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

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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 20.3 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 Jersey and New York portions of the Project in August and December 2010 (Elquist et al. 2010a, b, c, and d). Since that time additional Phase IA archaeological assessments have been conducted for a number of pipeline route variations (Elquist and Cherau 2011a, b, c, and d). The Phase IA archaeological assessment recommendations for the Project alignment and route variations have included 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 98 soil borings is currently proposed for the archaeologically sensitive areas of the Project pipeline route where subsurface soil conditions are unknown and/or considered too deep for conventional hand testing (Table 1). Of these, 33 soil borings were completed in December 2010. PAL anticipates the completion of the 65 outstanding borings in the spring/summer/winter of 2011 and 2012 as environmental permits and landowner access permissions are obtained.

The goal of the soil borings program was 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 continues to be dominated by industrial and commercial facilities, but the possibility remains that intact archaeological resources may be preserved 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.

Table 1. Archaeological Soil Borings Proposed for the New Jersey-New York Expansion Project.

Location	***Number of Proposed Soil Borings***	***Completed***	***Outstanding***	***Percentage Done***
Staten Island, NY	33	2	31	6%
Linden, NJ	7	2	5	29%
Bayonne, NJ	32	26	6	81%
Jersey City, NJ	26	3	23	12%
TOTAL	98	33	65	34%

The following report presents the need for and scope of proposed Phase IB archaeological surveys for the approximately 34 percent of archaeologically sensitive areas where soil borings have been completed to date. The Phase IB archaeological surveys have been formulated based on the results of the geoarchaeological investigations that included the excavation and analysis of the 32 borings located across eight properties in the communities of Staten Island (New York) and Linden, Bayonne, and Jersey City (New Jersey) (Table 2) (Figures 2 through 6). The cores typically extended to a depth of 5.8 meters (m) (20 feet [ft]) 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 Geoarcheology Research Associates (GRA), under subcontract to PAL, the cultural resources consultants to Spectra Energy. The GRA report is provided as Attachment A.

One soil boring in Staten Island, New York was provided by the environmental geotechnical program conducted as part of the project (Attachment B). The environmental geotechnical investigations (TRC 2011) also provided information on the types and levels of soil contaminants, if any, present in archaeologically sensitive areas to assist in determining the potential need for a site-specific Health and Safety Plan (HASP) as part of proposed Phase IB survey.

Table 2. Archaeological Soil Borings Conducted in December 2010, New Jersey-New York Expansion Project.

Universal Boring Tracking Number	***Existing Boring Number***	***Landowner Name***	***Date of Boring Completion***
Staten Island, NY			
1R-22.1-ARC-1 (replaced with (1R-22.1-ENV-6W)	SI-001 (replaced with B-4 (SI)	380 Development, LLC	12/9/2010
RCH-1-ARC-1	SI-002	Texas Eastern Transmission	12/9/2010
Linden, NJ			
20-12-ARC-1	LIN-003	M&M Corporate Enterprises	12/8/2010
20-13-ARC-1	LIN-004	M&M Corporate Enterprises	12/8/2010
Bayonne, NJ			
HUD-13.1-ARC-2	BAY-011	Bayonne Industries, Inc.	12/7/2010
HUD-13.1-ARC-3	BAY-012	Bayonne Industries, Inc.	12/7/2010
HUD-20-ARC-1	BAY-013	Bayonne Industries, Inc.	12/7/2010
HUD-20-ARC-2	BAY-014	Bayonne Industries, Inc.	12/7/2010
HUD-21R-ARC-1	BAY-015	East Jersey RR IMTT	12/7/2010
HUD-23.1-ARC-1	BAY-016	Lehigh Realty Co.	12/9/2010
HUD-26.2-ARC-1	BAY-017	Bayonne Industries, Inc.	12/7/2010
HUD-28-ARC-1	BAY-018	99 Hook Road, LLC	12/8/2011

Universal Boring Tracking Number	***Existing Boring Number***	***Landowner Name***	***Date of Boring Completion***
HUD-32-ARC-1	BAY-019	Bayonne Local Redevelopment Authority	12/8/2010
HUD-32-ARC-2	BAY-020	Bayonne Local Redevelopment Authority	CANCELLED Replaced with BAY-20A
HUD-32-ARC-3	BAY-020A	Bayonne Local Redevelopment Authority	12/8/2010
HUD-32-ARC-4	BAY-021	Bayonne Local Redevelopment Authority	12/8/2010
HUD-32-ARC-5	BAY-022	Bayonne Local Redevelopment Authority	12/9/2010
HUD-32-ARC-6	BAY-023	Bayonne Local Redevelopment Authority	12/9/2010
HUD-32-ARC-7	BAY-024	Bayonne Local Redevelopment Authority	12/9/2010
HUD-32-ARC-8	BAY-025	Bayonne Local Redevelopment Authority	12/9/2010
HUD-32-ARC-9	BAY-026	Bayonne Local Redevelopment Authority	12/9/2010
HUD-32-ARC-10	BAY-027	Bayonne Local Redevelopment Authority	12/9/2010
HUD-32-ARC-11	BAY-028	Bayonne Local Redevelopment Authority	12/9/2010
HUD-32-ARC-12	BAY-029	Bayonne Local Redevelopment Authority	12/9/2010
HUD-32-ARC-13	BAY-030	Bayonne Local Redevelopment Authority	12/9/2010
HUD-32-ARC-14	BAY-031	Bayonne Local Redevelopment Authority	12/10/2010
HUD-32-ARC-17	BAY-R-001	Bayonne Local Redevelopment Authority	12/10/2010
HUD-32-ARC-18	BAY-R-002	Bayonne Local Redevelopment Authority	12/10/2010
HUD-32-ARC-19	BAY-R-003	Bayonne Local Redevelopment Authority	12/10/2010
HUD-32-ARC-20	BAY-R-004	Bayonne Local Redevelopment Authority	12/10/2010
HUD-32-ARC-21	BAY-R-005	Bayonne Local Redevelopment Authority	12/10/2010
Jersey City, NJ			

Universal Boring Tracking Number	***Existing Boring Number***	***Landowner Name***	***Date of Boring Completion***
HUD-44-ARC-1	JC-006	Jersey Eagle Sales Company, LLC	12/6/2010
HUD-44-ARC-2	JC-007	Jersey Eagle Sales Company, LLC	12/6/2010
HUD-95-ARC-1	JC-026	Lorraine Mocco	12/6/2010

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. 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 a minimum of 2.2 m (7 ft) below surface to a maximum depth of approximately 4.5 m (15 ft) below surface, depending on conditions encountered during construction (e.g., depth of existing utilities). 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 York by the Office of Parks, Recreation, and Historic Preservation (OPRHP), and 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 and New York SHPOs 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); the standards and guidelines set forth in *Standards for Cultural Resource Investigations and the Curation of Archaeological Collections in New York State* (New York Archaeological Council [NYAC] 1994) adopted by the OPRHP; the standards and guidelines set forth in *Landmarks Preservation Commission Guidelines for Archaeological Work in New York City* (LPC 2002); 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).

RESULT AND PHASE IB SURVEY RECOMMENDATIONS

The analysis and review of geoarchaeological soil borings have resulted in the identification of six pipeline route sections in Staten Island, Linden, and Bayonne that contain archaeologically sensitive strata within the Project APE (Table 3). Phase IB subsurface testing investigations are recommended for these sensitive areas. Each pipeline section subjected to geoarchaeological soil borings is described in detail below.

Staten Island, New York

SI-001 (1R-22.1-ARC-1)

Geoarchaeological soil boring SI-001 (1R-22.1-ARC-1) was abandoned because of gross petroleum product contamination. For the purposes of the archaeological sensitivity analysis it was replaced with environmental geotechnical soil boring (1R-22.1-ENV-6W [B-4 SI]) because of their close proximity. The boring is located on property belonging to 380 Development, LLC on the south side of Lambert Avenue between Station Numbers (STA) 211+73.6 and 216+00 (Figure 7). This area was assigned high sensitivity for pre-contact resources located beneath marsh deposits (Elquist et al. 2010d:75). As noted above, no geoarchaeological soil boring was advanced at this location. The results of the adjacent environmental soil boring indicate the presence of gray fine to medium sand fill with an oily sheen and petroleum odor from ground surface to 16 ft in depth. At 16 ft the fill was underlain by a soft gray

organic silty clay to 20 ft at which depth a soft brown fibric peat was encountered (see Attachment 2). No environmental data on potential soil contaminants is currently available for this location (TRC 2011).
The fill deposits identified within the vertical pipeline trench APE are not considered to be archaeologically sensitive. This section of pipeline route is re-assessed as having no archaeological sensitivity (see Figure 7), and no Phase IB survey is recommended.

SI-002 (RCH-A-ARC-1)

Geoarchaeological soil boring SI-002 (RCH-1-ARC-1) is located on Texas Eastern Transmission, LP (Texas Eastern) property on the east side of Western Avenue north of Goethal's Road North. This area is included in Route Variation 50 (Elquist and Cherau 2011b), which is approximately 0.83 miles in length and deviates from the originally proposed NJ-NY Project pipeline right-of-way (ROW) at MP 4.07R and rejoins the ROW at MP 4.90R between STA 255+80 and 257+80 (September, 2010 Pre-Filing Application STA 249+00 to 250+22.5 [see Elquist et al. 2010 b]]) (Figure 8). 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 recorded Old Place Site dating between the Early Archaic and 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). Potentially significant pre-contact through post-contact period archaeological deposits were recently identified at the adjacent Route Variation 50 additional workspace to the southeast (Elquist et al. 2011).

The soil boring analysis determined the presence of archaeologically sensitive strata from about 40 centimeters below ground surface (cmbs) (1.3 ft) beneath a compact asphalt and fill overburden to about 160 cmbs (5.2 ft) for post-contact period resources, and from 160 (5.2 ft) to at least 235 cmbs (7.7 ft) for pre-contact period resources (GRA 2011:15-16, 26, 40). Environmental sampling determined an exceedance of semi-volatile organic compounds (benzo(a)pyrene) from 107 to 122 cmbs (3.5 to 4 ft) in this soil boring (TRC 2011).

A Phase IB archaeological survey is recommended for this sensitive work area. Given the presence of compact asphalt and gravel (parking lot overburden) fill and sensitive archaeological strata that could extend to at least 235 cmbs (7.7 ft deep, machine-assisted trenches will be used. The high archaeological sensitivity section of proposed pipeline route at this location measures approximately 75 m (246 ft). Approximately four (4) trenches, each measuring 4.5 m (15 ft) wide (width of top of pipeline trench) by 3 m (9.8 ft) long will be placed at 15-m (49 ft) intervals within this work area (see Figure 8). The trenches will extend to at least 250 cm (7.5 ft) deep 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.

Linden, New Jersey

LIN-003 (20-12-ARC-1) and LIN-004 (20-13-ARC-1)

The two geoarchaeological soil borings (LIN-003 [20-12-ARC-1] and LIN-004 [20-13-ARC-1]) in Linden are located on property belonging to M&M Corporate Enterprises on the east and west sides of Wood Avenue between STA 90+00 and 102+50 (Figures 9 and 10). This area was assigned moderate sensitivity for pre-contact Native American resources as well as post-contact resources associated with documented early twentieth-century worker or middle management housing for the Grasselli Chemical

Company (Elquist et al. 2010c:86-90). The soil borings analysis determined the presence of an intact surface-subsoil horizon and a subsoil between 60-80 cmbs (2-2.6 ft) and 80-115 cmbs (2.6-3.8 ft) in LIN-003 (GRA 2011:15, 26, 38). LIN-004 contained 40 cm (1.3 ft) of disturbed fill over truncated glacial till (GRA 2011: 26, 39). No environmental data on potential soil contaminants is currently available for these two soil borings (TRC 2011).

No further investigations are recommended for the pipeline route between STA 96+00 and 102+50 where topsoils consist of disturbed fill and the subsoils have been truncated to the glacial till horizon (LIN-004). No pre-contact period cultural resources are expected in the glacial till, and no post-contact period resources are documented in this section of the proposed pipeline trench. This section of pipeline route is re-assessed as having no archaeological sensitivity (see Figure 9), and no Phase IB survey is recommended.

A Phase IB archaeological survey is recommended for the moderate sensitivity work area between STA 93+00 and 95+50. This area contains the documented Grasselli Chemical Company worker housing and is also sensitive for pre-contact period resources. Given the presence of compact asphalt and gravel (parking lot overburden) fill and sensitive archaeological strata that extends to 115 cmbs (3.8 ft) , machine-assisted trenches will be used. The moderately sensitive section of proposed pipeline route at this location measures approximately 175 m (574 ft). Approximately six (6) trenches, each measuring 450 cm (15 ft) wide (width of top of pipeline trench) by 3 m (9.8 ft) long will be placed at 30-m (98.4 ft) intervals within this work space (see Figure 10). The trenches will extend to at least 115 cm (4.0 ft) deep through the sensitive archaeological strata within the Project APE at this location. The testing methodology for machine-assisted trenches is described in more detail below under Fieldwork Methodology.

Bayonne, New Jersey

BAY-011 (HUD-13.1-ARC-2), BAY-012 (HUD-13.1-ARC-3), and BAY-013 (HUD-20-ARC-1)

Three geoarchaeological soil borings (BAY-011 [HUD-13.1-ARC-2]; BAY-012 [HUD-13.1-ARC-3]; and BAY-013 [HUD-20-ARC-1]) are located on property belonging to Bayonne Industries, Inc. in the area northeast of the 5th Street Connector between STA 502+00 and 522+00 (Figures 11, 12, and 13). These areas were assigned a low and moderate sensitivity for pre-contact period resources including isolated finds and artifact scatters from any timeframe during this period (Elquist et al. 2010c:101-106). One additional soil boring (BAY-010 [HUD-13.1-ARC-1] was initially proposed to the south of BAY-011 [HUD-13.1-ARC-2]; however, extensive utilities confirmed by ground penetrating radar (GPR) are present, so no soil boring was possible and this area was re-assessed using the results of the three completed borings described below.

The soil borings analysis determined the presence of dense petroleum product in disturbed fill soils that exceeded 450 cm (15 ft), underlain by estuarine deposits (except in BAY-011) and glacial till in all three of these soil borings (GRA 2011:16-17, 27, 41-43). The water table was encountered between 152 and 244 cmbs (5 and 8 ft). This area lies within an industrial zone containing clustered structures associated with the petrochemical industry. Buried petrochemical product and gross contaminants (sheens) were encountered in the soil borings. Environmental sampling also determined exceedances of semi-volatile organic compounds and arsenic contaminants from 75 to 259 cmbs (2.5 to 8.5 ft) in these soil borings (TRC 2011).

The presence of intact estuarine sediments in two of the borings confirms that the area was former shallow tidal marsh along the margins of the Jersey Flats. However, no archaeologically sensitive strata were identified within the vertical pipeline trench APE, which contains thick disturbed fill contaminated with petrochemicals down to and including the estuarine sediments (GRA 2011:27). The pipeline route between STA 502+00 and 522+00 is re-assessed as having no archaeological sensitivity (see Figures 11, 12, and 13), and no Phase IB survey is recommended.

BAY-014 (HUD-20-ARC-2) and BAY-015 (HUD-21R-ARC-1)

Two geoarchaeological soil borings (BAY-014 [HUD-20-ARC-2] and BAY-015 [HUD-21R-ARC-1]) are located on property belonging to Bayonne Industries, Inc. and East Jersey RR IMTT along the east side and parallel to State Highway Route 440 and a service ramp for the highway between STA 522+00 and 530+50 (Figures 14 and 15). The area between STA 522+00 and 529+00 was assigned a moderate sensitivity for pre-contact period resources including isolated finds and artifact scatters from any timeframe during this period and the area between STA 529+00 and 530+50 was assigned a low sensitivity for pre-contact period resources (Elquist et al. 2010c:106-109). The soil borings analysis determined the presence of dense petroleum product in disturbed fill soils that exceeded 530 cm (17 ft), underlain by estuarine deposits and glacial till (GRA 2011:16-17, 27, 43-44). The water table was encountered at 152 cmbs (5 ft) in these soil borings.

Similar to the previous area, this sensitive area lies within an industrial zone containing clustered structures associated with the petrochemical industry. The soil borings were placed along a route that avoided both aboveground and belowground buried facilities. Despite these efforts, buried petrochemical product and gross contaminants (sheens) were encountered. Environmental sampling also determined exceedances of semi-volatile organic compound contaminants from 75 to 213 cmbs (2.5 to 7.0 ft) in these soil borings (TRC 2011).

The presence of intact estuarine sediments confirms that the area was former shallow tidal marsh along the margins of the Jersey Flats. However, no archaeologically sensitive strata were identified within the vertical pipeline trench APE, which contains thick disturbed fill contaminated with petrochemicals down to and including the estuarine sediments (GRA 2011:27). The pipeline route between STA 522+00 and 530+50 is re-assessed as having no archaeological sensitivity (see Figures 14 and 15), and no Phase IB survey is recommended.

BAY-016 (HUD-23.1-ARC-1) and BAY-017 (HUD 26.2-ARC-1)

Two geoarchaeological soil borings (BAY-016 [HUD-23.1-ARC-1] and BAY-017 [HUD 26.2-ARC-1]) are located on property belonging to Bayonne Industries, Inc. and Lehigh Realty Co that crosses Hook Road, State Highway Route 440, and East 22nd Street between STA 533+50 and 540+00 (Figure 15). This area was assigned a low sensitivity for pre-contact period resources (Elquist et al. 2010c:108-109). The soil borings analysis determined the presence of a deep fill sequence from 0-520 cm (17 ft) above disturbed estuarine silt to 580 cmbs (19 ft) in BAY-016 (GRA 2011: 17-18, 27, 44-45). The fill in BAY-016 contained ceramic sherds and fine glass fragments from 145 to 250 cmbs (4.7-8.2 ft). BAY-017 contained disturbed fill and estuarine sediments with dense petroleum product similar to the deposits encountered in BAY-011 to -015 described above. Environmental sampling also determined an exceedance of semi-volatile organic compounds from 152 to 168 cmbs (5.0 to 5.5 ft) in BAY-017. No environmental data on potential soil contaminants is available for BAY-016 (TRC 2011). The water table was encountered at 152 to 244 cmbs (5 to 8 ft) in these soil borings.

The soil borings indicate similar sequences of deep, contaminated fill over intact deposits of a subaqueous estuary below 450 cm (15 ft). No archaeologically sensitive strata were identified in the vertical pipeline trench APE (GRA 2011:27). The pipeline route between STA 533+50 and 540+00 is re-assessed as having no archaeological sensitivity (see Figure 15), and no Phase IB survey is recommended.

BAY-018 (HUD-28-ARC-1)

Geoarchaeological soil boring BAY-018 (HUD-28-ARC-1) is located in an asphalt parking lot for a large manufacturing facility on property belonging to 99 Hook Road, LLC along the east side of State Highway Route 440 between STA 563+00 and 577+50 (Figures 16 and 17). This area was assigned a low sensitivity for pre-contact period resources (Elquist et al. 2010c: 110-112). The soil boring analysis determined the presence of fill sequences from 0-120 cmbs (4 ft), underlain by a thick organic silt, peat, and muck sequence to 580 cmbs (19 ft) (GRA 2011: 18, 27, 45). The fill from 85-120 cm (2.8-3.9 ft) contained one large brick fragment and common cinders. The estuarine silts and clays are contaminated with petroleum product. No environmental data on potential soil contaminants is available for this soil boring (TRC 2011).

The soil boring indicates the presence of shallow fill over a subaqueous estuary below 450 cm (15 ft). No archaeologically sensitive strata were identified in the vertical pipeline trench APE (GRA 2011:27). The pipeline route between STA 563+00 and 577+50 is re-assessed as having no archaeological sensitivity (see Figures 16 and 17), and no Phase IB survey is recommended.

BAY-019 (HUD-32-ARC-1)

Geoarchaeological soil boring BAY-019 (HUD-32-ARC-1) is located on property belonging to the Bayonne Local Redevelopment Authority (BLRA) along the east side of State Highway Route 440 between STA 586+00 and 591+00 (Figures 17 and 18). This area was assigned high sensitivity for pre-contact resources related to shoreline camp sites as well as post-contact archaeological resources associated with documented nineteenth and possibly eighteenth-century buried landscapes containing structures, artifact deposits, and possible slave burials associated with the Van Buskirk Manor (Elquist et al. 2010c:111-113). The soil boring analysis, however, revealed the presence of a disturbed fill sequence from 0-435 cmbs (14 ft), underlain by a truncated glacial till to 580 cmbs (19 ft). No buried soils or surfaces were identified in the vertical pipeline trench APE (GRA 2011:18-19, 27, 46). Environmental sampling also determined exceedances of semi-volatile organic compounds and arsenic contaminants from 46 to 61 cmbs (1.5 to 2.0 ft) in these soil borings (TRC 2011).

Given the lack of archaeologically sensitive strata, the pipeline route between STA 586+00 and 591+00 is re-assessed as having no archaeological sensitivity (see Figures 17 and 18), and no Phase IB survey is recommended.

BAY-020A (HUD-32-ARC-3) through BAY-024 (HUD-32-ARC-7)

Five geoarchaeological soil borings (BAY-020A [HUD-32-ARC-3], BAY-021 [HUD-32-ARC-4], BAY-022 [HUD-32-ARC-5], BAY-023 [HUD-32-ARC-6], and BAY-024 [HUD-32-ARC-7]) are also located on property belonging to the BLRA along the east side of State Highway Route 440 between STA

592+00 and 603+00 (Figures 18 and 19). This area was also assigned high sensitivity for pre-contact resources related to shoreline camp sites as well as post-contact archaeological resources associated with documented nineteenth and possibly eighteenth-century buried landscapes containing structures, artifact deposits, and possible slave burials associated with the Van Buskirk Manor estate (Elquist et al. 2010c:112-113).

Only one of these soil borings (BAY-024 [HUD-32-ARC-7]) did not contain archaeologically sensitive strata. Similar to BAY-019, BAY-024 contained disturbed fill sequences from 0-85 cmbs (2.7 ft) underlain by glacial till to 490 cmbs (16 ft) (GRA 2011:50). The section of pipeline route between STA 598+50 and 603+00 is re-assessed as having no archaeological sensitivity (see Figures 18 and 19), and no Phase IB survey is recommended.

The remaining soil borings were placed along the upland margins of the Bayonne shoreline and all contained evidence of buried land surfaces beneath modern fill deposits (GRA 18-22, 28, 47-49). The buried land surfaces range in depth from 255 cmbs (8.3 ft) to 530 cmbs (17.5 ft) within the vertical APE of the pipeline trench. The suspected historic ground surface in BAY-020A in particular contained wood (possible disturbance) and fine brick fragments from 365-430 cmbs (12-14 ft). Intact B-horizon fine sandy clay loam subsoils were also noted in the soil borings, although the exact interface depth within the sensitive strata was unclear because of slump and poor recovery. The B horizon soils are directly underlain by the glacial till.

The sensitive archaeological strata in these borings are as follows: BAY-020A (365-530 cmbs [11.5-17.5 ft]); BAY-021 (280-390 cmbs [9-13 ft]); BAY-022 (375-400 cmbs [12-13.5 ft]); and BAY-023 (255-280 cmbs [8-9 ft]). Environmental sampling determined exceedances of semi-volatile organic compound contaminants from 23 to 152 cmbs (0.75 to 5.0 ft) in BAY-021, -022, -23, and -24 (TRC 2011). The water table was encountered from 168 to 305+ cmbs (5.5 to 10+ ft) in these soil borings.

A Phase IB survey is recommended for the high sensitivity work area containing archaeologically sensitive strata between STA 592+00 and 598+50 (see Figure 18). As noted above, this area could contain pre-contact period cultural deposits as well as post-contact period resources associated with the documented Van Buskirk Manor estate property. Given the presence of fill over buried land surfaces beginning at 255 cmbs (8.4 ft) below ground and extending to 530 cmbs 17.4 ft within and below the vertical APE of the pipeline trench, machine-assisted trenches will be used. The high sensitivity section of proposed pipeline route at this location measures approximately 240 m (787 ft). Approximately eleven (11) trenches, each measuring 4.5 m (15 ft) wide (width of top of pipeline trench) by 3 m (9.8 ft) long will be placed at 20-m (66 ft) intervals within this work space (see Figure 11). The trenches will extend through the depth of identified sensitive strata within the vertical pipeline trench APE. The testing methodology for machine-assisted trenches is described in more detail below under Fieldwork Methodology.

BAY-025 (HUD-32-ARC-8) through BAY-031 (HUD-32-ARC-14)

Seven (7) geoarchaeological soil borings (BAY-025 [HUD-32-ARC-8], BAY-026 [HUD-32-ARC-9], BAY-027 [HUD-32-ARC-10], BAY-028 [HUD-32-ARC-11], BAY-029 [HUD-32-ARC-12], BAY-030 [HUD-32-ARC-13], and BAY-031 [HUD-32-ARC-14]) are also located on property belonging to the BLRA along the east side of State Highway Route 440 between STA 603+00 and 622+00 (Figures 19 and 20). This area was assigned high sensitivity for pre-contact resources related to shoreline camp sites as well as post-contact archaeological resources associated with documented eighteenth and nineteenth-century buried landscapes containing structures, artifact deposits, and possible slave burials on the historic Cadmus and Vreeland manor estates (Elquist et al. 2010c:113-118).

Only one of these soil borings (BAY-025 [HUD-32-ARC-8]) did not contain archaeologically sensitive strata. BAY-025 contained disturbed fill sequences from 0-555 cm below ground (18.2 ft) underlain by organic silt containing very fine shell fragments (estuarine sediments) to 580 cmbs (19 ft) (GRA 2011:50). The section of pipeline route between STA 603+00 and 605+50 is re-assessed as having no archaeological sensitivity (see Figure 19), and no Phase IB survey is recommended.

The remaining soil borings were placed within the lower lying setting of the Bayonne shoreline and all contained evidence of intact sandy sediments which may be buried beaches and shorelines (GRA 23-24, 28, 50-56). Two of the borings, BAY-027 and -029, also contained evidence of a buried historic land surface below the fill from 145-165 cmbs (4.7-5.4 ft) and from 225-243 cmbs (7.4-8 ft), respectively. These buried surfaces may have been former historic surfaces, as the depth below surface would have been just above sea level during the post-contact period, and potentially during the late pre-contact period (GRA 2011:23). All of the borings contained upper fill deposits that ranged in depth from 145 cm (4.5 ft) (BAY-027) to 250 cm (8.2 ft) (BAY-026).

Estuarine silts and clays identified as likely nearshore estuaries are present below the beach sands from 405-580 cmbs (13-19 ft). Fine shell fragments were found throughout BAY-028, -029, and -030. BAY-031 was situated the furthest offshore and it contained evidence of a possible lacustrine fan from 235-520 cmbs (7.7-17 ft) and glacial lake deposits from 520-580 cmbs (7.7-19 ft). The soils at these depths contained fine shell fragments, which are typical in shorelines and large bodies of water (GRA 2011:24). The buried beach and landforms identified in these soil borings are interpreted as possible loci for pre-contact period resource procurement (i.e., source of shellfish) (GRA 2011:28).

The sensitive archaeological strata in these borings are as follows: BAY-026 (250-390 cmbs [8-13 ft]); BAY-027 (145-410 cmbs [4.5-13.5 ft]); BAY-028 (200-417 cmbs [6.5-14 ft]); BAY-029 (225-405 cmbs [7-13.5 ft]); BAY-030 (205-570 cmbs [6.5-19 ft]); and BAY-031 (145-235 cmbs [4.5-8 ft]). Environmental sampling determined exceedances of semi-volatile organic compound contaminants from 71 to 91 cmbs (2.5 to 3.0 ft) in BAY-027, -028, -29, and -30 (TRC 2011). The water table was encountered from 244 to 305+ cmbs (8 to 10+ ft) in these soil borings.

A Phase IB survey is recommended for the high sensitivity work area containing archaeologically sensitive strata between STA 605+50 and 622+00 (see Figures 19 and 20). As noted above, this area could contain pre-contact period cultural deposits as well as post-contact period resources associated with the documented Cadmus and Vreeland manor estates. Given the presence of paved roadways and fill over buried land surfaces beginning at approximately 145 cmbs (4.5 ft) and extending to approximately 570 cmbs (19 ft) within and below the vertical APE of the pipeline trench, machine-assisted trenches will be used. The high sensitivity section of proposed pipeline route at this location measures approximately 560 m (1837 ft). Approximately twenty-eight (28) trenches, each measuring 4.5 m (15 ft) wide (width of top of pipeline trench) by 3 m (9.8 ft) long will be placed at 20-m (66 ft) intervals within this work area (see Figures 19 and 20). The trenches will extend through the depth of identified sensitive strata within the vertical pipeline trench APE. The testing methodology for machine-assisted trenches is described in more detail below under Fieldwork Methodology.

BAY-R-001 (HUD-32-ARC-17) through BAY-R-005 (HUD-32-ARC-21)

Five (5) additional geoarchaeological soil borings (BAY-R-001 [HUD-32-ARC-17], BAY-R-002 [HUD-32-ARC-18], BAY-R-003 [HUD-32-ARC-19], BAY-R-004 [HUD-32-ARC-20], and BAY-R-005 [HUD-32-ARC-21] are also located on property belonging to the Bayonne Local Redevelopment Authority (BLRA) along the east side of State Highway Route 440 to the north and west of the pipeline route section between STA 600+00 and 622+00 discussed above (Figures 21 and 22). This area was assessed for archaeological sensitivity as part of the September, 2010 Pre-Filing Application pipeline route (Pre-Filing STA 600+00 to 622+00 [Elquist et al. 2010a:120-125]). It is located in the same high archaeologically sensitivity zone discussed above for pre-contact resources related to shoreline camp sites and shell middens as well as post-contact archaeological resources associated with documented eighteenth and nineteenth-century buried landscapes containing structures, artifact deposits, and possible slave burials on the historic Cadmus and Vreeland manor estates and historic Salterville Village (Elquist et al. 2010a:120-125).

All of these soil borings were located along the former upland surfaces of the BLRA property similar to those encountered in BAY-019 through -024 described above. No archaeologically sensitive strata were identified through the soil boring analysis of BAY-R-001, BAY-R-002, BAY-R-004, and BAY-R-005. BAY-R-001 contained a very thin (7 cm [.3 ft]) layer of modern fill over truncated glacial till to a depth of 610 cmbs (20 ft) (GRA 2011:57). BAY-R-002 contained modern fill to a depth of 140 cmbs (4.7 ft) over truncated glacial till to a depth of 600 cmbs (19.6 ft) (GRA 2011:58). One piece of clear flat glass was recovered in BAY-R-002 at 130 cm (4.3 ft) in the modern fill. BAY-R-004 and BAY-R-005 are located on surfaces truncated down to the glacial till where no fill or buried surfaces are present (GRA 2011: 19, 60-61). Because of an absence of archaeologically sensitive strata within the vertical pipeline trench APE, no further archaeological investigations are recommended for these areas (see Figures 21 and 22).

The remaining soil borings (BAY-R-003 [HUD-32-ARC-19], BAY-R-004 [HUD-32-ARC-20], and BAY-R-005 [HUD-32-ARC-21] all contained evidence of archaeologically sensitive strata buried beneath modern fill deposits.

BAY-R-003 contained a shallowly buried surface underneath disturbed and fill soils from 0-70 cmbs (2.2 ft). A possible buried historic surface may be mixed in with the fill from 25-70 cmbs (0.8-2.2 ft). From 70-150 cmbs (2.2-5 ft) loamy sands that may represent alluvial deposits in a small tidal creek along the former shoreline are present. The glacial till is present from 150-580 cmbs (5-19 ft) (GRA 2011:19, 59). The stratigraphic profile of BAY-R-003 closely resembles that of an area identified as a pre-contact Native American shell midden to the north on adjacent property. The shell midden is located in a buried A horizon at approximately 20 cm (0.6 ft) below blacktop asphalt and gray fill gravels. The buried A horizon extends from approximately 20-60 cmbs (0.6 -2 ft), and contains fragments of clam and oyster shells. B-horizon subsoils consisting of reddish brown to dark gray sands are present between 60-100 cmbs (2-3.3 ft), also similar to the subsoils observed in BAY-R-003. Glacial till is present below 100 cm (3.3 ft) (GRA 2011:20). Environmental sampling determined exceedances of semi-volatile organic compound contaminants from 30.5 to 45.7 cmbs (1.0 to 1.5 ft) in this soil boring (TRC 2011). The water table was encountered at 226 cmbs (7.4 ft).

A Phase IB survey is recommended for the high sensitivity work area containing the archaeologically sensitive shell midden strata at BAY-R-003 (see Figures 21 and 22). The sensitive strata in this location extend from 25-150 cmbs (0.8- 5ft), and include a possible buried historic surface. Given the depth of the sensitive strata a combination of hand test pits and machine-assisted trenches will be used in this area within the vertical APE of the pipeline trench. The high sensitivity section of proposed pipeline route at this location measures approximately 120 m (394 ft). Approximately 10 test pits, each measuring 50-x-50-cm (1.6-x-1.6-ft), and five (5) trenches, each measuring 4.5 m (15 ft) wide (width of top of pipeline trench) by 3 m (9.8 ft) long will be placed at 20-m (66 ft) intervals within this work space (see Figures 21 and 22). The test pits will be placed within the footprint of the proposed trenches, approximately two test pits per trench, in order to provide controlled hand excavation of the sensitive strata in the upper 91.4 cm (3 ft) of the trench. The machine trenches will then be used to investigate the sensitive strata from approximately 91.4-152.4 cmbs (3-5 ft) within the vertical pipeline trench APE. The testing methodology for hand excavations and machine-assisted trenches is described in more detail below under Fieldwork Methodology.

