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RA Consultants LLC

Geotechnical Engineering

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April 19, 2017
15C1077

Mr. Mark Green
Lightstone
460 Park Avenue
New York, NY 10022

REPORT OF: Geotechnical Investigation
130 William Street
New York, NY10038

Dear Mr. Green:

We are pleased to submit this electronic copy of our report covering a geotechnical investigation at the referenced site. Our services were provided in accordance with the contract dated August 21, 2015.

We appreciate this opportunity to be of service and look forward to working with you as the project proceeds.

Very truly yours,

Nidal M. AbiSaab, P.E.

STATE OF NEW YORK NIDAL M. ABI SAAB 089151 LICENSED PROFESSIONAL ENGINEER

Unauthorized alteration or addition to this report is a violation of New York State Education Law Article 145 section 7209.

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REPORT OF GEOTECHNICAL INVESTIGATION

PROJECT:

Number 15C1077
130 William Street
New York, NY 10038

PREPARED FOR:

Mr. Mark Green
Lightstone
460 Park Avenue
New York, NY 10022

PREPARED BY:

RA Consultants LLC
512 7th Avenue, 6th Floor
New York, NY 10018

April 19, 2017

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PROJECT DESCRIPTION

Location and Existing Conditions

The L-shaped site located in lower Manhattan, NY occupies an area of approximately 17,458-ft^2 as shown on the architectural survey by True North Surveyors, P.C. dated May 8, 2006. The site is bordered partially by Fulton Street and partially by William Street. The general site elevations are +27 to +29 NAVD88.

The combined lot is currently vacant and previous buildings have been demolished. Previous multi-story buildings were pile supported. Available drawings indicate that the western portion of the demolished, 12-story building occupying Lot 15 was supported by 50T capacity steel pipe piles and the wall bordering the subway structure (see below) is on a spread footing. We understand that the existing, adjacent 88 Fulton Street building has been proposed for landmark status.

NYCT subway tunnels lie below Fulton and William Streets. Base-of-rail is located within 18.25-ft diameter, circular, cast iron liner plate (with concrete fill) tunnels. It is approximately 51-ft below the Fulton Street surface but varies somewhat with stationing. We understand that the tunnel below William Street is about 32-ft below the street.

Proposed Construction

We understand that the proposed building will include a 60-story tower. A below-grade single cellar will occupy most of the site footprint. We anticipate that subgrade will be about 20-ft below site grade, or about el 9. The first floor will have an area of approximately 11,500-ft^2. The second and third stories will each have an area of approximately 9,282-ft^2. The tower portion will have an L-shaped footprint varying in area from approximately 7,360- to 7,784-ft^2 and will rise above the third story. Actual building dimensions and plans may vary as the designs are finalized.

Available Onsite Geologic Data

Langan prepared a geotechnical investigation for the 92 Fulton Street (Lot 22) site for a previous project. The available boring logs indicate subsurface conditions consisting of about 8-ft of uncontrolled Fill underlain by about 90-ft of Sand with varying gradations, and including occasional layers of silt or clay. Generally, these soils were characterized as medium dense to dense, with the density increasing with depth as indicated by Standard Penetration Test (SPT) N-values[1] . Very dense Glacial Till, about 25-ft thick, and apparently consisting mainly of boulders and cobbles was encountered below the Sand. The Till samples were retrieved mainly by coring.

Medium hard mica schist bedrock [class 1b] underlies the Till about 120-ft below existing grade. However, layers of poorer quality rock [class 1c and 1d] were encountered at varying depths in the rock mass.

Groundwater was recorded at about 18.5-ft below ground surface, corresponding approximately to el 4.5.

Available Geologic Data Nearby

In 2013 Langan prepared a geotechnical investigation for the 112-118 Fulton Street development site for Lightstone, which located about 250-ft from the subject project site. The subsurface conditions disclosed by the 112-118 Fulton Street investigation generally were similar to those described above. However the generalized Sand stratum appeared to contain thicker deposits of silts and silty sands than at Lot 22.

