and Baumgardt 1986).

Locations such as the Bowman's Site are known to have contained prehistoric agricultural tracts. The route is also located between parcels of land that were once part of the early 20th century Milliken Brothers iron and steel foundry site, which extended across both sides of Richmond Terrace. In the early 20th century, Skinner (1909) noted that the construction of the Milliken foundry had deleterious effects on the remains of prehistoric agricultural fields located at the Bowman's Brook Site. However recent assessments suggest that isolated pockets of the site may remain, such that the historic fills may signal areas of high historic archaeological potential. Prospects for recovery of intact prehistoric surface would appear to be somewhat less likely, given the extent and depth of historic disturbance recorded in the fill-dominant cores.

New York City Economic Development Corporation (NYCEDC) Property – *Richmond Terrace, Staten Island, NY*

(Group 5: RCH-6-ARC-1, RCH-6-ARC-2, RCH-6-ARC-3, RCH-6-ARC-4, RCH-6-ARC-5)

Six (6) cores were recovered from the NYCEDC property along Richmond Terrace that extended to the eastern edge of the Staten Island pipeline segment (Figure 10). All core locations were set on the alignment centerline and within the area of potential effect. The project area is bounded by Richmond Terrace to the south, the Kill Van Kull coastline to the north and northeast, and vacant lots, discontinuously covered by secondary overgrowth, to the west.

Figure 10. Cores along New York City Economic Development Corporation (NYCEDC) Property – ***Richmond Terrace, Staten Island, NY*** **(Source: Google Earth 2011).**

Local terrain is dominated by these vacant vegetated areas as well as sections of marsh land, paved lots, and fenced in property belonging to the New York City Department of Transportation. According to 19^{th} century maps the native landforms were well drained beyond the tidal margins, but marshes formed a proximal belt around the area currently fronted by the Kill Van Kull shoreline near the inlet. The earliest phase of infilling may have occurred as early as 1891 (PAL 2010, 85).

Soils along this section of the proposed pipeline route are mapped as *Inwood-Laguardia-Ebbets Complex*, consisting of a mixture of natural soil materials and construction debris (NRCS 2005; PAL 2010). The latter forms an extensive mantle along this section of the pipeline route.

The low lying terrain along the “RCH-6” alignment accounts for deep accumulations of capping fill, much as it does for the “RCH-5H” segment to the west. In general, however, fill thicknesses are somewhat shallower and more variable between cores. Moreover, all of the diagnostic soil-sediment complexes for the entire length of line—fill, Holocene soil, estuarine peats, and a series of Pleistocene depositional facies—are represented in several of the cores. Core RCH-6-ARC-1 preserved the most comprehensive sedimentary suite. Since fill depths were relatively thin (< 2 m), the base of the fill rests atop a relatively thick and intact 2 m deep basal soil. An Argillic solum (Bt horizon) was recognized, analogous in weathering features, structure, texture, and general expression to that noted for RCH-2-ARC-1 on the southern end of the Staten Island segment. The age of the soil could not be determined, but given its mature development and formation atop 2 m thick shoreline sands, it may well be of terminal Pleistocene or Early Holocene age. The parent materials within the column are generally slightly coarser than those for the shoreward portion of the segment and suggest that RCH-2-ARC-1 may be associated with an older landform (i.e., moraine edge, beach ridge) than the other four (4) locations currently fringing the marshland.

Thus the other, lower lying cores are capped by considerably thicker fills (to 3-4.5 m) which are directly underlain by 1-2 meters of dense and cyclically gleyed estuarine fines with occasional peat lenses and pockets of macro-organic vegetation mats. These are the thickest estuarine sediment bodies encountered anywhere along the alignment (they probably represent the lowest surface elevations as well) but regional chrono-stratigraphies would suggest that they date within the range 7000-1000 B.P. and probably skew to the later Holocene. The middle cores (ARC-3 and 4) preserved the deepest and heaviest (i.e., clay enriched) estuarine sediment matrices, which extended to the 6 m deep base of the core. The unconformity between the dense Holocene clays and the coarser (late Pleistocene) fluvial sands was reached in only two cores (ARC-1 and ARC-5).

Perhaps the most critical chrono-stratigraphic observation to emerge from this core set was that for most, if not all of the Staten Island alignment, ***Holocene soils appear to be preserved in stratigraphies where fill depths do not exceed 2 m.*** Thus, at lower lying elevations (at marsh edges, for example) deep fills very typically offset unconformities with estuarine and organic accumulations. The latter typically extend to the contact with either alluvium, stream channel gravel and sand complexes, or till; all of these basal sediment bodies are of Pleistocene age. It follows that the possibility of finding intact prehistoric materials would be possible only within the upper soil (where shielded from grading activities) or, more unpredictably and for older cultural deposits, atop mature soils formed on stabilized Pleistocene landforms over the past 10,000 years or less.

Historical studies of the area conducted by PAL (Public Archaeology Laboratory) (2010) indicate that numerous 19th century dwelling sites existed north of Richmond Terrace and were likely associated with “Sailors Row,” a former residence for retired sailors (PAL 2010, 85). The landscape of the area was largely unimproved until the early 20th century and the construction of the Milliken Brothers iron and steel foundry (Beers 1874; Dripps 1872; Hassler 1845; Sanborn 1910; USGS 1891; Walling 1860). The area under investigation traverses the northern parcel of this former complex (PAL 2010. 85).

This section of the proposed pipeline corridor is in close proximity to numerous pre-contact sites. These sites include the Bowman's Brook Site (NYSM 4594 and 7321), the Bowman's Brook North Site (A085-01-2364), and the Mariner's Harbors Site. This area of the proposed pipeline corridor has a high potential for pre-contact burials to the south of Richmond Terrace, while Revolutionary War burials may be present on either side of Richmond Terrace (PAL 2010; for more information see Kardas and Larrabee 1982, 7, citing Skinner 1926).

Known disturbances of the area include the filling of former marsh areas, the construction of the Milliken-Downey Complex north of Richmond Terrace, the development of the NYC DOT facilities, the installation of the existing pipeline and the local excavation of former underground storage tanks on the NYC DOT parcels. Records indicate that the USTs were removed from the NYC DOT property, but the exact locations of the excavations are unknown (PAL 2010; TRC 2010, File No. 12).

This area has previously been characterized as highly sensitive for prehistoric resources dating to the Archaic and Woodland Periods. Archaeological resources at the site dating to prehistoric periods may be associated with the Bowman's Brook and the Bowman's Brook North Sites (PAL 2010, 86).

The area surrounding Richmond Terrace is considered sensitive for pre-20th century farmsteads and domestic sites. More specifically, the area to the south of Richmond Terrace is considered sensitive for 20th century industrial remains (Flagg 1991a, 1991b; Kearns et al 1991; Payne and Baumgardt 1986). Historic maps do not indicate the presence of farmstead or domestic structures within the proposed pipeline corridor (PAL 2010, 86). The potential for historic resources such as Revolutionary War burials at the site endow the site with a moderate sensitivity for human remains.

5. GEOARCHAEOLOGICAL INTERPRETATIONS AND RECOMMENDATIONS

This third round of GRA investigations represents the initial attempt to assess the potential for locations in Staten Island to house deeply buried archaeological sites. The approach applied for this assessment is unique for two reasons. First, it examines subsurface potential for an alignment segment that spans only 1.13 miles. Second, this portion of the alignment traverses terrain that, while disturbed, nevertheless contains some of the most sensitive archaeological terrain in New York City. The latter concern is especially true for the prehistoric component of the cultural resources, since Staten Island generally, and this (northwest) portion of the island in particular, houses intact and stratified alluvial successions that are among the oldest in the Northeast. Towards this end we have generated archaeological sensitivity assessments based both on our interpretations of subsurface geological integrity and antiquity (Tables 1 and 2) as well as proximity of core locations to the more prominent prehistoric sites in the immediate vicinity of the alignment (Figure 11). For historic components, guidelines for sensitivity are based on known cultural resources (see PAL 2010) bolstered by evaluations of discrete fill components that conform to debris types that would be expected from the documented historic properties.

As in the case of earlier studies (GRA 2011a, b) it is emphasized that these recommendations are relevant to the immediate vicinities of the coring locations, and they should not be extrapolated to adjoining properties or tracts beyond the sampling interval of the boring program. The recommendations are based on close-interval sampling schemes and it is expected that the reliability of these recommendations is high. As noted, for New York State that interval is 300 feet (90 m). Nevertheless, the recommendations are proposed largely without the benefit of additional laboratory analyses. For this study, radiocarbon dating was undertaken at four (4) locations but we have not established an absolute chronology for landscapes (radiocarbon dating), nor do we have unequivocal evidence for reconstructing conclusive depositional histories for the extent of the alignment. To do so would require additional analysis bearing on landform origins (sedimentology and micromorphology), and reconstructing vegetation and climate (palynology and stable isotope studies). Such analyses will be performed at locations deemed paleo-environmentally sensitive, pending protocols determined in agreements between PAL and the New York State Office of Parks and Recreation (NYSORP).

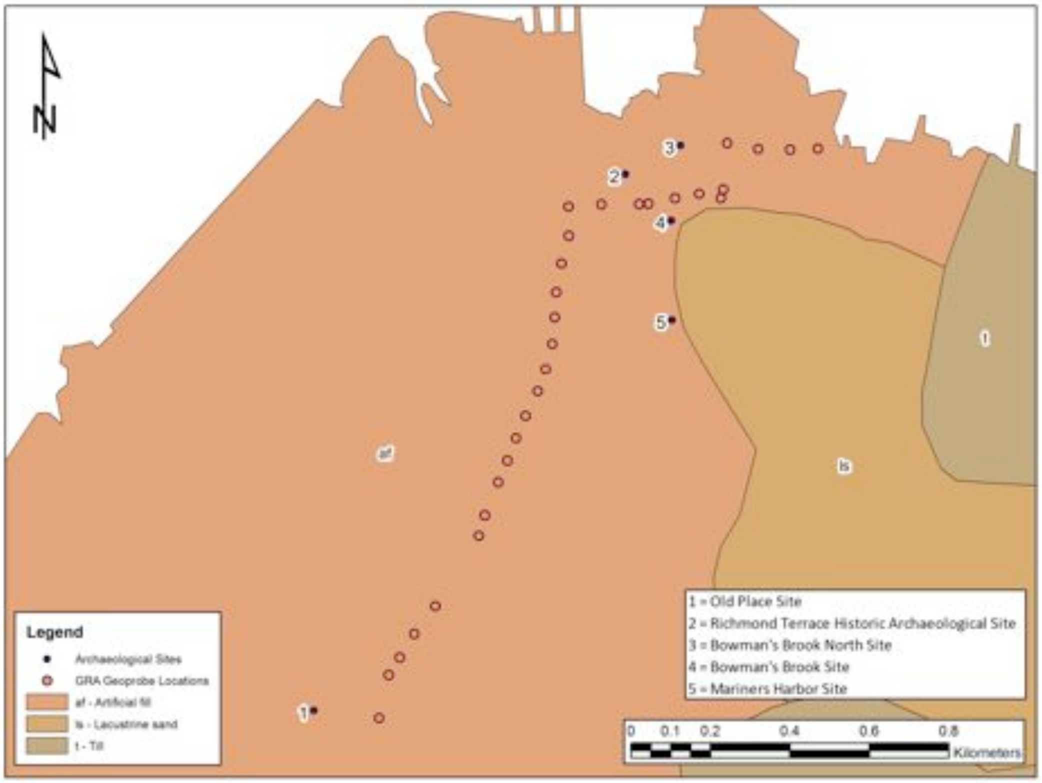

Figure 11. GRA core locations in relation to known archaeological sites.

For the greater project area, as well as for individual project tracts, the formulation of a chronology of deeply buried sequences would refine our archaeological sensitivity model. In many cases, there is not enough difference in the physical characteristics of deposits—as manifest in the limited exposure furnished by cores—to differentiate between sediments with archaeological sensitivity and deposits which pre-date human arrivals. We do know, for example, that there is a significant gap between the end of Pleistocene sedimentation in the project area and the known period of human activity in this part of the world. In yet other situations, refinement of depositional environments (through paleo-ecological analysis techniques) would allow for reconstructions with sufficient data to establish the types of sites that might be expected in certain settings.

The following provisional assessments of archaeological preservation along this alignment are based on the coring program and the stratigraphies preserved at the five core groups under consideration.

Tables 1 and 2 summarize the recommendations for follow up work for each of the five groups along the alignment. These tables justify our recommendations on the strength of preliminary examinations of core sequences.

Table 1 presents general assessments of archaeological sensitivity on a core-by-core basis. Historic and prehistoric resource potentials are considered separately for each core. Rankings are assessed on a relative basis, according to “high”, “medium”, and “low” levels of sensitivity (column 3). Stratigraphic and sedimentological evidence in support of the rankings are presented in the last column.

Table 2 specifies the locations in which follow up work is recommended on the basis of formal geoarchaeological criteria. These geoarchaeological criteria are structured around baseline stratigraphies and chronologies. Accordingly, columns 3 through 8 detail the six (6) geological units that accommodate the sequences recorded in the entire population of cores. As shown, these units grade from youngest to oldest (left to right) and include: (1) Deep/Mixed Fill; (2) Discrete Fill; (3) Buried Soil; (4) Estuarine/Peats; (5) Shore facies; and (6) Till. The units have unique properties in determining archaeological potential for Historic and Prehistoric sites respectively. We consider each.

Historic Units. Units (1) and (2), the fills, represent historic deposits associated with land clearing activities and can extend from the 17th through 21st centuries. Most large scale clearance dates to the late 19th century and subsequent. While fill is widely considered to have limited archaeological potential, we separate category (2), Discrete fill, as indicating degradation of a particular feature or episode of destruction that can be linked to a known historic structure. In that sense the Discrete Fill may represent a context favorable for yielding intact archaeological remains.

Prehistoric Units. Units (3), (4), and possibly (5) are contemporaneous with prehistoric occupations and resource environments. Thus they will invariably date to the last 10,000-12,000 (Holocene). Buried soils (3) are considered likely to contain prehistoric surfaces because they register stable environments of the Holocene. The category classed as Estuarine/Peats (4) are rich biotic settings which functioned as subsistence environments that would have attracted prehistoric peoples. Shore facies (5) are not well dated in Staten Island and may be of Pleistocene or Holocene age. Thus, they have some potential for containing prehistoric deposits. Till (6) is of late Pleistocene age and probably pre-dates prehistoric occupation.

In sum, it follows that sealed geological deposits of an age contemporaneous with human occupation are excellent indicators of buried cultural resource potential. For historic sites the optimal geological unit is (2) as it contains evidence for unique historic activities in a sealed sediment matrix. For prehistoric sites primary preservation contexts for archaeological materials include units (3) and (4).

In addition to sealed geological deposits, the archaeological sensitivity of a core location is enhanced by its proximity to known archaeological sites (column 9). Finally, the absolute dating of buried soils and sediments, through the radiocarbon method, confirms the age of a deposit and it too is an excellent measure of buried site potential (column 10).

Table 2 is a matrix that charts the set of cores by geological unit (columns 3-8) and additional measures of archaeological preservation potential—proximity to known sites (column 9) and radiocarbon dates (column 10)--to develop a measure of **archaeological potential** (column 11) that guides our recommendation for follow-up work. The key element for determining archaeological potential for each core is the age of the geological units preserved within the composite core column. A core that contains several units of prospective archaeological age, noted in Table 2 by "Yes" in the appropriate age column, would be a likely candidate for follow up testing. Proximity to archaeological sites and Radiocarbon Dates at the core location would further underscore the productivity of testing.

In general, cores for which 3 to 4 "Yes" responses are checked were considered viable candidates for prospective follow-up work. For example, if a single core preserved three geological units of archaeological age and was in proximity of a site, it would be selected for further testing. It is noted, of course, that while all the cores were in proximity of archaeological sites in this uniquely sensitive (northwestern) section of Staten Island, individual core locations would **not** be tested unless they fulfilled at least two other criteria, most typically containing at least two deposits of Holocene age. Following these guidelines a total of ten (10) of the thirty (30) core locations were selected for additional work.

Specific recommendations and guidelines for such work were dictated by the particular core stratigraphies. The following discussion presents the specific strategies proposed for each group of cores.

Group 1: Texas Eastern Transmission, LP (TETLP) Property – *Staten Island, NY*

RCH-1-ARC-1

Prehistoric archaeological sensitivity is underscored by the core's proximity to the Old Place Site (Ritchie and Funk 1971). The precise location of that site is not known, as its boundaries were never formally established, but it is probably within several hundred feet (west) of RCH-1-ARC-1. Moreover, the depositional context presented for the site was not provided in sufficient detail to reconstruct an accurate provenience. Moreover, the age of the alluvial sequence could only be speculated upon at the time of excavation, since higher resolution Late Quaternary chronologies for Staten Island had not yet been developed. The single radiocarbon date from a hearth feature, dated to 5310 ±140 B.P., coupled with the dense Archaic through Woodland artifact assemblages, argue for integrity of site stratigraphy (Ritchie and Funk 1971).

The core probe further documented the presence of an intact, if partially truncated, soil profile rendering it possible, if not likely, that parts of the intact sequence at Old Place extend to the Area of Potential Effect at the core location. As for historic resources, post-contact domestic sites dating from the 17th to the 20th century were located along the western side of Western Avenue (PAL 2010).

Preliminary indications of intact Holocene site stratigraphy, proximity to the Old Place Site, and integrity of historic fills point to the need for extensive follow up work. That work would involve further subsurface exploration and documentation of the entire sequence that would address: (1) the integrity of fill horizons to determine associations with documented historic resources; (2) preservation and antiquity of the documented soil horizon at ca. 2 m depth; (3) potential evidence for presence of a buried occupation surface.

