Western Rail Yard
INFRASTRUCTURE PROJECT

Appendix J1 Geotechnical Report – Platform

RELATED OXFORD
HUDSON YARDS

GEOTECHNICAL REPORT

HUDSON YARDS - WRY
PLATFORM & ASSOCIATED PROJECTS

Document No.:
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1 Introduction

This report presents the results of our geotechnical engineering study and provides recommendations for the design and construction of buildings and structure within the platform area of the West Rail Yard of Hudson Yards. All services were performed in general accordance with our proposal of 27 January 2017. Environmental conditions at the site will be discussed under separate cover.

Our understanding of the project is based on our review of the project documents, discussions with the design team, and our experience throughout Hudson Yards and the surrounding area. Architectural information was provided by the project architect (Kohn Pederson Fox Associates, PC – KPF), and structural information was provided by the project structural engineer (Mueser Rutledge Consulting Engineers – MRCE).

All elevations are referenced to the North American Vertical Datum of 1988 (NAVD88). Typical datum conversions are presented in Table 1. Note: The historical drawings and data referenced in this report utilize multiple datum planes; caution should be exercised in comparing this information.

Table 1: Typical Elevation Conversions from NAVD88

Datum	Conversion
National Geodetic Vertical Datum of 1929 (NGVD29)	NAVD88 + 1.076 ft
Borough President of Manhattan Datum (BPMD)	NAVD88 - 1.676 ft
Pennsylvania Railroad Tunnel Datum (PENN)	NAVD88 + 298.351 ft
New York City Transit Datum (NYCT)	NAVD88 + 98.423 ft

2 Site Description

The project is on the Far West Side of Manhattan within the western half of the Metropolitan Transportation Authority (MTA) – Long Island Rail Road (LIRR) West Side Yards. The West Rail Yard (WRY) site is divided into “platform” (Block 676, Lot 5) and “terra firma” (Block 676, Lot 1) parcels. This report focuses solely on the platform site. The platform site measures about 423,000 square feet and is bound by West 33rd Street on the north, the terra firma parcel on the south, the Eleventh Avenue viaduct on the east, and Twelfth Avenue (New York State Rout 9A/Westside Highway) on the west. The site location is shown in Figure 1.

The majority of the platform site is occupied by 30 east-west oriented railroad tracks that are separated by concrete walkways of varying width. An access road runs along the west and south site perimeters. Numerous structures are located within and adjacent to the site as discussed herein.

Surface grades within the site are relatively flat, from about el 7 ft to el 10 ft. However, grades on the streets fronting the site vary considerably and generally slope down to the west and south. The highest elevation is on the Eleventh Avenue viaduct east of the site. Eleventh Avenue crowns at about el 34 ft in the vicinity of the former West 32nd Street right of way; the street slopes down to about el 33 ft at the intersection with West 33rd Street at the north and down to about el 18 ft at the intersection with West 30th Street at the south. West 33rd Street slopes down from a high point of about el 33 ft at the intersection with Eleventh Avenue on the east to about el 6.0 ft at the intersection with Twelfth Avenue on the west. Twelfth Avenue is relatively flat varying from about el 5.5 ft to el 6.5 ft in the area of the site.

3 EXISTING STRUCTURES AND UTILITIES

The following sections briefly describe existing structures in the area of the platform site. The approximate locations of the existing structures are shown in Figure 2.

3.1 WRY Track Support

The tracks within the WRY are either: 1) directly fixed to reinforced concrete slabs (Tracks 4 through 30) or 2) spiked to wooden ties supported by ballast (Tracks 1 through 3). Ballasted track sections are comprised of an approximately 10-inch thick reinforced concrete subslab cast atop the soil subgrade, with stone ballast placed atop the subslab. Reinforced concrete slab sections are comprised of about 22 inches of subbase fill placed atop the soil subgrade that are capped by about 4 inches pf bituminous stabilized course and the reinforced concrete track slab that is about 13- to 14-inches thick.

3.2 LIRR Support Structures

There are three 2-story masonry buildings on the west side of the site, at the end of the tracks. These buildings serve as administrative and maintenance facilities for the rail yard and are referred to as the "Yard Operations", "Extraordinary Interior Cleaning (EIC) Storage" and "Transportation" buildings. These buildings are supported on spread footings bearing in soil, and will be demolished and reconstructed as part of the platform project.

3.3 Extraordinary Interior Cleaning (EIC) Platform

An 8.5-foot wide raised platform, referred to as the EIC platform, is present between tracks 27 and 28 and connects to the EIC building. The EIC platform is used to access trains for cleaning and maintenance and is covered by a canopy. The platform is supported on spread footings bearing in soil. The top of the platform varies from about el 12 ft to el 14.5 ft; the top of the canopy varies from about el 25 ft to el 26.5 ft.

3.4 Highline (City of New York)

The Highline Park elevated rail line is on the west end of the platform site parallel to Twelfth Avenue. The Highline is a steel-frame structure that served as a freight rail line and was recently converted into a public park. The structure is generally supported by timber piles with reinforced concrete pile caps in the vicinity of the platform; concrete piers bearing on rock support the structure adjacent to the Amtrak North River Tunnels. The top of the foundations are at about el 3.5 ft to el 5 ft.

The Highline is about 20 feet above grade on the west end of the platform site and will be incorporated into the proposed redevelopment. The Highline is to remain and be protected during construction. Design and construction near the Highline will be subject to review by the New York State Historic Preservation Office (SHPO) and NYC Parks/Friends of the Highline.

3.5 West 33rd Street Retaining Wall and Viaduct

The West 33rd Street right of way boarders the north property line of the platform site. The street transitions from an on-grade roadway about 64 feet east of Twelfth Avenue and is then supported by a stone masonry retaining wall that extends about 465 feet east. The roadway then transitions into a viaduct that connects to the Eleventh Avenue viaduct. The westernmost 50 feet of the retaining wall is supported by a concrete strip footing; the remainder of the retaining wall is supported by timber piles with concrete pile caps. A concrete abutment wall is present at the east end of the retaining wall and supports steel framing for the viaduct portion of the roadway. Surface grades atop the retaining wall vary from about el 8.4 ft to el 24.6 ft. An approximately 8-foot tall concrete parapet (security wall) is located atop the retaining wall. The security wall continues west of the retaining wall to the Twelfth Avenue property line.

The eastern portion of West 33rd Street is anticipated to be reconstructed to accommodate grade changes necessary for entry into the site. Generally, the West 33rd Street retaining walls are anticipated to remain and be protected during construction.

3.6 Eleventh Avenue Viaduct

The Eleventh Avenue viaduct borders the east side of the WRY. The viaduct generally consists of a steel-frame structure with a reinforced concrete deck with an earthen fill abutment at the south end. The viaduct was reconstructed during development of the West Side Yards in the 1980s. The south abutment was repaired; however, the foundation support of the abutment is unknown. Foundations supporting the viaduct within the yards include:

- Southern piers (Piers 1 through 3) are supported by steel pipe piles extending to bedrock with a concrete pile cap. The drawings show both vertical piles and piles battered to the north and south.
- Central piers (Piers 4 and 5) are adjacent to the North River Tunnels. These piers are supported by concrete caissons cored into bedrock to about el -43.5 ft (the approximate invert of the Amtrak North River tunnels).
- Northern piers (Piers 6 and 7) are supported by footings bearing on rock.

The viaduct will remain and must be protected during construction.

3.7 Twelfth Avenue

Twelfth Avenue (New York State Route 9A/Westside Highway) borders the site on the west at elevations similar to the rail yard. In the vicinity of the site, Twelfth Avenue is an eight-lane, divided highway. A concrete security wall runs the length of the site perimeter along Twelfth Avenue.

3.8 Amtrak North River Tunnels

The Amtrak North River Tunnels (NRTs) run east-west below the WRY, roughly coincident with the former West 32nd Street right of way. The tunnels were constructed by the Pennsylvania Railroad in the early 1900s to provide rail access to Manhattan via Penn Station.

West of Eleventh Avenue, the tunnels are comprised of 23-foot diameter segmental cast iron liners with an interior concrete lining. The tunnel inverts vary from about el -46.2 ft at the property boundary on Eleventh Avenue to about el -61.6 ft at the property boundary on Twelfth Avenue. The corresponding tunnel crown elevations vary from about el -23.2 ft to el -38.6 ft, respectively. The NRTs are fully in rock to about 360 feet west of Eleventh Avenue and transition to fully soil supported at a distance of about 500 feet west of Eleventh Avenue. The approximate extents of the NRTs are shown in Figure 2.

The NRTs will remain and must be protected during construction. Construction within 200 feet of the NRTs requires Amtrak's approval to obtain NYC DOB permits.

3.9 Amtrak North Access Tunnel (Empire Line)

The Amtrak North Access Tunnel (NAT), also known as the "Empire Line," passes beneath the northeast corner of the site near the intersection of West 33rd Street and Eleventh Avenue. The tunnel was constructed in the 1980s by Amtrak to provide rail access through the Westside of Manhattan to points north. The tunnel runs west-northwest below the ERY before heading north in a sweeping arc below the Eleventh Avenue viaduct, and continues to the northeast beneath the Jacob Javits Truck Marshaling Yard. The NAT is just below the railyard surface and crosses above the North River tunnels at about Eleventh Avenue. The tunnel invert is at about el -14.3 ft within the site and the crown is located at about el 7.2 ft (about 3 foot below existing surface grade).

The tunnel is a rectangular-shaped, reinforced-concrete structure built using cut and cover construction. The tunnel is partially embedded in soil and partially embedded in bedrock. The tunnel is relatively shallow, with the deepest point located beneath the ERY; ground cover decreases to the north and the tunnel daylights into a U-shaped, reinforced concrete portal north of West 34th Street. A vent/emergency

egress enclosure for the tunnel is beneath the West 33rd Street viaduct (under West 33rd Street, just west of Eleventh Avenue). The approximate locations of the tunnel and vent building are shown in Figure 2.

The NAT will remain and be must protected during construction. Construction within 200 feet of the NAT requires Amtrak's approval to obtain NYC DOB permits.

3.10 MTA No. 7 Line Extension

The MTA No. 7 Line Extension runs beneath Eleventh Avenue adjacent to the site. The No. 7 Line includes a station cavern (34th Street Station cavern), a ventilation tunnel (T1A), an interlocking tunnel section (south interlocking), and two running tunnels (CC1 and CC2) in the area of the site. The tunnels slope up from south to north at an inclination of about 0.5 percent. The 34th Street station cavern runs from about 70 feet south of West 33rd Street to about West 36th Street; the invert of the cavern is at about el -104.3 feet and the crown of the cavern is at about el -51 ft (about 58 feet below surface) adjacent to the site. The T1A ventilation tunnel is located off the east side of the station cavern's south end, turns north and connects to the Site J vent building north of West 33rd Street. The south interlocking section extends about 150 feet south of the 34th Street station cavern with an invert of about el -105.1 ft and the crown at about el -73.4 ft. The No. 7 Line transitions into two running tunnels about 220 feet south of West 33rd Street; inverts elevations adjacent to the site vary from about el -104.8 ft to el -106.4 ft and crown elevations vary from about el -82.5 ft to el -84.1 ft. The No. 7 Line is located about 16 to 17 feet east of the east property boundary of the WRY.

The station cavern and interlocking sections were excavated by a combination of tunnel boring machine (TBM) bores and controlled blasting. The running tunnels were bored by TBM and the T1A was excavated using controlled blasting.

The MTA No. 7 Line will remain and be must protected during construction. Construction within 200 feet of the No. 7 Line requires MTA Capital Construction/NYCT approval to obtain NYC DOB permits.

3.11 Utilities

A large number of documented and undocumented utilities exist within and adjacent to the site. Many of the utilities will likely require relocation to accommodate construction of the platform foundations. LIRR will likely require hand digging or vacuum excavation to determine the exact location of existing utilities to remain.

4 Adjacent Construction Activity

4.1 East Rail Yard Development

The East Rail Yard (ERY) Redevelopment project is currently under construction. The ERY construction includes completion of the platform over the rail yard, landscaped outdoor spaces, several commercial and residential towers, a retail podium, and a cultural building referred to as the Culture Shed.

4.2 Amtrak Gateway Tunnel

Amtrak has proposed a new multi-track rail tunnel as part of its Gateway project. The new tunnel will extend from Penn Station to New Jersey. The tunnel's alignment runs northeast-southwest beneath Hudson Yards. The first two segments of the tunnel were constructed beneath the ERY between the "Terminal West" area of Penn Station and the west side of Eleventh Avenue. The third segment of the tunnel is proposed to run from Eleventh Avenue to West 30th Street, within the terra-firma area of the WRY, and will to be constructed using cut-and-cover construction. Segment 3 is expected to be constructed between 2018 and 2021. Construction within the south end of the WRY will require coordination with that of the anticipated Amtrak construction.

5 Proposed Development

Our understanding of the proposed development is based on discussions with the design team and review of the preliminary design plans.

5.1 Platform

The proposed development includes construction of a platform over the WRY to support five high-rise towers and public space. A brief description of the proposed structures is as follows:

- Site 1: Located in the northwest part of the platform, Site 1 includes Tower 1A (59-stories) and Tower 1B (67-stories), with a connecting podium. The commercial space will occupy the podium level and the towers will contain residential units. LIRR facilities and parking areas will occupy the platform level. The lower level of the platform may be converted to occupied or utility space at sidewalk level.
- Site 2: Located in the northeast part of the platform, Site 2 includes Tower 2 (28-stories) above a podium (18-stories). The commercial space will occupy the podium level and the tower will contain residential units. Retail space, a commercial lobby, a loading lock, parking, and utility areas will the platform level.
- Site 3: Located in the south-central portion of the platform, Site 3 includes Tower 3 (57-stories) above a podium. The residential and retail space will occupy the podium level and the tower will contain residential units. Parking space will occupy the platform level.
- Site 4: Located in the southeast corner of the platform, Site 4 includes Tower 4 (64-stories) above a podium. The residential and retail space will occupy the platform and "lobby" level and the podium level and tower will contain residential units.
- Areas outboard of buildings will include a public plaza with landscaped areas and streets. A platform level will be located below the plaza and will house parking, utility space, and LIRR support facilities; a lawn area will be located on the far west side of the platform level.

The proposed platform is a composite-concrete-deck extending from West 33rd Street to the Terra Firma parcel and between Eleventh and Twelfth Avenues. The top of the platform will be at about el 28.5 ft to el 32.5 ft, and will be supported by columns extending to ground level in the service corridors between tracks. The columns are typically spaced 50 feet on center in the north-south direction and 25 feet on center in the east-west direction beneath the proposed towers, and 100 feet on center in the north-south direction and 25 feet on center in the east-west direction elsewhere. Detailed structural loads were not available as of this the date of this report. Service compression loads on columns are anticipated from about 5,000 to 10,000 kips beneath the towers and 2,000 to 4,000 kips for platform areas without buildings, based on discussions with the MRCE.

Consideration is being given to removing and replacing the tracks segmentally to allow for construction of foundations and tie beams to brace the foundations. Where used, tie beams will need to be constructed below the track slab.

The platform structure will be designed in accordance with the 2014 New York City Building Code (NYCBC).

5.2 LIRR Buildings

The three existing LIRR support buildings (Transportation, EIC, and Yard Operations) are scheduled for demolition and will be reconstructed in their current locations as part of the platform construction. Loads for the LIRR buildings have not been developed as of the time of this report. The LIRR buildings are subject to the requirements of the 2015 New York State Building Code (NYSBC).

6 Site Development History

The site lies outboard of the original Manhattan shoreline and has undergone numerous stages of development. The area was filled during the mid-nineteenth century and early twentieth century, progressively moving the shoreline westward to its current position, west of Twelfth Avenue. The shoreline was extended westward in stages, by placing miscellaneous fill into the river, often directly on soft river deposits of silt and clay. Numerous piers and bulkheads were present in the site footprint as illustrated in Figures 3 through 8. Remnant bulkhead structures and foundations may be present below grade across a large area of the WRY and should be anticipated during construction.

The site predominantly served as rail and storage yards since the mid-1800s.

7 LOCAL GEOLOGY

7.1 Bedrock Geology

The WRY is on Manhattan Island, which is within the southern terminus of the Manhattan Prong of the New England Upland province. Bedrock in the vicinity of the site generally consists of granite, schist, and gneiss. Bedrock is overlain by glacial and fluvial soil, as well as extensive fill. Although altered by urban development, original topography within Manhattan typically mimicked the contours of the underlying bedrock.

According to Baskerville (1994), bedrock stratigraphy in the vicinity of the site is part of the Hartland Formation, with rock of the Lower Cambrian (about 500 to 520 million years ago) to Middle Ordovician (about 461 to 472 million years ago) age and intrusive rock presumably of the Silurian age (about 416 to 444 million years ago), consisting of granite and megacrystalline pegmatite. The geologic map for the site vicinity is included as Figure 9. Generalized descriptions of rocks mapped in the vicinity of the site are:

Hartland Formation – Interbedded units of (1) gray, fine-grained quartz-feldspar granulite containing minor biotite and garnet; (2) fine-to-coarse grained, gray-to-tan weathering, quartz-feldspar-muscovite-biotite-garnet schist (mica schist); (3) dark greenish-black quartz-biotite-hornblende amphibolite. Intrusions of granite and pegmatite are common (Baskerville 1994). Metamorphism has resulted in foliation – a distinct planar alignment of mineral grains – within rocks of the Hartland Formation. This grain alignment is commonly referred to as schistosity in the more platy schistose rock or compositional banding in gneissic rocks. Foliation is typically oriented either northwest or southeast and dips steeply within Manhattan as discussed by Baskerville, but may be altered locally as a result of folding.

Granite and Pegmatite – Gray-white-pink medium- to coarse-grained, biotite-muscovite-microcline-quartz granite and megacrystalline pegmatite in dikes less than 3 feet thick and sills greater than 3 feet thick. Accessory minerals include tourmaline, pyrite, garnet, and epidote. A large sill of intrusive granite is mapped north of the site from West 35th Street to West 40th Street; however, historical boring data indicates that this granite sill extends farther south than mapped. Boundaries between the intrusive granite and Hartland formation rocks are not well-defined as evidenced by intermittent contacts and inclusions observed in rock cores throughout the area including in the West Side Yards and Penn Station.

7.2 Surficial Geology

The Hudson River is west of the site and historically covered the site prior to filling. The Hudson River formed mainly during glaciation about 2.5 million to 12,000 years ago. Southward-advancing ice sheets scoured the Hudson River Valley, deepening an existing river channel and removing surficial sediments and weathered rock. As the glaciers melted, till (a mixture of boulders, gravel, sand, silt and clay) and outwash sands were deposited on top of the scoured bedrock. A subsequent period of erosion removed much of the outwash sands and till from the Hudson River Valley. In the last 10,000 years, fluvial deposits of sand, silt and clay have covered the remaining glacial deposits. A gradual rise in sea level

has resulted in a decrease in the velocity of the Hudson River. Because of this change in velocity, the more recent alluvial deposits consist primarily of silt and clay, while the older alluvial deposits consist primarily of fine sand and silt. The historical shoreline and surface water drainage pathways are shown on Figure 10.

8 FEMA Flood Zone

The Federal Emergency Management Agency (FEMA) Primary Flood Insurance Rate Map (PFIRM), plate 3604970009G, shows the site is within Zone AE. The AE designation corresponds to "Special Flood Hazard Areas" subject to inundation by 1% annual chance flood (i.e. the 100-year flood or base flood). The FEMA base flood elevation varies from el 11 ft to 12 ft within the WRY. An excerpt of the PFIRM is attached as Figure 11.

Any structures located below the base flood elevation must be floodproofed in accordance with the NYCBC, NYS Building Code, ASCE 24, and all other agencies having jurisdiction. At a minimum, 1 foot of free board must be provided above the controlling base flood elevation. We understand that Related has elected to use a design flood elevation of el 15 ft.

We recommend that LIRR be consulted to determine any special flood proofing requirements for the design of their reconstructed buildings.

9 Subsurface Data

Subsurface data for the site was derived from numerous investigations performed within and adjacent to the WRY. This information includes borings and cone penetration testing (CPT) data as well as laboratory testing of soils and rock. The data includes studies performed by Langan and several other entities. The approximate locations of the borings and CPTs are shown in Figure 12. The following sections provide a brief overview of the data included in this study.

9.1 Proposed New York Sports and Convention Center (2004)

A geotechnical subsurface investigation was performed within the WRY for the design of the proposed New York Sports and Convention Center (NYSCC) in 2004. This investigation included 29 geotechnical test borings and 24 cone penetration tests (CPT). A laboratory test program was also performed as part of the project.

9.1.1 Borings

The NYSCC borings (identified as G-#) were drilled within and adjacent to the WRY by Warren George Inc. (WGI), of Jersey City, New Jersey between 11 October and 17 December 2004. The borings on the tracks were performed with two Acker 2D high-rail, truck-mounted drill rigs. Borings outside of the tracks were performed with an Acker 11 truck-mounted drill rig, a CME 55 truck-mounted drill rig, or a DK-50 track-mounted drill rig. The borings were advanced to depths from 52 to 160 feet below grade.

Each boring was cleared of utilities by hand or using standard drilling techniques with minimal water and no down-pressure on the drill string. The borings were advanced through overburden using mud-rotary drilling techniques with tri-cone roller bits and drilling fluid consisting of a mixture of polymer additive and water. Temporary flush-joint steel casing was installed through the soils, as required, to stabilize the boreholes and prevent fluid loss during drilling.

The Standard Penetration Test (SPT)[1] was performed in general accordance with ASTM D1586. SPT N-values[1] and visual soil classifications were recorded by Langan's engineers. Soils were sampled using a

[1] The Standard Penetration Test is a measure of soil density and consistency. The testing involves driving a 2-inch outer-diameter split-spoon sampler a distance of 2 feet, using a 140-lb hammer free falling from a height of 30 inches.

standard 2-inch outer-diameter split-spoon sampler. Undisturbed soil samples were obtained using 3-inch outer-diameter Shelby tubes in general accordance with ASTM D1587. Rock coring was performed in all borings, in accordance with ASTM D2113 using a double-wall core barrel to assist in determining bedrock depth, type, and quality.

Rock core recovery (REC)[2] and rock-quality designation (RQD)[3] for each core run were logged by our inspecting engineers. All recovered soil and rock samples were visually classified in the field. Soil and rock classifications, SPT N-values, and other field observations were recorded on the boring logs included in Appendix A.

9.1.2 Cone Penetration Testing

Cone penetration testing within the WRY included eight standard CPTs (identified as CPT-#) and 16 seismic cone-penetration tests (identified as SCPT-#). All cone-penetration testing was performed in accordance with ASTM D3441 by ConeTec, Inc. of West Berlin, New Jersey between 11 October and 19 November 2004. All of the test locations were pre-drilled to depths of about 10 feet by WGI to clear for utilities. In locations where obstructions were encountered in the fill, WGI returned and drilled to native soils. The CPTs were pushed to refusal, encountered at depths varying from about 22 to 111 feet below grade.

Cone-penetration testing consists of pushing an instrumented stainless steel cone through soil overburden using hydraulic pressure while continuously collecting data. The standard CPT cone measures penetration tip resistance, side friction, and pore water pressure at 5 cm (about 2 inch) intervals. The SCPTs also measure shear-wave velocity; a total of 277 seismic tests were performed at about 1 meter (about 3.3 feet) intervals. The seismic test involves generating vibrations at the ground surface and recording the shear wave's amplitude and travel time with a geophone mounted in the cone. A copy of the ConeTec field report is included in Appendix B.

9.1.3 Laboratory Testing

A laboratory testing program was performed to evaluate the general engineering index properties of select soil samples, as well as strength and compressibility properties of cohesive soils and bedrock as part of the NYSCC project. The laboratory test results are included in Appendix C.

Analyses included:

- Mechanical Grain Size (9 tests) [ASTM D 1140, D 422]
- Natural Water Content (92 tests) [ASTM D 2216]
- Liquid and Plastic (Atterberg) limits (51 tests) [ASTM D 4318]
- Organic Content (35 tests) [ASTM D 2974]
- Unconsolidated Undrained (UU) Triaxial Test (10 tests) [ASTM D 2850]
- Consolidated Undrained (CU) Triaxial Test (2 tests) [ASTM D 4767]
- Unconfined Compressive Strength of Rock (13 tests) [ASTM D 2938]
- Consolidation Test (4 tests) [ASTM D 2435]

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[1] N-value – The number of blows required to drive a 2-inch diameter split-spoon sampler 12 inches after an initial "seating" penetration of 6 inches, using a 140-pound hammer falling freely from a drop height of 30 inches.
[2] Rock core recovery (REC) is defined as the length of all core pieces recovered divided by the total core run length.
[3] Rock Quality Designation (RQD) is defined as the sum of all recovered sound rock core pieces measuring 4-inches or more in length (for type NX, NQ or PQ cores) divided by the total core run length. RQD is a relative indicator of rock quality.

9.2 Borings by Others

Numerous investigations were performed by others within and adjacent to the WRY; these investigations are summarized in Table 2. This information was used to supplement our data from NYSCC. In general, the reported subsurface conditions correlate well with our 2004 study, particularly stratigraphic changes and top of rock elevations. In some instances, the historical data lacks engineering data (e.g. N-value, REC, RQD, etc) and only documents subsurface stratigraphy. Copies of the historical boring data by others are included in Appendix D.

Table 2: Historical Borings by Others

Project	Company	Year
Various Projects	NYC Department of Design and Construction (DDC)	Various
North River Water Pollution Control Project	City of New York Department of Public Works	1968
MTA West Side Storage Yard	Mueser, Rutledge, Johnston, & DeSimone Consulting Engineers	1980-1981
MABSTOA Garage	Mueser, Rutledge, Johnston, & DeSimone Woodward Clyde Consultants	1982
Westway Project	Mueser, Rutledge, Johnston, & DeSimone Woodward Clyde Consultants	1980-1986
Amtrak North Access Tunnel	Parsons Brinckerhoff	1986-1987
Pier 36 Contingency Plan	City of New York Department of General Services	1994
No. 7 Subway	Parsons Brinckerhoff Quade & Douglas, Inc.	2003-2007
Trans-Hudson Expressway (ARC Tunnel)	NJ Transit	2008

10 SUBSURFACE CONDITIONS

The general subsurface stratigraphy at the site consists of uncontrolled fill, underlain by consecutive layers of clay and silt, sand, glacial till, and bedrock. A brief description of each layer is presented below in order of increasing depth. Typical subsurface profiles are attached as Figures 13 through 15.

10.1 Uncontrolled Fill [Class 7][1]

Fill is present beneath the entire site. The fill generally consists of sand with varying amounts of gravel, silt, boulders, brick, wood, and other miscellaneous debris. The thickness of the fill varies from about 10 to 40 feet, generally increasing in depth from east to west. The fill varies significantly with respect to content and density from one location to the next. SPT N-values varied from weight of hammer (WOH) to 100 blows per foot (bpf); however, in many cases the higher recorded N-values were attributed the presence of oversized materials (e.g., cobbles, boulders, timber, and other construction debris) and are generally not considered to be a representative indicator of in situ density. Blow counts generally decrease with depth as the transition into the softer organic clay was approached.

A void was encountered about 6 feet below grade at boring G-52 (LIRR track 14, about 50 feet west of Eleventh Avenue). The void was estimated to be about 5 feet in diameter, and at least 4 feet in height; the cause of the void could not be determined and the zone was grouted closed. Boring G-52 was offset 15 feet east of the original boring and re-drilled.

The fill is categorized as Class 7 (Uncontrolled Fill) in accordance with the NYCBC.

[1] Numbers in brackets indicate classification of soil and rock materials in accordance with the New York City Building Code (2014).

10.2 Organic Clay and Clay and Silt [Classes 6, 4c, 5b]

A stratum of organic clay and clay and silt underlie the fill throughout the site. This stratum is the historical river bottom deposit. The thickness of the silt and clay varied from about 10 to 90 feet, increasing from east to west. The top of the clay and silt layer varies from about el -5 ft to el -35 ft.

10.2.1 Organic Clay

The black-gray organic clay has variable concentrations of silt and trace-amounts of fine sand and organic matter, and varies from zero to 40 feet thick. The organic clay was observed primarily on the west side of the site. The split spoon sampler typically penetrated this stratum under the weight of the drill rods and hammer (WOH).

Unified Soil Classification System (USCS) descriptions for the organic clay layer include CH (highly plastic clay) and OH (organic clay and silt of high plasticity). The organic clay layer is generally categorized as NYCBC Class 6 (Soft Clay).

10.2.2 Silt and Clay

The organic clay was underlain by gray silt and clay with some shells, trace fine sand, and trace concentrations of organics. Interlayered (varved) silt and clay with occasional layers of fine silty sand was encountered in several borings, predominantly in the central and northwest corner of the site. Where encountered, the silty sand layers were typically 1- to 6-inches thick. The thickness of the silt and clay stratum varied from about 10 to 80 feet, increasing in thickness from east to west. N-values in this stratum ranged from WOH to 37 blows per foot. Values in excess of 10 blows per foot are likely attributed to inclusions of debris near the interface with the fill.

USCS descriptions for the silt and clay include CH (high plasticity clay) CL (low plasticity clay), MH (high plasticity silt), and ML (low plasticity silt). The silt and clay layer is generally categorized as NYCBC Class 6 (Soft Clay), Class 4c (Medium Clay) and Class 5b (Medium Silt).

10.3 Sand/Till [Classes 6, 3, 5]

Sand and glacial till was encountered above bedrock at some locations. The thickness of the sand and till varied from zero to 35 feet. The top of the sand/till layer varies from about el -12 ft to el -105 ft.

10.3.1 Sand

Where encountered, the sand was typically comprised of grey fine sand with varying amounts of silt and was up to 30 feet thick. N-values in the sand ranged from 4 to 40 blows per foot.

USCS classifications for the sand include SP (poorly-graded sand) and SM (silty sand). The sand layer is generally categorized as NYCBC Class 6 (Loose Sand) to Class 3a (Dense Sand).

10.3.2 Glacial Till

Where encountered, the glacial till was typically comprised of brown, red, and grey silt with variable concentrations of coarse to fine sand, gravel, clay with frequent cobbles and boulders. The thickness of the till varied from 2 to 11 feet. N-values in the glacial till varied from 22 blows per foot to more than 100 blows per foot. The higher SPT N-values were likely caused by the presence of gravel, cobbles, and boulders. The glacial till appears to be more prevalent on the north side of the site.

USCS classifications for the glacial till include SM (silty sand), SC (clayey sand), GM (silty sandy gravel), and ML (low plasticity silt). The glacial till layer falls within several soil classes per the NYCBC because of the constituent variability with respect to location and depth throughout the site, but is generally NYCBC Class 3a (Dense Sand) to Class 5a (Dense Silt).

10.4 Bedrock [Classes 1a to 1d]

Bedrock was encountered from about el -17 ft to -133 ft; the depth to bedrock generally increases from east to west. A layer of decomposed rock was encountered at the bedrock surface in some locations. Bedrock generally consists of dark gray mica schist, gneissic schist and granulite with intrusions of light gray to pink quartz- and feldspar-rich granite and pegmatite. Granite intrusions were observed to vary from about 1 to 20 feet thick. Rock core recovery varied from 40 to 100 percent. Rock quality designations (RQD) varied from zero to 100 percent.

Bedrock within the site is generally categorized as NYCBC Class 1a (Hard Rock) and 1b (Medium Hard Rock). Zones containing increased weathering and fracturing were observed sporadically near the surface and within the rock mass, and are classified as NYCBC Class 1c (Intermediate Rock). Highly weathered, highly fractured zones were reported in several borings at the surface and were also observed within the rock mass. Clay gouge was often observed in fractures in these more highly fractured zones. The highly weathered, highly fractured zones are categorized as NYCBC Class 1d (Soft/Decomposed Rock).

10.5 Groundwater

Groundwater levels were determined from monitoring wells installed throughout the site. The measured groundwater levels varied from as high as el 3.9 ft to as low as el -1.5 ft, but are generally expected to vary from about el 0 ft to el 2 ft. Groundwater levels are expected to be tidally influenced along the west side of the site because of the proximity to the Hudson River. In addition, groundwater levels are likely to fluctuate with seasonal changes and precipitation events. Zones of perched water may be present at some locations given the heterogeneous nature of the fill soils.

11 Seismic Design Parameters

Seismic design parameters presented herein are in accordance with the 2014 New York City Building Code (NYCBC) and 2015 New York State Building Code (NYSBC).

11.1 Seismic Evaluation

The site was initially evaluated using the general procedures outlined in the 2014 NYCBC and the 2015 NYSBC. Based on the general procedures the site was initially classified as Site Class E, but was assigned to Site Class F based on the potential for liquefaction. Site Class F requires a site-specific seismic study. A site-specific seismic study was subsequently performed to: 1) further evaluate the potential for liquefaction; 2) evaluate the potential excess pore pressure development during seismic events; and 3) to develop appropriate response spectra and determine the corresponding seismic design category for the site.

Site-specific total and effective stress analyses were performed for the six zones defined by the expansion joints shown in Figure 16. These analyses indicate the site's design spectrum falls along the 80 percent of Site Class E envelope (minimum spectrum permitted by code) for Zones 1 through 5. The design spectrum for Zone 6 falls between the general Site Class E envelope and the 80 percent of Site Class E envelope between periods of zero and 1-second, and along the 80 percent of Site Class E envelope at periods greater than 1-second.

We understand the platform is classified as NYCBC Structural Occupancy/Risk Category III. As such, the recommended design spectral accelerations obtained from our response spectra result in Seismic Design Category C in all six zones. Seismic design parameters are presented in Table 3 and Table 4 below. The recommended design response spectra are presented in Figures 17 and 18. The site specific seismic study report is included in Appendix E.

The effective stress analyses suggest that excess pore pressure development is not likely to trigger full liquefaction; however, significant softening may occur in fill soils located below the groundwater table.

The excess pore pressures were estimated to vary from zero to about 50 percent. As such, we recommend that the structure be designed to accommodate reduced bearing and lateral resistance.

Table 3: Seismic Design Parameters (Zones 1 to 5)

Parameter	Design Value
Site Class	E
Spectral Acceleration at short periods, S_{DS}	0.359 g
Spectral Acceleration at 1-sec period, S_{D1}	0.136 g
Risk Category	III
Seismic Design Category, *SDC*	C

Table 4: Seismic Design Parameters (Zone 6)

Parameter	Design Value
Site Class	E
Spectral Acceleration at short periods, S_{DS}	0.409 g
Spectral Acceleration at 1-sec period, S_{D1}	0.136 g
Risk Category	III
Seismic Design Category, *SDC*	C

11.2 Design and Construction Considerations

11.2.1 Platform

The following bullets briefly summarize significant design and construction considerations for the platform.

- The design and construction of the platform is subject to the requirements of the 2014 NYCBC.
- In addition to LIRR, the platform design and construction will be subject to review and approval of Amtrak (North River and North Access Tunnels), MTACC/NYCT (No. 7 Line subway), NYCDOT (Eleventh Avenue and West 33rd Street viaducts), and Friends of the Highline (Highline).
- The site is within the mapped FEMA flood hazard area. The FEMA base flood elevation varies from el 11 ft to el 12 ft. Structures located below design flood level will need to be floodproofed in accordance with the 2014 NYCBC and ASCE 24.
- Groundwater generally varies from about el -1.5 to el 2.0 ft. Temporary dewatering may be necessary for installation of, utilities, pile caps, tie-beams, etc.
- The subsurface conditions within the site are relatively poor and necessitate a deep foundation system. Drilled caissons will be required to support of the platform given the need to large axial and lateral loads.
- The site-specific seismic analyses confirm the platform structure and buildings atop the platform fall in Seismic Design Category C.
- The potential for excess pore pressure development during seismic events will reduce the lateral capacity of caissons in some areas of the site.
- Tie-beams between adjacent caissons are required because the site classifies as seismic design category C. Excavations for tie-beams will likely require removal of track slabs, utility relocations, and support and protection of adjacent structures (e.g. West 33rd Street retaining wall).
- A track isolation casing will likely be required by LIRR to mitigate transferring loads from the caissons into the track slab.
- Caissons located within the theoretic influence lines of tunnels bedded in rock may require bond breakers.

- Means and methods to construct caissons in close proximity of existing tunnels must mitigate potential for soil loss and disturbance. We expect that strict tolerances will be required to ensure that suitable lateral clearances are maintained between the caissons and tunnels.
- A detailed monitoring program is necessary to evaluate the performance of adjacent structures, the ground, and existing tunnels during platform construction. The monitoring program will be subject to review and approval of Amtrak, MTACC/NYCT, LIRR, NYCDOT, and Friends of the Highline.
- Large portions of the rail yard will remain active during platform construction and will require close coordination with LIRR.

11.2.2 LIRR Support Buildings

The following bullets briefly summarize significant design and construction considerations for the LIRR support buildings anticipated for reconstruction under this project.

- Design of the LIRR support buildings are subject to the requirements of the NYSBC.
- Driven piles or caissons (mini-caissons) are considered feasible for support the LIRR support buildings. Shallow foundations are not considered suitable given the potential for seismically induced settlement.
- The design flood elevation for the LIRR support buildings should be as dictated by LIRR. We recommend that LIRR be consulted early in the design process to determine appropriate design flood elevations. Structures located below design flood level will need to be floodproofed in accordance with the NYSBC and ASCE 24.
- Floor slabs and walls of permanent structures below the design flood elevation must be designed to resist hydrostatic pressures.
- Floodproofing should to the design flood elevation in accordance with the NYSBC and ASCE 24.
- Ground anchors may be required where sufficient dead load is not present to accommodate hydrostatic forces from either static groundwater or design flood conditions.
- Groundwater is at shallow depth on the west end of the site; construction dewatering should be anticipated where excavating below el 2 ft.