We provided geotechnical services for the nearby 151 William Street buildings (aka 111 Fulton Street). Borings at 151 William Street indicate subsurface conditions similar to those shown in the Langan borings for Lot 22. The Sand stratum extended to about 110-ft below street grade and contained interbedded layers of poorly graded sands, silty sand and occasional layers of clay. A thin veneer of decomposed rock (class 1d) was encountered above intermediate bedrock [class 1c] at about 110-ft depth below street grade. The deepest boring penetrated only 5-ft into the intermediate bedrock.

At all sites the bedrock elevations were consistent with published bedrock geology maps and other available bedrock information.

Groundwater elevations were consistent with those encountered by Langan at the project site.

PURPOSE AND SCOPE OF SERVICES

The purpose of the investigation was to obtain subsurface data at the site to provide recommendations for design and construction of foundations and comply with 2014 NYCBC code requirements.

We provided the following services:

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1 N-value is determined from the Standard Penetration Test (SPT). SPT is conducted by advancing the standard 2-in diameter split sampler 18- or 24-in by driving it with a 140-lb hammer (weight) falling freely through a 30-in drop. The N-value is the number of hammer blows required to advance the sampler the last 12-in of an 18-in drive or the middle 12-in of a 24-in drive.

1. Reviewed available data provided by Lightstone and in our files. The data included boring logs prepared by Langan for 92 Fulton Street (Lot 22) and 112-118 Fulton Street, boring logs prepared by us for 151 William Street, Rock Data Map of Manhattan, 1937 by New York City Division of Design, Department of Public Works, Civil Works Administration and 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, 1994 by Charles A. Baskerville, US Geological Survey.

2. Evaluated the data obtained and submitted a preliminary report.

3. Prepared a boring location plan to perform the geotechnical investigation and obtained permission from NYCT Outside Projects to drill the borings.

4. Engaged Warren George Inc. (WGI) to drill the recommended borings.

5. Observed the drilling operations to log samples in the field and verify that proper ASTM procedures were used. Soil samples will be stored for one month before disposal and can be shipped for inspection upon request.

6. Engaged TerraSense, LLC to conduct laboratory index property tests on representative samples selected by us to confirm field visual identifications and utilize available correlations to engineering properties.

7. Evaluated the data and submitted this final report containing the data obtained and a discussion of our evaluation and our recommendations.

8. Met with NYCT personnel to discuss potential foundation treatments as they relate to NYCT facilities. We also discussed findings with you and the design team.

9. We will execute the TR-1 forms when they are prepared by your expeditor.

GEOTECHNICAL INVESTIGATION

Borings

WGI drilled seven borings at the approximate locations shown in Figure 1 during the period of April 7 to April 17, 2017.

The borings were advanced by a track-mounted D-50 drill rig, a track-mounted Soilmax drill rig and a track-mounted Morooka XLS drill rig. The borings were advanced by rotary drilling using a roller bit with water or a bio-degradable mud as the drilling fluid. Variable lengths of 4-in and 5-in diameter steel casing were used to stabilize the upper portions of the borings as necessary. Generally, samples were obtained at 5-ft depth intervals by the Standard Penetration Test (SPT) method (ASTM D 1586). Safety hammers were used to drive the samplers. Rock core was retrieved by coring with an NX-size double tube core barrel. Core recovery and Rock Quality Designation (RQD)[2] as a percentage of the run were determined and recorded on the boring logs.

An observation well was installed in the completed boring B-4W. The well consisted of 2¼ -in diameter, 50-ft long PVC pipes with the bottom 10-ft section slotted. The borehole annulus was backfilled with silica sand and sealed at the surface with a flush mount cover. Stabilized groundwater level readings were obtained after the well installation. The readings are shown on the boring logs.

The boring operations were observed by our Mr. Paras Khaitan who identified and logged the samples in the field. The boring logs are presented in Appendix A.

Laboratory Testing

We selected six representative soil samples and sent them to TerraSense LLC laboratory for grain size analyses.

SUBSURFACE CONDITIONS

The subsurface strata as generalized from the boring data may be summarized as follows:

Fill

Uncontrolled fill was found immediately below the ground surface (bgs) at all borings. It consisted generally of a mixture of sand, silt, and gravel with varying percentages of bricks, concrete and possibly other construction debris and is classified as class 7 in accordance with the New York City Building Code (NYCBC). Typical N-values varied from 7- to 60-blows/ft with some of the samples reaching refusal (over 100 -blows/ft). Higher N-values most likely result from the presence of brick, concrete or other construction debris. The borings indicated that the Fill generally extends to about 11.5- to 28.5-ft or deeper below ground surface, corresponding to a bottom el of about -0.5 to +10.5.