Group 2: New York State Development Environmental Conservation (NYSDEC) Property *Staten Island, NY*

RCH-2-ARC-1, RCH-2-ARC-2, RCH-2-ARC-3, RCH-2-ARC-4

This series of cores contains the most intact and representative geoarchaeological information sets for the entire project alignment. All key stratigraphic units—discrete historic fills, buried soils (indicative of stable surfaces), estuarine sediment complexes, and basal Pleistocene deposits—are registered prominently. Radiocarbon dates, in proper sequence, record the succession of estuarine and stable landform settings over the past 3000 years and earlier dateable sequences are also in primary contexts. Buried landforms would appear to document the zonation of resource zones (estuarine sediment complexes) that are offset from potential occupation horizons (buried soils). Moreover, these well preserved sediment-landform complexes may establish continuity with the Old Place Site, situated only 1000 feet (0.3 km) to the south-southwest.

The present investigations recovered sufficient information to ascertain that larger scale subsurface excavations will contain the data pivotal for over-arching paleo-environmental and geoarchaeological reconstructions.

A comprehensive subsurface exploration program is proposed for this setting. Historic and paleoenvironmental data should be procured from each horizon and complete stratigraphic columns should be sampled. The suite of paleo-environmental tests, together with radiometric dating should be performed. This is the most diagnostic stratigraphic succession for this entire alignment segment. For the paleoenvironmental data base, establishing the ages of the beach, estuary, and underlying lacustrine/ marine/shoreline deposits is critical. Paleoenvironmental reconstructions should focus on sedimentology, micromorphology, pollen studies, paleobotanical identification of plant remains, and shell identifications. Because of the clustering of these locations it is proposed that 2-3 extensive trenches be excavated to depths of 5-6 m. These units should be centered in the vicinity of RCH-2-ARC-2 where evidence of the upper paleosol was encountered. More limited excavation should extend to greater depths to expose the stratification/composition of the estuarine deposits and to document the presence/absence of a lower soil.

Group 3: New York City Department of Transportation (NYCDOT) Property – Western Avenue
Staten Island, NY

RCH-4H-ARC-6.1, RCH-4H-ARC-7, RCH-4H-ARC-8, RCH-4H-ARC-9.1, RCH-4H-ARC-10, RCH-4H-ARC-11.1, RCH-4H-ARC-12, RCH-4H-ARC-13, RCH-4H-ARC-14, RCH-4H-ARC-15, RCH-4H-ARC-16, RCH-4H-ARC-17

The cores along Western Avenue primarily documented deep fill stratigraphies. Of the twelve (12) subsurface probes, eight (8) yielded stratified fills and these were clustered in the central portion of the alignment. Post-contact (historic) resources have been extensively documented and these may extend as far back as the Revolutionary War period (18^{th} century). In contrast, while prehistoric resources have been locally recorded, these are largely diffuse. The subsurface probes disclosed that historic fills extend either to the base of the probes (±6 m) or to contact with Pleistocene facies, either at erosional unconformities or fill-truncated shoreline or till matrices. A date of ^{14}C 16,940±70 B.P. (Beta-309857) points to a probable Pleistocene age for the buried shoreline. At only two (2) locations were there indications of a paleosol, and only a single profile (RCH-4H-ARC-8) offered suggestions of significant soil weathering with substantial thickness. Collectively, the subsurface data converge around potential preservation of earlier historic resources and very limited to negligible preservation for intact prehistoric surfaces.

> *Additional subsurface probing should be conducted at the lower-central segment of the alignment, in the vicinity of RCH-4H-ARC-8 through RCH-4H-ARC-10. The probing should isolate the extent and thickness of diagnostic fills with sampling of soils to ascertain the age and composition of a surviving paleosol(s). The widespread distribution of prehistoric finds suggests that the buried preservation contexts of intact aboriginal deposits should at least be tested, but this should be done in an area in which the possibilities for recovering information on historic resources are relatively high.*

Group 4: New York City Department of Transportation (NYCDOT) Property – Richmond Terrace
Staten Island, NY

RCH-5H-ARC-1, RCH-5H-ARC-2, RCH-5H-ARC-3, RCH-5H-ARC-4, RCH-5H-ARC-5, RCH-5H-ARC-6, RCH-5H-ARC-7, RCH-5H-ARC-8

Subsurface stratigraphies exposed in the core complex broadly mirrored the near continuous distributions of thick, historic fills that characterized the alignments along Western Avenue (Group 3, above). Six (6) of the eight (8) cores extended directly from the thick fill accumulations into Pleistocene substrate. A unique exception was RCH-5H-

ARC-5 which contained a possible Bt horizon whose organic cap (A-horizon) was dated to 117±0.3 pMC (Beta-309858). The date reflects contamination ("bomb carbon" determination) from downward percolation of organics from the fill complex. Nevertheless, obvious pedogenesis is confirmed by continuous ped development (with depth), progressive structural firmness and clear evidence of clay illuviation. It remains unclear, however, whether or not these soil forming features represent primary weathering of older shoreline or lake delta deposits (of Pleistocene age) or if they signify bi-sequal soil evolution (the formation of a Holocene soil within an antecedent [shoreline] soil of Pleistocene age). A second core, RCH-5H-ARC-6 preserved possible Inceptisol (A-C) horizonation, which could not be readily correlated across the alignment. That sequence could also represent an estuarine phenomenon, consistent with the location of the alignment at the distal tidal margins, where deep organic accretion would be minimal and mixing of terrestrial and tidal matrices is not unexpected.

These depositional and pedogenic considerations notwithstanding, at a maximum only two (2) cores presented evidence for intact Holocene soil or sediment sequencing between obvious Pleistocene and fill sediment complexes. More significant is the fact that these same locations, RCH-5H-ARC-5 and ARC-6, contained stratified historic fills. A third location, RCH-5H-ARC-2 is in close proximity (within several hundred feet) of the Richmond Terrace Historic site, although the fill offered no indications of unique degraded properties at this location.

Additional sub-surface investigations should be undertaken in the vicinity of RCH-5H-ARC-5 and ARC-6. Objectives are two fold: (1) to examine the composition of fill stratigraphy that links those sequences to historic cultural resources; and (2) to document weathering patterns within the deep soil at the former core location. The additional probing should extend to the top of a probable unconformity, which would facilitate determinations of (probable) Pleistocene antiquity based on weathering signatures and depositional origins.

Some limited coring (to 2-3 m) should be performed in the vicinity of RCH-5H-ARC-2 to follow out patterns of fill distribution that may be linked to the Richmond Terrace Historic Site.

Group 5: New York City Economic Development Corporation (NYCEDC) Property
Richmond Terrace
Staten Island, NY

RCH-6-ARC-1, RCH-6-ARC-2, RCH-6-ARC-3, RCH-6-ARC-4, RCH-6-ARC-5

This series of cores contains analogous stratigraphic sequences to those documented in Group 2. Here, in particular, a broad array of geological units is preserved that appears to reflect more complex landform relations in the past. Historic grading activities leveled off the older Holocene topography. In the substrate there is evidence for both marsh edge sedimentation and preservation of intact soils associated with higher landforms. It is unclear how the substrate relates to the variable topography of the past landscape. Fill sequences are generally thin (< 2m). Most significantly this part of the alignment provided clear indications that across the local terrain, Holocene soils are housed in stratigraphic columns where fill depths do not exceed 2 m. Hence, at lower lying elevations, in the marshes, deep fills offset unconformities with estuarine and organic accumulations. There is evidence for soil formation in the upper sequence. That soil should be dated to establish pedo-stratigraphic continuity with other dated and sampled areas. Historic fills are relatively uninformative but there is evidence for extensive 19th century occupation and consequential archaeological findings were identified in the vicinity of RCH-6-ARC-3.

> *Comprehensive sub-surface work should be undertaken in the vicinity of RCH-6-ARC-1. Historic and paleoenvironmental data should be procured from each horizon and complete stratigraphic columns should be sampled. The suite of paleo-environmental tests, together with radiometric dating should be performed. For paleoenvironmental purposes it should be possible to assemble the Middle to Late Holocene history of the marshes and the earlier (terminal Pleistocene-Early Holocene) history of older landforms and shoreline chronologies. Paleoenvironmental reconstructions should focus on sedimentology, micromorphology, pollen studies, paleobotanical identifications of plant remains and shell identification. Limited testing of the historic fill should also be initiated. While discrete historic deposition was identified at RCH-6-ARC-3, it should be possible to recover similar materials and contextual data at RCH-6-ARC-1.*

Table 1. Summary of Recommendations

A) Group 1 summary of archaeological sensitivity: TETLP (Western Avenue) property

Property	Core No.	Sensitivity Assesment	Preliminary Analysis Information			Comments
			Contamination (No Further Work)	Modern Fill = 15 ft BS (No Futher Work)	Modern Fill/ Historic Strata = 15 ft BS (Further Work)	
TETLP	RCH-1-ARC-1	High for prehistoric and historic resources			Present: complex fill sequence btw. 0-160 cm (0-5'4" below ground surface) may include historic fill; 160-235 cm (5'4"-7'8") is possiby intact truncated subsoil; 235-560 cm (7'7"-18'3") unweathered sands.	0-160 cm: stratified fill; 160-235 cm: intact truncated subsoil; 235-560 cm: stratified unweathered sands; 560-580 cm: till

B) Group 2 summary of archaeological sensitivity: NYSDEC (Western Avenue) property

Property	Core No.	Sensitivity Assesment	Preliminary Analysis Information			Comments
			Contamination (No Further Work)	Modern Fill = 15 ft BS (No Futher Work)	Modern Fill/ Historic Strata = 15 ft BS (Further Work)	
NYSDEC	RCH-2-ARC-1	High for prehistoric resources; low for historic resources				0-137cm: missing; 137-272 cm: soil; 272-600 cm: shoreline deposits with few vf shell frags and no organics.
NYSDEC	RCH-2-ARC-2	High for prehistoric resources; low for historic resources				0-93 cm: missing; 93-275 cm: soil; 275-600 cm: shoreline deposits w/ few fine rootlets at top and some shell frags that disappear toward bottom.
NYSDEC	RCH-2-ARC-3	High for prehistoric resources; low for historic resources				0-150 cm: organic mat; 150-440 cm: organic mat; 440-587 cm: shoreline deposits with few roots at top and krotovinas towards the bottom.
NYSDEC	RCH-2-ARC-4	High for prehistoric resources; moderate for historic resources			Present	0-183 cm: fill with cinders and few brick frags; 183-232 cm: organic mat, looks natural, possibly estuarine; 232-254 cm: few rootlets, looks natural, but has light petroleum smell - possibly estuarine; 254-357 cm: fill, clayish looking waste; 357-589 cm: soil, sampled from 446-450 cm; 589-600 cm: fluvial deposits.

C) Group 3 summary of archaeological sensitivity: DOT (Western Avenue) property

Property	Core No.	Sensitivity Assesment	Preliminary Analysis Information			Comments
			Contamination (No Further Work)	Modern Fill = 15 ft BS (No Futher Work)	Modern Fill/ Historic Strata = 15 ft BS (Further Work)	
DOT-Western Ave	RCH-4H-ARC-6.1	Low for prehistoric and historic resources.		Present		0-225 cm: fill; 225-545 cm: shoreline deposits with few shell frags in some units; 545-600 cm: fluvial deposits with many fine shell frags and krotovinas or root casts at top.
DOT-Western Ave	RCH-4H-ARC-7	Low for prehistoric and historic resources.				0-176 cm: fill; 176-300 cm: slurry, poor recovery; 300-392 cm: missing, poor recovery; 392-600 cm: shoreline deposits with few shell frags at top and charcoal lens at 592 cm.
DOT-Western Ave	RCH-4H-ARC-8	High for prehistoric resources; low for historic resources				0-88 cm: fill; 88-450 cm: shoreline deposits; 450-584 cm: soil, sample collected at 451-460 cm; 584-600 cm: fluvial deposits of alternating LS and SiCL.
DOT-Western Ave	RCH-4H-ARC-9.1	Low for prehistoric and historic resources.				0-88 cm: fill; 88-559 cm: shoreline deposits with some shells, and few flecks of charcoal (not dated); 559-600 cm: fluvial deposits.
DOT-Western Ave	RCH-4H-ARC-10	Moderate for prehistoric and historic resources.			Present	0-150 cm: fill w/ fine brick frags towards the bottom; 150-436 cm: shoreline deposits w/ some shell frags and few charcoal flecks (not dated); 436-600 cm: fluvial deposits with very thin charcoal lens (not dated).
DOT-Western Ave	RCH-4H-ARC-11.1	Low for prehistoric and historic resources.				0-110 cm: fill; 110-401 cm: shoreline deposits; 401-600 cm: fluvial deposits.
DOT-Western Ave	RCH-4H-ARC-12	Low for prehistoric and historic resources.				missing, poor recovery; 267-450 cm: shoreline deposits w/ many shell frags; 450-600 cm: not recovered in field.
DOT-Western Ave	RCH-4H-ARC-13	High for prehistoric and historic resources.				0-201 cm: fill; 201-234 cm: soil; 234-576 cm: shoreline deposits; 576-600 cm: fluvial deposits.
DOT-Western Ave	RCH-4H-ARC-14	Low for prehistoric and historic resources.				0-252 cm: fill; 252-600 cm: fluvial deposits.
DOT-Western Ave	RCH-4H-ARC-15	Low for prehistoric resources; high for historic resources.			Present	0-600 cm fill w/ few fine brick frags, petroleum smell towards bottom.
DOT-Western Ave	RCH-4H-ARC-16	Low for prehistoric and historic resources.				0-198 cm: fill; 198-600 cm: either fill or shoreline deposits.
DOT-Western Ave	RCH-4H-ARC-17	Low for prehistoric and historic resources.				0-150 cm: fill; 150-600 cm: shoreline deposits.

D) Group 4 summary of archaeological sensitivity: DOT (Richmond Terrace) property

Property	Core No.	Sensitivity Assesment	Preliminary Analysis Information			Comments
			Contamination (No Further Work)	Modem Fill = 15 ft BS (No Futher Work)	Modem Fill/ Historic Strata = 15 ft BS (Further Work)	
DOT-Richmond Terrace	RCH-5H-ARC-1	Low for prehistoric and historic resources.				0-176 cm: fill, hit concrete, so no further boring was conducted past 176 cm.
DOT-Richmond Terrace	RCH-5H-ARC-2	High for prehistoric and historic resources.				0-600 cm: fill, high PID readings.
DOT-Richmond Terrace	RCH-5H-ARC-3	Low for prehistoric and historic resources.				0-600 cm: fill, strong petroleum smell, photo'd then discarded.
DOT-Richmond Terrace	RCH-5H-ARC-4	Low for prehistoric resources; high for historic resources.			Present	0-600 cm: fill with whiteware ceramic frag, metal wire at 66-88 cm, brick frags and wood frags at 88-154 cm, flat, rounded pebbles stacked from 515-600 cm.
DOT-Richmond Terrace	RCH-5H-ARC-5	High for prehistoric resources; low for historic resources				0-250 cm: fill; 250-570 cm: soil that might be fill instead, sample collected at 267-270 cm; 570-600 cm: soil.
DOT-Richmond Terrace	RCH-5H-ARC-6	Low for prehistoric and historic resources.			Present	0-207 cm: fill with brick frags (88-110 cm); 207-378 cm: soil; 378-600 cm: deltaic deposits with some charcoal (not dated).
DOT-Richmond Terrace	RCH-5H-ARC-7	Low for prehistoric resources; moderate for historic resources.				0-473 cm: fill with some wood (66-88 cm); 473-600 cm: shoreline deposit w/ few shell frags.
DOT-Richmond Terrace	RCH-5H-ARC-8	Low for prehistoric resources; high for historic resources.			Present	0-150 cm: fill with glass, brick frags (22-66 cm), wood frags and slate (66-150 cm); 150-600 cm: shoreline deposits.

E) Group 5 summary of archaeological sensitivity: NYC EDC (Richmond Terrace) property

Property	Core No.	Sensitivity Assesment	Preliminary Analysis Information			Comments
			Contamination (No Further Work)	Modern Fill = 15 ft BS (No Futher Work)	Modern Fill/ Historic Strata = 15 ft BS (Further Work)	
NYCEDC	RCH-6-ARC-1	High for prehistoric resources; moderate for historic resources				0-181 cm: fill with organics throughout and brick frags at top; 181-412 cm: soil; 412-425 cm: shoreline deposits; 425-433 cm: lacustrine deposits with a large shell frag at bottom; 425-600 cm: shoreline deposits with few shell frags.
NYCEDC	RCH-6-ARC-2	Low for prehistoric and historic resources.				0-279 cm: fill with brick frags and some organics; 279-300 cm: soil; 300-360 cm: missing, poor recovery; 580-600 cm: fluvial deposits.
NYCEDC	RCH-6-ARC-3	Low for prehistoric resources; high for historic resources.			Present	0-391 cm: fill with brick frags throughout, wood frags, and glass; 391-600 cm: estuarine deposits - organic mat.
NYCEDC	RCH-6-ARC-4	Low for prehistoric resources; moderate for historic resources.				0-372 cm: fill with brick frags (40-116 cm); 372-521 cm: estuarine deposits of organic mats; 581-600 cm: shoreline deposits with shell frags.
NYCEDC	RCH-6-ARC-5	Low for prehistoric resources; moderate for historic resources				0-290 cm: fill with cinders; 290-447 cm: marsh - organic mats; shoreline deposits with few organics; 555-600 cm: fluvial deposits.