12 Design Recommendations – Platform

12.1 Drilled Caissons

We recommend that the platform be supported by drilled caissons. Caissons consist of a permanent steel casing drilled through soil to bedrock, with an uncased socket extending into bedrock. The casing and rock socket are filled with steel reinforcing and concrete. Steel reinforcing may consist of rolled steel sections, built-up plate steel shapes, and/or rebar cages; however, we expect that use of rebar cages will be preferable because of the difficulty splicing core beams (time and space requirements). Caissons develop axial load capacity through a combination of peripheral shear resistance between the concrete and rock, and end-bearing on the rock. End-bearing should be neglected for caissons less than 18 inches in diameter. We recommend that the caisson rock sockets be proportioned assuming an allowable peripheral bond stress of 200 pounds per square inch (psi) for compression and 100 psi for uplift. Additionally, we recommend an allowable end-bearing of 40 tons per square foot (tsf). The recommended design values assume rock meeting NYCBC Class 1c or better for rock socket sidewalls and NYCBC Class 1b for rock socket bottoms. All rock sockets must be inspected to verify the quality of the bedrock before installing reinforcing steel and concreting. We recommend that verification be performed through video inspection with a down-the-hole camera or by drilling large diameter cores (minimum 85 mm) at the center axis of the caisson in conjunction with borehole geophysical logging (acoustic and/or optical televiewer).

We understand that caissons varying from 36-inch to 72-inch in diameter are contemplated for support of the platform and buildings, with service loads varying from about 4,000 to 15,000 kips, respectively.

Caissons should be designed to accommodate the combined effects axial loading and bending. Short caissons may be subject to development of plastic hinges when transitioning from soil to rock support. The shear capacity of such elements should be evaluated and where required, additional shear reinforcing should be provided or the casing should be seated further into rock. The effects of excess pore water pressure during seismic loading should be considered when evaluating the lateral capacity of the caissons.

12.1.1 Load Tests

Axial load tests are not required for NYCBC code compliance, but could be used to justify higher peripheral bond stresses and end bearing resistance. Load tests performed on rock within the ERY demonstrated that higher values are possible and can provide time and cost savings by reducing socket bond lengths; however, the rock conditions within the WRY are generally expected to provide a weaker response. The cost versus benefit of performing axial load testing will be evaluated with the design team and ownership.

Lateral load tests will be required for caissons that exceed 1 ton of lateral capacity per the NYCBC. At least two lateral load tests are required for each caisson diameter and lateral capacity to satisfy NYCBC requirements. Given the variable subsurface conditions, load tests should be performed in areas containing the “poorest” conditions unless additional load tests are performed to evaluate each area of differing subsurface conditions throughout the site. Where caissons of the same diameter contain differing quantities of reinforcement or have differing concrete strength, the test caissons should utilize the least amount of reinforcement and lowest compressive strength of concrete to provide a lower bound envelope of the lateral capacity unless additional load tests are performed for each caisson material configuration. Load tests must be performed in accordance with ASTM D3966.

We recommend that the lateral load test caissons be instrumented with inclinometers, strain gages, or a combination thereof to estimate the full-depth deflected shape necessary to back calculate the p-y response. The results of load testing should be used to calibrate soil models used for final design of the caissons with respect to lateral capacity.

We believe that it is possible to perform lateral testing on a single intermediate caisson size to calibrate software soil models. The allowable capacity of the remaining caisson sizes would then be estimated using programs such as Lpile or DFSAP, with an appropriate safety factor. We note that a variance will be required from the Department of Buildings in order to forgo testing multiple diameters. We believe that such a variance is achievable and this approach is prudent given the logistical challenges of the site and cost of such additional testing.

12.1.2 Group Effects

The caissons should have a minimum center-to-center spacing of at least 2.5 diameters to prevent axial group effects. If the minimum center-to-center spacing of caissons is less than 2.5 diameters, analysis must be performed to determine if the axial capacity is governed by the caisson group or individual caissons

Lateral group effects should be considered where caisson center to center spacing is less than six diameters.

12.1.3 Drilling Methods

Caisson installation methods must prevent settlement of material beneath the track slab and minimize vibrations. Drilling of the caissons through overburden can be performed using rotary or auger drilling techniques. Given the potential for borehole collapse within loose silty soils and bottom heave in soft

clays, we recommend that temporary casing and a positive head of water be maintained during drilling. Where required a mineral or polymer slurry should be provided to improve bottom stability. In addition, we recommend the drill stem be kept inside the casing while drilling through overburden soils to minimize the potential for bottom heave or running-sand conditions. The drill stem should be kept inside the casing a minimum of 1 foot until the casing is seated into rock. A concrete plug may be necessary to seal the casing to rock in areas containing steeply sloping or fractured rock.

A down-the-hole hammer will be required to efficiently advance the rock socket. Caissons should be flushed using water or compressed air (or other approved methods) upon completion of drilling rock sockets to remove all debris accumulated on the bottom of the rock socket. Thorough cleaning of the bottom of the rock socket is critical for caissons designed with end-bearing, and proper cleaning must be verified through inspection, as discussed below.

Obstructions, such as remnant foundations or bulkheads, and debris in the historical fill, should be anticipated throughout the site. The Contractors' means and methods should consider the need for penetrating or bypassing such obstructions. Means to bypass the obstructions may include pre-drilling using oversized cased boreholes and then backfilling. We recommend that careful drilling techniques be employed to avoid disturbance of these materials. Pre-drilling activities to clear potential obstructions must be evaluated relative to possible loss of lateral resistance. We recommend that the contractor be precluded from performing pre-drilling in open holes below the groundwater. All pre-drilling areas should be backfilled and compacted with an approved material satisfactory to the geotechnical engineer. Where possible, pre-drilling should be performed by advancing oversized casing with the hole cleaned out and backfilled with Controlled Low Strength Material (CLSM) prior to withdrawal of the casing.

12.1.4 Reinforcing Steel Splices

Deformed bar and threaded bar cages can be spliced using staggered mechanical couplers or conventional lap splices. We recommend that only mechanical couplers capable of developing full capacity of the bars be used for tension elements.

The splice connection between core beams must be capable of achieving the necessary stress and moment transfer at the splice depth. Splices should be milled to bear should utilize either complete joint penetration (CJP) or partial joint penetration (PJP) welds as necessary. Bolted connections may also be considered, but such mechanical connections could inhibit constructability because the splice can require significant area within the caisson section, thus potentially limiting concrete flow or installation of concrete tremie tubes.

12.1.5 Centralizers

All reinforcing steel must be centered within the caisson. Where rebar cages are implemented, centralizers should be spaced no more than 10 feet on center. Steel core beams should be provided with at least one centralizer at the base. The tops of core beams should be aligned at the top of the casing using either a template or by manual wedges.

12.1.6 Concrete Placement

Concrete should be placed as soon as possible following cleaning and within 72 hours of inspecting the rock socket. If placement is delayed the socket must be reinspected. Concrete must be placed using tremie methods, and must be performed in a continuous operation. Concrete must consist of a flowable mixture and must remain workable throughout the anticipated duration of the pour. We recommend the use of self-consolidating concretes.

12.1.7 Foundation Settlement

Caissons settlements will generally be similar to that of elastic shortening. We expect that such movements will be up to about ½-inch based on the caisson configurations currently considered by the project structural engineer.

12.1.8 Minimum Clearances (Amtrak and MTA Tunnel Structures)

Coordination with Amtrak and the MTA will be required to determine the minimum allowable clear distances (lateral and vertical) between caissons and tunnel structures. At this time, we suggest that a minimum lateral clearance of 10 feet (measured at the ground surface) be carried for caissons adjacent to the Amtrak North River tunnels. Closer clearances are possible at the Amtrak North Access tunnel because this structure is at shall depth and can readily be exposed to verify clearances. Lateral clearances to the No. 7 Line subway are not expected to govern as the tunnels fall greater than 10 feet beyond the east property line.

Finite element method analyses will be necessary to demonstrate that the caissons do not negatively impact the existing tunnel structures and justify the vertical location of rock socket bond zones relative to the existing tunnels. At this time, we recommend that that bond zones for caissons adjacent to the North River and North Access tunnels be assumed start below a theoretic influence line starting at the tunnel invert and projecting outward and upward from the tunnel at an inclination of 2V:1H; caissons adjacent to the No. 7 Line should be assumed to have bond zones starting at 3 feet below the top of rock.

The locations and extents of the existing tunnels must be verified in the field by the contractor's licensed surveyor prior to drilling.

12.1.9 Plumbness Monitoring

We recommend that all caissons located less than 25 feet from existing tunnels be monitored during construction to ensure the caissons are installed plumb. Standard construction tolerances dictate that the caissons deviate no more than 2 percent from vertical alignment. Where required, casings should be survey monitored prior to initial penetration to ensure proper vertical alignment. Thereafter, plumbness of the caissons should be measured incrementally during the drilling process using borehole geophysical methods suitable for determining azimuth and inclination (e.g. gyroscopic methods).

12.1.10 Bond Breaker

Bond breakers may be necessary to prevent shedding loads onto the tunnels. The specific requirements for bond breakers should be determined for each governing agency, and should be evaluated based on the actual caisson layout and loading. Bond breakers may not be necessary in areas where caissons bear well above tunnels founded in rock (e.g. No. 7 Line). Justification for eliminating such bond breakers is generally demonstrated through a finite element method analysis.

While several methods are available to provide a bond breaker, we recommend that the specific means and methods be proposed by the Contractor. Conceptually, a bond breaker can be provided by: 1) drilling a temporarily cased oversized borehole to the intended top of rock socket; 2) installing a smaller bituminous coated permanent casing inside the temporary casing; 3) grouting the annulus, and removal of the temporary casing, and; 4) drilling the final rock socket from within the remaining permanent casing. Alternatively, bond breakers can be accomplished by hanging a bituminous coated pipe (isolation casing) within a portion of the rock socket. Often the isolation casing is supported from the reinforcing cage or core beam.

12.1.11 Track Isolation Casing

The LIRR has previously stated that caissons within the tracks must be installed using isolation casings to prevent transferring lateral loads to the adjacent tracks. This requirement should be confirmed with the LIRR. The isolation casing will likely be 6 inches larger in diameter than the permanent casing and will

extend a minimum depth of 4 feet below the top of the caisson. The isolation casings locations should be excavated using hand tools for the first 6 feet due the presence of utilities beneath the track slab. The annulus between the isolation casing and permanent casing must be filled with compressible elastic foam or other means to seal the gap without allowing load transfer.

13 Design Recommendations – LIRR support Buildings

13.1 Foundation Discussion

Driven steel piles and mini-caissons are considered feasible for support of the LIRR support buildings. Shallow foundations are not recommended given the potential for seismically induced settlements.

13.2 Driven Piles

Driven steel piles, end-bearing on bedrock (NYCBC Class 1c or better) are considered feasible for support of LIRR support buildings. The capacity of end-bearing piles will generally be controlled by the structural capacity of the pile section. Where implemented, we recommend that driven piles consist of H-piles conforming to ASTM A572 Grade 50. The piles should be sized to accommodate axial and lateral loading requirements for the building and driving stresses necessary to bypass timber and rubble that may be present within fill soils. Pipe piles may be an alternative, but are generally expected to be more difficult to drive through the fills soils. We expect that H-piles can achieve axial compressive capacities of about 150 to 200 tons each. Settlements of H-piles are expected to be less than 1-inch (including elastic shortening).

All H-piles should be fitted with protective points such as the Hard-Bite manufactured by Associated Pile Fitting Corp. or equivalent.

The contractor should perform and submit a wave-equation analysis (WEAP), including driving stresses in the pile, once a final pile section and driving hammer are selected to ensure the pile is not overstressed during installation and to develop driving criteria. The WEAP is necessary to help evaluate if the proposed pile and driving system can install the pile through the till and decomposed rock to achieve the allowable capacity without damaging the pile.

13.2.1 Index Piles and Compression Load Tests

At the beginning of pile driving operations, we recommend installing a minimum of eight index piles to evaluate driving conditions across the building footprint and the need for predrilling to bypass obstructions. All index piles shall be installed to final bearing and be monitored with a Pile Driving Analyzer (PDA). The purpose of the PDA is to determine the actual energy delivered to the pile, and to confirm the pile stresses during driving are not excessive. The data will also be used to estimate the ultimate pile capacity. The index piles may be used, if properly installed, as production piles.

At least one pile load test will be required to satisfy the requirements of the NYSBC for driven pile capacities exceeding 40 tons. Load tests may be performed in accordance with ASTM D1143 or D4945. For consistency with NYC practice, we recommend a minimum of two static load tests be performed in accordance with ASTM D1143.

Production piles should be installed in the same manner, using the same driving equipment as the successfully load-tested piles.

13.3 Mini-caissons

Mini-caissons (defined as micropiles per the NYSBC) may be used in lieu of driven piles for support of the LIRR support buildings. Mini-caissons are similar to large diameter caissons, except the diameter is limited to less than 14-inches. Mini-caisson rock sockets should be proportioned in accordance with the recommendations previously outlined for drilled caissons. The structural design of mini-caissons should

conform to the requirements for micropiles as outlined in the NYSBC. Mini-caisson elements should be designed to accommodate the combined effects axial loading and bending.

Axial load testing is not required for mini-caissons under the NYSBC. In addition, lateral load testing is not required under the NYSBC; however, we recommend that a minimum of two lateral load tests be performed in accordance ASTM D3966. All rock sockets should be verified with either down-hole cameras or via borings.

Settlements of mini-caissons will be governed by elastic shortening and are generally expected to be less than ½-inch.

13.4 Floor Slabs

Floor slabs and sump pits at the LIRR support buildings should be designed as structural pressure slabs designed assuming hydrostatic uplift corresponding to the design flood elevation dictated by LIRR. Where possible, pressure slabs should be keyed into walls and should be cast with integral water-stops at all joints (PVC "dumbbells" and post-construction grouting tubes). Pressure slabs should be waterproofed as per the recommendations presented herein and those of the project waterproofing consultant.

13.5 Below Grade Walls

Any permanent below grade walls will be subjected to lateral pressures from soil, groundwater (hydrostatic), and surcharge loads. Restrained walls (walls that are braced against moving/rotating, such as basement walls) should be designed for at-rest earth pressure. The soil parameters shown in Table 5 should be used for the design of lateral earth pressure loads on restrained below grade walls.

Table 5: Below Grade Wall Soil Design Parameters (Restrained Walls)

Parameter	Recommended Value
Wall Backfill:	Fill
Typical Soil Unit Weight:	120 pcf
Friction Angle:	30 Degrees
Coefficient of At-Rest Earth Pressure:	0.50
Design Water Level	As directed by LIRR

13.6 Permanent Groundwater Control

We recommend that all walls and slabs of the LIRR buildings below the design flood elevation be completely encapsulated using a membrane type waterproofing system, such as those manufactured by Grace Construction Products (GCP) Applied Technologies, Inc., Carlisle Coatings and Waterproofing, Inc., or Laurenco Systems, Inc. The use of bentonite waterproofing or negative-side crystalline waterproofing is not recommended as a means of primary waterproofing.

Horizontal waterproofing membranes should be installed on a minimum 2-inch-thick lean concrete mud slab placed over an approved subgrade to provide a smooth and uniform application surface. Vertically applied waterproofing membranes should extend up to the design flood elevation. Substrate preparation should be per the manufacturer's recommendation.

Quality control is critical to a successful waterproofing project. The waterproofing installation should be inspected daily, especially during placement of reinforcement for the floor slabs and perimeter walls. Any holes or tears should be repaired in accordance with the manufacturer's recommendations and utility penetrations should be carefully sealed. All seams, including separations between wall and slab membranes should be checked for tightness. We recommend that the waterproofing manufacturer

inspect the waterproofing operations during construction and approve all work prior to placement of concrete.

14 Construction Recommendations

14.1 Excavations

We anticipate that excavation through soil will be required for utility relocations, and construction of pile caps and grade beams. Excavations in soil can be accomplished with conventional earthmoving equipment (i.e., track-hoes, etc). Obstructions such as remnant foundations, timber cribbing/bulkheads, abandoned and live utilities, rubble, and boulders should be anticipated when excavating or installing deep foundations through soils. Larger equipment may be required to remove obstructions. Means and methods for the removal of obstructions must be coordinated against the design to mitigate the potential for reducing axial or lateral capacity of foundation elements.

All excavations should be benched or sloped in accordance with applicable OSHA standards. Where required, temporary excavation support should be installed as per the recommendations presented herein.

Care must be exercised if pre-excavating to clear potential obstructions at caisson locations to avoid disturbance that can reduce lateral resistance of soils and ultimately reduce caisson lateral capacity. We recommend that the contractor be precluded from performing pre-excavation in open holes below groundwater. All areas of pre-excavation should be backfilled and compacted with an approved material satisfactory to the geotechnical engineer. Where possible, pre-excavation should be performed by advancing oversized casing with the hole cleaned out and backfilled with CLSM.

14.2 Temporary Support of Excavation

Temporary excavation support may be required to accommodate utility relocations and construction of pile caps and tie-beams. The contractor or responsible subcontractor should design temporary construction support of excavation in accordance with all OSHA, local, state and federal safety regulations.

We recommend that support of excavation be designed assuming the soil parameters provided in Table 6. We also recommend that SOE should be designed assuming the following minimum loading conditions:

- Braced Excavations - Free draining or dewatered walls should be designed using a uniform pressure distribution of 28H psf, where H is the total height of the wall. Walls that are not free draining or are not dewatered should also be designed using a uniform pressure of 28H psf, where H is the total height of the wall plus a triangular hydrostatic pressure of 62.4 psf per ft below the groundwater table (el 2.0 ft).
- Lateral pressures from surface loads should assume vehicular loading. Surface surcharges should be added as an inverted triangle having a maximum pressure at the ground surface equal to one-half of the vertical surface load (minimum 600 psf). Lateral surcharge pressure can be reduced to zero at a depth of 15 ft below ground surface.
- Lateral pressures resulting from adjacent structures and railway loading should be determined using elastic methods and should be added to the above loads. Railway surcharges should be in accordance with the AREMA Manual for Railway Engineering and any additional LIRR requirements.
- Temporary construction loads such as cranes and other equipment are not considered herein and must be assessed on a case-by-case basis.

Table 6: Soil and Groundwater Design Parameters (SOE)

Material	Parameter	Recommended Value
Groundwater	Elevation	el 2.0 ft
Fill	Moist Unit Weight	120 pcf
	Friction Angle:	30 degrees
	Cohesion:	0 psf
Silty Clay	Moist Unit Weight	105 pcf
	Friction Angle:	0 degrees
	Cohesion:	500 psf
Sand/ Till	Moist Unit Weight	125 pcf
	Friction Angle:	36 degrees
	Cohesion:	0 psf

14.3 Temporary Construction Dewatering

Localized excavations for utility relocation and tie-beams may be below the static groundwater level; therefore, temporary construction dewatering may be required. Controlling the groundwater will be critical in order to allow for subgrade preparation. We expect that groundwater should be controllable with sump pumps during foundation work.

All groundwater discharged from the site into NYC sewers will require temporary dewatering permits from the NYCDEP. Treatment may be required where the groundwater is found insufficient for meeting water quality standards dictated by the regulatory agencies having jurisdiction.

14.4 Soil Subgrades

Pile cap, grade beam, floor slab, and track subgrades should be level and clear of debris, standing or frozen water, and other deleterious materials. Soils should be excavated with care to avoid disturbance that may reduce axial or lateral resistance. We recommend that the final 12 inches of excavation be performed with flat bladed buckets in open areas and by hand in confined areas. Subgrades should be protected from the effects of frost, precipitation, groundwater and surface water run-off and construction until concrete is cast. As such, we recommend that the Contractor limit the area of exposed subgrade to prevent deterioration of the bearing conditions; however, excavations should be made large enough to allow passage of a compactor.

Areas disturbed by excavation and other areas found to be unacceptable should be re-compacted, or stabilized as necessary, using geogrid or geotextiles in conjunction with compacted structural fill or gravel. CLSM or lean concrete may also be used. The subgrade following placement of fill and compaction should be firm and unyielding under the weight of heavy equipment without evidence of rutting, pumping, or heaving. Vibratory compaction shall not be performed on soils that are not within 2 percent of optimum moisture content. Compaction should be discontinued in the event that soils are observed to “pump or heave” due to wet conditions.

Following compaction, subgrades should be capped with crushed stone fill. This material will help protect the subgrade from degradation and can be used to assist in conveyance of water during dewatering activities. A mud slab may also be cast to provide protection and may be required to provide a suitable substrate for waterproofing in building areas.

14.5 Fill Materials, Placement, and Compaction

Structural fill is expected around tie-beams and at the LIRR support buildings. Additional fill should be limited to utility trenches, minor earthwork, or roadway reconstruction. Structural fill should consist of a well-graded durable granular material having a maximum particle size of 4 inches in any dimension, and no more than 10 percent fines passing the No. 200 sieve. All fill should be free of trash, debris, roots, vegetation, peat, or other deleterious materials and should be approved by the geotechnical engineer prior to placement. Lean concrete or controlled low-strength material (CLSM) may be substituted for structural fill.

Fill should be placed in uniform loose lifts not exceeding 12 inches in open areas that can be compacted using heavy compaction equipment, and 6 inches in confined areas where hand operated equipment is required. All fill should be compacted to at least 95 percent of the soil's maximum dry density as determined by ASTM D1557. The water content at the time of compaction should be within a 2 percent of the optimum value determined by ASTM D1557.

Fill should not be placed on subgrades not inspected and approved by the geotechnical engineer. All fill must meet the requirements of the approved Remedial Action Work Plan (see below).

14.6 Restrictive Declaration Soil Management

The site is being developed under the oversight of the New York City Office of Environmental Remediation (NYCOER) pursuant to a restrictive declaration (RD) executed by WRY Tenant LLC on 10 April 2014. The restrictive declaration includes requirements for hazardous materials testing, air emissions control, and noise attenuation. Soil management (excavation, staging, transport, disposal and importing) must follow all requirements of the NYCOER-approved Remedial Action Work Plan (RAWP).

14.7 Monitoring

We recommend that a detailed monitoring program be developed and incorporated into the Contract Documents. Monitoring should include means to measure both structural movement and vibrations from construction operations. The type and locations of specific monitoring equipment, threshold values, and durations should be developed based on review of the anticipated construction means and methods in conjunction with proximity to existing structures and utilities. The purpose of performing monitoring is to provide reasonable feedback to the engineer as to performance of the contractor with respect to protecting existing structures and utilities, and to assess any necessary changes to means and methods of construction.

Specific requirements for monitoring are likely to be imposed by governing agencies including NYCDOT, MTACC/NYCT, Amtrak, Friends of the Highline. Critical structures which are likely to require monitoring include:

1. the existing LIRR tracks to remain in service,
2. the Highline,
3. the West 33rd Street retaining wall and viaduct,
4. the Eleventh Avenue viaduct,
5. the Amtrak North Access Tunnel (NAT),
6. the Amtrak North River Tunnels (NRTs),
7. the Gateway Tunnel, and
8. the MTA No. 7 Line subway

We recommend that a dialog be established with all governing agencies prior to construction to determine specific monitoring requirements.

The monitoring program would likely include optical surveying, seismographs (vibration monitoring), and crack gauges. We recommend that a plan be developed after discussion with the governing agencies and further development of design drawings. Given the expected duration for foundation construction, remote sensors capable of relaying data in real-time via wireless communications should be used. The monitoring plan should address means and methods for measuring ground and structural deformation, and vibration levels. We recommend that all monitoring be performed by a third-party consultant independent of the contractor; however, the contractor should reserve the right to perform additional monitoring. Monitoring should be performed throughout drilling, excavation and platform construction.

14.8 Preconstruction Conditions Documentation

We recommend that preconstruction conditions documentation be performed, for any structures to remain, about one month prior to commencing construction activities. Each agency will likely require documentation of their facilities. This would most likely include the tracks, Highline, West 33rd Street retaining wall and viaduct, Eleventh Avenue viaduct, existing Amtrak tunnels, and MTA No. 7 Line Extension structures. The purpose of these observations is to provide photographic and video documentation representative of general existing conditions and identify obvious visual deficiencies. The preconditions observations should also identify areas requiring specific monitoring during construction. Structural integrity is not addressed in such documentation. This baseline information is often critical in the event of future damage claims resulting from construction activities.

14.9 Special Inspections

Excavation and foundation work are subject to various Special Inspections as per the requirements outlined in Chapter 17 of the NYCBC and the Rules of the City of New York and any requirements of the LIRR. Construction activities that require geotechnical quality control inspections include installation of the caisson foundations, driven piles, mini-caissons, excavation, subgrades, and lateral support systems, backfilling, and compaction. This work must be performed under the inspection of a qualified geotechnical engineer. The inspecting engineer should be familiar with the subsurface conditions, as well as the proposed and existing construction onsite. We recommend that all inspectors meet the minimum requisite qualifications outlined in 1RCNY 101-06.

15 Construction Documents

Technical specifications and design drawings should incorporate the recommendations contained herein to ensure that subsurface conditions and other geotechnical issues at the site are adequately addressed in the construction documents.

We recommend that the language in foundation and earthwork specifications emphasize the potential for encountering buried obstructions during excavation with the intent of mitigating change-of-conditions claims arising during construction. All excavation should be assumed to be unclassified such that the contractor is responsible for providing the necessary performance of the foundation system regardless of conditions encountered.

16 Owner and Contractor Responsibilities

The Contractor is responsible for construction quality control, which includes satisfactorily constructing the foundation system and any associated temporary works to achieve the design intent while not adversely impacting or causing loss of support to neighboring property, structures, utilities, roadways, etc. Construction activities that can alter the existing ground conditions such as excavation, fill placement, foundation construction, ground improvement, pile driving/drilling, dewatering, etc. can also induce stresses, vibrations, and movements in nearby structures and utilities, and disturb occupants. Contractors are solely responsible to ensure that their activities will not adversely affect the structures and utilities, and will not disturb occupants. Contractors must also take all necessary measures to protect the existing structures, utilities, etc during construction. By using this report, the Owner agrees that Langan will not be held responsible for any damage to adjacent structures, utilities, etc.

The preparation and use of this report is based on the condition that the project construction contract between the Owner and their Contractor(s) will include: 1) Langan being added to the Project Wrap and/or Contractor's General Liability insurance as an additional insured, and 2) language specifically stating the Foundation Contractor will defend, indemnify, and hold harmless the Owner and Langan against all claims related to disturbance or damage to adjacent structures, utilities, etc or properties.

17 LIMITATIONS

The conclusions and recommendations provided in this report are based on subsurface conditions inferred from a limited number of borings and in situ testing performed within and adjacent to the proposed expansion, and historic records and information provided by others.

Information on subsurface strata and groundwater levels shown on the logs represents conditions encountered only at the locations indicated and at the time of investigation. If different conditions are encountered, they should immediately be brought to our attention for evaluation as they may affect our recommendations.

This report has been prepared to assist the Owner in developing the site. The information in this report cannot be relied upon by engineers or contractors without specific permission or for adjacent properties that are beyond the limits of that which is the specific subject of this report.

Environmental issues (such as potentially contaminated soil and groundwater) are outside the scope of this study.

18 References

Baskerville, C.A. (1994) “Bedrock and Engineering Geology Maps of New York County, and parts of Kings and Queens Counties, New York, and parts of Bergen and Hudson Counties, New Jersey”. I-MAP 2306, Sheets 1&2, USGS.

Bridges, W. & Maverick, P. (1811) “This map of the city of New York and island of Manhattan, as laid out by the commissioners appointed by the legislature, April 3d, 1807 is respectfully dedicated to the mayor, aldermen and commonalty thereof.” [New York: s.n] [Map] Retrieved from the Library of Congress.

Bromley, G. W. & Robinson, E. (1879) “Outline and Index Map of New York City, New York” From actual surveys and official records by G.W. Bromley & Co., civil engineers. Published by Geo. W. Bromley & E. Robinson. 82 & 84 Nassau St., New York. 1879. Entered 1879, by G.W. Bromley & Co., Washington. Engraved by A.H. Mueller, Walnut St., Philadelphia. Printed by F. Bourquin, S. Sixth St., Philadelphia

Perris, William (1865) “Map of the City of New York” Lionel Pincus and Princess Firyal Map Division, The New York Public Library. (1857 - 1862). Volume 6 Index Map

Robinson, E. (1885), Lionel Pincus and Princess Firyal Map Division, The New York Public Library. “Outline & Index Map of New York City. Index I”

Bromley, G.W. & Bromley, W.S. (1897), Lionel Pincus and Princess Firyal Map Division, The New York Public Library. “Outline and Index Map of Atlas of New York City : Manhattan Island”

Viele (1865) “Sanitary & Topographical Map of the City and Island of New York” Prepared for the Council of Hygiene and Public Health of the Citizens Association. Under the direction of Egbert L. Viele, Topographical Engineer. Entered 1865 by Egbert L. Viele New York. Ferd. Mayer & Co. Lithographers, 96 Fulton St. N.Y.

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End of Report

FIGURES

NOTES:
BASEMAP PROVIDED BY UNITED STATES GEOLOGICAL SURVEY, 2016

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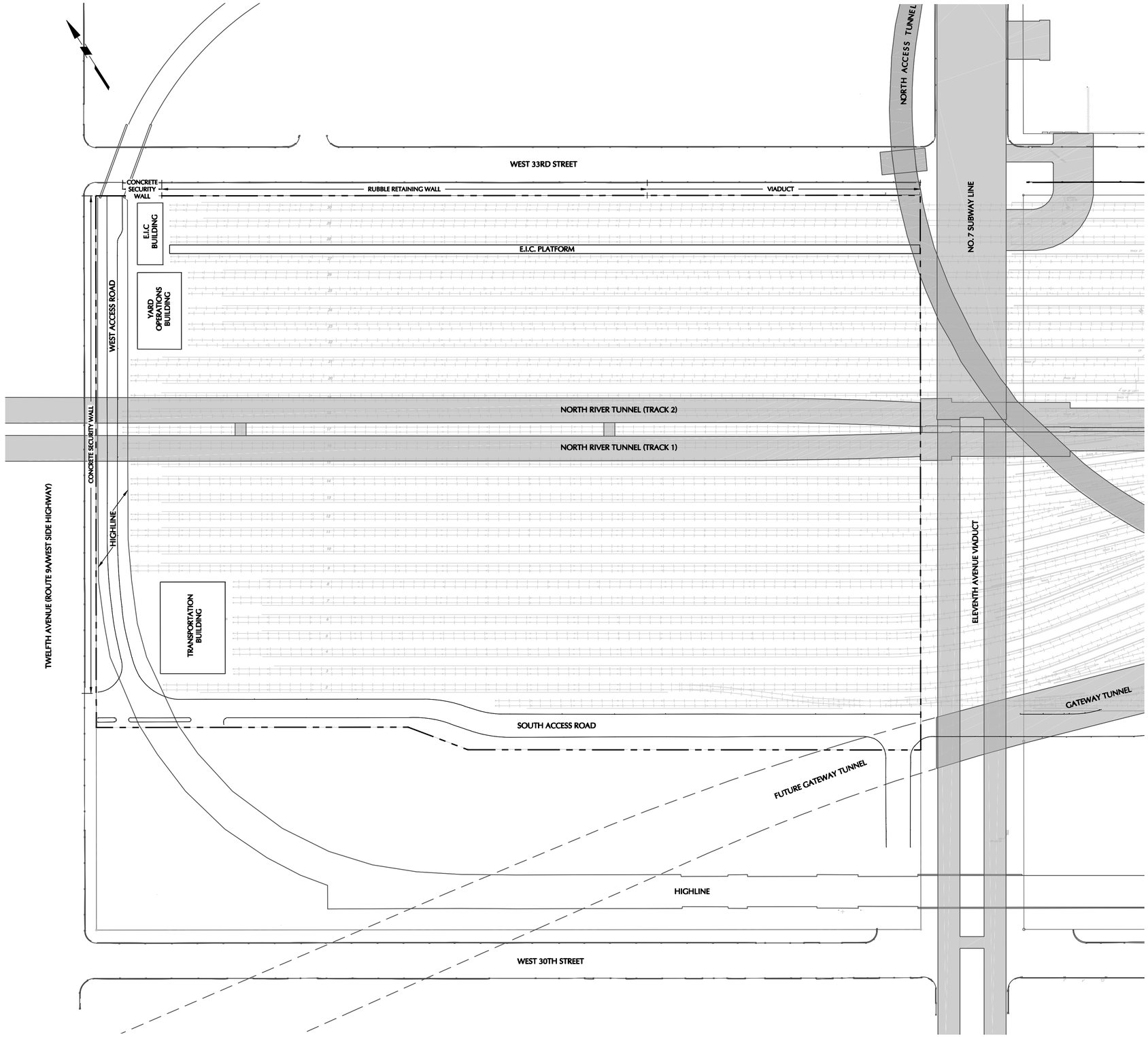
Project
WEST RAIL YARD PLATFORM
HUDSON YARDS
MANHATTAN NEW YORK

Drawing Title
SITE LOCATION MAP

Project No.	170444101
Date	03/31/2017
Scale	1"=2000'
Drawn By	MG
Submission Date	03/31/2017
Drawing	1
Sheet	1 of 18

Path: \\langan.com\data\NY\data1\170444101\ArcGIS\ArcMap_Documents\Figure 1 - Site_Location_Map.mxd



NOTES

1. EXISTING INFORMATION TAKEN FROM TOPOGRAPHIC AND BOUNDARY SURVEY PREPARED BY LANGAN ENGINEERING, ENVIRONMENTAL, SURVEYING AND LANDSCAPED ARCHITECTURE, D.P.C., DATED 4 APRIL 2004, AND LAST REVISED 13 MARCH 2017.
2. PROPOSED GATEWAY TUNNEL EXTENTS TAKEN FROM AMTRAK HUDSON YARDS PHASE II – WEST RAIL YARDS PROJECT LOCATION PLAN, X–011, DATED 30 DECEMBER 2016.
3. THIS PLAN WAS PRODUCED USING DATA FROM MULTIPLE SOURCES. LANGAN MAKES NO WARRANTEE AS TO THE ACCURACY OF DATA NOT SPECIFICALLY WITNESSED BY LANGAN PERSONNEL.

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WEST RAIL YARD PLATFORM

HUDSON YARDS

MANHATTAN NEW YORK

Drawing Title

EXISTING CONDITIONS PLAN

Project No. 170444101	Drawing No. 2
Date 4/17/2017	
Scale 1" = 50'	
Drawn By KM / Checked By MP	
Submission Date -	Sheet 2 of 18

PROJECT NO. 170444101 SUBMISSION DATE: ### LANGAN

Filename: \\langan.com\data\NY\data1\170444101\Cadd Data - 170444101\SheetFiles\Geotechnical Report\Dwg 2. Existing Conditions Plan.dwg Date: 4/25/2017 Time: 10:29 User: kmerrill Style Table: Langan.stb Layout: ANSID-SL

NOTES:
BASEMAP SOURCE: BRIDGES, W. AND MAVERICK, P. (1811) "MAP OF THE CITY OF NEW YORK AND ISLAND OF MANHATTAN AS LAID OUT BY THE COMMISSIONERS APPOINTED BY THE LEGISLATURE, APRIL 3RD, 1807". PUBLISHED IN NEW YORK, 1811.

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Drawing Title
HISTORICAL SITE MAP (W. BRIDGES, 1811)

Project No.	170444101
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Scale	1"=1000'
Drawn By	MG
Submission Date	03/31/2017
Drawing	3
Sheet	3 of 18

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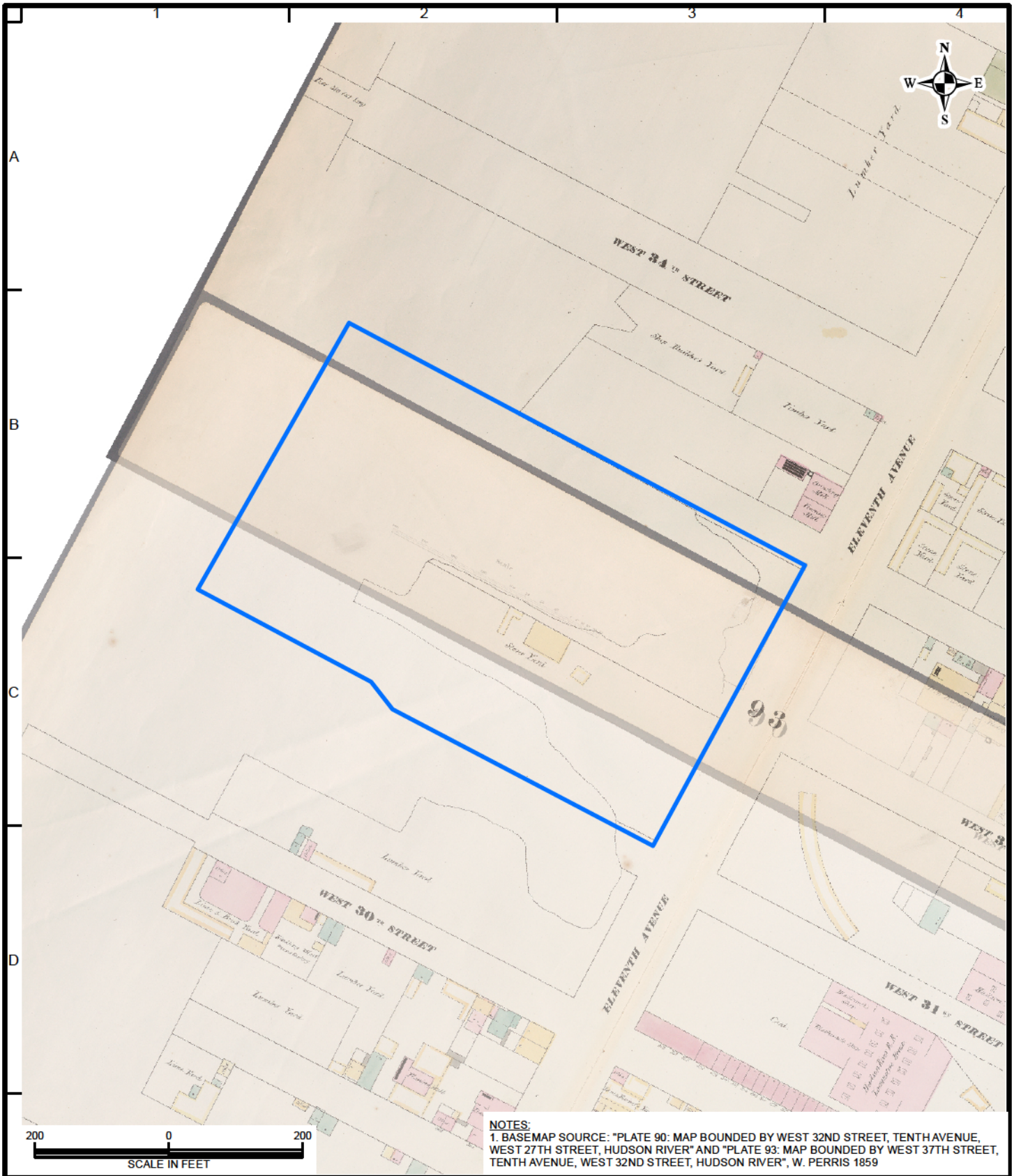

NOTES:
1. BASEMAP SOURCE: "PLATE 90: MAP BOUNDED BY WEST 32ND STREET, TENTH AVENUE, WEST 27TH STREET, HUDSON RIVER" AND "PLATE 93: MAP BOUNDED BY WEST 37TH STREET, TENTH AVENUE, WEST 32ND STREET, HUDSON RIVER", W. PERRIS 1859

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Drawing Title
HISTORICAL SITE MAP (Perris, 1859)

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Date	04/19/2017
Scale	1"=200'
Drawn By	MG
Submission Date	04/19/2017

Drawing 4

Sheet 4 of 18

Path: \\langan.com\data\NY\data1\170444101\ArcGIS\ArcMap_Documents\Figure 4 - 1859 W Perris.mxd

NOTES:
BASEMAP SOURCE: VIELE (1865) "SANITARY AND TOPOGRAPHICAL MAP OF THE CITY AND ISLAND OF NEW YORK" PREPARED FOR THE COUNCIL OF HYGIENE AND PUBLIC HEALTH OF THE CITIZENS ASSOCIATION. UNDER THE DIRECTION OF EGBERT L. VIELE, TOPOGRAPHICAL ENGINEER. ENTERED 1865 BY EGBERT L. VIELE NEW YORK. FERD. MAYER AND CO. LITHOGRAPHERS, 96 FULTON ST. N.Y.