Jersey City, New Jersey

JC-006 (HUD-44-ARC-1) and JC-007 (HUD-44-ARC-2)

Two (2) geoarchaeological soil borings (JC-006 [HUD-44-ARC-1] and JC-007 [HUD-44-ARC-2]) are located in an abandoned asphalt road on property belonging to Jersey Eagle Sales Company, LLC. The abandoned roadway runs parallel along the east side of the New Jersey Turnpike north and south of Linden Avenue between STA 693+00 and 707+00 (Figure 23). The entire area on both sides of Linden Avenue was assigned a low sensitivity for post-contact period resources associated with possible eighteenth-century remains of the Colonel Thomas Brown property and other documented mid- to late-nineteenth-century resources including boat clubs, bath houses, and possible dwellings. The presence of late twentieth-century commercial/light industrial buildings in this area indicated the potential for some degree of disturbances to historic period land surfaces. The south side of Linden Avenue was assigned low sensitivity and the north side moderate sensitivity for pre-contact period resources because of the proximity of a known pre-contact site near the intersection of Linden Avenue and Caven Point Road (Elquist et al. 2010c:128-131).

The soil borings analysis determined the presence of deep fill sequences above natural water-lain deposits that capped a buried surface and intact subsoils (GRA 2011:24-25, 28-29, 62-63). The fill in both borings extended from ground surface to 145 cmbs (4.7 ft) and consisted of gravelly sand to gravelly sandy clay loam. The fill in JC-006 contained domestic debris such as glass, brick, porcelain ceramic sherds, and shell fragments. Natural alluvial and/or estuary deposits are present below the fill horizon from 145-195 cmbs (4.7-6.4 ft) in JC-006 and 165-215 cm (5.4-7 ft) in JC-007. A buried surface containing one whiteware ceramic sherd is present in JC-006 from 195-230 cmbs (6.4-7.5 ft) below the natural deposits, followed by intact B-horizon subsoils from 230-315 cm (7.4-10.3 ft). In JC-007 this buried surface extends from 215-240 cm (7-7.9 ft), although it appears more disturbed with common mottles and occasional pebbles, underlain by intact B-horizon subsoils from 240-260 cmbs (7-8.5 ft). Glacial till was present below the subsoil horizons in both soil borings.

The buried A horizon with post-contact period cultural materials and intact subsoils below the waterlain deposits is consistent with water flow over a stable land surface. Since the Morris Canal is documented to have been located on the west side of the New Jersey Turnpike opposite this location, it may be that another artificial channel was present along this portion of the proposed pipeline route, or the water may reflect a transgression of tidal estuary, or localized run-off from the Palisade ridge diverted by Turnpike construction (GRA 2011:25). The sensitive archaeological strata for JC-006 are located from 195-315 cmbs (6.4-10.3 ft) and for JC-007 from 215-260 cmbs (7-8.5 ft). No environmental data on potential soil contaminants is available for these two soil borings (TRC 2011). The water table was encountered at 244 cmbs (8 ft) in both areas.

A Phase IB survey is recommended for the low and moderate sensitivity work areas containing archaeologically sensitive strata between STA 693+00 and 707+00 (see Figure 23). As noted above, this area could contain pre-contact period cultural deposits as well as post-contact period resources associated with documented eighteenth and nineteenth-century domestic and recreational land uses. Given the presence of paved roadways and fill over buried land surfaces beginning at approximately 195 cmbs (6.4 ft) and extending to approximately 260 cmbs (8.5 ft) within the vertical APE of the pipeline trench, machine-assisted trenches will be used. The low sensitivity section of the proposed pipeline route measures approximately 140 m (459 ft) and the moderate sensitivity section measures approximately 340 m (1116 ft). Approximately five (5) trenches, each measuring 4.5 m (15 ft) wide (width of top of pipeline trench) by 3 m (9.8) long will be placed at 30-m (98.4 ft) intervals within the low sensitivity work space, and approximately fifteen (15) trenches, same dimensions, will be placed at 20-m (66 ft) intervals within the moderate sensitivity work space (see Figure 23). The trenches will extend through the depth of identified sensitive strata within the vertical pipeline trench APE. The testing methodology for machine-assisted trenches is described in more detail below under Fieldwork Methodology-Machine Trenching.

JC-026 (HUD-95-ARC-1)

Geoarchaeological soil boring JC-026 (HUD-95-ARC-1) is located on property belonging to Lorraine Mocco within an area of elevated New Jersey Turnpike roadways and the elevated Pulaski Skyway between STA 913+00 and 929+25.4 (Figure 24). This area was assigned a low sensitivity for pre-contact period resources below deep fill deposits, but no post-contact period sensitivity because of modern disturbances associated with the extensive railroad and highway construction that has occurred in this area (Elquist et al. 2010c:159-162). The soil boring analysis confirmed the presence of very thick modern fill above glacial till in this area that has been significantly modified by made land for the railroad yards and highway corridors. Cinders, wood fragments, and concrete chunks were present in the fill from 0-515 cmbs (17 ft), including a large fragment of wood, possibly a board, post, or log cored through between 515 and 535 cmbs (17-17.5 ft). The wood appeared to have been intentionally placed at this depth. Glacial till was present from 535 cm (17.5 ft) to the bottom of the boring at 580 cmbs (19 ft) (GRA 2011:25, 29, 64). No environmental data on potential soil contaminants is available for this boring (TRC 2011). The water table was encountered at 381 cm (12.5 ft).

Given the lack of archaeologically sensitive strata, the pipeline route between STA 913+00 and 929+25.4 is re-assessed as having no archaeological sensitivity, and no Phase IB survey is recommended. This section of pipeline route has now been replaced with Route Variation 51 between STA 915+09 and 927+99.5R, which shifts the alignment of the proposed pipeline west of the originally proposed route (see Figure 24). This new pipeline route variation was assessed as having no archaeological sensitivity based on the soil borings data analysis from JC-026 (HUD-95-ARC-1) (Elquist and Cherau 2011c).

TESTING METHODOLOGY

PAL's Phase IB archaeological survey testing methodology has been formulated according to the standards and guidelines set forth in *New Jersey Historic Preservation Office Guidelines for Phase I Archaeological Investigations: Identification of Archaeological Resources* (HPO 2004); *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 hand excavated test pits and machine-assisted trenches to locate and identify potentially significant belowground resources within the vertical APE of the pipeline trench (to depths of between 7 and 15 ft below surface). 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 NJ and NY One Call/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. Site-specific HASPs are anticipated for all of the proposed testing areas because of the presence of soil contaminant exceedances including semi-volatile organic compounds (SVOCs) and arsenic in particular. PAL's Certified Industrial Hygienist (CIH) subconsultant, in consultation with the TRC environmental staff, will develop the necessary HASPs, which will be reviewed by Spectra Energy's Environmental Health and Safety (EHS) group. The HASPs may require air monitoring if personnel enter trenches deeper than91.4-122 cmbs (3-4 ft). Mobile lighting devices may also be needed for recordation in trenches below these depths.

All hand excavated test pits will be in the form of 50-x-50-cm (1.6-x-1.6-ft) test pits excavated in arbitrary 10-cm (.33 ft) levels to sterile subsoils unless impeded by rocks, large roots or other obstructions. All excavated soil will be screened through ¼-inch hardware cloth and remaining cultural material will be collected. Soil horizons will be recorded for each unit on standardized field forms. Cultural material and samples will be bagged and labeled with provenience information. Digital photographs will be taken of all test pit locations within the Project area.

Upon completion, all excavation test pits and 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, as well as in accordance 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 permanent repository can be determined in consultation with the New York SHPO for artifacts found in the New York portion of the Project, and artifacts found in the New Jersey portion of the project can be transferred to the Bureau of Archaeology and Ethnology at the New Jersey State Museum or other appropriate facility for permanent curation.

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), the New Jersey SHPO (2004), 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 15-20 weeks, weather and logistics dependant, and can begin as soon as landowner permissions are obtained. 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).

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Table 3. Results and Phase IB Survey Recommendations for Completed Soil Borings, NJ-NY Expansion Project.

Boring No.	*Universal Boring Tracking No.*	*Pipeline Route Section*	*Alignment Sheets(s)*	*2010 Phase IA Sensitivity Assessment*	*Geoarchaeological/Geotechnical Results*	*Recommendation*	*Phase IB Testing Strategy*
SI-001 (replaced with B-4[SI])	1R-22.1-ARC-1 (1R-22.1-ENV-6W)	Staten Island, NY, STA 211+73.6 to 216+00	LD-A-1017	High for pre-contact resources	Modern fill with oily sheet and petroleum odor from 0-16 ft	No sensitive strata in vertical APE; no Phase IB survey	None
SI-002	RCH-1-ARC-1	Staten Island, NY, STA 249+00 to 250+22.5 (Route Variation 50 STA 255+80 to 257+80)	LD-A-1020.1	High for pre- and post-contact resources	In parking lot: complex fill sequence between 0-160 cm (0-5'4" below ground surface) may include historical fill; 160-235 cm (5'4"-7'8") is possibly intact truncated subsoil; 235-560 cm (7'7"-18'3") unweathered sands	Phase IB survey, ~ 40 cmbs to 235+ cmbs (7.5 ft) in 75 m (246 ft) long section of parking lot	4 machine-assisted trenches at 15-m (49 ft) intervals
LIN-003	20-12-ARC-1	Linden, NJ, STA 90+00 to 95+50	LD-A-1007 and 1008	Moderate for pre-and post-contact resources	In parking lot: possible intact post-contact and pre-contact period soil horizon interface between 60-80 cm (~2-2'8" below ground surface) and 80-115 cm (2'8"-3'8")	Phase IB survey, ground surface to ~115 cmbs (4.0 ft) in 175 m (574 ft) long section of parking lot	6 machine-assisted trenches at 30 m (98.4 ft) intervals
LIN-004	20-13-ARC-1	Linden, NJ, STA 96+00 to 102+50	LD-A-1008	Moderate for pre-and post-contact resources	0-40 cm: disturbed fill; 40-580 cm: truncated glacial till	No sensitive strata in vertical APE; no Phase IB survey	None
BAY-011 through BAY-013	HUD-13.1-ARC-2, HUD-13.1-ARC-3, HUD-20-ARC-1	Bayonne, NJ, STA 506+00 to 522+00	LD-A-1041, LD-A-1042, LD-A-1043	Moderate for pre-contact resources	BAY-011: 0-40 cm fill; 40-455 cm: product contaminated fill; 455-465 cm: contaminated/disturbed subsoil; 465-560 cm: till ; BAY-012: 0-82 cm fill; 82-137 cm: product contaminated fill; 137-183 cm: clean fill with construction debris; 183-305 cm: product contaminated fill; 305-345 cm: mixed contaminated fill and natural organic silts; 345-365 cm estuarine organic silts with product contaminant; 365-590 cm: intact Holocene estuary organic silt to silt sequence with no contamination ; BAY-013: 0-30 cm: fill; 30-400 cm: product contaminated fill; 400-455 cm: estuarine organic silts contaminated with product, which decreases with depth	No sensitive strata in vertical APE; no Phase IB survey	None
BAY-014 and BAY-15	HUD-20-ARC-2, HUD-21R-ARC-1	Bayonne, NJ, STA 522+00 to 530+50	LD-A-1044	Moderate for pre-contact resources	BAY-014: 0-20 cm: fill; 20-535 cm: product contaminated fill; 535-580 cm: intact estuarine organic silts contaminated with product, which decreases to no contamination with depth ; BAY-015: 0-145 cm: fill; 145-430 cm: product contaminated fill; 430-580 cm: intact estuarine organic silts contaminated with product, which decreases to no contamination with depth	No sensitive strata in vertical APE; no Phase IB survey	None
BAY-016 and BAY-017	HUD-23.1-ARC-1, HUD 26.2-ARC-1	Bayonne, NJ, STA 533+50 to 540+00	LD-A-1045	Low for pre-contact resources	BAY-016: 0-520 cm: cindery fill with oily sheen; 520-580: organic clay ; BAY-017: 0-132 cm: fill; 132-354 cm: product contaminated fill; 354-425 cm: intact estuarine organic silts contaminated with product, which decreases to no contamination	No sensitive strata in vertical APE; no Phase IB survey	None

Boring No.	*Universal Boring Tracking No.*	*Pipeline Route Section*	*Alignment Sheets(s)*	*2010 Phase IA Sensitivity Assessment*	*Geoarchaeological/Geotechnical Results*	*Recommendation*	*Phase IB Testing Strategy*
BAY-018	HUD-28-ARC-1	Bayonne, NJ, STA 563+00 to 577+50	LD-A-1048 and 1049	Low for pre-contact resources	0-120: fill; 120-405: organic silts contaminated; 405-580: organic silts, upper portion contaminated	No sensitive strata in vertical APE; no Phase IB survey	None
BAY-019	HUD-32-ARC-1	Bayonne, NJ, STA 586+00 to 591+00	LD-A-1049 and 1050	High for pre- and post-contact resources	0-435 cm: fill; 435-555 cm: lost due to slump/slurry; 555-580: glacial till	No sensitive strata in vertical APE; no Phase IB survey	None
BAY-020A, -021, -022, -023, -024	HUD-32-ARC-3, HUD-32-ARC-4, HUD-32-ARC-5, HUD-32-ARC-6, HUD-32-ARC-7	Bayonne, NJ, STA 592+00 to 603+00	LD-A-1050	High for pre- and post-contact resources	BAY-020A: 0-365 cm: fill; 365-430 cm: wood fragment capping buried organic rich surfaces, possible brick fragments towards base at 430 cm (maybe natural soil redox mottles); 430-530 cm: possible subsoil with intrusive brick fragments, most of sample lost in slurry at contact between C and D cores; 530-580 cm: till; BAY-021: 0-280 cm: fill; 280-290+ cm: disturbed historic surface, could possibly extend to 330 cm; 330-390 cm: intact subsoil; 390-580 cm: glacial till; BAY-022: 0-375 cm: fill; 375-400 cm: disturbed buried surface, few possibly intrusive mottles: 400-580: glacial till ; BAY-023: 0-255 cm: fill; 255-280 cm: possibly buried surface with very few glassy cinders, 280-580: glacial till ; BAY-024: 0-85 cm: fill; 85-490: glacial till.	Phase IB survey, beginning at ~255 cmbs below surface (8 ft) in 240 m (787 ft) long section of BLRA Property (historic Van Buskirk Manor)	12 machine-assisted trenches at 20 m (66 ft) intervals
BAY-025, -026, -027, -028, -029, -030, -031	HUD-32-ARC-8, HUD-32-ARC-9, HUD-32-ARC-10, HUD-32-ARC-11, HUD-32-ARC-12, HUD-32-ARC-13, HUD-32-ARC-14	Bayonne, NJ, STA 603+00 to 622+00	LD-A-1051 and 1052	High for pre- and post-contact resources	BAY-025: 0-555 cm: fill; 555-580: organic silts, possible pre-contact estuary ; BAY-226: 0-250 cm: fill; 250-390 cm: sandy, gravelly sandy, beach deposits; 390-550: organic silts and clays; 550-580 cm: reduced glacial till ; BAY-027: 0-145 cm: fill; 145-165 cm: buried surface high in organics; 165-410 cm: sands to gravelly sands of either beach or fill; 410-435 cm: estuarine sandy loam with organics ; BAY-028: 0-200 cm: fill; 200-417 cm: sandy, gravelly sandy beach deposits; 417-580 cm: estuarine organic silts, clays, and loams; BAY-029: 0-225 cm: fill; 225-243 cm: organic rich buried surface; 243-405 cm: sandy, gravelly sandy beach deposits; 405-580 cm estuarine silts and clays; BAY-030: 0-205 cm: fill; 205-570 cm: sandy, gravelly sandy beach deposits; 570-580 cm: estuarine clays with organics; BAY-031: Complex sequence of: 0-145 cm: Recent Fill; 145-235 cm: fining upward sequence of clean sands, possible Holocene shoreline/estuary deposits; 235-520 cm: reworked till (lacustrine fan?) moderately sorted sands with occasional fine shell fragments; 520-580 cm: silts with fine beds of partially decayed organics (likely glacial Lake Bayonne).	Phase IB survey, beginning at ~145 cmbs (4.5 ft) in 560 m (1837 ft) long section of BLRA Property (historic Cadmus and Vreeland Manor Estates)	28 machine-assisted trenches at 20 m (66 ft) intervals
BAY-R-001, -002, -003, -004, -005	HUD-32-ARC-17, HUD-32-ARC-18, HUD-32-ARC-19, HUD-32-ARC-20, HUD-32-ARC-21	Bayonne, NJ, September, 2010 Pre-Filing section STA 600+00 to	September, 2010 Pre-Filing: LD-A-1048 and 1049	High for pre- and post-contact resources	BAY-R-001: 7 cm of modern fill over truncated glacial till (Rahway); BAY-R-002: Fill (incl. 1 clear flat glass fragment at 130 cm) to a depth of 140 cm (4 ft 7 in). Below is truncated glacial till (Rahway); BAY-R-003: Complex sequence of: 0-25 cm: recent Fill; 25-70 cm: possible mixed	Phase IB survey, beginning at ~25 cmbs (10-in) in 120 m (294 ft) long section of BLRA Property (sensitive for	5 machine-assisted trenches at 20 m (66 ft) intervals with ~10 shovel test pits (2 per trench)

Boring No.	***Universal Boring Tracking No.***	***Pipeline Route Section***	***Alignment Sheets(s)***	***2010 Phase IA Sensitivity Assessment***	***Geoarchaeological/Geotechnical Results***	***Recommendation***	***Phase IB Testing Strategy***
		622+00			fill and buried historic surface; 70-150 cm loamy sands of possibly mixed slopewash, local alluvial or shoreline margins; 150-580 glacial till - similar to shell midden stratigraphy observed to northeast of the property; BAY-R-004: Top 20 cm disturbed with a weakly developed modern surface soil forming over truncated glacial till (Rahway); BAY-R-005: Top 30 cm disturbed with a weakly developed modern surface soil forming over truncated glacial till (Rahway).	pre-contact shell midden strata)	
JC-006 and JC-007	HUD-44-ARC-1, HUD-44-ARC-2	Bayonne, NJ, STA 693+00 to 707+00	LD-A-1059	Low and moderate for pre- and post-contact resources, respectively	JC-006: 0-156 cm: fill with brick, shell, glass; 156-195 cm: natural alluvial/estuary deposits; 195-230 cm: buried historic surface; 230-315 cm: subsoil below surface; 315-580 cm: till; JC-007: 0-165 cm: fill; 165-215 cm: natural alluvial/estuary deposits w/ perched water table; 215-240 cm: buried historic surface; 240-260 cm: subsoil below surface; 260-580 cm: till.	Phase IB survey, beginning at ~195 cmbs (6.4 ft) in 480-m (1575 ft) long section of Jersey Eagle Sales Co. property	20 machine-assisted trenches at 20 (66 ft) and 30 m (98.4 ft) intervals
JC-026	HUD-95-ARC-1	Jersey City, STA 915+19.3 to 925+00	LD-A-1075	low for pre-contact resources	0-515 cm: thick fill sequences; 515-535 cm: wood fragment; 535-580 cm: till	No sensitive strata in vertical APE; no Phase IB survey	None

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

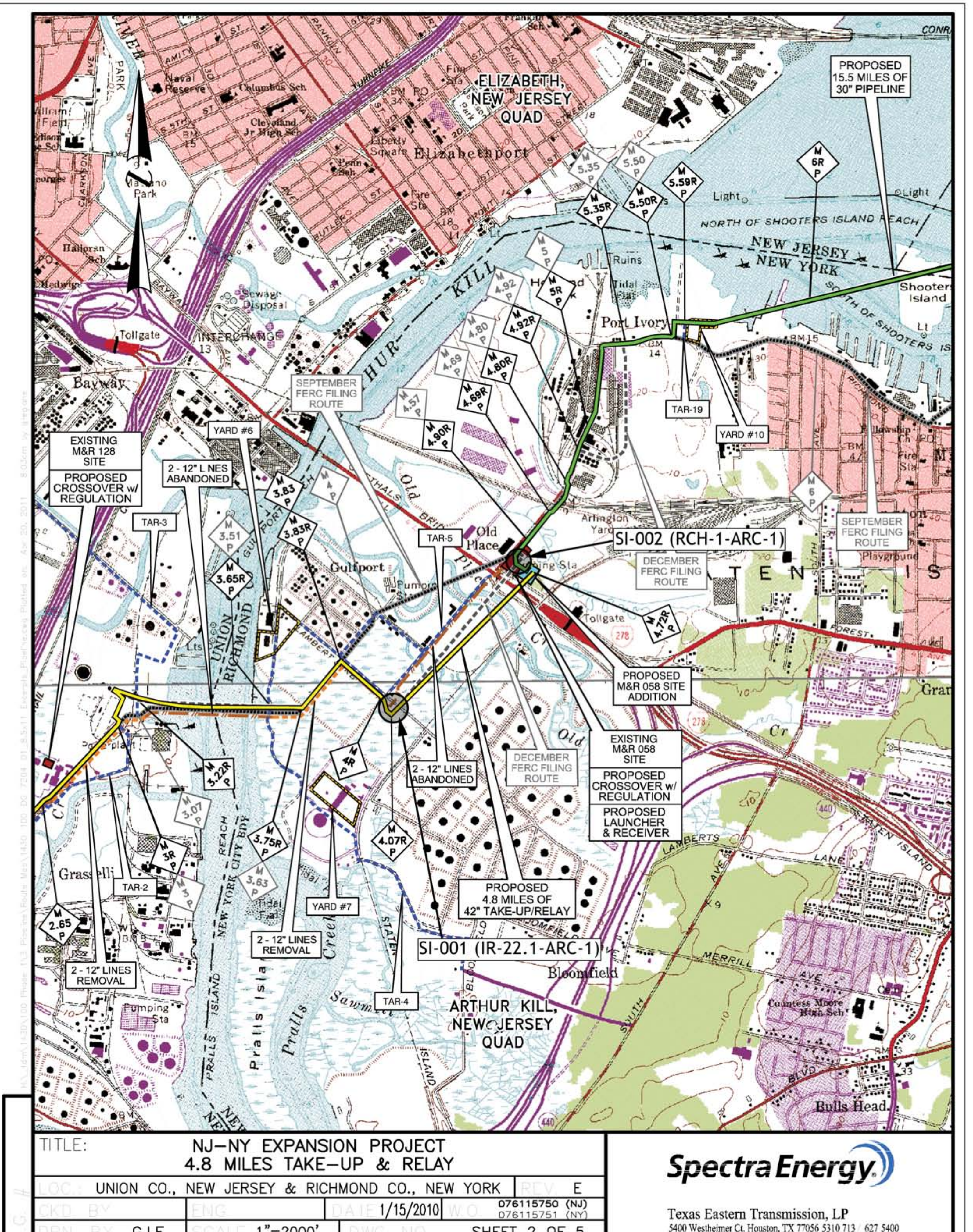

Figure 2. NJ-NY Project area, showing the location of georchaeological soil boring SI-001 (1R-22.1-ARC-1) replaced with Environmental Soil Boring B-4(SI) (1R-22.1-ENV-6W) and SI-002 (RCH-1-ARC-1) on the Elizabeth and Arthur Kill, NJ, USGS topographic quadrangles, 7.5 minute series.

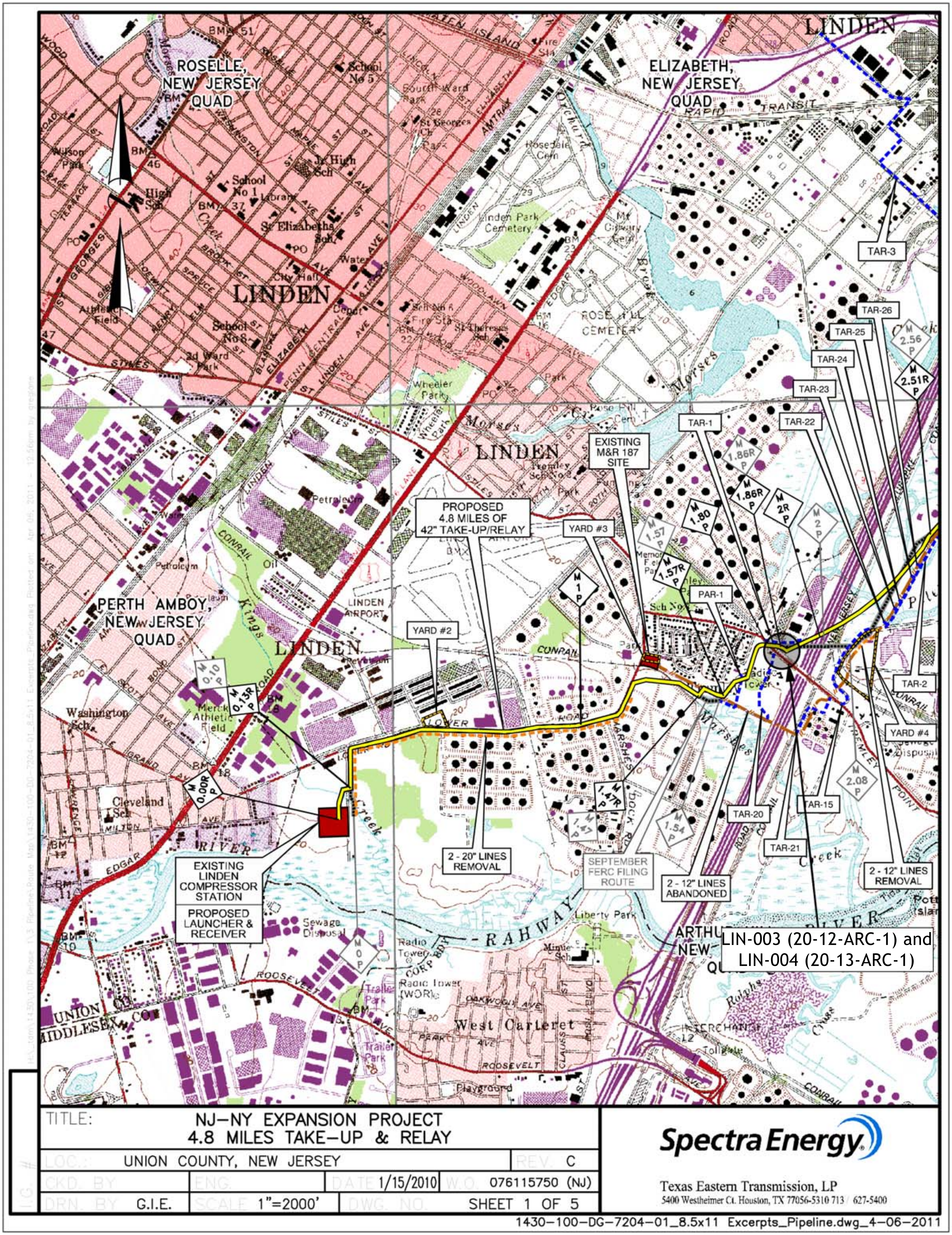

Figure 3. NJ-NY Project area, showing the location of geoarchaeological soil borings LIN-003 (20-12-ARC-1) and LIN-004 (20-13-ARC-1) on the Elizabeth and Arthur Kill, NJ, USGS topographic quadrangles, 7.5 minute series.

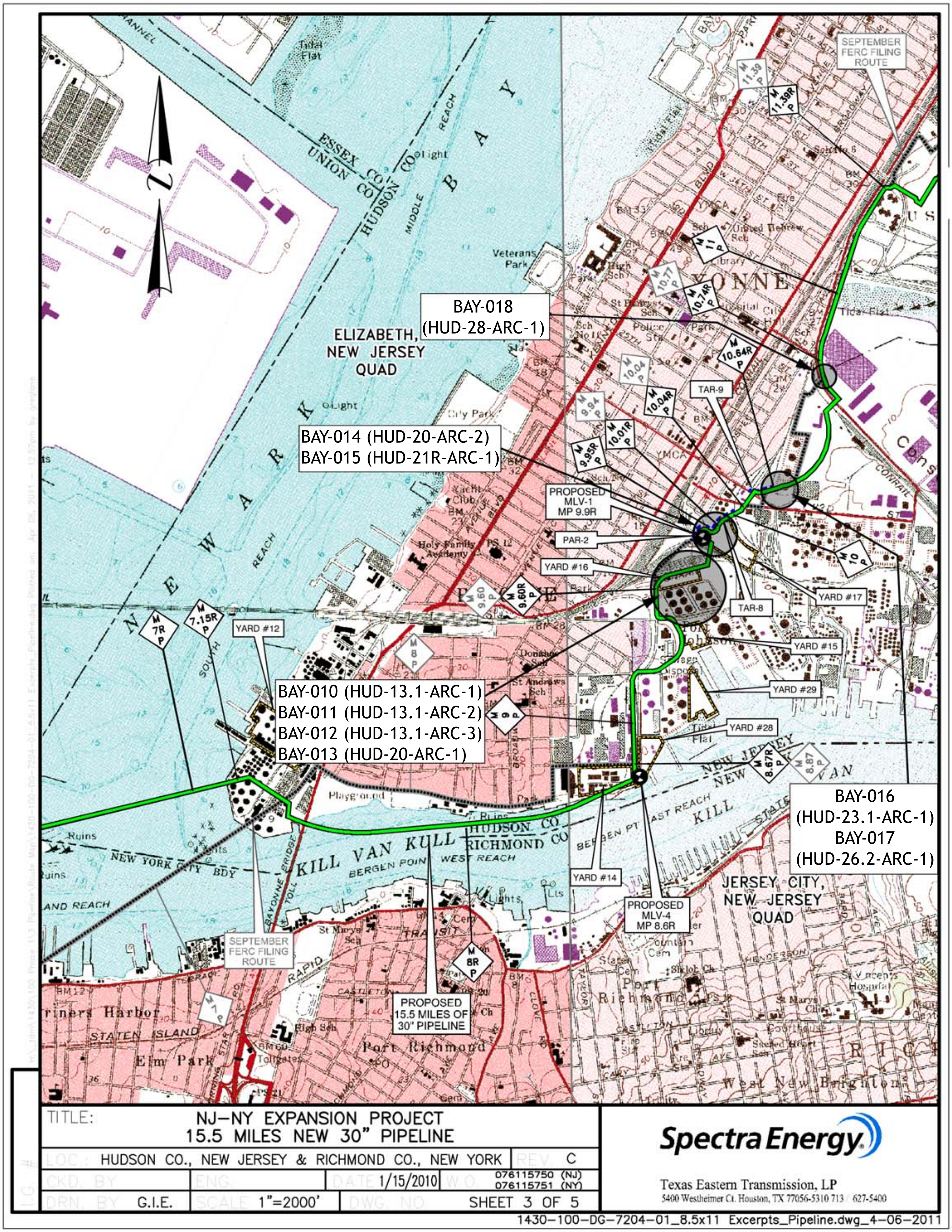

Figure 4a. NJ-NY Project area, showing the location of geoarchaeological soil borings BAY-010 (HUD-13.1-ARC-1), BAY-011 (HUD-13.1-ARC-2), BAY-012 (HUD-13.1-ARC-3), BAY-013 (HUD-20-ARC-1), BAY-014 (HUD-20-ARC-2), BAY-015 (HUD-21R-ARC-1), BAY-016 (HUD-23.1-ARC-1), BAY-017 (HUD-26.2-ARC-1), and BAY-018 (HUD-28-ARC-1) on the Elizabeth and Jersey City, NJ, USGS topographic quadrangles, 7.5 minute series.