Sand

A Sand stratum, consisting of varying gradations of sand with varying percentage of silt and gravel (SP, SW, SP-SM, SC-SM, SP-SC, SW-SM and SC per USCS, Class 3a, 3b and 6 per NYCBC) underlies the Fill stratum. The N-values varied from 7- to 87-blows/ft with some of the samples

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[2] Rock Quality Designation (RQD) is defined as the percentage of the NX core run that is recovered in pieces 4-in in length or longer. Breaks occurring during drilling are ignored.

reaching refusal (over 100 -blows/ft). Its thickness varied from 21.5- to 51.5-ft. The bottom of the sand was approximately 43.5 to 70-ft below ground surface corresponding to el -42 to -13.5.

Silt/Clay

A Silt or Clay stratum was found underlying the Sand in B-5 and B-7. It generally consisted of a mixture of silt and clay with varying percentages of sand (ML, CL-ML per USCS and Class 4a, 4b, 5b per NYCBC). N values typically varied from 16- to 34-blows/ft. Its thickness was about 10- to 15-ft with a bottom elevation about el -28.5 to -15.5.

Glacial Till

Glacial Till, consisting of fine to coarse sand with varying percentages of silt, gravel, clay, cobbles and boulders (SP, SP-SM, GP, SW-SM, SW, ML, CL-ML per USCS, Class 2a, 3a, 3b, 4a and 5a per NYCBC) was found beneath the Sand stratum. Typical N-values ranged from 28- to 97-blows/ft with some of the samples reaching refusal (over 100-blows/ft). The high N-values probably reflect the presence of cobbles and boulders.

Boring B-7 terminated in this stratum.

The lower parts of the till contained significant amounts of cobbles and boulders. Drilling is expected to be hard through the till layer.

Decomposed Rock

A layer of decomposed rock was encountered directly beneath the Glacial Till stratum in B-4W, B-5 and B-6. It is considered class 1d in accordance with the 2014 NYCBC. The stratum ranged in thickness from about 5- to 65-ft (Boring B-6) with top elevation ranging from El. -72 to El. -112.

Bedrock

Medium hard rock (Class 1b) to Hard sound mica schist rock (Class 1a) was encountered underlying the Glacial Till in B-1, B-2, B-3 and underlying Decomposed Rock in B-4W, B-5 and B-6. All borings cored at least 5-ft of bedrock except B-7. Core recoveries and RQD's ranged from 62% to 100% and 61% to 100% respectively. The top of Bedrock was encountered at depths ranging from 97- to 165-ft below grade corresponding to elevation El. -137 to El. -74.

Groundwater

The apparent stabilized groundwater level was measured in the observation well in boring B-4W at about 25.8-ft bgs, corresponding approximately to el +3.2. Groundwater levels may vary with weather conditions, seasonal factors, or other unknown conditions.

EVALUATION AND RECOMMENDATIONS

Foundations, High Rise Portion

Experience indicates a high-rise structure with foundations bearing directly on the Sand stratum would experience intolerable settlements due to the compressibility of the Sand stratum as indicated by the N-values. Therefore, the foundation loads should be transferred to more competent underlying strata. This may be accomplished by deep foundations such as drilled micro-piles or drilled caissons. We recommend against the use of hammer- or vibro-driven piles because pile driving vibrations probably will cause densification of the Sand resulting in settlement of adjacent facilities. Vibrations caused by drilling are significantly less than those caused by driving or vibro-installation.

Drilled Micro-Piles

These piles are installed by rotary drilling a steel casing to the desired depth using water or mud as the drilling fluid. The soil within the interior of the casing is removed by the rotary drilling process. As the casing is slowly withdrawn to a desired depth a cement grout is placed under pressure into the casing creating a bond zone.