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HISTORICAL SITE MAP (VIELE, 1865)

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Scale	1"=1000'
Drawn By	MG
Submission Date	03/31/2017

Drawing 5

Sheet 5 of 18

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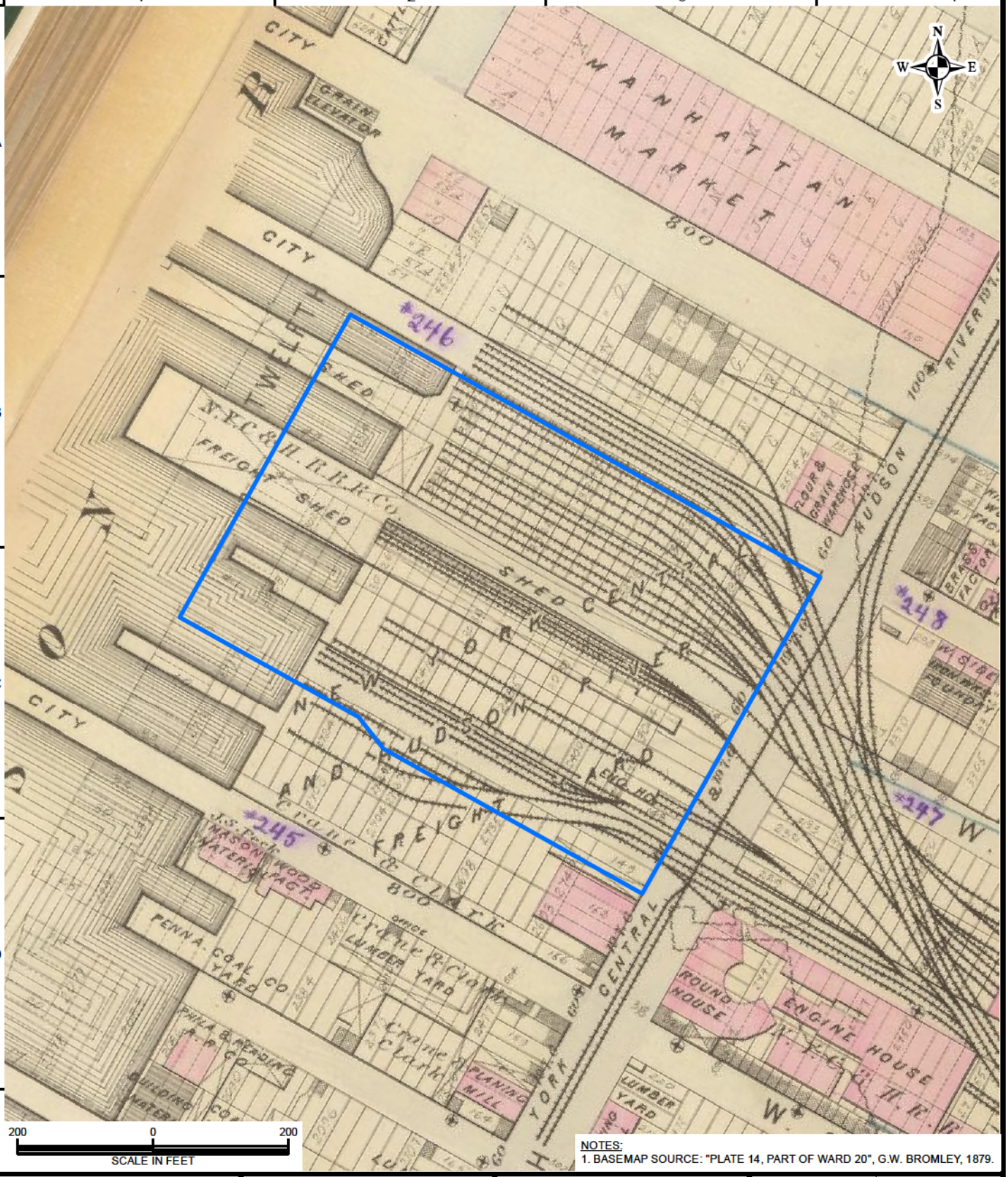

NOTES:
1. BASEMAP SOURCE: "PLATE 14, PART OF WARD 20", G.W. BROMLEY, 1879.

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HISTORICAL SITE MAP (BROMLEY, 1879)

Project No.	170444101
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Scale	1"=200'
Drawn By	MG
Submission Date	04/19/2017

Drawing 6

Sheet 6 of 18

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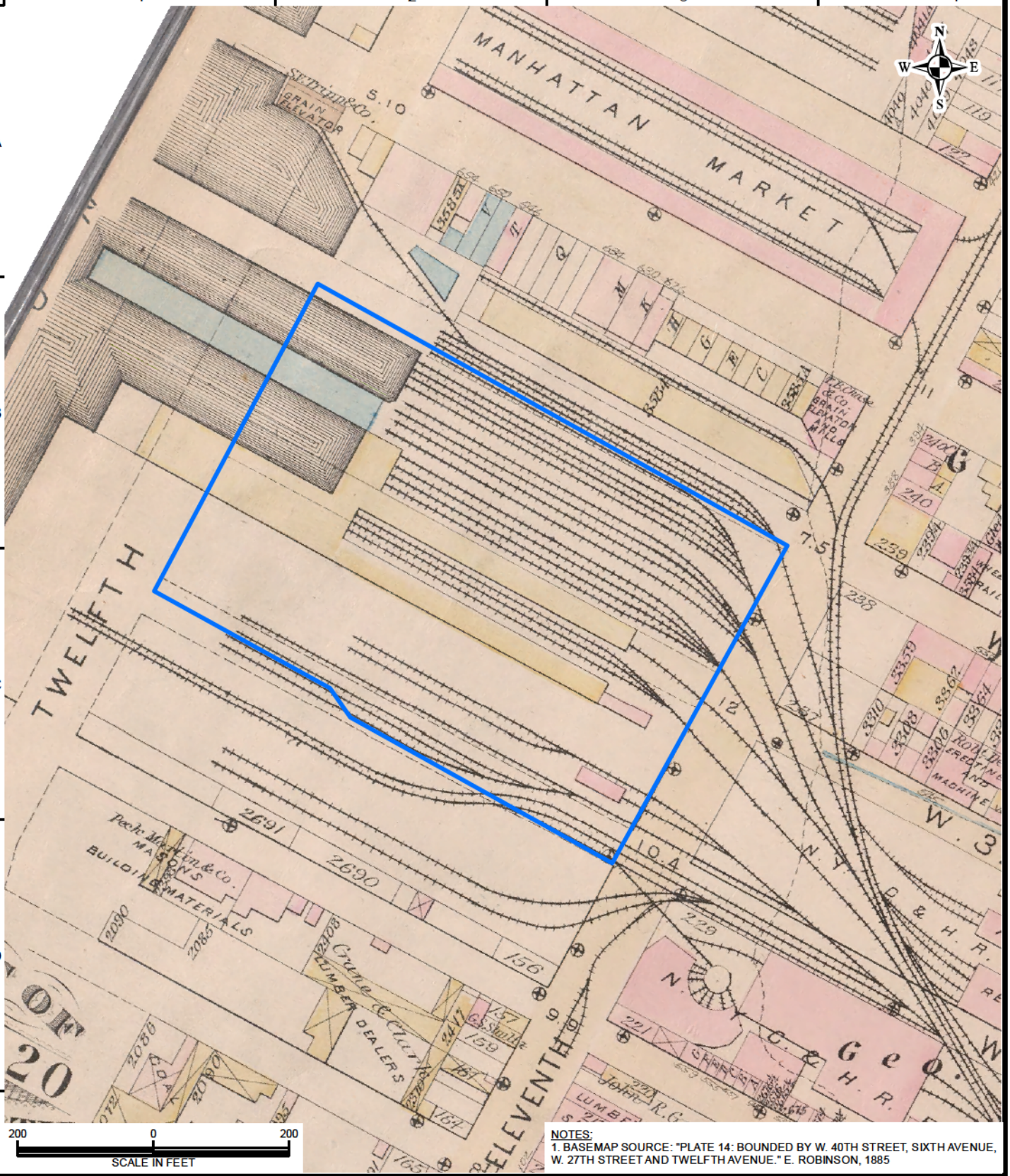

NOTES:
1. BASEMAP SOURCE: "PLATE 14: BOUNDED BY W. 40TH STREET, SIXTH AVENUE, W. 27TH STREET AND TWELFTH AVENUE." E. ROBINSON, 1885

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HISTORICAL SITE MAP (ROBINSON, 1885)

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Drawn By	MG
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Drawing	7
Sheet	7 of 18

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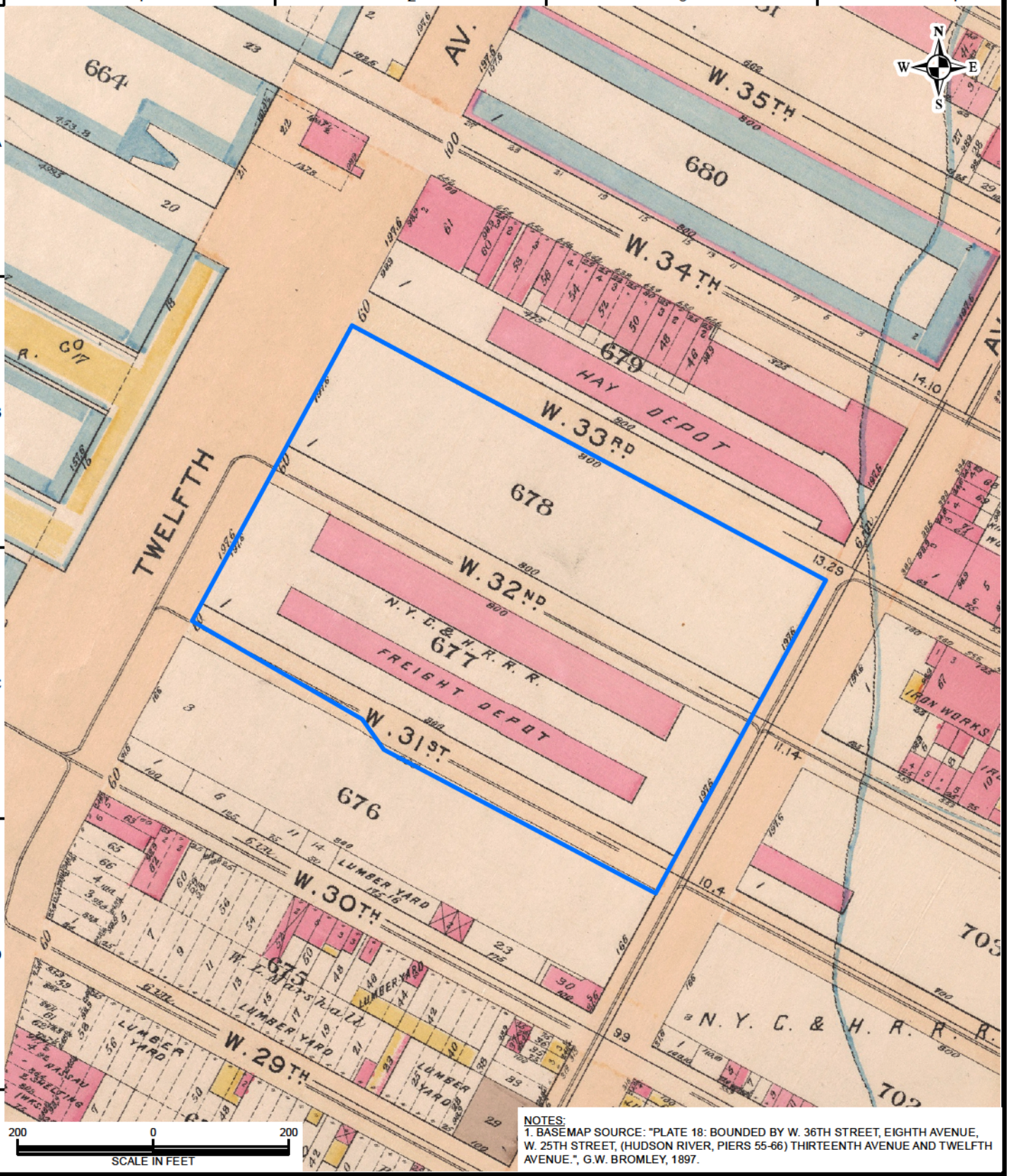

NOTES:
1. BASEMAP SOURCE: "PLATE 18: BOUNDED BY W. 36TH STREET, EIGHTH AVENUE, W. 25TH STREET, (HUDSON RIVER, PIERS 55-66) THIRTEENTH AVENUE AND TWELFTH AVENUE.", G.W. BROMLEY, 1897.

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HISTORICAL SITE MAP (BROMLEY, 1897)

Project No. 170444101	Drawing 8
Date 04/19/2017	
Scale 1"=200'	
Drawn By MG	
Submission Date 04/19/2017	Sheet 8 of 18

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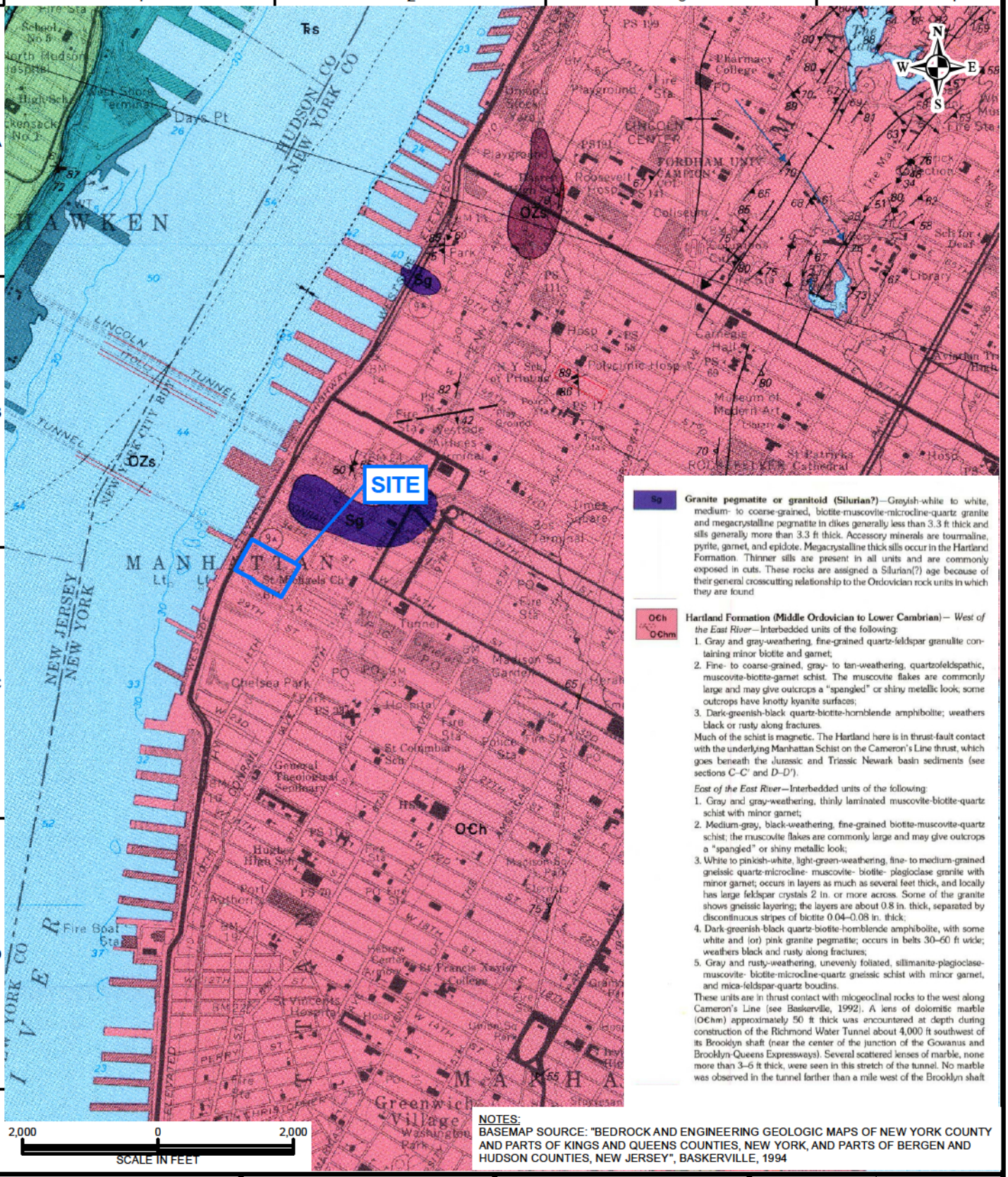

Sg — **Granite pegmatite or granitoid (Silurian?)**—Greyish-white to white, medium- to coarse-grained, biotite-muscovite-microcline-quartz granite and megacrystalline pegmatite in dikes generally less than 3.3 ft thick and sills generally more than 3.3 ft thick. Accessory minerals are tourmaline, pyrite, garnet, and epidote. Megacrystalline thick sills occur in the Hartland Formation. Thinner sills are present in all units and are commonly exposed in cuts. These rocks are assigned a Silurian(?) age because of their general crosscutting relationship to the Ordovician rock units in which they are found

OCh, OChm — **Hartland Formation (Middle Ordovician to Lower Cambrian)**— *West of the East River*—Interbedded units of the following:

1. Gray and gray-weathering, fine-grained quartz-feldspar granulite containing minor biotite and garnet;
2. Fine- to coarse-grained, gray- to tan-weathering, quartzofeldspathic, muscovite-biotite-garnet schist. The muscovite flakes are commonly large and may give outcrops a "spangled" or shiny metallic look; some outcrops have knotty kyanite surfaces;
3. Dark-greenish-black quartz-biotite-hornblende amphibolite; weathers black or rusty along fractures.

Much of the schist is magnetic. The Hartland here is in thrust-fault contact with the underlying Manhattan Schist on the Cameron's Line thrust, which goes beneath the Jurassic and Triassic Newark basin sediments (see sections *C–C'* and *D–D'*).

East of the East River—Interbedded units of the following:

1. Gray and gray-weathering, thinly laminated muscovite-biotite-quartz schist with minor garnet;
2. Medium-gray, black-weathering, fine-grained biotite-muscovite-quartz schist; the muscovite flakes are commonly large and may give outcrops a "spangled" or shiny metallic look;
3. White to pinkish-white, light-green-weathering, fine- to medium-grained gneissic quartz-microcline- muscovite- biotite- plagioclase granite with minor garnet; occurs in layers as much as several feet thick, and locally has large feldspar crystals 2 in. or more across. Some of the granite shows gneissic layering; the layers are about 0.8 in. thick, separated by discontinuous stripes of biotite 0.04–0.08 in. thick;
4. Dark-greenish-black quartz-biotite-hornblende amphibolite, with some white and (or) pink granite pegmatite; occurs in belts 30–60 ft wide; weathers black and rusty along fractures;
5. Gray and rusty-weathering, unevenly foliated, sillimanite-plagioclase-muscovite- biotite-microcline-quartz gneissic schist with minor garnet, and mica-feldspar-quartz boudins.

These units are in thrust contact with miogeoclinal rocks to the west along Cameron's Line (see Baskerville, 1992). A lens of dolomitic marble (OChm) approximately 50 ft thick was encountered at depth during construction of the Richmond Water Tunnel about 4,000 ft southwest of its Brooklyn shaft (near the center of the junction of the Gowanus and Brooklyn-Queens Expressways). Several scattered lenses of marble, none more than 3–6 ft thick, were seen in this stretch of the tunnel. No marble was observed in the tunnel farther than a mile west of the Brooklyn shaft

NOTES:
BASEMAP SOURCE: "BEDROCK AND ENGINEERING GEOLOGIC MAPS OF NEW YORK COUNTY AND PARTS OF KINGS AND QUEENS COUNTIES, NEW YORK, AND PARTS OF BERGEN AND HUDSON COUNTIES, NEW JERSEY", BASKERVILLE, 1994

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BEDROCK GEOLOGY MAP

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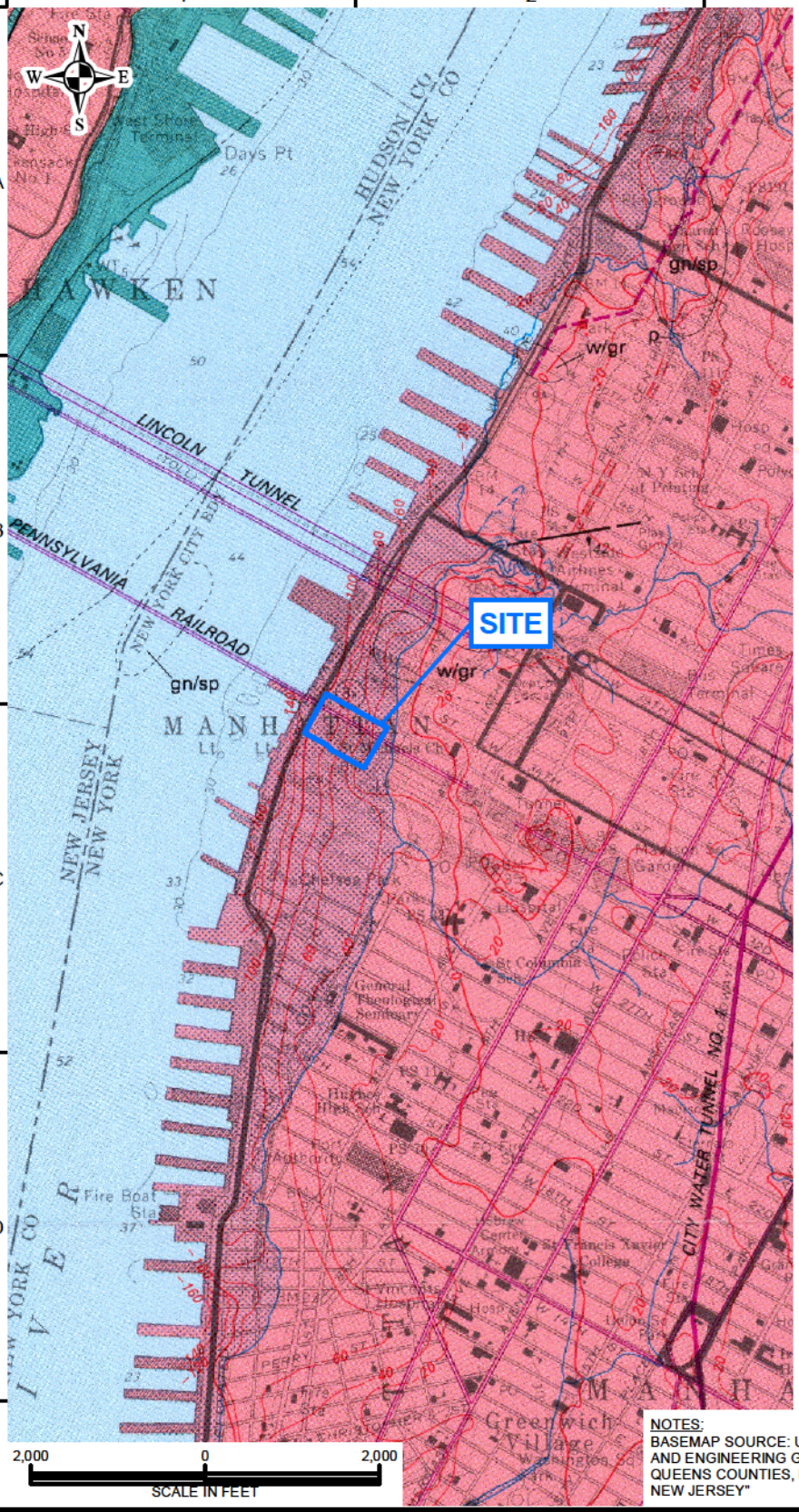
Path: \\langan.com\data\NY\data1\170444101\ArcGIS\ArcMap_Documents\Figure 9 - Bedrock Geology Map.mxd



g/smt/s	Gray sillimanite-muscovite-tourmaline schist (Manhattan Schist)
g/pqm/s	Gray plagioclase-quartz-muscovite schist (Walloomsac Formation)
w/cd/m	White calcite-dolomite marble (Inwood Marble and marbles interlayered with units of the Fordham Gneiss)
w/q	White quartzite (Lowerre Quartzite)
p/qpb/g	Pink quartz-plagioclase-biotite gneiss (Yonkers Gneiss)
p/mbq/g	Pink muscovite-biotite-plagioclase gneiss (Fordham Gneiss, member A)
dg/hbq/g	Dark-gray hornblende-biotite-quartz gneiss (Fordham Gneiss, member D)
bw/gpb/g	Black and white garnet-plagioclase-biotite gneiss (Fordham Gneiss, member B)
g/qbp/s	Gray quartz-biotite-plagioclase schist (Foedham Gneiss, member C)
w/qmim/gr	White quartz-microcline-muscovite granite
g/bmq/s	Gray biotite-muscovite-quartz schist
g/mbq/s	Gray muscovite-biotite-quartz schist
g/spm/s	Gray sillimanite-plagioclase-muscovite schist
gb/am	Greenish-black amphibolite
g/sgmi/g	Gray sillimanite-garnet-microcline gneiss (Ravenswood Granodiorite)

(Hartland Formation)

g/gps/g	Gray garnet-plagioclase-sillimanite gneiss
g/spb/g	Gray sillimanite-plagioclase-biotite gneiss
g/bh/g	Gray biotite-hornblende gneiss

(Hartland Formation, Pelham Bay Member)

am — Amphibolite (same rock as gb/am, but outcrops are large enough to show separately on map)

Geologic unit Sg on sheet 1 is not shown here because its outcrops generally are very narrow and are not considered critical to the design of engineering structures. Moreover, in the Hartland Formation most occurrences are in public parks. This unit's engineering behavior is similar to that of the more granitic, intact gneisses in Bronx County.

EXPLANATION OF MAP SYMBOLS

SUBSURFACE ENGINEERING STRUCTURES

- **Old and New Croton Aqueducts**—Former is shown incomplete north of Major Deegan Expressway because it currently is not in use
- **City Water Tunnels No. 1, 2 or 3**
- **Subway and (or) railroad tunnel**
- **Consolidated Edison Company gas tunnel**
- **Sewer tunnel**

FORMER DRAINAGE AND SHORELINE

Former drainage and shoreline—In blue. Shown only where different from present drainage and shoreline. Areas formerly under water are shown by dot pattern. Where extremely small, former ponds are labelled "p." Straight line segments probably are furrows and ditches built to lower the water table

Former swamp or marsh—In blue. Dashed line defines where swamp or marsh adjoins higher ground. Extremely small occurrences are labelled "s"

GEOLOGY—SURFACE AND SUBSURFACE

- **Contact between geologic units**—Dashed where approximately located; dotted where under water; queried where uncertain. Where shown solid under water, was located by test borings and tunnel data
- **Fault**—Paired arrows show relative movement; U, upthrown side; D, downthrown side. Dashed where approximately located; dotted where under water; queried where uncertain. Where seen in tunnel, arrow shows inclined dip, and short line normal to fault trace shows vertical dip
- **Thrust fault**—Sawteeth on upper plate. Dashed where approximately located; dotted where under water. Where seen in tunnel is shown solid. Alternating solid and open sawteeth indicate thrust faults coincident in map view (near Roosevelt [Welfare] Island; see sheet 1)
- **Overturned thrust fault**—Sawteeth are on lower plate, but point in direction of movement of overturned upper plate; bars are on upper plate (see sheet 1, cross section A–A')
- **Crush or shear zone encountered in underground workings**—Shows dip where known
- **Contours on the bedrock surface**—Based on same datum as topographic contours. Closed, hachured areas indicate depressions. Contour interval 10 ft
- **Single outcrop or area of closely spaced outcrops**

NOTES:
BASEMAP SOURCE: UNITED STATES GEOLOGICAL SURVEY (USGS, 1994). "BEDROCK AND ENGINEERING GEOLOGIC MAPS OF NEW YORK COUNTY AND PARTS OF KINGS AND QUEENS COUNTIES, NEW YORK, AND PARTS OF BERGEN AND HUDSON COUNTIES, NEW JERSEY"

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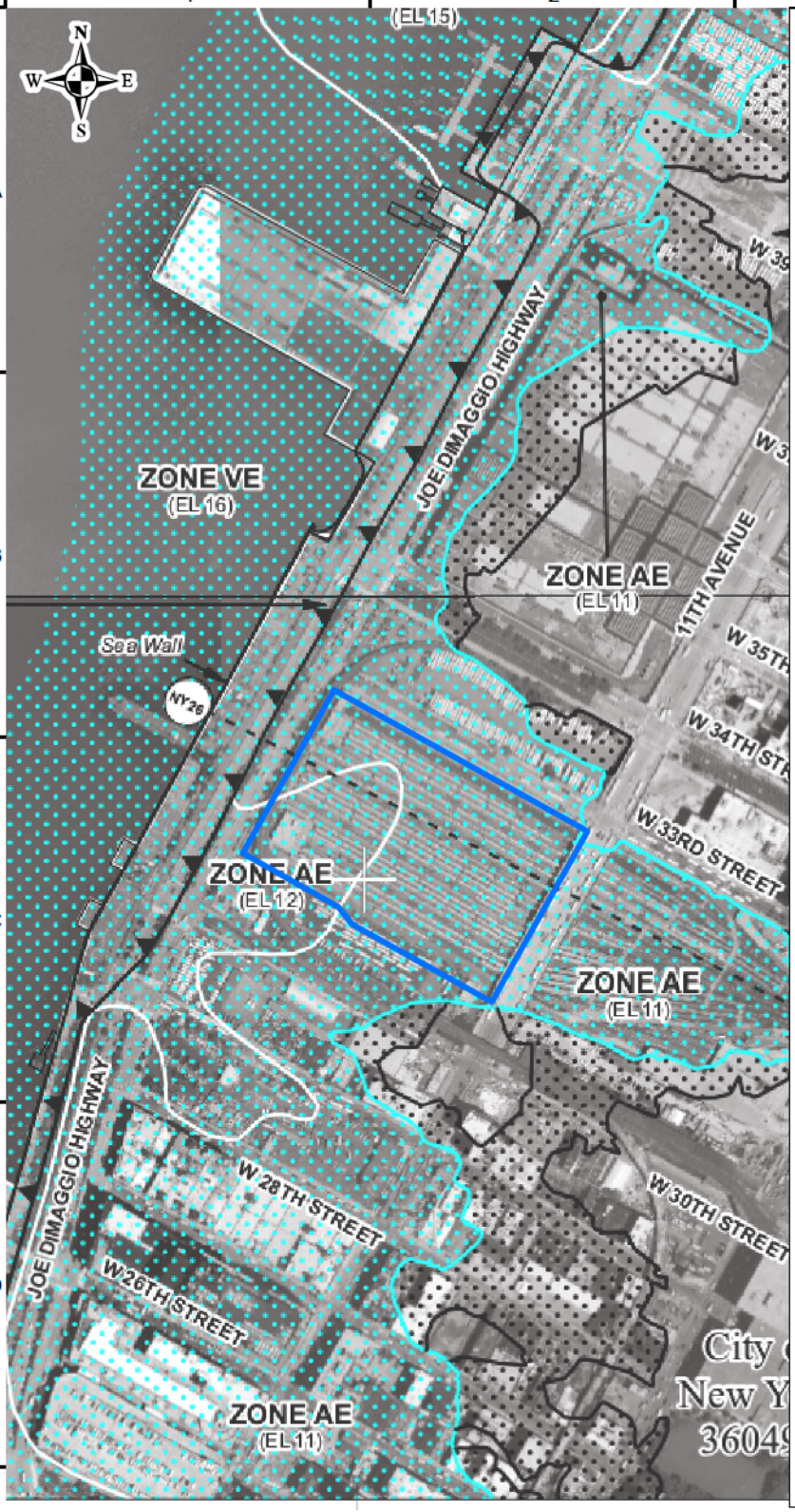
Drawing 10
Sheet 10 of 18

Path: \\langan.com\data\NY\data1\170444101\ArcGIS\ArcMap_Documents\Figure 10 - Bedrock Geology Map.mxd



LEGEND

SPECIAL FLOOD HAZARD AREAS SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X — Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X — Areas determined to be outside the 0.2% annual chance floodplain.

ZONE D — Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

- 1% annual chance floodplain boundary
- 0.2% annual chance floodplain boundary
- Floodway boundary
- Zone D boundary
- CBRS and OPA boundary
- Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
- Limit of Moderate Wave Action
- 513 — Base Flood Elevation line and value; elevation in feet*
- (EL 987) — Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988

- Cross section line
- Transect line
- Culvert, Flume, Penstock or Aqueduct
- Road or Railroad Bridge
- Footbridge
- 87°07'45", 32°22'30" — Geographic coordinates referenced to the North American Datum of 1983 (NAD 83), Western Hemisphere
- 4276000mN — 1000-meter Universal Transverse Mercator grid values, zone 18
- 600000 FT — 5000-foot grid values: New York State Plane coordinate system, Long Island zone (FIPSZONE 3104), Lambert Conformal Conic projection
- DX5510 — Bench mark (see explanation in Notes to Users section of this FIRM panel)
- M1.5 — River Mile

MAP REPOSITORY
Refer to listing of Map Repositories on Map Index

INITIAL NFIP MAP DATE
June 28, 1974

FLOOD HAZARD BOUNDARY MAP REVISIONS
June 11, 1976

FLOOD INSURANCE RATE MAP EFFECTIVE
November 16, 1983

FLOOD INSURANCE RATE MAP REVISIONS

500 0 500
SCALE IN FEET

NOTES:
BASEMAP SOURCE: FEMA FLOOD INSURANCE RATE MAP (FIRM) PANEL # 3604970069G DATED DECEMBER 5, 2013

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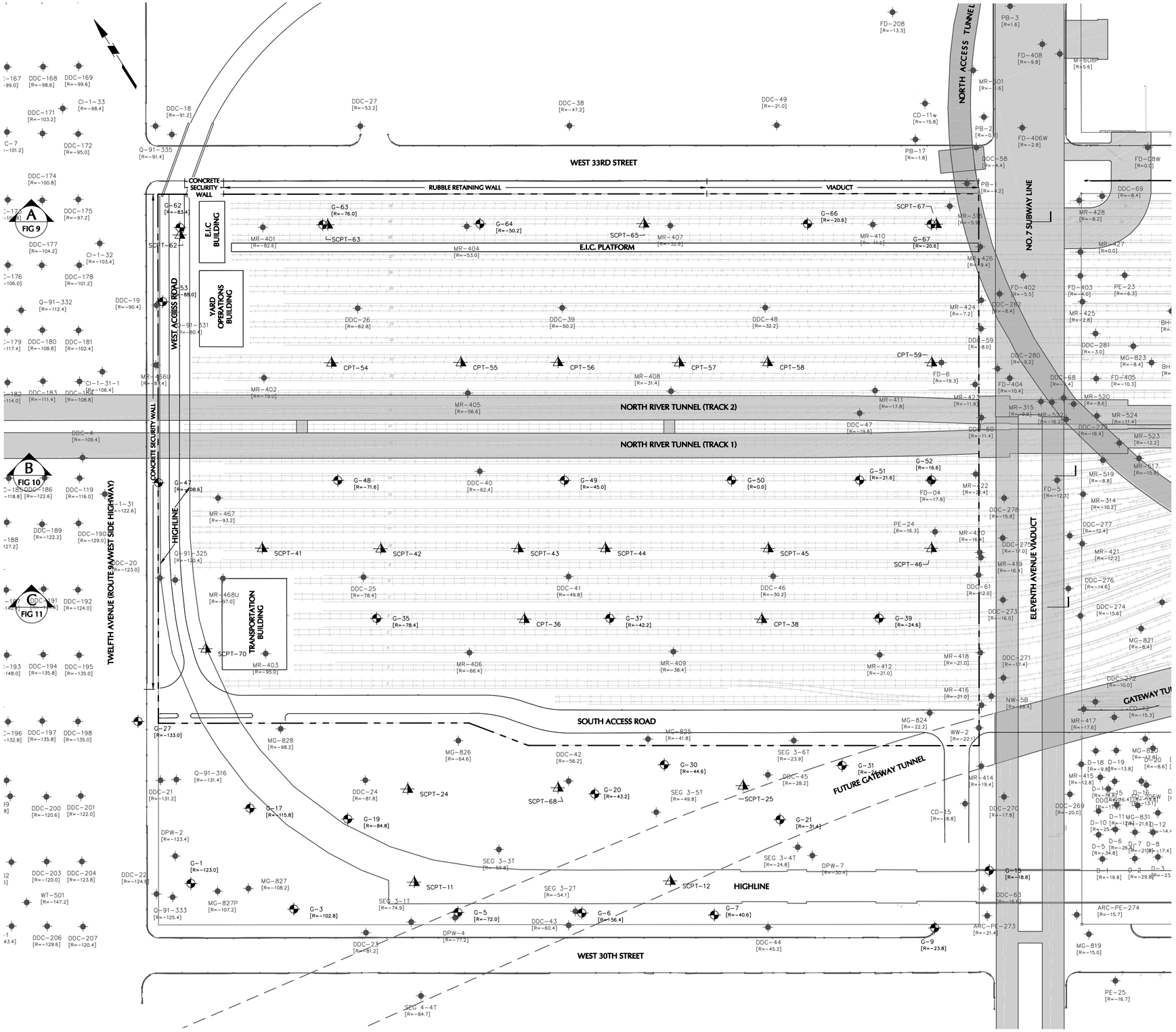
Langan International LLC
Collectively known as Langan

Project
WEST RAIL YARD PLATFORM
HUDSON YARDS
MANHATTAN NEW YORK

Drawing Title
FEMA PRELIMINARY FLOOD INSURANCE RATE MAP

Project No. 170444101	Drawing 11
Date 03/31/2017	
Scale 1"=500'	
Drawn By MG	
Submission Date 03/31/2017	Sheet 11 of 18

Path: \\langan.com\data\NY\data1\170444101\ArcGIS\ArcMap_Documents\Figure 11 - FEMA Map.mxd



NOTES

1. EXISTING INFORMATION TAKEN FROM TOPOGRAPHIC AND BOUNDARY SURVEY PREPARED BY LANGAN ENGINEERING, ENVIRONMENTAL, SURVEYING AND LANDSCAPED ARCHITECTURE, D.P.C., DATED 4 APRIL 2004, AND LAST REVISED 13 MARCH 2017.
2. PROPOSED GATEWAY TUNNEL EXTENTS TAKEN FROM AMTRAK HUDSON YARDS PHASE II – WEST RAIL YARDS PROJECT LOCATION PLAN, X-011, DATED 30 DECEMBER 2016.
3. ELEVATIONS SHOWN HEREIN ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88) WHICH IS 1.681 FEET BELOW THE BOROUGH OF MANHATTAN DATUM (BPMD).