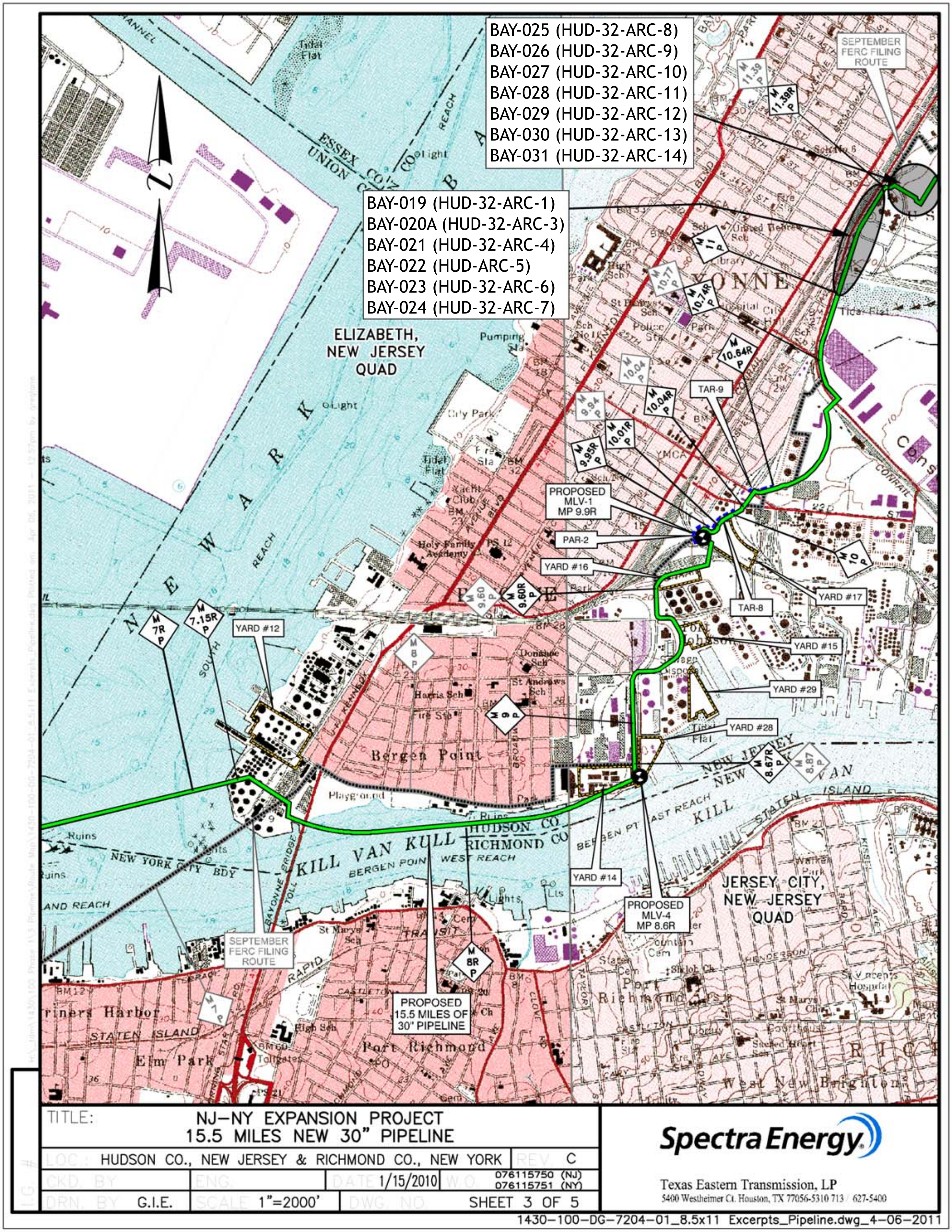

Figure 4b. NJ-NY Project area, showing the location of georarchaeological soil borings BAY-019 (HUD-32-ARC-1), BAY-020A (HUD-32-ARC-3), BAY-021 (HUD-32-ARC-4), BAY-022 (HUD-32-ARC-5), BAY-023 (HUD-32-ARC-6), BAY-024 (HUD-32-ARC-7), BAY-025 (HUD-32-ARC-8), BAY-026 (HUD-32-ARC-9), BAY-027 (HUD-32-ARC-10), BAY-028 (HUD-32-ARC-11), BAY-029 (HUD-32-ARC-12), BAY-030 (HUD-32-ARC-13), and BAY-031 (HUD-32-ARC-14) on the Elizabeth and Jersey City, NJ, USGS topographic quadrangles, 7.5 minute series.

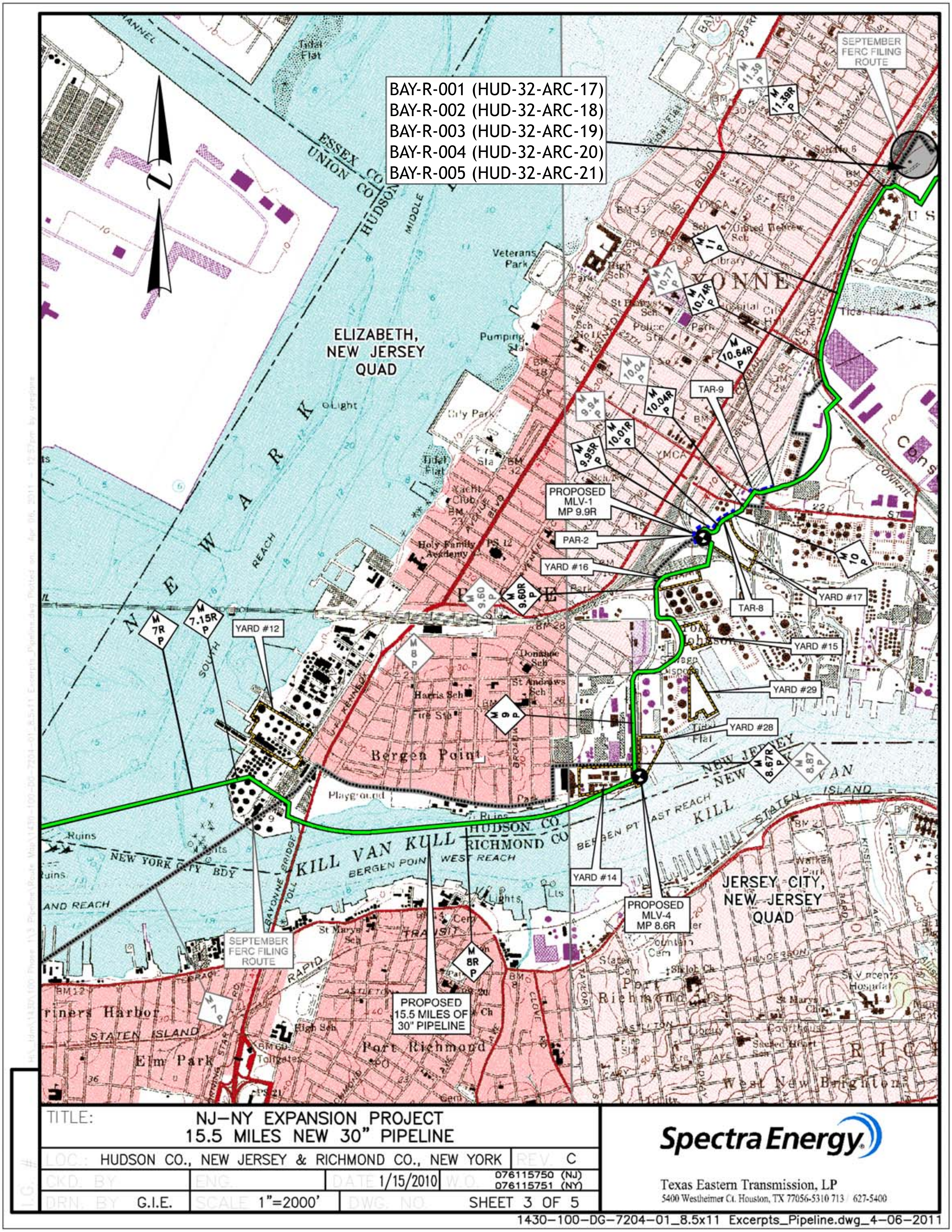

Figure 4c. NJ-NY Project area, showing the location of geoarchaeological soil borings BAY-R-001 (HUD-32-ARC-17), BAY-R-002 (HUD-32-ARC-18), BAY-R-003 (HUD-32-ARC-19), BAY-R-004 (HUD-32-ARC-20), and BAY-R-005 (HUD-32-ARC-21) on the Elizabeth and Jersey City, NJ, USGS topographic quadrangles, 7.5 minute series.

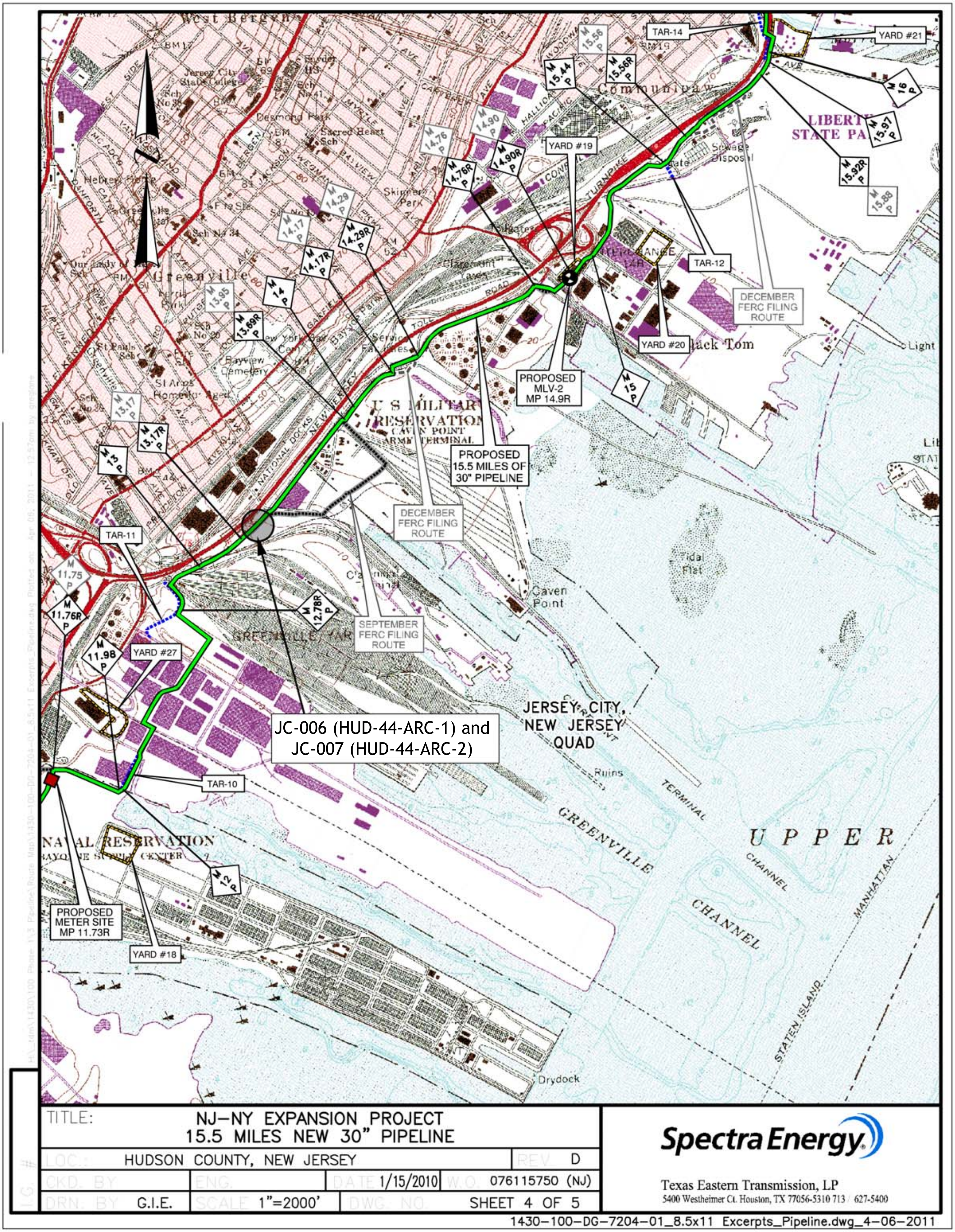

Figure 5. NJ-NY Project area, showing the location of geoarchaeological soil borings JC-006 (HUD-44-ARC-1) and JC-007 (HUD-44-ARC-2) on the Jersey City, NJ, USGS topographic quadrangle, 7.5 minute series.

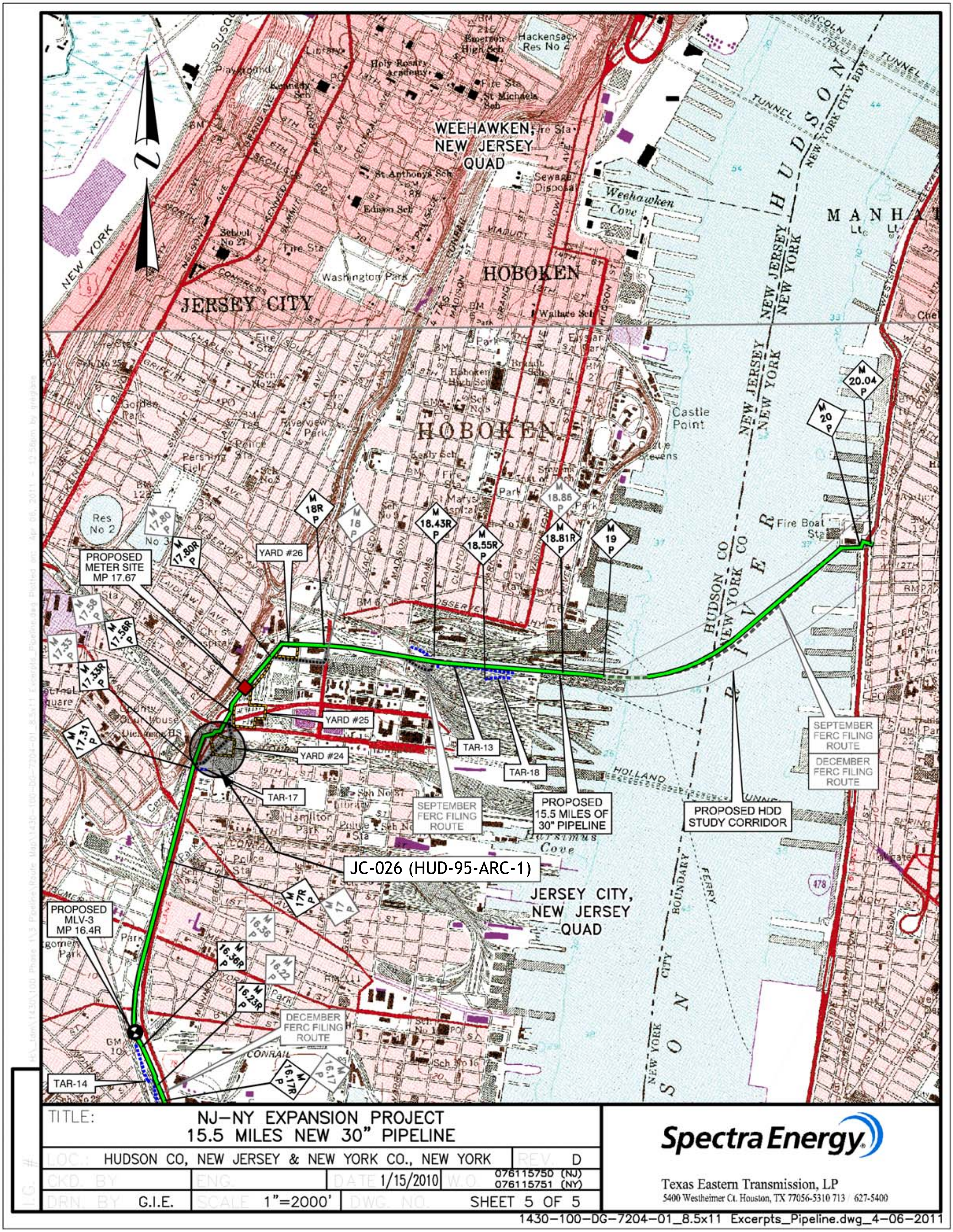

Figure 6. NJ-NY Project area, showing the location of geoarchaeological soil boring JC-026 (HUD-95-ARC-1) on the Jersey City, NJ, USGS topographic quadrangle, 7.5 minute series.

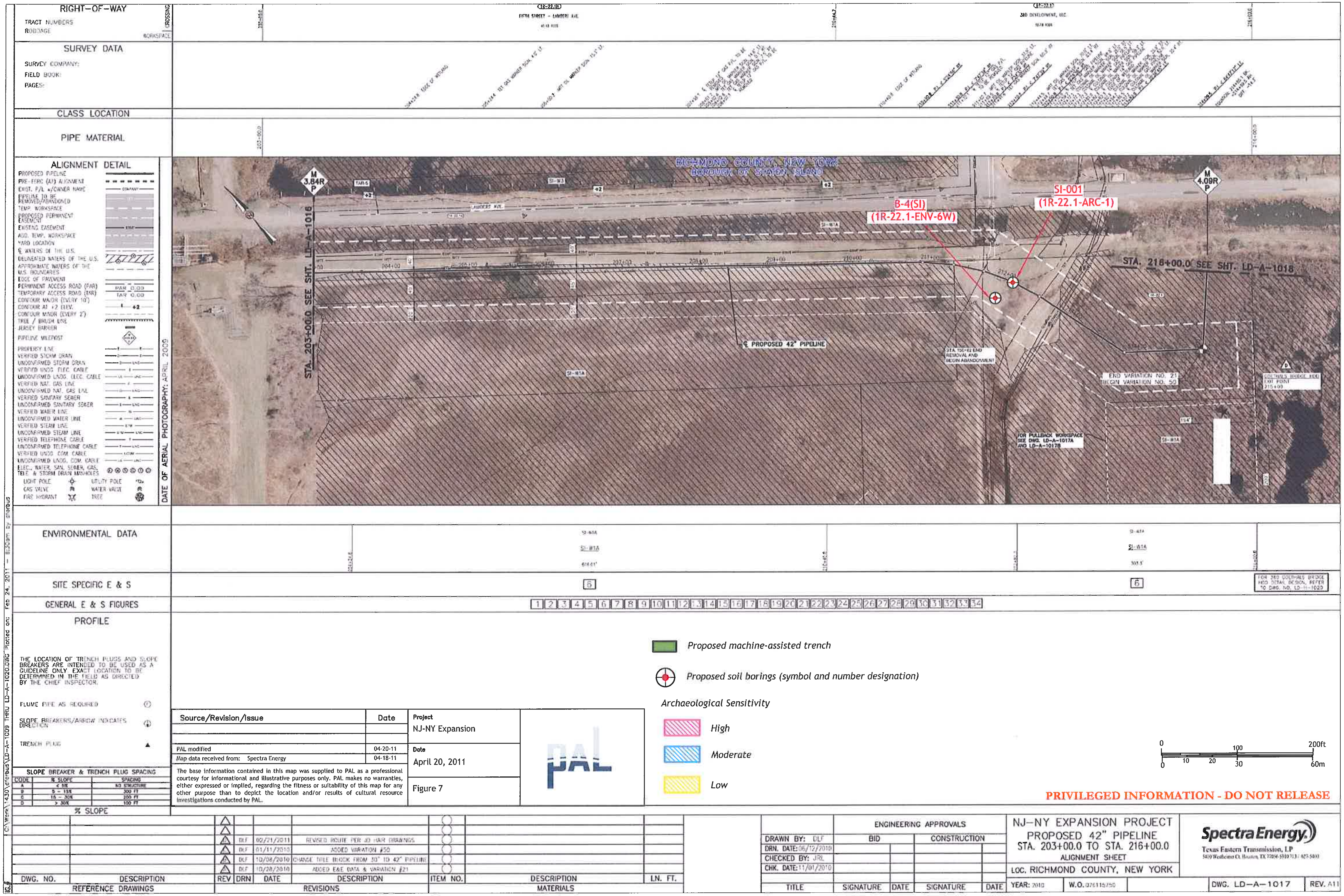

Figure 7. Revised archaeological sensitivity of the pipeline route, STA 211+73.6 to STA 216+00, Staten Island, NY.

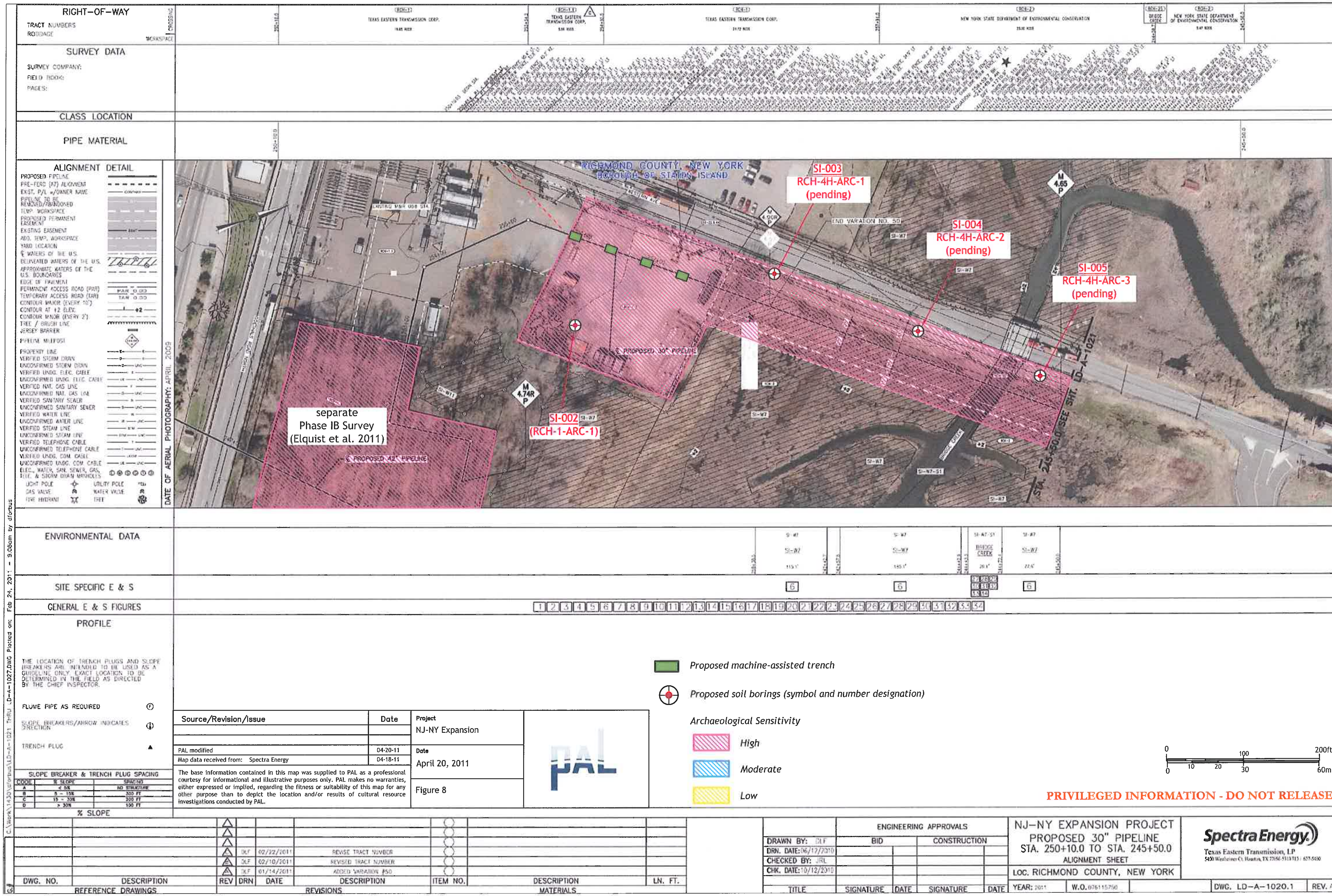

Figure 8. Proposed Phase IB testing within the pipeline route, STA 255+80 to 257+80, Staten Island, NY.

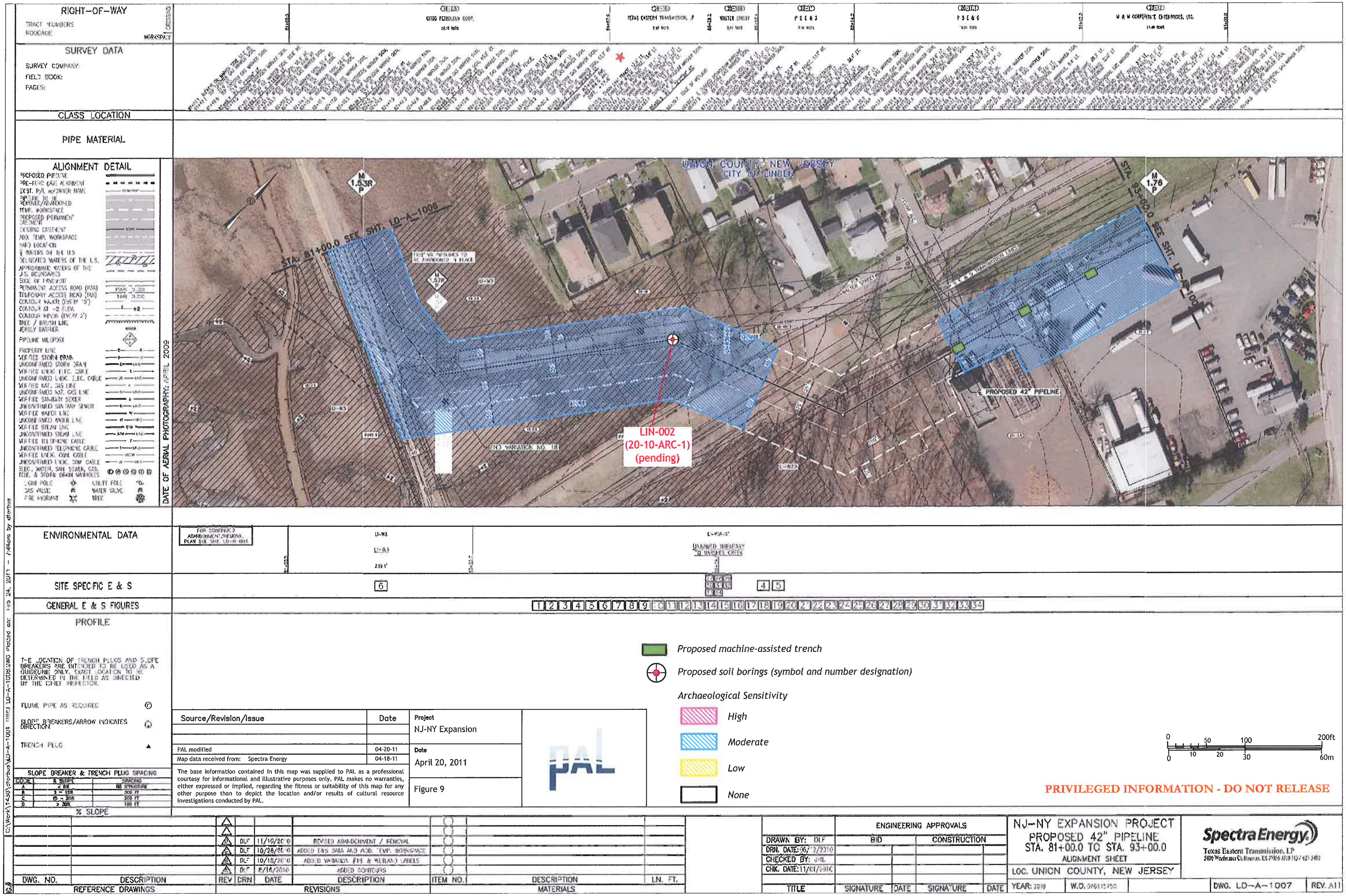

Figure 9. Proposed Phase IB testing within the pipeline route, STA 90+00 to 93+00, Linden, NJ.

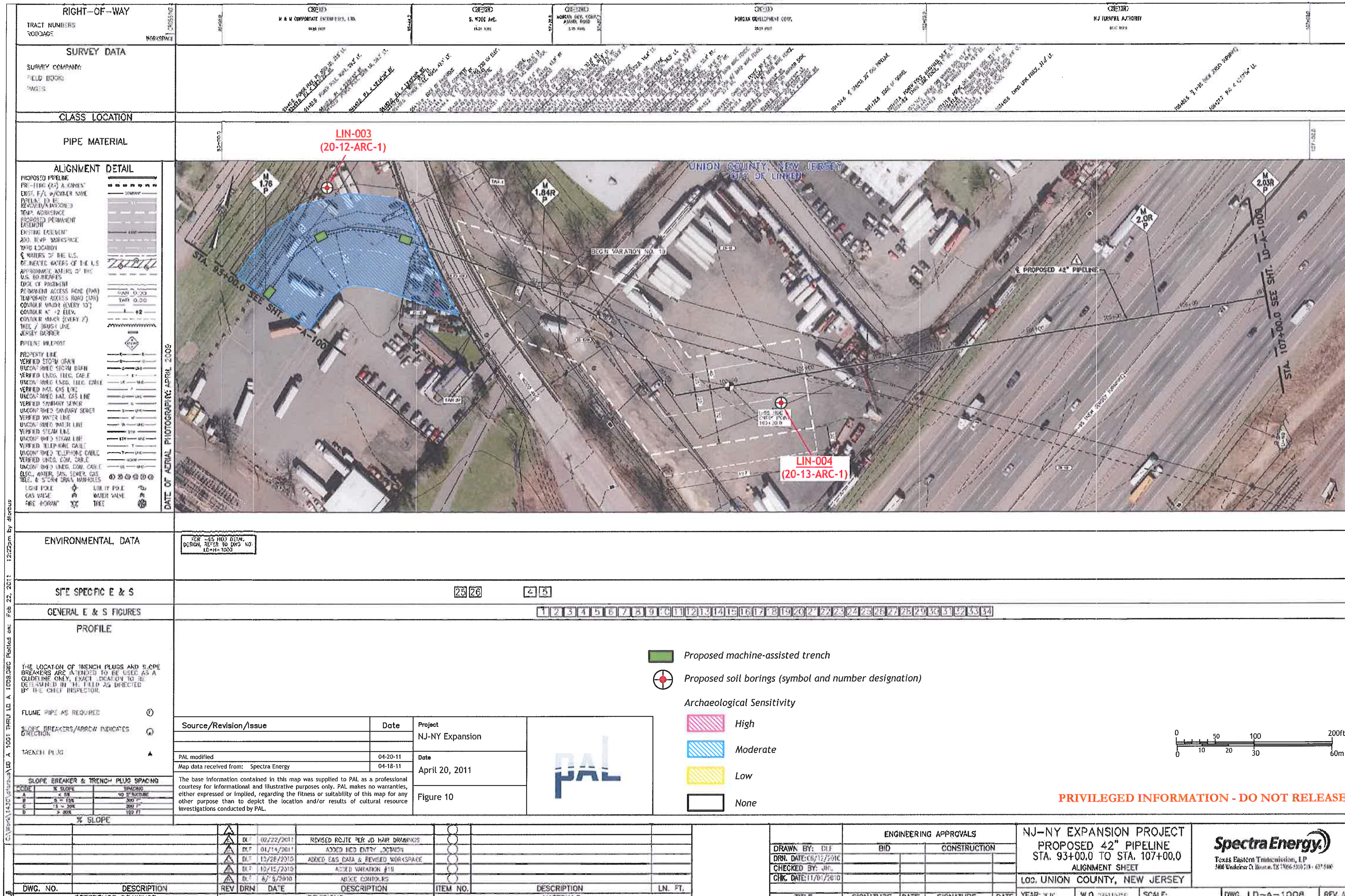

Figure 10. Revised archaeological sensitivity assessment for STA 96+00 to 102+50 and proposed Phase IB testing within the pipeline route, STA 93+00 to 95+50, Linden, NJ.

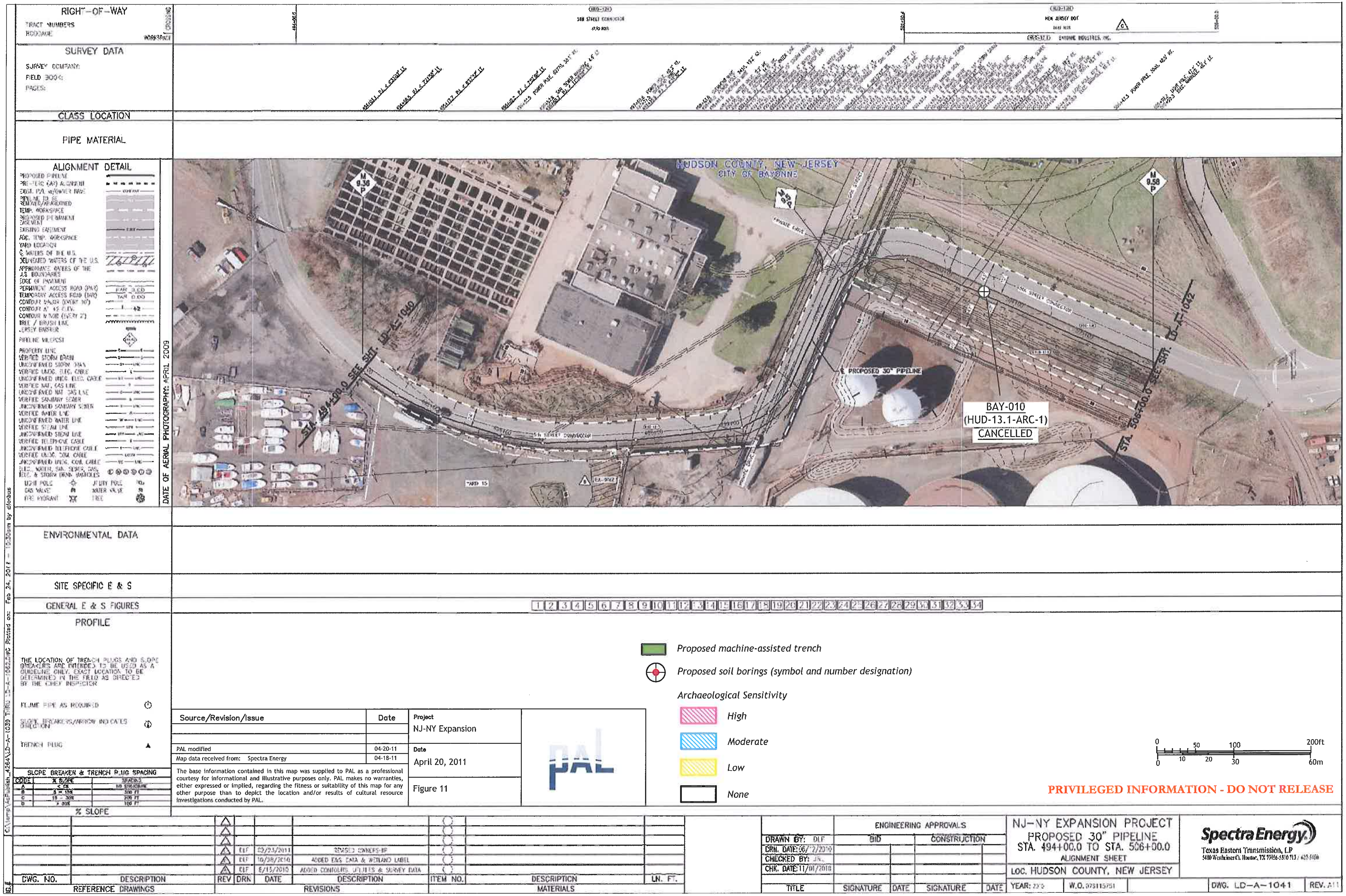

Figure 11. Revised archaeological sensitivity assessment of the pipeline route, STA 502+00 to 506+00, Bayonne, NJ.