Typical micro-pile capacities:

Casing GR50	Reinforcing GR75	Axial Capacity [kips] / Stiffness [kips/in]	Tension Capacity [kips] / Stiffness [kips/in]	Lateral Capacity [kips] / Stiffness [kips/in]	Soil Socket Diameter [in] / Length in Till [ft]
13.375x0.480	1 # 18	200 / 1,250	150 / 1,250	10 / 20	13.375 / 43
9.625x0.545	1 # 18	200 / 750	150 / 750	6 / 12	9.625 / 63
9.625x0.545	1 # 11	150 / 750	50 / 750	6 / 12	9.625 / 47

Where these piles are within the NYCT influence zone the upper portion of the pile would have to be surrounded by an open casing with an inside diameter approximately 1½-in larger than the outer diameter of the pile. The casing would prevent the piles from applying loads to the NYCT facilities.

Typical lateral design capacity of these piles would be approximately 8- and 1-tons for the piles without and with upper casing respectively, respectively. We expect that settlements of these piles, occurring mainly during construction, would be about 1- to 2-in due to elastic shortening of the piles and settlement of the Glacial Till layer below the piles.

We expect that higher vertical design capacities (up to about 100 tons) could be obtained by increasing the length of the bond zone into the Glacial Till stratum. The lateral capacities would be unchanged. We expect that settlement of these piles might be slightly less than the lower capacity piles, depending on the depth of penetration into the Till. The presence of boulders and cobbles could significantly increase the cost and time for construction of the deeper drilled piles.

Pile load tests would be required in accordance with the NYCBC. At least two pile load tests will be required for the site. The load tests generally would be in accordance with ASTM D 1143 with certain modifications. The final test load shall be at least twice the design capacity of the piles. For the 75-ton capacity piles the final test load shall remain in place at least 12 hours and until the average rate of settlement over a 12-hour period equals or is less than 0.001- in/hour. In the tests of the higher capacity piles the final load increment shall remain in place for a total of at least 24 hours; single test piles shall be subjected to cyclical loading or suitably instrumented with telltales and strain gauges so that the movements of the pile tip and butt may be independently determined and load transfer to the soil evaluated. A complete record demonstrating satisfactory performance of the test shall be submitted to the commissioner.

Also, improving the Sand strata (making it significantly less compressible) could be considered.

Drilled Caissons

Caissons are also installed by rotary drilling a steel casing. The casing is drilled and seated into bedrock using water or mud as the drilling fluid. The soil within the interior of the casing is removed by the rotary drilling process. The socket is drilled into the bedrock using a pneumatic down-the-hole hammer. Steel reinforcing thread-bars or cage is placed and cement grout is tremied into the casing.

Typical caisson capacities:

Casing GR50	Reinforcing GR75	Axial Capacity [kips] / Stiffness [kips/in]	Tension Capacity [kips] / Stiffness [kips/in]	Lateral Capacity [kips] / Stiffness [kips/in]	Minimum Rock Socket Diameter [in] / Length [ft]
16x0.5	4 # 32	1,700 / 4,200	600 / 1,300	40 / 80 *	14 / 17
16x0.5	4 # 28	1,400 / 3,500	600 / 1,000	40 / 80 *	14 / 14
16x0.5	3 # 28	1,200 / 3,200	600 / 750	40 / 80 *	14 / 12
13.375x0.480	1 # 28	550 / 1,000	350 / 1,000	10 / 20	12 / 15
9.625x0.545	1 # 28	450 / 700	350 / 700	6 / 12	8 / 16

* Piles within NYCT influence should be considered to have zero lateral capacity

Note that competent rock is expected to be approximately 100- to 140-ft or more below design subgrade.

As with the deeper drilled piles, drilling through boulders and cobbles could be problematic, and more difficult with large casing sizes. Therefore, depending on subsurface conditions encountered, it may be necessary to reduce the casing size and use lower design capacities than indicated above.

Abandoned piles exist within the site footprint. The installation of new caissons should avoid the locations of abandoned piles.

Where these caissons are within the NYCT influence zone the upper portion of the caisson may have to be surrounded by an open casing with inside diameter approximately 1½-in larger than the outer diameter of the caisson. The casing would prevent the caissons from applying loads to the NYCT facilities.

We expect that settlements of the caissons, occurring mainly during construction, would be about 3/4-in due to elastic shortening.