   DATUM CONVERSIONS
   BPMD = NAVD88 – 1.676'
   NGVD29 = NAVD88 + 1.076'
   NYCT = NAVD88 + 98.423'
   PENN = NAVD88 + 298.351'
4. BORING, CPT AND TEST PIT LOCATIONS SHOULD BE CONSIDERED APPROXIMATE.
5. BORINGS DENOTED AS G-# WERE DRILLED BY WARREN GEORGE, INC BETWEEN 11 OCTOBER AND 17 DECEMBER 2004 UNDER THE FULL-TIME INSPECTION OF A LANGAN ENGINEER.
6. CONE PENETRATION TESTS DENOTED AS (S)CPT-# WERE PREFORMED BY CONETEC, INC. BETWEEN 11 OCTOBER AND 19 NOVEMBER 2004 UNDER THE FULL-TIME INSPECTION OF A LANGAN ENGINEER.
7. THIS PLAN WAS PRODUCED USING DATA FROM MULTIPLE SOURCES. LANGAN MAKES NO WARRANTEE AS TO THE ACCURACY OF DATA NOT SPECIFICALLY WITNESSED BY LANGAN PERSONNEL.

BORING AND TEST PIT SERIES INFORMATION

G	WRY PLATFORM, LANGAN 2004
HRP	HUDSON RIVER PARK, LANGAN 2001
D	HUDSON YARDS TOWER D, LANGAN 2013
BH	HUDSON YARDS ERY PLATFORM, LANGAN 2013
CD	NO. 7 SUBWAY EXTENSION, PB TEAM 2003
PE	NO. 7 SUBWAY EXTENSION, PB TEAM 2003
FD	NO. 7 SUBWAY EXTENSION, PB TEAM 2004
DDC	VARIOUS PROJECTS COMPILED BY NYCDDC
MR	MTA WEST SIDE YARDS, MRCE 1980-81
WT/TT	WESTWAY PROJECT, MRCE 1980-86
MG	MABSTOA GARAGE, MRCE 1986
Q	AS REPORTED FOR MTA WEST SIDE YARDS, MRCE 1980-81
M	AS REPORTED FOR MTA WEST SIDE YARDS, MRCE 1980-81
ARC	ARC TUNNEL, PB/STV 2008
PB	NORTH ACCESS TUNNEL (EMPIRE LINE), 1987
CI	NORTH RIVER POLLUTION CONTROL, 1968
SEG3	GATEWAY TUNNEL, PB/STV 2015
SEG4	GATEWAY TUNNEL, PB/STV 2015
NW/WW	GATEWAY TUNNEL, PB/STV 2015
DPW	PIER 36, NYC DEPT. OF GENERAL SERVICES, 1994

LEGEND

G-# ELEV (NAVD88)	LANGAN BORINGS 2004 APPROXIMATE ELEVATION (TOP OF ROCK)
(S)CPT-#	LANGAN CONE PENETRATION TESTING 2004
##-# ELEV (NAVD88)	APPROXIMATE ELEVATION (TOP OF ROCK) BORINGS BY OTHERS SEE LIST ABOVE
	APPROXIMATE LIMITS OF PROPOSED WEST RAIL YARD DEVELOPMENT

50 0 25 50
SCALE IN FEET

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Langan Engineering and Environmental Services, Inc.
Langan CT, Inc.
Langan International LLC
Collectively known as Langan

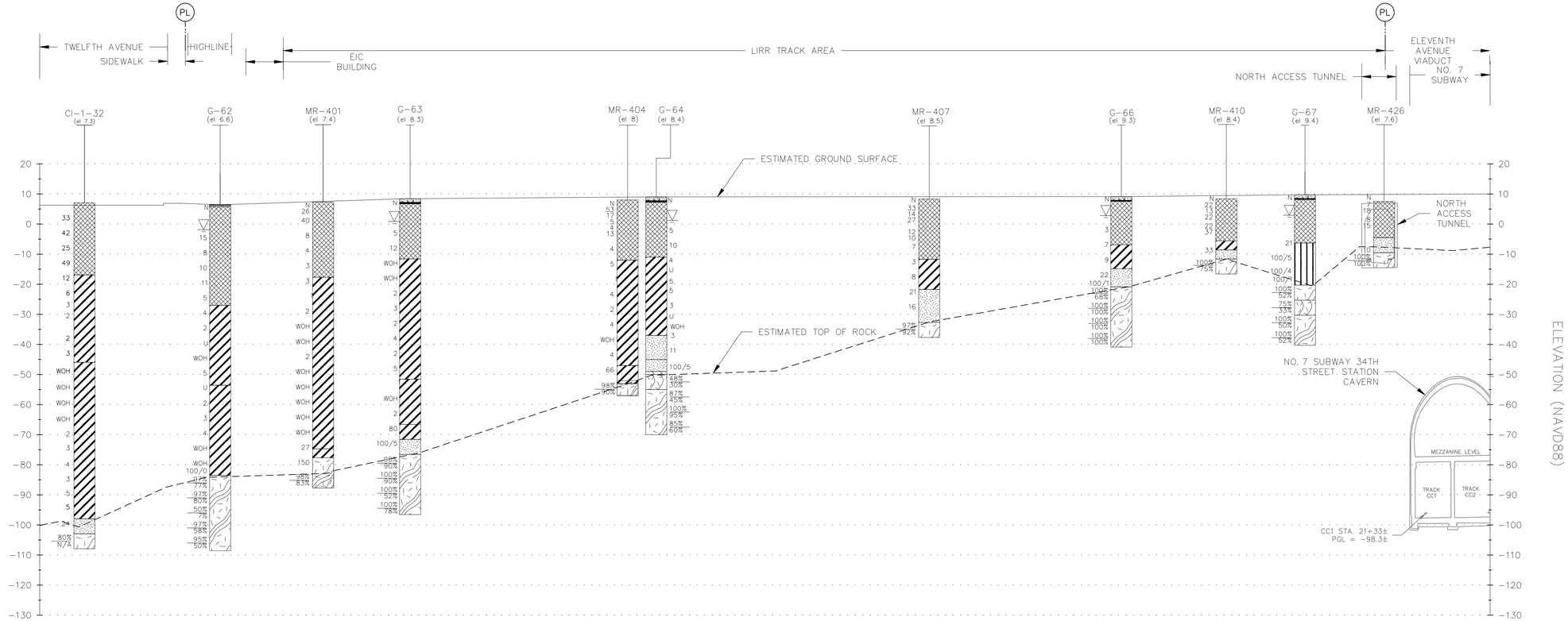
Project
WEST RAIL YARD PLATFORM
HUDSON YARDS
MANHATTAN NEW YORK

Drawing Title
BORING AND CPT LOCATION PLAN

Project No. 170444101	Drawing No. 12
Date 3/24/2017	
Scale 1" = 50'	
Drawn By KM / Checked By MP	
Submission Date -	Sheet 12 of 18

PROJECT NO. 170444101 SUBMISSION DATE: ### LANGAN

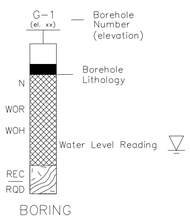
Filename: \\langan.com\data\NY\data1\170444101\Cadd Data - 170444101\SheetFiles\Geotechnical Report\Dwg 12. Boring Location Plan.dwg Date: 4/27/2017 Time: 16:48 User: kmerrill Style Table: Langan.stb Layout: ANSID-SL



A SUBSURFACE PROFILE AT 25' FROM NORTH PROPERTY LINE

VERTICAL SCALE: 1"=20'. HORIZONTAL SCALE: 1"=40'

BORING KEY DIAGRAM



EXPLANATION OF BOREHOLE LITHOLOGY

N	STANDARD PENETRATION RESISTANCE; NUMBER OF BLOWS OF A 140 LB HAMMER FREE FALLING 30 IN TO DRIVE A 2 INCH O.D. SPLIT SPOON SAMPLER 12 INCH, AFTER 6 IN OF INITIAL PENETRATION
WOR	2 FT PENETRATION OF THE SPLIT SPOON SAMPLER UNDER THE WEIGHT OF DRILL RODS
WOH	2 FT PENETRATION OF THE SPLIT SPOON SAMPLER UNDER THE STATIC WEIGHT OF THE DRIVING HAMMER
U	UNDISTURBED SAMPLE
REC	(LENGTH OF ROCK RETRIEVED) / (LENGTH OF ROCK CORED) * 100%
RQD	(LENGTH OF ROCK 4 IN OR LONGER) / (LENGTH OF ROCK CORED) * 100%

LITHOLOGY GRAPHICS

BEDROCK (CLASS 1A-1C)
SOFT BEDROCK (CLASS 1D)
GRAVEL (CLASS 2, 6)
GRANULAR SOILS (CLASS 3, 6)
CLAY (CLASS 4, 6)
SILT (CLASS 5, 6)
FILL (CLASS 7)
CONCRETE
ASPHALT

LITHOLOGY NOTES

NEW YORK CITY BUILDING CODE MATERIAL CLASSIFICATION NOTES:

BEDROCK
- 1A (HARD SOUND ROCK) – RQD > 85% W/ SIZE NX CORE OR REC > 85% W/ SIZE BX CORE.
- 1B (MEDIUM ROCK) – 50 < RQD < 85% W/ SIZE NX CORE OR 50% > REC < 85% W/ SIZE BX CORE.
- 1C (INTERMEDIATE ROCK) – 35% < RQD < 50% W/ SIZE NX CORE OR 35% < REC 50% W/ SIZE BX CORE.
- 1D (SOFT ROCK) – RQD LESS THAN 35% W/ SIZE NX CORE OR REC < 35% W/ SIZE BX CORE, OR SPT N-VALUE > 50 BPF. APPLIES ONLY TO ROCK WITH COMPLETELY WEATHERED ZONES OF LESS THAN 3-INCHES THICK.

SANDY GRAVEL AND GRAVELS (GW, GP)
- 2A (DENSE) – MATERIAL HAVING SPT N-VALUE > 30 BPF.
- 2B (MEDIUM) – MATERIAL HAVING SPT N-VALUES BETWEEN 10 AND 30 BPF.

GRANULAR SOILS (GM, GC, SM, SC, SP, SW)
- 3A (DENSE) – MATERIAL HAVING SPT N-VALUE > 30 BPF.
- 3B (MEDIUM) – MATERIAL HAVING SPT N-VALUES BETWEEN 10 AND 30 BPF

CLAYS (CL, CH)
- 4A (HARD) – MATERIAL HAVING SPT N-VALUE > 30 BPF, UNCONFINED COMPRESSIVE STRENGTH (UCS) > 4TSF
- 4B (STIFF) – MATERIAL HAVING SPT N-VALUES BETWEEN 8 AND 30 BPF, UCS BETWEEN 1 AND 4 TSF
- 4C (MEDIUM) – MATERIAL HAVING SPT N-VALUES BETWEEN 4 AND 8 BPF, UCS BETWEEN 0 AND 1 TSF

CLASS 5 – SILTS AND CLAYEY SILTS (ML, MH)
- 5A (DENSE) – MATERIAL HAVING SPT N-VALUE > 30 BPF
- 5B (MEDIUM) – MATERIAL HAVING SPT N-VALUES BETWEEN 10 AND 30 BPF

CLASS 6 – NOMINALLY UNSATISFACTORY BEARING MATERIALS
- LOOSE SANDY GRAVEL AND GRAVELS, GRANULAR SOILS, AND SILTS OF CLASSES 2, 3, OR 5, RESPECTIVELY HAVING SPT N-VALUES < 10 BPF
- SOFT CLAYS OF CLASS 4 HAVING SPT N-VALUES < 4 BPF, UNCONFINED COMPRESIVE STRENGTHS LESS THAN 0 TSF
- PEAT, ORGANIC SILT, ORGANIC CLAY, VARVED SILT.

CLASS 7 – CONTROLLED AND UNCONTROLLED FILL
- ALL FILLS HAVING BEEN PLACED IN EITHER CONTROLLED OR UNCONTROLLED SETTINGS.

NOTES

1. ELEVATIONS WITHIN THIS DRAWING REFER TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88).

   DATUM CONVERSIONS:
   BPMD = NAVD88 – 1.676'
   NGVD29 = NAVD88 + 1.076'
   NYCT = NAVD88 + 98.423'
   PENN = NAVD88 + 298.351'
2. APPROXIMATE PROFILE GRADE LINE (PGL) ELEVATIONS ARE ESTIMATED FROM NO. 7 LINE DRAWINGS (CONTRACT C-26503).
3. EXISTING ABOVE GRADE STRUCTURES NOT SHOWN FOR CLARITY.
4. BORING LOCATIONS SHOULD BE CONSIDERED APPROXIMATE. SEE DRAWING NO. 2 FOR BORING LOCATIONS AND DETAILS.
5. SUBSURFACE LITHOLOGY INTERPRETED FROM RECOVERED SOIL AND ROCK CORE SAMPLES AND OR AS REPORTED BY OTHERS.
6. THIS PLAN WAS PREPARED USING DATA FROM VARIOUS SOURCES. LANGAN MAKES NO WARRANTEE AS TO THE ACCURACY OF SUBSURFACE DATA NOT COLLECTED BY LANGAN PERSONNEL.
7. THIS PROFILE REPRESENTS A GENERALIZED SOIL CROSS SECTION INTERPRETED FROM WIDELY SPACED BORINGS. SOIL AND BEDROCK MAY VARY IN TYPE, LOCATION ELEVATION, ENVIRONMENTAL, AND ENGINEERING PROPERTIES BETWEEN POINTS OF EXPLORATION. VARIATIONS IN SUBSURFACE CONDITIONS SHOULD BE EXPECTED BETWEEN BORINGS.

40 0 20 40
HORIZONTAL SCALE IN FEET

20 0 10 20
VERTICAL SCALE IN FEET

Date	Description	No.
REVISIONS		

SIGNATURE DATE SIGNED
PROFESSIONAL XXXXXXXXXX
STATE LIC. No. XXXXX

LANGAN
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Langan Engineering and Environmental Services, Inc.
Langan CT, Inc.
Langan International LLC
Collectively known as Langan

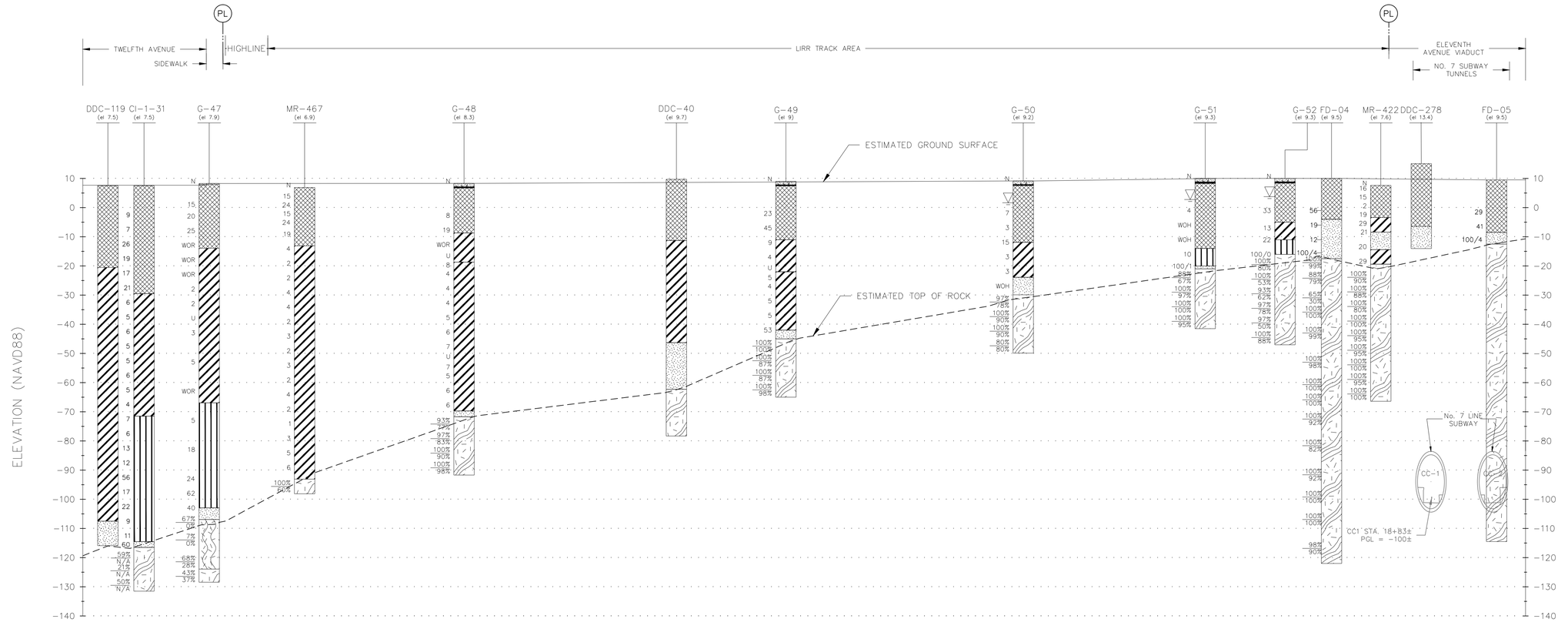
Project: WEST RAIL YARD PLATFORM
HUDSON YARDS
MANHATTAN NEW YORK

Drawing Title: SUBSURFACE PROFILE A

Project No. 170444101	Drawing No. 13
Date 4/4/2017	
Scale AS SHOWN	
Drawn By KM / Checked By MP	
Submission Date -	Sheet 13 of 18

LANGAN
PROJECT NO. 170444101 SUBMISSION DATE: ####

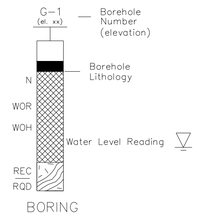
Filename: \\langan.com\data\NY\data1\170444101\Cadd Data - 170444101\2D-DesignFiles\Geotechnical\WRY Report\170444101-B-PF0102.dwg Date: 4/27/2017 Time: 16:56 User: kmerrill Style Table: Langan.stb Layout: Section A



B SUBSURFACE PROFILE AT 275' FROM NORTH PROPERTY LINE

VERTICAL SCALE: 1"=20'. HORIZONTAL SCALE: 1"=40'

BORING KEY DIAGRAM



EXPLANATION OF BOREHOLE LITHOLOGY

N	STANDARD PENETRATION RESISTANCE; NUMBER OF BLOWS OF A 140 LB HAMMER FREE FALLING 30 IN TO DRIVE A 2 INCH O.D. SPLIT SPOON SAMPLER 12 INCH, AFTER 6 IN OF INITIAL PENETRATION
WOR	2 FT PENETRATION OF THE SPLIT SPOON SAMPLER UNDER THE WEIGHT OF DRILL RODS
WOH	2 FT PENETRATION OF THE SPLIT SPOON SAMPLER UNDER THE STATIC WEIGHT OF THE DRIVING HAMMER
U	UNDISTURBED SAMPLE
REC	(LENGTH OF ROCK RETRIEVED) / (LENGTH OF ROCK CORED) * 100%
RQD	(LENGTH OF ROCK 4 IN OR LONGER) / (LENGTH OF ROCK CORED) * 100%

LITHOLOGY GRAPHICS

BEDROCK (CLASS 1A-1C) · SOFT BEDROCK (CLASS 1D) · GRAVEL (CLASS 2, 6) · GRANULAR SOILS (CLASS 3, 6) · CLAY (CLASS 4, 6) · SILT (CLASS 5, 6) · FILL (CLASS 7) · CONCRETE · ASPHALT

LITHOLOGY NOTES

NEW YORK CITY BUILDING CODE MATERIAL CLASSIFICATION NOTES:

BEDROCK
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- 4A (HARD) – MATERIAL HAVING SPT N-VALUE > 30 BPF, UNCONFINED COMPRESSIVE STRENGTH (UCS) > 4TSF
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- 4C (MEDIUM) – MATERIAL HAVING SPT N-VALUES BETWEEN 4 AND 8 BPF, UCS BETWEEN 0 AND 1 TSF

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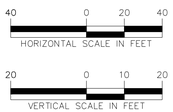
NOTES

1. ELEVATIONS WITHIN THIS DRAWING REFER TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88).

   DATUM CONVERSIONS:

BPMD	= NAVD88 – 1.676'
NGVD29	= NAVD88 + 1.076'
NYCT	= NAVD88 + 98.423'
PENN	= NAVD88 + 298.351'

2. APPROXIMATE PROFILE GRADE LINE (PGL) ELEVATIONS ARE ESTIMATED FROM NO. 7 LINE DRAWINGS (CONTRACT C-26503).
3. EXISTING ABOVE GRADE STRUCTURES NOT SHOWN FOR CLARITY.
4. BORING LOCATIONS SHOULD BE CONSIDERED APPROXIMATE. SEE DRAWING NO. 2 FOR BORING LOCATIONS AND DETAILS.
5. SUBSURFACE LITHOLOGY INTERPRETED FROM RECOVERED SOIL AND ROCK CORE SAMPLES AND OR AS REPORTED BY OTHERS.
6. THIS PLAN WAS PREPARED USING DATA FROM VARIOUS SOURCES. LANGAN MAKES NO WARRANTEE AS TO THE ACCURACY OF SUBSURFACE DATA NOT COLLECTED BY LANGAN PERSONNEL.
7. THIS PROFILE REPRESENTS A GENERALIZED SOIL CROSS SECTION INTERPRETED FROM WIDELY SPACED BORINGS. SOIL AND BEDROCK MAY VARY IN TYPE, LOCATION ELEVATION, ENVIRONMENTAL, AND ENGINEERING PROPERTIES BETWEEN POINTS OF EXPLORATION. VARIATIONS IN SUBSURFACE CONDITIONS SHOULD BE EXPECTED BETWEEN BORINGS.



Date	Description	No.
REVISIONS		

SIGNATURE DATE SIGNED
PROFESSIONAL XXXXXXXXXX
STATE LIC. No. XXXXX

LANGAN
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Langan Engineering, Environmental, Surveying and Landscape Architecture, D.P.C.
Langan Engineering and Environmental Services, Inc.
Langan CT, Inc.
Langan International LLC
Collectively known as Langan

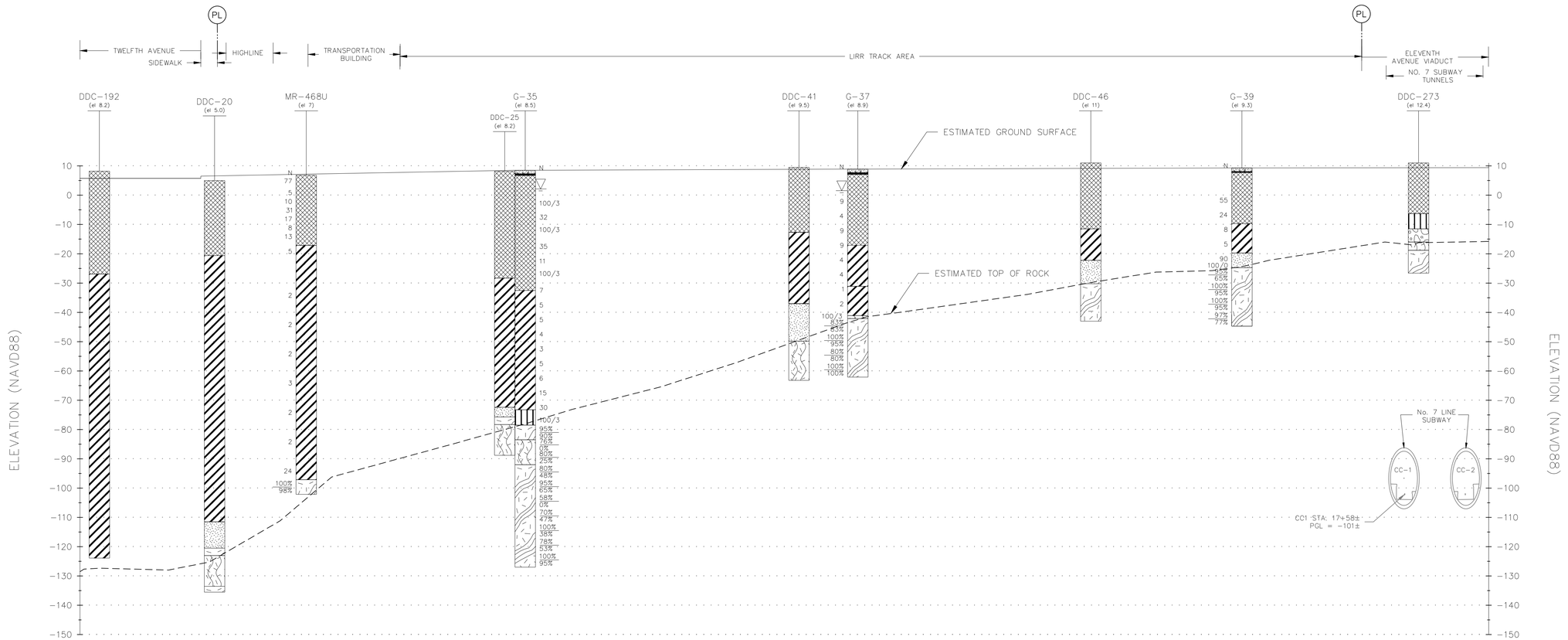
Project: WEST RAIL YARD PLATFORM
HUDSON YARDS
MANHATTAN NEW YORK

Drawing Title: SUBSURFACE PROFILE B

Project No. 170444101	Drawing No. 14
Date 4/6/2017	
Scale AS SHOWN	
Drawn By KM / Checked By MP	
Submission Date -	Sheet 14 of 18

Filename: \\langan.com\data\NY\data1\170444101\Cadd Data - 170444101\2D-DesignFiles\Geotechnical\WRY Report\170444101-B-PF0102.dwg Date: 4/27/2017 Time: 16:55 User: kmerrill Style Table: Langan.stb Layout: Section B

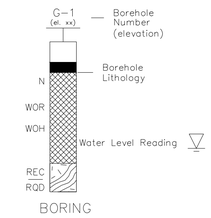
LANGAN
PROJECT NO. 170444101 SUBMISSION DATE: ####



C SUBSURFACE PROFILE AT 400' FROM NORTH PROPERTY LINE

VERTICAL SCALE: 1"=20'. HORIZONTAL SCALE: 1"=40'

BORING KEY DIAGRAM



EXPLANATION OF BOREHOLE LITHOLOGY

N	STANDARD PENETRATION RESISTANCE; NUMBER OF BLOWS OF A 140 LB HAMMER FREE FALLING 30 IN TO DRIVE A 2 INCH O.D. SPLIT SPOON SAMPLER 12 INCH, AFTER 6 IN OF INITIAL PENETRATION
WOR	2 FT PENETRATION OF THE SPLIT SPOON SAMPLER UNDER THE WEIGHT OF DRILL RODS
WOH	2 FT PENETRATION OF THE SPLIT SPOON SAMPLER UNDER THE STATIC WEIGHT OF THE DRIVING HAMMER
U	UNDISTURBED SAMPLE
REC	(LENGTH OF ROCK RETRIEVED) / (LENGTH OF ROCK CORED) * 100%
RQD	(LENGTH OF ROCK 4 IN OR LONGER) / (LENGTH OF ROCK CORED) * 100%

LITHOLOGY GRAPHICS

BEDROCK (CLASS 1A-1C)
SOFT BEDROCK (CLASS 1D)
GRAVEL (CLASS 2, 6)
GRANULAR SOILS (CLASS 3, 6)
CLAY (CLASS 4, 6)
SILT (CLASS 5, 6)
FILL (CLASS 7)
CONCRETE
ASPHALT

LITHOLOGY NOTES

NEW YORK CITY BUILDING CODE MATERIAL CLASSIFICATION NOTES:

BEDROCK
- 1A (HARD SOUND ROCK) – RQD > 85% W/ SIZE NX CORE OR REC > 85% W/ SIZE BX CORE.
- 1B (MEDIUM ROCK) – 50 < RQD < 85% W/ SIZE NX CORE OR 50% > REC < 85% W/ SIZE BX CORE.
- 1C (INTERMEDIATE ROCK) – 35% < RQD < 50% W/ SIZE NX CORE OR 35% < REC 50% W/ SIZE BX CORE.
- 1D (SOFT ROCK) – RQD LESS THAN 35% W/ SIZE NX CORE OR REC < 35% W/ SIZE BX CORE, OR SPT N-VALUE > 50 BPF. APPLIES ONLY TO ROCK WITH COMPLETELY WEATHERED ZONES OF LESS THAN 3-INCHES THICK.

SANDY GRAVEL AND GRAVELS (GW, GP)
- 2A (DENSE) – MATERIAL HAVING SPT N-VALUE > 30 BPF.
- 2B (MEDIUM) – MATERIAL HAVING SPT N-VALUES BETWEEN 10 AND 30 BPF.

GRANULAR SOILS (GM, GC, SM, SC, SP, SW)
- 3A (DENSE) – MATERIAL HAVING SPT N-VALUE > 30 BPF.
- 3B (MEDIUM) – MATERIAL HAVING SPT N-VALUES BETWEEN 10 AND 30 BPF

CLAYS (CL, CH)
- 4A (HARD) – MATERIAL HAVING SPT N-VALUE > 30 BPF, UNCONFINED COMPRESSIVE STRENGTH (UCS) > 4TSF
- 4B (STIFF) – MATERIAL HAVING SPT N-VALUES BETWEEN 8 AND 30 BPF, UCS BETWEEN 1 AND 4 TSF
- 4C (MEDIUM) – MATERIAL HAVING SPT N-VALUES BETWEEN 4 AND 8 BPF, UCS BETWEEN 0 AND 1 TSF

CLASS 5 – SILTS AND CLAYEY SILTS (ML, MH)
- 5A (DENSE) – MATERIAL HAVING SPT N-VALUE > 30 BPF
- 5B (MEDIUM) – MATERIAL HAVING SPT N-VALUES BETWEEN 10 AND 30 BPF

CLASS 6 – NOMINALLY UNSATISFACTORY BEARING MATERIALS
- LOOSE SANDY GRAVEL AND GRAVELS, GRANULAR SOILS, AND SILTS OF CLASSES 2, 3, OR 5, RESPECTIVELY HAVING SPT N-VALUES < 10 BPF
- SOFT CLAYS OF CLASS 4 HAVING SPT N-VALUES < 4 BPF, UNCONFINED COMPRESIVE STRENGTHS LESS THAN 0 TSF
- PEAT, ORGANIC SILT, ORGANIC CLAY, VARVED SILT.

CLASS 7 – CONTROLLED AND UNCONTROLLED FILL
- ALL FILLS HAVING BEEN PLACED IN EITHER CONTROLLED OR UNCONTROLLED SETTINGS.

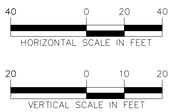
NOTES

1. ELEVATIONS WITHIN THIS DRAWING REFER TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88).

   DATUM CONVERSIONS:

BPMD	= NAVD88 – 1.676'
NGVD29	= NAVD88 + 1.076'
NYCT	= NAVD88 + 98.423'
PENN	= NAVD88 + 298.351'

2. APPROXIMATE PROFILE GRADE LINE (PGL) ELEVATIONS ARE ESTIMATED FROM NO. 7 LINE DRAWINGS (CONTRACT C-26503).
3. EXISTING ABOVE GRADE STRUCTURES NOT SHOWN FOR CLARITY.
4. BORING LOCATIONS SHOULD BE CONSIDERED APPROXIMATE. SEE DRAWING NO. 2 FOR BORING LOCATIONS AND DETAILS.
5. SUBSURFACE LITHOLOGY INTERPRETED FROM RECOVERED SOIL AND ROCK CORE SAMPLES AND OR AS REPORTED BY OTHERS.
6. THIS PLAN WAS PREPARED USING DATA FROM VARIOUS SOURCES. LANGAN MAKES NO WARRANTEE AS TO THE ACCURACY OF SUBSURFACE DATA NOT COLLECTED BY LANGAN PERSONNEL.
7. THIS PROFILE REPRESENTS A GENERALIZED SOIL CROSS SECTION INTERPRETED FROM WIDELY SPACED BORINGS. SOIL AND BEDROCK MAY VARY IN TYPE, LOCATION ELEVATION, ENVIRONMENTAL, AND ENGINEERING PROPERTIES BETWEEN POINTS OF EXPLORATION. VARIATIONS IN SUBSURFACE CONDITIONS SHOULD BE EXPECTED BETWEEN BORINGS.



Date	Description	No.
REVISIONS		

SIGNATURE DATE SIGNED
PROFESSIONAL XXXXXXXXXX
STATE LIC. No. XXXXX

LANGAN
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Collectively known as Langan

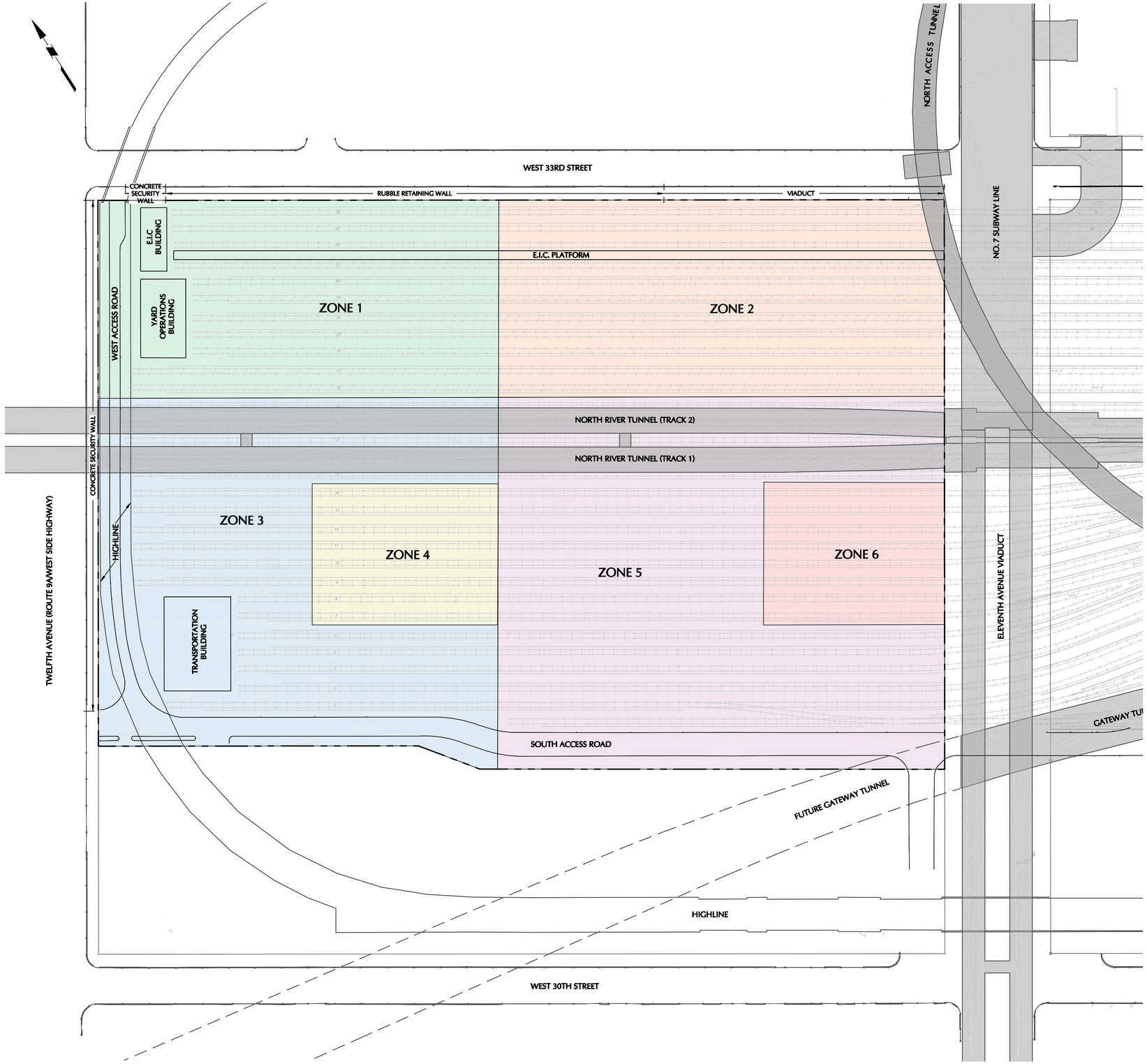
Project: WEST RAIL YARD PLATFORM
HUDSON YARDS
MANHATTAN NEW YORK

Drawing Title: SUBSURFACE PROFILE C

Project No.	170444101
Date	4/6/2017
Scale	AS SHOWN
Drawn By	KM
Checked By	MP
Submission Date	-
Drawing No.	15
Sheet	15 of 18

PROJECT NO. 170444101 SUBMISSION DATE: ####

Filename: \\langan.com\data\NY\data1\170444101\Cadd Data - 170444101\2D-DesignFiles\Geotechnical\WRY Report\170444101-B-PF0102.dwg Date: 4/27/2017 Time: 16:53 User: kmerrill Style Table: Langan.stb Layout: Section C



NOTES

1. EXISTING INFORMATION TAKEN FROM TOPOGRAPHIC AND BOUNDARY SURVEY PREPARED BY LANGAN ENGINEERING, ENVIRONMENTAL, SURVEYING AND LANDSCAPED ARCHITECTURE, D.P.C., DATED 4 APRIL 2004, AND LAST REVISED 13 MARCH 2017.
2. PROPOSED GATEWAY TUNNEL EXTENTS TAKEN FROM AMTRAK HUDSON YARDS PHASE II – WEST RAIL YARDS PROJECT LOCATION PLAN, X-011, DATED 30 DECEMBER 2016.
3. THIS PLAN WAS PRODUCED USING DATA FROM MULTIPLE SOURCES. LANGAN MAKES NO WARRANTEE AS TO THE ACCURACY OF DATA NOT SPECIFICALLY WITNESSED BY LANGAN PERSONNEL.
4. SEISMIC ZONE BOUNDARIES WERE PROVIDED BY MUESER RUTLEDGE CONSULTING ENGINEERS.