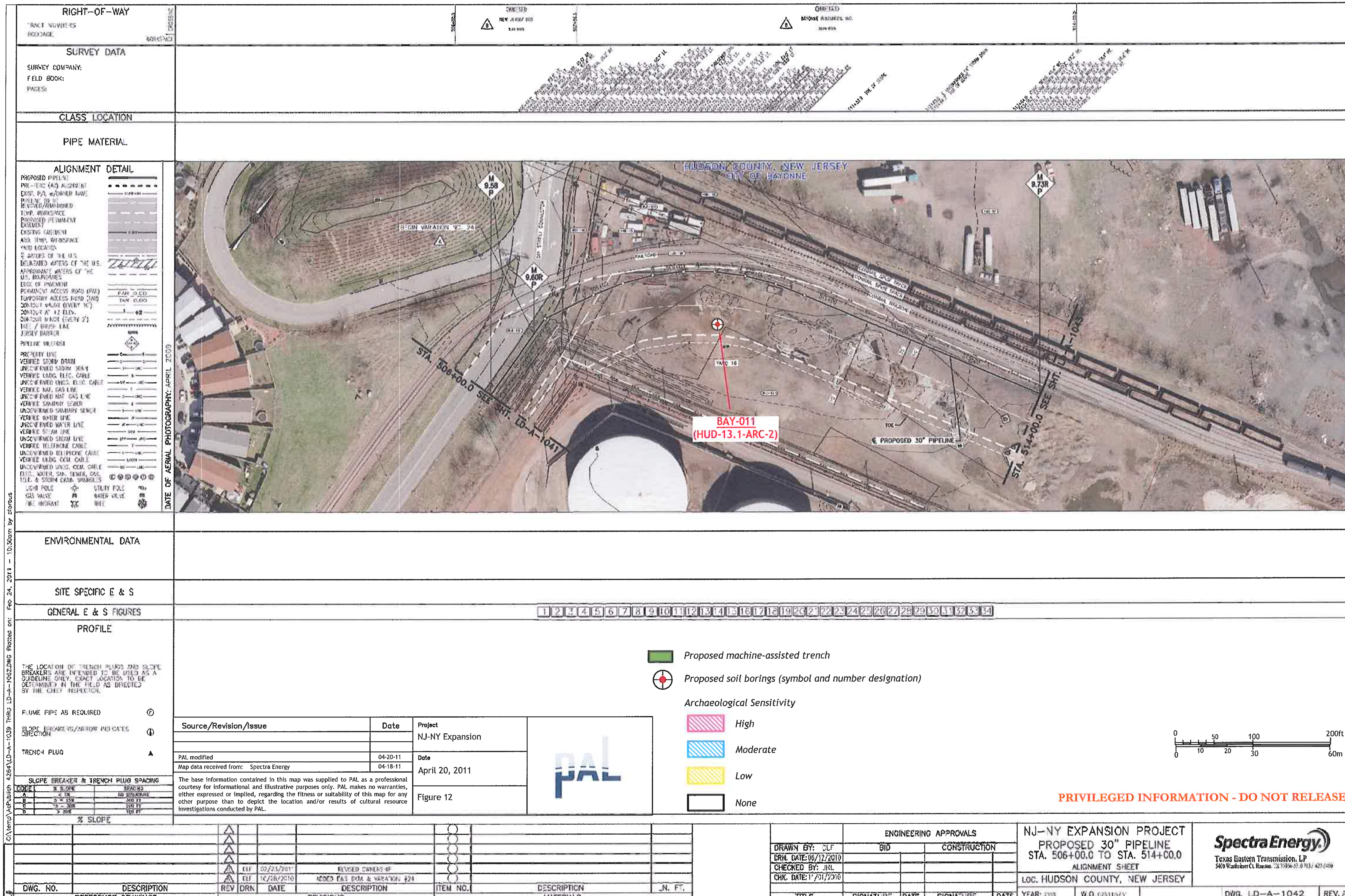

Figure 12. Revised archaeological sensitivity assessment of the pipeline route, STA 506+00 to 514+00, Bayonne, NJ.

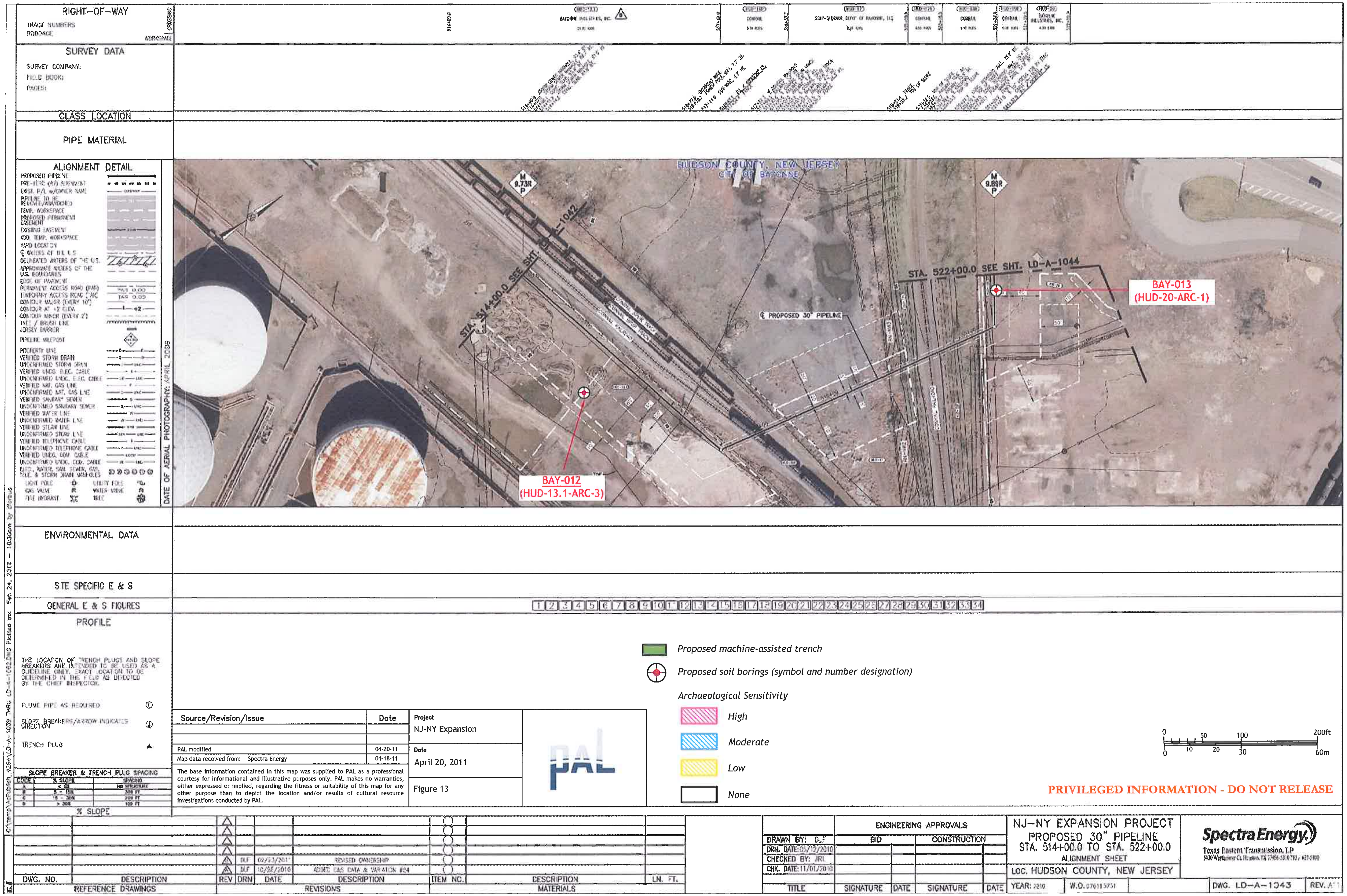

Figure 13. Revised archaeological sensitivity assessment of the pipeline route, STA 514+00 to 522+00, Bayonne, NJ.

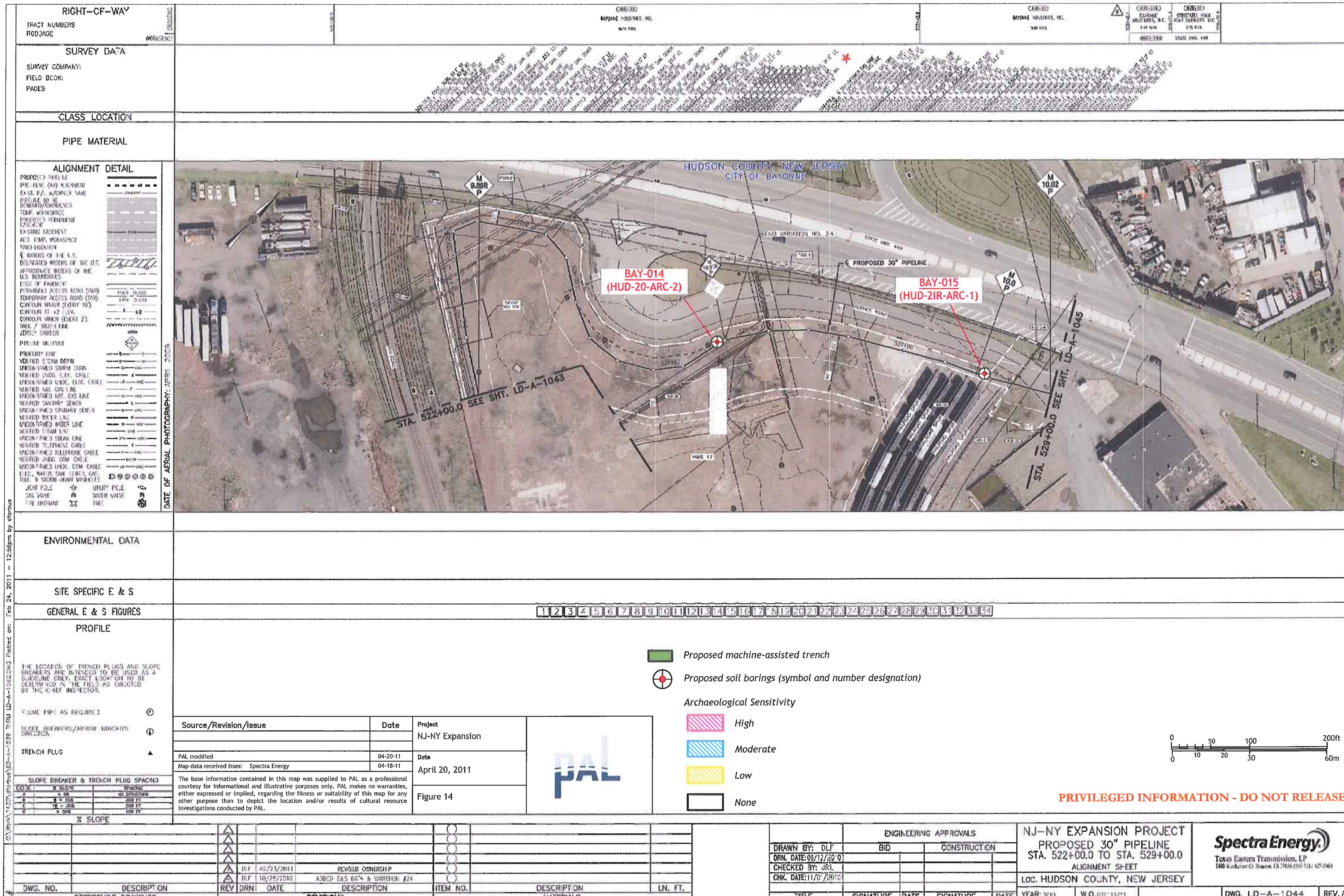

Figure 14. Revised archaeological sensitivity assessment of the pipeline route, STA 522+00 to 529+00, Bayonne, NJ.

RIGHT-OF-WAY

TRACT NUMBERS

FOOTAGE

SURVEY DATA

SURVEY COMPANY:

FIELD BOOK:

PAGES:

CLASS LOCATION

PIPE MATERIAL

ALIGNMENT DETAIL

ENVIRONMENTAL DATA

SITE SPECIFIC E & S

GENERAL E & S FIGURES

PROFILE

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

SLOPE BREAKER & TRENCH PLUG SPACING

% SLOPE

- Proposed machine-assisted trench
- Proposed soil borings (symbol and number designation)

Archaeological Sensitivity

- *High*
- *Moderate*
- *Low*
- *None*

Source/Revision/Issue	Date
PAL modified	04-20-11
Map data received from: Spectra Energy	04-18-11

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.

Project NJ-NY Expansion

Date April 20, 2011

Figure 15

0 50 100 200ft
0 10 20 30 60m

PRIVILEGED INFORMATION - DO NOT RELEASE

REV	DRN	DATE	DESCRIPTION
	DLF	02/23/2011	REVISE TRACT NUMBER
	DLF	10/28/2010	ADDED E&S DATA & VARIATION #25/33

DWG. NO. | DESCRIPTION — REFERENCE DRAWINGS

REVISIONS

ITEM NO. | DESCRIPTION | LN. FT. — MATERIALS

DRAWN BY: DLF
DRN. DATE: 06/12/2010
CHECKED BY: JRL
CHK. DATE: 11/31/2010

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

NJ-NY EXPANSION PROJECT
PROPOSED 30" PIPELINE
STA. 529+00.0 TO STA. 540+00.0
ALIGNMENT SHEET

LOC. HUDSON COUNTY, NEW JERSEY

YEAR: 2010 | W.O. 376115751

Spectra Energy
Texas Eastern Transmission, LP

DWG. LD-A-1045 | REV. A11

Figure 15. Revised archaeological sensitivity assessment of the pipeline route, STA 529+00 to 540+00, Bayonne, NJ.

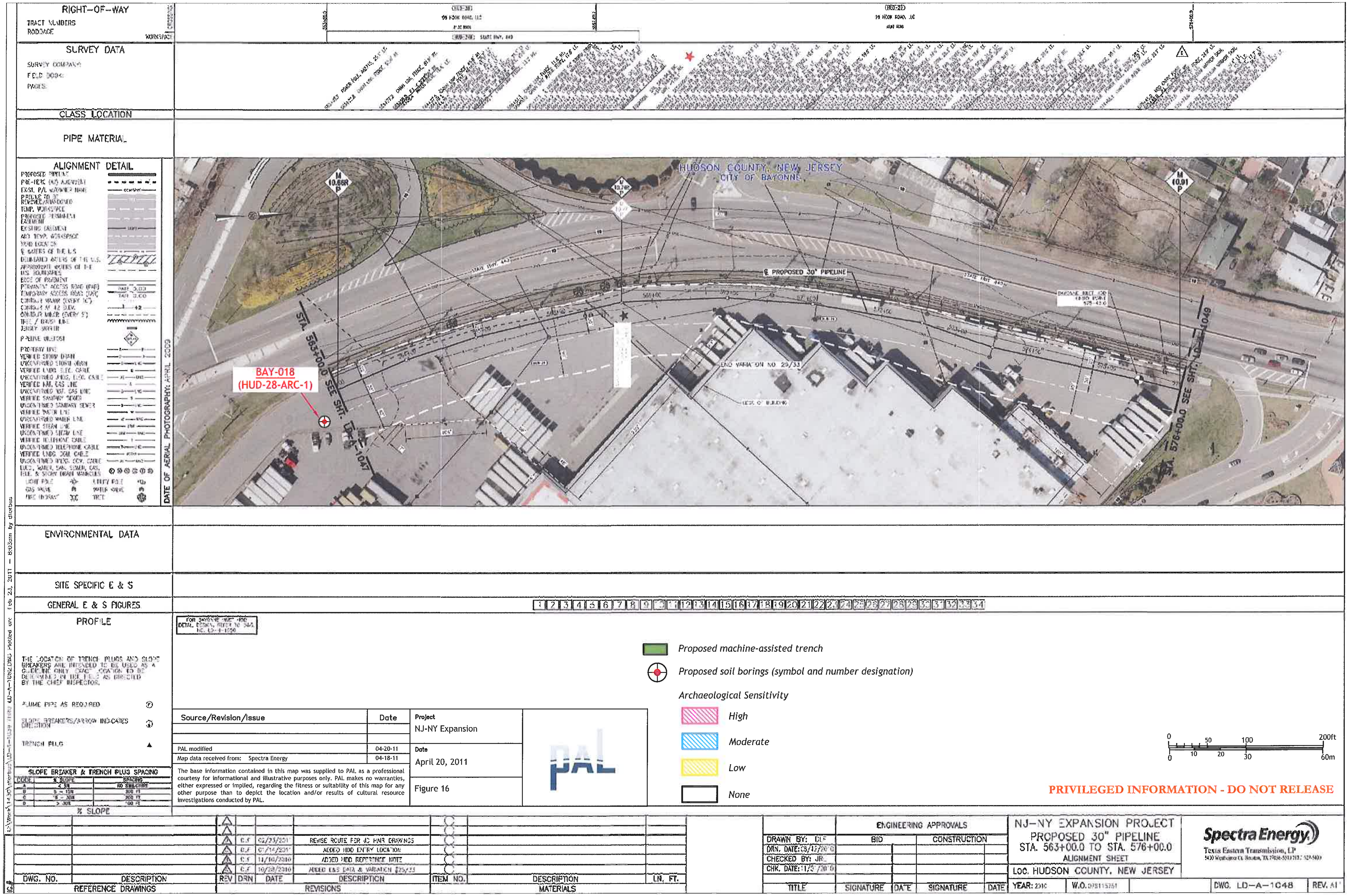

Figure 16. Revised archaeological sensitivity assessment of the pipeline route, STA 563+00 to 576+00, Bayonne, NJ.

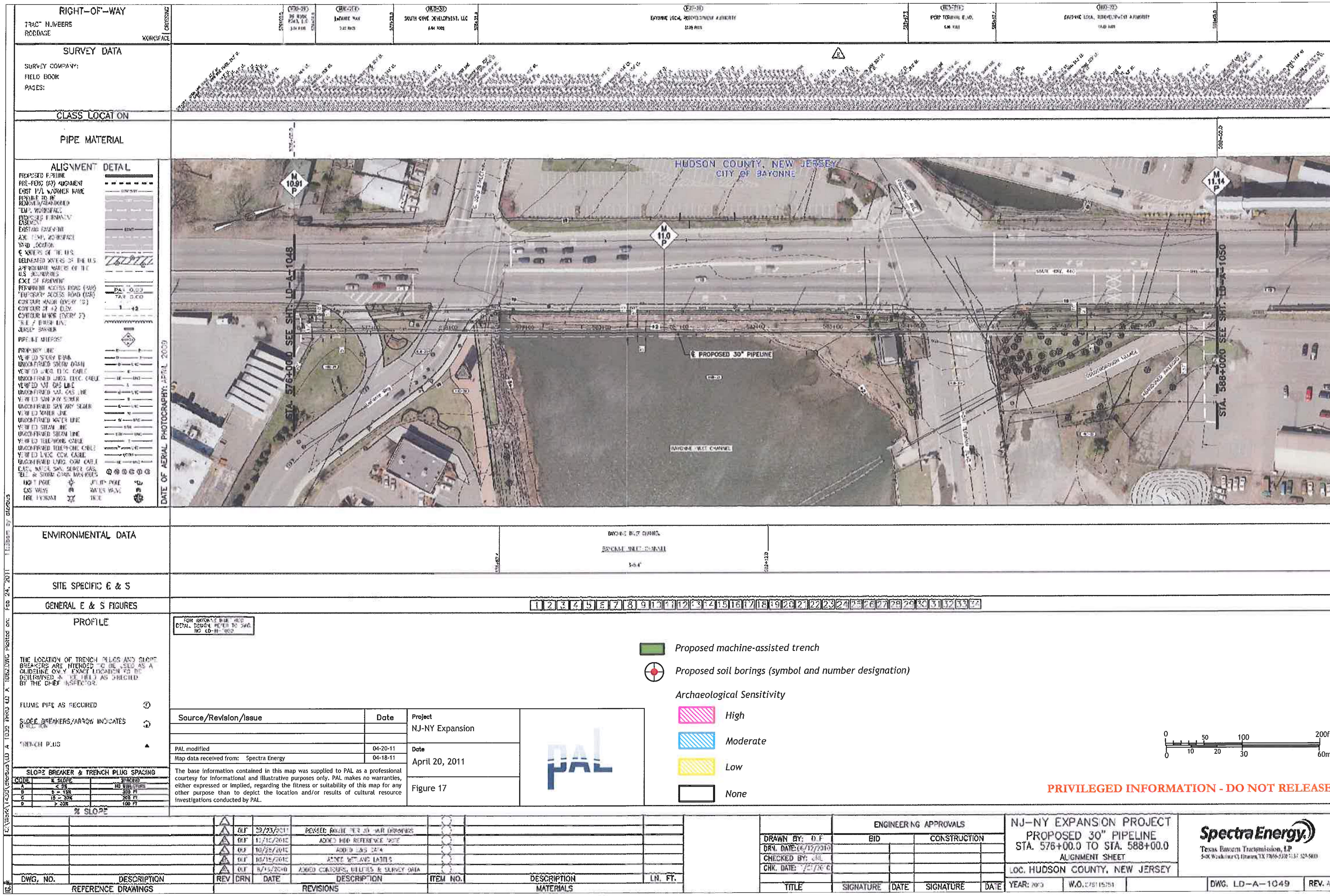

Figure 17. Revised archaeological sensitivity assessment for STA 576+00 to 577+50 and STA 586+00 to 588+00, Bayonne, NJ.

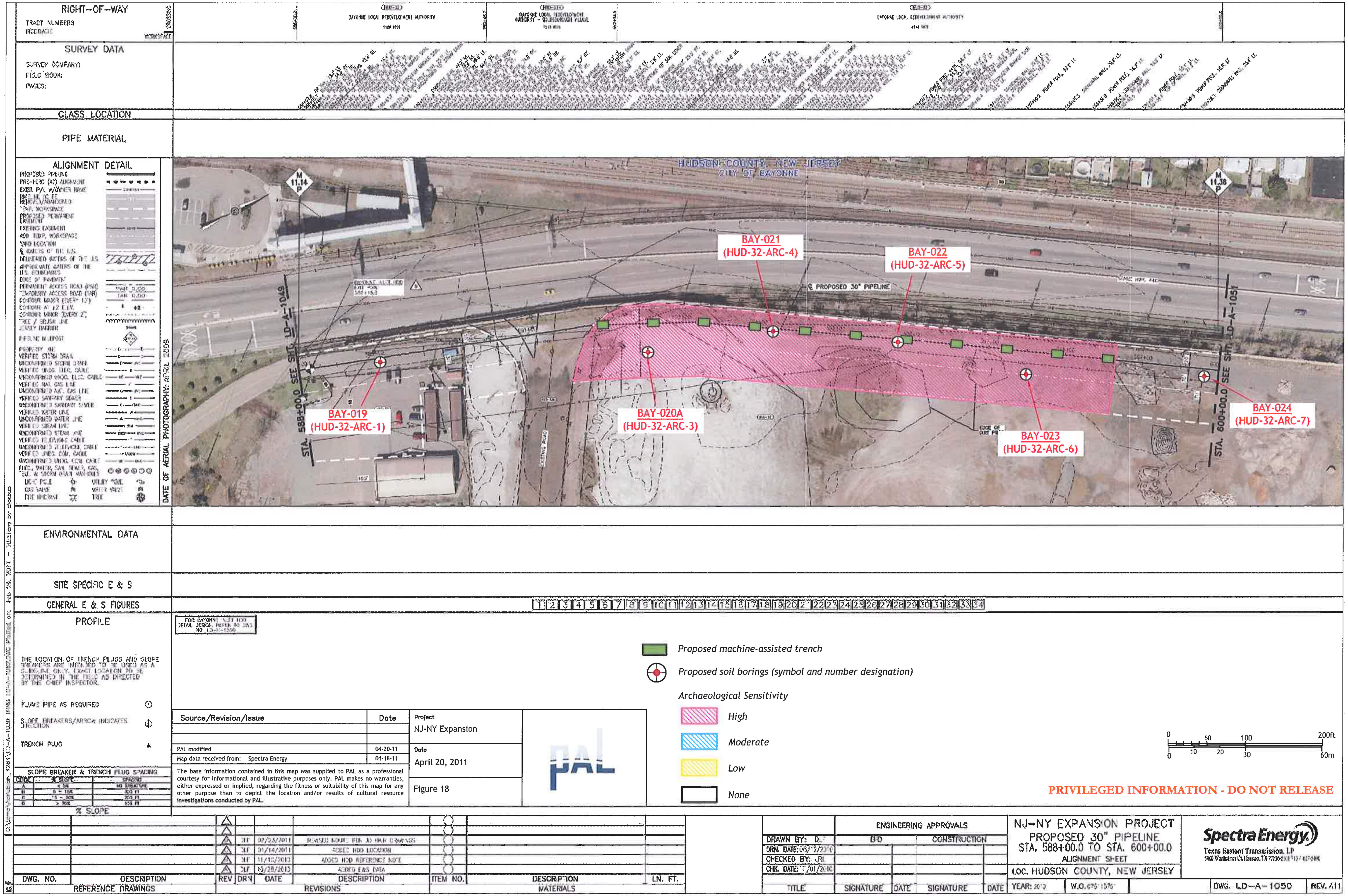

Figure 18. Revised archaeological sensitivity assessment for STA 588+00 to 591+00 and STA 598+50 to 600+00, and proposed Phase IB testing within the pipeline route, STA 592+00 to 598+50, Bayonne, NJ.

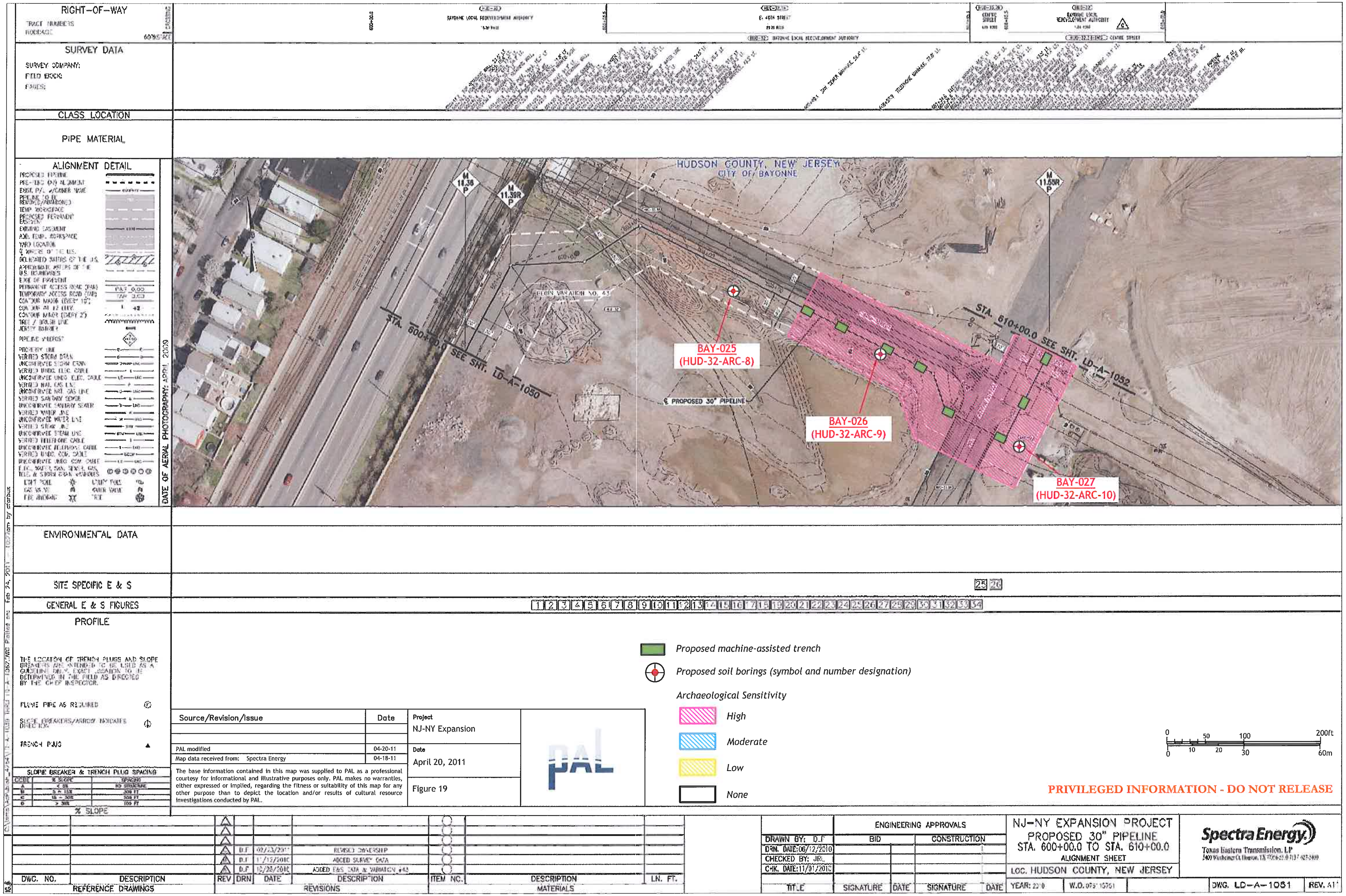

Figure 19. Revised archaeological sensitivity assessment for STA 600+00 to 605+50 and proposed Phase IB testing within the pipeline route, STA 605+50 to 610+00, Bayonne, NJ.

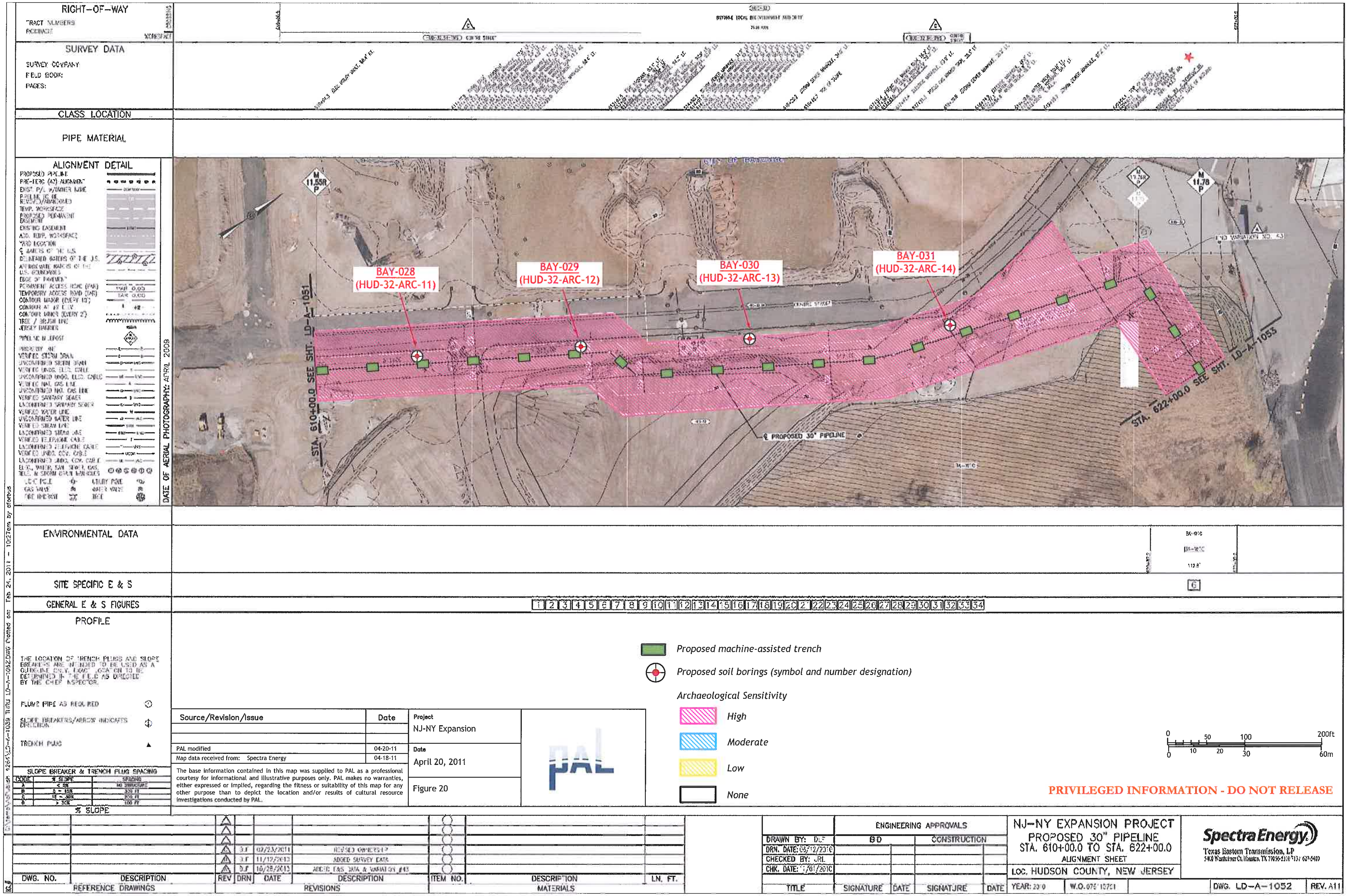

Figure 20. Proposed Phase IB testing within the pipeline route, STA 610+00 to 622+00, Bayonne, NJ.