No axial load tests would be required if each caisson is visually inspected by means of down-the-hole TV. Lateral load tests will be required for loads in excess of 1-ton.

We recommend a minimum spacing of deep foundation elements of 4-ft.

Caisson Test Program

The client engaged a subcontractor to install 3 caissons as part of a test program at the site. The caisson installation confirmed difficult drilling through the boulders at the bottom of the till. The production caisson subcontractor should review the caisson test program results and make themselves familiar with the findings.

Refer to Appendix C for summary report.

Foundations, Low Rise Portion

The low-rise portion of the proposed structure will be two to three stories over the cellar. The available data suggest that the subgrade will be in the generally medium dense Sand stratum and that spread footings with an allowable bearing value of 3-tons/ft^2 may be used as foundation support.

The existing piles in the area should be cut off at least three ft below footing subgrade. The excavated footing area should be backfilled with compacted controlled fill, compacted crushed stone, gravel or RCA. Alternatively, the existing piles (50T design capacity) may be used as foundation support but may be used only for half of their original design capacity.

Controlled fill shall be a well graded mixture of sand and gravel having 12 per cent or less passing the No. 200 sieve and a maximum particle size of 1-in. It should be placed in lifts having a thickness less than 6-in and compacted using vibratory plates or drum rollers to a dry density of at least 95 per cent of the maximum dry density obtained in the laboratory modified Proctor compaction test (ASTM 1557).

Crushed stone, gravel or RCA shall have a maximum size of 1-in and less than 5 per cent passing the No. 200 sieve. It shall be placed in lifts having a thickness less than 6-in and each lift compacted with at least four passes of a vibratory plate or drum roller.

We estimate that settlements of the foundations in the low rise portion of the structure may be about ½- to 1-in.

Basement Slabs

A compacted crushed stone, gravel or RCA stabilizing layer should be placed over the subgrade. The surface of the stabilizing layer should be compacted with at least four overlapping passes of a twin drum walk behind vibratory roller. If an underslab drainage system is used (see below) the stabilizing layer may be used as the drainage medium. However RCA shall not be used as part of the drainage medium.

Cellar slabs on grade may be designed using a coefficient of subgrade reaction of 150-tons/ft^3 and a maximum edge stress of 4-tons/ft^2.

Groundwater Control

The measured groundwater level appears to be at or below design cellar subgrade level. Based on the available data we recommend that permanent design groundwater level be considered at el +10 considering probable long term ground water level variations. An extreme low probability event such as a water main break flooding the street also should be considered.

During Construction

We anticipate that localized dewatering with sumps and pumps may be necessary, especially at pile caps and shallow pits, and after rain storms. Deep pits may require the use of localized well points.

After Construction

A water proofed pressure slab may be required to resist the hydrostatic pressures resulting from the extreme design water level. An underslab drainage system to relieve the pressures could be considered. The outflow from the system and into the City system would be intermittent and occasional, depending on actual water levels. We anticipate that most of the time groundwater levels would be below the design level and the outflow from the system would be zero or insignificant. Nevertheless, permits and approval of City agencies (e.g. Department of Environmental Protection (DEP)) for use may be required.

The underslab drainage system should consist of a non-woven geotextile placed on the subgrade with at least 6-in of crushed stone or gravel (maximum particle size of one inch with zero passing the No. 200 sieve) over the geotextile and 6-in diameter perforated PVC drainage pipes spaced about 20-ft apart within the drainage medium with at least 6-in of the drainage medium surrounding the pipes. Clean outs should be provided at bends in the pipes. The pipes should drain to sumps (one for approximately every 3,000-ft^2 of footprint area) equipped with self-activating duplex electric pumps. The pumps should have a design capacity of at least 75-gal/min. In our opinion an emergency backup electric generator is unnecessary because of the low probability of a water main break or future ground water rise and power failure occurring at the same time.

The slabs and walls shall be waterproofed in accordance with NYCBC requirements.

Soil Parameters

We estimated the engineering properties of the subsoils based on our experience and information available in the engineering literature. The values in the table below represent the probable values of the soil parameters and may not represent locally differing soil conditions across the site.