Table 2: Assessments of Archaeological Potential and Follow Up Testing

		RELATIVE AGE YOUNGEST ⟹ OLDEST									
			POTENTIALLY ARCHEOLOGICALLY SENSITIVE								
				HOLOCENE							
Group	Core number	Deep/Mixed Fill	Discrete Fill	Buried Soil	Estuarine/ Peat	Shore facies[1,2]	Till	Proximity to known Arc sites*	RC Dates	ARCHAEOLOGY POTENTIAL (x/-)	COMMENTS
1	RCH-1-ARC-1	NO	YES	YES	NO	NO	YES	YES		x	intact truncated subsoil (2BC, 160-225 cm)
2	RCH-2-ARC-1	NO	NO	YES	YES	YES	YES	YES	YES	x	soil (A, E, Bt; 140-270 cm), no fill documented
	RCH-2-ARC-2	NO	NO	YES	YES	YES	YES	YES		x	A, E, Bw present
	RCH-2-ARC-3	NO	NO	YES	YES	YES	NO	YES		x	peaty; horizons A-C present
	RCH-2-ARC-4	NO	YES	YES	YES	NO	NO	YES	YES (2)	x	organic mat (5C) under 180 cm of fill (brick, cinders)
3	RCH-4H-ARC-6.1	YES	NO	NO	NO	YES	NO	YES		-	thick (~300 m) deposit of sands with no discernable inclusions
	RCH-4H-ARC-7	YES	NO	NO	NO	YES	NO	YES		-	primarily shore facies below 300 cm; charcoal lens at 590 cm
	RCH-4H-ARC-8	NO	YES	YES	NO	YES	NO	YES	YES	x	paleosol below 450 cm; sampled for charcoal at 455 cm
	RCH-4H-ARC-9.1	NO	YES	NO	NO	YES	NO	YES		-	shore facies with few charcoal flecks between 420-450 cm
	RCH-4H-ARC-10	NO	YES	NO	NO	YES	NO	YES		-	shore facies from 150-440 cm; few charcoal flecks at bottom
	RCH-4H-ARC-11.1	NO	YES	NO	NO	YES	NO	YES		-	few black laminations between shore facies, fluvial deposits
	RCH-4H-ARC-12	NO	YES	NO	NO	YES	NO	YES		-	contaminated core (plastic) at ~370 cm
	RCH-4H-ARC-13	NO	YES	YES	NO	YES	NO	YES		x	potential soil (A-C; 200-230 cm) under asphalt fill
	RCH-4H-ARC-14	YES	NO	NO	NO	NO	NO	YES		-	fill (Ap) down to 575 cm
	RCH-4H-ARC-15	YES	NO	NO	NO	NO	NO	YES		-	Ap (fine brick frags near bottom)
	RCH-4H-ARC-16	NO	YES	NO	NO	YES	NO	YES		-	transition from Ap to shore facies at 200 cm
	RCH-4H-ARC-17	NO	YES	NO	NO	YES	YES	YES		-	transition from shore facies to till at 275 cm
4	RCH-5H-ARC-1	YES	NO	NO	NO	NO	NO	YES		-	encountered concrete; no material from below 175 cm
	RCH-5H-ARC-2	YES	NO	NO	NO	NO	NO	YES		x	Fill (Ap) from 0-600 cm
	RCH-5H-ARC-3	YES	NO	NO	NO	NO	NO	YES		-	Apparently contaminated Ap from 0-600 com
	RCH-5H-ARC-4	YES	NO	NO	NO	NO	NO	YES		-	fill (whiteware, wire, brick, wood) from 0-600 cm
	RCH-5H-ARC-5	NO	YES	YES	NO	NO	NO	YES	YES	x	soil (2A, 2Bt, 2C; 570-600 cm) under fill
	RCH-5H-ARC-6	NO	YES	YES	NO	NO	NO	YES		-	shore facies (with charcoal, undated) under fill
	RCH-5H-ARC-7	YES	NO	NO	NO	YES	NO	YES		-	240-470 cm: transition from fill (Ap, cinders) to shore facies
	RCH-5H-ARC-8	NO	YES	NO	NO	YES	NO	YES		-	shore facies under glass/wood/brick/slate fill
5	RCH-6-ARC-1	NO	YES	YES	NO	YES	NO	YES		x	soil (2A, 2Bt; 181-412 cm) under fill; shore/lacustrine sequence
	RCH-6-ARC-2	NO	YES	NO	YES	NO	NO	YES		-	soil (A, C) under 300 cm fill
	RCH-6-ARC-3	YES	NO	NO	YES	NO	NO	YES		-	organic mat under 400 cm fill (brick, wood, glass)
	RCH-6-ARC-4	NO	YES	NO	YES	YES	NO	YES		-	similar to RCH-6-ARC-4
	RCH-6-ARC-5	NO	YES	NO	YES	NO	NO	YES		-	soil (4A, 4Bw, 4C; 450-530 cm) under organic mat and fill

*within ~1.0 km

[1] - potential Pleistocene material

[2] - lacustrine and marine

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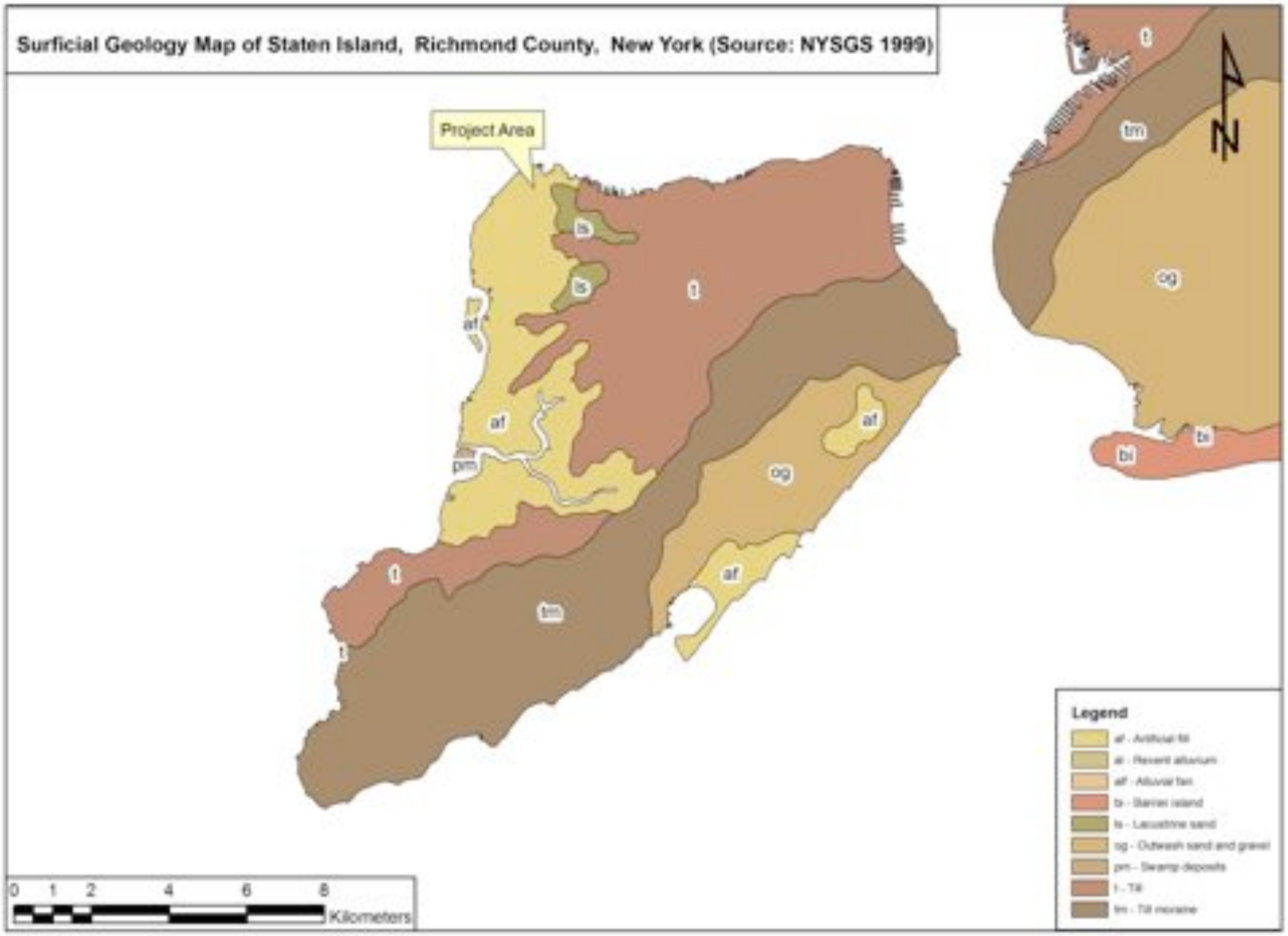
Appendix A: Surficial Geology Map



Surficial Geology Map of Staten Island, Richmond County, New York (Source: NYSGS 1999)

Appendix B: Core Photographs and Descriptions

RCH-1-ARC-1 (labeled as SI-002 in photograph)

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
FILL (PAVEMENT & BUILDINGS, WET SUBSTRATUM- LAGUADIA- EBBETS COMPLEX)	0-40	40	Ap1-FILL-1	7.5YR3/2	GSL	dist	l	a	many (40%) fine broken asphalt, fill gravels, and pebbles
	40-80	40	Ap2-FILL-2	7.5YR4/3	LS	mass-strat	fri	a	well sorted with a few fine to medium lenses of 7.5YR3/1 LS towards the base
	80-92	12	Ap3-FILL-3	5YR4/4	GSL	mass-dist	slfi	a	common (10%) fine to medium heterolithic gravels (quartzite, red and gray mudstone); possibly compacted artificial surface?
	92-160	68	Ap4-FILL-4	7.5YR2.5/1	GFSL-GSCL	dist	fi	c	common (10%) porrly sorted angular to subangular heterolithic gravels, common (10%) fine (with few medium) prominent 7.5YR5/4 and 10YR3/2 mottles, micaceous, very few organic fragments
	160-235	75	2BC1	2.5Y4/2	SCL	1mstrat	vfi	a	1-3% very fine root fragments throughout, few faint medium vertical 2.5YR3/1 streaks towards top of horizon, slightly moist
	235-275	40	2C2	10YR5/4	FS to FSL	strat	slfi	a	saturated, well sorted, micaceous
	275-545	270	2C3	7.5YR5/3	SL	mass	slfi	a	moist, well sorted, few fine lenses of 5YR4/3 SCL, and occasional lenses of coarser sands with occasional pebbles (eg. 425 cm)
	545-560	15	2C4	7.5YR3/3	S	strat	fri	a	common fine to medium lenses of 7.5YR3/1 S to SL, moist
TILL	560-580	20	3C	2.5YR4/3	C	mass	vfi	na	common (5%) fine to medium angular to subangular heterolithic gravels

Texture:	Si = silt; L = loam; C = clay; S = sand; F = fine; V = very; G = Gravel; O = Organic
Structure:	1 = weak; 2 = moderate; 3 = strong; f = fine; m = medium; c = coarse
	gr = granular; mass = massive; strat = stratified; sbk = subangular blocky; ab = angular blocky; pr = prismatic
	pl =platy; dist. = disturbed/no structure
Consistence:	fri = friable; sl = slightly; v = very; l = loose; fi = firm; st = sticky; ss = strongly sticky
Bounday Distinctness:	a = abrupt; c = clear; d = diffuse; g = gradual; s = sharp
Bondary Topography:	w = wavy; s = smooth; a = abrupt
Miscellaneous:	n/a=not applicable; n/r=not recorded

RCH-2-ARC-1

RCH-2-ARC-1

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
MISSING	0-137	137	n/r	n/r	n/r	n/r	n/r	n/r	Poor recovery
	137-141	4	A	10YR 2/1	SiCL	1sbk	vfri	c	Many f-m roots; soil; sampled 137-141
	141-250	109	E	5Y 5/3	SCL	2sbk	slfi-fi	n/a	Few rootlets and other organics suggesting part of a soil sequence - E-horizon; RC date, 1500±30 B.P. (Beta-309854); pollen sampled, 141-144 cm.
	250-257	7	Bt1	7.5YR 4/6	SCL	cr-1sbk	fri-slfi	g	Organics only present at boundary with material above.
SOIL	257-272	15	Bt2	10YR 5/6	SC-SCL		fi	g	Clay rip ups (10Y 5/2); organics present; some Fe staining.
	272-280	8	C	5Y 5/2	S	mass	l	g	No organics present.
	280-441	161	2C	10YR 4/3	LS	mass	l	n/a	Some Fe stains.
	441-470	29	3C1	7.5YR 4/4	LS	mass-1sbk	l	n/a	Few, v. fine shell frags; clay lense at 446.5-447 cm; clay ball at 448-449 cm; no organics present.
	470-536	66	3C2	7.5YR 3/4	LS	mass-1sbk	fri-slfi	c	No organics present; few, v. fine shell frags.
	536-545	9	4C1	7.5YR 3/4	SiCL	mass-1sbk	fri-slfi	g	No organics present; few, v. fine shell frags.
	545-590	45	4C2	7.5YR 3/4	SiCL-SCL	mass-1sbk	fri-slfi	g	No organics present.
SHORELINE	590-600	10	4C3	7.5YR 3/4	SiCL	mass-1sbk	fri-slfi	n/a	No organics or shell frags.

Texture: Si=silt; L=loam; C=clay; S=sand; F=fine; V=very; G=gravel; O=organic:

Structure: 1=weak; 2= moderate; 3=strong; f=fine; m=medium; c=coarse
gr=granular; mass=massive; strat=stratified; sbk=subangular blocky; ab=angular blocky; pr=prismatic
pl=platy; dist=disturbed/no structure

Consistence: fri=friable; sl=slightly; v=very; l=loose; fi=firm; h=hard; st=sticky; ss=strongly sticky

Boundary Distinctness: a-abrupt; c=clear; d=diffuse; g=gradual; s=sharp

Boundary Topography: w=wavy; s=smooth; a=abrupt

Miscellaneous: n/a=not applicable; n/r=not recorded

RCH-2-ARC-2

RCH-2-ARC-2

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
MISSING	0-93	93	n/r	n/r	n/r	n/r	n/r	n/r	Poor recovery
	93-108	15	A	10YR 3/1	SCL	mass-cr	slfi	c	Organic rich - many f-c roots.
	108-130	22	E	10YR 3/1	LS	cr-1sbk	fri	g	Common f-m roots.
	130-187	57	Bw1	10YR 4/3	LS	cr-mass	l-fri	g	Few, f-m roots; few Fe stains; very well sorted.
SOIL	187-275	88	Bw2	10YR 4/3	LS	cr-mass	l-fri	g	More organics than material above, but still few; no Fe stains.
	275-288	13	C	10YR 5/6	SiL	1sbk-strat	fi-slfi	c	Weak stratification - very thin layers of clay (10YR 6/1) with the silt loam; few fine rootlets.
	288-308	20	2C1	10YR 4/4	FS-LS	mass-cr	l-fri	g	Organics not present; few, very fine shell frags.
	308-417	109	2C2	10YR 4/4 10YR 5/4	F-MS	mass	l	g	Continuation of 288-300 cm, except clay content diminishes downward and color lightens downward as well; common, very fine shell frags.
SHORELINE	417-491	74	2C3	10YR 4/4	F-MS	mass	l	c	Continuation of 316-417 cm, but color darkens.
	491-560	69	3C1	5YR 3/3	SCL	mass	slfi	g	No organics present.
TILL	560-600	40	3C2	5YR 3/3	SiCL	mass	slfi	n/a	No organics present.

Texture: Si=silt; L=loam; C=clay; S=sand; F=fine; V=very; G=gravel; O=organic:

Structure: 1=weak; 2= moderate; 3=strong; f=fine; m=medium; c=coarse
gr=granular; mass=massive; strat=stratified; sbk=subangular blocky; ab=angular blocky; pr=prismatic
pl=platy; dist=disturbed/no structure

Consistence: fri=friable; sl=slightly; v=very; l=loose; fi=firm; h=hard; st=sticky; ss=strongly sticky

Boundary Distinctness: a-abrupt; c=clear; d=diffuse; g=gradual; s=sharp

Boundary Topography: w=wavy; s=smooth; a=abrupt

Miscellaneous: n/a=not applicable; n/r=not recorded

RCH-2-ARC-3

RCH-2-ARC-3

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
	0-22	22	A1	10YR 2/2	SL-SiL	mass	fri	n/a	Organic mat.
	22-88	66	A2	10YR 2/1 - 10YR 2/2	Si	mass	fri-st	n/a	Less organic-rich than material above.
	88-150	62	C	10YR 4/1 10YR 3/2	Peat SiC	mass	vst	n/a	Peat with a silty clay matrix.
	150-300	150	2A1	2.5Y 3/1	SiC	mass	vst	n/a	Common f-m roots; sampled 232-237 cm.
	300-390	90	2A2	2.5Y 3/1	SiC-SC	mass	vst	g	Some grittiness, could be from high organic content, or sand.
	390-440	50	2C	2.5Y 3/1	SiC	mass	vst	g	None.
SALT MARSH	440-475	10	3C	2.5Y 3/1	SC	mass	slst	c	Few, f-m roots.
SHORELINE	475-585	85	4C	2.5Y 6/1	LS	mass-1sbk	fri-l	g	Krotovinas present from 566-582 cm; many v.fine shell frags; yellowish sand (2.5Y 6/2) is mixed in and increases towards the bottom; charcoal sampled at 521-525 cm.
TRANSITION FROM SHORELINE TO FLUVIAL	585-589	4	4C/5C	2.5Y 6/1 5YR 4/3	LS LS-SL				Transitional zone between material above and below.
	589-600	11	5C	5YR 4/3	LS-SL	mass-strat	l-fi	n/a	Few subrounded gravels; gravel-sized clay rip-ups; faint layering at top; no organics present.