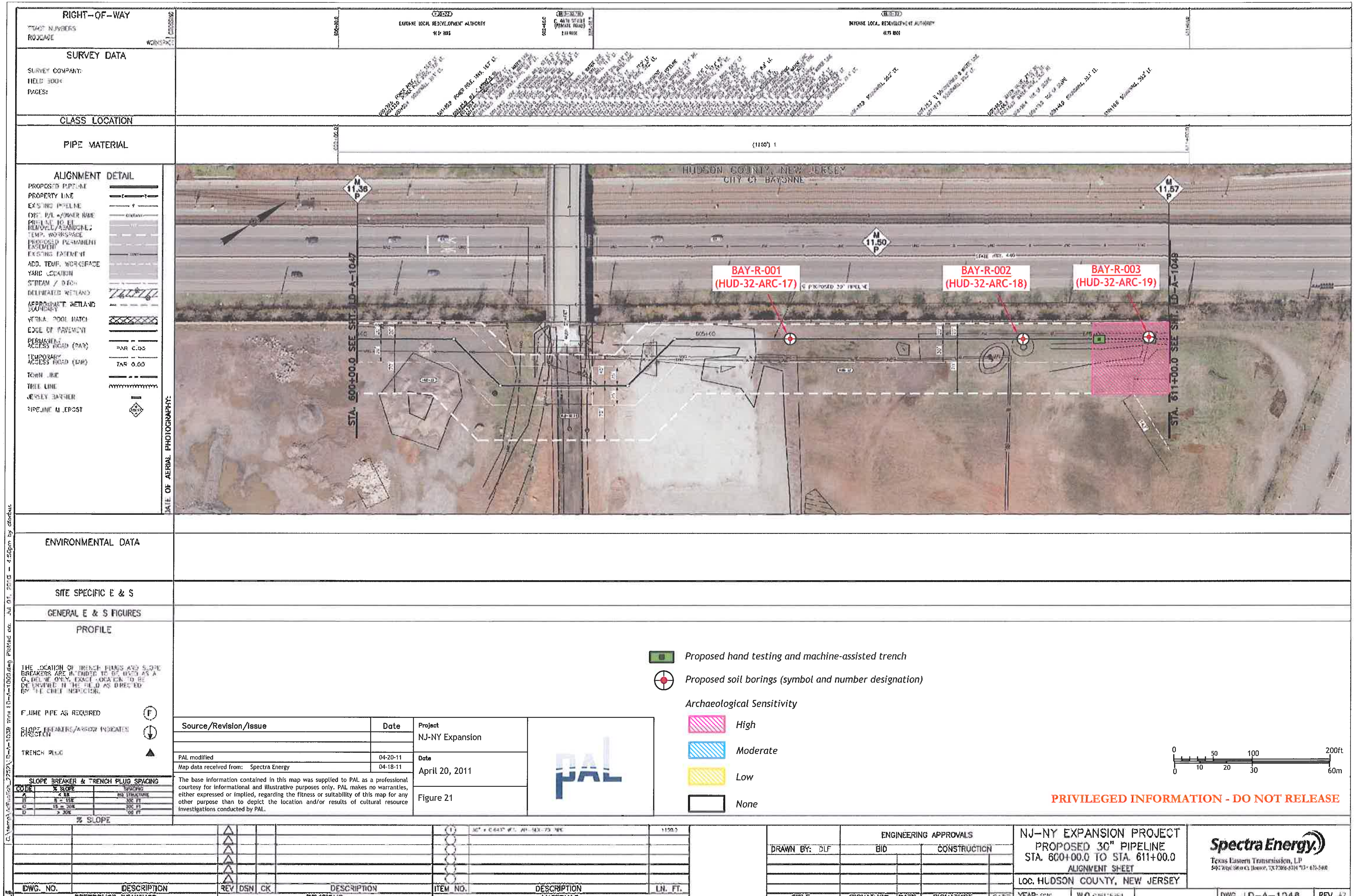

Figure 21. Revised archaeological sensitivity assessment for September pre-filing pipeline route, STA 600+00 to 610+00 and STA 614+00 to 616+00, and proposed Phase IB testing within the pipeline route, STA 610+00 and 611+00, Bayonne, NJ.

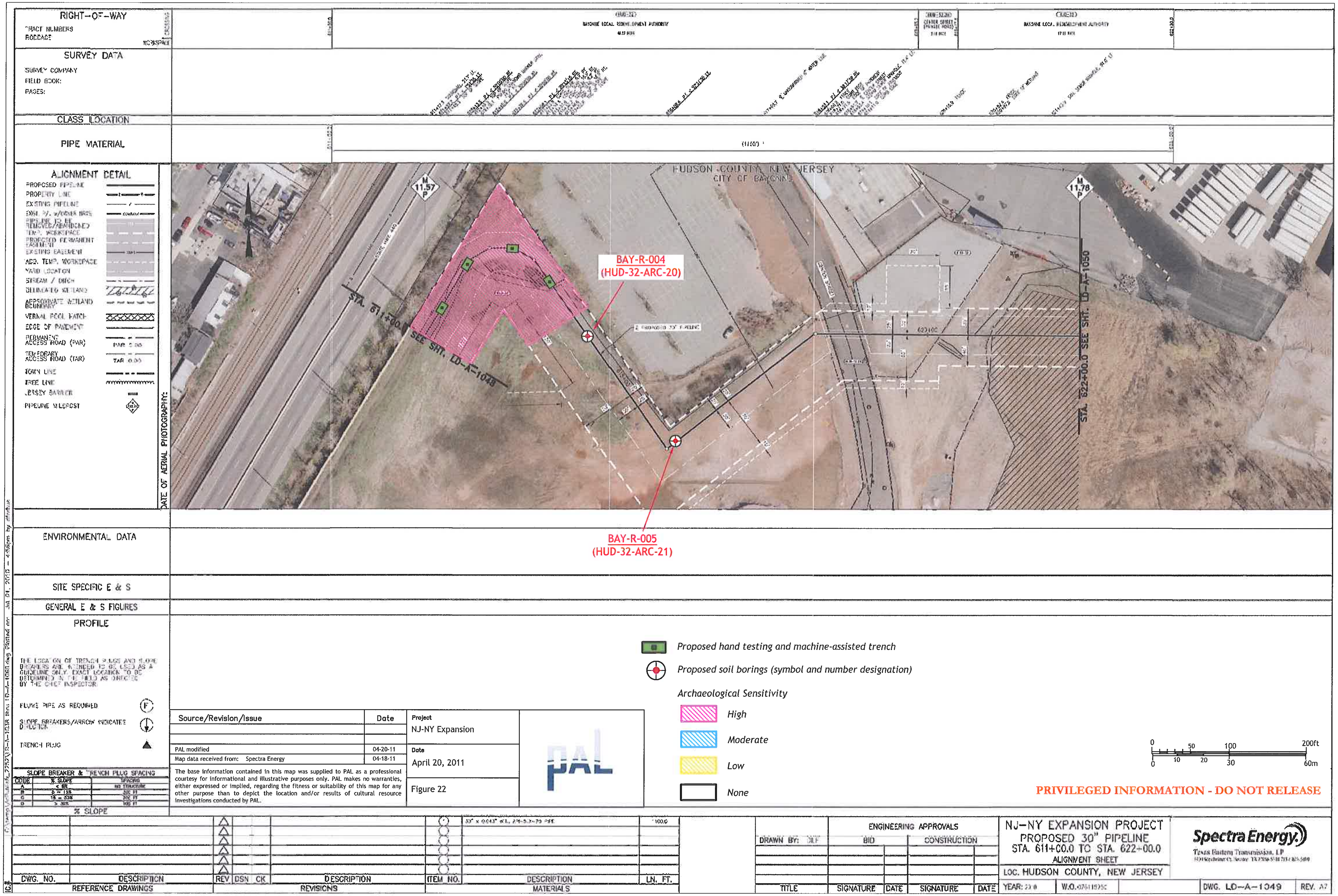

Figure 22. Revised archaeological sensitivity assessment for September pre-filing pipeline route, STA 614+00 to 616+00, and proposed Phase IB testing within the pipeline route, STA 611+00 and 614+00, Bayonne, NJ.

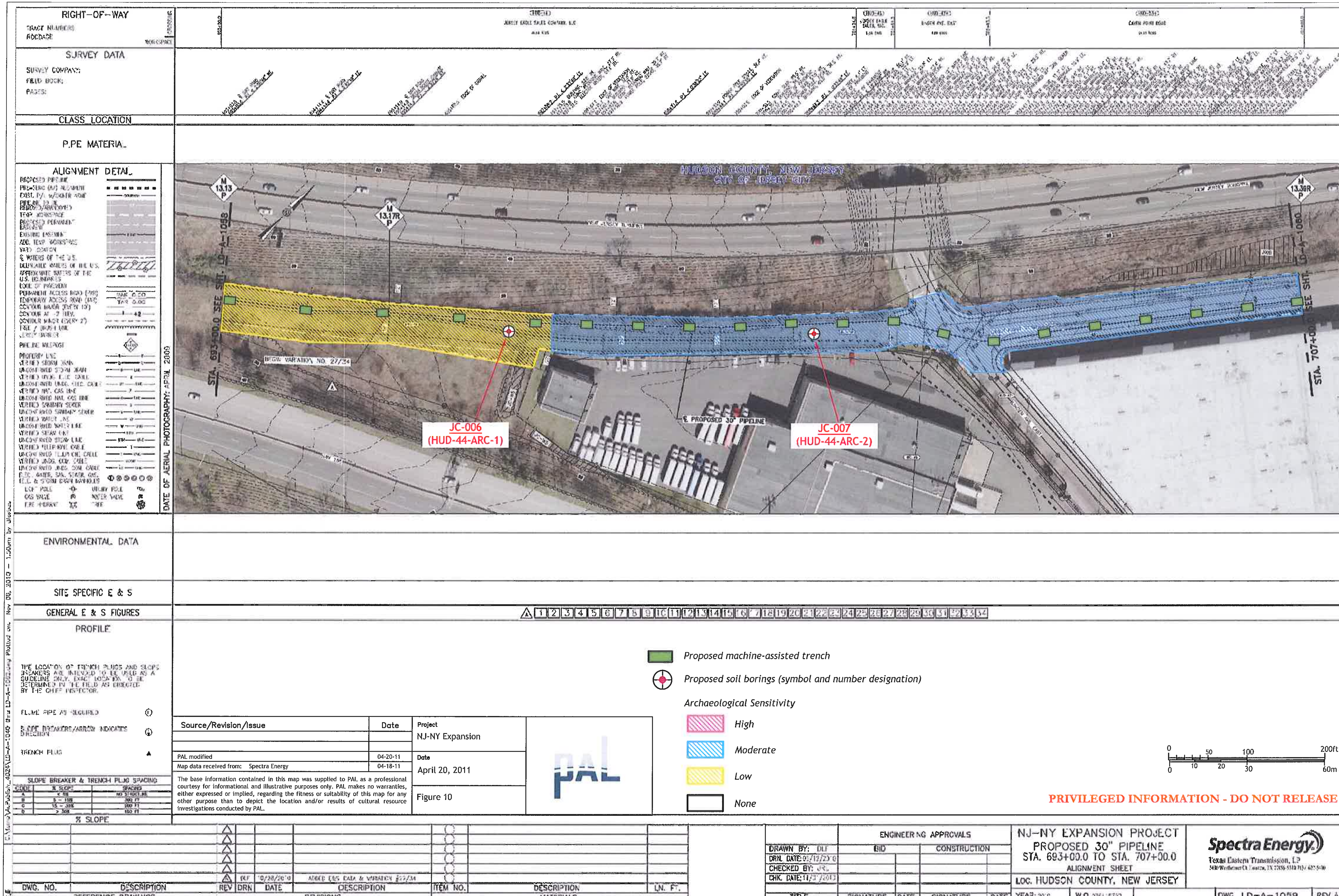

Figure 23. Proposed Phase IB testing within the pipeline route, STA 693+00 to 707+00, Jersey City, NJ.

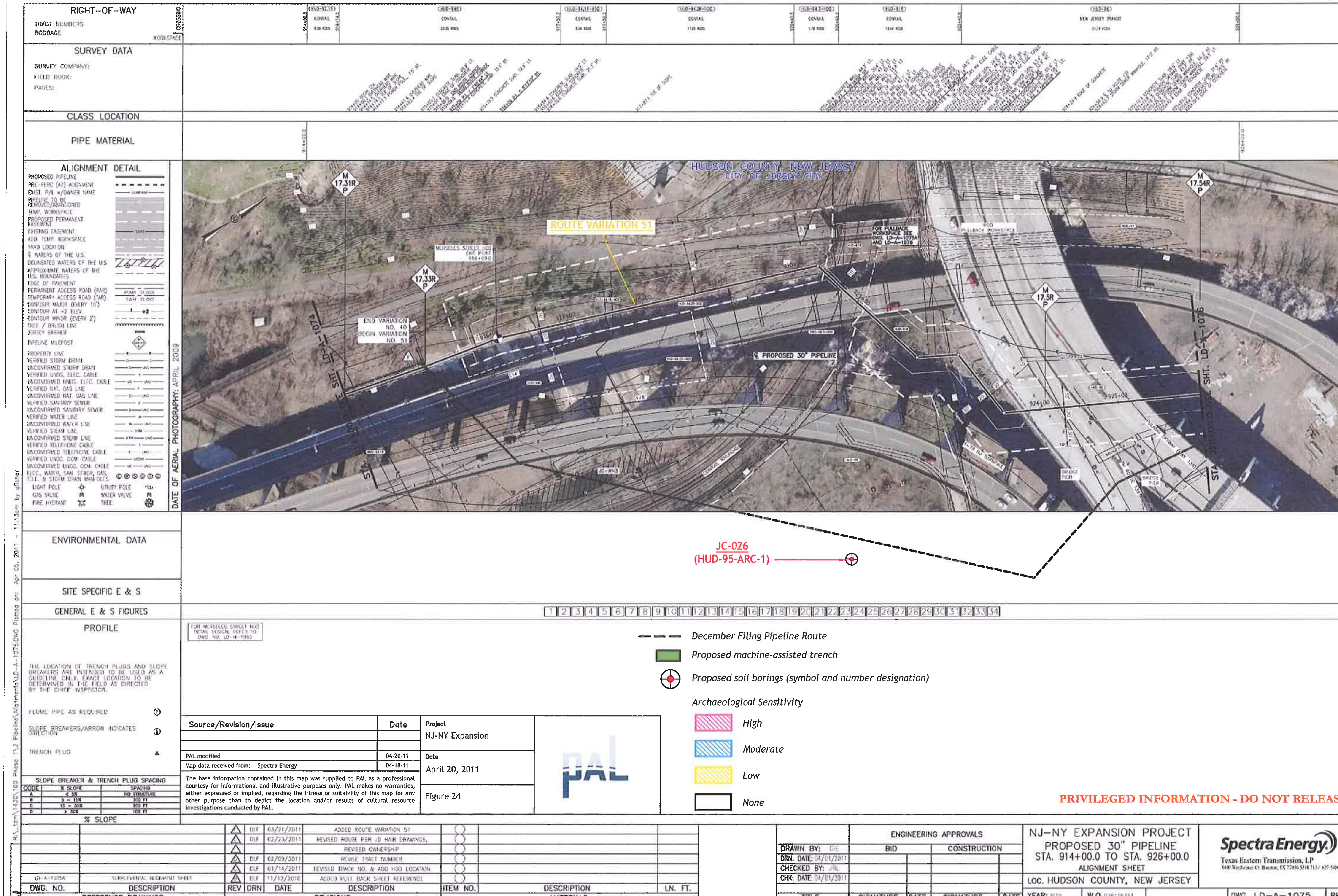

Figure 24. Revised archaeological sensitivity assessment for December filing pipeline route, STA 915+19.3 to 925+00, showing new Route Variation 51, no archaeological sensitivity, Jersey City, NJ.

ATTACHMENT A

GEOARCHEOLOGY RESEARCH ASSOCIATES – SOIL BORING REPORT #1

PRELIMINARY REPORT:
"PRE-ANALYSIS" RESULTS OF THE DECEMBER, 2010 PHASE IA GEOARCHEOLOGICAL INVESTIGATIONS FOR THE NJ-NY EXPANSION PROJECT

LINDEN, UNION COUNTY, NEW JERSEY; BAYONNE AND JERSEY CITY, HUDSON COUNTY, NEW JERSEY; 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

and

Michael Aiuvalasit, M.A.
Project Geoarcheologist

April 5, 2011

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1. INTRODUCTION

This report presents the preliminary results of field investigations conducted in December, 2010 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 is a "pre-analysis" report that assembles the stratigraphy of subsurface deposits to the degree that technical field studies permit. This geoarchaeological study is being undertaken to develop a probability model for the Phase IB archaeological survey. By conducting a systematic survey involving deep testing, 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.

Only a select number of locations along the 20.3 miles of proposed line were tested in this first round of fieldwork due to limited access and uncertainties associated with the ultimate routing of the pipeline. A total of thirty two (32) borings was excavated across eight (8) properties in the states of New York and New Jersey (Figure 1). These borings cover a relatively small portion (ca. 10%) of the total linear extent of the pipeline. Cores typically extended to a depth of 20 feet (580 cm) 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.

This preliminary report presents baseline results of this initial investigation. A basic 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 given to the interpretive potential of using deep coring to develop 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 and mosaic photos of the opened cores are found 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 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 example, the possibility of formulating a comprehensive landscape history in the vicinity of the BLRA property is unique insofar and it contains an almost pristine Holocene micro-environment together with potentially intact archaeological components. By the same token, the present study has sampled only one segment of the pipeline and we would 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.

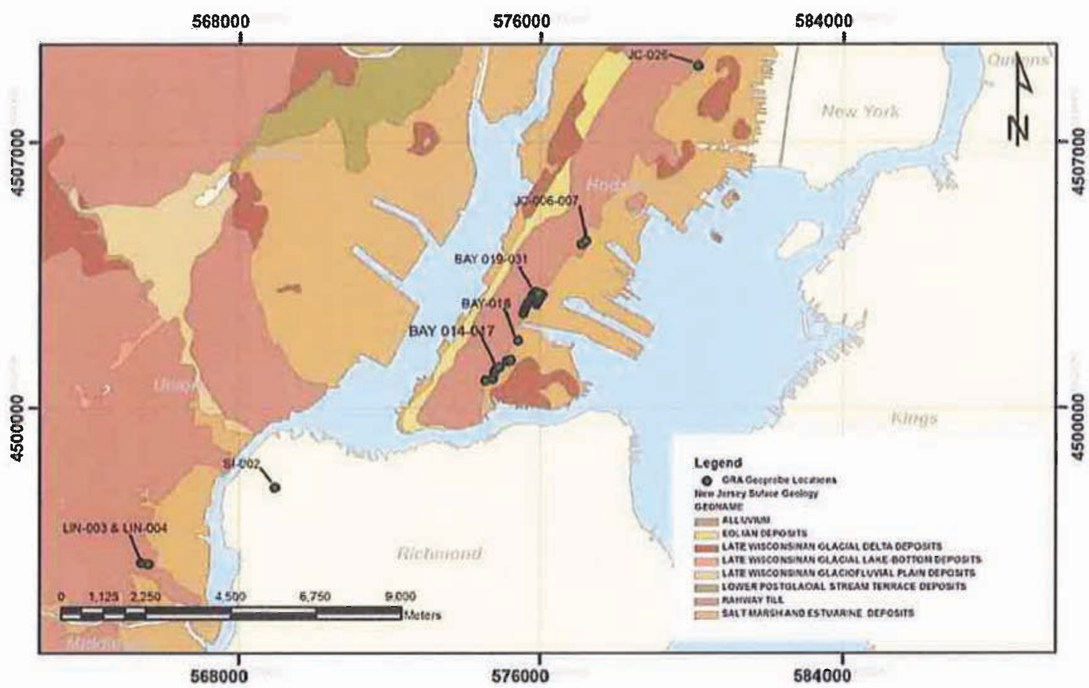

Figure 1. Surficial geology map of New Jersey with boring locations (based on Stone et al., 2002 and Cadwell 1989).

2. PROJECT GEOMORPHIC BACKGROUND

The proposed pipeline corridor is located along urbanized segments of nearshore 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 recorded extensively 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 during 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, which 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 proglacial 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 BP 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 (89ft)-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., (2006). 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 (1969), 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 (1964); and Nikitina et al. (2001) 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.

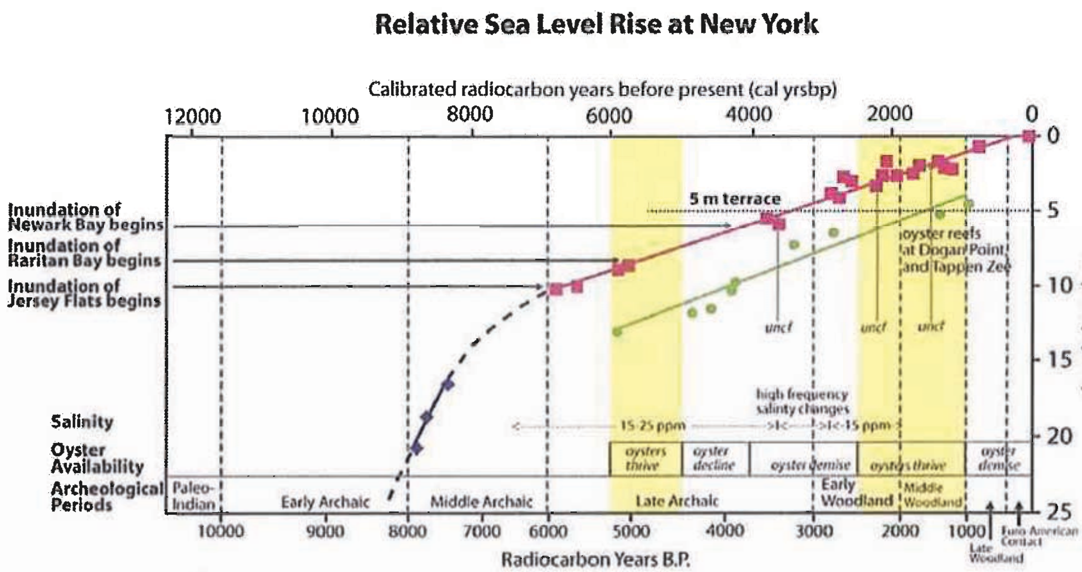

Figure 2. Sea level rise model for New York Harbor (from Schuldenrein et al. 2007).

In general terms, the new relative sea level model can be retrofit to account for reflooding of the incised Hudson channel and Upper New York Bay as described by Thieler et al., (2006) 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 7000 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 nearshore settings through which the 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 successions of the project area (Elquist et al., 2010a and 2010b).

Expected Geological Sequence within the Project Area

There are four surficial deposits mapped within our project area, three of which are depicted in Figure 1. The fourth, artificial fill, is the mapped unit in Staten Island, NY (Cadwell 1989). The surficial geology of Staten Island is not presented in this figure because the New York mapping is at a smaller scale than New Jersey's mapping, and it lacks the level of accuracy and refinement cast in the New Jersey projections. The three New Jersey-based surficial units of relevance to the project are: *Rahway till*; *Late Wisconsinan Glacial Delta Deposits*; and *Salt-Marsh and Estuarine Deposits*.

Thick deposits of poorly sorted gravels and sediments deposited below the glacier known as *diabase* or *till* blanket the region (Stone et al. 2002). Within the project area the till is designated Rahway till. The latter is described by Stanford (2002) as "reddish-brown to light reddish brown silty sand to sandy clayey silt containing some to many subrounded and subangular pebbles and cobbles and a few subrounded boulders. (The latter) are poorly sorted, nonstratified, (and) generally compact below the soil zone." Basins gouged out by glacial ice became a sequence of lakes after the glaciers retreated.

Deltas formed along 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. While none of the borings were emplaced directly on 'Late Wisconsinan Glacial Delta Deposits', many borings in Bayonne, NJ were located adjacent to these sediment complexes (Figure 1). This unit is generically mapped as "Glacial Lake Bayonne deposits" on the regional scale, as applied by Stone et al. (2002: 11). On the coarser level (quadrangle based) utilized by Stanford (1995) these units correspond to "Glacial Lake Bayonne Deltaic deposits". Sedimentologically, these are "well sorted and stratified reddish-yellow, light reddish-brown, gray sand with some pebble gravel and minor cobble gravel, that can be up to 100 feet thick" (Stanford 1995).

Salt-Marsh and Estuarine Deposits are found in near-shore and off-shore settings, often buried by artificial fill. The deposits are described as: "organic silt and clay, and salt-marsh peat, with some sand." Matrices may contain "some shells and it can range in thickness from 20 feet in the Newark Bay-Kearny area to 300 feet thick in the Hudson Valley (Stanford 1995)".

3. METHODS

A prescribed sampling interval was agreed upon by the State Historic Preservation Officers (SHPO's) of New Jersey and New York. In New Jersey the sampling interval was set at one test boring every 500 feet (150 m), while in New York the interval was set at 300 feet (90 m). Boring locations emplaced at these regular intervals were determined through negotiations by PAL and Spectra Energy and included considerations of representative sampling modified by logistical concerns (ie., accessibility and presence of buried contaminants). All boring locations were mapped in by surveyors contracted by Spectra Energy, and there were only minor in-field adjustments to boring proveniences, typically no more than 5-10 feet from designated surveyed location. Remote sensing for buried utilities or obstructions was conducted at of the 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 OneCall Service. Remote sensing provided an additional control delimiting the presence and orientation of subsurface utilities and features.

Subsurface excavation for the GRA study was performed by a Geoprobe™ boring device, operated by Zebra Environmental, of Lynbrook, NY. A 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.

For this project, cores of approximately 2 ½ inch (6 cm) diameter were collected in 5 foot sections (145 cm) to depths of up to 20 feet (6 m) below ground surface. Typically the upper 1-3 feet (0.3-0.9 m) of each boring was hand-cleared in order to verify absence of 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 ion detection (PID) meter over the samples to test for volatile organic compounds. The in-field examination of the cores guided health and safety procedures regarding the handling and collection of the cores.

All of the core sleeves were sealed in the field and transported to GRA's lab facilities where they were subsequently split, described, and sampled (Figure 4). 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 are 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.

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, such as the presence of a water table, unconsolidated sediments, and dramatic changes in sediment texture can lead to less than optimal sediment preservation. Based on our experience working with this technique (Schuldenrein 2006, 2007), as well as our experience in the region, we are accustomed to making extrapolations of both the thicknesses and depths of deposits.

Figure 3. Field collection of cores.

Figure 4. Split core prepared for documentation and sampling under laboratory conditions.

4. PRELIMINARY RESULTS

The results from our December 2010 field investigations are presented along a generally southwest to northeast transect (Figure 1). The descriptions below are grouped by property and core number.

Morgan Trucking Property *-Linden, NJ* (LIN-003, LIN-004)

Both cores LIN-003 and LIN-004 extended to depths of 20 feet (~580 cm) and were bored through asphalt and gravel covered parking lots (see Appendix A and B-1, -2). The underlying surface geology of the property is mapped as Rahway Till (Figure 1). LIN-004 has a sequence of 40 cm of cinder and gravel fill capping a deep sequence of truncated glacial till, with the water table encountered at 435 cm. LIN-003 has a similar sequence to LIN-004, however below 60 cm of capping fill there is an intact, truncated subsoil from 60-115 cm, formed above the underlying glacial till. In both cores the till is reddish brown to dark reddish gray gravelly sandy clay loam to silt that conforms to texture and structure of Rahway till. The subsoil formed in the upper portion of the till is truncated (i.e. it lacks an intact surface soil). The subsoil consists of two horizons: an upper horizon (2BAp) from 60-80 cm below ground surface, of reddish brown (5YR4/3) clay loam with weak fine subangular blocky structure, few fine roots, and evidence of disturbance in the form of few fine pebbles towards the top of the horizon. The lower subsoil (2BC) extends from 80-115 cm, and consists of a brown (7.5YR4/3) silt loam with fine, moderately well-developed subangular blocky structure. The presence of an intact subsoil in LIN-003 indicates there is the potential that across this property there may be instances where fill does not extend down completely to the sterile glacial till (see Table 1). The potential for preservation of cultural resources in subsoils is largely confined to intact intrusive features, such as pits and foundations, emplaced below ground surface.

TETLP Property *-Staten Island, NY* (SI-002)

Core SI-002 was bored through an asphalt and gravel covered parking lot in Staten Island (Figure 1). The core, which extended to 20 feet (~580 cm) recovered a deep and complex fill sequence over buried natural deposits and glacial till, which is analogous to the surficial geology mapping of the site (Figure 1 and Appendix A and B-3). The location has been mapped as artificial fill adjacent to upland glacial till deposits (Cadwell 1989). In core SI-002, fill material extended to a depth of 160 cm. The fill consisted of four horizons, with broken asphalt, cinders and fill gravels from 0-40 cm, above a clean brown (7.5YR4/3) well sorted loamy sand fill from 40-80 cm. From 80-92 cm there is a compacted reddish brown (5YR4/4) gravelly sandy loam. The firm consistence and common heterolithic (mixed types) gravels suggests this might be a buried, compacted artificial surface, as it caps a more typical fill of mixed black (7.5YR2.5/1) gravelly fine sand to gravelly sandy clay loam with common mottles and occasional organic fragments.

The fill sequence abruptly overlies natural deposits, which extend from 160 cm to the base of the core. These natural deposits are capped by what may be a truncated subsoil (2BC1) from 160-235 cm. This horizon is a dark grayish brown (2.5Y4/2) sandy clay loam with a few very fine root fragments throughout and a few faint medium vertical very dark gray (2.5YR3/1) mottled streaks towards the top of the horizon. A weakly developed medium stratified structure, with the presence of roots and intact vertical mottles, is suggestive of intact subsoil. Unweathered sandy deposits suggestive of a transition from outwash and delta deposits to a shoreline were recovered from 235-560 cm. These deposits are typically brown (7.5YR5/3), massive to stratified, and well sorted with occasional lenses of coarser sands and gravels. Collecting a bulk soil date from these units could help resolve the ambiguity over the depositional setting, as these deposits could be of either Holocene or Pleistocene antiquity. Finally, olive brown (2.5YR4/3) clay with gravels, which conforms to descriptions of Rahway till, was recovered at the base of the core from 560-580 cm. In total, the complex fill sequence and the potentially intact subsoils suggest that there is potential in this area for archaeologically sensitive deposits (Table 1).

IMTT Property -*Bayonne, NJ* (BAY-011 to -015, and BAY-017)

Six (6) cores were excavated across the IMTT property (Figure 5). The IMTT property is an industrial zone with clustered structures associated with the petrochemical industry. Our cores were placed along a route that avoids both above ground and below ground buried facilities. Even with these efforts, buried product and contaminants were encountered (Appendix A and B). As such, we did not collect complete samples from the cores on the IMTT property. Instead, only isolated, sub-contaminant specimens were procured for descriptive characterization at our laboratory facility. The initial depth of collection ranged from 10 ft below ground surface in cores BAY-012, and -017, 13 ft in core BAY-013, and 15 ft in cores BAY-011, -014, -015. The overlying contaminants were observed while in the field and occasionally the lower contact between contaminants and underlying natural deposits was collected in our first sample. With the exception of core BAY-011, the underlying natural sediments recovered at the base of our cores conformed to the mapped salt-marsh and estuarine deposits (Figure 4). BAY-011 produced till from 465-580 cm, above which (455-465 cm) were possibly disturbed estuary deposits. The latter were too contaminated and disturbed to make an accurate determination.

Intact estuarine sediments consisted of black (5Y2.5/1) to dark gray (GLEY 1 4/N) silts with organic fractions decreasing in concentration with depth (Appendix A). All of the remaining cores (BAY-012, -013, -014, -015, and -017) have a horizon of highly organic enriched silt (technically a peat) found below the product-stained fill. The organics are matted, partially decayed roots and decayed fibers with occasional seeds and plant stems. These peat horizons average 50 cm thick, although it should be noted that they are commonly truncated and bottom out at the base of the 20 ft core section. The upper portions of the peat often have a strong product smell. In instances featuring underlying horizons of silt below the peat (BAY-017), the latter horizon measured 71 cm thick. In this core the organic content decreases gradually with depth from 435-580 cm to only occasional (3-5%) organics at the base of the core. Concomitant with the decrease in organics was an irregular density of fine marine shell fragments.

The intact peat horizons are probably organic mat segments that accumulated in shallow tidal marsh zones found along the margins of the Jersey Flats. These zones represent accumulations from tidal movements, and they are not likely to preserve archaeological materials. Radiocarbon dating of a representative sample from these horizons would index these landforms relative to adjacent nearby radiocarbon sub-tidal deposits, collected in the Jersey Flats and off Liberty Island (see Schuldenrein et al. 2007). The marked decrease in organics and increase in fine shell fragments recovered in BAY-017 is reflective of a transition in depositional environments to a more offshore setting.