Soil Type	Saturated unit, weight, γ (pcf)	Effective friction angle, ϕ' (deg)	Undrained Shear strength, S_u (lbs/ft^2)	Effective Cohesion, c', (lbs/ft^2)
Fill	125	30	0	0
Sand	130	34	0	0
Glacial Till	130	38	0	0

Refer to Permanent Foundation Walls section and Seismic Considerations section below for additional soil parameters.

Permanent Foundation Walls

Permanent foundation walls should be designed for two conditions. Refer to Figure 2 for an illustration of these conditions.

1. At-Rest Earth Pressures: A triangular pressure distribution based on the at-rest earth pressure coefficient, K_o, multiplied by the appropriate effective unit weight. Above the water table the saturated unit weight (total unit weight may be used conservatively). Below the water table the buoyant unit weight (saturated unit weight minus the unit weight of water) may be used. K_o may be estimated as $1 - \sin \phi'$. Our recommended at rest earth pressure distribution is shown in Figure 2 based on soil parameters above.

2. Earthquake Loading Plus Active Pressures: Seismic earth pressures (ΔP_{AE}) should be added to static earth pressures calculated with the active earth pressure coefficient and the

appropriate unit weight, as discussed above. The acceleration coefficient, A, should be taken equal to the value of maximum considered earthquake geometric mean peak ground accelerations, PGA_M. Our recommended value of the seismic pressure as a function of the wall height is shown in Figure 2. Refer to seismic section below for PGA_M value.

Hydrostatic Pressures should be included with the above cases where applicable below the water table. Hydrostatic pressures can be estimated as a triangular distribution based on the unit weight of water, $\gamma_w = 62.4\text{-lbs/ft}^3$.

Surcharge from sidewalk, street, adjacent structures, or other existing features should also be considered in the design for the above cases. The horizontal, rectangular distribution may be taken as K_o x q_s, where K_o is the at-rest earth pressure coefficient and q_s is the vertical surcharge area load.

Underpinning and Lateral Support

The bottom of footing elevations of adjacent buildings, ancillary structures, or yards should be confirmed before mass excavation begins. Refer to additional investigation below. Underpinning or rigid support of excavation system will be required if the proposed subgrade extends below an influence line drawn at a slope of 1V:1½H from the bottom of existing foundation to the bottom of the new excavation. No uncontrolled open excavations should be allowed adjacent to existing slabs or foundations. Tight timber lagging should be provided in all underpinning pits and adjacent to existing structures to prevent migration of fines into the excavation or underpinning pits.

The underpinning should be designed to resist lateral earth pressures as well as the vertical foundation loads. Therefore, lateral bracing may be required. Active earth pressures may be estimated based on soil properties provided above.

Underpinning should consist of concrete piers installed in tightly sheeted or lagged pits and extending at least 12-in below the design subgrade of the adjacent proposed excavation. Underpinning subgrade shall be of equal or better quality than the existing footing subgrade.

The pits should be approximately 3- to 4-ft wide opened in such a manner as to avoid an open excavation exceeding 4-ft in length. Tight sheeting or lagging with a lift thickness limited to a few inches more than the width of the lagging should be used in excavating the underpinning pits to minimize loss of ground from beneath the foundations. We recommend a maximum excavation depth of about 12-in before installing timber lagging. The piers shall be constructed in one vertical lift. Steel wedges, shims and plates should be used to transfer the foundation and wall loads to the underpinning piers. Jacking should be required to minimize post construction settlements because the underpinning will be bearing on soil at or near the groundwater level. Dewatering using sumps and pumps or well-points probably will be required. Small local settlements should be expected during the underpinning process.

If underpinning is undesirable, the excavation and basement slab could be benched provided it is not within the 1V:1½H influence zone and a curb or bench should be designed to stabilize the footing and foundation wall.

A professional engineer licensed in the state on NY shall prepare drawings for Support of Excavation and Underpinning and file with the DOB and applicable agencies prior to construction.

Temporary excavation side slopes in soil above the groundwater table should be no steeper than 1V:1½H and the contractor should follow all pertinent OSHA and other applicable regulations.

We anticipate that the contractor will use soldier pile and lagging walls where lateral support is necessary outside the influence of existing structures. To minimize vibrations soldier piles should be drilled in, or installed in pre-drilled holes that are backfilled with grout or lean concrete. Lagging should be spaced or louvered to allow drainage of storm water.