Texture:	Si=silt; L=loam; C=clay; S=sand; F=fine; V=very; G=gravel; O=organic:
Structure:	1=weak; 2= moderate; 3=strong; f=fine; m=medium; c=coarse
	gr=granular; mass=massive; strat=stratified; sbk=subangular blocky; ab=angular blocky; pr=prismatic
	pl=platy; dist=disturbed/no structure
Consistence:	fri=friable; sl=slightly; v=very; l=loose; fi=firm; h=hard; st=sticky; ss=strongly sticky
Boundary Distinctness:	a-abrupt; c=clear; d=diffuse; g=gradual; s=sharp
Boundary Topography:	w=wavy; s=smooth; a=abrupt
Miscellaneous:	n/a=not applicable; n/r=not recorded

RCH-2-ARC-4

RCH-2-ARC-4

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
	0-89	89	Ap1	10YR 2/2	GLS-GSL	dist	l-fri	g	Small A horizon forming at top; many vf-m roots; common subangular pebbles-cobbles.
	89-101	12	Ap2	5YR 4/4	CL	dist	fi-vfi	g	Few cinders; few ang-subang pebbles.
	101-110	9	Ap2/Ap3						Transitonal zone between material above and below.
	110-130	20	Ap3	5YR 4/2	SCL	dist	l-fri	g	Mixed - cinders and SCL; many f-c brick frags; many cinders;
FILL	130-183	20	Ap4	10YR 2/1	G	dist	l	c	Mostly cinders with very little sandy matrix; few organics; looks burned.
	183-232	16	5C	10YR 2/1	SiC	mass	fri	c	Organic mat, many fine roots and rootlets; no other inclusions discernable.
SALT MARSH	232-254	22	6C	Gley1 3/N	SiC	mass	st	g	Very few rootlets; petroleum smell.
FILL	254-357	103	7C	10YR 8/2 Gley1 4/N	mixed	dist	ss	n/a	Mixed silty clayish waste; only goes to 278 cm because segment was broken off.
	357-450	93	8A	5Y 2.5/1	SiC	mass-1pl	st	n/a	Organic rich with organics decreasing down the profile, rootlets/medium roots; RC date 1700±30 B.P. (Beta-309855); sampled for pollen at 425-430 cm.
	450-500	50	8AB	5Y 2.5/1	SC	mass-1sbk	st	g	Organic rich, common fine roots and rootlets; gets slightly lighter in color downward.
	500-535	35	8Bw1	5Y 4/1	SC-SCL	mass-1sbk	slst	g	Less clay content than material above; few medium root casts; few f-m roots; RC date 2670±30 B.P. (Beta-309856)
	535-576	41	8C1	5Y 4/1	LS-SL	mass	fri	c	No organics discernable; few vf shell frags; few pea-size gravels.
SOIL	576-589	13	8C2	5Y 4/1	LS-SL	mass-1sbk	fri-slfi	g	No organics discernible; very well sorted.
FLUVIAL	589-600	11	9C	7.5YR 4/3	SL-LS	strat	fri	n/a	Faint, fine layering: dark material, grayish brown, brown; no organics discernible; clay rip-ups

Texture: Si=silt; L=loam; C=clay; S=sand; F=fine; V=very; G=gravel; O=organic:

Structure: 1=weak; 2= moderate; 3=strong; f=fine; m=medium; c=coarse
gr=granular; mass=massive; strat=stratified; sbk=subangular blocky; ab=angular blocky; pr=prismatic
pl=platy; w=wedge; dist=disturbed/no structure

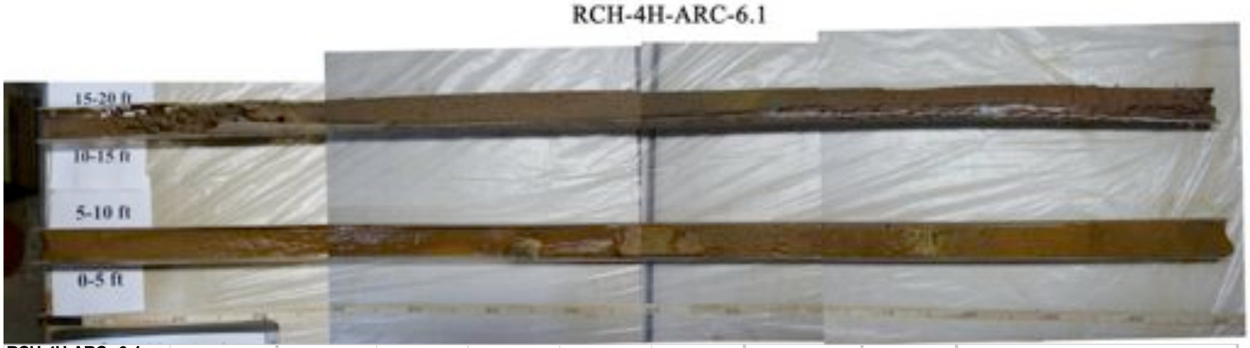
Consistence: fri=friable; sl=slightly; v=very; l=loose; fi=firm; h=hard; st=sticky; ss=strongly sticky

Boundary Distinctness: a-abrupt; c=clear; d=diffuse; g=gradual; s=sharp

Boundary Topography: w=wavy; s=smooth; a=abrupt

Miscellaneous: n/a=not applicable; n/r=not recorded

RCH-4H-ARC-6.1

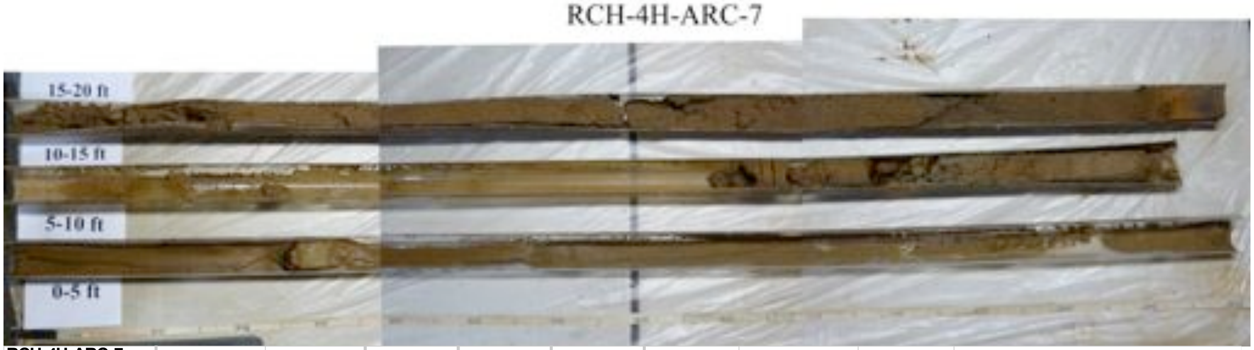


RCH-4H-ARC- 6.1

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
FILL (PAVEMENT, WET SUBSTRATUM-LAGUARDIA-EBBETS COMPLEX)	0-11	11	Ap1	10YR 2/1		dist	efi	s	Asphalt
	11-22	11	Ap2	10YR 2/1	GSiL	dist	l-slfi	c	Gravel bed.
	22-44	22	Ap3	10YR 2/2	G	dist	l	n/a	Moslty ang-subang cobbles; very little matrix.
	44-66	22	Ap4	10YR 3/3	SL	dist	l-slfi	n/a	Very few pebbles; well sorted.
	66-225	159	Ap5	7.5YR 4/4	SL	dist	l-slfi	n/a	Water table encountered at about 110 cm; 1 large pebble.
	225-235	10	2C1	10YR 4/4 10YR 5/2	SiCL	mass-cr	slfi-fi	g	Mixed; no inclusions discernible.
	235-263	28	2C2	10YR 4/4	LS	mass	fri	c	Many v. fine shell frags; few small gravels.
	263-267	4	3C	2.5Y 6/2	SiCL	mass-cr	fi	c	Some Fe stains; no inclusions discernible.
	267-300	33	4C	10YR 4/4	LS	mass	fri	n/a	Many v. fine shell frags; few small gravels.
	300-346	46	5C	10YR 5/3	F-MS	mass	l-slfi	n/a	Described in field; no discernible inclusions.
	346-380	34	6C1	2.5Y 5/2	FS	mass	l-slfi	n/a	Described in field; no discernible inclusions.
	380-470	90	6C2	10YR 5/3	F-MS	mass	l-slfi	n/a	Described in field; no discernible inclusions.
	470-540	70	7C1	10YR 4/2	LS	mass	fri	g	Common v.f. shell frags; v. few, fine gravels.
SHORELINE	540-545	5	7C2	2.5Y 5/3	LS	mass	fri	c	Slightly finer than material above (489-540 cm) and better sorted.
FLUVIAL	545-600	55	8C	7.5YR 4/3	SL	cr-1sbk	fri-slfi	n/a	Many clay rip-ups; many v.fine shell frags; krotovina or root casts at top, no organics discernible- does not look like a paleosol.

Texture:	Si=silt; L=loam; C=clay; S=sand; F=fine; V=very; G=gravel; O=organic:
Structure:	1=weak; 2= moderate; 3=strong; f=fine; m=medium; c=coarse
	gr=granular; mass=massive; strat=stratified; sbk=subangular blocky; ab=angular blocky; pr=prismatic
	pl=platy; dist=disturbed/no structure
Consistence:	fri=friable; sl=slightly; v=very; e=extremely; l=loose; fi=firm; h=hard; st=sticky; ss=strongly sticky
Boundary Distinctness:	a-abrupt; c=clear; d=diffuse; g=gradual; s=sharp
Boundary Topography:	w=wavy; s=smooth; a=abrupt
Miscellaneous:	n/a=not applicable; n/r=not recorded

RCH-4H-ARC-7



RCH-4H-ARC-7

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
FILL (PAVEMENT, WET SUBSTRATUM-LAGUARDIA-EBBETS	0-11	11	Ap1	10YR 2/1		dist	efi	s	Asphalt.
	11-44	33	Ap2	10YR 2/2	G	dist		c	Gravel bed.
	44-176	44	Ap3	10YR 4/4	SL	gr	fri	n/a	Few, subangular pebbles; encountered water table at 55-66 cm.
SLURRY	176-300	24	n/a	n/a	n/a	n/a	n/a	n/a	Mostly slurry with one intact area from 184-189 cm, but not sure if it moved during transport.
MISSING	300-392	92	n/a	n/a	n/a	n/a	n/a	n/a	Poor recovery.
SHORELINE	392-463	58	2C1	7.5YR 5/6	LS	gr-1sbk	fri	n/a	Very few, very fine shell frags.
	463-592	117	2C2	7.5YR 5/4	LS	gr-1sbk	fri	n/a	same as 392-450 cm.
	592-595	3	3C	7.5YR 5/6	SCL	2sbk	fi-vfi	g	Charcoal lens at contact w/ material above (475-592 cm); some Fe stains; sampled 592-594 cm for charcoal.
	595-600	5	4C	7.5YR 4/3	SiCL	2sbk	fi-vfi	n/a	No inclusions discernible.

Texture:	Si=silt; L=loam; C=clay; S=sand; F=fine; V=very; G=gravel; O=organic:
Structure:	1=weak; 2= moderate; 3=strong; f=fine; m=medium; c=coarse
	gr=granular; mass=massive; strat=stratified; sbk=subangular blocky; ab=angular blocky; pr=prismatic
	pl=platy; dist=disturbed/no structure
Consistence:	fri=friable; sl=slightly; v=very; e=extremely; l=loose; fi=firm; h=hard; st=sticky; ss=strongly sticky
Boundary Distinctness:	a-abrupt; c=clear; d=diffuse; g=gradual; s=sharp
Boundary Topography:	w=wavy; s=smooth; a=abrupt
Miscellaneous:	n/a=not applicable; n/r=not recorded

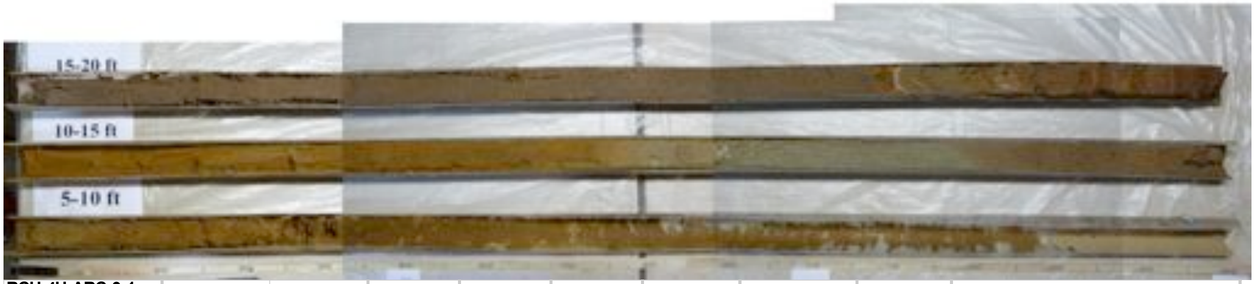
RCH-4H-ARC-8

RCH-4H-ARC-8

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
FILL (PAVEMENT, WET SUBSTRATUM-LAGUARDIA-EBBETS COMPLEX)	0-11	11	Ap1	10YR 2/1		dist	efi	n/a	Asphalt
	11-44	33	Ap2	10YR 2/2	G	dist	l	n/a	Gravel bed.
	44-66	22	Ap3	7.5YR 4/6	SL	dist	gr	n/a	Mottles: 10YR 3/3; very few subang pebbles; wet.
	66-88	22	Ap4	7.5YR 4/4	SL	dist	gr	n/a	Mottles: 10YR 3/3; very few subang pebbles; very wet.
	88-188	100	2C	10YR 5/6	SCL	gr	1sbk	n/a	Mottles: 10YR 3/3; very few subang pebbles; water table encountered between 110-132 cm.
SHORELINE	188-273	85	3C1	10YR 4/6	LS	sg-cr	l-fri	g	Common, fine shell frags; few clay rip-ups.
	300-450	143	3C2	10YR 4/6	LS C	mass	fri-fi	c	Mixed - higher energy; similar to 200-273 cm, but contains many more rip-ups throughout, except at base.
SOIL	450-465	14	4A	Gley1 3/N	LS-SL	sg-cr	l-fri	g	Looks like a paleosol; charcoal present; RC date on organics, 16,940±60 B.P. (Beta-309857); pollen sampling at 460-464 cm
	465-475	10	4Bw	10YR 4/3	SL	cr	fri-slfi	g	Few fine shell frags; few faint root casts.
	475-503	28	4BC	10YR 4/6 10YR 4/4	SL LS	mass	fri-slfi l-fri	g	Mixed; common fine shell frags in loamy sand.
	503-584	77	4C	10YR 4/4	LS	mass-cr	l-fri	c	Common fine shell frags; sampled 520-530 cm for pollen.
FLUVIAL	584-600	9	5C	10YR 4/4 5YR 4/4	LS SiCL	strat	fri	n/a	Alternating LS and SiCL; mostly LS; faint stratification; few fine pebbles.

Texture:	Si=silt; L=loam; C=clay; S=sand; F=fine; V=very; G=gravel; O=organic:
Structure:	1=weak; 2= moderate; 3=strong; f=fine; m=medium; c=coarse
	gr=granular; mass=massive; strat=stratified; sbk=subangular blocky; ab=angular blocky; pr=prismatic
	pl=platy; dist=disturbed/no structure
Consistence:	fri=friable; sl=slightly; v=very; l=loose; fi=firm; h=hard; st=sticky; ss=strongly sticky
Boundary Distinctness:	a-abrupt; c=clear; d=diffuse; g=gradual; s=sharp
Boundary Topography:	w=wavy; s=smooth; a=abrupt
Miscellaneous:	n/a=not applicable; n/r=not recorded

RCH-4H-ARC-9.1



RCH-4H-ARC-9.1

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
FILL (PAVEMENT, WET SUBSTRATUM-LAGUARDIA-EBBETS COMPLEX)	0-11	11	Ap1	10YR 2/1		mass	efi	s	Asphalt.
	11-44	33	Ap2	10YR 2/2	G	mass	l	c	Gravel bed.
	44-66	22	Ap3	7.5YR 4/6	SL	sg	l	n/a	Very few subang pebbles
	66-88	22	Ap4	7.5YR 4/4	SL	sg	l	n/a	Mottles: 10YR 3/3; very few subang pebbles; water table encountered at 88 cm.
	88-132	44	2C	10YR 2/1	SL	sg	l	n/a	Mottles: 10YR 3/3; very few subang pebbles.
	132-176	44	3C	10YR 5/4	SCL	gr-1sbk	fri-slfi	n/a	Mottles: 10YR 3/3; very few subang pebbles; very wet.
SHORELINE	176-250	74	4C1	10YR 4/6	SL	cr-1sbk	fri-slfi	g	Few fine shell frags.
	250-377	127	4C2	10YR 4/6	SL-LS	cr-1sbk	fr-slfi	g	Common fine shell frags; well sorted.
	377-420	43	5C	2.5Y 5/2	SL-LS	1sbk	slfi	g	Common fine shell frags; well sorted; wet.
	420-450	30	6C1	10YR 4/3	LS-SL	1sbk	slfi	g	Few charcoal flecks; common clay balls; sampled 434-441 cm for charcoal.
	450-559	109	6C2	10YR 4/3	LS-SL	1sbk	slfi		Same as 420-450 cm, but no charcoal.
FLUVIAL	559-560	1	7C1	7.5YR 4/4	SL-LS	cr-1sbk	fri-slfi	c	Very well sorted.
	560-561	1	7C2	5YR 4/4	SiCL	mass-1sbk	slfi-fi	c	Probably a lens.
	559-571	10	7C3	10YR 5/3	LS	mass	l-fri	g	None.
	571-600	29	8C	7.5YR 4/3 7.5YR 4/3	SiCL SCL	1sbk cr	fi-slfi fri-slfi	n/a	Alternating sequence of SiCL and SCL, with SiCL being thicker; SCL contains few rounded pebbles.