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Project
WEST RAIL YARD PLATFORM
HUDSON YARDS
MANHATTAN NEW YORK

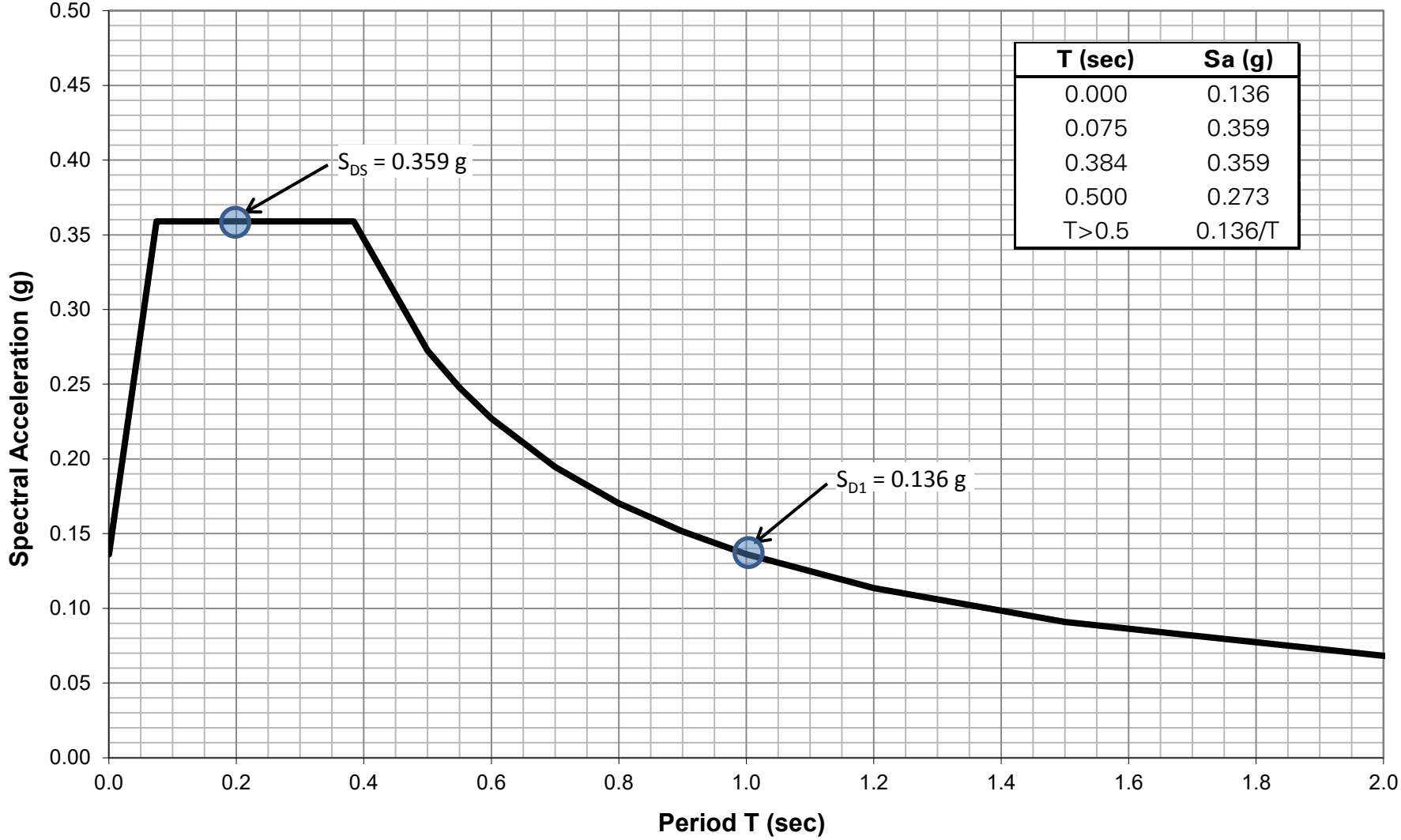
Drawing Title
SEISMIC ANALYSIS ZONE LOCATION PLAN

Project No. 170444101	Drawing No. 16
Date 4/10/2017	
Scale 1" = 50'	
Drawn By KM / Checked By MP	
Submission Date -	Sheet 16 of 18

PROJECT NO. 170444101 SUBMISSION DATE: ### LANGAN

Filename: \\langan.com\data\NY\data1\170444101\Cadd Data - 170444101\SheetFiles\Geotechnical Report\Dwg 16. Seismic Zone Location Plan.dwg Date: 4/25/2017 Time: 10:25 User: kmerrill Style Table: Langan.stb Layout: ANSID-SL

Recommended Surface Design Acceleration Response Spectrum (ξ=5%)



T (sec)	Sa (g)
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T>0.5	0.136/T

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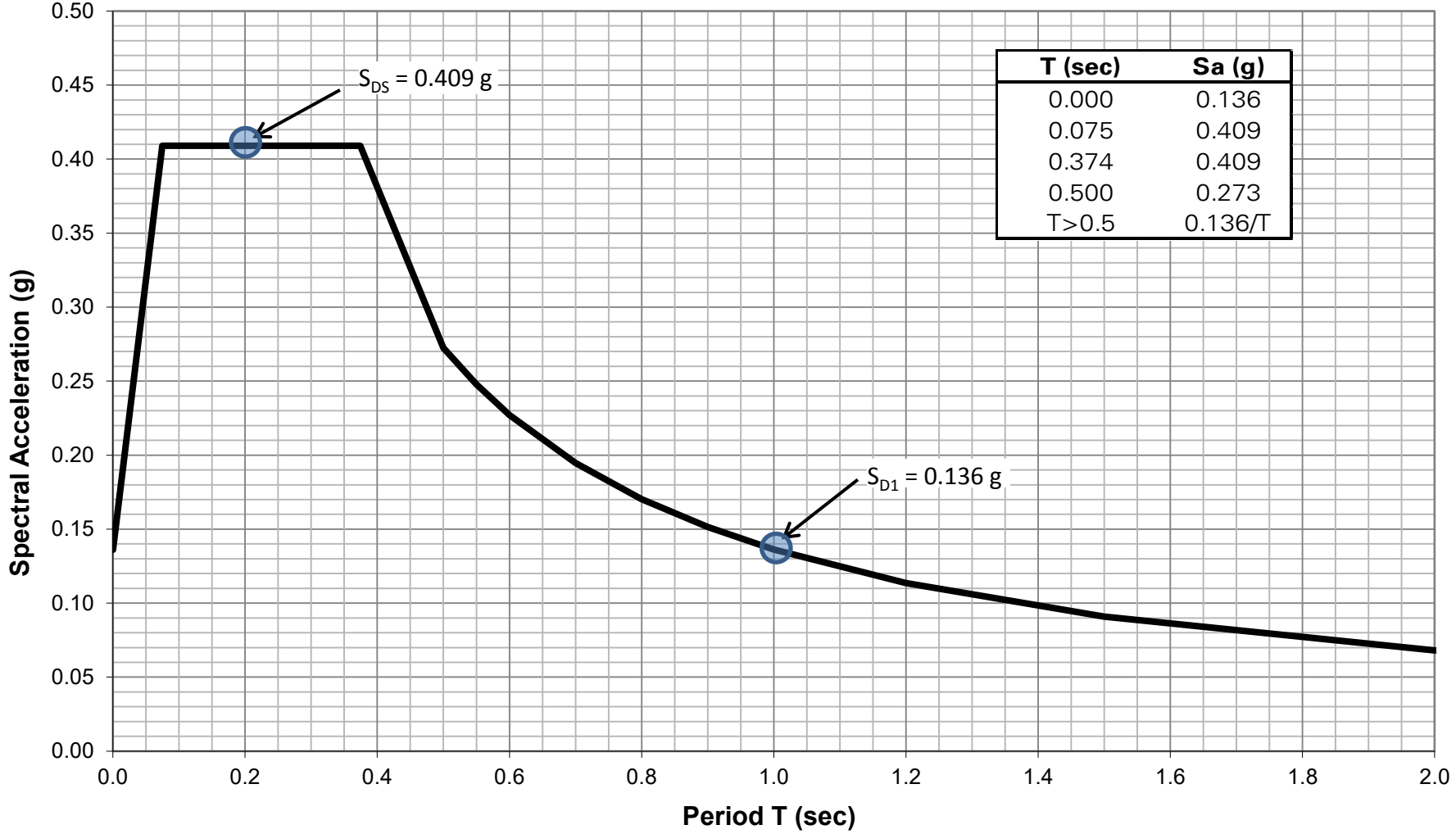
Project	WEST RAIL YARD PLATFORM HUDSON YARDS MANHATTAN NEW YORK
Drawing Title	RECOMMENDED SITE-SPECIFIC DESIGN RESPONSE SPECTRUM (ZONES 1-5)
Project No.	170444101
Date	4/25/2017
Scale	N.T.S
Drawn By	KM
Submission Date	-
Drawing No.	17
	Sheet 17 of 18

Recommended Surface Design Acceleration Response Spectrum (ξ=5%)



T (sec)	Sa (g)
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0.075	0.409
0.374	0.409
0.500	0.273
T>0.5	0.136/T

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Project
WEST RAIL YARD PLATFORM
HUDSON YARDS
MANHATTAN NEW YORK

Drawing Title
RECOMMENDED SITE-SPECIFIC DESIGN RESPONSE SPECTRUM (ZONE 6)

Project No. 170444101
Date 4/25/2017
Scale N.T.S
Drawn By KM
Submission Date -

Drawing No. 18

APPENDIX A

2004 Langan Boring Logs (NYSCC)

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Log of Boring **G-1** Sheet 1 of 7

Project: Hudson Yards - WRY	Project No.: 170444101
Location: LIRR West Side Yard, Manhattan, NY	Elevation and Datum: Approx. 6.9 NAVD88
Drilling Company: Warren George, Inc.	Date Started: 11/3/04 — Date Finished: 11/15/04
Drilling Equipment: Acker-11 Truck Rig	Completion Depth: 150 ft — Rock Depth: 130 ft
Size and Type of Bit: 3 7/8" Tri-Cone Rollerbit	Number of Samples: Disturbed 24 — Undisturbed 2 — Core 5
Casing Diameter (in): 3"/4" Flush Joint Steel — Casing Depth (ft): 128	Water Level (ft.): First — Completion — 24 HR.
Casing Hammer: Donut — Weight (lbs): 300 — Drop (in): 30	Drilling Foreman: Corry Tirro
Sampler: 2" O.D. Split Spoon / 3" Shelby Tube	Field Engineer: Nipam Shah
Sampler Hammer: Automatic — Weight (lbs): 140 — Drop (in): 30	

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	+6.9			0						Boring located in southwest corner of NYDS gas station, about 41' north of 30th Street fence and about 27' east of 12th Avenue fence
	+6.4	6" Concrete		1						
		Dark brown, SAND, some gravel, brick (Fill) [NYCBC Class 7]		2						qu (tsf) estimated from Pocket Penetrometer
				3						Hand auger to 5'
				4						Plastic grid pieces at 4'
				5						
				6						Dill to 10' using rollerbit and water with no down pressure
				7						
				8						
				9						
		S-1: Brown, coarse to fine SAND, some silt, some coarse to fine gravel, concrete fragments (Fill) [NYCBC Class 7]		10	S-1	SS	12	8 54 48 62	102	Spin 4" casing to 10'
				11						
				12						
				13						
				14						
		S-2: Dark brown, coarse to fine SAND, some silt, concrete, trace medium to fine gravel (Fill) [NYCBC Class 7]		15	S-2	SS	11	20 19 16 11	35	
				16						
				17						Rollerbit to 20'
				18						
				19						
				20						

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Log of Boring **G-1** Sheet 2 of 7

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 6.9 NAVD88

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-13.1	S-3: Brown-dark brown, coarse to fine SAND, some silt, trace coarse to fine gravel, concrete, brick, root fragments (Fill) [NYCBC Class 7]		20	S-3	SS	12	4 4 4 2	8	
				21						
				22						Drilling mud additive (revert) mixed with water
				23						Roller bit to 25'
				24						
		S-4: Dark brown-black, fine to medium SAND, some silt, some fine gravel, trace shell fragments (Fill) [NYCBC Class 7]		25	S-4	SS	13	3 5 5 11	10	
				26						
				27						Spin 4" casing to 30'
				28						Casing breaks inside hole
				29						Missed sample 30 ft to 32 ft due to casing problem (break and retrieval)
				30						
				31						Rollerbit to 35'
				32						
				33						
				34						
		S-5: Dark brown-black, medium to fine SAND, some fine gravel, trace clay, trace silt (Fill) [NYCBC Class 7]		35	S-5	SS	5	6 4 4 3	8	
				36						
				37						Rollerbit to 40'
				38						
				39						
	-33.1			40						
		S-6: Dark grey, CLAY (CH), trace silt, trace shell fragments [NYCBC Class 4c]		41	S-6	SS	22	3 3 2 3	5	q_u=0.5 tsf
				42						Rollerbit to 45'
				43						
				44						
				45						

N-Value (Blows/ft) scale: 10 20 30 40

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Log of Boring **G-1** Sheet 3 of 7

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 6.9 NAVD88

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-38.1	S-7: Dark grey, CLAY (CH), trace silt, trace shell fragments [NYCBC Class 4c]		45	S-7	SS	11	3 2 2 3	4	q_u=0.5 tsf Shelby tube sample attempted 45' to 47' (No recovery)
				46						Take split spoon sample at same depth
				47	U-1	UNDIST	8			2nd attempt for shelby tube 47' to 49'
				48						
				49						
		S-8: Dark grey, CLAY (CH), some silt, trace fine gravel, trace shell fragments [NYCBC Class 4c]		50	S-8	SS	13	2 2 3 3	5	q_u=0.25 tsf
				51						
				52						Rollerbit to 55'
				53						
				54						
		S-9: Dark grey, CLAY (CH), trace silt, trace shell fragments [NYCBC Class 4c]		55	S-9	SS	24	2 2 2 2	4	q_u=0.25 tsf
				56						
				57	U-2	UNDIST	19			
				58						
				59						
		S-10: Dark grey, CLAY (CH), some shell fragments [NYCBC Class 4c]		60	S-10	SS	14	1 2 2 3	4	q_u=0.4 tsf
				61						
				62						
				63						
				64						
		S-11: Dark grey, CLAY (CL), some shell fragments, trace silt [NYCBC Class 4c]		65	S-11	SS	11	2 2 3 3	5	
				66						
				67						Rollerbit to 70'
				68						
				69						
				70						

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Log of Boring **G-1** Sheet 4 of 7

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 6.9 NAVD88

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-63.1	S-12: Dark grey, CLAY (CL), trace shell fragments [NYCBC Class 4c]		70	S-12	SS	23	2 3 3 3	6	q_u=0.15 tsf
				71						
				72						Rollerbit to 75'
				73						
				74						
		S-13: Dark grey, silty CLAY (CL), trace shell fragments [NYCBC Class 4c]		75	S-13	SS	12	WOR 2 3 2	5	q_u=0.25 tsf
				76						
				77						Rollerbit to 80'
				78						
				79						
		S-14: Dark grey, silty CLAY (CL), trace shell fragments [NYCBC Class 4c]		80	S-14	SS	24	1 2 2 1	4	
				81						
				82						Rollerbit to 85'
				83						
				84						
		S-15: Dark grey, silty CLAY (CL), trace fine sand, trace shell fragments [NYCBC Class 6]		85	S-15	SS	24	WOR WOR 1 1		
				86						
				87						Rollerbit to 90'
				88						
				89						
	-83.1	S-16: Grey, clayey SILT (ML), some fine sand, trace shell fragments [NYCBC Class 5b]		90	S-16	SS	24	2 3 8 6	11	
				91						
				92						Rollerbit to 95'
				93						
				94						
	-88.1			95						

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Log of Boring **G-1** Sheet 5 of 7

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 6.9 NAVD88

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-88.1	S-17: Grey, fine SAND (SM), some silt, trace shell fragments [NYCBC Class 3b]		95–120	S-17	SS	20	3 3 10 13	13	Rollerbit to 100'
		S-18: Gray fine SAND (SM), some silt, trace shell fragments [NYCBC Class 3b]			S-18	SS	24	5 6 12 14	18	Spin 3" casing to 100' Rollerbit to 105'
		S-19: Grey, fine SAND (SM), some silt, trace fine gravel, trace shell fragments [NYCBC Class 6]			S-19	SS	10	3 3 4 7	7	Rollerbit to 110'
		S-20:NO RECOVERY. GRAVEL IN SPOON TIP.			S-20	SS	0	WOR WOR WOR WOR		Rollerbit to 115'
		S-21: Grey, fine SAND (SM), some silt, trace rock fragments [NYCBC Class 3b]			S-21	SS	1	6 8 9 15	17	Rollerbit to 120'

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Log of Boring **G-1** Sheet 6 of 7

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 6.9 NAVD88

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-113.1	S-22: Dark grey-grey, fine SAND (SM), some silt, trace wood fragments, trace fine gravel [NYCBC Class 3b]		120	S-22	SS	12	6, 7, 10, 12	17	
				121						
				122						Rollerbit to 125'
				123						
	-117.1			124						
				125	S-23	SS	0	100/0"	100/0"	Rig chattering and hard drilling 124' to 125' (Boulder)
				126						Spin 3" casing to 125'
		S-24: Grey-brown, medium to fine SAND (SM), some silt, some fine gravel, trace rock fragments (Glacial Till) [NYCBC Class 3a]		127						Drill through boulder and spin casing to 128'
				128	S-24	SS	8	6, 22, 100/1"	100/1"	Top of rock at 130'
	-123.1			129						
				130						
		C-1: Grey-black, mica SCHIST, rough, moderately weathered to highly weathered, moderately to highly fractured, fine to medium grained, strong rock, very closely to widely spaced fractures. [NYCBC Class 1b]	8	131	C-1	NX CORE BARREL	REC=60"/60" =100%	RQD=44"/60" =73%		
			7	132						
			6	133						
	-127.1	Clay coated fracture 134' to 135'	6	134						
	-128.1		6	135						
		C-2: Grey, mica SCHIST, rough, moderately weathered to highly weathered, moderately to highly fractured, fine to medium grained, strong rock, very closely fractured. [NYCBC Class 1b] 137' to 138.9' white granitic pegmatite zone with highly fractured joints	8	136	C-2	NX CORE BARREL	REC=60"/60" =100%	RQD=36"/60" =60%		
			8	137						
			7	138						
			7	139						
			7	140						
		C-3: Grey-black, mica SCHIST, rough, moderately weathered to highly weathered, moderately to highly fractured, fine to medium grained, strong rock, very closely to widely spaced fractures. [NYCBC Class 1b]	8	141	C-3	NX CORE BARREL	REC=60"/60" =100%	RQD=35"/60" =58%		
			8	142						
			8	143						
			8	144						
			7	145						

N-Value (Blows/ft) scale: 10 20 30 40

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Log of Boring **G-1** Sheet 7 of 7

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 6.9 NAVD88

MATERIAL SYMBOL	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-138.1			145						
			7		C-3					
		C-4: Grey-white, mica SCHIST, rough moderately to highly fractured, fine to medium grained, strong rock, closely to widely spaced fractures. [NYCBC Class 1b]		146						
			8	147						
			8	148	C-4	NX CORE BARREL	REC=42"/48" =88%	RQD=24"/48" =50%		
			7	149						
			8							
	-143.1			150						
		End of boring at 150'		151						Borehole backfilled with cuttings and surface patched upon completion
				152						
				153						
				154						
				155						
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				158						
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				170						

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Log of Boring **G-15** Sheet 1 of 3

Project: Hudson Yards - WRY	Project No.: 170444101
Location: LIRR West Side Yard, Manhattan, NY	Elevation and Datum: Approx. 22.2 NAVD88
Drilling Company: Warren George, Inc.	Date Started: 10/22/04 — Date Finished: 10/25/04
Drilling Equipment: DK-50 Track Rig	Completion Depth: 61 ft — Rock Depth: 41 ft
Size and Type of Bit: 3 7/8" Tri-Cone Rollerbit	Number of Samples: Disturbed 8 — Undisturbed 0 — Core 4
Casing Diameter (in): 3"/4" Flush Joint Steel — Casing Depth (ft): 41	Water Level (ft.): First ▽ — Completion ▼ — 24 HR. ▼
Casing Hammer: Donut — Weight (lbs): 300 — Drop (in): 30	Drilling Foreman: Robert Ware
Sampler: 2" O.D. Split Spoon	Field Engineer: Juan Pinzon
Sampler Hammer: Donut — Weight (lbs): 140 — Drop (in): 30	

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	+22.2			0						Boring located on 11th Avenue sidewalk, about 67' north of 30th Street
	+22.0	3" Concrete Slab		1						
				2						Drill to 6' with rollerbit and water with no down pressure
				3						qu (tsf) estimated from Pocket Penetrometer
				4						Install 4" casing to 4'
				5						
		S-1: Dark brown, medium to fine SAND, some fine gravel, trace brick (Fill) [NYCBC Class 7]		6	S-1	SS	12	15 23 27 36	50	
				7						
				8						Rollerbit to 10' Install 4" casing to 9' Clean to 10' Mix revert
				9						
		S-2: Brick fragments, some silty sand (Fill) [NYCBC Class 7]		10	S-2	SS	3	4 5 6 4	11	
				11						
				12						Rollerbit to 15'
				13						
				14						
		S-3: Brown, medium to fine SAND, some silt, trace rock fragments (Fill) [NYCBC Class 7]		15	S-3	SS	6	10 8 5 6	13	
				16						
				17						Rollerbit to 20' Install 4" casing to 14' Clean to 20'
				18						
				19						
				20						

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Log of Boring **G-15** Sheet 2 of 3

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 22.2 NAVD88

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	+2.2	S-4: Brown-grey, medium to fine silty SAND, trace fine gravel, trace brick fragments (Fill) [NYCBC Class 7]		20	S-4	SS	16	WOH 1 2 1	3	
				21						
				22						Push 4" casing to 19' Rollerbit to 25'
				23						
				24						
		S-5: Grey, medium to fine SAND, some silt, some fine gravel, trace brick (Fill) [NYCBC Class 7]		25	S-5	SS	5	6 5 6 9	11	
				26						
				27						Rollerbit to 30'
				28						
				29						
	-7.8	S-6: Dark grey, silty CLAY (CH), trace fine sand, trace shell fragments [NYCBC Class 4c]		30	S-6	SS	6	5 4 3 3	7	
				31						
				32						Rollerbit to 35'
				33						
				34						
		S-7: Dark grey, silty CLAY (CH), trace fine sand, trace shell fragments [NYCBC Class 4c]		35	S-7	SS	24	4 4 4 5	8	q_u=0.5 tsf WC=59.1 , LL=64 , PL=26 Organic Content = 4.4% (burnoff)
				36						
				37						Rollerbit to 40'
				38						
	-16.8	S-8: Very dense, brown, medium to fine silty SAND (SM), some clay, some fine gravel [NYCBC Class 3a]		39						
				40	S-8	SS	11	9 12 100/0"	100/0"	Spoon refusal/bouncing at 41'
	-18.8			41						Push 3" casing to 29', spin to 40'
		C-1: Grey, fractured mica SCHIST, Hard, slightly weathered joints, some iron stained joints, foliation dip: 40-60 degrees [NYCBC Class 1b]	2.5	42	C-1	NX CORE BARREL	REC=55"/60" =92%	RQD=42"/60" =70%		
			5	43						
			4	44						
			4	45						

N-Value (Blows/ft) scale: 10 20 30 40

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Log of Boring **G-15** Sheet 3 of 3

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 22.2 NAVD88

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-22.8	Granitic PEGMATITE from 45' to 46'	3.5	45	C-1					
			5	46	C-2	NX CORE BARREL	REC=60"/60" =100%	RQD=38"/60" =63%		
		C-2: Grey, fractured mica SCHIST, hard, slightly weathered joints [NYCBC Class 1b] PEGMATITE from 46' to 46.3' and 49' to 49.8'	4	47						
			5.5	48						
			5.5	49						
			4.5	50						
			5	51	C-3	NX CORE BARREL	REC=60"/60" =100%	RQD=60"/60" =100%		
		C-3: Grey, slightly fractured mica SCHIST, hard, slightly weathered joints, foliation dip: 30-60 degrees [NYCBC Class 1a]	5	52						
			5.5	53						
			5	54						
			5.5	55						
			5	56	C-4	NX CORE BARREL	REC=58"/60" =97%	RQD=58"/60" =97%		
		C-4: Grey, sound mica SCHIST, hard, mechanical fractures along foliation, foliation dip: 50-60 degrees [NYCBC Class 1a]	5.5	57						
			5.5	58						
			5	59						
			5	60						
	-38.8	End of boring at 61'		61						Borehole backfilled with cuttings and surface patched upon completion
				62						
				63						
				64						
				65						
				66						
				67						
				68						
				69						
				70						

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Log of Boring **G-17** Sheet 1 of 6

Project: Hudson Yards - WRY	Project No.: 170444101
Location: LIRR West Side Yard, Manhattan, NY	Elevation and Datum: Approx. 7.1 NAVD88
Drilling Company: Warren George, Inc.	Date Started: 10/27/04 — Date Finished: 11/2/04
Drilling Equipment: Acker-11 Truck Rig	Completion Depth: 143 ft — Rock Depth: 123 ft
Size and Type of Bit: 3 7/8" Tri-Cone Rollerbit	Number of Samples: Disturbed 23 — Undisturbed 3 — Core 4
Casing Diameter (in): 3"/4" Flush Joint Steel — Casing Depth (ft): 123	Water Level (ft.): First ▽ — Completion ▼ — 24 HR. ▼
Casing Hammer: Donut — Weight (lbs): 300 — Drop (in): 30	Drilling Foreman: Corry Tirro
Sampler: 2" O.D. Split Spoon / 3" Shelby Tube	Field Engineer: S. Daripally / Nipam Shah
Sampler Hammer: Donut — Weight (lbs): 140 — Drop (in): 30	

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	+7.1			0						Boring located in northeast corner of NYDS gas station, about 95' east of 12th Avenue and 130' north of 30th Street
	+6.4	9" Concrete		1						
		Black, fine to coarse SAND and GRAVEL, some cobbles, trace brick, dry (Fill) [NYCBC Class 7]		2						qu (tsf) estimated from Pocket Penetrometer
				3						
				4						Rollerbit to 6' with water and no down pressure
				5						
				6						
				7						
				8						Drive 4" casing to 10' Rollerbit to 10'
				9						
		S-1: Black, medium to fine silty SAND, some rock fragments (Fill) [NYCBC Class 7]		10	S-1	SS	6	4 4 5 5	9	
				11						
				12						Rollerbit to 15'
				13						
				14						
		S-2: Black, GRAVEL, brick fragments, some medium to fine sand (Fill) [NYCBC Class 7]		15	S-2	SS	6	5 3 4 8	7	
				16						
				17						Drive 4" casing to 15' Rollerbit to 20'
				18						
				19						
				20						

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Log of Boring **G-17** Sheet 2 of 6

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 7.1 NAVD88

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-12.9	S-3: Black GRAVEL, some coarse to fine sand, trace wood, trace brick (Fill) [NYCBC Class 7]		20	S-3	SS	8	14, 8, 19, 15	27	
				21						
				22						Drive 4" casing to 20' Rollerbit to 25'
				23						
				24						
		S-4: Black GRAVEL, some coarse to fine sand, some silt, trace fine gravel (Fill) [NYCBC Class 7]		25	S-4	SS	5	8, 5, 9, 8	14	
				26						
				27						Drive 4" casing to 25' Rollerbit to 30'
				28						
				29						Rig chatter at 29'
		S-5: Black medium to fine SAND, some silt, rock fragments, trace wood (Fill) [NYCBC Class 7]		30	S-5	SS	8	15, 11, 11, 7	22	
				31						
				32						Drive 4" casing to 30' Rollerbit to 35'
				33						
				34						
		S-6: No recovery		35	S-6	SS	0	44, 100/2"	100/2"	
	-29.9			36						Hard drilling - (1.5' boulder)
				37						
				38						
				39						
		S-7: Black-grey, organic silty CLAY (OH), trace fine sand, trace wood [NYCBC Class 4c]		40	S-7	SS	24	2, 2, 4, 4	6	
				41						
				42						Drive 4" casing to 40' Rollerbit to 45'
				43						
				44						
				45						

N-Value (Blows/ft) scale: 10 20 30 40

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Log of Boring **G-17** Sheet 3 of 6

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 7.1 NAVD88

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-37.9	S-8: Dark grey, organic silty CLAY (OH), some shell fragments [NYCBC Class 4c]		45	S-8	SS	6	3 2 4 3	6	q_u=0.5 tsf
				46						Add revert to wash
				47						Rollerbit to 50'
				48						
				49						
		S-9: Dark grey, organic silty CLAY (OH), some shell fragments [NYCBC Class 4c]		50	S-9	SS	24	2 1 3 3	4	q_u=0.4 tsf
				51						
				52	U-1	UNDIST	24			Rollerbit to 52'
	-46.9			53						
		S-10: Dark grey, CLAY (CL), some shell fragments, trace silt [NYCBC Class 4c]		54	S-10	SS	24	3 3 4 5	7	q_u=0.75 tsf
				55						
				56	U-2	UNDIST	0			Rollerbit to 56'
				57						
		S-11: Dark grey, silty CLAY (CL), trace fine sand, trace shell fragments [NYCBC Class 4c]		58	S-11	SS	24	3 3 3 3	6	q_u=0.5 tsf
				59						
		S-12: Dark grey, organic silty CLAY (CL), trace fine sand, trace shell fragments [NYCBC Class 4c]		60	S-12	SS	6	2 3 2 3	5	Shelby tube attempted at 60', no recovery Take spoon instead
				61						
				62						Rollerbit to 65'
				63						
				64						
		S-13: Dark grey, silty CLAY (CH), trace shell fragments [NYCBC Class 6]		65	S-13	SS	24	2 1 2 4	3	q_u=1 tsf
				66						
				67						Rollerbit to 70'
				68						
				69						
				70						

N-Value (Blows/ft) scale: 10 20 30 40

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Log of Boring **G-17** Sheet 4 of 6

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 7.1 NAVD88

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-62.9	S-14: Dark grey, silty CLAY (CL), some shell fragments [NYCBC Class 4c]		70	S-14	SS	15	3 3 4 4	7	q_u=1.25 tsf
				71						
				72						Rollerbit to 75'
				73						
				74						
		S-15: Dark grey, silty CLAY (CL), some shell fragments [NYCBC Class 4c]		75	S-15	SS	24	WOH 3 2 3	5	q_u=0.75 tsf
				76						
				77						Rollerbit to 80'
				78						
				79						
		S-16: Dark grey, silty CLAY (CH), some f sand, trace shell fragements [NYCBC Class 6]		80	S-16	SS	24	WOH WOH 2 3		
				81						
				82	U-3	UNDIST	18			WC=27.1 , LL=27 , PL=14
		S-17: Dark grey, silty CLAY (CL), some fine sand, trace shell fragments [NYCBC Class 4b]		83						
				84	S-17	SS	24	4 5 9 16	14	q_u=0.25 tsf
				85						
				86						Rollerbit to 90'
				87						
				88						
				89						
		S-18: Dark grey, silty CLAY (CL), some fine sand, trace shell fragments [NYCBC Class 4c]		90	S-18	SS	24	2 3 5 11	8	q_u=0.25 tsf
				91						
				92						Rollerbit to 95'
				93						
				94						
				95						

N-Value (Blows/ft) scale: 10 20 30 40

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Log of Boring **G-17** Sheet 5 of 6

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 7.1 NAVD88

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-87.9	S-19: Dark grey, silty CLAY (CL), some fine sand, trace shell fragments [NYCBC Class 4c]		95	S-19	SS	24	1 3 4 9	7	q_u=0.25 tsf
				96						
				97						Rollerbit to 100'
				98						
				99						
		S-20: Dark grey, silty CLAY (CL), some fine sand, trace shell fragements [NYCBC Class 4b]		100	S-20	SS	2	5 8 13 16	21	
				101						
				102						Rollerbit to 105'
				103						
				104						
		S-21: Dark grey, silty CLAY (CL), some fine sand, trace shell fragments [NYCBC Class 4c]		105	S-21	SS	24	WOR WOR 6 6		q_u=0.6 tsf
				106						
				107						Rollerbit to 110
				108						
				109						
	-102.9			110						
		S-22: Dark grey, clayey SILT (ML), trace fine sand, wood fragments [NYCBC Class 5b]		111	S-22	SS	24	6 5 8 10	13	
				112						Rollerbit to 115'
				113						
				114						
		S-23: Dark grey, clayey SILT (ML), some fine sand, wood fragments [NYCBC Class 6]		115	S-23	SS	24	5 3 6 8	9	
				116						
				117						
				118						
	-111.9			119						Rig chatter at 119'
				120						

N-Value (Blows/ft) scale: 10 20 30 40

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Log of Boring **G-17** Sheet 6 of 6

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 7.1 NAVD88

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-112.9			120						
				121						
				122						
	-115.9			123						Spin 3" casing to 123'
		C-1: Greyish black, mica SCHIST, pegmatite from 123'-124', slightly weathered, slightly fractured, close to wide fracture spacing, strong rock, medium to fine grained [NYCBC Class 1a]	7	124	C-1	NX2 CORE BARREL	REC=60"/60" =100%	RQD=54"/60" =90%		
			6	125						
			5	126						
			7	127						
			8	128						
		C-2: Grey, granitic PEGMATITE, slightly weathered, slightly fractured, very wide fracture spacing, very strong rock, fine to medium grained, iron-oxide straining at 129' [NYCBC Class 1a]	8	129	C-2	NX2 CORE BARREL	REC=60"/60" =100%	RQD=60"/60" =100%		
			9	130						
			8	131						
			3	132						Core barrel jammed at 132.25'
			9	133						
		C-3: Grey, granitic PEGMATITE, slightly weathered except lightly weathered at 135'-137', slightly fractured except highly fractured 135'-137', close to very close fracture spacing, strong rock, fine to medium grained, chloride staining at 134'-137' [NYCBC Class 1b]	8	134	C-3	NX2 CORE BARREL	REC=60"/60" =100%	RQD=37"/60" =62%		
			9	135						
			10	136						
			10	137						
			10	138						
		C-4: Grey, granitic PEGMATITE, moderately weathered except highly weathered at 137'-138', moderately fractured, close to wide fracture spacing, very strong rock, fine grained, chloride staining at 138' and 142' [NYCBC Class 1b]	12	139	C-4	NX2 CORE BARREL	REC=59"/60" =98%	RQD=47"/60" =78%		
			12	140						
			15	141						
			14	142						Core barrel jammed at 141.75'
	-135.9	End of boring at 143'		143						Borehole backfilled with cuttings and surface patched upon completion
				144						
				145						

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Log of Boring **G-19** Sheet 1 of 5

Project: Hudson Yards - WRY	Project No.: 170444101
Location: LIRR West Side Yard, Manhattan, NY	Elevation and Datum: Approx. 7.2 NAVD88
Drilling Company: Warren George, Inc.	Date Started: 11/8/04 — Date Finished: 11/10/04
Drilling Equipment: CME 55 Truck Rig	Completion Depth: 112 ft — Rock Depth: 92 ft
Size and Type of Bit: 3 7/8" Tri-Cone Rollerbit	Number of Samples: Disturbed 16, Undisturbed 2, Core 4
Casing Diameter (in): 3"/4" Flush Joint Steel — Casing Depth (ft): 90	Water Level (ft.): First ▽, Completion ▼, 24 HR. ▼
Casing Hammer: Donut — Weight (lbs): 300 — Drop (in): 30	Drilling Foreman: Robert Ware
Sampler: 2" O.D. Split Spoon / 3" Shelby Tube	Field Engineer: Stuart Knoop
Sampler Hammer: Donut — Weight (lbs): 140 — Drop (in): 30	

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40
	+7.2			0					
	+6.8	5" Asphalt		1					
				2					
				3					
				4					
				5					
		S-1: Dark brown, fine to coarse GRAVEL, some wood fragments, trace ceramics (Fill) [NYCBC Class 7]		6	S-1	SS	5	4 7 13 6	20
				7					
				8					
				9					
		S-2: Grey-brown, clayey SILT, some fine gravel, trace brick fragments (Fill) [NYCBC Class 7]		10	S-2	SS	9	1 2 2 2	4
				11					
				12					
				13					
				14					
		S-3: Dark brown, sandy SILT, some clay, trace gravel (Fill) [NYCBC Class 7]		15	S-3	SS	3	4 1 WOH 1	
				16					
				17					
				18					
				19					
				20					