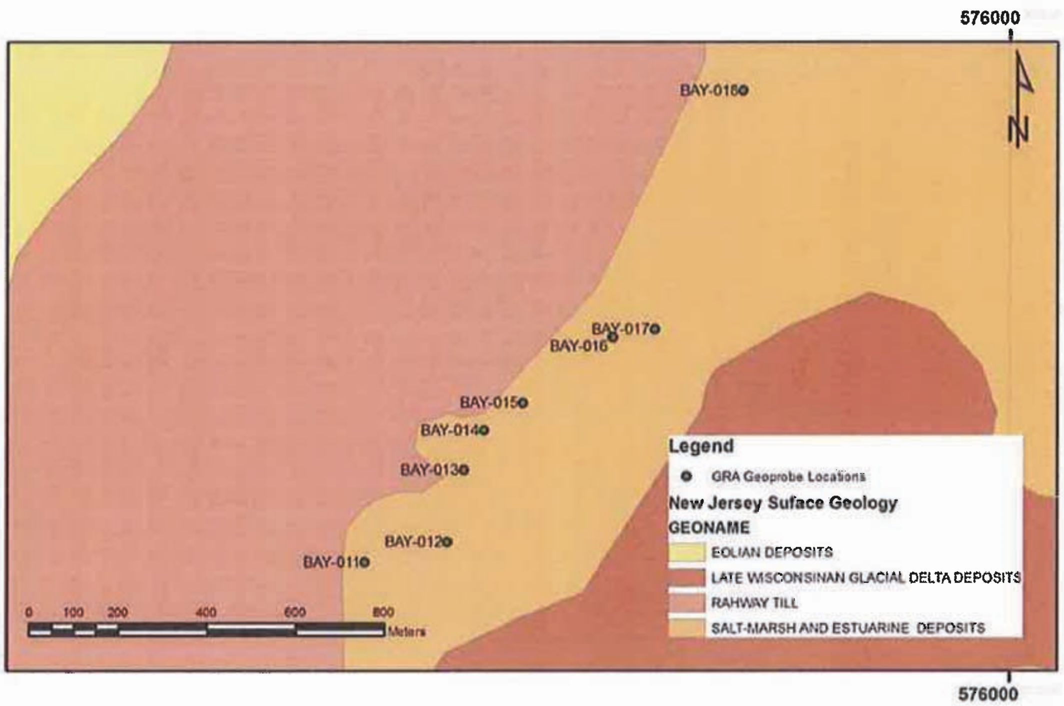

Figure 5. Close-up surface geology mapping of the cores along the IMTT, Lehigh, and 99 Hook Road Properties (based on Stone 2002).

Lehigh Property *–Bayonne, NJ* (BAY-016)

At BAY-016 the complete 0-20 ft. section was collected. The boring location was a grassy tract adjacent to an access road leading to an IMTT storage facility (Figure 5). This core recovered a deep fill sequence above disturbed estuarine silt deposits similar to what was observed at the base of BAY-017 (Appendix A and B). A dark brown (7.5YR3/1) gravelly loam fill from 0-220 cm caps a thick product stained fill from 220-

520 cm. Unlike the cores on the IMTT property, the fill of BAY-016 has domestic debris. A whiteware ceramic sherd was recovered from 145 cm, while fine glass and ceramic fragments were observed from 220-250 cm in product-stained, cindery gravels. Disturbed estuary deposits were recovered from 520-580 cm. These sediments consisted of very dark gray (10YR3/1) clay, with an oily, product scent in its upper contact with the product stained fill. The clay had a low organic content of only 3%, which is similar to the low organic silt observed towards the base of the 425-580 cm sequence in core BAY-017. As such, this core registers a similar sequence with deep, contaminated fill over intact deposits of a subaqueous estuary. The presence of contaminants in the upper portion of the intact clays rule out the potential for radiocarbon dating from this core.

99 Hook Road Property –*Bayonne, NJ* (BAY-018)

BAY-018 was bored through an asphalt parking lot in the loading and unloading zone of a large manufacturing facility (Figure 5). A complete 20 ft section was recovered (Appendix A and B). While the surficial mapping for this zone implicates salt-marsh estuarine deposits like BAY-011 to -017, the sequence of the substrate is different (Figure 1). Fill is relatively shallow, extending to 120 cm with a succession of: asphalt and cinders from 0-40 cm, clean fill sand from 40-65 cm; and a very dark gray (10YR3/1) gravelly sandy clay loam fill with one large brick fragment recovered at 85 cm and common cinders and mottles. Below the fill is a thick horizon of very dark gray (10YR3/1 to GLEY 1 3N) silt to silt loam from 120-405 cm. Unlike some of the other intact beds of estuarine silt, this deposit is contaminated with product. The entire depth is saturated and has a product smell with distinct lenses of an oily sheen. The remainder of the core (405-580 cm) is a peat of fine partially decayed fibrous peat to muck, with a gradual decrease in product scent with depth, to no smell at the base of the core. Significantly, since these sediments appear to be vertically stratified and undisturbed, the probable cause of contamination would appear to be lateral seepage in the water table. This precludes any additional sampling, and it can be inferred that fine-grained clays and peats are a proxy for near- and off-shore sedimentation.

Bayonne Local Redevelopment Authority (BLRA) Property –*Bayonne, NJ* (BAY-019- to -031, and BAY-R-001 to -005)

A total of eighteen (18) cores were extracted along the BLRA property, the highest number of cores on any property reported on in this preliminary study (Figure 6). Based on the surficial geologic mapping and current topography the cores across the BLRA property can be divided into two groups: eleven (11) cores along Route 440 on higher elevations ranging from 12 to 20 feet above sea level; and seven (7) cores further east emplaced on made-lands that are only 8-10 feet above sea level (Figure 6). This grouping correlates to landscape reconstructions presented by PAL in the background research (Elquist et al. 2010a). Historical documentation shows that the cores along Rt. 440 would have been on uplands and near-shore settings overlooking the shoreline to the east, while the remainder would have straddled near-shore or offshore locales.

Upland Cores (n=11)

The eleven (11) cores emplaced along the former upland surfaces consist of: BAY-019, -20A, -021, -022, -023, -024, R-001, R-002, R-003, R-004, and R-005 (Figure 6). Of this upland grouping, four (4) cores have a sequence of fill above truncated till (BAY-019, BAY-024, BAY-R-001, and BAY-R-002) with no buried soils or surfaces (see Appendix A and B). Two (2) cores, BAY-R-004 and BAY-R-005 are on surfaces truncated down to the glacial till thereby removing any fill or buried surfaces. The depth of fill was highly variable, with only a thin 7 cm of fill in BAY-R-001, ranging to a thick sequence of fill in BAY-019. In the case of BAY-019, fill extends to at least 435 cm, and includes product stained silt loams below 400 cm. This thick fill sequence likely reflects the positioning of this core closer to the natural shoreline than some of the others. None of these six (6) upland cores (BAY-019, -024, R-001, R-002, R-004, and R-005) have potential for recovering intact archaeological materials.

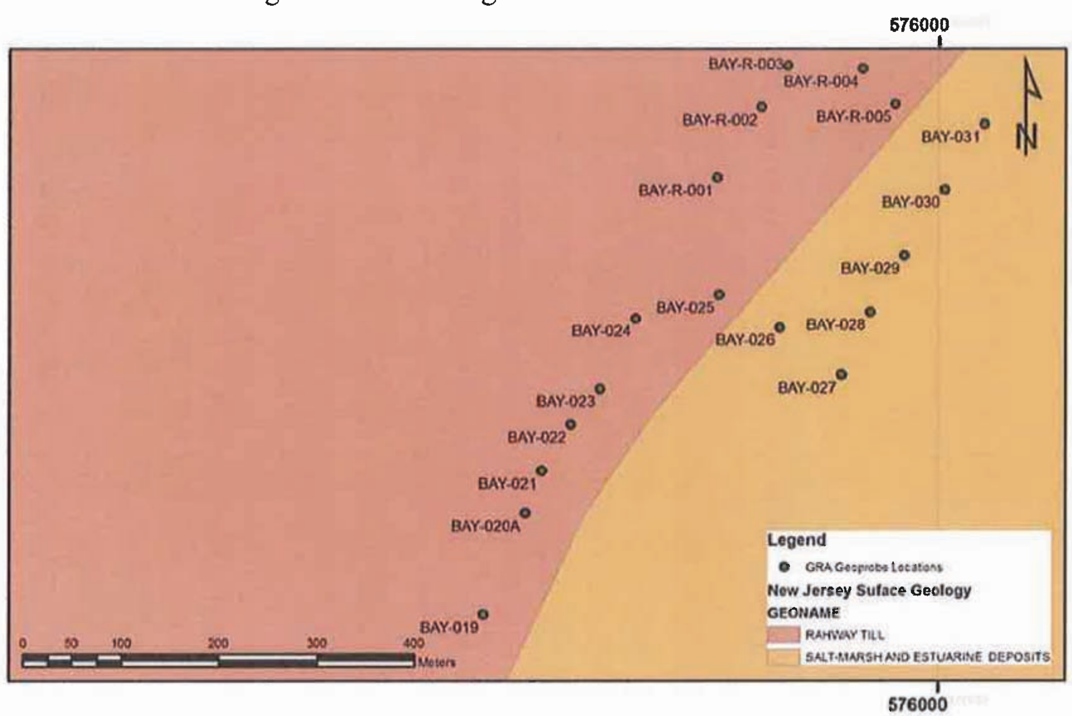

Figure 6. Close-up surficial geology mapping of borings located on the BLRA property (based on Stone et al. 2002).

The five (5) remaining cores of the uplands group featured buried surfaces. These are: BAY-020, BAY-021, BAY-022, BAY-023, and BAY-R-003. Only core BAY-R-003 has a shallowly buried surface. The upper sequence of BAY-R-003 consists of a disturbed soil (Apb2) below fill from 25-70 cm. The soil is a very dark grayish brown (10YR3/2) gravelly fine sandy loam with occasional fine brick fragments, roots, and angular gravels. Below the soil are unweathered stratified reddish brown (5YR4/3) to dark gray (10YR4/1) sands from 70-150 cm. These sands represent the narrow alluvial fill of a small tidal creek along the former shoreline. Below 150 cm is a deep till sequence of dark reddish brown (2.5YR3/3) gravelly silt loam to silty clay which extends to the base of the core.

The stratigraphy of BAY-R-003 is significant because this core most closely mirrors the stratigraphic sequence observed in profile at a newly discovered prehistoric site on an adjacent property (Figure 7). This site, which to our knowledge has not been previously documented, is a prehistoric shell midden buried underneath an asphalt parking lot (Figure 8). The site is exposed in profile immediately north of BAY-R-004 and BAY-R-005. The site was exposed because approximately 1-2 m of the BLRA property has been removed. The shell midden is located in a buried A horizon at approximately 20 cm below blacktop asphalt and gray fill gravels (Figure 9). The buried A horizon extends from approximately 20-60 cm below ground surface, and contains fragments of clam and oyster shells. Below approximately 60 cm are Bw horizons formed in gravelly reddish brown (5YR4/3) to dark gray (10YR4/1) sands to 100 cm, which are similar to the matrices observed in BAY-R-003. Below 100 cm are gravelly loams of poorly sorted glacial till, that are pre-cultural. The significance of this archaeological site to the archaeological potential of the BLRA property is discussed further in the recommendations chapter.

Figure 7. View from core BAY-R-003 looking at stripped surface to the north and east. Newly discovered prehistoric archaeological site was identified on adjacent property in the background, below the black asphalt cap. The property with the archaeological site is analogous to the surface of BAY-R-003.

Figure 8. View from cut exposing shell midden near BAY-R-004, looking west towards the location of BAY-R-003. Brownish gray horizon below the asphalt cap and dead grasses is the buried A horizon with a prehistoric shell midden.

Cores BAY-020 and BAY-022 both have deeply buried surfaces below fill at approximately 370 cm below ground surface (Appendix A and B). BAY-020 has a thick disturbed sequence of buried A-horizons between 365-430 cm. It includes a wood fragment from 365-372 cm, and disturbed buried A horizons (2Abp1-2) between 372-430 cm. These horizons are very dark gray to black (7.5YR3/1-2.5/1) silt loam to silty clay loam with granular structure and common roots and decayed organics. The probability for disturbance is signified by the wood fragment capping the horizon, and the mixed character of the underlying 2BCp horizon. The horizon had poor recovery with an indeterminate lower boundary. Organic fragments, mottles, and possible fine brick fragments were observed. Glacial till was positively identified from 530-580 cm. BAY-022 featured a much simpler sequence, with fill extending to 375 cm, a buried surface from 375-400 cm, and till extending down the remainder of the core from 400-580 cm. The buried surface has a similar texture, color and soil structure as BAY-020, as it is a very dark gray (7.5YR3/1) silt loam with granular structure. The presence of disturbances in the buried soil and of the subsoil below suggests these buried surfaces are of historic age (Table 1).

Figure 9. Buried shell midden on adjoining property to BLRA, immediately north of BAY-R-004 and BAY-R-005. Intact buried A horizon with prehistoric shell midden is found below black asphalt and gray gravel lens.

Cores BAY-021 and BAY-023 are more shallowly buried at approximately 280 cm below ground surface (Appendix A and B). Both cores are capped with complex fill successions. In BAY-021 the buried surface (2Abp horizon) extends from 280 cm to 290 to 330 cm. Unfortunately due to slump and poor recovery, the contact between the buried A and the underlying horizon is undetermined. The 2Abp horizon is a dark gray (5YR2.5/1) fine sandy loam with platy structure and occasional organic mottles. Below the horizon, from 330-390 cm, is a subsoil possibly formed in estuarine or nearshore deposits. The horizons consist of a gray (GLEY 1 5/N) silt loam (2BC1 horizon) over a dark gray (5Y4/1) fine sandy clay loam (2BC2 horizon). Till of olive brown (2.5Y4/4) gravelly sandy clay loam underlies the estuarine sequence from 390 cm to the base of the core. BAY-023 has a simpler sequence, with a buried surface (2Apb) from 255-280 cm located immediately above glacial till (3C horizon) from 280 cm to the bottom of the core. The buried surface is a black (5YR2.5/1) gravelly silt loam with fine platy structure as well as a few gravels and a few glassy cinders. The till (3C horizon) is a dark reddish gray (2.5YR4/1, 4/3) gravelly sandy clay loam.

Lowland Cores (n=7)

A total of seven (7) cores were emplaced in lower-lying settings. The cores emplaced along the lower surfaces comprised of fill above estuary deposits are: BAY-025, BAY-026, BAY-027, BAY-028, BAY-029, BAY-030, and BAY-031. These borings revealed some of the most complex stratigraphic sequences on the BLRA property. All cores were capped with fill, which ranged in depth from 145 cm (BAY-027) to 555 cm (BAY-025) and had an average thickness of 246 cm (Appendix A and B). Two (BAY-027 and BAY-029) have a buried surface below the fill. In BAY-027 the buried surface (2Apb horizon) extends from 145-165 cm and is a very dark grayish brown (10YR3/2) sandy loam with granular structure and few fine roots. In BAY-029 the buried surface (2Ab horizon) extends from 225-243 cm. It is a very dark brown (10YR2/2) organic silty loam with 40% of the matrix consisting of matted fine organics, with a faint chemical smell. Both of these buried surfaces may have been former historic surfaces, as the depth below surface would have been just above sea level during Historic times, and potentially during the Late Prehistoric period as well.

Below the buried surfaces, in all of the cores except BAY-025, are intact sandy sediments which may be buried beaches and shorelines. The sandy beach and shoreline matrices range in thickness between 90 cm (BAY-031) and 365 cm (BAY-030), and average 203 cm thick. The sediments are quite variable from core to core, but they are typically stratified dark grayish brown (10YR4/2) to dark reddish brown (5YR3/2) and coarsen upward from silts and very fine sands to gravelly sands. The gravel morphology is typically well to sub-rounded. Fine shell fragments are found throughout (BAY-028, BAY-029, BAY-030), as are occasional fine root fragments and thin organic lamina (BAY-026, BAY-028, BAY-029, BAY-030, and BAY-031). Organic fractions collected from the sands have the potential to date what are possibly paleo-shorelines (Table 1). Such locations could have been the loci for both Historic and Prehistoric human activity along the margins of Bayonne.

Finer grained silts and clays of what are likely nearshore estuaries were identified below the beach sands. In most cases, estuarine deposits were the terminal unit recovered in the 20 ft cores. Only BAY-026 and BAY-031 exposed underlying sediments, and these are described in the following paragraph. The estuary deposits are typically very dark gray (2.5Y3/1) to gray (10YR5/1) silt, clay, and silty clay. They are commonly finely stratified with lenses of fine organics, coarser sediments like coarse sands and fine pebbles. Four of the cores (BAY-025, BAY-026, BAY-028, BAY-029) yielded fine shell fragments. BAY-028 is unique in that it has an organically enriched peat which caps the estuary sequence from 417-430 cm. The relatively common organics throughout the matrix can be readily radiocarbon dated, which would provide a chrono-stratigraphic marker for a critical transition in the prehistorically aged depositional environment (Table 1).

BAY-026 and BAY-031 preserved deeper, sub-estuarine stratigraphies. These exposed reduced glacial till in BAY-026 and what is possibly a lacustrine fan and glacial lake deposits in BAY-031 (Appendix A). In BAY-026 the basal sediments (550-580 cm) are a saturated gray (GLEY 1 6/N) gravelly clay loam (glacial till) with iron redox concentrations and a moderately well developed subangular blocky structure. As BAY-026 occupies a mid-slope position between the uplands and the offshore deposits, the discovery of glacial till is an expected context. BAY-031 is the furthest offshore (basinward) core, and it registers what may be a lacustrine fan from 235-520 cm and glacial lake deposits from 520-580 cm. The lacustrine fan consists of a massive bed of brown (7.5YR4/2) to very dark gray (7.5YR3/1) loamy sand to gravelly loamy sand. The gravels are heterolithic (i.e. of a variety of rock types) which is typical of glacial source material, however it contains fine shell fragments, which are typical in shorelines and large bodies of water. This suggests that this deposit is a fan deposited along a shoreline – possibly of a lacustrine fan along a proglacial lake or perhaps a delta formed along the margin of Lake Bayonne. The bottom-most deposits are finely laminated dark brown (7.5YR3/2) to very dark gray (10YR3/1) clay to very fine silt. The very fine laminations are organic enriched silts of very dark gray (7.5YR3/1) to very dark brown (10YR2/2) varves, which are diagnostic sediments of lake deposits. As the only lakes within the New York Harbor basin are glacial in origin, these deposits pre-date cultural occupation of the valley.

The lowland sequences document a sequence in which dynamic pro-glacial lake transgressions were transgressed by sea level rise and eventually transformed into an estuary as sea levels stabilized.

Jersey Eagle Property- ***Jersey City, NJ*** **(JC-006 and JC-007)**

Two cores (JC-6 and JC-7) were emplaced along the Jersey Eagle Property. The cores were positioned approximately 400 ft (120 m) apart along an abandoned asphalt road that runs parallel with the New Jersey Turnpike Extension (I-78). The background literature review by PAL identified the potential for encountering historical sites near the intersection with Linden Road, which is closest to JC-7. The Morris Canal, an NRHP listed 19th century canal, is located nearby; however mapping by PAL suggests it is outside of the project area, to the northwest of the Turnpike (Elquist et al. 2010a). Both borings extended to a depth of 20 feet, and encountered thick fill deposits as well as a possible buried surface and natural estuarine sequences (see Appendices A and B). Boring JC-6 had superior recovery to JC-7, as a perched water table in JC-7 saturated the sediments which were recovered as a slurry in most of the core.

Both cores registered fill material between the surface and 145 cm (JC-006) and 165 cm (JC-007). The fill consisted of gravelly sand to gravelly sandy clay loam. The fill of JC-006 included domestic debris such as historic glass, brick, porcelain and shell fragments (see discussion below). Below the fill horizon was a coarsening upward sequence, implicating either episodic alluviation or estuarine aggradation. This sedimentary suite extended from 145-195 cm in core JC-006 (as 2C1-2C4 horizons) and 165-215 cm in JC-007 (as 2C horizon). The horizon was poorly expressed in JC-007 because it was saturated by a perched water table. In JC-006 the coarsening upward was very clear, as facies change from a very dark gray (GLEY 1 3/n) gleyed finely bedded clay at the base (175-195 cm) to dark gray (GLEY 1 4/N) and brown (7.5YR4/3) sands from 156-175 cm, to finally a dark brown (7.5YR3/2) gravelly loamy sand at the top of the deposit. No archaeological materials or diagnostic remains were recovered in this natural succession. Below the natural deposits was a buried surface (3Apb horizon). In JC-006 this buried surface extended from 195-230 cm and it is a black (10YR2/1) fine sandy clay loam. One whiteware ceramic sherd was recovered from this horizon at 215 cm. Fine shattered shell fragments were found throughout, as were fine root fragments. These remains, and a massive to granular soil structure, are indicative of an intact buried surface. JC-007 had a similar horizon between 215-240 cm, however it appeared more disturbed with common mottles and occasional pebbles. Intact subsoil horizons (3Bw-3BC in JC-006 and 3BC in JC-007) are found below the buried A horizons. In JC-006, the sequence extends from 230-315 cm, and consists of a grayish brown (2.5Y5/2) to light grayish brown (2.5Y6/2) sandy clay loam to silt. Soil structure ranges from fine subangular blocky in the 3Bw horizon to massive to finely stratified in the 3BC horizon. Vertical streaks of translocated organics as well as iron redox concentrations are indicative of soil formation associated with long-term stable surfaces. Only the 3BC horizon was recovered in JC-007, and it ranged from 240-260 cm. Below the subsoil horizons are glacial till (3C horizon) of reddish brown (2.5YR4/3) gravelly silt-loam, which extends from 315 cm to the base of the core in JC-006 and from 260 cm to the base in JC-007.

The buried A horizon with historical remains and the intact subsoils below water-lain deposits have the potential to be archaeologically significant. Such a stratigraphic succession is a proxy for major historical landscape alteration consistent with water flow over a stable land surface. A canal or other artificial channel would be the most obvious explanation, but the location of the Morris Canal verified on the opposite side of the Turnpike (Elquist et al., 2010). In this case, there may have been another artificial channel along this portion of the project area. Alternatively, landscape modifications may reflect on a transgression of a tidal estuary, or perhaps a localized run-off from the Palisade ridge perhaps accelerated and/or diverted because of Turnpike construction.

Mocco Property –*Jersey City, NJ* (JC-026)

Boring JC-026 is located on an infilled empty lot immediately adjacent to a parking lot. The boring extended to 20 ft, and recovered a deep fill succession above till (see Appendices A and B). The fill is gravelly sand that extends to a depth of 515 cm. Cinders are common throughout the fill, while fragments of wood, roots, and concrete were also observed in the upper 66 cm. A large fragment of wood, possibly a board, post, or log was cored completely through between 515-535 cm. The wood was moist and only partially decayed. The size of the wood fragment and the location at the base of the fill suggests it was deliberately emplaced and not a natural occurrence. Below is a reddish brown (2.5YR4/3) gravelly silt loam till from 535 cm to the base at 580 cm. As there were neither cultural artifacts within the fill sequence, nor intact natural sediments above the till, no buried archaeological resources were identified in this core (Table 1).

5. RECOMMENDATIONS

The present GRA investigations afford an opportunity to offer preliminary recommendations on the potential for deeply buried archaeological deposits at the project areas under investigation. The depths of archaeologically sensitive deposits are presented core-by-core in Table 1. It should be reiterated that these recommendations are limited to the areas surrounding the coring locations, and they should not be extrapolated to adjoining properties or tracts beyond the sampling interval of the boring program. In New Jersey the interval is 500 feet (150 m), while in New York City the interval is 200 feet (60 m). These recommendations are also proposed without the benefit of additional laboratory analyses, such as establishing an absolute chronology for landscapes (radiocarbon dating), identifying their depositional origins (sedimentology and micromorphology), and reconstructing vegetation and climate (palynology and stable isotope studies). In some cases, developing a chronology of deeply buried sequences would refine our archaeological sensitivity model. In other cases, there is not enough difference in the physical characteristics of deposits for us to differentiate between sediments with archaeological sensitivity verses far older pre-cultural sediments. 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.

Morgan Trucking Property -*Linden, NJ* (LIN-003, LIN-004)

- Intact soils, including the transitional surface-subsoil horizon (2BAp), and a subsoil (2BC) were identified in LIN-003 (Appendix A and Table 1). These soils are relatively shallow (maximum depth of 115 cm), and formed above glacial till deposits. The PAL report indicates that this area was not significantly developed during the historic period, but that it may have the potential for shallowly buried prehistoric deposits (Elquist et al. 2010a: 90).

- While no archaeological materials were identified in our boring, additional testing via standard archaeological methods (ie. shovel testing) should be undertaken to test these intact soils.

TETLP Property -*Staten Island, NY* (SI-002)

- This core demonstrated the potential for archaeological sensitivity both in the fill (0-160 cm), intact subsoils (160-235 cm), and perhaps in underlying sandy deposits (235-560 cm) (Appendix A and Table 1). One horizon within the fill, 80-92 cm, appeared to be a compacted historic surface. This horizon may be worth testing via traditional archaeological survey methods (i.e. shovel testing). The intact subsoils may be reflective of pre-contact deposits, and bare future deep testing. Radiocarbon dating of the underlying sand deposits is recommended because their lithology and landscape position, indicate they could be either archaeology sensitive beach sands or pre-cultural outwash deposits. The background literature review identified the potential for both historical and prehistoric archaeological materials in this area, and this core confirms that hypothesis (Elquist et al, 2010b: 76).

- Sedimentology of the intact subsoils and underlying deposits may help identify depositional environments and soil forming mechanisms, as well as relative antiquity.

IMTT Property -*Bayonne, NJ* (BAY-011 to -015, and BAY-017)

- All borings along the IMTT Property demonstrated thick fill sequences contaminated with product (Appendix A and Table 1). Underlying estuarine deposits were common in all but one core (BAY-011) which was underlain by till. These estuary deposits are typically good candidates for radiocarbon dating, however due to the overlying petrochemicals there is a good chance that the organic carbon content of the estuarine sediments have become contaminated with older petrocarbons. No further work is recommended along these portions of the project area within the IMTT property.

Lehigh Property –*Bayonne, NJ* (BAY-016)

- While this boring recovered historic debris within fill, the entire fill was contaminated with product (Appendix A and Table 1). Deep estuarine sediments were recovered at the base of the core, however as in the case of the IMTT property. This core is not a good candidate for radiocarbon dating or other follow up analysis. No further work is recommended in the vicinity of BAY-016.

99 Hook Road Property –*Bayonne, NJ* (BAY-018)

- Unlike the contaminated borings on the IMTT and Lehigh properties, this boring has relatively shallow fill (to 120 cm) above a thick estuarine sequence that is contaminated with product (Appendix A and Table 1). The intact, product stained estuarine silts and clays are not good candidates for radiocarbon dating and they would not be productive for testing, as they are likely subaqueous deposits. No further work is recommended in the vicinity of BAY-018.

Bayonne Local Redevelopment Authority (BLRA) Property –*Bayonne, NJ* (BAY-019- to -031, and BAY-R-001 to -005)

- The eighteen (18) cores emplaced across the BLRA property were excavated into former nearshore, shoreline, and offshore settings along the margins of the Historical shoreline of Bayonne (see Figure 5, Appendix A, and Table 1). These cores disclosed the presence of complex buried stratigraphies, which in many cases, preserve pre-industrial landscapes.

- BAY-019, BAY-024, BAY-R-001, BAY-R-002, BAY-R-004 and BAY-R-005 demonstrated no potential for buried archaeological resources. These cores either had fill directly above truncated glacial till, or were truncated glacial till with no fill sequence.

- Cores along the upland margins of Bayonne with buried surfaces are BAY-020, BAY-021, BAY-022, BAY-023, and BAY-R-003. The depth of the buried surfaces range in depth. Only BAY-R-003 has a buried surface shallow enough to be tested with standard archaeological survey technique (shovel tests). The rest would require deep testing to access. No prehistoric materials were recovered from these buried surfaces, and there is some evidence of historical disturbance in the form of intrusive gravels. These surfaces could be radiocarbon dated to determine the antiquity of the deposits.

- While no prehistoric archaeological materials were recovered in the uplands, BAY-R-003 recovered a stratigraphic sequence analogous to a previously unrecorded prehistoric shell midden observed in profile on an immediate adjacent property to the north. Close interval testing on surfaces adjacent to BAY-R-003 is recommended to fully assess the potential for intact archaeological sequences.

- The lowland cores recovered sediment facies associated with beaches and estuaries. These buried landforms may have been the loci for prehistoric resource procurement (i.e. source of shellfish) and a paleolandscape reconstruction along a transect bisecting these buried, preserved landforms is critical to evaluate the integrity and archaeological potential of the BLRA property, and potentially other paleoshoreline positions along Bayonne and Jersey City. As such, radiocarbon dating of key components of the beach, estuary, and underlying lacustrine fan/delta deposits is critical. The fine-grained estuary deposits also hold the potential for paleoenvironmental reconstructions via pollen studies, paleobotanical identification of plant remains and shell identification.

- A broad range of radicarbon, sedimentological, palynological, and paleo-biotic and climatic analyses would help to reconstruct the landscape, prehistoric, and historic succession of this uniquely preserved Holocene micro-environment.

Jersey Eagle Property- *Jersey City, NJ* (JC-006 and JC-007)

- Both cores recovered sequences of fill above natural water-lain deposits that capped a buried surface and intact subsoils. Core JC-006 had more optimal recovery, as a perched water table in JC-007 led to fragmentary sediment yield in the range of the buried surface. The intact surface is approximately 230 cm below ground surface, and it may have preserved both historic and prehistoric components; both historic artifacts and broken shells were recovered from the buried surface.

- The stratigraphic sequence is what might be expected for a buried canal. However the Morris Canal is outside of the project area (Elquist et al. 2010a). The project area may represent a local artificial canal or waterway that resculpted a historic landscape.

- Additional deep testing is recommended for the area around these cores. Radiocarbon dating, sedimentological and micromorphological analysis from the buried surface and underlying subsoils may help determine the chronology and depositional context of these deposits.

Mocco Property –*Jersey City, NJ* (JC-026)

- This boring encountered very thick modern fill above glacial till on a property that looks to be significantly modified by made land (Appendix A and Table 1). No further deep testing is recommended in the vicinity of JC-026.

Table 1. Preliminary recommendations based on geoarchaeological investigations.