Texture:	Si=silt; L=loam; C=clay; S=sand; F=fine; V=very; G=gravel; O=organic:
Structure:	1=weak; 2= moderate; 3=strong; f=fine; m=medium; c=coarse
	gr=granular; mass=massive; strat=stratified; sbk=subangular blocky; ab=angular blocky; pr=prismatic
	pl=platy; dist=disturbed/no structure
Consistence:	fri=friable; sl=slightly; v=very; l=loose; fi=firm; h=hard; st=sticky; ss=strongly sticky
Boundary Distinctness:	a-abrupt; c=clear; d=diffuse; g=gradual; s=sharp
Boundary Topography:	w=wavy; s=smooth; a=abrupt
Miscellaneous:	n/a=not applicable; n/r=not recorded

RCH-4H-ARC-10

RCH-4H-ARC-10

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
FILL (PAVEMENT, WET SUBSTRATUM-LAGUARDIA-EBBETS COMPLEX)	0-15	15	Ap1	10YR 2/1		dist	efi	s	Asphalt.
	15-66	51	Ap2	10YR 2/2	G	dist	l	c	Gravel bed.
	66-110	44	Ap3	2.5Y 3/2	SL	dist	l-slfri	n/a	Water table at bottom.
	88-150	62	Ap4	2.5Y 3/2	M-FS	dist	l-slfri	n/a	Fine brick frags; subang gravels.
	150-300	150	2C	2.5Y 4/3	M-FS	mass	n/r	n/a	Described in field; many Fe oxide features; few reduced Fe features.
	300-367	67	3C1	7.5YR 4/3	SL	cr-1sbk	fri	g	Common, vf shell frags; well sorted.
	367-405	38	3C2	5YR 4/3	SCL	cr-1sbk	st	g	Very few subr-subang pebbles.
SHORELINE	405-436	31	3C3	5YR 4/3	SC	mass	st	s	Small clay rip-ups; charcaol flecks throughout; sampled from 424-427 cm.
	436-450	14	4C	5YR 3/3	SL	cr-1sbk	fri	n/a	Contact seems to be truncated; charcoal at contact w/ material above; sampled 437-440 cm.
SHORELINE/FLUVIAL	450-600	150	5C	5YR 4/3 - 5YR 4/6	M-FS	mass	n/r	n/a	Described in field; very few inclusions.

Texture:	Si=silt; L=loam; C=clay; S=sand; F=fine; V=very; G=gravel; O=organic
Structure:	1=weak; 2= moderate; 3=strong; f=fine; m=medium; c=coarse
	gr=granular; mass=massive; strat=stratified; sbk=subangular blocky; ab=angular blocky; pr=prismatic
	pl=platy; dist=disturbed/no structure
Consistence:	fri=friable; sl=slightly; v=very; e=extremely; l=loose; fi=firm; h=hard; st=sticky; ss=strongly sticky
Boundary Distinctness:	a-abrupt; c=clear; d=diffuse; g=gradual; s=sharp
Boundary Topography:	w=wavy; s=smooth; a=abrupt
Miscellaneous:	n/a=not applicable; n/r=not recorded

RCH-4H-ARC-11.1

RCH-4H-ARC-11.1

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
FILL (PAVEMENT,	0-44	44	Ap1	10YR 2/1	G	dist	efi	s	Asphalt.
WET	44-66	22	Ap2	7.5YR 3/1	SL	dist	l	c	Moderately to well-sorted.
SUBSTRATUM-LAGUARDIA-	66-88	22	Ap3	7.5YR 3/1	S	dist	l	n/a	Gleyed sandy clay nodules; water table encountered at base.
	88-110	22	Ap4	10YR 4/2	SCL	dist		n/a	Moderately to well-sorted.
	110-217	107	2C	5YR 4/6	SCL	gr-1sbk		g	Moderately to well-sorted.
	217-293	76	3C1	5YR 4/4	SL	gr	fri	g	Common, very fine shell frags; few clay balls
	293-319	26	3C2	5YR 4/3	SC	mass	st	g	No inclusions discernable.
	319-339	20	4C1	2.5Y 4/4	SL	gr	fri	c	No inclusions discernable.
SHORELINE	339-401	62	4C2	2.5YR 4/3	CL	pl	vfi	s	Few subang pebbles; slight petroleum smell.
	401-427	26	5C1	5YR 4/3	SL	gr-strat		g	Few faint black laminations.
	427-450	23	5C2	7.5YR 4/3	SL-LS	gr-strat	fri	g	Contains less clay than material above; common, faint black laminations similar to those above (401-427 cm); sand is slightly coarser than material above.
	450-576	126	6C1	7.5YR 4/3	SL-LS	2ab-1sbk	fi	g	Similar to material above (427-450 cm), but laminations are absent; 1 clay rip-up; common, fine Mn nodes; clay content diminishes down the unit.
FLUVIAL	576-600	24	6C2	5YR 4/3	SL	gr-1sbk	fri-slfi	n/a	Few clay rip-ups; vew few subr-subang pebbles; sand is finer than material above (450-576 cm).

Texture:	Si=silt; L=loam; C=clay; S=sand; F=fine; V=very; G=gravel; O=organic:
Structure:	1=weak; 2= moderate; 3=strong; f=fine; m=medium; c=coarse
	gr=granular; mass=massive; strat=stratified; sbk=subangular blocky; ab=angular blocky; pr=prismatic
	pl=platy; dist=disturbed/no structure
Consistence:	fri=friable; sl=slightly; v=very; l=loose; fi=firm; h=hard; e=extremely; st=sticky; ss=strongly sticky
Boundary Distinctness:	a-abrupt; c=clear; d=diffuse; g=gradual; s=sharp
Boundary Topography:	w=wavy; s=smooth; a=abrupt
Miscellaneous:	n/a=not applicable; n/r=not recorded

RCH-4H-ARC-12

RCH-4H-ARC-12

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
PAVEMENT, WET SUBSTRATUM-LAGUARDIA-EBBETS COMPLEX	0-11	11	Ap1	10YR 2/2		dist	efi	s	Angular pebbles consolidated in petroleum-based matrix.
	11-44	33	Ap2	10YR 3/2 - 10YR 2/2	G	dist	l	c	Mostly gravel-based roadbed.
	44-88	22	Ap3	5YR 4/4	GSL	dist	l-fri	n/a	Coarse ang-subang cobbles and rounded pebbles.
	88-176	22	Ap4	2.5Y 4/3	SC	dist	fi	n/a	Gleyed band at ~132 cm; sand content increases down the unit.
MISSING	176-267	100	n/r	n/r	n/r	n/r	n/r	n/r	Poor recovery.
SHORELINE	267-353	33	2C	7.5YR 4/4	LS-SL	cr-1sbk	fri	g	Many fine shell frags; Mn stains.
	353-450	97	3C	5YR 4/4	SiC	mass	slst	n/a	Common subang-subr gravel; plastic object at 375-378 cm (half-dome with vertical slits - part of drillling rig?, found in the middle of the core.
Not collected	450-600	150	n/r	n/r	n/r	n/r	n/r	n/r	Not collected.

Texture:	Si=silt; L=loam; C=clay; S=sand; F=fine; V=very; G=gravel; O=organic:
Structure:	1=weak; 2= moderate; 3=strong; f=fine; m=medium; c=coarse
	gr=granular; mass=massive; strat=stratified; sbk=subangular blocky; ab=angular blocky; pr=prismatic
	pl=platy; dist=disturbed/no structure
Consistence:	fri=friable; sl=slightly; v=very; e=extremely; l=loose; fi=firm; h=hard; st=sticky; ss=strongly sticky
Boundary Distinctness:	a-abrupt; c=clear; d=diffuse; g=gradual; s=sharp
Boundary Topography:	w=wavy; s=smooth; a=abrupt
Miscellaneous:	n/a=not applicable; n/r=not recorded

RCH-4H-ARC-13

RCH-4H-ARC-13

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
	0-22	22	Ap1	10YR 2/1		dist	efi	s	Asphalt
FILL	22-44	22	Ap2	5YR 4/3	SiCL	dist	l	n/a	Ang-subang cobbles of asphalt.
(PAVEMENT,	44-66	22	Ap3	5YR 4/6	SiCL	dist	l-fri	n/a	Ang-subang cobbles of asphalt.
WET SUBSTRATUM-	66-88	22	Ap4	5YR 4/6	SiCL	1sbk	l-fri	n/a	Similar to material above, but asphalt cobbles are absent.
LAGUARDIA-	88-110	22	Ap5		SCL	gr-1sbk	fri	n/a	Water table encountered.
EBBETS COMPLEX)	110-201	91	Ap6	10YR 5/6	SC	mass	slst	n/a	No inclusions discernible; very wet.
	201-233	32	2A	7.5YR 4/4	LS	cr-1sbk	fri	c	Very few organics, not enough to collect; could be a paleosol.
SOIL	233-234	1	2C	7.5YR 5/6	SL-SCL	cr	fri-slst	c	No inclusions discernible.
	234-240	6	3C1	10YR 4/3	SL	cr-1sbk	fri-slfi	g	Clay rip-ups at base.
	240-262	22	3C2	5YR 3/4	SCL	1sbk	slst	g	Many clay rip-ups, and they are same color as matrix.
	262-320	58	3C3	5YR 4/4 5YR 4/4	CL SCL	mass mass	st slst	c	Alternating CL and SCL; CL dominates from 282-300 cm; few clay rip-ups in which some are same color and others gleyed; sampled 292-296 cm for C14.
	320-351	31	4C1	7.5YR 3/4	SL	cr-1sbk	fri-slfi	g	Few rounded pea-size pebbles.
	351-450	99	4C2	5YR 3/3	SiCL	1ab-1sbk	slfi-fi	g	Few subr-subang pebbles; Mn nodules (look like charcoal).
	450-508	58	5C	10YR 4/4	LS	l-mass	sg-fri	c	Very well sorted - no discernible inclusions.
SHORELINE	508-576	68	6C	5YR 4/4	SiC	1ab-1sbk	fi-vfi	s	Common Mn nods; few clay rip-ups; v.few subrounded pebbles.
FLUVIAL	576-600	24	7C	7.5YR 3/4	LS-SL	strat/1sbk	fri-slfi	n/a	Very faint layering, some of the bands are darker like Mn oxide; no discernible inclusions.

Texture:	Si=silt; L=loam; C=clay; S=sand; F=fine; V=very; G=gravel; O=organic:
Structure:	1=weak; 2= moderate; 3=strong; f=fine; m=medium; c=coarse
	gr=granular; mass=massive; strat=stratified; sbk=subangular blocky; ab=angular blocky; pr=prismatic
	pl=platy; dist=disturbed/no structure
Consistence:	fri=friable; sl=slightly; v=very; e=extremely; loose; fi=firm; h=hard; st=sticky; ss=strongly sticky
Boundary Distinctness:	a-abrupt; c=clear; d=diffuse; g=gradual; s=sharp
Boundary Topography:	w=wavy; s=smooth; a=abrupt
Miscellaneous:	n/a=not applicable; n/r=not recorded

RCH-4H-ARC-14

RCH-4H-ARC-14

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
FILL (PAVEMENT, WET SUBSTRATUM-LAGUARDIA-EBBETS COMPLEX)	0-11	11	Ap1	10YR 2/1		dist	efi	s	Asphalt.
	11-44	33	Ap2	10YR 2/2	G	dist	l	c	Gravel base.
	44-66	22	Ap3	2.5YR 4/4	SiCL	gr-1sbk	fri-slfi	n/a	Very few, rounded pebbles.
	66-176	110	Ap4	2.5YR 4/4	SiCL	1sbk	slfi	n/a	Water table encountered at about 88 cm.
	176-252	76	Ap5	5YR 4/4	SC	mass/dist	vst	g	Many angular-subangular pebbles and cobbles; very wet.
	252-575	232	Ap6/2C1	5YR 4/4	SiC-SiCL	mass-pl	fi-vfi	g	Few angular to subangular pebbles that increase slightly down the unit.
	575-587	12	Ap7/2C2	5YR 4/4	G	mass	l	c	Subangular-subrounded cobbles in a matrix similar to 450-575 cm.
FLUVIAL	587-600	13	3C	5YR 4/3	CL	weg-pl	vfi-h	n/a	Very few, very fine inclusions of coarse sand.

Texture:	Si=silt; L=loam; C=clay; S=sand; F=fine; V=very; G=gravel; O=organic:
Structure:	1=weak; 2= moderate; 3=strong; f=fine; m=medium; c=coarse
	gr=granular; mass=massive; strat=stratified; sbk=subangular blocky; ab=angular blocky; pr=prismatic
	pl=platy; weg=wedge; dist=disturbed/no structure
Consistence:	fri=friable; sl=slightly; v=very; e=extremely; l=loose; fi=firm; h=hard; st=sticky; ss=strongly sticky
Boundary Distinctness:	a-abrupt; c=clear; d=diffuse; g=gradual; s=sharp
Boundary Topography:	w=wavy; s=smooth; a=abrupt
Miscellaneous:	n/a=not applicable; n/r=not recorded

RCH-4H-ARC-15

RCH-4H-ARC-15

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
FILL (PAVEMENT, WET SUBSTRATUM-LAGUARDIA-EBBETS COMPLEX)	0-11	11	Ap1	10YR 2/1		dist	efi	s	Asphalt.
	11-22	11	Ap 2		G	dist	l	c	Gravel base.
	22-44	22	Ap3	10YR 3/3	GS	dist	l	n/a	Mosly gravel with very little sandy matrix.
	44-66	22	Ap4	10YR 3/3	GSL	dist	fri-slfi	n/a	Clay inclusions: 2.5YR 4/4;
	66-176	110	Ap5	2.5YR 4/4	SiCL	dist	slfi-fi	n/a	Few subangular pebbles.
	176-600	441	Ap6	5YR 4/3	SiC	dist	fi-vfi	n/a	Common, subrounded-subangular pebbles; petroleum smell; few fine brick frags throughout.

Texture:	Si=silt; L=loam; C=clay; S=sand; F=fine; V=very; G=gravel; O=organic:
Structure:	1=weak; 2= moderate; 3=strong; f=fine; m=medium; c=coarse
	gr=granular; mass=massive; strat=stratified; sbk=subangular blocky; ab=angular blocky; pr=prismatic
	pl=platy; dist=disturbed/no structure
Consistence:	fri=friable; sl=slightly; v=very; l=loose; fi=firm; h=hard; st=sticky; ss=strongly sticky
Boundary Distinctness:	a-abrupt; c=clear; d=diffuse; g=gradual; s=sharp
Boundary Topography:	w=wavy; s=smooth; a=abrupt
Miscellaneous:	n/a=not applicable; n/r=not recorded

RCH-4H-ARC-16

RCH-4H-ARC-16

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
FILL (PAVEMENT, WET SUBSTRATUM-LAGUARDIA-EBBETS COMPLEX)	0-18	18	Ap1	10YR 2/1		dist	efi	s	Asphalt
	18-22	4	Ap2	10YR 2/2	G	dist	l	c	Gravel base.
	22-44	22	Ap3	5YR 4/6	SL	dist	fri	n/a	Few, medium, angular gravels.
	44-66	22	Ap4	5YR 4/6	SL	dist	fri	n/a	None.
	66-88	22	Ap5	5YR 2/4	SCL	dist	fri-slfi	n/a	No inclusions discernible.
	88-110	22	Ap6	2.5YR 3/3	SC	dist	st	n/a	Sand coarsens upward from fine to medium.
	110-132	22	Ap7	2.5YR 3/3	GSCL	dist	l-fi	n/a	Many pebbles throughout.
	132-154	22	Ap8	2.5YR 4/3	GSCL	dist	l-fri	n/a	Many subr-subang pebbles; water table encountered at base.
	154-198	44	Ap9	2.5YR 4/3	G	dist	l	n/a	Composed of m-c gravel.
	198-300	102	Ap10/2C	2.5YR 4/3	SiCL	1ab/dist	fi-vfi	n/a	Many clay balls; many subang-subr large pebbles.
	300-326	26	Ap11/3C	7.5YR 4/3	LS	gr	l	c-s	No inclusions discernible.
FILL/SHORELINE	326-600	274	Ap12/4C	2.5YR 4/3	SiCL	1ab/dist	fi-vfi	n/a	None.

Texture:	Si=silt; L=loam; C=clay; S=sand; F=fine; V=very; G=gravel; O=organic:
Structure:	1=weak; 2= moderate; 3=strong; f=fine; m=medium; c=coarse
	gr=granular; sg= single grain; mass=massive; strat=stratified; sbk=subangular blocky; ab=angular blocky; pr=prismatic
	pl=platy; weg=wedge; dist=disturbed/no structure
Consistence:	fri=friable; sl=slightly; v=very; e=extremely; l=loose; fi=firm; h=hard; st=sticky; ss=strongly sticky
Boundary Distinctness:	a-abrupt; c=clear; d=diffuse; g=gradual; s=sharp
Boundary Topography:	w=wavy; s=smooth; a=abrupt
Miscellaneous:	n/a=not applicable; n/r=not recorded

RCH-4H-ARC-17

RCH-4H-ARC-17

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
	0-11	11	Ap1	10YR 2/1		dist	efi	s	Asphalt.
	11-22	11	Ap2	10YR 2/2	G	dist	l		Gravel base.
	22-44	22	Ap3	5YR 5/8	SL	dist	l-fri	c	Very few medium, subang pebbles.
FILL	44-150	106	Ap4	5YR 4/4	SL	dist	l-fri	n/a	Very few medium, subang pebbles.
	150-187	37	2C	5YR 3/3	SL	mass	fri-slfi	g	Common subr-subang gravels.
	187-264	77	2C2	5YR 3/3	GSCL	sg-mass	l	c	Mostly subr-subang gravels with little SCL matrix; very wet.
	264-277	13	3C	5YR 3/3	SCL	cr-1sbk	fri-slfi	g	Very fine sand with appreciable amount of silt.
	277-317	40	4C1	5YR 3/3	SiCL	pl	fi-vfi	g	Few subrounded pebbles.
SHORELINE	317-600	283	4C2	5YR 3/3	SiCL	pl	fi-vfi	n/a	Similar to material from 277-287 cm, but pebbles are more common; few clay balls; 1 cobble inclusion.