Temporary walls using a single level of bracing may be designed to resist active earth pressures using a soil parameters presented above. If multiple bracing levels are used, a uniform earth pressure distribution with the intensity calculated as 0.65 x the maximum active pressure should be used for design.

Potential Effects on Nearby Buildings

Buildings

No significant effects of the proposed construction on the adjacent structures and facilities are anticipated. However, underpinning almost always results in small settlements or lateral movements of the underpinned structure. With a proper design and quality contractor workmanship, these movements usually are less than about ½-in. This could cause cosmetic cracking that may require repairs.

Retaining structures will also provide lateral support to maintain the integrity of the ground and adjacent structures. With excavation in granular soils, some settlement of the adjacent ground (or buildings) should be expected. Settlements of about ¼ percent to ½ percent of the excavation depth are typical for pre-stressed tied back or preloaded raker-braced soldier pile walls. The zone that may experience settlements should be expected to extend a horizontal distance from the excavation equal to about 1½- to 2-times the depth of the excavation, with the settlement diminishing with distance from the excavation.

NYCT Tunnels

As described earlier settlements of the Glacial Till stratum caused by foundation elements bearing directly on it might extend to the NYCT tunnel facilities. We expect that calculated settlements would be quite small and without potential negative effects on the NYCT facilities.

No potential settlements caused by caisson loads are expected. Good control of installation procedures especially maintaining a soil plug at the bottom of the lead casing coupled with internal flush should minimize negative effects on adjacent facilities.

Monitoring

Vibration and Optical

We recommend monitoring of vibrations and lateral and vertical movements of the nearby structures before and during support of excavation construction. Monitoring should start at least three weeks prior to any construction activities to establish a baseline. Monitoring data should be reviewed by a qualified engineer on a daily basis during construction to verify that no unforeseen problems are developing.

The retaining structures supporting the excavation should also be monitored during construction. Visual observations should be taken daily for cracks in adjacent buildings, pavements, sidewalks, local settlements, etc.

Criteria for vibration and optical monitoring shall be developed by the support of excavation engineer in accordance with DOB and NYCT requirements.

Seismic Considerations

The site may be classified as Class D "Stiff soil profile" in accordance with the 2014 New York City Building Code Table 1613.5.2 (Site Class Definitions).

A = Acceleration coefficient = PGA_M = 0.24 [Table 1813.2.1]

Several N_{60} data points plotted on the NYCBC Screening Diagram (Fig 1813.1) suggested that liquefaction should be analyzed. We did the appropriate analyses using a Magnitude 5.7 earthquake and peak ground acceleration (pga) of 0.24g. The results indicated that liquefaction need not be considered in the design.

Controlled Fill

Structural Fill: shall be well-graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand meeting 2014 NYC Building Code requirements for Controlled Fills [BC 1803.5]. Structural fill is typically used below footings and base mats on soil, and below sidewalks. On-site natural soil, excluding rock or gravel greater than 3 inches, can be used as structural fill if Contractor submits compaction curves and maintains proper moisture content of the material.

Gravel Base Course: shall be clean crushed durable natural stone or washed gravel with 100% passing a 1 ½" sieve and 100% retained on a ¾" sieve, not soluble in groundwater or subject to deterioration in the presence of compounds occurring in groundwater. Recycled concrete will not be accepted.

Flowable Fill: shall be a mixture of sand, cement, fly ash, admixtures, and water meeting NYC Building Code requirements for controlled low-strength material [BC 1803.6]. The mix design shall produce a flowable material with little or no bleed water, which produces a minimum compressive strength of 50 psi and maximum compressive strength of 100 psi at 56 days. The cured material shall be excavatable and have a maximum dry unit weight of 100 pounds per cubic foot. Slump shall be from 7 inches to 10 inches. Admixtures specifically designed for flowable fill may be used to improve flowability, reduce unit weight, control strength development, reduce settlement and reduce bleed water. Admixtures shall be Rheocell-Rheofill by Master Builders, Inc.; DafaFill by Grade Construction Products; or approved equal.