CORE No.	SENSITIVITY ASSESSMENT	PRELIMINARY ANALYSIS INFORMATION			Comments
		Contamination* (No Further Work)	Modern Fill = 15 ft BS (No Further Work)	Modern Fill/Historic Strata = 15 ft BS (Further Work)	
LIN-003	moderate for pre-and post-contact resources			present: possible intact Historic-Prehistoric soil between 60-80 cm (~2-2'8" below ground surface) and 80-115 cm (2'8"-3'8")	0-60 cm: Fill; 60-80 cm: possibly intact transition from buried surface soil to subsoil; 80-115 cm: subsoil; 115-580: glacial till
LIN-004	moderate for pre-and post-contact resources		present		0-40 cm: disturbed fill; 40-580: truncated glacial till
SI-002	high for pre- and post-contact resources			present: complex fill sequence between 0-160 cm (0-5'4" below ground surface) may include historical fill; 160-235 cm (5'4"-7'8") is possibly intact truncated subsoil; 235-560 cm (7'7"-18'3") unweathered sands	0-160 cm: stratified fill; 160-235 cm: possibly intact truncated subsoil; 235-560 cm: stratified unweathered sands; 560-580 cm: till

CORE No.	SENSITIVITY ASSESSMENT	PRELIMINARY ANALYSIS INFORMATION			Comments
		Contamination* (No Further Work)	Modern Fill = 15 ft BS (No Further Work)	Modern Fill/Historic Strata = 15 ft BS (Further Work)	
BAY-011	moderate for pre-contact resources	present			0-40 cm fill; 40-455 cm: product contaminated fill; 455-465 cm: contaminated/disturbed subsoil; 465-560 cm: till
BAY-012	moderate for pre-contact resources	present			0-82 cm fill; 82-137 cm: product contaminated fill; 137-183 cm: clean fill with construction debris; 183-305 cm: product contaminated fill; 305-345 cm: mixed contaminated fill and natural organic silts; 345-365 cm estuarine organic silts with product contaminant; 365-590 cm: intact Holocene estuary organic silt to silt sequence with no contamination
BAY-013	moderate for pre-contact resources	present			0-30 cm: fill; 30-400 cm: product contaminated fill; 400-455 cm: estuarine organic silts contaminated with product, which decreases with depth
BAY-014	moderate for pre-contact resources	present			0-20 cm: fill; 20-535 cm: product contaminated fill; 535-580 cm: intact estuarine organic silts contaminated with product, which decreases to no contamination with depth
BAY-015	moderate for pre-contact resources	present			0-145 cm: fill; 145-430 cm: product contaminated fill; 430-580 cm: intact estuarine organic silts contaminated with product, which decreases to no contamination with depth
BAY-016	low for pre-contact resources	present			0-520 cm: cindery fill with oily sheen; 520 580: organic clay
BAY-017	low for pre-contact resources	present			0-132 cm: fill; 132-354 cm: product contaminated fill; 354-425 cm: intact estuarine organic silts contaminated with product, which decreases to no contamination with depth; 425-580 cm: intact Holocene estuary organic silt to silt sequence with no contamination
BAY-018	low for pre-contact resources	present			0-120: fill; 120-405: organic silts contaminated; 405-580: organic silts, upper portion contaminated

CORE No.	SENSITIVITY ASSESSMENT	PRELIMINARY ANALYSIS INFORMATION			Comments
		Contamination* (No Further Work)	Modern Fill = 15 ft BS (No Further Work)	Modern Fill/Historic Strata = 15 ft BS (Further Work)	
BAY-019	high for pre- and post-contact resources		present		0-435 cm: fill; 435-555 cm: lost due to slump/slurry; 555-580: glacial till
BAY-020A	high for pre- and post-contact resources			present: possible disturbed surface with intact subsoil 365-430+cm (11'10"-14'2"+)	0-365 cm: fill; 365-430 cm: wood fragment capping buried organic rich surfaces, possible brick fragments towards base at 430 cm (maybe natural soil redox mottles); 430-530 cm: possible subsoil with intrusive brick fragments, most of sample lost in slurry at contact between C and D cores; 530-580 cm: till
BAY-021	high for pre- and post-contact resources			present: possible disturbed buried surface 280-290 cm (9'2"-9'5", possibly to 10'10"); intact subsoils: 330-390 cm (9'5"-12'10")	0-280 cm: fill; 280-290+ cm: disturbed historic surface, could possibly extend to 330 cm; 330-390 cm: intact subsoil; 390-580 cm: glacial till
BAY-022	high for pre- and post-contact resources			present: disturbed buried surface 375-400 cm (12'4"-13'1")	0-375 cm: fill; 375-400 cm: disturbed buried surface, few possibly intrusive mottles: 400-580: glacial till
BAY-023	high for pre- and post-contact resources			present: possible disturbed historic surface 255-280 cm (8'4"-9'2")	0-255 cm: fill; 255-280 cm: possibly buried surface with very few glassy cinders, 280-580: glacial till
BAY-024	high for pre- and post-contact resources		present		0-85 cm: fill; 85-490: glacial till
BAY-025	high for pre- and post-contact resources		present		0-555 cm: fill; 555-580: organic silts, possible prehistoric estuary
BAY-026	high for pre- and post-contact resources			present: Low probability shoreline & nearshore deposits, beach sands 250-390 cm (8'3"-12'9") ; offshore-nearshore estuary 390-550 cm (12'9"-18')	0-250 cm: fill; 250-390 cm: sandy, gravelly sandy, beach deposits; 390-550: organic silts and clays; 550-580 cm: reduced glacial till
BAY-027	high for pre- and post-contact resources			present: Buried surface (possibly historic) 145-165 cm (4'8"-5'5"); undetermined Beach or Fill below 165-410 cm (5'5"-13'6")	0-145 cm: fill; 145-165 cm: buried surface high in organics; 165-410 cm: sands to gravelly sands of either beach or fill; 410-435 cm: estuarine sandy loam with organics
BAY-028	high for pre- and post-contact resources			present: Low probability shoreline & nearshore deposits, beach sands 200-417 cm (6'6"-13'7"); offshore-nearshore estuary 417-580 cm (13'7"-19')	0-200 cm: fill; 200-417 cm: sandy, gravelly sandy beach deposits; 417-580 cm: estuarine organic silts, clays, and loams
BAY-029	high for pre- and post-contact resources			present: Buried surface (possibly historic) 225-243 cm (7'5"-8'); Low probability shoreline and nearshore deposits, beach sands 243-405 cm (8'-13'3"), offshore-nearshore estuary 405-580 (13'3"-19')	0-225 cm: fill; 225-243 cm: organic rich buried surface; 243-405 cm: sandy, gravelly sandy beach deposits; 405-580 cm estuarine silts and clays

CORE No.	SENSITIVITY ASSESSMENT	PRELIMINARY ANALYSIS INFORMATION			Comments
		Contamination* (No Further Work)	Modern Fill = 15 ft BS (No Further Work)	Modern Fill/Historic Strata = 15 ft BS (Further Work)	
BAY-030	high for pre- and post-contact resources			present: Low probability shoreline and nearshore deposits, beach sands 205-570 cm (6'8"-18'8"), offshore-nearshore estuary 570-580 (18'8"-19'	0-205 cm: fill; 205-570 cm: sandy, gravelly sandy beach deposits; 570-580 cm: estuarine clays with organics
BAY-031	high for pre- and post-contact resources			present below 145 cm (4 ft 9 inches) for Historic-Prehistoric shorelines	Complex sequence of: 0-145 cm: Recent Fill; 145-235 cm: fining upward sequence of clean sands, possible Holocene shoreline/estuary deposits; 235-520 cm: reworked till (lacustrine fan?) moderately sorted sands with occasional fine shell fragments; 520-580 cm: silts with fine beds of partially decayed organics (likely glacial lake Bayonne) Sequence can be dated by AMS from organic frag collected at 150 cm (top) and from common dacayed organics at base (560-580 cm). Greatest potential for archaeology between 145-235 cm. Deposits between these depths may represent an intact prehistoric landform contemporaneous to the nearby shell midden.
BAY-R-001	high for pre- and post-contact resources		present		7 cm of modern fill over truncated glacial till (Rahway)
BAY-R-002	high for pre- and post-contact resources		present		Fill (incl. 1 clear flat glass fragment at 130 cm) to a depth of 140 cm (4 ft 7 inches). Below is truncated glacial till (Rahway)
BAY-R-003	high for pre- and post-contact resources			present between 25-150 cm (between 10 inches and 4 ft 11 inches) for Historic-Prehistoric surface analogous to shell midden site (although evidence for disturbances)	Complex sequence of: 0-25 cm: Recent Fill; 25-70 cm: Possible mixed fill and buried historic surface; 70-150 cm loamy sands of possibly mixed slopewash, local alluvial or shoreline margins; 150-580 glacial till *note core stratigraphy and surface elevation is most analogous to the prehistoric shell midden observed to the NE of boring BAY-R-004
BAY-R-004	high for pre- and post-contact resources		present		Top 20 cm disturbed with a weakly developed modern surface soil forming over truncated glacial till (Rahway)
BAY-R-005	high for pre- and post-contact resources		present		Top 30 cm disturbed with a weakly developed modern surface soil forming over truncated glacial till (Rahway)

CORE No.	SENSITIVITY ASSESSMENT	PRELIMINARY ANALYSIS INFORMATION			Comments
		Contamination* (No Further Work)	Modern Fill = 15 ft BS (No Further Work)	Modern Fill/Historic Strata = 15 ft BS (Further Work)	
JC-006	low for pre- and post-contact resources			present, with buried historic (& possibly prehistoric surface) 195-230 cm (6'2" to 7'6") and intact subsoil 230-315 cm (7'6" to 10') which may have the potential for intrusive features	0-156 cm: fill with brick, shell, glass; 156-195 cm: natural alluvial/estuary deposits; 195-230 cm: buried historic surface; 230-315 cm: subsoil below surface; 315-580 cm: till
JC-007	moderate for pre- and post-contact resources			present, with buried historic (& possibly prehistoric) surface between 215-240 cm (7' to 7'9"), *note not as intact as in JC-006 b/c saturated; and intact subsoil 240-260 cm (7'9" to 8'6")	0-165 cm: fill; 165-215 cm: natural alluvial/estuary deposits w/ perched water table; 215-240 cm: buried historic surface; 240-260 cm: subsoil below surface; 260-580 cm: till
JC-026	low for pre-contact resources		present		0-515 cm: thick fill sequences; 515-535 cm: wood fragment; 535-580 cm: till

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Appendix A: Core Descriptions

LIN-003

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
FILL	0-60	60	Ap-FILL	10YR3/1	VGS	dist.	l	a	many (60%) gritty fine to medium angular gravels and cinders
SUBSOIL FORMED IN TILL	60-80	20	2BAp	5YR4/3	CL	1fsbk	fi	c	2% very fine pebbles, very few fine roots
	80-115	35	2BC	7.5YR4/3	SiL	1msbk	fi	a	few to common (3%) medium to fine angular gravels
TILL, water table ~400 cm	115-145	30	2C1	2.5YR4/4	GSCL	mass	Vfi	undet.	common (10%) fine gritty angular pebbles (heterolithic), undetermined lower boundary due to break between A and B cores (first and second)
	145-435	290	2C2	10R4/4	Si	1strat	fi	d	common (5-10%) subangular to rounded fine with occasional medium heterolithic pebbles, becomes moist with depth
	435-580	145	2C3	10YR3/3	Si	1strat to mass	slfi	na	fine stratified beds of VFS become more prominent with depth

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

LIN-004

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
FILL	0-40	40	Ap-FILL	10YR2/1	GS	dist	l	a	many (60%) fine to medium gritty fill gravels and cinders
	40-75	35	2Cp1	5YR3/3	GSiL	2fsbk	slfi	c	many (30%) fine to medium subangular to angular heterolithic gravels (red mudstone, gneiss, diabase, quartzite, few distinct medium 2.5YR3/4 mottles
	75-135	60	2C2	5YR4/2	SiC	mass	slfi	a	few (2%) heterolithic gravels (red mudstone, schist, ghosts of sedimentary rocks); faint product smell
TILL	135-435	300	2C3	10YR3/4	GSiC	mass	fi	c	common (20%) medium to fine rounded to subrounded heterolithic gravels
TILL-water table	435-580	145	2C4	10YR4/4	GSiCL	mass	fri	na	saturated, common (20%) medium to fine rounded to subrounded 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

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

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

SI-002

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
	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?
FILL- COMPLEX SEQUENCE - POSS. HISTORIC?	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
TRUNCATED SUBSOIL?	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
INTACT UNWEATHERED SHORELINE DELTA, OUTWASH?	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

BAY-011

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
FILL	0-25	25	Ap1/FILL-1	10YR4/4	vGS	dist	fri	a	common (15%) medium clasts
	25-40	15	Ap2/FILL-2	10YR2/1	vGS	dist	l	a	small (5-10mm) common gritty gravels
CONTAM. FILL	40-455	420	Ap3/FILL-3	10YR2/1, 3/1	vS-SCL	dist	fi	a	thick fill sequence saturated by product, occasional gravels throughout
CONTAM/ DIST. SUBSOIL?	455-465	10	2BC	mottled	C	na	fi	a	mottled clay observed at base of 10-15' core, contaminated by product, not observed in 15-20' section
TILL	465-580	120	3C	5YR3/4	vGSCL	mass	fi	na	many (60%) medium to large angular red and gray mudstone, slightly moist, prominent product odor upper 20 cm

*note only core section 15-20'(460-580 cm) was collected and observed in the lab, the rest of the overlying core descriptions (0-15'/0-460 cm) were made in the field

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

BAY-012

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
	0-30	30	Ap1-FILL-1	10YR4/4	G	dist	fri	a	chipped rubble of angular stones
	30-45	15	Ap2-FILL-2	10YR6/4	GS	dist	na	na	compact, cohesive disaggregated rocks in sandy matrix
FILL- COMPLEX	45-70	25	Ap3-FILL-3	10YR2/1	GSL	dist	na	na	common brick debris, isolated organic fragments, and gravels
SEQUENCE	70-82	12	Ap4-FILL-4	2.5Y8/1	na	dist	l	a	decomposed concrete
CONTAM. FILL	82-137	55	2Ap6-FILL-	10YR2/1	GS	dist	na	na	product stained gritty sands and occasional 2.5YR4/6 crushed brick and building debris
FILL- COMPLEX	137-172	35	3Ap6-FILL-	GLEY 1 3/10	C	dist	st	na	reducted, saturated, occasional brick debris and matted fibrous organic fragments
SEQUENCE	172-183	11	3Ap7-FILL-	2.5YR4/6	dist	dist	dist	a	crushed brick
CONTAM. FILL	183-305	122	4Ap8-FILL-	10YR2/1	LS	dist	dist	c	moist to saturated with product
	305-345	40	5Cp1	7.5YR4/2	SiL	dist	slfi	c	few fine gravels and organic fragments with product
CONTAM. To NON-CONTAM. ORGANIC SILT	345-365	20	5C2	2.5Y4/2	Osi	strat-pl	slfi	g	40-60% fine partially decayed roots forming organic mat, few fine seeds and plant frags, slightly moist, product scented
ORGANIC CLAY	365-510	145	5C3	GLEY 1 4/N	C	strat-pl	fi	c	common (20%) partially decayed 10YR6/6 grass-like stems and occasion roots, slightly moist
SILT	510-590	80	2C4	5Y3/1	Si	strat-pl	fi	na	few (2%) fine organic fragments, 1-2% fine shell fragments

*note only core sections 10-20'(305-580 cm) were collected and observed in the lab, the rest of the overlying core descriptions (0-10'/0-305 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; 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

BAY-013

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
FILL	0-30	30	Ap1-FILL-1	7.5YR3/3	LS	dist	fri	a	few small fragments of brick, stone, and cinders
CONTAM. FILL	30-115	85	Ap2-FILL-2	2.5Y3/1	S	dist	fri	a	compacted sand with product
	115-130	15	Ap3-FILL-3	2.5Y5/1	GfS	dist	fri	a	common gritty fine gravels
	130-400	265	Ap3-FILL-4	10YR2/1 to	SiL-GS	dist	fri-slfi	a	moist to saturated with product
CONTAM. To NON-CONTAM. ORGANIC SILT	400-455	55	2C	2.5Y3/1	Osi	platy	fi	na	many (40% of matrix) organics, fine partially decayed roots, matted, occasional larger plant fragments and seeds, slightly moist, product smell at top deminishes with depth

*note only core section 13-15'(396-460) was collected and observed in the lab, the rest of the overlying core descriptions (0-13'/0-396 cm) were made in the field

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

BAY-014

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
FILL	0-20	20	Ap1/FILL-1	10YR4/3	GS	dist	l	a	common gritty cinders and concrete fragments
CONTAM. FILL	20-70	50	2Ap2/FILL-2	10YR2/2	SiL	dist	slfi	a	product stained, few fine decayed plant fragments
	70-535	465	2Ap3/FILL-3	10YR2/1	S-VGS	dist	fri-slfi	a	moist to saturated with product, lenses of clean sand and gritty gravels all with product sheen, smell
CONTAM. To NON-CONTAM. ORGANIC SILT	535-580	45	3C	5Y4/2	Osi	strat	slfi	na	many (60%) partially decayed fine root mat with occasional larger stems, seeds, slightly moist, slight product smell

*note only core section 15-20'(460-580 cm) was collected and observed in the lab, the rest of the overlying core descriptions (0-15'/0-460 cm) were made in the field

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

BAY-015

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
FILL	0-145	145	Ap1-FILL-1	7.5YR4/3	S-SL	dist	fri	na	poorly sorted, isolated pockets of brick materials and crushed stone
CONTAM. FILL	145-430	285	2Ap2-FILL-2	7.5YR3/1	VGS-SL	dist	l-fri	a	moist to saturated with product, lenses of gravelly sands and clean sands all with product sheen, smell
CONTAM. To NON-CONTAM. ORGANIC SILT	430-580	150	3C	5YR2.5/2	Osi	strat	slfi	na	many (60%) partially decayed fine matted roots, few larger roots and seeds, slightly moist, slight product smell

*note only core section 15-20'(460-580 cm) was collected and observed in the lab, the rest of the overlying core descriptions (0-15'/0-460 cm) were made in the field

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

BAY-016

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
FILL	0-220	220	FILL-1	7/5YR3/2	GL	mass	slfi	a	common (15%) fine to medium angular to subangular gravel, white ware ceramic sherd at 145 cm
CONTAM. FILL	220-250	30	FILL-2	10YR2/2	G	dist	fri	a	fine to medium cinders with black oily sheen, common fine glass and ceramic fragments
	250-290	40	FILL-3	5YR4/3	LS	mass	fi	a	common (5%) gravels
	290-520	230	FILL-4	10YR2/1 to 4/4	GS	dist	fri	a	many (40%) gritty cinders with strong oily scent and sheen
CONTAM. To NON-CONTAM. ORGANIC CLAY	520-580	60	2C	10YR3/1	C	mass	fi	ma	few (3%) fine partially decayed organic fragments, upper portion of horizon has oily scent

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

BAY-017

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
	0-38	38	Ap1-FILL-1	7.5YR4/3	GS	dist	l	a	heterolithic gravels
	38-81	43	Ap2-FILL-2	7.5YR4/3, 5/4	SL-S	dist	l	a	decrease in gravels
FILL	81-132	51	Ap3-FILL-3	7.5YR3/2	SiL	1msbk	slfi	a	compacted
CONTAM. FILL	132-354	222	2Ap4-FILL-4	10YR2/1	GS-GSL	dist	l-slfi	a	moist to saturated with product, common heterolithic gritty gravels
CONTAM. ORGANIC SILT	354-425	71	3C1	5Y2.5/2	Osi	strat	slif	g	many (60%) partially decayed fine matted roots, occasional medium roots and seeds, decreases in organic percent to 20% with depth, product scent, which decreases in strength with depth
ORGANIC SILT	425-580	155	3C2	GLEY 1 4/N	OSiC-Si	mass-1fstrat	slfi to fri (soft)	na	organic content decreases from 20% with partially decayed yellow plant stems and roots to only 5% with depth,of fine detrial fragments, occasional few fine shell fragments throughout, soft, moist

*note only core sections 10-20'(305-580 cm) were collected and observed in the lab, the rest of the overlying core descriptions (0-10'/0-305 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; 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

BAY-018

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
	0-40	40	FILL-1	10YR2/2	GS	dist	fri	a	concrete/asphalt and cinders
	40-65	25	FILL-2	10YR6/3	S	mass	fri	a	clean fill sand
FILL	65-120	55	FILL-3	10YR3/1	GSCL	dist	fri	a	common (20%) medium to fine angular gravels, 7.5YR3/4 silt mottles, 1 large brick fragment at 85 cm
CONTAM. ORGANIC SI	120-405	285	2C1	10YR3/1 to GLEY 1 3/N	Si to SiL	mass	fri	a	few (3-5%) fine partially decayed organics, becomes moist and saturated with a very noxious oily-chemical smell (possibly lateral movement) and thin lenses of oily sheen
CONTAM. to NON-CONTAM. ORGANIC SILT	405-580	175	2C2	10YR2/2	OSi	strat	slst	na	many (30%) fine partially decayed fibrous organic muck to peat, noxious smell decreases with depth to no smell at base

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

BAY-019

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
COMPLEX FILL SEQUENCE	0-75	75	Ap1-Fill-1	10YR4/2	GLS	dist	fri	a	many (20-30%) fine to medium angular heterolithic gravels, 5 cm thick lenses of fill
	75-165	90	Ap2-Fill-2	2.5YR4/3	GSCL	2m-fgr	fi	a	common (20%) medium to fine angular heterolithic gravels, dry
	165-225	60	Ap3-Fill-3	7.5YR4/1	SL	mass	fri	a	saturated, well sorted
MOIST TO SATURATED FILL SEQUENCE	225-250	25	Ap4-Fill-4	5YR3/2, 4/	GSiL	dist	fri	a	common (15%) medium to fine gravels, saturated to moist, slurry-like
	250-285	35	Ap5-Fill-5	5YR3/1	m-cS	mass	fri	c	very few medium angular gravels at top, few shattered large shell fragments (possibly oyster), quartzitic, slightly micaceous, slightly moist
	285-400	115	Ap6-Fill-6	7.5YR3/1	LfS	mass	slfi	a	saturated, well sorted, quartzitic, slightly micaceous
CONTAM. FILL	400-435+	>35	Ap7-Fill-7	10YR2/1	SiL	dist	fri	na	moderate product smell and color with a slight oil sheen, moist, undetermined lower boundary because it is lost in break between core C & D
TILL	555-580	25	2C	2.5YR4/3	GSCL	mass	fri-slfi	na	common (10%) medium angular gravels, moist

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

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

BAY-020

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
COMPLEX FILL SEQUENCE	0-10	10	Ap1-Fill-1	2.5YR3/1	GSCL	dist	fri	a	many (30%) angular gravels
	10-25	15	Ap2-Fill-2	7.5YR2.5/1	GcS	dist	fri	a	many very fine cindery asphalt fragments
	25-75	50	Ap3-Fill-3	10YR5/2	Lc-mS	mass	fri	a	common (10%) fine broken shell fragments, micaceous
	75-180	105	Ap4-Fill-4	10YR4/2	vGSCL	1fgr	fri	a	many (60%) medium to large angular concrete and schist gravels
	180-255	75	Ap5-Fill-5	10R4/3	GCL	1fgr	fi	a	common (20%) fine to mediu angular pebbles
	255-265	10	Ap6-Fill-6	10YR2/1	G	dist	l	a	moist, black stained cinders and gravels
	265-365	100	Ap7-Fill-7	7.5YR41	SCL	mass	fi-fri	a	becomes increasingly moist with depth, few (2%) very fine heterolithic gravels, very few fine shells
BURIED SURFACE, POSS. HISTORIC	365-372	7	2Ob	7.5YR3/1	O	na	fi	a	moist decaying wood fragment, parts into fine horizontal sheets
	372-400	28	2Ab(p)1	7.5YR3/1	SiL	2m-fgr	fri	a	common (10-20%) fine to medium roots and plant stems, slightly micaceous
	400-430	30	2Ab(p)2	7.5YR2.5/1	SiL-SiCL	1fgr	fri	a	common (20%) very fine partially decayed organics, slightly micaceous
UNDETERMINED SUBSOIL-DISTURBED SOIL	430+	na	2BCp	7.5YR4/1	fSL-GfSCL	mass	slfi	c	gravels increase in size and % with depth, from 2% very fine gravels to 15% fine to medium angular gravels with depth, few medium organic fragments towards the top, very few 2.5YR4/4 very fine soft masses throughout (possibly brick, possibly red mudstone)
TILL	530-580	50	3C	2.5YR4/3	GSiC	1ab	fi	na	many (40%) fine to medium angular heterolithic gravels, slightly moist

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

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

BAY-021

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
COMPLEX FILL SEQUENCE	0-45	45	Ap1-FILL-1	7.5YR3/2	GSCL	dist	fri	a	many (30%) fine to medium angular gravels, very few fine roots
	45-55	10	Ap2-FILL-2	7.5YR6/1	f-mS	mass	slfi	a	
	55-70	15	Ap3-FILL-3	7.5YR2.5/1	GSCL	dist	slfi	a	common (10%) fine to medium gravels, few cinders, few clay 5YR3/4 mottles/nodules and brown mudstone ghosts
SATURATED FILL	70-280	210	Ap4-FILL-4	5YR4/4	GSCL-GSL	1mgr-dist	slfi	a	5-15% small angular heterolithic gravels, becomes saturated below 205 cm, mottled with fine nodules of clay
BURIED HISTORIC SURFACE	280-290+	10/~50	2Abp	5YR2.5/1	fSL	1mpl	slfri	na	occasional fine wood fragment, occasional fine glass fragment (including 1 fine flat clear glass), few fine 10YR5/2 mottles, slightly micaceous
SUBSOIL, POSS. MIXED ESTUARINE	330-360	30	2BC1	GLEY 1 5/N	SiL	2fpl	fi-slfri	c	very fine sand, slightly micaceous, few 5YR2.5/1 organic mottles in upper 5 cm
	360-390	30	2BC2	5Y4/1	fSCL	mass	slfi	g	slightly moist
TILL	390-580	190	2C	2.5Y4/4	GSCL-GSiL	mass	fi-slfri	na	common (20%) fine to medium 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
Boundary Topography: w = wavy; s = smooth; a = abrupt

BAY-022

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
COMPLEX FILL SEQUENCE	0-25	25	Ap1-FILL-1	10YR5/3	S	dist	l	a	few (5%) fine to medium pebbles
	25-45	20	Ap2-FILL-2	5YR3/2	GLS	dist	slfri	a	common (15%) gravels, common very fine 2.5YR4/6 mottles, few fine roots
	45-375	330	Ap3-FILL-3	2.5YR4/3	GSL	dist	fri-fi	a	10-20% gravels with lenses of medium angular heterolithic gravels, cinders, amber glass fragment at 120 cm
BURIED POSS. HISTORIC SURFACE	375-400	25	2Apb	7.5YR2.5/1	SiL	1fgr	slfi to fri	a	moist, mottles of 10YR4/3 and 5YR3/2 towards the base
TILL	400-580	180	3C	2.5YR4/3	GfSL-GSiL	1ab	fi	na	becomes saturated at 435 cm, many (20-40%) angular to subangular heterolithic gravels with few large red mudstone

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

BAY-023

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
	0-35	35	Ap1-FILL-1	10YR2/2	GS	dist	l	a	many (40%) cindery with large schist gravel
	35-75	40	Ap2-FILL-2	5YR3/1	GSCL	2mpl	slfi	a	common (10%) fine angular to subangular pebbles
	75-105	30	Ap3-FILL-3	10YR2/1	GSL	dist	slfi-l	a	cindery grit
	105-126	21	Ap4-FILL-4	10YR5/3	LS	strat	l	a	5% very fine gravels of quartzite, few very fine shells
	126-132	6	Ap5-FILL-5	10YR2/1	fSL	dist	slfi	a	cindery, few (2%) fine subangular pebbles
COMPLEX FILL SEQUENCE	132-255	123	Ap6-FILL-6	2.5YR4/3	GSiL	dist	fri	a	common (10%) fine to medium angular to subangular pebbles, with few large schist fragments, common distinct 2.5YR5/1 vertical channels, moist
BURIED HISTORIC SURFACE	255-280	25	2Apb	5YR2.5/1	GSiL	1fpl	slfi	a	few (5-10%) angular to subangular gravels, increasing in % with depth, moist, very few fine roots, few very fine glassy cinders
TILL	280-580	300	3C	2.5YR4/1, 4/3	GSCL-GSi	2fsbk	slfi to fi	na	common (10-30%) fine to medium with occasional large angular to subangular heterolithic gravels, moist to saturated

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

BAY-024

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
CINDER FILL	0-15	15	Ap1-FILL-1	10YR2/1	GSL	dist	l	a	many (30%) fine to medium cinders and gravels, few fine roots, few fine plastic fragments
FILL	15-70	55	FILL-2	2.5YR3/2	GSiL	dist-1gr	slfi	a	common (20%) fine to medium angular to subangular pebbles, 5YR3/2 and 5YR4/1 fine mottles
CINDER FILL	70-85	15	FILL-3	10YR2/1	GS	dist	l	a	many (60%) cinders in fine cinder matrix
TILL	85-350	265	2C	2.5YR4/4	GSiL-GSC	1fsbk-gr	fi-slfi	g	common (15%) fine to large (poorly sorted) heterolithic gravels
TILL	350-490	140	3C	5YR4/3	GSCL-GSI	1fsbk	fi-slfi	na	common (10%) fine to medium with occasional large (poorly sorted) angular heterolithic gravels, moist becoming saturated by 15'

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

BAY-025

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
	0-185	185	Ap1-FILL-1	2.5YR4/4	GFSL	1gr	slfi	a	common (20%) fine with occasional medium to large heterolithic gravels
	185-420	235	Ap2-FILL-2	5YR4/2 to 2.5Y4/1	GSL-GSCL	dist-1gr	slfi	c	mottled, common (10-15%) fine angular gravels, occasional fine debris - cinder, plastic, metal fragments
FILL	420-555	135	Ap3-FILL-3	2.5YR3/2	GSCL	dist	slfi	a	common (20%) fine to medium angular heterolithic gravels, moist to saturated
	555-565	10	2C1	10YR2/2	L	2mgr	fri	a	few (3%) very fine angular gravels, fine organic fragments, including fine wood fragment at base, slightly moist
ESTUARY	565-580	15	2C2	5YR4/1	Si	2pl	slfi	na	common (5%) very fine shell fragments throughout, moist

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

BAY-026

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
FILL	0-185	185	Ap1-FILL-1	10YR4/1	GFS	dist	l-slfi	a	common (10%) poorly sorted fine to large angular to subangular heterolithic gravels with schist, micaceous, few cinders
	185-250	65	Ap2-FILL-2	7.5YR5/3	fLS-fS	mass	slfi	c	common (5%) fine well rounded pebbles
BEACH DEPOSITS	250-390	140	2C	5YR3/2	GcS-LmS	strat to ma	fri	a	common (5%) subrounded to rounded granules to very fine pebbles, few fine lamina of organics towards base, slightly moist
ESTUARY-NEARSHORE	390-407	17	3C	5YR4/3	OvfS-Si	strat	fi	a	common 5YR2.5/1 5 mm thick organic lenses every 2 cm, 1 medium twig cross cutting lenses, few organic fragments towards base, micaceous
	407-440	33	4C1	5Y3/1	SiC	strat	fi	c	interbedded with LfS, common (10%) fine to medium partially decayed stringy root and stem fragments
	440-465	25	4C2	5Y3/1	C-SiC	2mpl	fi	c	cross bedded, few very fine hair-filament like organics
	465-535	70	4C3	5Y3/1	C	1mpl	fi	a	lamina of 7.5YR5/2 very fine sand to silt, moist
	535-550	15	4C4	2.5Y3/1	SCL	strat	slfi	a	5% fine shell fragments, few medium red mudstone pebbles
reduced TILL?	550-580	30	5Cg	GLEY 1 6/	GCL	2fsbk	fi	na	common (10%) medium angular to subrounded mudstone, saturated, mottles of 7.5YR5/4 redox concentrations, few fine organic stains

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

BAY-027

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
	0-20	20	Ap1	7.5YR3/2	SL	1gr	slfi	a	few (2%) fine gravels, common fine roots and wood fragments
	20-90	70	Ap2	10YR6/1	fS	mass	fri	a	clean fill, very well sorted, slightly moist
FILL	90-145	55	Ap3	2.5YR3/1	GSL	dist	slfi	a	common (20%) medium heterolithic gravels (dominated by schist), high mica content, slightly moist
BURIED SURFACE	145-165	20	2Apb	10YR3/2	SL	1fgr	slfi	c	few to moderate fine roots, high mica content, slightly moist
	165-255	90	2C1	10YR4/4	S-cS	mass	slfi	c	well sorted, slightly moist, high mica content
	255-300	45	2C2	5YR4/2	S-SL	strat-mass	slfi	g	occasional lenses of 5YR4/3 SiL, poorly sorted with coarse sand towards base, dry
	300-370	70	2C3	5YR4/2	GS-GSL	mass	slfi	a	common (15%) fine well rounded heterolithic pebbles (dominated by quartzite), moderately sorted, saturated
POSS BEACH, POSS FILL	370-410	40	2C4	5YR4/3	VfS-Si	2fpl	fi	a	occasional faint very fine lamina of 5YR3/1 that increase in frequency with depth, micaceous, saturated
ESTUARY	410-435	25	3C	7.5YR4/1	SL	mass	fi	na	2 cm thick organic matt capping horizon, saturated, micaceous

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

BAY-028

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
FILL	0-200	200	Ap1-FILL-1	10YR3/2	GSL	dist	fri	a	common (20%) medium to small angular schist, red mudstone, and cinders, dry, few fine roots at top and bottom, plastic bag fragments at base
	200-290	90	2C1	5YR4/2	SL	strat	l-slfi	c	fine lenses of 5YR4/2 SL every 10 cm, few medium oyster shell fragments, 5-10% fine to well rounded pebbles, few fine lamina of well decayed organics at 250 cm
	290-390	100	2C2	7.5YR4/1	GS	mass	fri	a	common (20%) poorly sorted rounded to subrounded fine pebbles, coarse sand, few fine shell fragments, saturated
	390-405	15	2C3	2.5YR4/2	VfS-Si	strat	fi	a	common fine lamina of 2.5YR3/1 silt, micaceous, saturated
BEACH-SHORELINE	405-417	12	2C4	2.5YR4/1	Si-SiC	pl	fi	a	wedge structure, finely cross bedded, very common fine lamina of 2.5YR3/1, few very fine roots-hairlets, moist
	417-430	13	3Ob	2.5Y2.5/1	OSiC	strat	fi	c	40% fine to medium well decayed and partially decayed plant fragments, matted roots, stems, few very fine shell fragments, moist
	430-565	135	3C1	2.5Y3/1	fSL	mass	slfi	a	occasional fine organic fragments and matted partially decayed organic fragments, moist
ESTUARY	565-580	15	3C2	2.5Y2.5/1	C	strat	fi	na	finely laminated, slightly micaceous

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

BAY-029

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
FILL	0-140	150	Ap1-FILL-1	10YR3/2	GSL	dist	slfi-fri	a	common (20%) angular to subangular heterolithic gravels and few fine cinders
	140-225	85	Ap1-FILL-2	10YR6/3	fS	mass	fri	a	well sorted, few fine roots
BURIED SURFACE	225-243	18	2Ab	10YR2/2	OSiL	strat	fri	a	40% matted fine roots, faint chemical smell
BEACH-SHORELINE	243-310	67	2C1	10YR4/2	S	mass	fri	a	3% fine to medium roots, well sorted, very few fine shell fragments
	310-405	95	2C2	5YR3/1	LcS	mass	fri	a	5% well rounded granules to very fine pebbles, few fine roots, few large shell fragments (oyster) at base, moist
NEARSHORE ESTUARY	405-415	10	3C1	5YR4/2	C	mass	st	a	few medium well rounded pebbles
	415-430	15	3C2	5YR3/1 to 5YR4/3	C	strat	vfi	a	very finely laminated, moist
	430-545	115	4C1	7.5YR3/1	SL	mass	slst	a	5% well rounded granules to very fine pebbles, few fine shell fragments, saturated
	545-580	35	4C2	10YR3/1	SiC	strat	vfi	na	very finely laminated, moist