Remarks
(Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)

Boring located in Greyhound, about 14' east of operations building and 12' south of trench drain

"Use rollerbit with water and no down pressure to drill to 2'

Hard material at 2', hand auger to 2.5'"

Cobble obstruction at 2.5', rollerbit through

Hand auger to concrete obstruction at 4.5'

Rollerbit through obstruction, use no pressure to 6'

Rollerbit to 10'

Rollerbit to 15'

Rollerbit to 20'

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Log of Boring **G-19** Sheet 2 of 5

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 7.2 NAVD88

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-12.8	S-4: Dark grey, silty CLAY, trace fine gravel (Fill) [NYCBC Class 7]		20	S-4	SS	6	1 WOH WOH 20		
				21						
				22						Rollerbit to 25'
				23						
				24						
		S-5: No recovery		25	S-5	SS	2	11 100/0"	100/0"	Cobble at 25.5'
				26						
				27						Rollerbit through cobble
				28						Spin 4" casing to 30' Rollerbit to 30'
				29						
		S-6: Grey-brown, fine to coarse SAND, some fine gravel, some mica, rock fragements (Fill) [NYCBC Class 7]		30	S-6	SS	2	31 82 11 21	93	
				31						
				32						Rollerbit to 35'
				33						Hard drilling 30-34'
	-26.8			34						Spin 4" casing to 35'
		S-7: Dark grey, CLAY (OH), some organics, trace silt, trace shell fragments [NYCBC Class 4c]		35	S-7	SS	22	WOH 2 2 3	4	WC=57.7 , LL=77 , PL=28
				36						Organic Content = 5.9.% (burnoff)
				37						Spin 4" casing to 40' Rollerbit to 40'
				38						
				39						
	-32.8			40						
		S-8: Dark grey, CLAY (CH), trace silt, trace shell fragments [NYCBC Class 4b]		41	S-8	SS	24	3 3 4 2	7	
				42						Rollerbit to 45'
				43						
				44						
				45						

N-Value (Blows/ft) scale: 10 20 30 40

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Log of Boring **G-19** Sheet 3 of 5

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 7.2 NAVD88

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-37.8	S-9: Dark grey, organic CLAY (CH), trace silt, trace shell fragments [NYCBC Class 6]		45	S-9	SS	24	WOH 1 2	3	
				46						
				47				2 1		Rollerbit to 50'
				48						
				49						
				50	U-1	UNDIST	21			
				51						
				52						Rollerbit to 55'
				53						
				54						
		S-10: Dark grey, organic CLAY (CH), trace silt, trace shell fragments [NYCBC Class 6]		55	S-10	SS	24	WOH 1		
				56				2	3	
				57				1		Rollerbit to 60'
				58						
				59						
				60	U-2	UNDIST	24			WC=43.3 , LL=43 , PL=19
				61						
				62						Rollerbit to 65'
				63						
				64						
		S-11: Dark grey, organic clayey SILT (ML) with clay lenses, trace shell fragments [NYCBC Class 6]		65	S-11	SS	24	2		
				66				2 1	3	
				67				2		Rollerbit to 70'
				68						
				69						
				70						

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Log of Boring **G-19** Sheet 4 of 5

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 7.2 NAVD88

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-62.8	S-12: Dark grey, organic CLAY (CL), some silt, trace shell fragments [NYCBC Class 6]		70	S-12	SS	19	WOR WOR WOH WOH		
				71						
				72						Rollerbit to 75'
				73						
				74						
	-67.8	S-13: Dark grey, silty fine SAND (SM), trace clay, shell fragments, wood, silty clay lenses [NYCBC Class 6]		75	S-13	SS	24	WOH WOH 7 4		
				76						
				77						Rollerbit to 80'
				78						
				79						
		S-14: Dark grey, silty fine SAND (SM), trace clay, trace shell fragments [NYCBC Class 6]		80	S-14	SS	24	5 2 2 9	4	
				81						
				82						Rollerbit to 85'
	-76.8			83						
				84						
		S-15: Dark grey, clayey SILT (ML), trace fine sand, wood fragments, shell fragments [NYCBC Class 5b]		85	S-15	SS	22	7 10 11 18	21	
				86						
				87						Rollerbit to 90'
				88						
				89						
		S-16: Dark grey, silty CLAY (CH), trace fine sand, trace wood and shell fragments [NYCBC Class 4c]		90	S-16	SS	23	WOH 3 4 100/5"	7	Push 3" casing to 90'WC=42.1 , LL=52 , PL=20
	-84.8			91						
		C-1: Grey-white, quartz-muscovite-feldspar SCHIST with ~5" layers (apophasies) of brown-black biotite-chlorite-garnet schist (~20%), qtz schist is hard, biotite schist is medium hard - foliation at 60 degrees, fractures are generally fresh, with oxide [NYCBC Class 1c]	5	92	C-1	NX CORE BARREL	REC=42"/60" =70%	RQD=26"/60" =43%		
			5	93						
			5	94						
				95						

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Log of Boring **G-19** Sheet 5 of 5

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 7.2 NAVD88

MATERIAL SYMBOL	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-87.8			95						
			5		C-1					
			4	96						
				97						Diffuse granitic texture 97'-97.5'
			5							
		C-2: Green-black biotite-chlorite-garnet SCHIST, medium hard [NYCBC Class 1b]		98						
			5		C-2	NX CORE BARREL	REC=53"/60" =88%	RQD=50"/60" =83%		
		99'-100' Grey-white quartz-muscovite-feldspar SCHIST (as above)	5	99						
		Green-black biotite-chlorite-garnet SCHIST, foliation at ~60 degrees, parallel foliation								
			6	100						
			4	101						
				102						
			5							
		C-3: Green-black biotite-chlorite-garnet SCHIST, with 2" grey-white schist lenses (as above) [NYCBC Class 1a]		103						
			6		C-3	NX CORE BARREL	REC=60"/60" =100%	RQD=60"/60" =100%		
				104						
			4							
				105						
			4							
				106						
			6							
				107						
		C-4: Green-black biotite-chlorite-garnet SCHIST [NYCBC Class 1a]	3							
				108						
		Grey-white quarts-muscovite-feldspar SCHIST seam from 108-109'	3							
				109						
			3		C-4	NX CORE BARREL	REC=58"/60" =97%	RQD=58"/60" =97%		
				110						
			3							
				111						
			4							
	-104.8			112						
		End of boring at 112'								Borehole backfilled with cuttings and surface patched upon completion
				113						
				114						
				115						
				116						
				117						
				118						
				119						
				120						

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Log of Boring **G-20** Sheet 1 of 4

Project: Hudson Yards - WRY	Project No.: 170444101
Location: LIRR West Side Yard, Manhattan, NY	Elevation and Datum: Approx. 7.9 NAVD88
Drilling Company: Warren George, Inc.	Date Started: 11/15/04 — Date Finished: 11/16/04
Drilling Equipment: CME 55 Truck Rig	Completion Depth: 71 ft — Rock Depth: 51 ft
Size and Type of Bit: 3 7/8" Tri-Cone Rollerbit	Number of Samples: Disturbed 8 — Undisturbed 2 — Core 4
Casing Diameter (in): 3"/4" Flush Joint Steel — Casing Depth (ft): 51	Water Level (ft.): First ▽ — Completion ▼ — 24 HR. ▼
Casing Hammer: Donut — Weight (lbs): 300 — Drop (in): 30	Drilling Foreman: Robert Ware
Sampler: 2" O.D. Split Spoon / 3" Shelby Tube	Field Engineer: Stuart Knoop
Sampler Hammer: Donut — Weight (lbs): 140 — Drop (in): 30	

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks
	+7.9			0						Boring located in Greyhound parking, about 115' north of 30th Street and 450' east of 12th Avenue
	+7.2	8" Asphalt		1						
				2						qu (tsf) estimated from Pocket Penetrometer
				3						
				4						Use rollerbit and water with no down pressure to 6'
				5						
		S-1: Brown-grey, medium to fine SAND, some coarse gravel, trace concrete fragments (Fill) [NYCBC Class 7]		6	S-1	SS	3	22 36 30 31	66	
				7						
				8						Spin 4" casing to 10' Rollerbit to 10'
				9						
		S-2: Grey-black, medium to fine SAND, trace coarse gravel, trace brick fragments - stained, petroleum odor (Fill) [NYCBC Class 7]		10	S-2	SS	6	22 25 17 12	42	
				11						Petroleum odor
				12						Spin/push 4" casing to 15' Rollerbit to 15'
				13						
				14						
		S-3: Grey-black, clayey SILT, trace fine gravel, trace wood, trace brick fragments (Fill) [NYCBC Class 7]		15	S-3	SS	3	3 16 7 5	23	
				16						
				17						Rollerbit to 20'
				18						Wash change to dark grey ~18'
	-10.6			19						
				20						

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Log of Boring **G-20** Sheet 2 of 4

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 7.9 NAVD88

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-12.1	S-4: Dark grey, organic CLAY (OH) [NYCBC Class 6]		20	S-4	SS	18	WOH WOH WOH 1		q_u=0.25 tsf
				21						
				22						Push 4" casing to 20' Rollerbit to 25'
				23						
				24						
				25	U-1	UNDIST	21			
				26						
				27						Rollerbit to 30'
				28						
				29						
		S-5: Dark grey, organic silty CLAY (OH), some shell fragments [NYCBC Class 6]		30	S-5	SS	22	WOH WOH WOH WOH		
				31						
				32						Rollerbit to 35'
				33						
				34						
				35	U-2	UNDIST	24			
				36						
				37						Push 4" casing to 40' Rollerbit to 40'
				38						
				39						
		S-6: Dark grey, organic silty CLAY (OH), trace shell fragments - strong organic odor [NYCBC Class 6]		40	S-6	SS	24	WOH 1 1 2 2		q_u=0.25 tsf
				41						
				42						Rollerbit to 45'
				43						
				44						
				45						

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Log of Boring **G-20** Sheet 3 of 4

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 7.9 NAVD88

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-37.1	S-7A: Dark grey, organic silty CLAY (OH), trace shell fragments [NYCBC Class 6]		45	S-7	SS	24	1 1 3 3	4	q_u=0.5 tsf
	-38.1	S-7B: Dark grey, medium to fine SAND (SM), some silt, trace shell fragments [NYCBC Class 6]		46						Organic Content = 1.6.% (burnoff)
				47						Rollerbit to 50'
				48						
				49						
	-42.1	S-8: Weathered rock (mica schist) [NYCBC Class 3a]		50	S-8	SS	6	100/6"	100/6"	Spin 3" casing to 51'
	-43.1			51						
		C-1: Grey-black biotite SCHIST, moderately hard to hard, very slightly weathered, m grained, close fractures dipping ~70 degrees sub-parallel to foliation [NYCBC Class 1b] Bluish grey muscovite-quartz SCHIST (meta-granite), hard, m grained, close fractures dip ~10 degrees, foliation ~60 degrees	6	52	C-1	NX CORE BARREL	REC=54"/60" =90%	RQD=34"/60" =57%		
			3	53						
			6	54						
			6	55						
		Dark grey biotite-muscovite-quartz SCHIST, hard to very hard, very slightly weathered, transitional between biotite schist and harder meta-granite, 1" quartz veins (leucosomes), foliation is 0-70 degrees and folded around harder lenses	6	56						
			6	57	C-2	NX CORE BARREL	REC=58"/60" =97%	RQD=47"/60" =78%		
		C-2: Green chlorite SCHIST, soft to moderately hard, very slightly weathered, fractures parallel, foliation at ~70 degrees [NYCBC Class 1b]	7	58						
			10	59						
		Dark grey biotite-quartz-muscovite SCHIST (as above), hard	6	60						
			6	61						
			4	62	C-3	NX CORE BARREL	REC=56"/60" =93%	RQD=45"/60" =75%		
		C-3: Bluish grey quartz-muscovite SCHIST (as above), very hard [NYCBC Class 1b]	7	63						
			7	64						
			6	65						
			8	66						
		C-4: Dark grey biotite-muscovite-quartz SCHIST, hard, interlayered with cm-scale grey black biotite SCHIST, moderately hard and 2" very hard quartz rich layers [NYCBC Class 1b]	8	67	C-4	NX CORE BARREL	REC=57"/60" =95%	RQD=42"/60" =70%		
			5	68						
			7	69						
			6	70						

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Log of Boring **G-20** Sheet 4 of 4

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 7.9 NAVD88

MATERIAL SYMBOL	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-62.1			70						
			5		C-4					
	-63.1			71						
		End of boring at 71'								Borehole backfilled with cuttings and surface patched upon completion
				72						
				73						
				74						
				75						
				76						
				77						
				78						
				79						
				80						
				81						
				82						
				83						
				84						
				85						
				86						
				87						
				88						
				89						
				90						
				91						
				92						
				93						
				94						
				95						

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Log of Boring **G-21** Sheet 1 of 3

Project: Hudson Yards - WRY	Project No.: 170444101
Location: LIRR West Side Yard, Manhattan, NY	Elevation and Datum: Approx. 8.7 NAVD88
Drilling Company: Warren George, Inc.	Date Started: 11/11/04 — Date Finished: 11/15/04
Drilling Equipment: CME 55 Truck Rig	Completion Depth: 63 ft — Rock Depth: 42 ft
Size and Type of Bit: 3 7/8" Tri-Cone Rollerbit	Number of Samples: Disturbed 7 — Undisturbed 0 — Core 5
Casing Diameter (in): 3"/4" Flush Joint Steel — Casing Depth (ft): 42	Water Level (ft.): First ▽ — Completion ▼ — 24 HR. ▼
Casing Hammer: Donut — Weight (lbs): 300 — Drop (in): 30	Drilling Foreman: Robert Ware
Sampler: 2" O.D. Split Spoon	Field Engineer: Stuart Knoop
Sampler Hammer: Donut — Weight (lbs): 140 — Drop (in): 30	

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	+8.7			0						Boring located in Greyhound, about 89' west of NYCT fence and 117' north of 30th Street
				1						
				2						
				3						
				4						Use rollerbit and water with no down pressure to drill to 6'
				5						
				6						
		S-1: Dark grey, coarse to fine SAND, some coarse gravel, trace brick fragments (Fill) [NYCBC Class 7]		7	S-1	SS	10	8 8 12 7	20	
				8						Drive 4" casing to 10' Rollerbit to 10'
				9						
		S-2: Brown, sandy SILT, trace coarse gravel, trace brick fragments (Fill) [NYCBC Class 7]		10						
				11	S-2	SS	7	4 4 8 8	12	
				12						Drive 4" casing to 15' Rollerbit to 15'
				13						
				14						
		S-3: No recovery		15						
				16	S-3	SS	0	7 7 8 8	15	
				17						Push 4" casing to 20' Rollerbit to 20'
				18						
				19						
				20						

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Log of Boring **G-21** Sheet 2 of 3

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 8.7 NAVD88

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-11.3	S-4: Tan-grey, mottled brown and orange, silty fine SAND, trace fine gravel (Fill) [NYCBC Class 7]		20	S-4	SS	4	9 5 6 8	11	
				21						
				22						Push 4" casing to 25' Rollerbit to 25'
				23						Dark grey wash at ~23'
	-14.8	S-5: Dark grey, organic silty CLAY (CH-OH), trace shell fragments [NYCBC Class 4c]		24						
				25	S-5	SS	20	3 2 3 3	5	
				26						
				27						Rollerbit to 27'
				28						
				29						
		S-6: Dark grey, organic silty CLAY (CH-OH), trace shell fragments [NYCBC Class 4c]		30	S-6	SS	24	2 3 4 4	7	WC=53 , LL=57 , PL=22
				31						"Organic Content = 4.6.% (burnoff) LL = 41 after burnoff (change of ~28%)" Rollerbit to 35'
	-24.3			32						
				33						
				34						
		S-7: Dark grey, fine SAND (SM), some silt, trace rock fragments [NYCBC Class 3b]		35	S-7	SS	4	WOH 4 8 100/3"	12	
	-28.3			36						
				37						Rollerbit to 40'
		Weathered Rock		38						Hard drilling to 40' (very slow)
				39						
	-31.3			40						No recovery from 40' to 42'
		C-1: No recovery - some dark gray medium to fine sand in core barrel [NYCBC Class 1d]	2	41	C-1	NX CORE BARREL	REC=24"/48" =50%	RQD=17"/48" =35%		
			3	42						
			5	43						
			4							
	-35.3		4	44	C-2					Core barrel clogged at 44'
				45						

N-Value (Blows/ft) scale: 10 20 30 40

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Log of Boring **G-21** Sheet 3 of 3

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 8.7 NAVD88

MATERIAL SYMBOL	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-36.3	C-2: Grey-black, biotite-quartz-garnet SCHIST, moderately weathered, hard, 40-60 degree foliation, fractures parallel foliation, fresh fracture surfaces [NYCBC Class 1a] 3" quartz vein at 46.5'	3 5 3	45 46 47	C-2	NX CORE BARREL	REC=45"/48" =94%	RQD=41"/48" =85%	10 20 30 40	
		C-3: Grey-black, biotite-quartz-garnet SCHIST, hard, foliation at ~60 degrees, fractures parallel to foliation, fresh fractures [NYCBC Class 1b]	3 4 3 4 4	48 49 50 51 52 53	C-3	NX CORE BARREL	REC=60"/60" =100%	RQD=50"/60" =83%		
		Quartz vein from 53.4' to 54.8', very hard C-4: Grey-black, biotite-quartz-garnet SCHIST (as above) [NYCBC Class 1a]	5 4 5 5 5	54 55 56 57 58	C-4	NX CORE BARREL	REC=56"/60" =93%	RQD=53"/60" =88%		
		C-5: Grey-black, biotite-quartz-garnet SCHIST (as above) [NYCBC Class 1a]	4 4 4 4 3	59 60 61 62 63	C-5	NX CORE BARREL	REC=60"/60" =100%	RQD=60"/60" =100%		
	-54.3	End of boring at 63'		64 65 66 67 68 69 70						Borehole backfilled with cuttings and surface patched upon completion

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Log of Boring **G-27** Sheet 1 of 7

Project: Hudson Yards - WRY	Project No.: 170444101
Location: LIRR West Side Yard, Manhattan, NY	Elevation and Datum: Approx. 7 NAVD88
Drilling Company: Warren George, Inc.	Date Started: 11/2/04 — Date Finished: 11/5/04
Drilling Equipment: CME 55 Truck Rig	Completion Depth: 160 ft — Rock Depth: 142 ft
Size and Type of Bit: 3 7/8" Tri-Cone Rollerbit	Number of Samples: Disturbed 25 — Undisturbed 2 — Core 4
Casing Diameter (in): 3"/4" Flush Joint Steel — Casing Depth (ft): 140	Water Level (ft.): First ▽ 6 — Completion ▼ — 24 HR. ▼
Casing Hammer: Donut — Weight (lbs): 300 — Drop (in): 30	Drilling Foreman: Robert Ware
Sampler: 2" O.D. Split Spoon / 3" Shelby Tube	Field Engineer: Stuart Knoop
Sampler Hammer: Donut — Weight (lbs): 140 — Drop (in): 30	

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40
	+7.0			0					
	+6.3	8" Concrete slab		1					
				2					
				3					
				4					
				5					
		S-1: Grey-brown-black, silty fine SAND, some fine to coarse gravel, trace clay, wood fragments, (Fill) [NYCBC Class 7] ▽		6	S-1	SS	11	4 5 6 12	11
				7					
				8					
				9					
		S-2: Grey-brown-black, silty fine SAND, medium sand lense (~5"), trace fine to coarse gravel, brick, glass fragments (Fill) [NYCBC Class 7]		10	S-2	SS	11	2 5 14 19	19
				11					
				12					
				13					
				14					
		S-3: Grey-brown-black, fine SAND, some silt, trace coarse gravel, (Fill) [NYCBC Class 7]		15	S-3	SS	11	5 2 3 4	5
				16					
				17					
				18					
				19					
				20					

Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)

Boring located on 12th Avenue sidewalk about 187' north of 30th Street

qu (tsf) estimated from Pocket Penetrometer

Use 4 7/8" rollerbit to drill concrete slab

Use rollerbit with water and no down pressure to drill to 6'

Push 4" casing to 10' Rollerbit to 10'

Rollerbit to 15'

Rollerbit to 17'

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Log of Boring **G-27** Sheet 2 of 7

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 7 NAVD88

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-13.0	S-4: Grey-brown-black, fine SAND, some silt, trace coarse gravel, (Fill) [NYCBC Class 7]		20	S-4	SS	7	2 2 3 2	5	
				21						
				22						Rollerbit to 25'
				23						
				24						
		S-5: Brown-grey, fine to medium SAND, some fine to coarse gravel, trace silt, trace brick (Fill) [NYCBC Class 7]		25	S-5	SS	6	10 8 14 15	22	
				26						
				27						Rollerbit to 30'
				28						
				29						
		S-6: Grey-brown, mottled pink, fine to medium SAND, some fine gravel, trace brick (Fill) [NYCBC Class 7]		30	S-6	SS	14	20 10 15 24	25	
				31						Organic Content = 1.2% (burnoff)
				32						Rollerbit to 35'
				33						
				34						
		S-7: Dense, grey-brown, gravelly fine to medium SAND, trace brick (Fill) [NYCBC Class 7]		35	S-7	SS	2	27 28 9 6	37	
				36						
				37						Push 4" casing to 20' Rollerbit to 40'
				38						
				39						
	-31.5	S-8: Dark grey, CLAY (CL), trace silt, trace fine sand [NYCBC Class 6]		40	S-8	SS	24	2 WOH 1 2		q_u=0.6 tsf
				41						
				42						"Rollerbit to 45'
				43						Very soft drilling"
				44						
				45						

N-Value (Blows/ft) scale: 10 20 30 40

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Log of Boring **G-27** Sheet 3 of 7

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 7 NAVD88

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-38.0			45						WC=42.3 , LL=49 , PL=22
				46	U-1	UNDIST	20			Organic Content = 4.2% (burnoff)
				47						Rollerbit to 50'
				48						
				49						
		S-9: Dark grey, CLAY (CL), trace silt, trace fine sand [NYCBC Class 6]		50	S-9	SS	24	1 WOH WOH 1		q_u=0.75 tsf
				51						
				52						Rollerbit to 55'
				53						
				54						
				55						q_u=0.5 tsf WC=50 , LL=21 , PL=29
				56	U-2	UNDIST	13			Organic Content = 4.1% (burnoff)
				57						Rollerbit to 60'
				58						
				59						
		S-10: Dark grey, CLAY (CL), trace silt, trace fine sand [NYCBC Class 6]		60	S-10	SS	24	1 WOH WOH 1		q_u=0.5 tsf WC=41.9 , LL=49 , PL=23
				61						
				62						Rollerbit to 65'
				63						
				64						
		S-11: Dark grey, CLAY (CL), trace silt, trace fine sand [NYCBC Class 4c]		65	S-11	SS	24	WOH 2 2 4 3		q_u=0.75 tsf
				66						
				67						Rollerbit to 70'
				68						
				69						
				70						

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Log of Boring **G-27** Sheet 4 of 7

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 7 NAVD88

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-63.0	S-12: Dark grey, CLAY (CH), trace silt, trace fine sand, trace shell fragments [NYCBC Class 6]		70	S-12	SS	24	2 1 2 3	3	q_u=0.75 tsf WC=46.9 , LL=57 , PL=24
				71						
				72						Rollerbit to 75'
				73						
				74						
		S-13: Dark grey, CLAY (CH), trace silt, trace fine sand, trace shell fragments [NYCBC Class 6]		75	S-13	SS	24	1 WOH WOH WOH		q_u=0.5 tsf
				76						
				77						Rollerbit to 80'
				78						
				79						
		S-14: Dark grey, CLAY (CH), trace silt, trace fine sand, trace shell fragments [NYCBC Class 6]		80	S-14	SS	24	1 WOH WOH WOH		q_u=0.5 tsf
				81						
				82						Rollerbit to 85'
				83						
				84						
		S-15: Dark grey, CLAY (CL), some silt, trace fine sand, trace wood, trace shell fragments [NYCBC Class 6]		85	S-15	SS	24	2 WOH WOH 4		q_u=0.25 tsf WC=36.3 , LL=37 , PL=18 Organic Content = 2.9% (burnoff)
				86						
				87						Rollerbit to 90'
	-81.5			88						
		S-16: Dark grey, sandy SILT (ML), some clay, trace shell fragments [NYCBC Class 5b]		89						
				90	S-16	SS	24	5 3 10 15	13	
				91						
				92						Rollerbit to 95'
				93						
				94						
	-88.0			95						

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Log of Boring **G-27** Sheet 5 of 7

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 7 NAVD88

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-88.0	S-17: Dark grey, silty fine SAND (SM), trace clay, trace shell fragments [NYCBC Class 3b]		95–96	S-17	SS	24	2 0 7 7	7	
				96–97						Rollerbit to 100'
	-91.0	S-18: Dark grey, sandy SILT (ML), some clay, clay lenses, trace shell fragments [NYCBC Class 6]		97–98						
				98–99						
				99–100						
				100–101	S-18	SS	24	WOH 5 3 3	8	
				101–102						Rollerbit to 105'
				102–103						
				103–104						
				104–105						
		S-19: Dark grey, sandy SILT (ML), trace clay, trace rock fragments (schist), trace shell fragments [NYCBC Class 3b]		105–106	S-19	SS	24	WOH 11 15 16	26	
				106–107						Rollerbit to 110'
	-102.0			107–108						
				108–109						
		S-20: Dark grey, silty fine SAND (SM) [NYCBC Class 3b]		109–110						
				110–111	S-20	SS	24	10 12 15 19	27	
				111–112						Rollerbit to 115'
	-106.0			112–113						
				113–114						
				114–115						
		S-21: Dark grey, SILT (ML), some fine sand, trace clay [NYCBC Class 5b]		115–116	S-21	SS	18	6 6 8 8	14	
				116–117						Rollerbit to 120'
				117–118						
				118–119						
				119–120						

N-Value (Blows/ft) scale: 10 20 30 40

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Log of Boring **G-27** Sheet 6 of 7

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 7 NAVD88

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-113.0	S-22: Dark grey, clayey SILT (ML), trace fine sand, trace coarse gravel [NYCBC Class 5b]		120	S-22	SS	15	6 8 8 11	16	Rollerbit to 125'
		S-23: Dark grey, silty CLAY (CH), trace fine sand, trace wood [NYCBC Class 4b]		125	S-23	SS	24	10 10 12 13	22	WC=43.6 , LL=64 , PL=27 Organic Content = 9.1% (burnoff) Rollerbit to 130'
	-122.0	S-24: Dark orange, fine to medium SAND (SM), some silt, trace fine gravel, trace rock fragments (Glacial Till) [NYCBC Class 3a]		130	S-24	SS	10	17 73 100/1"	100/1"	Spin 3" casing to 132' Softer material encountered Spin 3" casing to 135'
		S-25: Red-orange, mottled grey, fine SAND (SM), some silt, some mica, trace fine gravel (Glacial Till) [NYCBC Class 3a]		135	S-25	SS	4	100/4"	100/4"	"Rollerbit to 140' Very slow drilling"
	-133.0	C-1: White-grey, quartz-muscovite SCHIST, fresh, hard, foliation dipping at ~60 degrees, orange staining on fracture surfaces [NYCBC Class 1c]	1 6 4 4 4	140 141 142 143 144 145	C-1	NQ CORE BARREL	REC=36"/60" =60%	RQD=26"/60" =43%		

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Log of Boring **G-27** Sheet 7 of 7

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 7 NAVD88

MATERIAL SYMBOL	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-138.0	White-grey, quartz muscovite SCHIST (as above)	8	145						
		C-2: Black-grey, biotite-muscovite SCHIST, accessory garnet, fresh, moderately hard, fresh fracture surfaces, fractures parallel foliation at ~60 degrees, interlayed with quartz-muscovite schist [NYCBC Class 1c]	7	146	C-2	NQ CORE BARREL	REC=54"/60" =90%	RQD=29"/60" =48%		
			2	147						
			3	148						
			2	149						
			2	150						
		C-3: White-grey, quartz-muscovite SCHIST, accessory biotite and garnet, interlayed with 2" biotite-muscovite schist, fresh, hard, foliation at ~60 degrees, fractures are fresh, occur within biotite schist and are parallel to foliation [NYCBC Class 1c]	7	151	C-3	NQ CORE BARREL	REC=49"/60" =82%	RQD=27"/60" =45%		
			5	152						
			17	153						
			7	154						
			5	155						
		C-4: White-grey, quartz-muscovite SCHIST, accessory biotite and garnet, interlayed with 2" biotite-muscovite schist, fresh, hard, foliation at ~60 degrees, fractures are fresh, occur within biotite schist and are parallel to foliation [NYCBC Class 1a]	3	156	C-4	NQ CORE BARREL	REC=58"/60" =97%	RQD=58"/60" =97%		
			6	157						
			8	158						
			6	159						
	-153.0	End of boring at 160'		160						Borehole backfilled with cuttings and surface patched upon completion
				161						
				162						
				163						
				164						
				165						
				166						
				167						
				168						
				169						
				170						

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Log of Boring **G-3** Sheet 1 of 6

Project: Hudson Yards - WRY	Project No.: 170444101
Location: LIRR West Side Yard, Manhattan, NY	Elevation and Datum: Approx. 7.1 NAVD88
Drilling Company: Warren George, Inc.	Date Started: 11/15/04 — Date Finished: 11/18/04
Drilling Equipment: Acker-11 Truck Rig	Completion Depth: 132 ft — Rock Depth: 110 ft
Size and Type of Bit: 3 7/8" Tri-Cone Rollerbit	Number of Samples: Disturbed 18 — Undisturbed 2 — Core 4
Casing Diameter (in): 3"/4" Flush Joint Steel — Casing Depth (ft): 25	Water Level (ft.): First ▽ — Completion ▼ — 24 HR. ▼
Casing Hammer: Donut — Weight (lbs): 300 — Drop (in): 30	Drilling Foreman: Corry Tirro
Sampler: 2" O.D. Split Spoon / 3" Shelby Tube	Field Engineer: Nipam Shah
Sampler Hammer: Automatic — Weight (lbs): 140 — Drop (in): 30	

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	+7.1			0						Boring located in southeast corner of NYDS gas station, about 30' north of 30th Street and 12' west of wash building
	+6.6	6" Concrete		1						
				2						qu (tsf) estimated from Pocket Penetrometer
				3						Hand auger to a depth of 5'
				4						Slowly drill to 10' without pressure using water
				5						Hand augering was very hard between 4' and 6'
				6						Drive 4" casing to a depth of 10'
				7						
				8						
				9						
				10	S-1	SS	8	6 4 5 7	9	Drive 4" casing to a depth of 15' Strong organic odor.
		S-1: Dark brown, fine to coarse SAND and GRAVEL, some cobbles, some brick, dry (Fill) [NYCBC Class 7]		11						
				12						Rollerbit to 15'
				13						
				14						
				15	S-2	SS	10	2 3 1 1	4	Drilling mud additive mixed with water
		S-2: Dark brown, coarse to fine SAND, some coarse to fine gravel, some silt, trace brick fragments, wood (Fill) [NYCBC Class 7]		16						
				17						Rollerbit to 20'
				18						
				19						
	-12.9			20						

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Log of Boring **G-3** Sheet 2 of 6

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 7.1 NAVD88

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-12.9	S-3: Dark brown-black, medium to fine SAND, some rock fragments, some silt, strong organic odor (Fill) [NYCBC Class 7]		20	S-3	SS	5	2 1 2 3	3	
				21						
				22						Rollerbit to 25'
				23						
				24						
		S-4: Black, organic clayey SILT (OH), some fine sand, trace fine gravel, trace coal fragments [NYCBC Class 6]		25	S-4	SS	18	WOH 1 1 2	2	Drive 4" casing to a depth of 25'
				26						
				27						Rollerbit to 30'
				28						
				29						
				30	U-1	UNDIST	24	PUSH		
				31						
				32						Rollerbit to 35'
				33						
				34						
				35	U-2	UNDIST	18	PUSH		
				36						
				37						Rollerbit to 40'
				38						
				39						
	-32.9	S-5: Black, organic silty CLAY (OH), some shell fragments, trace fine sand, trace coal fragments [NYCBC Class 6]		40	S-5	SS	24	WOH 2 1 2	3	q_u=0.35 tsf
				41						
				42						Rollerbit to 45'
				43						
				44						
				45						

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Log of Boring **G-3** Sheet 3 of 6

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 7.1 NAVD88

MATERIAL SYMBOL	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-37.9	S-6: Dark grey, CLAY (CH), some shell fragments, trace silt [NYCBC Class 6]		45	S-6	SS	24	WOH 2 2 4 1		q_u=0.2 tsf
				46						
				47						Rollerbit to 50'
				48						
				49						
		S-7: Dark grey, CLAY (CH), trace silt, shell fragments [NYCBC Class 4c]		50	S-7	SS	24	1 2 2 4 2		q_u=0.25 tsf
				51						
				52						Rollerbit to 55'
				53						
				54						
		S-8: Dark grey, silty CLAY (CH), some shell fragments, trace rock fragments [NYCBC Class 6]		55	S-8	SS	20	WOR WOR WOR WOR		q_u=0.25 tsf
				56						
				57						Rollerbit to 60'
				58						
				59						
		S-9: Dark grey, silty CLAY (CH), some shell fragments [NYCBC Class 6]		60	S-9	SS	24	1 1 2 1 2		q_u=0.3 tsf
				61						
				62						Rollerbit to 65'
				63						
				64						
		S-10: Dark grey, CLAY (CH), trace silt, trace shell fragments [NYCBC Class 6]		65	S-10	SS	22	WOR WOR WOR WOR		q_u=0.45 tsf
				66						
				67						Rollerbit to 70'
				68						
				69						
				70						

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Log of Boring **G-3** Sheet 4 of 6

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 7.1 NAVD88

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-62.9	S-11: Dark grey, CLAY (CH), trace silt, trace shell fragments, trace rock fragments [NYCBC Class 6]		70	S-11	SS	24	WOH 1 2 3 2		q_u=0.19 tsf
				71						
				72						Rollerbit to 75'
				73						
				74						
		S-12: Dark grey, CLAY (CH), trace silt, trace shell fragments [NYCBC Class 6]		75	S-12	SS	24	WOR WOR WOR WOR		q_u=0.2 tsf
				76						
				77						Rollerbit to 80'
				78						
				79						
		S-13: Dark grey, CLAY & SILT (CH-MH), trace sand, trace shell fragments [NYCBC Class 6]		80	S-13	SS	24	WOR WOR WOR WOR		q_u=0.27 tsf
				81						
				82						Rollerbit to 85'
				83						
				84						
	-77.9	S-14: Dark grey, clayey SILT (MH), some fine sand, some shells, trace fine gravel [NYCBC Class 6]		85	S-14	SS	7	WOR WOR 5 10		
				86						
				87						Rollerbit to 90'
				88						
				89						
		S-15: Dark grey, clayey SILT (MH), trace fine sand, trace shell fragments [NYCBC Class 6]		90	S-15	SS	10	WOR WOR 4 5		q_u=0.28 tsf
				91						
				92						Rollerbit to 95'
				93						
				94						
				95						

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Log of Boring **G-3** Sheet 5 of 6

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 7.1 NAVD88

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-87.9	S-16: Dark gray, clayey SILT (MH), trace shell fragments [NYCBC Class 6]		95	S-16	SS	24	WOR WOR WOR WOR		q_u=0.25 tsf
				96						
				97						Rollerbit to 100'
				98						
				99						
		S-17: Dark grey, clayey SILT (MH), some fine sand, trace shell fragments [NYCBC Class 5b]		100	S-17	SS	24	WOH 6 14 18	20	q_u=0.5 tsf
				101						
				102						Rollerbit to 105'
				103						
				104						
		S-18: Dark grey, clayey SILT (MH), some fine sand, some wood chips with organic matter [NYCBC Class 6]		105	S-18	SS	24	WOR 2 6 7	8	
				106						
				107						Rollerbit to 110'
	-102.9			108						Rig chatter between 109' and 110'
				109						Top of bedrock at 110'
				110						Spin 3" casing to a depth of 110'
				111						Rollerbit to 112'
		C-1: Gray-black-green, mica SCHIST, highly weathered, highly fractured strong rock, fine to medium grained, close to wide fracture spacing. [NYCBC Class 1d] Fracture zone:114' to 115' Pegmatic content on entire run	8 8 7 7 8	112	C-1	NX CORE BARREL	REC=39"/60" =65%	RQD=20"/60" =33%		Core barrel blocked between 115' and 117' Loss of recovery possibly due to drilling out bottom 2' run. (Highly weathered/ decomposed rock) Core barrel blocked between 115' and 117'
				113						
				114						
				115						
				116						
		C-2: Gray-black-green, mica SCHIST, highly weathered, highly fractured strong rock, fine to medium grained, close to wide fracture spacing. [NYCBC Class 1c] Fracture zone:118.3' to 119' Pegmatic content on entire run	8 8 8	117	C-2	NX CORE BARREL	REC=53"/60" =88%	RQD=29"/60" =48%		Loss of recovery possibly due to drilling out bottom 2'. (Highly weathered/ decomposed rock)
				118						
				119						
				120						

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Log of Boring **G-3** Sheet 6 of 6

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 7.1 NAVD88

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-112.9		7	120	C-2					
			7	121						
		C-3: Gray-black-green, mica SCHIST, highly weathered, highly fractured strong rock, fine to medium grained, close to wide fracture spacing. [NYCBC Class 1b] Fracture zone:124' to 125' Pegmatic content on entire run	9	122	C-3	NX CORE BARREL	REC=53"/60" =88%	RQD=36"/60" =60%		Core barrel jammed at 125' Drive 3" casing to a depth of 125'
			9	123						
			10	124						
			9	125						
			8	126						
		C-4: Gray-black-green, mica SCHIST, highly weathered, highly fractured strong rock, fine to medium grained, close to wide fracture spacing. [NYCBC Class 1b]	9	127	C-4	NX CORE BARREL	REC=54"/60" =90%	RQD=48"/60" =80%		
			9	128						
			8	129						
			8	130						
			8	131						
	-124.9	End of boring at 132'		132						Borehole backfilled with cuttings and surface patched upon completion
				133						
				134						
				135						
				136						
				137						
				138						
				139						
				140						
				141						
				142						
				143						
				144						
				145						