Texture:	Si=silt; L=loam; C=clay; S=sand; F=fine; V=very; G=gravel; O=organic:
Structure:	1=weak; 2= moderate; 3=strong; f=fine; m=medium; c=coarse
	gr=granular; mass=massive; strat=stratified; sbk=subangular blocky; ab=angular blocky; pr=prismatic
	pl=platy; dist=disturbed/no structure
Consistence:	fri=friable; sl=slightly; v=very; l=loose; fi=firm; h=hard; st=sticky; ss=strongly sticky
Boundary Distinctness:	a-abrupt; c=clear; d=diffuse; g=gradual; s=sharp
Boundary Topography:	w=wavy; s=smooth; a=abrupt
Miscellaneous:	n/a=not applicable; n/r=not recorded

RCH-5H-ARC-1
Photograph Not Available

RCH-5H-ARC-1

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
FILL (PAVEMENT, LAGUARDIA-EBBETS COMPLEX)	0-22	22	Ap1	10YR 2/1		dist	efi	s	Asphalt
	22-44	22	Ap2	7.5YR 3/4	SL	dist	l-fri	n/a	Few subang rocks; mottles (5YR 4/6).
	44-66	22	Ap3	7.5YR 4/4	SL	dist	l-fri	n/a	Few subang rocks.
	66-88	22	Ap4	7.5YR 4/4	SCL	dist	fri-slfi	n/a	Similar to above, but clay content increases towards the bottom.
	88-176	88	Ap5	5YR 4/4	SCL	dist	fri-slfi	n/a	Very few rock frags; encountered concrete at base of unit, no further drilling was possible.

Texture:	Si=silt; L=loam; C=clay; S=sand; F=fine; V=very; G=gravel; O=organic:
Structure:	1=weak; 2= moderate; 3=strong; f=fine; m=medium; c=coarse
	gr=granular; sg= single grain; mass=massive; strat=stratified; sbk=subangular blocky; ab=angular blocky; pr=prismatic
	pl=platy; weg=wedge; dist=disturbed/no structure
Consistence:	fri=friable; sl=slightly; v=very; e=extremely; l=loose; fi=firm; st=sticky; ss=strongly sticky
Boundary Distinctness:	a-abrupt; c=clear; d=diffuse; g=gradual; s=sharp
Boundary Topography:	w=wavy; s=smooth; a=abrupt
Miscellaneous:	n/a=not applicable; n/r=not recorded

RCH-5H-ARC-2
Photograph Not Available

RCH-5H-ARC-2	Entirely described in field due to contamination.								
Unit	**Depth (cm)**	**Thickness (cm)**	**Soil Horizon**	**Munsell Color**	**Texture**	**Structure**	**Consistence**	**Boundary**	**Comments**
FILL (PAVEMENT, WET SUBSTRATUM-LAGUARDIA-EBBETS COMPLEX)	0-11	11	Ap1	10YR 2/1		dist	efi	n/a	Asphalt
	11-22	11	Ap2		G	dist	l	n/a	Gravel base
	22-44	22	Ap3	7.5YR 3/4	SL	dist	l-fri	n/a	Few, subangular pebbles.
	44-66	22	Ap4	7.5YR 5/8	SL	dist	l-fri	n/a	Very few subrounded rocks; mottles: 7.5YR 3/4.
	66-88	22	Ap5	7.5YR 4/6	GSL	dist	l-fri	n/a	Common pebbles.
	88-110	22	Ap6	7.5YR 4/6	SCL	dist	fri-slfi	n/a	Few, subrounded pebbles.
	110-176	66	Ap7	7.5YR 3/4	SCL	dist	fri-slfi	n/a	Few, subrounded pebbles; mottles: 2.5YR 4/6; sewage-like odor; high PID reading towards the base.
	176-300	124	Ap8	7.5YR 3/4	SiCL	dist	slfi-fi	n/a	Very wet.
	300-600	300	Ap9	7.5YR 3/4	SiCL	dist	slfi-fi	n/a	Mottles: 2.5YR 4/6.

Texture:	Si=silt; L=loam; C=clay; S=sand; F=fine; V=very; G=gravel; O=organic:
Structure:	1=weak; 2= moderate; 3=strong; f=fine; m=medium; c=coarse
	gr=granular; sg= single grain; mass=massive; strat=stratified; sbk=subangular blocky; ab=angular blocky; pr=prismatic
	pl=platy; weg=wedge; dist=disturbed/no structure
Consistence:	fri=friable; sl=slightly; v=very; e=extremely; l=loose; fi=firm; st=sticky; ss=strongly sticky
Boundary Distinctness:	a-abrupt; c=clear; d=diffuse; g=gradual; s=sharp
Boundary Topography:	w=wavy; s=smooth; a=abrupt
Miscellaneous:	n/a=not applicable; n/r=not recorded

RCH-5H-ARC-3

RCH-5H-ARC-3

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
	0-11	11	Ap1	10YR 2/1		dist	efi	s	Asphalt.
	11-22	11	Ap2	10YR 2/2	GSL	dist	l	c	Gravel base.
	22-44	22	Ap3	10YR 3/3	GSL	dist	l	n/a	Common subrounded pebbles.
	44-66	22	Ap4	2.5YR 4/4	SL	dist	l-fri	n/a	Very few subrounded pebbles.
	66-176	110	Ap5	2.5YR 4/4	SiCL	dist	slfi	n/a	Very few subrounded pebbles.
FILL (PAVEMENT, INWOOD-LAGUARDIA-EBBETS COMPLEX)	150-600	450	Ap6	n/r	SiC-C	dist	n/r	n/a	Entire sequence is composed of a reddish SiC or C waste material that has a very strong petroleum smell. It contains rock frags. Appears highly contaminated. Photographed then disposed of in steel drum.

Texture:	Si=silt; L=loam; C=clay; S=sand; F=fine; V=very; G=gravel; O=organic:
Structure:	1=weak; 2= moderate; 3=strong; f=fine; m=medium; c=coarse
	gr=granular; mass=massive; strat=stratified; sbk=subangular blocky; ab=angular blocky; pr=prismatic
	pl=platy; dist=disturbed/no structure
Consistence:	fri=friable; sl=slightly; v=very; e=extremely; l=loose; fi=firm; h=hard; st=sticky; ss=strongly sticky
Boundary Distinctness:	a-abrupt; c=clear; d=diffuse; g=gradual; s=sharp
Boundary Topography:	w=wavy; s=smooth; a=abrupt
Miscellaneous:	n/a=not applicable; n/r-not recorded

RCH-5H-ARC-4

RCH-5H-ARC-4

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
FILL (PAVEMENT, INWOOD-LAGUARDIA-EBBETS COMPLEX)	0-11	11	Ap1	10YR 2/1		dist	efi	s	Asphalt.
	11-22	11	Ap2			dist	efi	s	Concrete.
	22-44	22	Ap3	10YR 3/1	GSCL	dist	l-slfi	n/a	Many, medium subang pebbles.
	44-66	22	Ap4	10YR 2/1	SiCL	dist	slfi-fi	n/a	Mottles: 2.5YR 5/4
	66-88	22	Ap5	5YR 3/2	GSCL	dist	1-slfi	n/a	Whiteware ceramics; misc metal wires; concrete; common, subang pebbles; mottles: 2.5YR 5/4.
	88-154	66	Ap6	5YR 3/4	SiCL	dist	slfi-fi	n/a	Shell frags; cinders; brick frags; wood frags; very few subr rocks; few mottles: 2.5YR 5/4.
	154-254	100	n/r	n/r	n/r	n/r	n/r	n/r	Poor recovery.
	254-267	13	Ap7	10YR 2/1	G	dist	l-vr	s	Asphalt with sandy loam matrix; mixed.
	267-430	163	Ap8	5YR 4/3	SiC	dist	slfi-fi	g	Few, fine brick frags; few subang-subr pebbles.
	430-450	20	Ap9	2.5YR 4/3	GSiCL	dist	fi	g	Many subang-subr pebbles.
	450-600	150	Ap10	2.5YR 4/3	GSiCL	dist	fi	n/a	Same as 430-450 cm but contains more inclusions - cobble at 495-499 cm; flat, rounded, stacked pebbles from 515-600 cm.

Texture:	Si=silt; L=loam; C=clay; S=sand; F=fine; V=very; G=gravel; O=organic:
Structure:	1=weak; 2= moderate; 3=strong; f=fine; m=medium; c=coarse
	gr=granular; sg= single grain; mass=massive; strat=stratified; sbk=subangular blocky; ab=angular blocky; pr=prismatic
	pl=platy; weg=wedge; dist=disturbed/no structure
Consistence:	fri=friable; sl=slightly; v=very; e=extremely; l=loose; fi=firm; h=hard; r=rigid; st=sticky; ss=strongly sticky
Boundary Distinctness:	a-abrupt; c=clear; d=diffuse; g=gradual; s=sharp
Boundary Topography:	w=wavy; s=smooth; a=abrupt
Miscellaneous:	n/a=not applicable; n/r=not recorded

RCH-5H-ARC-5

RCH-5H-ARC-5

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
	0-22	22	Ap1	10YR 3/2	SL	dist	fri-slfi	n/a	Very few rock frags; some clay balls.
	22-66	44	Ap2	7.5Y 4/3	SC	dist	slst	n/a	Very few subang pebbles; clay balls appear at 44 cm.
	66-110	44	Ap3	7.5Y 4/3	SCL	dist	n/r	n/a	Well sorted; consistence too wet to make out; sandier towards base of unit.
	110-132	22	Ap4	5YR 4/3	SCL	dist	slfi	n/a	Sandier
	132-176	44	Ap5	5YR 4/4	SCL	dist	slfi	n/a	Becomes sandier towards base of unit.
FILL (PAVEMENT, INWOOD-LAGUARDIA-EBBETS COMPLEX)	176-250	74	Ap6	7.5YR 4/3	LS	dist	l-slfi	g	Very few clay balls ~1cm; 1 flat sba rock frag ~3cm: clay ball attached to it with blackish color; round-sbr pebbles (also blackish); some mixing with layer below; v. wet.
SOIL	250-275	25	2A	10YR 3/1	LS	l-1sbk	slfi	g	material above; common, fine roots; looks like a paleosol; few subangular-subrounded small and large pebbles; radiocarbon date of 117.3±0.3 pMC (Beta-309858).
SOIL	275-308	33	2Bt1	5YR 4/4	SiC	1sbk	fi	g	Very few Mn surface coats at base; very few rounded gravels.
SOIL	308-480	172	2Bt2	5YR 4/4	SiC	2sbk	fi-vifi	g	Similar to material above (275-300 cm), but slightly lower silt content down the unit; few subang-subr medium-large pebbles.
SOIL	480-570	90	2Bt3	5YR 4/4	SiC	2sbk	fi-vfi	c	Similar to material above (300-450 cm), but with some greenish gray material at 523 cm that appears like weathered rock or shell - very little of it (~1 cm).
SOIL/FLUVIAL	570-600	30	2C	5YR4/4	LS	mass-gr	l-slfi	n/a	Very well sorted; no inclusions discernible.

Texture: Si=silt; L=loam; C=clay; S=sand; F=fine; V=very; G=gravel; O=organic:

Structure: 1=weak; 2= moderate; 3=strong; f=fine; m=medium; c=coarse
gr=granular; mass=massive; strat=stratified; sbk=subangular blocky; ab=angular blocky; pr=prismatic
pl=platy; dist=disturbed/no structure

Consistence: fri=friable; sl=slightly; v=very; l=loose; fi=firm; h=hard; st=sticky; ss=strongly sticky

Boundary Distinctness: a-abrupt; c=clear; d=diffuse; g=gradual; s=sharp

Boundary Topography: w=wavy; s=smooth; a=abrupt

Miscellaneous: n/a=not applicable

RCH-5H-ARC-6

RCH-5H-ARC-6

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
FILL (PAVEMENT, INWOOD-LAGUARDIA-EBBETS COMPLEX)	0-44	22	Ap1	10YR 2/1	GSL	dist	l	n/a	Asphalt; cinders; brick frags; some red clay balls.
	44-66	22	Ap2	10YR 2/1	SCL	dist	l	n/a	Few red clay balls; very wet.
	66-88	22	Ap3	10YR 2/1	LS	dist	l	n/a	Common red clay balls; very wet.
	88-110	22	Ap4	10YR 3/2	LS	dist	slfi	n/a	Brick frag; few cinders; few black clay balls; few subang rock frags.
	110-132	22	Ap5	10YR 3/2	LS	dist	slfi	n/a	Common silty clay balls.
	132-207	75	Ap6	10YR 3/2	SL	dist	l-slfi	n/a	Similar to material above but sandier with less silt and clay; few fine brick frags; clay balls increase in abundance and size down the unit.
SOIL	207-251	44	2A	2.5Y 4/2	LS	mass	l-fri	g	Few organics.
	251-326	75	2C1	7.5YR 4/4 5Y 4/2	LS LS	strat	l-fri	g	Alternating reddish gravelly sand (thicker) and grayish gravelly sand (thinner) that contain clay balls.
	326-378	52	2C2	7.5YR 4/4	LS	mass	l-fri	g	Some clay balls
DELTAIC	378-450	72	3C	5YR 4/4	CL	mass-1sbk	fri-slfi	n/a	Few pebbles and cobbles; charcoal present; sampled 412-416 cm.
REMOVED	450-475	25	n/a	n/a	n/a	n/a	n/a	n/a	Removed due to sleeve being mangled.
DELTAIC	475-600	125	4C	5YR 4/3	SL	gr-mass	fri-slfi	n/a	Common clay rip-ups throughout (same color); well sorted.

Texture:	Si=silt; L=loam; C=clay; S=sand; F=fine; V=very; G=gravel; O=organic:
Structure:	1=weak; 2= moderate; 3=strong; f=fine; m=medium; c=coarse
	gr=granular; mass=massive; strat=stratified; sbk=subangular blocky; ab=angular blocky; pr=prismatic
	pl=platy; dist=disturbed/no structure
Consistence:	fri=friable; sl=slightly; v=very; l=loose; fi=firm; h=hard; st=sticky; ss=strongly sticky
Boundary Distinctness:	a-abrupt; c=clear; d=diffuse; g=gradual; s=sharp
Boundary Topography:	w=wavy; s=smooth; a=abrupt
Miscellaneous:	n/a=not applicable; n/r=not recorded

RCH-5H-ARC-7

RCH-5H-ARC-7

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
FILL (PAVEMENT, INWOOD-LAGUARDIA-EBBETS COMPLEX)	0-22	22	Ap1	10YR 2/1		dist	efi	a	Asphalt and concrete.
	22-44	22	Ap2	5YR 4/4	SCL	dist	fri-slfi	n/a	Few subang pebbles.
	44-66	22	Ap3	5YR 4/4	GSiCL	dist	l-fi	n/a	Common subang pebbles.
	66-88	22	Ap4	5YR 4/4	GSiL	dist	l-slfi	n/a	Common ang pebbles; wood present; wet
	88-176	88	Ap5	7.5YR 5/4	SiL	dist	slfi	n/a	Very wet.
	176-240	64	Ap6	7.5YR 4/4	LS	dist	l-fri	c	No inclusions discernible.
	240-473	60	Ap7	5YR 4/4	SiCL	dist	slfi	g	Many cinder frags throughout; few subang-ang pebbles.
FILL/ SHORELINE	473-520	47	Ap7/2C	5YR 4/4; 5YR 3/3	SiCL; LS-SL	mixed	fri-slfi	g	Transitional zone between material above and material below, mostly sandy like material below.
SHORELINE	520-600	80	2C	5YR 3/3	LS-SL	cr-1sbk	fri-slfi	n/a	Very few, very fine shell frags at contact w/ transitional zone; no other inclusions.

Texture:	Si=silt; L=loam; C=clay; S=sand; F=fine; V=very; G=gravel; O=organic:
Structure:	1=weak; 2= moderate; 3=strong; f=fine; m=medium; c=coarse
	gr=granular; strat=stratified; sbk=subangular blocky; ab=angular blocky; pr=prismatic
	pl=platy; dist=disturbed; structureless: mass=massive; sg=single grain
Consistence:	fri=friable; sl=slightly; v=very; e=extremely; l=loose; fi=firm; h=hard; st=sticky; ss=strongly sticky
Boundary Distinctness:	a-abrupt; c=clear; d=diffuse; g=gradual
Boundary Topography:	w=wavy; s=smooth; a=abrupt
Miscellaneous:	n/a=not applicable; n/r=not recorded

RCH-5H-ARC-8

RCH-5H-ARC-8

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
FILL (PAVEMENT, INWOOD-LAGUARDIA-EBBETS COMPLEX)	0-22	22	Ap1	10YR 2/1		dist	efi	a	Asphalt and concrete.
	22-66	44	Ap2	10YR 2/3	GSiCL	dist	l-fi	n/a	Subrounded pebbles; glass; concrete; bricks; slag.
	66-150	84	Ap3	10YR 2/2 5YR 4/6	SiCL mottles	dist	slfi-fi	n/a	Very few subrounded pebbles; slag; wood; slate.
	150-190	40	2C1	5YR 4/3	GSiCL-GSC	mass	st	g	Common ang-subang pebbles.
SHORELINE	190-195	5	2C2	5YR 4/3	GSC-GSCL	dist	slst	n/a	SC-SCL matrix w/ two flat, rounded pebbles.
MISSING	195-300	105	n/r	n/r	n/r	n/r	n/r	n/r	Poor recovery.
	300-328	28	2C3	5YR 4/3	GSC	mass	st	d	Common subang-subr pebbles.
	328-355	27	3C	5YR 4/3	SL	gr-1sbk	slfi-fi	d	Very wet; no inclusions discernible.
	355-380	25	4C	5YR 4/3	SiC	mass	st	d	No inclusions discernible.
	380-450	70	5C	5YR 4/3	SiCL	2sbk	slfi-fi	d	No inclusions discernible.
SHORELINE	450-600	150	6C	5YR 4/4	LS	gr-1sbk	fri-slfi	n/a	Clay content increases slightly towards the bottom; no inclusions discernible.