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

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

BAY-030

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
FILL	0-205	205	Ap1-FILL-1	10YR3/2	GSL	dist	fri	a	common (20%) fine to medium angular heterolithic gravels with cinders
	205-265	60	2C1	10YR7/3	FS	mass	fri	a	well sorted to medium sand with depth
	265-272	7	2C2	10YR3/1	S	mass	fri	a	1% granules to very fine pebbles, very few fine shell fragments
	272-410	138	2C3	10YR5/4	GS-GSL	strat	fri	c	alternating 20 cm thick beds of sand become coarser and more poorly sorted with depth, gravel content increases to 15% with depth of small subrounded to well rounded pebbles, colors grade to 10YR3/1 to 5YR4/2, few shell fragments with depth, slightly moist
	410-555	145	2C4	5YR3/1	GSL	mass	fri	c	5% fine well to subrounded pebbles, well sorted, saturated
BEACH SANDS	555-570	15	2C5	5YR4/1	Si	pl	fi	a	wedge structure, lamina of 5YR3/1, few fine to medium partially decayed plant fragments and stems, saturated
NEARSHORE ESTUARY	570-580	10	3C	2.5Y3/1	C	strat	st-vfi	na	common (20%) partially decayed plant fragments that decrease in concentration with depth, micaceous

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

BAY-031

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
	0-12	12	Ap	10YR3/3	GSL	dist	sl-l	c	mottles of 10YR4/2 sand, common (20%) medium to fine angular gravels and few fine brick fragments
FILL	12-145	133	FILL	10YR4/3	GLFS	dist	slfi	undet.	many (30%) micaceous schist, granite, medium sized angular gravels with a few concrete and fine brick fragments, common sand sized platy mica flecks throught, undetermined lower boundary because at contact between cores A & B
	145-190	45	2C1	10YR5/1	FS	mass-fstrat	slfi	c	few fine to medium faint 10YR6/6 oxidation streaks, very few medium to fine root fragments, possibly intrusive, near top of the horizon **(collected)**, moderately micaceous
SHORELINE/ ESTUARY	190-210	20	2C2	10YR5/2	S-FS	mass	fri	a	micaceous
	210-235	25	2C3	10YR4/1	S	mass	fri	a	medium to fine sand, micaceous
LACUSTRINE FAN?	235-520	285	3C	7.5YR4/2 to 7.5YR3/1	Lm-cS to GLcS	mass	slfi	c	medium to coarse well sorted sands with common (10-20%) fine to medium heterolithic subrounded pebbles (red mudstone, quartzite) and few to common (3%) very fine shell fragments, becomes saturated with depth
	520-540	20	4C1	7.5YR3/2	Si to VFS	strat	slfi	a	very finely laminated with 1 mm thick 7.5YR3/1 organic silts every 5 mm, moist
GLACIAL LAKE	540-580	40	4C2	10YR3/1	C to SiC	strat	fi	na	common 10YR2/2 organic lenses of partially decayed plant fragments, finely stratified, moist

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

BAY-R-001

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
FILL	0-7	7	ACp	7.5YR3/2	GSL	dist	fri	a	many (60%) angular fine to medium gravels
TILL	7-65	58	C1	2.5YR3/4	GSiL	pl to fgr	fri	g	common (20%) angular to subangular gravels
	65-135	70	C2	5YR4/2	SCL	mass	fi	c	common faint 7.5YR6/2 mottles
	135-485	350	C3	2.5YR3/2	GSiC	mass	vfi	c	common (10-20%) fine angular heterolithic gravels
TILL & WATER TABLE	485-610	125	C4	5YR4/2	GSCL	mass	fi	na	saturated, common (20%) 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

BAY-R-002

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
	0-7	7	FILL-1/Ap1	10YR3/3	SL	dist-1gr	fri	a	common fine roots
	7-60	53	FILL-2/Ap2	10YR2/2	fSL	2mgr	fri	a	common (5%) fine angular to subangular pebbles, few medium to fine roots, few medium faint 7.5YR4/3 mottles, few very fine brick fragments
	60-105	45	FILL-3/Ap3	10YR3/1	L	1fgr	fri	g	common (10%) fine to medium angular gravels, few medium roots, faint to distinct medium 5YR4/2 mottles that increase in prominence with depth
FILL	105-140	35	FILL-4/Ap4	7.5YR4/3	FS to SCL	mass	fri	a	common (10%) fine gravels, poorly sorted, common distinct 7.5YR6/2 fine sand mottles, 1 small clear flat glass fragment towards base
TILL	140-250	110	2C1	2.5YR4/3	GSCL-SiL	mass	fi	g	common (10-20%) angular fine to medium heterolithic gravels
TILL & WATER TABLE	250-600	350	2C2	2.5YR4/3	GSCL	mass	fi	na	common (10) very fine to medium angular gravels, common (20%) prominent 7.5YR5/1 mottles, becomes saturated at ~550 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; st = sticky; ss = strongly sticky
Boundary Distinctness: a = abrupt; c = clear; d = diffuse; g = gradual; s = sharp
Bondary Topography: w = wavy; s = smooth; a = abrupt

BAY-R-003

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
FILL	0-25	25	FILL-1/Ap1	10YR2/2	GLS	dist	l	a	many (40%) angular small to medium fill gravels, few slag fragments, few fine roots
DIST. SOIL	25-70	45	Apb2	10YR3/2	GFSL	2fpl	slfi	a	common (20%) small to medium angular gravels, common distinct medium to fine 10YR3/2 mottles, very few very fine roots, very few very fine brick fragments
	70-105	35	2C1	10YR4/1	SL	strat	slfi	c	slightly micaceous, medium sands
	105-122	17	2C2	10YR5/3	LS-S	strat	fri	a	common micaceous fine sand grains
POSS. ESTU., BEACH DEPOSITS	122-150	28	3C1	5YR4/3	LS-S	strat	slfi	undet	common micaceous fine sand grains, undetermined lower boundary because at break between A & B cores
TILL	150-225	75	4C1	2.5YR4/3	SiCL-SiC	mass	fi	a	few soft angular red sandstone-mudstone gravels, very slightly micaceous
TILL & WATER TABLE	225-270	45	4C2	2.5YR3/3	GSiC-C	mass	vfi-st	a	saturated, 20% fine angular to subangular pebbles, slightly micaceous, perched water table
TILL	270-580	310	4C3	2.5YR3/2	GsSi-CL	mass	fi	na	common (10%) fine to medium angular to subangular poorly sorted heterolithic gravels, moist becoming dry with depth

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

Boundary Distinctness: a = abrupt; c = clear; d = diffuse; g = gradual; s = sharp
Bondary Topography: w = wavy; s = smooth; a = abrupt

BAY-R-004

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
DISTURBED SURFACE	0-20	20	Ap	5YR3/3	L	dist	fri	a	few fine plant fragments, weakly humic
TILL	20-270	250	C1	5YR5/3	GSL	mass	fi	a	common (15%) poorly sorted angular to subangular fine to medium heterolithic gravels of red mudstone, gray diabase, and few well rounded quartzite, non-micaceous
TILL & WATER TABLE	270-415	145	C2	5YR5/4	GLS	mass	fri	c	common (5%) fine angular to subangular heterolithic gravels, non-micaceous, becoming moist to saturated with depth
TILL	415-435	20	C3	5YR4/3	SiL w/VFS	strat	slfi	na	few (3-5%) fine to subrounded pebbles, moist

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

Boundary Distinctness: a = abrupt; c = clear; d = diffuse; g = gradual; s = sharp
Bondary Topography: w = wavy; s = smooth; a = abrupt

BAY-R-005

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
DISTURBED SURFACE	0-30	30	Ap	7.5YR2.5/3	GSL	dist	l	a	many (30%) fine to medium subrounded pebble fill of mica schist, gritty
	30-90	60	C1	2.5YR4/3	S-SL	mass	fri	a	few (3-5%) small gravels, few very fine roots
	90-125	35	C2	2.5YR4/3	Si	mass	fi	a	
	125-165	40	C3	2.5YR4/4	GSL	mass	slfri	c	many (20-30%) fine to medium flaggy red mudstone, gneiss, and gray diabase (heterolithic)
TILL	165-290	125	C4	2.5Y4/4	GL-GSiL	mass	fi	na	common (20%) fine to medium subangular flaggy to subrounded heterolithic gravels, slightly moist, common prominent 2.5YR5/3 mottles

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

Boundary Distinctness: a = abrupt; c = clear; d = diffuse; g = gradual; s = sharp
Bondary Topography: w = wavy; s = smooth; a = abrupt

JC-006

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
FILL	0-16	16	Ap1	10YR2/2	SL	1gr	fri	c	common undecayed and partially decayed organic plant fragments
	16-145	129	FILL-1/Ap2	10YR3/1	GSCL	dis	slfi	a	common (20%) angular to subangular mediun to fine gravels and occasional glass, shell and brick frags, very few fine root fragments, micaceous
HISTORIC/ RECENT ALLUVIAL-NATURAL DEPOSITS; MORRIS CANAL?	145-156	11	2C1	7.5YR3/2	GLS	mass	fri	a	common (10%) fine well rounded quartzite pebbles, few partiallly decayed organic fragments, moist, micaceous
	156-165	9	2C2	7.5YR4/3	Lm-cS	strat	slfi	a	micaceous, moist
	165-175	10	2C3	GLEY 1 4/N	VFS-cS	mass	slfi	a	micaceous, moist
	175-195	20	2C4	GLEY 1 3/N	C	mass to 2fpl	st	a	becomes very finely bedded with depth with very fine sands on parting surfaces, moist, micaceous
BURIED HISTORIC SURFACE? MORRIS CANAL?	195-230	35	3Apb	10YR2/1	fSCL	mass to gr	slfi	a	common (10%) fine shattered shell fragments thorughout, few to common (5%) fine root fragments, dry, one whiteware sherd at 215 cm, micaceous
INTACT SUBSOIL	230-275	45	3Bw	2.5Y5/2	SCL	1fsbk	fi	g	common distinct 2.5YR4/1 mottles along vertical axis (organic stains?), matrix becomes 2.5YR5/3 with depth, very slightly moist
	275-315	40	3BC	2.5Y6/2	Si	mass to 1pl	vfi	a	few distinct 10YR5/8 FFM redox mottles, dry
TILL	315-580	265	3C	5YR4/3	GSiL	mass	vfi	na	common (20%) medium to fine heterolithic gravels, becomes moist with depth

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

Boundary Distinctness: a = abrupt; c = clear; d = diffuse; g = gradual; s = sharp
Bondary Topography: w = wavy; s = smooth; a = abrupt

JC-007

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
	0-35	35	Ap	10YR3/2	GLS	dist	l	a	common (20%) fine to meedium well rounded gravels, angular cinders and concrete
FILL	35-165	130	FILL	10YR6/2	m-cS	strat	fri	g	common 10YR3/4 SL lenses 2 cm thick every 10 cm, quartizitic and micaceous sands
HISTORIC/ RECENT ALLUVIAL-NATURAL DEPOSITS; MORRIS CANAL?	165-215	50	2C	10YR3/1	SL to VLS-cSi	mass to 1fpl	fi	a	saturated, micaceous
BURIED HISTORIC SURFACE? MORRIS CANAL?	215-240	25	3Apb	10YR3/1	SCL	dist-gr	fri	a	common (30%) 10YR2.5/1 mottles and soft masses, common (5%) very fine shell fragments, few (2%) very fine rounded pebbles, very moist
INTACT SUBSOIL	240-260	20	3BC	7.5YR4/3	SCL	mass	fi	a	few to common (5%) fine angular gravels, dry, few dark organic 2.5Y4/1 mottles towards the top that decreases with depth
TILL	260-580	320	3C	2.5YR4/3	GSiL	mass	fi	na	common (20%) angular to subangular medium to fine heterolithic gravels, becoming moist below 435 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; st = sticky; ss = strongly sticky

Boundary Distinctness: a = abrupt; c = clear; d = diffuse; g = gradual; s = sharp
Bondary Topography: w = wavy; s = smooth; a = abrupt

JC-026

Unit	Depth (cm)	Thickness (cm)	Soil Horizon	Munsell Color	Texture	Structure	Consistence	Boundary	Comments
	0-66	66	FILL-1/Ap1	7.5YR2/2	GSL	dist	l	a	common (20%) heterolithic medium to fine gravels with fine cinders and concrete, few fine roots and wood fragments, hand dug
	66-250	184	FILL-2/Ap2	10YR2/1	GS	strat-dist	l	a	fining upward common granule to fine pebble sized cinders and occasional medium gravel, dry
	250-290	30	FILL-3/Ap3	5YR4/3	GS	strat-dist	fri	a	common (10%) very fine gravels (dominated by quartzite) with interbedded 10YR2/1 very fine cinders
FILL	290-515	25	FILL-4/Ap4	10YR2/1	GS	strat-dist	fri	a	coarse to granular sized cinders, moist
WOOD	515-535	20	WOOD	7.5YR2.5/1	wood	dist	fi	a	decaying wood fragment, possibly a log or plank, moist
TILL	535-580	45	2C	2.5YR4/3	GSiL	mass	fi	na	common (15%) angular to subangular fine to medium gravels, saturated

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

Boundary Distinctness: a = abrupt; c = clear; d = diffuse; g = gradual; s = sharp
Bondary Topography: w = wavy; s = smooth; a = abrupt

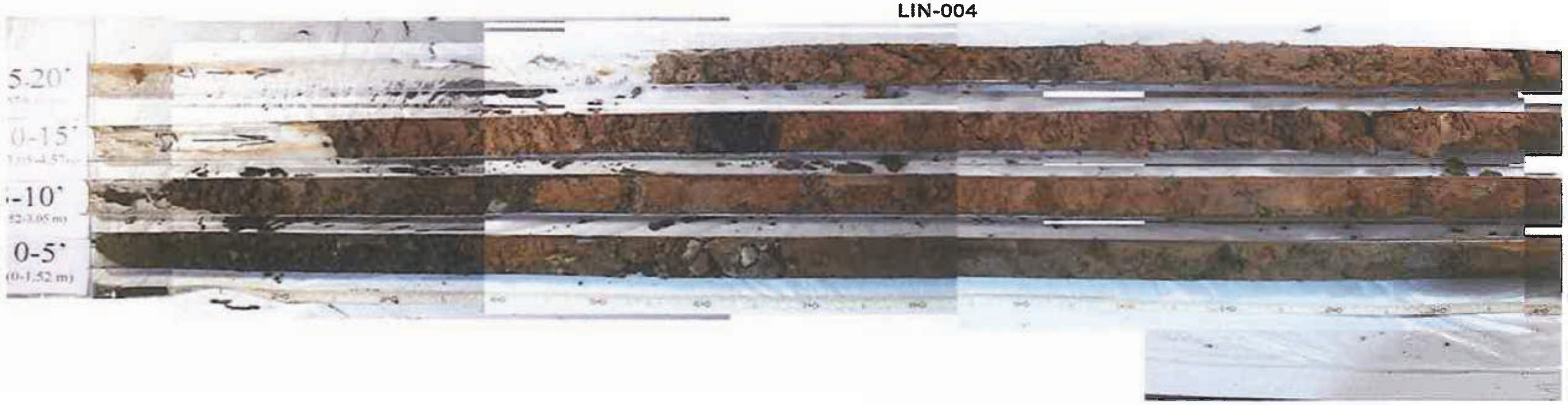
APPENDIX B. CORE PHOTOGRAPHS

B-1. LIN-003

LIN-003

B-2. LIN-004

LIN-004



B-3. SI-002

B-4. BAY-011

B-5. BAY-012

B-6. BAY-013

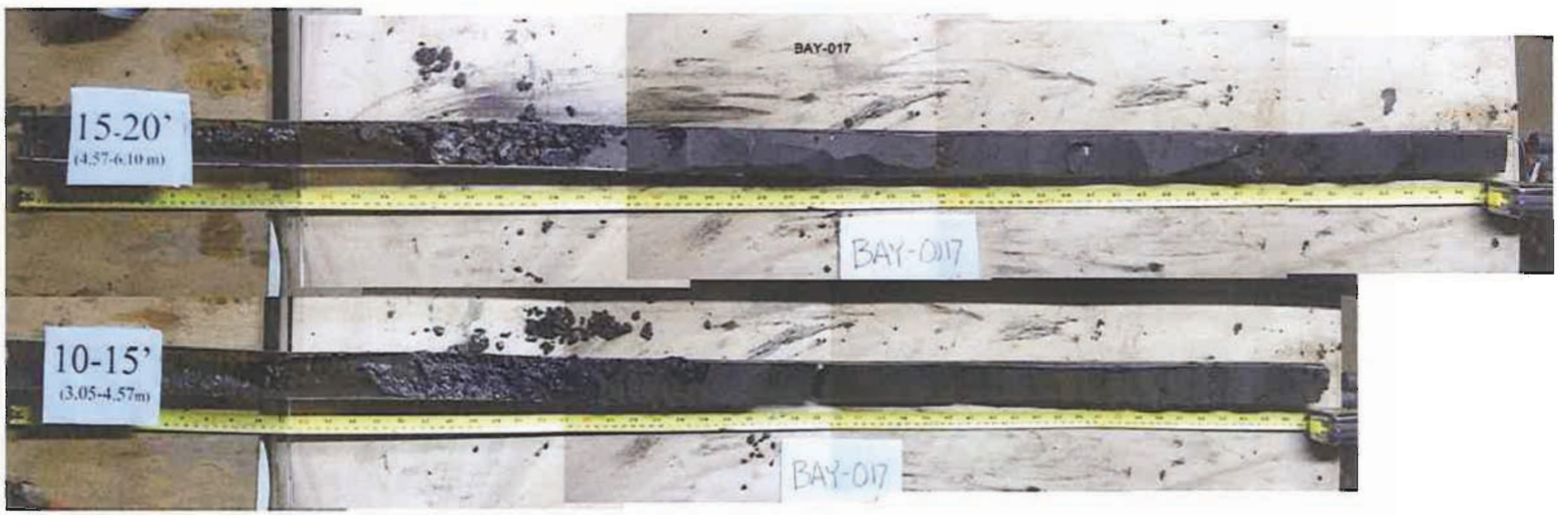
B-7. BAY-014

B-8. BAY-015

B-9. BAY-016

BAY-016

B-10. BAY-017



B-11. BAY-018

B-12. BAY-019

B-13. BAY-020-A

B-14. BAY-021

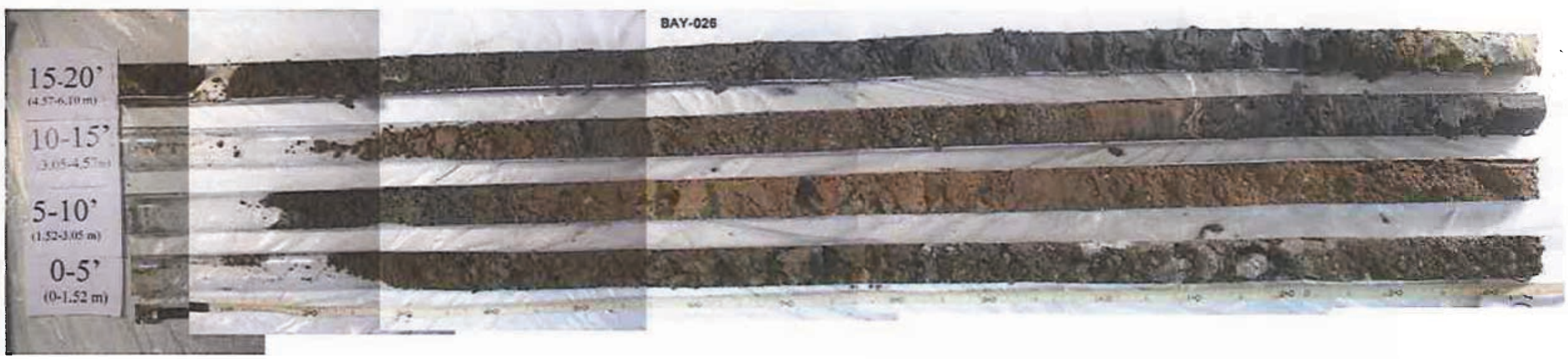
B-15. BAY-022

B-16. BAY-023

B-17. BAY-024

B-18. BAY-025

B-19. BAY-026



B-20. BAY-027

B-21. BAY-028

B-22. BAY-029

B-23. BAY-030

B-24. BAY-031

B-25. BAY-R-001

B-26. BAY-R-002

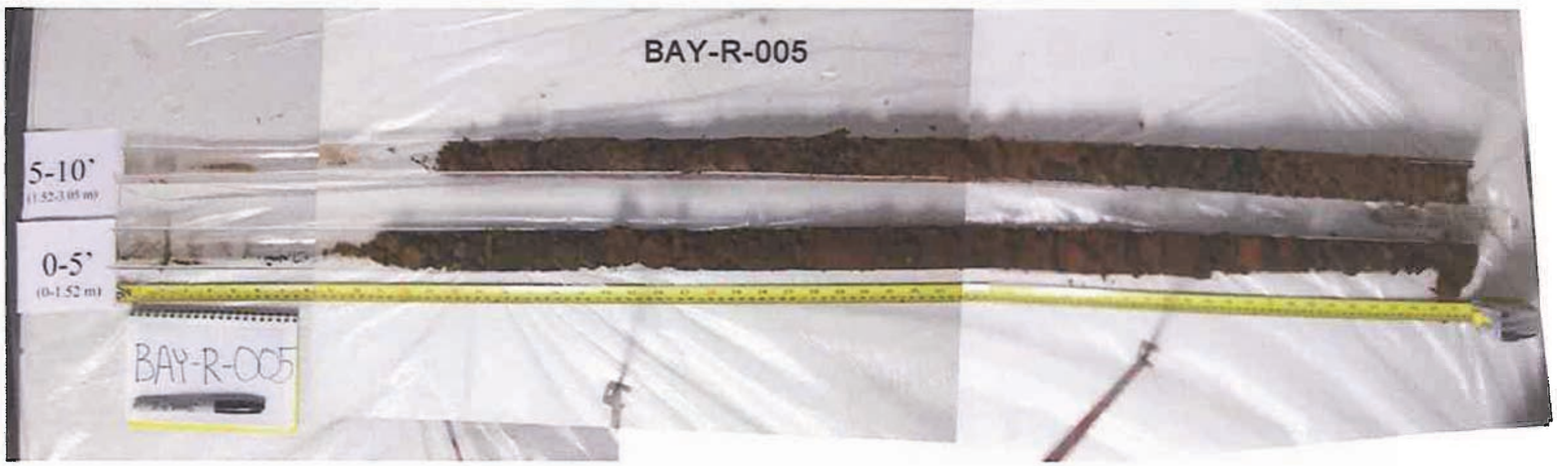

BAY-R-002
15-20'
(4.57-6.10 m)
10-15'
(3.05-4.57m)
5-10'
(1.52-3.05 m)
0-5'
(0-1.52 m)
BAY-R-002

B-27. BAY-R-003

15-20'
(4.57-6.10 m)
10-15'
(3.05-4.57m)
5-10'
(1.52-3.05 m)
0-5'
(0-1.52 m)
BAY-R-003
BAY-R-003

B-28. BAY-R-004

B-29. BAY-R-005



B-30. JC-006

B-31. JC-007

B-32. JC-026

ATTACHMENT B

MUESER RUTLEDGE CONSULTING ENGINEERS – SOIL BORING LOG

MUESER RUTLEDGE CONSULTING ENGINEERS

BORING LOG

PROJECT:	SPECTRA ENERGY GAS PIPELINE - LAND BORINGS
LOCATION:	STATEN ISLAND, NEW YORK
BORING NO.	B-4 (SI)
SHEET 1 OF	7
FILE NO.	11277
SURFACE ELEV.	4.8
RES. ENGR.	ADAM M. DYER

DAILY PROGRESS	SAMPLE NO.	SAMPLE DEPTH	SAMPLE BLOWS/6"	SAMPLE DESCRIPTION	STRATA	DEPTH	CASING BLOWS	REMARKS
11:30							DRILLED	
10-22-10					ASPHALT		AHEAD	
Friday						3	4" 3"	
Sunny	1HA	3.0	HAND	Gray medium sand, trace silt (Fill) (SP-SM)				Hand auger from 3' to
55°F		3.5	AUGER			5		7'.
	2HA	4.0	HAND	Wood (Fill)				1HA: Oily sheen,
		4.5	AUGER					petroleum odor,
	3HA	5.5	HAND	Gray medium to fine sand, some silt, trace	F/S			PID 84.3 ppm.
		6.0	AUGER	wood (Fill) (SM)				(Total volatile organic
	4D	7.0	4-2	Gray fine to medium sand, trace silt, coarse		10		vapors).
		9.0	1-2	sand (Fill) (SP-SM)				Wood from 4' to 4.75'.
								2HA: Wood, PID 315
						13		ppm.
								3HA: PID 110 ppm.
						15		4D: REC=8",
								PID <1 ppm
	5D	16.0	WR/12"	Soft gray organic silty clay, trace vegetation (OH)				Organic odor in wash
		18.0	WH-3					at 13'.
					O/Pt			5D: WC=97, pp<0.25,
						20		REC=24"
	6D	20.0	WH/18"	Soft brown fibric peat (Pt)				6D: WC=324
14:45		22.0	6					Wash changed from
07:45								gray to brown at 20'.
10-25-10						23.5		6D: WC=324, REC=18"
Monday						25		Repeated caving,
Sunny	7D	25.0	5-24	Brown coarse to fine sand, some gravel,	S			sand in wash, added
65°F To 70°F		27.0	31-35	trace silt, red silty clay pockets (SP-SM)				Accu-Vis at 25'.
								7D: REC=9"
						28.5		
						30		
	8D	30.0	11-19	Medium red brown clayey silt, trace gray				8D: WC=27, pp=0.5,
		32.0	9-15	cemented clay pockets (ML)				REC=16"
						35		
	9D	35.0	6-7	Soft red brown clayey silt, trace gray cemented	M			9D: pp=0.25, REC=24"
		37.0	8-10	clay pockets (ML)				
						40		
	10D	40.0	2-2	Soft red brown clayey silt (ML)				10D: pp<0.25, REC=24"
		42.0	3-3					
						43.5		
						45		
	11D	45.0	17-33	Hard red brown clayey silt, trace fine to coarse				11D: pp>4.5, REC=9"
		46.3	100/3"	sand, gravel (ML)				
					T1			
						50		
	12D	50.0	36-61	Red brown clay, fine to coarse sand, some				12D: pp>4.5, REC=13"
		52.0	72-70	gravel (SC)				

MUESER RUTLEDGE CONSULTING ENGINEERS

BORING LOG

BORING NO. B-4 (SI)
SHEET 2 OF 7
FILE NO. 11277
SURFACE ELEV. 4.8
RES. ENGR. ADAM M. DYER

PROJECT: SPECTRA ENERGY GAS PIPELINE - LAND BORINGS
LOCATION: STATEN ISLAND, NEW YORK

DAILY PROGRESS	SAMPLE NO.	SAMPLE DEPTH	SAMPLE BLOWS/6"	SAMPLE DESCRIPTION	STRATA	DEPTH	CASING BLOWS	REMARKS
Cont'd							DRILLED	
10-25-10					T		AHEAD	
Monday						53	3"	Rig chatter at 53'.
Sunny								
65°F To 70°F						55		
	13D	55.0	100/4"	Red brown clayey fine to coarse sand, some				13D: pp>4.5, REC=4"
		55.3		rock fragments (Decomposed Rock) (SC)				
					DR			
						60		
	14D	60.0	12-100/3"	Red brown & gray clayey fine to coarse sand,				14D: pp>4.5, REC=6"
		60.8		some rock fragments (Decomposed Rock)				
14:45				(SC)		63		Hard drilling from 63'
08:15								to 63.5'.
10-26-10	1C	64.0	REC=93%	Intermediate to medium hard slightly weathered		65	4*	
Tuesday		69.0	RQD=44%	red siltstone, jointed to closely jointed,			4*	
Sunny				weathered joints			3*	
60°F To 65°F							3*	
							3*	
	2C	69.0	REC=100%	Medium hard slightly weathered red siltstone,		70	6*	
		74.0	RQD=90%	jointed to blocky, weathered, mineral coated			5*	
				joints			6*	
							4*	
							6*	
	3C	74.0	REC=93%	Do 2C		75	5*	
		79.0	RQD=87%				7*	
							6*	
							7*	
							5*	
	4C	79.0	REC=100%	Medium hard slightly weathered red siltstone,		80	6*	
		84.0	RQD=94%	blocky to moderately jointed, weathered joints			6*	
				& mineral joints			3*	
					R		3*	
							4*	
	5C	84.0	REC=94%	Medium hard slightly weathered red siltstone,		85	5*	
		89.0	RQD=76%	broken to blocky, weathered joints			4*	
							5*	
							4*	
							4*	
	6C	89.0	REC=98%	Medium hard slightly weathered red siltstone,		90	3*	
		94.0	RQD=91%	jointed to blocky, weathered joints			3*	
							3*	
							3*	
							3*	
	7C	94.0	REC=86%	Medium hard to intermediate slightly weathered		95	3*	
		99.0	RQD=32%	to moderately weathered red siltstone,			3*	
				broken to moderately jointed, weathered &			3*	
				mineral coated joints			3*	
							3*	
	8C	99.0	REC=96%	Medium hard slightly weathered red siltstone,		100	3*	
		104.0	RQD=76%	jointed to blocky, weathered & mineral coated			3*	
				joints			2*	

MUESER RUTLEDGE CONSULTING ENGINEERS

BORING LOG

PROJECT:	SPECTRA ENERGY GAS PIPELINE - LAND BORINGS
LOCATION:	STATEN ISLAND, NEW YORK
BORING NO.	B-4 (SI)
SHEET 3 OF	7
FILE NO.	11277
SURFACE ELEV.	4.8
RES. ENGR.	ADAM M. DYER

DAILY PROGRESS	SAMPLE NO.	SAMPLE DEPTH	SAMPLE BLOWS/6"	SAMPLE DESCRIPTION	STRATA	DEPTH	CASING BLOWS	REMARKS
Cont'd 10-26-10 Tuesday Sunny 60°F To 65°F 15:00					R	104	3*	End of Boring at 104'.
						105	3*	WC=Water Content in percent of dry weight.
						110		pp=Pocket Penetrometer Unconfined Compressive Strength in tsf.
						115		
						120		
						125		
						130		
						135		
						140		
						145		
						150		

MUESER RUTLEDGE CONSULTING ENGINEERS

		BORING NO.	B-4 (SI)
		SHEET	7 OF 7
PROJECT	SPECTRA ENERGY GAS PIPELINE - LAND BORINGS	FILE NO.	11277
LOCATION	STATEN ISLAND, NEW YORK	SURFACE ELEV.	4.8
BORING LOCATION	SEE BORING LOCATION PLAN	DATUM	NAD

BORING EQUIPMENT AND METHODS OF STABILIZING BOREHOLE

TYPE OF BORING RIG		TYPE OF FEED DURING CORING		CASING USED		[X] YES		[ ] NO	
TRUCK	DIETRICH 50	MECHANICAL		DIA., IN.	4	DEPTH, FT. FROM	0	TO	34
SKID		HYDRAULIC	X	DIA., IN.	3	DEPTH, FT. FROM	0	TO	64
BARGE		OTHER		DIA., IN.		DEPTH, FT. FROM		TO	
OTHER									

TYPE AND SIZE OF:

D-SAMPLER: 2" O. D. & 1-3/8" I. D. SPLIT SPOON
U-SAMPLER:
S-SAMPLER:
CORE BARREL: NX DOUBLE TUBE
CORE BIT: NX DIAMOND
DRILL RODS: NWJ

DRILLING MUD USED [X] YES [ ] NO
DIAMETER OF ROTARY BIT, IN.: 3-7/8, 2-7/8
TYPE OF DRILLING MUD: ACCU-VIS AFTER 25'

AUGER USED [ ] YES [X] NO
TYPE AND DIAMETER, IN.:

*CASING HAMMER, LBS. 140 AVERAGE FALL, IN. 26 TO 30
*SAMPLER HAMMER, LBS. 140 AVERAGE FALL, IN. 30
*ROPE, 2 WRAPS, 8" C/H, SAFETY

WATER LEVEL OBSERVATIONS IN BOREHOLE

DATE	TIME	DEPTH OF HOLE	DEPTH OF CASING	DEPTH TO WATER	CONDITIONS OF OBSERVATION
10-26-10	08:15	63.5	63 (3")	+2	2' ABOVE GROUND SURFACE, OVERNIGHT.

PIEZOMETER INSTALLED [ ] YES [X] NO SKETCH SHOWN ON

STANDPIPE:	TYPE		ID, IN.		LENGTH, FT.		TOP ELEV.	
INTAKE ELEMENT:	TYPE		OD, IN.		LENGTH, FT.		TIP ELEV.	
FILTER:	MATERIAL		OD, IN.		LENGTH, FT.		BOT. ELEV.	

PAY QUANTITIES

3.5" DIA. DRY SAMPLE BORING	LIN. FT.	57	NO. OF 3" SHELBY TUBE SAMPLES	
3.5" DIA. U-SAMPLE BORING	LIN. FT.		NO. OF 3" UNDISTURBED SAMPLES	
CORE DRILLING IN ROCK	LIN. FT.	40	OTHER: HAND AUGER	7'

BORING CONTRACTOR: WARREN GEORGE INC.
DRILLER: ALLEN DEPUE/CESAR MOREIRA HELPERS: OSCAR VAZQUEZ
REMARKS: BOREHOLE TREMIE GROUTED UPON COMPLETION.
RESIDENT ENGINEER: ADAM M. DYER DATE: 10-27-10
CLASSIFICATION CHECK: CHERYL J. MOSS TYPING CHECK: ADAM M. DYER