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Log of Boring **G-30** Sheet 1 of 4

Project: Hudson Yards - WRY	Project No.: 170444101
Location: LIRR West Side Yard, Manhattan, NY	Elevation and Datum: Approx. 7.9 NAVD88
Drilling Company: Warren George, Inc.	Date Started: 10/28/04 — Date Finished: 10/29/04
Drilling Equipment: CME 55 Truck Rig	Completion Depth: 72.5 ft — Rock Depth: 52.5 ft
Size and Type of Bit: 3 7/8" Tri-Cone Rollerbit	Number of Samples: Disturbed 8 — Undisturbed 2 — Core 4
Casing Diameter (in): 3"/4" Flush Joint Steel — Casing Depth (ft): 34	Water Level (ft.): First ▽ — Completion ▼ — 24 HR. ▼
Casing Hammer: Donut — Weight (lbs): 300 — Drop (in): 30	Drilling Foreman: Robert Ware
Sampler: 2" O.D. Split Spoon / 3" Shelby Tube	Field Engineer: Juan Pinzon
Sampler Hammer: Donut — Weight (lbs): 140 — Drop (in): 30	

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	+7.9									Boring located in Greyhound, about 500' east of 12th Avenue and 170' north of 30th Street
	+7.4	Asphalt Pavement		0						
				1						qu (tsf) estimated from Pocket Penetrometer
				2						
				3						
				4						Rollerbit with water and no pressure to 6'
				5						
		S-1: Black, medium SAND, some rock fragments and gravel, trace brick fragments (Fill) [NYCBC Class 7]		6	S-1	SS	4	1 8 12 8	20	
				7						
				8						Install casing to 9'
				9						
		S-2: Black, medium to fine SAND, some clay, trace gravel and brick fragmets (Fill) [NYCBC Class 7]		10	S-2	SS	6	2 1 1 1	2	
				11						
				12						Install casing to 14' Rollerbit to 15'
				13						
				14						Hard drilling 14' to 14.5'
		S-3: Black, medium to fine SAND and rock fragments, trace brick fragments (Fill) [NYCBC Class 7]		15	S-3	SS	2	25 100/2"	100/2"	
				16						Rollerbit to 20' Hard drilling 16' to 17', lost water Install casing to 19' Casing bent (cannot advance rollerbit), pull out casing Rock frag inside casing's tip Spin casing to 19' Clean to 20'
				17						
				18						
				19						
				20						

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Log of Boring **G-30** Sheet 2 of 4

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 7.9 NAVD88

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-12.1	S-4: No Recovery		20	S-4	SS	0	100/0"	100/0"	Rollerbit to 25' Hard drilling 20' to 21' and 24' to 24.5' Spin casing to 24' Clean to 25'
		S-5: Gravel, trace brick fragments (Fill) [NYCBC Class 7]		25	S-5	SS	5	9 33 10 23	43	
		S-6: Gravel, some brown, medium sand, trace clay (Fill) [NYCBC Class 7]		30	S-6	SS	4	6 19 17 14	36	Rollerbit to 30' Hard drilling 27' to 29' Spin casing to 29' Clean to 30'
	-25.6			35						Rollerbit to 35' Wash water color change ~33'
		S-7: Grey, silty CLAY (CL), some shell frag [NYCBC Class 4c]		35	S-7	SS	24	3 2 3 2	5	q_u=0.5 tsf
				40						Spin casing to 34' Rollerbit to 40'
		Grey, silty CLAY (CH)		40	U-1	UNDIST	13			WC=51.5 , LL=52 , PL=19
				45						Rollerbit to 45'

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Log of Boring **G-30** Sheet 3 of 4

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 7.9 NAVD88

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-37.1	S-8: Grey, silty CLAY (CL), some shell frag [NYCBC Class 6]		45	S-8	SS	24	3 1 2 1 1	10 20 30 40	q_u=0.75 tsf
				46						
				47						Rollerbit to 50'
				48						
				49						
		Grey, silty CLAY (CL-ML)		50	U-2	UNDIST	10			Rollerbit to 55' Rollerbit refusal @ 52.5' Spin 3in casing to 52' Clean to 52.5'WC=23.7 , LL=22 , PL=16
				51						
	-44.6			52						
		C-1A: Light grey, QUARTZITE	4	53	C-1	NX CORE BARREL	REC=50"/60" =83%	RQD=50"/60" =83%		
		C-1B: Grey, sound, mica SCHIST, hard, weathered at transition between quartzite and schist, Foliation dip: 50-60 degrees [NYCBC Class 1b]	2	54						
			2	55						
			1.5	56						
			1	57						
		C-2: Grey, slightly fractured, mica SCHIST, hard, weathered from 57.5' to 58.5', Foliation dip: 60 degrees [NYCBC Class 1b]	1	58	C-2	NX CORE BARREL	REC=52"/60" =87%	RQD=45"/60" =75%		
			1.5	59						
			1.5	60						
			1	61						
		No recovery zone from 61.5' to 63.5', possible weathered zone	1	62						
	-54.6									
		C-3: Grey, sound, mica SCHIST, hard [NYCBC Class 1a]	1	63	C-3	NX CORE BARREL	REC=53"/60" =88%	RQD=53"/60" =88%		
			1.5	64						
			1.5	65						
			1.5	66						
			1	67						
		C-4: Grey, slightly fractured, mica SCHIST, hard, weathered from 71.5' to 72.5', Foliation dip: 40-60 degrees [NYCBC Class 1b]	1.5	68	C-4	NX CORE BARREL	REC=51"/60" =85%	RQD=44"/60" =73%		
			1.5	69						
				70						

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Log of Boring **G-30** Sheet 4 of 4

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 7.9 NAVD88

MATERIAL SYMBOL	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-62.1		1	70					10 20 30 40	
		(see above)	1.5	71	C-4	NX CORE BARREL				
			2	72						Borehole backfilled with cuttings and surface patched upon completion
	-64.6	End of boring at 72.5'		73						
				74						
				75						
				76						
				77						
				78						
				79						
				80						
				81						
				82						
				83						
				84						
				85						
				86						
				87						
				88						
				89						
				90						
				91						
				92						
				93						
				94						
				95						

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Log of Boring **G-31** Sheet 1 of 3

Project: Hudson Yards - WRY	Project No.: 170444101
Location: LIRR West Side Yard, Manhattan, NY	Elevation and Datum: Approx. 9 NAVD88
Drilling Company: Warren George, Inc.	Date Started: 10/26/04 — Date Finished: 10/27/04
Drilling Equipment: DK-50 Track Rig	Completion Depth: 53 ft — Rock Depth: 33 ft
Size and Type of Bit: 3 7/8" Tri-Cone Rollerbit	Number of Samples: Disturbed 4 — Undisturbed 2 — Core 4
Casing Diameter (in): 3"/4" Flush Joint Steel — Casing Depth (ft): 31	Water Level (ft.): First ▽ — Completion ▼ — 24 HR. ▼
Casing Hammer: Donut — Weight (lbs): 300 — Drop (in): 30	Drilling Foreman: Robert Ware
Sampler: 2" O.D. Split Spoon / 3" Shelby Tube	Field Engineer: Juan Pinzon
Sampler Hammer: Donut — Weight (lbs): 140 — Drop (in): 30	

Material Symbol	Elev. (ft)	Sample Description
	+9.0	
	+8.3	8" Concrete Slab
		S-1: Brown, coarse to medium SAND, some fine gravel and brick fragments (Fill) [NYCBC Class 7]
	-4.5	
		S-3: Black, silty CLAY (CH-OH), some organics, wood [NYCBC Class 4c]

Coring (min)

Depth Scale: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

Sample Data

Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)
S-1	SS	4	2 2 1 4	3
S-2	SS	4	9 19 5 3	24
S-3	SS	11	6 1 4 4	5

N-Value (Blows/ft): 10 20 30 40

Remarks

(Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)

Boring located in Greyhound, about 140' west of 11th Avenue and 170' north of 30th Street

qu (tsf) estimated from Pocket Penetrometer

Drill through concrete slab
Rollerbit to 6' with water and no pressure

Install casing to 9'
Rollerbit to 10'

Mix Revert
Rollerbit to 15ft

q_u=0.25 tsf
Install casing to 19ft
Rollerbit to 20ft

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Log of Boring **G-31** Sheet 2 of 3

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 9 NAVD88

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-11.0	Dark grey-black, silty CLAY (CH-OH), some organics [NYCBC Class 4c]		20						Rollerbit to 25 ftWC=66.2 , LL=83 , PL=30
				21	U-1	UNDIST	24			
				22						Organic Content = 5.7% (burnoff)
	-14.0			23						
				24						
		S-4: Grey, silty CLAY (CL), some shell frag [NYCBC Class 6]		25	S-4	SS	24	2 1 2 1 2		q_u=0.5 tsf Rollerbit to 30ft
				26						
				27						
				28						
				29						
		No Recovery		30	U-2	UNDIST	0			No recovery Tube's tip bent
				31						
				32						Rollerbit to 35ft Rollerbit refusal @ 33ft Install casing to 31ft Clean to 33ft Rock Coring Run #1 (33ft-38ft)
	-24.0			33						
			4.5	34	C-1	NX CORE BARREL	REC=55"/60" =92%	RQD=51"/60" =85%		
		C-1: Grey, slightly fractured MICA SCHIST, hard, slightly weathered, iron stained joints Foliation dip: 50 - 70 degrees. [NYCBC Class 1a]	5.5	35						
			5.5	36						
			5	37						
			5.5	38						Run #2 (38ft-43ft) Increase RPM (from previous Run)
		C-2: Grey, slightly fractured MICA SCHIST, hard, slightly weathered, iron stained joints, some quartz from 40' to 41' and from 42.5' to 43' Foliation dip: 40-60 degrees [NYCBC Class 1a]	2.5	39	C-2	NX CORE BARREL	REC=58"/60" =97%	RQD=51"/60" =85%		
			1.5	40						
			2.5	41						
			3	42						
			3	43						
		C-3: Grey slightly fractured MICA SCHIST, hard, slightly weathered, iron stained joint [NYCBC Class 1a]	4	44	C-3					Run #3 (43ft-48ft) Barrel stopped moving @ 43.5ft (Drilled for 50 min @ 43.5ft, change bit and continue
			3	45						

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Log of Boring **G-31** Sheet 3 of 3

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 9 NAVD88

MATERIAL SYMBOL	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-36.0		3	45	C-3	NX CORE BARREL	REC=60"/60" =100%	RQD=60"/60" =100%	10 20 30 40	coring @ 43.5ft)
			2.5	46						
			3.5	47						
		C-4: Grey, slightly fractured MICA SCHIST, hard, slightly weathered, iron stained joints Foliation dip: 50-60 degrees. [NYCBC Class 1a]	2.5	48						Run #4 (48ft-53ft)
			3	49	C-4	NX CORE BARREL	REC=56"/60" =93%	RQD=52"/60" =87%		
			3	50						
			2	51						
			2	52						
	-44.0	End of boring at 53'		53						Borehole backfilled with cuttings and surface patched upon completion
				54						
				55						
				56						
				57						
				58						
				59						
				60						
				61						
				62						
				63						
				64						
				65						
				66						
				67						
				68						
				69						
				70						

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Log of Boring **G-35** Sheet 1 of 6

Project: Hudson Yards - WRY	Project No.: 170444101
Location: LIRR West Side Yard, Manhattan, NY	Elevation and Datum: Approx. 8.5 NAVD88
Drilling Company: Warren George, Inc.	Date Started: 11/1/04 — Date Finished: 11/8/04
Drilling Equipment: Acker 2D Hi-Rail Truck Rig	Completion Depth: 135.5 ft — Rock Depth: 87 ft
Size and Type of Bit: 3 7/8" Tri-Cone Rollerbit	Number of Samples: Disturbed 16 — Undisturbed 0 — Core 10
Casing Diameter (in): 3"/4" Flush Joint Steel — Casing Depth (ft): 43	Water Level (ft.): First ▽ 5 — Completion ▼ — 24 HR. ▼
Casing Hammer: Donut — Weight (lbs): 300 — Drop (in): 30	Drilling Foreman: Reynolds Bridgpal
Sampler: 2" O.D. Split Spoon	Field Engineer: Stephen Morse
Sampler Hammer: Donut — Weight (lbs): 140 — Drop (in): 30	

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40
	+8.5	14" Reinforced Concrete		0					
	+7.3	Asphalt		1					
	+6.8			2					
				3					
				4					
		▽		5					
				6					
				7					
				8					
				9					
		S-1: Dark brown-grey, GRAVEL, some rock fragments, some fine to medium sand (Fill) [NYCBC Class 7]		10	S-1	SS	4	36 60 100/3"	100/3"
				11					
				12					
				13					
				14					
		S-2: Dark grey-brown, GRAVEL, some rock fragments, some fine to medium sand, trace silt (Fill) [NYCBC Class 7]		15	S-2	SS	8	14 14 18 36	32
				16					
				17					
				18					
				19					
				20					

Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)

Boring located on LIRR track 6, about 65' east of bumper block

qu (tsf) estimated from Pocket Penetrometer
Su (tsf) estimated from Pocket Torvane

Rollerbit through concrete and ashpalt
Hand auger to 5'
No pressure Rollerbit with water to 10'

4" Casing pushed to 9'
Rollerbit to 10'

Rollerbit to 15'
Casing meeting resistance @ 9'
Casing cannot be pushed or hammered
Attempt additional drilling
Casing hammered successfully to 14'

Hammer casing to 19'
Rollerbit to 20'

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Log of Boring **G-35** Sheet 2 of 6

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 8.5 NAVD88

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-11.5	S-3: Dark grey, GRAVEL, some fine to medium sand, trace rock fragments, trace silt (Fill) [NYCBC Class 7]		20	S-3	SS	2	100/3"	100/3"	Spoon refusal Rollerbit to 25' Loss of water @ 20'
				21						
				22						
				23						
				24						
		S-4: Dark grey, GRAVEL, some medium sand, rock fragments, trace mica flakes (Fill) [NYCBC Class 7]		25	S-4	SS	12	12 24 11 11	35	
				26						
				27						Hammer casing to 24' Hammer casing to 29' Rollerbit to 30' Water return @ 25' Loss of water @ 25.5'
				28						
				29						
		S-5: Dark grey, GRAVEL, rock fragments, mica flakes, trace silt, trace clay in bottom 0.5" of recovery (Fill) [NYCBC Class 7]		30	S-5	SS	6	7 9 2 20	11	
				31						
				32						Rollerbit to 35'
				33						
				34						
		S-6: Dark grey, GRAVEL, rock fragments, mica flakes (Fill) [NYCBC Class 7]		35	S-6	SS	3	100/3"	100/3"	
				36						Hammer casing to 33' Rollerbit to 40'
				37						
				38						
				39						
		S-7A: (Top 6" of Recovery) Dark grey, GRAVEL , some rock frag, mica flakes (Fill) [NYCBC Class 7]		40	S-7	SS	20	3 3 4 6	7	q_u=0.25 tsf Sample crushed easily by fingers after drying
	-32.5			41						
		S-7B: (Bottom 14" of Recovery) Dark grey, CLAY and SILT (CH), trace shells [NYCBC Class 4b]		42						Hammer casing to 38' Hammer casing to 43' Rollerbit to 45'
				43						
				44						
				45						

N-Value (Blows/ft) scale: 10 20 30 40

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Log of Boring **G-35** Sheet 3 of 6

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 8.5 NAVD88

MATERIAL SYMBOL	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-36.5	S-8: Dark grey, CLAY (CH), trace shells, trace silt [NYCBC Class 4c]		45	S-8	SS	24	3 3 2 3	5	q_u=0.5 tsf
				46						
				47						Rollerbit to 50'
				48						
				49						
		S-9: Dark grey, clayey SILT (MH), trace mica flakes [NYCBC Class 4c]		50	S-9	SS	24	3 3 2 2	5	q_u=0.75 tsf Sample crushed easily by fingers after drying
				51						
				52						Rollerbit to 55'
				53						
				54						
		S-10: Dark grey, CLAY (CH), trace mica flakes [NYCBC Class 4c]		55	S-10	SS	14	3 2 2 2	4	q_u=0.25 tsf Rollerbit to 60'
				56						
				57						
				58						
				59						
		S-11: Dark grey, clayey SILT (MH), some small shells [NYCBC Class 6]		60	S-11	SS	24	2 1 2 3	3	q_u=0.13 tsf Sample crushed easily by fingers after drying
				61						
				62						Rollerbit to 65'
				63						
				64						
		S-12: Dark grey, CLAY (CH), trace shells [NYCBC Class 4c]		65	S-12	SS	24	1 2 3 3	5	q_u=0.5 tsf
				66						
				67						Rollerbit to 70'
				68						
				69						
				70						

N-Value (Blows/ft) scale: 10 20 30 40

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Log of Boring **G-35** Sheet 4 of 6

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 8.5 NAVD88

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-61.5	S-13: Dark grey, CLAY (CH), trace shells, trace mica [NYCBC Class 4c]		70	S-13	SS	24	2, 3, 3, 3	6	q_u=0.25 tsf
				71						
				72						Rollerbit to 75'
				73						
				74						
		S-14: Dark grey, CLAY (CH), some shells, trace mica flakes, wood fragments in sample [NYCBC Class 4b]		75	S-14	SS	18	5, 7, 8, 5	15	q_u=0.5 tsf
				76						
				77						Rollerbit to 80'
				78						
				79						
		S-15A: Dark grey, CLAY (CH), some shells, trace mica flakes [NYCBC Class 4a]		80	S-15	SS	24	5, 3, 27, 27	30	q_u=0.5 tsf
	-73.3	S-15B: (Bottom 3" of Recovery) Brown SILT (ML) (Glacial Till) [NYCBC Class 5a]		81						
				82						Rollerbit to 85'
				83						
				84						Spoon bouncing Sample collected Resume Rollerbit @ 85.5'
		S-16: Brown, SILT (ML), trace coarse sand, rock fragments (Glacial Till) [NYCBC Class 5a]		85	S-16	SS	3	100/3"	100/3"	Rock encountered
				86						
	-78.5			87						Rollerbit to 87' Began coring rock @ 87' 11/03/04
		C-1: Medium grey, mica SCHIST, sound, very fractured 90.6', strong rock, foliation: 80-85 degrees. Note: Many undulating rough mechanical breaks(10-50 degrees) [NYCBC Class 1a]	6	88	C-1	NX CORE BARREL	REC=57"/60" =95%	RQD=54"/60" =90%		
			6	89						
			5	90						
			5	91						
			5	92						
		C-2: Medium grey, mica SCHIST, moderately to highly fractured, medium strong to weak rock, foilation: 50-65 degrees [NYCBC Class 1d]	20	93	C-2	NX CORE BARREL	REC=32"/42" =76%	RQD=0"/42" =0%		Core barrel blocked up @ 95.5'
			15	94						
			10	95						

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Log of Boring **G-35** Sheet 5 of 6

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 8.5 NAVD88

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-86.5	C-3: Medium grey, mica SCHIST, medium grained, moderately fractured to sound, medium strong, unfoliated [NYCBC Class 1d]	10 8	95 96	C-3	NX CORE BARREL	REC=48"/60" =80%	RQD=15"/60" =25%	10 20 30 40	White clay modules 1/8" dia along joint 99.5' to 99.7'
		CLAY seam (98.4'-98.7'), decomposed very weak rock	8	97						Rough undulating and smooth curved joint surfaces 99.8' to 101' at 70-85 degrees
		99.8'-100.5' SCHIST fine grained with 1/2" mica vein Foliation: 75-90 degrees	10 15 18	98 99 100						Curved joint at 99.8' to 101' has hard clay coating along 70-85 degree joint surface
		C-4A: Medium grey, mica SCHIST, medium strong, sound to moderately fractured, foliation: 70 degrees [NYCBC Class 1c]	10	101	C-4	NX CORE BARREL	REC=48"/60" =80%	RQD=29"/60" =48%		
		C-4B: Grey-white GRANITE, medium grained, sound Note: Per wash, probable white / gray clay seam at about 103 [NYCBC Class 1c]	10 12 12	102 103 104 105						
		C-5: Light grey, mica SCHIST, medium strong, moderately fractured [NYCBC Class 1a]	6	106	C-5	NX CORE BARREL	REC=57"/60" =95%	RQD=39"/60" =65%		Smooth drilling Clean wash
		6" Quartz-feldspar seam at 107'	6	107						
		6" Highly fractured and weathered zone at 109'	6 7	108 109						
		C-6: Dark grey, mica SCHIST, highly fractured, weak rock [NYCBC Class 1d]	10 6	110 111	C-6	NX CORE BARREL	REC=35"/60" =58%	RQD=0"/60" =0%		Soft drilling @ 110' Hit a seam Wash more white than typical Very soft and broken rock getting stuck in core barrel and fracturing
			7 6 7	112 113 114						
		C-7: Dark grey, mica SCHIST, close to widely spaced fractures, moderately strong [NYCBC Class 1c]	15 7	115 116	C-7	NX CORE BARREL	REC=42"/60" =70%	RQD=28"/60" =47%		Broken rock frag at bottom of core
			10 9 8	117 118 119						
				120						

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Log of Boring **G-35** Sheet 6 of 6

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 8.5 NAVD88

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-111.5		11	120						
		C-8: Light grey, mica SCHIST, moderately to closely spaced fractured, moderately hard rock [NYCBC Class 1c]	9	121	C-8	NX CORE BARREL	REC=60"/60" =100%	RQD=23"/60" =38%		
		121.25-121.75 Natural vertical joint, highly weathered, clay present	9	122						
		121.75-122.5 Very highly weathered, very highly fractured	15	123						
			10	124						Blocked up @ 123.5' Pull casing Very soft rock breaking into small pieces Clay present in joints
			10	125						
		C-9: Light grey, mica SCHIST, moderately fractured, moderately strong [NYCBC Class 1b]	9	126						Driller switched diamond bit Reamed hole for larger diameter
		Soft rock from 128.5'-133	6	127	C-9	NX CORE BARREL	REC=47"/60" =78%	RQD=32"/60" =53%		
			8	128						
			15	129						
			10	130						Tempory lose of water Very white wash when return
		C-10: Light grey, mica SCHIST, slightly fractured, hard [NYCBC Class 1a]	9	131						
		1' Vertical joint at 131.5	10	132						
			9	133	C-10	NX CORE BARREL	REC=60"/60" =100%	RQD=57"/60" =95%		
			11	134						
			10	135						
	-127.0	End of boring at 135.5'		136						Borehole backfilled with cuttings and surface patched upon completion
				137						
				138						
				139						
				140						
				141						
				142						
				143						
				144						
				145						

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Log of Boring **G-37** Sheet 1 of 4

Project: Hudson Yards - WRY	Project No.: 170444101
Location: LIRR West Side Yard, Manhattan, NY	Elevation and Datum: Approx. 8.9 NAVD88
Drilling Company: Warren George, Inc.	Date Started: 11/9/04 — Date Finished: 11/11/04
Drilling Equipment: Acker 2D Hi-Rail Truck Rig	Completion Depth: 71 ft — Rock Depth: 51 ft
Size and Type of Bit: 3 7/8" Tri-Cone Rollerbit	Number of Samples: Disturbed 9 — Undisturbed 0 — Core 4
Casing Diameter (in): 3"/4" Flush Joint Steel — Casing Depth (ft): 29	Water Level (ft.): First ▽ 6 — Completion ▼ — 24 HR. ▼
Casing Hammer: Donut — Weight (lbs): 300 — Drop (in): 30	Drilling Foreman: Reynolds Bridgpal
Sampler: 2" O.D. Split Spoon	Field Engineer: Michael Paquette
Sampler Hammer: Donut — Weight (lbs): 140 — Drop (in): 30	

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40
	+8.9	14" Reinforced Concrete		0					
	+7.7	5" Asphalt		1					
	+7.1	Light brown, medium to coarse SAND, some gravel, dry (Fill) [NYCBC Class 7]		2 3 4 5 6 7 8 9 10					
		S-1: Dark brown, fine to coarse SAND, grading to silt bottom 3", trace gravel, trace brick, trace fibers (Fill) [NYCBC Class 7]		11 12 13 14	S-1	SS	10	7 4 5 4	9
		S-2: Brown-grey, silty fine to coarse SAND, trace gravel, trace brick, bone fragment (Fill) [NYCBC Class 7]		15 16 17 18 19 20	S-2	SS	6	5 2 2 2	4

Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)

Boring located on LIRR track 6, about 292' east of bumper block

qu (tsf) estimated from Pocket Penetrometer
Su (tsf) estimated from Pocket Torvane
Hand auger to 5'
Rollerbit with water and no pressure to 10'
Push 4" casing to 10'
Rollerbit to 10'

Push casing to 14'
Rollerbit to 15'

Rollerbit to 20'
Dark grey wash

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Log of Boring **G-37** Sheet 2 of 4

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 8.9 NAVD88

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-11.1	S-3: Dark brown, SILT, trace gravel, trace brick (Fill) [NYCBC Class 7]		20	S-3	SS	12	5 3 6 5	9	Rollerbit to 25'
	-17.1	S-4A: Top 4" of Recovery: Dark brown, fine to coarse SAND, trace gravel, trace rock frag, trace fibers (Fill) [NYCBC Class 7] S-4B: Bottom 4" of Recovery Dark grey, organic CLAY (OH), trace fine silt [NYCBC Class 4b]		25	S-4	SS	8	5 3 6 5	9	Rollerbit to 30' Push 4" casing to 29' Dark grey, thick wash
		S-5: Light grey, silty CLAY (CH-OH), trace fine sand, trace mica flakes, trace shells [NYCBC Class 4c]		30	S-5	SS	15	2 2 2 10	4	WC=58.6 , LL=69 , PL=27 Organic Content = 4.4% (burnoff) Rollerbit to 35' Dark grey wash
		S-6: Light grey, sily CLAY (CH-OH), trace fine sand, trace shells, trace fibers [NYCBC Class 4c]		35	S-6	SS	24	1 3 1 2	4	q_u=0.25 tsf s_u=0.1 tsf WC=50.6 , LL=62 , PL=23 Organic Content = 4.6% (burnoff) LL = 43 after burnoff (change ~30%) Rollerbit to 40'
	-31.1	S-7: Light grey, silty CLAY (CL), trace fine sand, trace shells, trace fibers [NYCBC Class 6]		40	S-7	SS	24	1 WOH 1 2		q_u=0.27 tsf s_u=0.13 tsf Strong sulfur odor Rollerbit to 45'
				45						

N-Value (Blows/ft) scale: 10 20 30 40

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Log of Boring **G-37** Sheet 3 of 4

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 8.9 NAVD88

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-36.1	S-8: Light grey, silty CLAY (CL), trace fine sand, trace shells, trace fibers [NYCBC Class 6]		45	S-8	SS	20	1 1 2 1 1	2	q_u=0.27 tsf s_u=0.5 tsf WC=26.8 , LL=34 , PL=17 Organic Content = 2.0% (burnoff) Rollerbit to 50'
	-41.1	S-9: Dark grey, decomposed MICA SCHIST, trace sands, trace shells (retains structure of parent rock) [NYCBC Class 3a]		50	S-9	SS	6	30 100/3"	100/3"	Spooning bouncing @ approximately 50.75' Start coring to 56'
	-42.1	C-1: Light grey, mica SCHIST, no fractures, moderately hard [NYCBC Class 1b]	9 10 5 5 5	51 52 53 54 55	C-1 NX CORE BARREL		REC=50"/60" =83%	RQD=50"/60" =83%		
		C-2: Light grey, mica SCHIST, very lightly fractured, soft weathered joint @ 56', 3" quartz intrusion @ 60', 3" fractured zone @ 60.8' [NYCBC Class 1a]	8 5 9 12 5	56 57 58 59 60	C-2 NX CORE BARREL		REC=60"/60" =100%	RQD=57"/60" =95%		
		C-3A: Light grey, mica SCHIST, lightly fractured, very lightly weathered joints, mechanical breaks [NYCBC Class 1b]	8 5 6	61 62 63	C-3 NX CORE BARREL		REC=48"/60" =80%	RQD=48"/60" =80%		
		C-3B: Grey-white, quartz and feldspar PEGMATITE, sound [NYCBC Class 1b]	4 5	64 65						45 degree joint at interface
		C-4: Light grey, mica SCHIST, quartz / feldspar veins, hard rock [NYCBC Class 1a]	10 8 8 6	66 67 68 69 70	C-4 NX CORE BARREL		REC=60"/60" =100%	RQD=60"/60" =100%		45 degree joints, lightly weathered

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Log of Boring **G-37** Sheet 4 of 4

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 8.9 NAVD88

MATERIAL SYMBOL	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-61.1			70						
			7		C-4					
	-62.1			71						
		End of boring at 71'								Borehole backfilled with cuttings and surface patched upon completion
				72						
				73						
				74						
				75						
				76						
				77						
				78						
				79						
				80						
				81						
				82						
				83						
				84						
				85						
				86						
				87						
				88						
				89						
				90						
				91						
				92						
				93						
				94						
				95						

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Log of Boring **G-39** Sheet 1 of 3

Project: Hudson Yards - WRY	Project No.: 170444101
Location: LIRR West Side Yard, Manhattan, NY	Elevation and Datum: Approx. 9.3 NAVD88
Drilling Company: Warren George, Inc.	Date Started: 10/31/04 — Date Finished: 11/3/04
Drilling Equipment: Acker 2D Hi-Rail Truck Rig	Completion Depth: 54 ft — Rock Depth: 34 ft
Size and Type of Bit: 3 7/8" Tri-Cone Rollerbit	Number of Samples: Disturbed 6 — Undisturbed 0 — Core 4
Casing Diameter (in): 3"/4" Flush Joint Steel — Casing Depth (ft): 34	Water Level (ft.): First ▽ — Completion ▼ — 24 HR. ▼
Casing Hammer: Donut — Weight (lbs): 300 — Drop (in): 30	Drilling Foreman: Bob Verbent
Sampler: 2" O.D. Split Spoon	Field Engineer: Cynthia Burzynski
Sampler Hammer: Donut — Weight (lbs): 140 — Drop (in): 30	

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	+9.3	14" Reinforced CONCRETE		0						Boring located on LIRR track 6, about 100' west of 11th Avenue overpass
	+8.1			1						
	+7.7	5" ASPHALT								
		Light brown, coarse to fine SAND, some coarse to fine gravel (subrounded) (Fill)		2						
				3						
		Dark brown coarse to fine GRAVEL and coarse to fine SAND, trace silt (Fill)		4						Core concrete with 9" thin wall Hand auger to 5'
				5						Rollerbit to 10' using water and no down pressure
				6						Drove 4" casing to 10' Rollerbit to 10' hard drilling from 8'
				7						
				8						
				9						
		S-1: Medium grey, fine GRAVEL, some coarse to fine sand, trace clay, trace silt, trace brick fragments (Fill) [NYCBC Class 7]		10	S-1	SS	8	4 47 8 10	55	
				11						
				12						Rollerbit to 15' hard drilling from 14' Drove 4" casing to 15'
				13						
				14						
		S-2: Dark grey, fine GRAVEL, some coarse to fine sand, trace silt (Fill) [NYCBC Class 7]		15	S-2	SS	4	18 18 6 7	24	
				16						
				17						Rollerbit to 20' easier drilling from 19' Pushed 4" casing to 20'
				18						
	-9.7			19						
				20						

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Log of Boring **G-39** Sheet 2 of 3

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 9.3 NAVD88

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-10.7	S-3: Dark grey, organic SILT and CLAY (CH-OH), trace fibers (slight organic odor) [NYCBC Class 4b]		20	S-3	SS	6	4 4 4 5	8	Rollerbit to 25' Installed 4" casing to 25'
				21						
				22						
				23						
				24						
		S-4: Dark grey, organic CLAY and SILT (CH-OH), trace fine sand, trace mica flakes [NYCBC Class 4c]		25	S-4	SS	24	2 2 3 3	5	WC=44.9 , LL=64 , PL=24
				26						Organic Content = 3.9% (burnoff)
				27						
				28						
	-19.7			29						Harder drilling @ 29' (Till)
		S-5: Red brown coarse to fine SAND (SM), some clay, some silt, trace coarse to fine gravel (Glacial Till) (Decomposed schist in tip of spoon) [NYCBC Class 3a]		30	S-5	SS	20	28 38 52 98	90	
				31						
				32						
				33						Attempted soil sample at 34'
	-24.7	S-6: No Recovery		34	S-6	SS	0	100/0"	100/0"	
		C-1: Medium grey, mica SCHIST, medium strong, slightly weathered, sound to moderately fractured, wavey foliation 45-60 degrees, 1/8" soil seam @ 34.7', 2. 2" quartz vein at 37.9' [NYCBC Class 1b]	4	35	C-1 NX CORE BARREL		REC=57"/60" =95%	RQD=39"/60" =65%		4" diameter casing kicked off @ 15' (in approximate North direction according to driller) Removed 15' 4"dia and installed 34' of 3"dia casing
			4	36						
			5	37						
			7	38						
			7	39						
		C-2: Medium grey, mica SCHIST, medium strong, sound slightly weathered, wavey foliation 45-60 degrees, 1/16" clay seam @ 42.2' with 70 degree foliation [NYCBC Class 1a]	7	40	C-2 NX CORE BARREL		REC=60"/60" =100%	RQD=57"/60" =95%		
			6	41						
			6	42						
			7	43						
			7	44						
		C-3A: White-light grey, medium grained, GRANITE vein, very strong	9	45	C-3					Decomposed rock along joint 60 degrees @ 43.4' (1/2" thick)

N-Value (Blows/ft) scale: 10 20 30 40

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Log of Boring **G-39** Sheet 3 of 3

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 9.3 NAVD88

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-35.7	[NYCBC Class 1a]		45						
		C-3B: Medium grey, mica SCHIST, sound to moderately fractured, slightly weathered, medium strong, slightly foliated @ 60 degrees.	8	46	C-3	NX CORE BARREL	REC=60"/60" =100%	RQD=57"/60" =95%		Very weak rock from 48.7' to 49'
		[NYCBC Class 1a]	7	47						
			7	48						
			6	49						
		C-4A: Medium grey, mica SCHIST, moderately fractured, very weak to extremely weak	2	50	C-4	NX CORE BARREL	REC=58"/60" =97%	RQD=46"/60" =77%		
		[NYCBC Class 1b]	9	51						
		C-4B: White-light grey, GRANITE, medium grained (slightly micaceous), very strong, no fractures	9	52						
		[NYCBC Class 1b]	9	53						
	-44.7		9	54						
		End of boring at 54'		55						Borehole backfilled with cuttings and surface patched upon completion
				56						
				57						
				58						
				59						
				60						
				61						
				62						
				63						
				64						
				65						
				66						
				67						
				68						
				69						
				70						

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Log of Boring **G-47** Sheet 1 of 6

Project: Hudson Yards - WRY	Project No.: 170444101
Location: LIRR West Side Yard, Manhattan, NY	Elevation and Datum: Approx. 6.3 NAVD88
Drilling Company: Warren George, Inc.	Date Started: 12/13/04 — Date Finished: 12/17/04
Drilling Equipment: Acker XLS Truck Rig	Completion Depth: 136.5 ft — Rock Depth: 115 ft
Size and Type of Bit: 3 7/8" Tri-Cone Rollerbit	Number of Samples: Disturbed 19 — Undisturbed 1 — Core 4
Casing Diameter (in): 3"/4" Flush Joint Steel — Casing Depth (ft): 115	Water Level (ft.): First ▽ — Completion ▼ — 24 HR. ▼
Casing Hammer: Automatic — Weight (lbs): 300 — Drop (in): 30	Drilling Foreman: Dave Puzycki
Sampler: 2" O.D. Split Spoon / 3" Shelby Tube	Field Engineer: Stuart Knoop
Sampler Hammer: Automatic — Weight (lbs): 140 — Drop (in): 30	

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	+6.3									Boring located approx. 446' north of West 30th Street and 5' east of 12th Avenue curb
	+6.0	4" Concrete Sidewalk		0						
				1						
				2						
				3						qu (tsf) obtained from Pocket Penetrometer
				4						Hand auger to 6'
				5						
		S-1: Medium dense, brown, silty fine SAND, trace coarse gravel, trace concrete fragments (Fill) [NYCBC Class 7]		6	S-1	SS	24	4 6 9 12	15	
				7						
				8						Spin 4" casing to 5' Rollerbit to 10'
				9						
		S-2: Brown-grey, fine SAND, some silt, trace fine gravel, (Fill) [NYCBC Class 7]		10	S-2	SS	19	5 8 12 5	20	
				11						
				12						Spin 4" casing to 10' Rollerbit to 15'
				13						Hard, slow drilling at 13' wood in cuttings
				14						Rig chatter at 14'
		S-3: Green-brown, coarse SAND, trace fine to medium gravel, trace rubber fragments (Fill) [NYCBC Class 7] 3" white-pink sandstone boulder		15	S-3	SS	12	17 17 8 8	25	
				16						
				17						Difficulty re-entering boring below 13'
				18						4" casing hammered to 15' Rollerbit to 15' 4" casing hammered to 20' Rollerbit to 20'
				19						
				20						

N-Value (Blows/ft) scale: 10 20 30 40

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Log of Boring **G-47** Sheet 2 of 6

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 6.3 NAVD88

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-13.7	S-4: Dark brown, coarse SAND, trace fine to medium gravel, trace brick fragments (Fill) [NYCBC Class 7]		20	S-4	SS	18	WOR WOR WOR WOR		1" Clay in bottom of spoon
	-15.7			21						
				22						Hammer 4" casing to 25' Rollerbit to 25'
				23						
				24						
		S-5: Black, organic CLAY (OH) [NYCBC Class 6]		25	S-5	SS	24	WOR WOR WOR WOR		
				26						
				27						Rollerbit to 30'
				28						
				29						
		S-6: Black, organic CLAY (OH) [NYCBC Class 6]		30	S-6	SS	24	WOR WOR WOR WOR		q_u=0.5 tsf
				31						
				32						Rollerbit to 35'
				33						
				34						
		S-7: Black, organic CLAY (OH), trace gravel [NYCBC Class 6]		35	S-7	SS	24	WOR 1 2 1 2		q_u=0.5 tsf
				36						
				37						Rollerbit to 40'
				38						
				39						
		S-8: Black, organic CLAY (OH), trace shells [NYCBC Class 6]		40	S-8	SS	24	1 1 2 1 1		q_u=0.5 tsf
				41						
				42						Rollerbit to 45'
				43						
				44						
				45						