Texture:	Si=silt; L=loam; C=clay; S=sand; F=fine; V=very; G=gravel; O=organic:
Structure:	1=weak; 2= moderate; 3=strong; f=fine; m=medium; c=coarse
	gr=granular; sg= single grain; mass=massive; strat=stratified; sbk=subangular blocky; ab=angular blocky; pr=prismatic
	pl=platy; weg=wedge; dist=disturbed/no structure
Consistence:	fri=friable; sl=slightly; v=very; e=extremely; l=loose; fi=firm; h=hard; st=sticky; ss=strongly sticky
Boundary Distinctness:	a-abrupt; c=clear; d=diffuse; g=gradual
Boundary Topography:	w=wavy; s=smooth; a=abrupt
Miscellaneous:	n/a=not applicable; n/r=not recorded

RCH-6-ARC-1

RCH-6-ARC-1

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
PAVEMENT, INWOOD-LAGUARDIA-EBBETS COMPLEX	0-22	22	Ap1	5YR 4/4	SL	dist	l-fri	n/a	Roots and wood present; common ang pebbles; burnt brick frags.
	22-44	22	Ap2	5YR 4/4	S	dist	l	n/a	Mod. well sorted; fewer detrital pieces; few smaller pebbles.
	44-66	22	Ap3	10YR 4/3	S	dist	l	n/a	Well sorted to coarser than material above; very minor detrital component; looks natural.
	66-88	22	Ap4	10YR 4/3	SL	dist	fri	n/a	Higher conc. of fine sediments; some fill-like detrital material; small pebbles.
	88-150	22	Ap5	10YR 4/3	S	dist	l	n/a	Well sorted and coarser than material above.
	150-181		Ap6	7.5YR 5/6	GLS	dist	fi-vfi	c	10% gravel; few m-c roots.
SOIL	181-207	28	2A	10YR 3/1	LS	1sbk	fi-vfi	g	Paleosol; sample:190-200 cm; many v.f. roots to c. roots, well-sorted.
	207-255	48	2Bt1	5YR 5/6	SiC	mass	vfi	g	Few rootlets; large root cast (225-254 cm), roots still present, coated with clay 10Y 5/2; 10% gravel; B horizon.
	255-412	157	2Bt2	5YR 5/6	C	mass	vfi		Similar to material above, but root casts are absent, and higher clay content.
SHORELINE/ FLUVIAL	412-416	4	2C1	7.5YR 5/6	SiL	strat	slfi	c	Alternating bands of of reddish brown (thicker) and black (thinner) sediments.
	416-420	4	2C2	7.5YR 5/6	VFS	strat	l	c	411-419 cm could be stratified deposits of a similar event, but 416-419 cm gradually goes into 419-425 cm.
	420-425	5	2C3	7.5YR 5/4	VFS	mass	l	a	Very well sorted; truncates lower stratified deposits.
SHORELINE	425-428	3	3C1	7.5YR 4/6 (VFS) 7.5YR 2.5/1 (C)	VFS C	strat	l-fri	c	None.
	428-431	3	3C2	7.5YR 5/4	VFS	mass	l-fri	g	None.
	431-433	2	3C3	7.5YR 4/6	VFS	strat	l-fri	c	Shell frag takes up entire sequence; 425-433 cm are lacustrine deposits w/ some other type of deposit (fluvial?).
	433-452	17	4C1	5YR 5/4	LS	mass-1sbk	l-fri	c	Truncated by deposits above.
	452-477	25	4C2	5YR 5/4	SL	2sbk	fri-vfi	g	Similar to 433-450 cm, but higher clay content.
	477-600	123	4C3	7.5YR 5/4	LS	gr-1sbk	fri-slfi	n/a	Few, fine shell frags; well sorted.

Texture: Si=silt; L=loam; C=clay; S=sand; F=fine; V=very; G=gravel; O=organic:

Structure: 1=weak; 2= moderate; 3=strong; f=fine; m=medium; c=coarse
gr=granular; mass=massive; strat=stratified; sbk=subangular blocky; ab=angular blocky; pr=prismatic
pl=platy; dist=disturbed/no structure

Consistence: fri=friable; sl=slightly; v=very; l=loose; fi=firm; h=hard; st=sticky; ss=strongly sticky

Boundary Distinctness: a-abrupt; c=clear; d=diffuse; g=gradual; s=sharp

Boundary Topography: w=wavy; s=smooth; a=abrupt

Miscellaneous: n/a=not applicable; n/r=not recorded

RCH-6-ARC-2

RCH-6-ARC-2

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
	0-22	22	Ap1	10YR 2/1	SL	dist	fri-slfi	n/a	Phragmites and other fleshy roots; riprap stones present.
	22-66	44	Ap2	10YR 2/1 - 10YR 2/2	SL	dist	fri-slfi	n/a	Similar to above, but fewer roots.
	66-88	22	Ap3	10YR 3/1	GS	dist	l	n/a	Wet; fine pebbles.
	88-220		Ap4	10YR 2/1	GS	dist	l	n/a	Brick frags; cinder frags.
	220-250	30	Ap5	10YR 2/1	GSCL	dist	l	g	Some organics, mostly fine roots at the top; few large (3 cm) Fe concretions; few subang cobbles; many fine shell frags; petroleum smell.
FILL	250-279	29	Ap6	10YR 2/1	GSCL	dist	l	c	Many cinders; many f-m shell frags; few Fe concretions.
	279-300	21	2A	10YR 2/1	CL	2sbk	slfi	n/a	Organic rich; common, vf shell frags; very little sand coating on base (290-300 cm).
	300-360	60	n/r	n/r	n/r	n/r	n/r	n/r	Poor recovery.
MIXED FILL/ ESTUARINE	360-402	42		5Y 3/1	SiCL	gr	fi	g	Organic rich, mostly rootlets; possibly organic mat; many fine shell frags; few subang gravels.
	402-470	68		10YR 2/1	CL-LC	gr	h-vh	c	Similar to material above, but also contains medium roots; sampled 420-430 cm.
	470-529	59		10YR 2/1	SiCL	mass-1sbk	slfi-fi	c	Organic rich, f-m roots throughout, looks like an organic mat; sampled 510-520 cm.
	529-550	21	A	2.5Y 3/1	SCL	mass-1sbk	fri-slfi	c	Few organics; sampled 534-538 cm; v. little gravel.
ESTUARINE	550-580	30	C	Gley1 4/10Y	GSCL	mass	fri-slfi	g	Common rounded large pebbles; could be till; gleyed; no organics disernable.
SOIL/ FLUVIAL	580-585	5				mixed			Transitional zone between material above and below.
FLUVIAL	585-600	15		10YR 5/3	SL-LS	mass	fri-slfi	n/a	Very well sorted, no inclusions.

Texture:	Si=silt; L=loam; C=clay; S=sand; F=fine; V=very; G=gravel; O=organic:
Structure:	1=weak; 2= moderate; 3=strong; f=fine; m=medium; c=coarse
	gr=granular; mass=massive; strat=stratified; sbk=subangular blocky; ab=angular blocky; pr=prismatic
	pl=platy; dist=disturbed/no structure
Consistence:	fri=friable; sl=slightly; v=very; l=loose; fi=firm; h=hard; st=sticky; ss=strongly sticky
Boundary Distinctness:	a-abrupt; c=clear; d=diffuse; g=gradual; s=sharp
Boundary Topography:	w=wavy; s=smooth; a=abrupt
Miscellaneous:	n/a=not applicable; n/r=not recorded

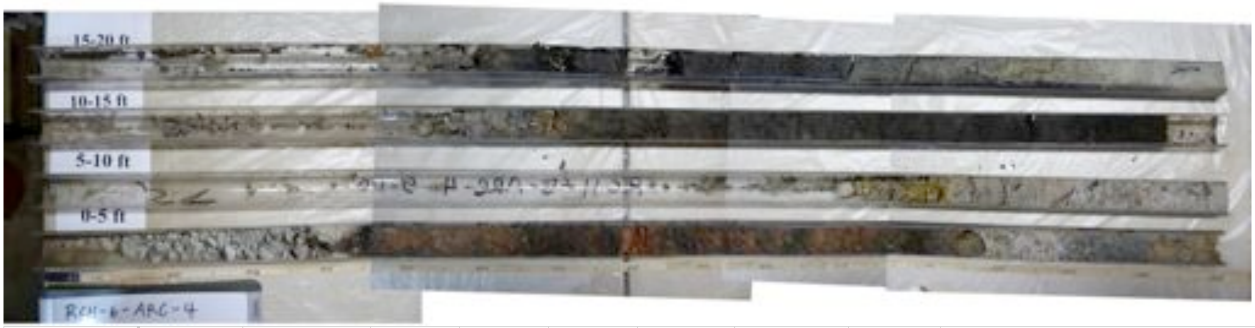
RCH-6-ARC-3

RCH-6-ARC-3

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
FILL (PAVEMENT, INWOOD-LAGUARDIA-EBBETS COMPLEX)	0-22	22	Ap1	7.5YR 4/3	LS	dist	l	n/a	Common f-c brick frags; common woody material; well sorted.
	22-44	22	Ap2	7.5YR 3/3	LS	dist	l	n/a	Increasing amount of brick and wood fragments.
	44-88	44	Ap3	7.5YR 3/3	SL	dist	l	n/a	Few glass frags, wood frags, cinders pebbles; water table encountered at base of unit.
	88-174	86	Ap4	2.5YR 3/4	CL	dist	slst	n/a	Ceramics; milk glass; common,med pebbles and riprap.
	174-391	217	Ap5	10YR 2/1	SCL	dist	l	n/a	Petroleum smell; glass, brick, and mortar present; v. few roots.
ESTUARINE	391-431	40	2C1	10YR 2/1	SiCL	mass	vfi	g	Organic mat - many fine roots.
	431-457	26	2C2	10YR 2/1	SCL	mass	fi-vfi	g	Organic mat - many fine roots.
	457-565	108	2C3	10YR 2/1	SiCL	mass	fi-vfi	A section is missing	Organic mat - many f-m roots.
	565-600	35	2C4	10YR 2/1	SCL	mass	fi-vfi	n/a	Similar to material above, but sandier and less silty.

Texture:	Si=silt; L=loam; C=clay; S=sand; F=fine; V=very; G=gravel; O=organic:
Structure:	1=weak; 2= moderate; 3=strong; f=fine; m=medium; c=coarse
	gr=granular; mass=massive; strat=stratified; sbk=subangular blocky; ab=angular blocky; pr=prismatic
	pl=platy; dist=disturbed/no structure
Consistence:	fri=friable; sl=slightly; v=very; l=loose; fi=firm; h=hard; st=sticky; ss=strongly sticky
Boundary Distinctness:	a-abrupt; c=clear; d=diffuse; g=gradual; s=sharp
Boundary Topography:	w=wavy; s=smooth; a=abrupt
Miscellaneous:	n/a=not applicable; n/r=not recorded

RCH-6-ARC-4



RCH-6-ARC-4

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
FILL (PAVEMENT, INWOOD-LAGUARDIA-EBBETS COMPLEX)	0-40	40	Ap1	Gley1 8/N	G	dist	vfi	g	Crushed rock and vf sandy matrix.
	40-116	76	Ap2	10YR 2/1	mixed	dist	l	c	Many f-c brick frags, many cinders; some clay in places (5YR 5/4).
	116-129	13	Ap3	Gley1 8/N	mixed	dist	l-efi	g	Gravelly with fine sandy matrix.
	129-140	11	Ap4	2.5Y 4/1	mixed	dist	l-efi	g	Same as material above, but different color.
	140-150	10	Ap5	10Y 6/2	mixed	dist	l-efi	n/a	Same as material above, but different color.
	150-255	105	n/r	n/r	n/r	n/r	n/r	n/r	Poor recovery.
	255-372	117	Ap6	2.5Y 4/1	mixed	dist	l-efi	c	Similar to material from 129-140 cm, but contains few organics and f-m shell frags.
	372-431	59	2C1	10YR 2/1	SiCL	mass	slfi-fi	g	Organic mat - f-m roots; clay content increases toward the bottom; common very fine shell frags.
	431-521	19	2C2	10YR 2/1	SiCL	mass	slfi-fi	c	Organic mat; finer roots and more degraded than material above; subaqueous; sampled 440-445 cm.
	521-551	30	2C3	10YR 2/1	SiL-SiCL	mass-1pl	fi	g	Common roots at top, but decrease towards the bottom; sample 530-535 cm.
ESTUARINE	551-581	30	2C4	5Y 6/1	SiCL	gr	slfi-fi	g	None.
SHORELINE	581-600	19	3C	5Y 6/1	SL	mass	fri-slfi	n/a	Common very fine shell frags; no discernible gravels.

Texture: Si=silt; L=loam; C=clay; S=sand; F=fine; V=very; G=gravel; O=organic:

Structure: 1=weak; 2= moderate; 3=strong; f=fine; m=medium; c=coarse
gr=granular; mass=massive; strat=stratified; sbk=subangular blocky; ab=angular blocky; pr=prismatic
pl=platy; weg=wedge; dist=disturbed/no structure

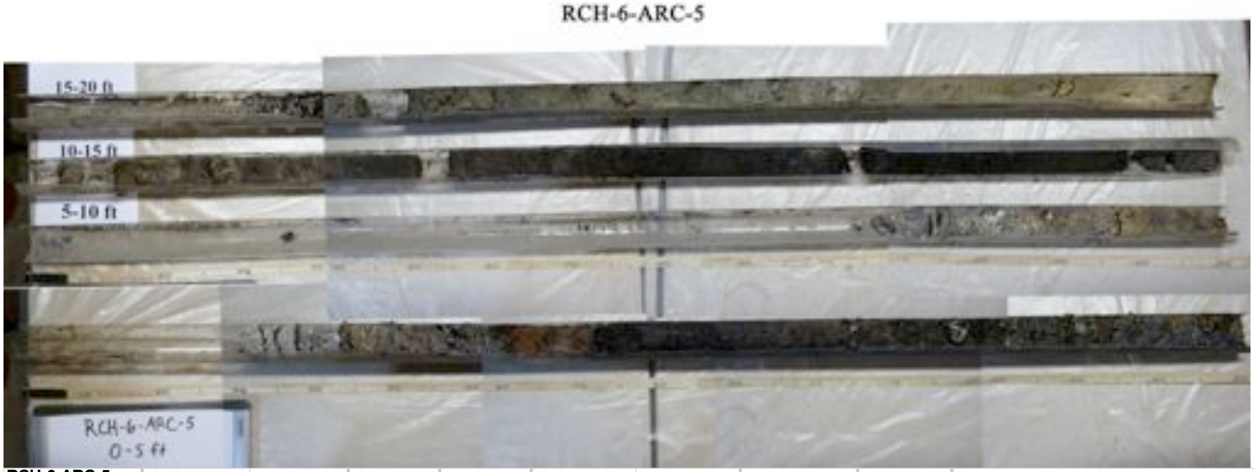
Consistence: fri=friable; sl=slightly; v=very; e=extremely; l=loose; fi=firm; h=hard; st=sticky; ss=strongly sticky

Boundary Distinctness: a-abrupt; c=clear; d=diffuse; g=gradual; s=sharp

Boundary Topography: w=wavy; s=smooth; a=abrupt

Miscellaneous: n/a=not applicable; n/r=not recorded

RCH-6-ARC-5



RCH-6-ARC-5

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
FILL (PAVEMENT,	0-150	150	Ap1	N9.5; 5YR 4/4	mixed	dist		n/a	White concrete (top); red SiL (mid); peaty SC.
INWOOD-	150-265	115	n/r	n/r	n/r	n/r	n/r	n/r	Poor recovery.
LAGUARDIA-EBBETS COMPLEX)	265-290	25	Ap2	5Y 6/1	mixed	dist	h-vh	c	Common cinders; pebble-cobble-size frags; f-c shell frags.
	290-319	29	2C	2.5Y 4/2	SiCL-SCL	mass	fi-vfi	c	Organic rich - very many roots and rootlets; no inclusions discernible.
	319-371	52	3C1	10YR 2/1	SiL	pl	vfi	g	Organic rich - v. many rootlets.
	371-447	76	3C2	10YR 2/1	CL	mass	fi	c	Organic mat - rootlets and f-c roots.
	447-450	3	4A	2.5Y 3/1	SCL	mass-2sbk	vfi-h	c	Few fine roots; few fine shell frags.
ESTUARINE	450-525	75	4A	5Y 4/2	SCL	1sbk	fi	g	Very few organics - rootlets and medium roots; very few fine shell frags.
SHORELINE	525-555	30	4C	5Y 5/3	GLS	mass	vfi	g	Very few organics; very few rounded pebbles.
FLUVIAL	555-600	45	5C	5Y 5/3	LS	mass	slfi-fi	n/a	Few clay balls (7.5YR 4/4) towards bottom (580cm and 594 cm); common very fine shell frags; well sorted.

Texture:	Si=silt; L=loam; C=clay; S=sand; F=fine; V=very; G=gravel; O=organic:
Structure:	1=weak; 2= moderate; 3=strong; f=fine; m=medium; c=coarse
	gr=granular; mass=massive; strat=stratified; sbk=subangular blocky; ab=angular blocky; pr=prismatic
	pl=platy; weg=wedge; dist=disturbed/no structure
Consistence:	fri=friable; sl=slightly; v=very; l=loose; fi=firm; h=hard; st=sticky; ss=strongly sticky
Boundary Distinctness:	a-abrupt; c=clear; d=diffuse; g=gradual; s=sharp
Boundary Topography:	w=wavy; s=smooth; a=abrupt
Miscellaneous:	n/a=not applicable; n/r=not recorded

Appendix C: Radiocarbon Results

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REPORT OF RADIOCARBON DATING ANALYSES

BETA

BETA ANALYTIC INC.