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Log of Boring **G-47** Sheet 3 of 6

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 6.3 NAVD88

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-38.7	Black, organic CLAY (OH), trace shells		45						
				46	U-1	UNDIST	16			
				47						Rollerbit to 50'
				48						
				49						
		S-10: Black, organic CLAY (OH), trace silt [NYCBC Class 6]		50				WOR 1		
				51	S-10	SS	24	2 3 2		
				52						Rollerbit to 60'
				53						
				54						
				55						
				56						
				57						
				58						
				59						
		S-11: Black, organic CLAY (OH), trace silt [NYCBC Class 4c]		60				WOR 2		q_u=0.6 tsf
				61	S-11	SS	24	3 5 3		
				62						Rollerbit to 70'
				63						
				64						
				65						
				66						
				67						
				68						
				69						
				70						

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Log of Boring **G-47** Sheet 4 of 6

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 6.3 NAVD88

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-63.7	S-12: Black, organic CLAY (OH), trace silt, trace shells [NYCBC Class 6]		70	S-12	SS	24	WOR WOR WOR WOR		q_u=0.5 tsf
				71						
				72						Rollerbit to 80'
				73						
				74						
	-68.7			75						
				76						
				77						
				78						
				79						
		S-13: Black, SILT (ML), some clay [NYCBC Class 6]		80	S-13	SS	24	1 2 3 5	5	q_u=0.6 tsf
				81						
				82						Rollerbit to 90'
				83						
				84						
				85						
				86						
				87						
				88						
				89						
		S-14: Black, SILT (ML), some clay, trace shells [NYCBC Class 5b]		90	S-14	SS	24	6 8 10 14	18	q_u=0.5 tsf
				91						
				92						Rollerbit to 100'
				93						
				94						
				95						

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Log of Boring **G-47** Sheet 5 of 6

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 6.3 NAVD88

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-88.7			95					10 20 30 40	
				96						
				97						
				98						
				99						
		S-15: Black, SILT (ML), some clay [NYCBC Class 5b]		100	S-15	SS	24	8 10 14 14	24	q_u=0.5 tsf
				101						
				102						Rollerbit to 105'
				103						
				104						
		S-16: Dark grey, clayey SILT (ML), trace wood, trace shells [NYCBC Class 5a]		105	S-16	SS	24	14 35 27 18	62	
				106						
				107						Rollerbit to 110'
				108						
				109						
		S-17A: Dark grey, varved SILT (ML), some wood fragments [NYCBC Class 5a]		110	S-17	SS	24	2 27 13 22	40	
	-104.7	S-17B: Brown-red, silty fine SAND (SM), trace mica [NYCBC Class 3a]		111						
				112						Rollerbit to 115'
				113						
				114						
	-108.7			115						Drill refusal at 115'
		C-1: Dark green, SERPENTINITE, accessory chlorite and fibrous antigorite, moderately hard, fractures at ~80 degrees, black stained fractures [NYCBC Class 1d]	4 3	116	C-1	NX CORE BARREL	REC=16"/24" =67%	RQD=0"/24" =0%		
			5	117						Barrel blocked at 117'
		C-2: Black-green, chlorite SCHIST, moderately hard, very close fractures, very weathered fractures, foliation at ~65 degrees [NYCBC Class 1d]	2 8	118	C-2	NX CORE BARREL	REC=8"/120" =7%	RQD=0"/120" =0%		
				119						
				120						

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Log of Boring **G-47** Sheet 6 of 6

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 6.3 NAVD88

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-113.7	No recovery	11	120						
			6	121						6" of decomposed rock recovered from 10' run
			10	122	C-2	NX CORE BARREL	REC=8"/120" =7%	RQD=0"/120" =0%		Spin barrel from 117'-122' attempt to recover core C-2, sand in barrel
			6	123						
		No recovery	5	124						
			6	125						Rollerbit to clean hole to 127' Grey silty sand cuttings with mica
			6	126						
		C-3A: Pale green SERPENTINITE (6") Black biotite SCHIST (5") Serpentine is altered to tabular mineral, rock is v soft with close fractures [NYCBC Class 1d] No recovery	7	127						
			4	128	C-3	NX CORE BARREL	REC=41"/60" =68%	RQD=17"/60" =28%		
			6	129						
		C-3B: Grey-black, biotite muscovite SCHIST, moderately hard, v close to close fracture spacing, foliation and fractures at ~60 degrees, v slightly weathered [NYCBC Class 1d]	5	130						
			4	131						
			8	132						
		C-4: Grey-black muscovite biotite SCHIST, moderately hard, slightly weathered, foliation at ~40 degrees [NYCBC Class 1c] No recovery	8	133						~8" of cobble/pebble rock fragments at top of core
			11	134	C-4	NX CORE BARREL	REC=26"/60" =43%	RQD=22"/60" =37%		sandstone, mudstone conglomerate (glacial outwash falling into hole)
			7	135						
	-130.2		11	136						Core barrel blocked, abandon hole
		End of boring at 136.5'		137						Borehole backfilled with cuttings & surface patched upon completion
				138						
				139						
				140						
				141						
				142						
				143						
				144						
				145						

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Log of Boring **G-48** Sheet 1 of 5

Project: Hudson Yards - WRY	Project No.: 170444101
Location: LIRR West Side Yard, Manhattan, NY	Elevation and Datum: Approx. 8.3 NAVD88
Drilling Company: Warren George, Inc.	Date Started: 10/21/04 — Date Finished: 10/26/04
Drilling Equipment: Acker 2D Hi-Rail Truck Rig	Completion Depth: 100 ft — Rock Depth: 80 ft
Size and Type of Bit: 3 7/8" Tri-Cone Rollerbit	Number of Samples: Disturbed 14 — Undisturbed 3 — Core 4
Casing Diameter (in): 3"/4" Flush Joint Steel — Casing Depth (ft): 80	Water Level (ft.): First — Completion — 24 HR.
Casing Hammer: Donut — Weight (lbs): 300 — Drop (in): 30	Drilling Foreman: Bob Verbent
Sampler: 2" O.D. Split Spoon / 3" Shelby Tube	Field Engineer: Cynthia Burzynski
Sampler Hammer: Donut — Weight (lbs): 140 — Drop (in): 30	

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40
	+8.3	14" Reinforced Concrete		0					
	+7.1			1					
	+6.7	5" Asphalt							
		Light brown, medium to fine SAND, some rounded gravel, trace 6" to 8" cobbles		2					
				3					
				4					
		Dark grey-brown, coarse to fine SAND, some silt, some coarse to fine gravel (FILL) [NYCBC Class 7]		5					
				6					
				7					
				8					
				9					
		S-1: Grey, SILT, some fine gravel, trace clay (Fill) [NYCBC Class 7]		10	S-1	SS	5	7 4 4 5	8
				11					
				12					
				13					
				14					
	-6.7	S-2: Wood fragments, grain horizontal		15	S-2	SS	4	85 12 7 12	19
	-8.7			16					
				17					
				18					
				19					
				20					

Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)

Boring located on LIRR track 14, about 125' east of bumper block

qu (tsf) estimated from Pocket Penetrometer
Su (tsf) estimated from Pocket Torvane
Use 10" thin wall to core track slab
Hand auger to a depth of 5'

Use rollerbit with water and no down pressure to drill to 10'

Drive 4" casing to 10'
Rollerbit to 10'

Drive 4" casing to 15'
Hard driving into wood at 13.5'
Rollerbit to 15' (very slow)

Rollerbit to 20'
Wash changed from light grey to very dark grey at 17'

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Log of Boring **G-48** Sheet 2 of 5

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 8.3 NAVD88

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-11.7	S-3: Black, organic silty CLAY (CH-OH), trace fibers, trace shells, trace cinders [NYCBC Class 6]		20–21	S-3	SS	24	WOR WOR WOR WOR		q_u=0.06 tsf
				22						Rollerbit to 25'
				23–24						
		Black, organic silty CLAY (CH-OH), trace fibers, trace shells, trace cinders		25–26	U--2	UNDIST	24			q_u=0.08 tsf WC=69.4 , LL=80 , PL=29 Organic Content = 6.5% (burnoff)
	-18.7	S-4: Grey, silty CLAY (CL) (1/2" to 3/4"), alternating with thin layers of grey silt [NYCBC Class 4c]		27–28	S-4	SS	24	3 4 4 4	8	q_u=0.07 tsf Rollerbit to 30'
				29						
		S-5: Grey, silty CLAY (CL)(1/2" to 3/4"), alternating with thin layers of grey silt [NYCBC Class 4c]		30–31	S-5	SS	24	1 2 2 2	4	q_u=0.08 tsf
				32						Rollerbit to 35'
				33–34						
		S-6: Grey, silty CLAY (CL) (3/4" to 1 1/2"), alternating with thin layers of grey silt [NYCBC Class 4c]		35–36	S-6	SS	23	2 2 2 1	4	
				37						Rollerbit to 40'
				38–39						
		S-7: Grey, varved CLAY and SILT (CL-ML), trace small shells, trace fine gravel [NYCBC Class 4c]		40–41	S-7	SS	23	2 2 2 2	4	
				42						Rollerbit to 45'
				43–44						
				45						

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 8.3 NAVD88

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-36.7	S-8: Grey, varved CLAY and SILT (CL-ML), trace shells [NYCBC Class 4c]		45	S-8	SS	22	2 2 3 3	5	q_u=0.16 tsf
				46						
				47						Rollerbit to 50'
				48						
				49						
		S-9: Grey, varved CLAY and SILT (CL-ML), layered with thin grey silt [NYCBC Class 4c]		50	S-9	SS	22	4 3 3 3	6	q_u=0.18 tsf
				51						
				52						Rollerbit to 55'
				53						
				54						
		S-10: Grey, varved CLAY and SILT (CL-ML), trace small shells [NYCBC Class 4c]		55	S-10	SS	24	4 3 4 4	7	q_u=0.2 tsf
				56						
				57						Rollerbit to 60'
				58						
				59						
		Grey, varved CLAY and SILT (CL)		60	U-3	UNDIST	24			q_u=0.25 tsf WC=37.8 , LL=33 , PL=17
				61						
		S-11: Grey, varved CLAY and SILT (CL-ML), some small shells [NYCBC Class 4c]		62	S-11	SS	24	3 4 3 5	7	q_u=0.22 tsf
				63						
				64						Rollerbit to 65'
		S-12: Grey, varved CLAY and SILT (CL-ML), trace small shells [NYCBC Class 4c]		65	S-12	SS	24	4 2 3 2	5	q_u=0.27 tsf
				66						
				67						Rollerbit to 70'
				68						
				69						
				70						

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Log of Boring **G-48** Sheet 4 of 5

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 8.3 NAVD88

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-61.7	S-13: Grey, varved CLAY and SILT (CL-ML), trace small shells, trace fine sand [NYCBC Class 4c]		70	S-13	SS	24	4 3 3 5	6	q_u=0.16 tsf
				71						
				72						Rollerbit to 75'
				73						
				74						
		S-14: Grey, varved CLAY and SILT (CL-ML), trace small shells, trace fine sand, trace fine gravel [NYCBC Class 4c]		75	S-14	SS	24	2 3 3 3	6	q_u=0.22 tsf
				76						
				77						
	-69.7			78						Rig chatter at 78' Refusal at 80' Spin 3" casing to 80'
		Weathered rock or Glacial Till		79						
	-71.7		6	80						Rollerbit to clean casing to 80'
		C-1: Grey, mica SCHIST, medium grained, sound to moderately fractured, medium strong, slightly weathered, foliation 45 to 60 degrees [NYCBC Class 1b]	7	81	C-1	NX CORE BARREL	REC=56"/60" =93%	RQD=46"/60" =77%		Mechanical breaks from 80' to 82.2'
			7	82						
			8	83						From 82.2' to 85' joint across foliation are rough and undulating joints along foliation (~60 degrees) are smooth and planer
			8	84						
			8	85						
		C-2: Grey, mica SCHIST, medium grained, sound to slightly fractured, medium strong, slightly weathered, foliation 50 to 55 degrees [NYCBC Class 1b]	6	86	C-2	NX CORE BARREL	REC=58"/60" =97%	RQD=50"/60" =83%		
			6	87						
			5	88						
			5	89						
			4	90						
		C-3: Grey, mica SCHIST, medium grained, sound to slightly fractured, medium strong, slightly weathered, foliation wavey 45 to 60 degrees [NYCBC Class 1a]	4	91	C-3	NX CORE BARREL	REC=60"/60" =100%	RQD=54"/60" =90%		Two quartz veins: 91.4'-91.8' (~4") 92.7'-93' (~3")
			5	92						
			4	93						Few garnets
			4	94						
				95						

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Log of Boring **G-48** Sheet 5 of 5

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 8.3 NAVD88

MATERIAL SYMBOL	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-86.7			95					10 20 30 40	
		C-4: Grey, mica SCHIST, medium grained, sound, strong, slightly weathered, foliation wavey 45 to 60 degrees [NYCBC Class 1a]	5	96	C-4	NX CORE BARREL	REC=60"/60" =100%	RQD=59"/60" =98%		Two quartz veins: 96.0'-96.2' (~2") 97.5'-97.7' (~2")
			5	97						
			5	98						
			5	99						
			5	100						
	-91.7	End of boring at 100'		101						Borehole backfilled with cuttings & concrete patched upon completion
				102						
				103						
				104						
				105						
				106						
				107						
				108						
				109						
				110						
				111						
				112						
				113						
				114						
				115						
				116						
				117						
				118						
				119						
				120						

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Log of Boring **G-49** Sheet 1 of 4

Project: Hudson Yards - WRY	Project No.: 170444101
Location: LIRR West Side Yard, Manhattan, NY	Elevation and Datum: Approx. 9 NAVD88
Drilling Company: Warren George, Inc.	Date Started: 10/27/04 — Date Finished: 10/28/04
Drilling Equipment: Acker 2D Hi-Rail Truck Rig	Completion Depth: 74 ft — Rock Depth: 54 ft
Size and Type of Bit: 3 7/8" Tri-Cone Rollerbit	Number of Samples: Disturbed 9 — Undisturbed 1 — Core 4
Casing Diameter (in): 3"/4" Flush Joint Steel — Casing Depth (ft): 54	Water Level (ft.): First ▽ — Completion ▼ — 24 HR. ▼
Casing Hammer: Donut — Weight (lbs): 300 — Drop (in): 30	Drilling Foreman: Bob Verbent
Sampler: 2" O.D. Split Spoon / 3" Shelby Tube	Field Engineer: Cynthia Burzynski
Sampler Hammer: Donut — Weight (lbs): 140 — Drop (in): 30	

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	+9.0	14" Reinforced Concrete		0						Boring located on LIRR track 14, about 345' east of bumper block
	+7.8			1						
	+7.4	5" Asphalt								
		Orange-brown, coarse to fine SAND, some coarse gravel (FILL) [NYCBC Class 7]		2						qu (tsf) estimated from Pocket Penetrometer Su (tsf) estimated from Pocket Torvane
		Dark brown, coarse to fine SAND, some silt, trace coarse to fine gravel, moist (FILL) [NYCBC Class 7]		3						
				4						Core concrete slab with thin wall machine Hand auger to depth of 5'
				5						Drill to 10' using rollerbit and water with no down pressure
				6						
				7						
				8						
				9						
		S-1: Grey, medium to fine SAND, some fine gravel, trace silt, trace clay (Fill) [NYCBC Class 7]		10	S-1	SS	8	30 12 11 16	23	Push 4" casing to 9' Rollerbit to 10'
				11						
				12						Push 4" casing to 14' rollerbit to 15'
				13						
				14						
		S-2: Grey-white, coarse to medium SAND, some fine gravel, some decomposed mica schist (Fill) [NYCBC Class 7]		15	S-2	SS	7	28 22 23 16	45	
				16						
				17						Install 4" casing to 19' Rollerbit to 20'
				18						
				19						
	-11.0			20						

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Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 9 NAVD88

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-11.0	S-3: Grey, organic CLAY and SILT (OH), some medium to fine sand, trace shell fragments, trace mica [NYCBC Class 4b]		20						Easier drilling, dark grey wash color at 20'
				21	S-3	SS	6	1 3 6 19	9	
				22						Push 4" casing to 24' Rollerbit to 25'
				23						
				24						
		S-4: Grey, organic silty CLAY (OH), trace mica flakes [NYCBC Class 4c]		25						q_u=0.11 tsf WC=72.5 , LL=80 , PL=29
				26	S-4	SS	22	2 1 3 3	4	Organic Content = 6.2% (burnoff)
				27						Push 4" casing to 29' Rollerbit to 30'
				28						
				29						
		Top: grey, organic silty CLAY (OH), some coarse gravel (2" diameter, platey)		30						WC=60.4 , LL=67 , PL=25
	-22.0	Bottom: grey, silty CLAY, trace small shells (CH)		31	U-1	UNDIST	24			
		S-5: Grey, varved CLAY and SILT (CL), 1/2" layers of small shells (fine gravel size) [NYCBC Class 4c]		32						q_u=0.19 tsf
				33	S-5	SS	24	2 2 3 4	5	
				34						Rollerbit to 35'
		S-6: Grey, varved CLAY and SILT (CL), with 1/8" to 1/2" layer of small shells (fine gravel size) at 2" intervals [NYCBC Class 4c]		35						q_u=0.2 tsf WC=50.4 , LL=63 , PL=24
				36	S-6	SS	24	1 2 2 4	4	Organic Content = 3.8% (burnoff)
				37						Rollerbit to 40'
				38						
				39						
		S-7: Grey, varved CLAY and SILT (CL), with 1/16" layers of silt and small shells at 1" intervals [NYCBC Class 4c]		40						q_u=0.2 tsf
				41	S-7	SS	24	2 2 3 3	5	
				42						Rollerbit to 45'
				43						
				44						
				45						

N-Value (Blows/ft) scale: 10 20 30 40

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Log of Boring **G-49** Sheet 3 of 4

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 9 NAVD88

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-36.0	S-8: Grey, varved SILT and CLAY (CL), some fine sand, trace fine gravel, trace small shells [NYCBC Class 4c]		45	S-8	SS	24	2 2 3 4	5	q_u=0.11 tsf WC=22.6 , LL=23 , PL=13
				46						
				47						Rollerbit to 50'
				48						
				49						
				50						
	-42.0	S-9: Brown, medium to fine SAND (SM) (micacous), some silt, some clay, trace coarse gravel (Glacial Till) [NYCBC Class 3a]		51	S-9	SS	8	12 21 32 80	53	Glacial Till at ~51'
				52						
				53						Very hard drilling at 53'
	-45.0			54						Spin 3" casing to 54'
		C-1: Medium grey, mica SCHIST, medium strong, sound, wavey foliation from 54'-58', 55 to 60 degree foliation from 58'-59' [NYCBC Class 1a]	5	55	C-1 NX CORE BARREL		REC=60"/60" =100%	RQD=60"/60" =100%		
			5							
			4	56						
			5	57						
			5	58						Orange staining at rough cross foliated joint at 25 degrees
			5	59						
		C-2A: Medium grey, mica SCHIST, medium strong, foliation 65 to 75 degrees [NYCBC Class 1a]	5	60	C-2 NX CORE BARREL		REC=60"/60" =100%	RQD=52"/60" =87%		Several mechanical breaks along foliation of about 70 to 75 degrees
			5	61						
			5	62						
		C-2B: Light grey-white, quartz PEGMATITE [NYCBC Class 1a]	5	63						
		C-3A: Medium grey, mica SCHIST, with white-light grey PEGMATITE vein (~1" thick) (Ribbon) along schist (vertical formation), medium grained, foliation 65 to 70 degrees [NYCBC Class 1a]	6	64	C-3 NX CORE BARREL		REC=60"/60" =100%	RQD=52"/60" =87%		Sandy section at 63.6' (1/4" thick)
			5	65						
			5	66						
			6	67						
		C-3B: White-light grey, quartz PEGMATITE, with 1" wide vein of mica SCHIST along side [NYCBC Class 1a]	6	68						
			6	69	C-4					
				70						

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Log of Boring **G-49** Sheet 4 of 4

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 9 NAVD88

MATERIAL SYMBOL	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-61.0			70					10 20 30 40	
		C-4: White-light grey, quartz PEGMATITE, with 1" wide vein of mica SCHIST along side [NYCBC Class 1a]	6	71	C-4	NX CORE BARREL	REC=60"/60" =100%	RQD=59"/60" =98%		
			6	72						
			6	73						
			6	74						
	-65.0	End of boring at 74'		75						Borehole backfilled with cuttings and surface patched upon completion
				76						
				77						
				78						
				79						
				80						
				81						
				82						
				83						
				84						
				85						
				86						
				87						
				88						
				89						
				90						
				91						
				92						
				93						
				94						
				95						

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Log of Boring **G-5** Sheet 1 of 5

Project: Hudson Yards - WRY	Project No.: 170444101
Location: LIRR West Side Yard, Manhattan, NY	Elevation and Datum: Approx. 7.9 NAVD88
Drilling Company: Warren George, Inc.	Date Started: 10/14/04 — Date Finished: 10/21/04
Drilling Equipment: CME 75 Truck Rig	Completion Depth: 100 ft — Rock Depth: 80 ft
Size and Type of Bit: 3 7/8" Tri-Cone Rollerbit	Number of Samples: Disturbed 15, Undisturbed 2, Core 4
Casing Diameter (in): 3"/4" Flush Joint Steel — Casing Depth (ft): 75	Water Level (ft.): First ▽ — Completion ▼ — 24 HR. ▼
Casing Hammer: Donut — Weight (lbs): 300 — Drop (in): 30	Drilling Foreman: Corry Tirro
Sampler: 2" O.D. Split Spoon / 3" Shelby Tube	Field Engineer: Stephen Morse / Nipam Shah
Sampler Hammer: Automatic — Weight (lbs): 140 — Drop (in): 30	

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40
	+7.9			0					
	+7.4	6" Asphalt		1					
				2					
				3					
				4					
				5					
		S-1: Brown-black, GRAVEL and SILT (Fill) [NYCBC Class 7]		6	S-1	SS	5	5 3 2 3	5
				7					
				8					
				9					
		S-2: Brown-black, GRAVEL and SILT (Fill) [NYCBC Class 7]		10	S-2	SS	5	4 4 3 2	7
				11					
				12					
				13					
				14					
		S-3: Brown-black, GRAVEL and SILT, some brick fragments (Fill) [NYCBC Class 7]		15	S-3	SS	3	6 4 3 5	7
				16					
				17					
				18					
				19					
				20					

Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)

Boring located in NYDS parking area, about 300' east of 12th Avenue and 27' north of 30th Street

qu (tsf) estimated from Pocket Penetrometer

Drill to 6' using rollerbit and water with no down pressure

Push and drive 4" casing to 9'

Rollerbit to 10'

Drive 4" casing to 14'
Rollerbit to 15'

Install 4" casing to 19'
Rollerbit to 20'

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Log of Boring **G-5** Sheet 2 of 5

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 7.9 NAVD88

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-12.1	S-4: Brown-black, GRAVEL and SILT, some cobbles (Fill) [NYCBC Class 7]		20	S-4	SS	5	6 8 7 5	15	
				21						
				22						Install 4" casing to 24' Rollerbit to 25'
				23						
				24						
		S-5: Brown-grey, GRAVEL and SILT, some rock fragments (FILL) [NYCBC Class 7]		25	S-5	SS	4	5 4 4 4	8	
				26						
				27						Spin 4" casing to 30' Rollerbit to 30'
				28						
				29						
		S-6: Brown, coarse to fine SAND, some silt, some fine gravel (Fill) [NYCBC Class 7]		30	S-6	SS	6	4 4 8 5	12	
				31						
				32						Add revert to drilling fluid
				33						Rollerbit to 35'
				34						
		S-7: Brown, coarse to fine SAND, some silt, some fine gravel (Fill) [NYCBC Class 7]		35	S-7	SS	12	7 6 4 7	10	
				36						
				37						Rollerbit to 40' Reddish brown wash
				38						
				39						
		S-8: No recovery		40	S-8	SS	0	4 3 3 2	6	
				41						
				42						Rollerbit to 45'
	-35.1			43						
				44						
				45						

N-Value (Blows/ft) scale: 10 20 30 40

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Log of Boring **G-5** Sheet 3 of 5

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 7.9 NAVD88

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-37.1	S-9: Grey, organic CLAY (OH), some silt, some shell fragments, trace fine gravel [NYCBC Class 4c]		45	S-9	SS	15	3 2 3 4	5	q_u=0.05 tsf
		Grey, organic silty CLAY (OH), trace fine sand		46						
				47	U-1	UNDIST	15			Rollerbit to 47'
		S-10: Grey, organic silty CLAY (OH), some shell fragments, trace fine sand [NYCBC Class 6]		48						
				49	S-10	SS	8	2 1 2 3	3	q_u=0.1 tsf
		No recovery		50						
				51	U-2	UNDIST	0			Rollerbit to 51'
				52						
				53						Rollerbit to 55'
				54						
		No recovery		55	U-3	UNDIST	0			
				56						
		S-11: Grey, organic silty CLAY (OH), some fine sand, some shell fragments, roots [NYCBC Class 6]		57	S-11	SS	24	2 1 1 2	2	q_u=0.17 tsf
				58						
				59						Rollerbit to 60'
	-52.1	S-12: Grey, clayey SILT (ML), some fine sand, some shell fragments, trace fine gravel [NYCBC Class 5b]		60	S-12	SS	4	6 6 5 5	11	
				61						
				62						Rollerbit to 65'
				63						
				64						
		S-13: Grey, silty CLAY (CL), some fine sand, trace fine gravel, trace shell fragments [NYCBC Class 4c]		65	S-13	SS	20	6 5 1 1	6	q_u=0.14 tsf No recovery for Shelby tube taken at 65', drive spoon
				66						
				67						Rollerbit to 70'
				68						
				69						
				70						

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Log of Boring **G-5** Sheet 4 of 5

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 7.9 NAVD88

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-62.1	S-14: Dark grey, clayey SILT (ML), some fine sand, trace fine gravel, trace shell fragments [NYCBC Class 6]		70	S-14	SS	24	WOH 1 2 3	3	q_u=0.13 tsf
				71						
				72						Rollerbit to 75'
				73						
				74						
		S-15: Dark grey, clayey SILT (ML), some fine sand, trace fine gravel, trace shell fragments [NYCBC Class 6]		75	S-15	SS	6	5 4 5 7	9	
				76						Hole caved in Spin 3" casing to 75'
				77						Rollerbit to 80'
				78						
				79						
	-72.1			80						Rock encountered at 80'
		C-1: Grey, mica SCHIST, moderately weathered, sound, wide fracture spacing, strong rock, medium grained, slightly to moderately weathered [NYCBC Class 1b]	5	81	C-1	NX CORE BARREL	REC=54"/60" =90%	RQD=45"/60" =75%		
			5	82						
		highly weathered PEGMATITE between 83'-84'	5	83						
			4	84						
			4	85						
		C-2: Grey, mica SCHIST, slightly weathered, sound, wide fracture spacing, strong rock, fine grained, slightly weathered foliation, moderately weathered at 87.8' [NYCBC Class 1a]	3	86	C-2	NX CORE BARREL	REC=56"/60" =93%	RQD=55"/60" =92%		
			5	87						
			5	88						
			5	89						
			5	90						
		C-3: Grey, mica SCHIST, highly weathered, moderately fractured, close to wide fracture spacing, strong rock, medium grained, iron-oide staining 92.5'-94' [NYCBC Class 1b]	5	91	C-3	NX CORE BARREL	REC=60"/60" =100%	RQD=50"/60" =83%		
			4	92						
			3	93						
			5	94						
			5	95						

N-Value (Blows/ft): 10 20 30 40

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Log of Boring **G-5** Sheet 5 of 5

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 7.9 NAVD88

MATERIAL SYMBOL	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-87.1	C-4: Grey, mica SCHIST, moderately weathered, slightly fractured, close to wide fracture spacing, strong, medium grained, iron-oxide staining at 96'-99' [NYCBC Class 1a]	5 5 5 5 4	95 96 97 98 99	C-4	NX CORE BARREL	REC=60"/60" =100%	RQD=60"/60" =100%		
	-92.1	End of boring at 100'		100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120						Borehole backfilled with cuttings and surface patched upon completion

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Log of Boring **G-50** Sheet 1 of 3

Project: Hudson Yards - WRY	Project No.: 170444101
Location: LIRR West Side Yard, Manhattan, NY	Elevation and Datum: Approx. 9.2 NAVD88
Drilling Company: Warren George, Inc.	Date Started: 10/28/04 — Date Finished: 10/29/04
Drilling Equipment: Acker 2D Hi-Rail Truck Rig	Completion Depth: 59 ft — Rock Depth: 39 ft
Size and Type of Bit: 3 7/8" Tri-Cone Rollerbit	Number of Samples: Disturbed 6 — Undisturbed 0 — Core 4
Casing Diameter (in): 3"/4" Flush Joint Steel — Casing Depth (ft): 38	Water Level (ft.): First ▽ 7 — Completion ▼ — 24 HR. ▼
Casing Hammer: Donut — Weight (lbs): 300 — Drop (in): 30	Drilling Foreman: Bob Verbent
Sampler: 2" O.D. Split Spoon	Field Engineer: Stephen Morse
Sampler Hammer: Donut — Weight (lbs): 140 — Drop (in): 30	

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	+9.2	14" Reinforced Concrete		0						Borehole located on LIRR track 14, about 530' east of bumper block
	+8.0			1						
	+7.6	5" Asphalt		2						qu (tsf) estimated from Pocket Penetrometer Su (tsf) estimated from Pocket Torvane
				3						
				4						Use thin wall to core concrete slab Rollerbit through asphalt
				5						Hand auger to 5' Rollerbit with water and no pressure on drill head to 10'
				6						Push 4" casing to 10' Rollerbit to 10'
				7						
				8						
				9						
		S-1: Dark brown-black, medium to coarse SAND, some asphalt, some silt, rock fragments (Fill) [NYCBC Class 7]		10	S1	SS	4	50 4 3 2	7	
				11						
				12						Drive 4" casing to 15' Rollerbit to 15'
				13						
				14						
		S-2: No Recovery		15	S2	SS	0	5 2 1 5	3	Two spoons attempted, no recovery
				16						
				17						Push 4" casing to 20' Rollerbit to 20'
				18						
				19						
				20						

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Log of Boring **G-50** Sheet 2 of 3

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 9.2 NAVD88

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-10.8			20					10 20 30 40	
		S-3A: 5" dark brown-black, medium to coarse SAND, some silt, rock fragments (Fill) [NYCBC Class 7]			S3	SS	8	13 7 8 16	15	q_u=0.16 tsf
	-11.8	S-3B: 3" dark grey, organic silty CLAY (OH), some shells [NYCBC Class 4b]		21						
				22						Push 4" casing to 25' Rollerbit to 25'
				23						
				24						
		S-4: Dark grey, organic silty CLAY (OH), some shells, trace wood fibers [NYCBC Class 6]		25	S4	SS	10	2 1 2 5	3	q_u=0.06 tsf WC=55 , LL=66 , PL=26 Organic Content = 4.5% (burnoff)
				26						
				27						Push 4" casing to 30' Rollerbit to 30'
				28						
				29						
		S-5: Dark grey, organic silty CLAY (OH), trace fine sand, rock fragments [NYCBC Class 6]		30	S5	SS	4	2 1 2 33	3	
				31						Obstruction at 32' Hard drilling at 33'
	-23.8			32						
				33						
				34						
		S-6: Dark grey, silty SAND (SM), trace shells, rock fragments [NYCBC Class 6]		35	S6	SS	4	WOH WOH WOH 10		Organic Content = 1.0% (burnoff)
				36						
				37						
				38						
	-29.8			39						
			5	40	C1	NX CORE BARREL	REC=58"/60" =97%	RQD=47"/60" =78%		
		C-1: Grey, mica SCHIST, vertical foliation top 12", banded bottom 4', moderatley fractured, moderately weathered joints, silt in joints, some vertical joints [NYCBC Class 1b]	6	41						
			7	42						
			4	43						
			4	44						
			7	45	C2					

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Log of Boring **G-50** Sheet 3 of 3

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 9.2 NAVD88

MATERIAL SYMBOL	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-35.8	C-2: Grey, mica SCHIST, vertical foliation from 44'-46.5', 45 degree bands to 49', slightly weathered fractures, weak joint at 45', vertical joint 46'-47' [NYCBC Class 1a]	5	45	C2	NX CORE BARREL	REC=60"/60" =100%	RQD=54"/60" =90%		
			5	46						
			5	47						
			5	48						
			5	49						
		C-3: Grey, mica SCHIST, moderately weathered joints, weak joint at 54', top 24" vertical foliation [NYCBC Class 1a]	5	50	C3	NX CORE BARREL	REC=60"/60" =100%	RQD=54"/60" =90%		
			3	51						
			3	52						
			3	53						
			4	54						
		C-4: Grey, mica SCHIST, slightly fractured, moderately weathered joints, silt in joints, harder rock than upper 15' [NYCBC Class 1b]	7	55	C4	NX CORE BARREL	REC=48"/60" =80%	RQD=48"/60" =80%		Part of core may have been left in hole
			7	56						
			4	57						
			4	58						
	-49.8		5	59						
		End of boring at 59'		60						Borehole backfilled with cuttings and surface patched upon completion
				61						
				62						
				63						
				64						
				65						
				66						
				67						
				68						
				69						
				70						

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Log of Boring **G-51** Sheet 1 of 3

Project: Hudson Yards - WRY	Project No.: 170444101
Location: LIRR West Side Yard, Manhattan, NY	Elevation and Datum: Approx. 9.3 NAVD88
Drilling Company: Warren George, Inc.	Date Started: 10/26/04 — Date Finished: 10/29/04
Drilling Equipment: Acker 2D Hi-Rail Truck Rig	Completion Depth: 51.5 ft — Rock Depth: 31 ft
Size and Type of Bit: 3 7/8" Tri-Cone Rollerbit	Number of Samples: Disturbed 5 — Undisturbed 0 — Core 4
Casing Diameter (in): 3"/4" Flush Joint Steel — Casing Depth (ft): 30	Water Level (ft.): First ▽ 6 — Completion ▼ — 24 HR. ▼
Casing Hammer: Donut — Weight (lbs): 300 — Drop (in): 30	Drilling Foreman: Reynolds Bridgpal
Sampler: 2" O.D. Split Spoon	Field Engineer: Michael Paquette
Sampler Hammer: Donut — Weight (lbs): 140 — Drop (in): 30	

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	+9.3	14" Reinforced Concrete		0						Boring located on LIRR track 14, about 120' west of 11th Avenue overpass
	+8.1	Asphalt Pavement		1						
	+7.6	Light brown, medium to coarse SAND, some gravel, dry sample (Fill) -Moist @ 4ft [NYCBC Class 7]		2						
				3						
				4						Hand auger to 5' below slab
				5						Use rollerbit with water and no down pressure to drill to 10'
		▽		6						
				7						
				8						
				9						
		S-1: Black-white, coarse SAND, some fine gravel, trace silt (Fill) [NYCBC Class 7]		10	S-1	SS	4	3 2 2 1	4	Push 4" casing to 10' Rollerbit to 10'
				11						
				12						Push 4" casing to 15' Rollerbit to 15'
				13						
				14						
		S-2: Black, fine to coarse SAND, some fine gravel (Fill) [NYCBC Class 7]		15	S-2	SS	4	1 WOH WOH WOH		1 blow/24"
				16						
				17						Push 4" casing to 20' Very little resistance Rollerbit to 20'
				18						
				19						
				20						

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Log of Boring **G-51** Sheet 2 of 3

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 9.3 NAVD88

Material Symbol	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-10.7	S-3: No Recovery (some coarse sand on inside of spoon) (wash) [NYCBC Class 6]		20	S-3	SS	0	1 WOH WOH 1		0" recovery 1st spoon Redrive: 1-WOH-WOH-WOH (1 blow/24") 0" recovery 2nd spoon
				21						
				22						Push 4" casing to 25' Very little resistance Rollerbit to 25' dark brown wash
				23						
	-14.7			24						Hard drilling at 24' followed by sudden drop (Boulder?)
		S-4: Light brown, SILT (ML), trace fine sand [NYCBC Class 5b]		25	S-4	SS	2	4 5 5 8	10	
				26						
				27						Rollerbit to 30' Rig chatter at 30'
				28						
				29						
	-20.7			30	S-5	SS	1	100/1"	100/1"	Spoon bouncing at 30' Drive 4" casing to 30'
	-21.7	S-5: Brown, very coarse SAND (SP), some gravel, some mica, trace silt, rock fragments (schist) (Glacial Till) [NYCBC Class 3a]		31						Rollerbit to clean and flush casing Heavy rig chatter at 30'
		C-1: Light grey, mica SCHIST, moderately weathered, very soft rock, 30 degree dip in joints [NYCBC Class 1b]	5	32	C-1 NX CORE BARREL		REC=53"/60" =88%	RQD=40"/60" =67%		
			5	33						Can break rock with fingers
			5	34						
			7	35						Some soil and decomposed rock in natural joints
			5	36						
		C-2: Light grey, mica SCHIST, lightly weathered joints, moderately hard, 30-45 degree dip in joints [NYCBC Class 1a]	5	37	C-2 NX CORE BARREL		REC=60"/60" =100%	RQD=58"/60" =97%		
			6	38						Need hammer to break rock
			5	39						
			8	40						
			9	41						
		C-3: Light grey, mica SCHIST, very lightly weathered joints, lightly fractured, 30-45 degree dip in joints, hard rock [NYCBC Class 1a]	9	42	C-3 NX CORE BARREL		REC=60"/60" =100%	RQD=60"/60" =100%		
			5	43						Majority of breaks appear fresh and mechanical
			8	44						
				45						

N-Value (Blows/ft) scale: 10 20 30 40