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REPORT OF RADIOCARBON DATING ANALYSES

[redacted]

(Variables: C13/C12=-27.3:lab. mult=1)

Laboratory number: **Beta-309854**

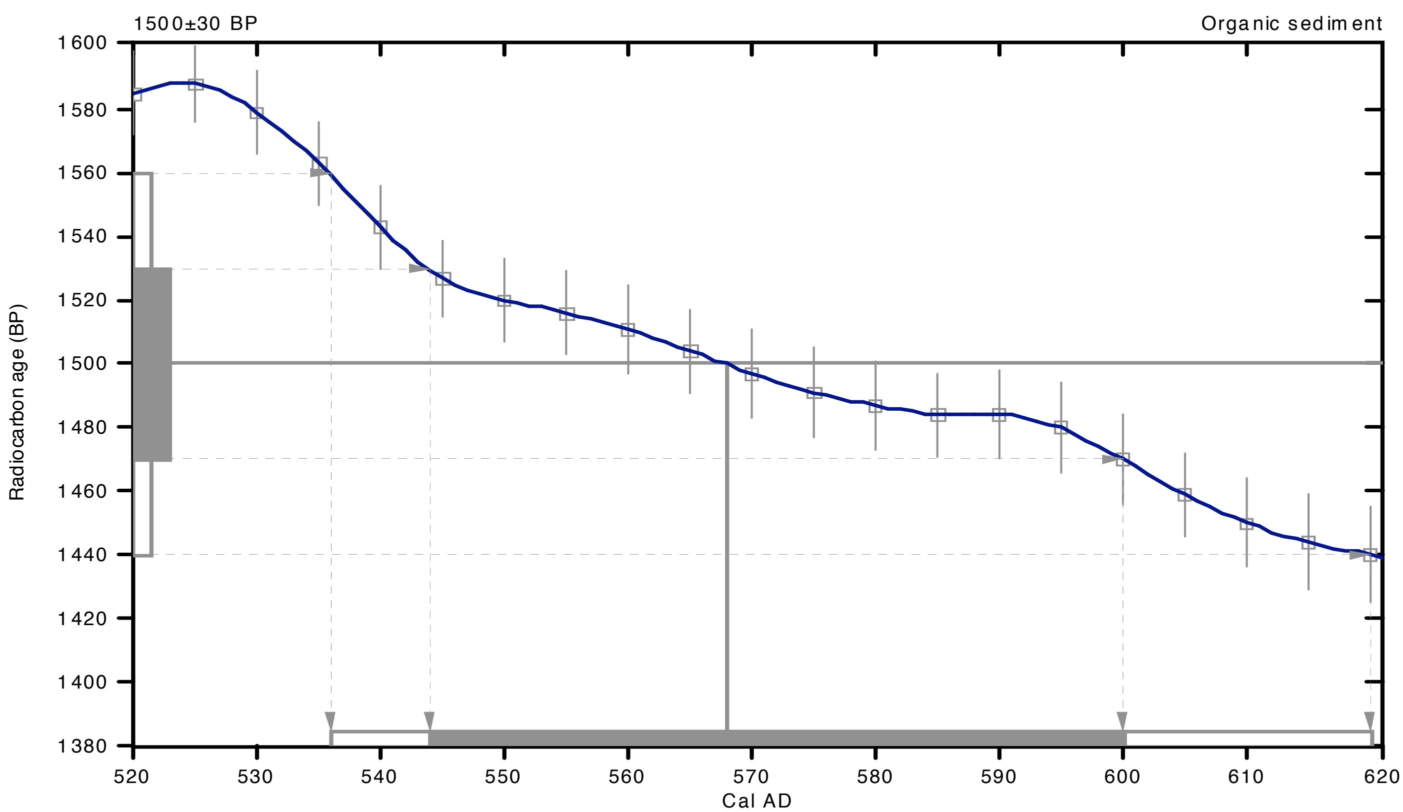
Conventional radiocarbon age: **1500±30 BP**

2 Sigma calibrated result: **Cal AD 540 to 620 (Cal BP 1410 to 1330)**
(95% probability)

Intercept data

Intercept of radiocarbon age with calibration curve: Cal AD 570 (Cal BP 1380)

1 Sigma calibrated result: Cal AD 540 to 600 (Cal BP 1410 to 1350)
(68% probability)



References:

Database used

INTCAL09

References to INTCAL09 database

Heaton,et.al.,2009, Radiocarbon 51(4):1151-1164, Reimer,et.al, 2009, Radiocarbon 51(4):1111-1150, Stuiver,et.al,1993, Radiocarbon 35(1):137-189, Oeschger,et.al.,1975,Tellus 27:168-192

Mathematics used for calibration scenario

A Simplified Approach to Calibrating C14 Dates

Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2):317-322

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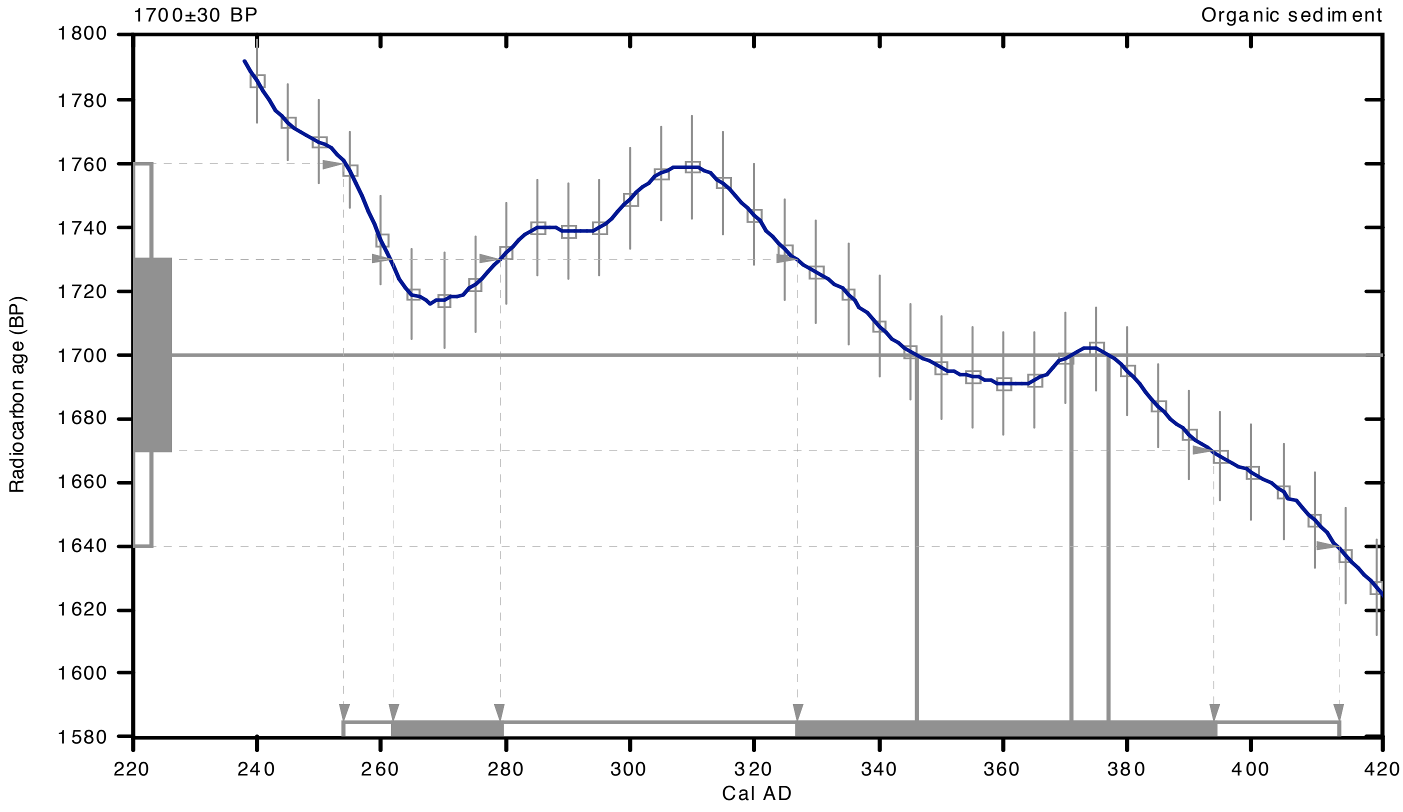
[redacted]

(Variables: C13/C12=-18:lab. mult=1)

Laboratory number:	**Beta-309855**
Conventional radiocarbon age:	**1700±30 BP**
2 Sigma calibrated result: **(95% probability)**	**Cal AD 250 to 410 (Cal BP 1700 to 1540)**

Intercept data

Intercepts of radiocarbon age with calibration curve:	Cal AD 350 (Cal BP 1600) and Cal AD 370 (Cal BP 1580) and Cal AD 380 (Cal BP 1570)
1 Sigma calibrated results: (68% probability)	Cal AD 260 to 280 (Cal BP 1690 to 1670) and Cal AD 330 to 390 (Cal BP 1620 to 1560)



References:

Database used

INTCAL09

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Mathematics used for calibration scenario

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Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2):317-322

Beta Analytic Radiocarbon Dating Laboratory

4985 S.W. 74th Court, Miami, Florida 33155 • Tel: (305)667-5167 • Fax: (305)663-0964 • E-Mail: beta@radiocarbon.com

(Variables: C13/C12=-26.1:lab. mult=1)

Laboratory number: **Beta-309856**

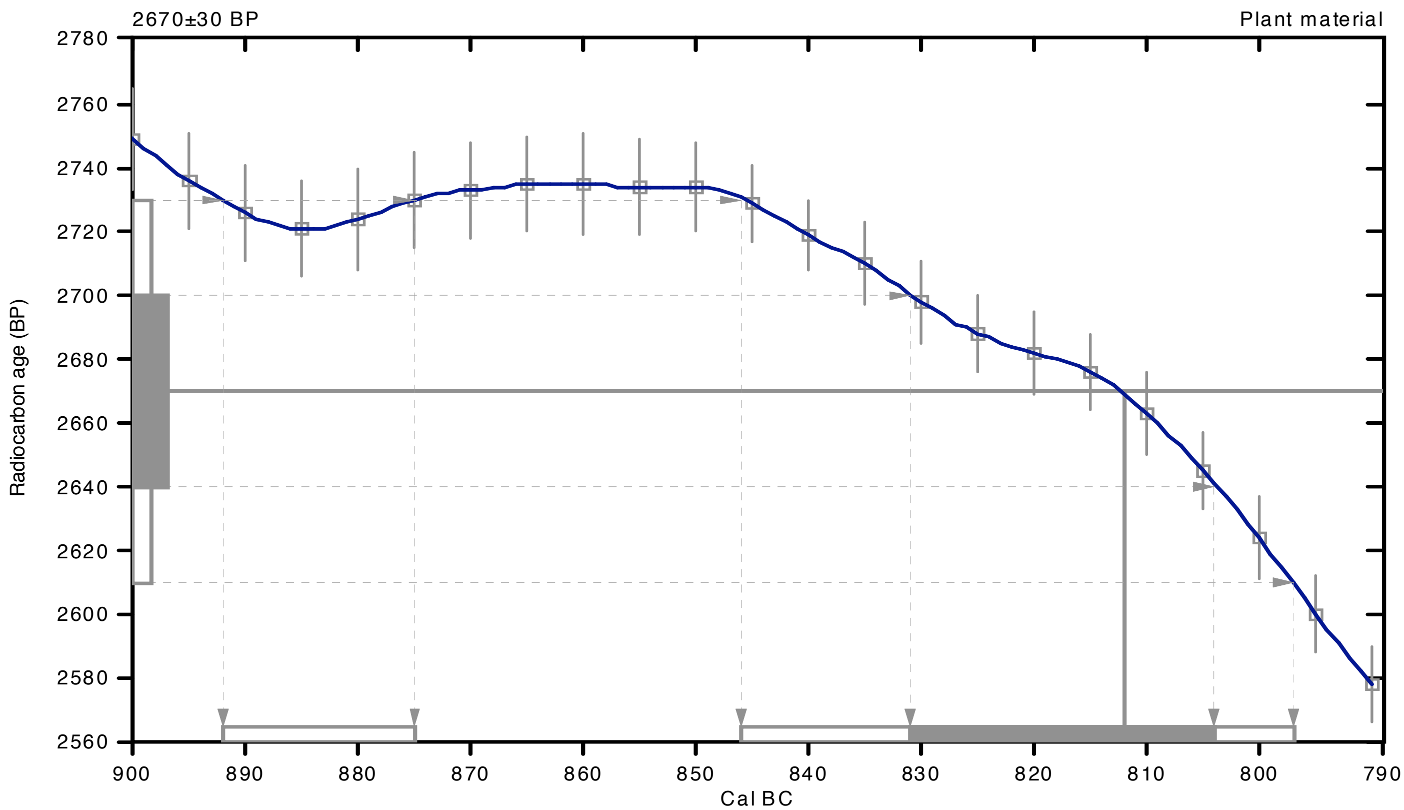
Conventional radiocarbon age: **2670±30 BP**

2 Sigma calibrated results: **Cal BC 890 to 880 (Cal BP 2840 to 2820) and**
(95% probability) **Cal BC 850 to 800 (Cal BP 2800 to 2750)**

Intercept data

Intercept of radiocarbon age with calibration curve: Cal BC 810 (Cal BP 2760)

1 Sigma calibrated result: Cal BC 830 to 800 (Cal BP 2780 to 2750)
(68% probability)



References:

Database used
INTCAL09
References to INTCAL09 database
Heaton,et.al.,2009, Radiocarbon 51(4):1151-1164, Reimer,et.al, 2009, Radiocarbon 51(4):1111-1150, Stuiver,et.al,1993, Radiocarbon 35(1):137-189, Oeschger,et.al.,1975,Tellus 27:168-192
Mathematics used for calibration scenario
A Simplified Approach to Calibrating C14 Dates
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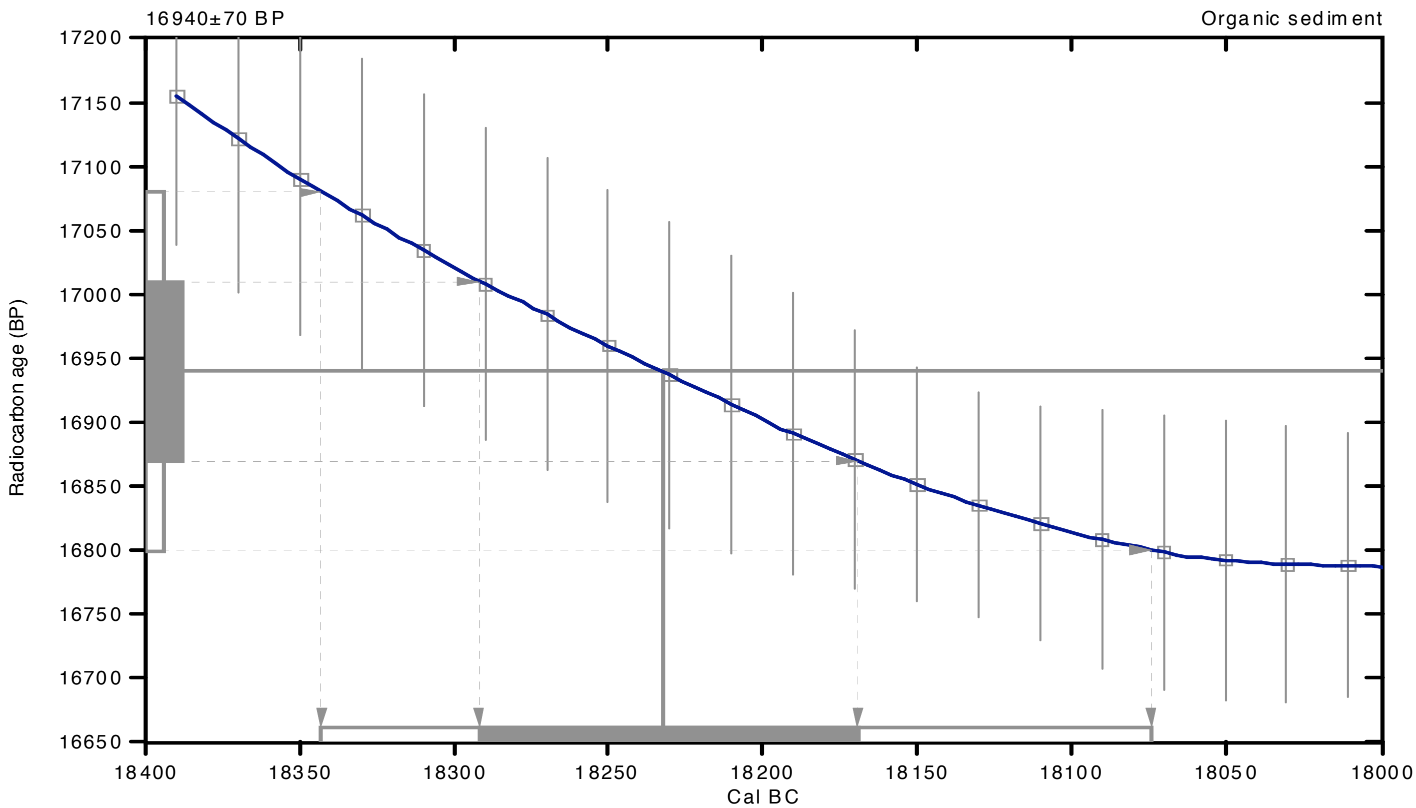
(Variables: C13/C12=-26.2:lab. mult=1)

Laboratory number:	**Beta-309857**
Conventional radiocarbon age:	**16940±70 BP**
2 Sigma calibrated result: **(95% probability)**	**Cal BC 18340 to 18070 (Cal BP 20290 to 20020)**

Intercept data

Intercept of radiocarbon age with calibration curve:	Cal BC 18230 (Cal BP 20180)
1 Sigma calibrated result: (68% probability)	Cal BC 18290 to 18170 (Cal BP 20240 to 20120)



References:

Database used

INTCAL09

References to INTCAL09 database

Heaton,et.al.,2009, Radiocarbon 51(4):1151-1164, Reimer,et.al, 2009, Radiocarbon 51(4):1111-1150, Stuiver,et.al,1993, Radiocarbon 35(1):137-189, Oeschger,et.al.,1975,Tellus 27:168-192

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