SPECIAL INSPECTION

A special inspector and/or special inspection agency shall have responsibilities as set forth in chapter 17 of the 2014 New York City building code and elsewhere in the codes where special inspections are required. The responsibilities of the special inspector or special inspection agency at a special inspection shall include those tasks and standards set forth in chapter 17 of the code, the reference standards and elsewhere in the code, this rule or any rule of any agency in connection with the work that is the subject of such special inspection.

Necessary special inspections

The special inspections necessary for SOE and Geotechnical Investigation are:

- Subsurface Investigation (Borings/Test Pits) (BC 1704.7.4)
- Excavation - Sheeting, Shoring, and Bracing (BC 1704.20.2).
- Underpinning (BC 1704.20.3, BC 1814)
- Deep Foundation Elements (BC 1704.8)
- Subgrade Inspection (BC 1704.7.1)
- Structural Stability - Existing Buildings (BC 1704.20.1)
- Structural Steel - Welding (BC 1704.3.1). If SOE is required.
- Concrete - Cast-in-Place (BC 1704.4)
- Concrete - Sampling and Testing (BC 1905.6 BC 1913.10)
- Concrete - Design Mix (BC 1905.5 BC 1913.5)
- Subsurface Conditions – Fill Placement & In-Place Density (BC 1704.7.2 BC 1704.7.3)

ADDITIONAL INVESTIGATION

Finite element analyses may be required to evaluate potential effects of construction on adjacent NYCT facilities. This would depend on the foundation types selected, as discussed above.

Locations of abandoned piles should be confirmed to avoid drilling the new caissons in locations of abandoned piles.

OWNER AND CONTRACTOR OBLIGATIONS

It is the Contractor's responsibility to ensure that construction activities will not cause loss of support to neighboring structures or adversely affect the functions of adjacent structures and utilities. By using this report, the Owner agrees that RA Consultants LLC will not be held responsible for any damages to adjacent structures.

RA Consultants shall be added to the Project Wrap and/or Contractor's General Liability Insurance as an additional insured. In addition, any project construction contract between the Owner and the Contractor will explicitly state that the Contractor will defend, indemnify, and hold harmless RA Consultants LLC against all claims related to disturbance or damage to adjacent structures or properties.

LIMITATIONS

The conclusions and recommendations presented herein are applicable only to this project as described above. They are based on our evaluation of the borings done for this investigation and our understanding of the project as described above. The subsurface data is applicable at the exploration locations only. Recommendations provided in this report assume that subsurface conditions do not significantly deviate from those revealed by the borings. If subsurface conditions or project conditions differ from those presented herein we should be notified and requested to re-evaluate our recommendations.

We appreciate this opportunity to be of service and look forward to working with you as the project proceeds.

LEGEND:

- APPX. BORING LOCATION
- APPX. BORING LOCATION WITH OBSERVATION WELL
- BORING BY OTHERS
- <+XX> TOP OF DECOMPOSED ROCK EL.
- [+YY] TOP OF ROCK EL.

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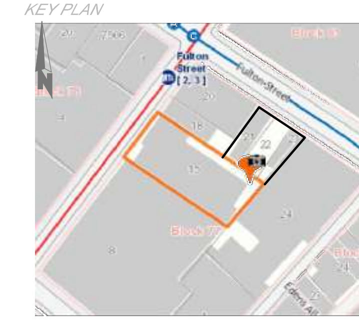
KEY PLAN



NOT TO SCALE:

BLOCK 77
LOT 15,21,22,23

NOTES:

1. BORINGS B-1 TO B-7 WERE DRILLED BY WARREN GEORGE, INC. AND OBSERVED BY RA CONSULTANTS LLC. DURING PERIOD OF APRIL 7-18, 2017.
2. ALL ELEVATIONS REFERENCE NAVD-88.
3. SITE ELEVATIONS ARE BASED ON SURVEY BY TRUE NORTH SURVEYORS, P.C. DATED MAY 8TH, 2006.

REVISIONS

TITLE

BORING LOCATION PLAN

DATE: 04/14/2017

PROJ. NO.: 15C1077

DRN/CKD: SRM-HY/NMA

DRAWING:

FIGURE 1

PROJECT: 130 WILLIAM STREET NEW YORK, NY 10038

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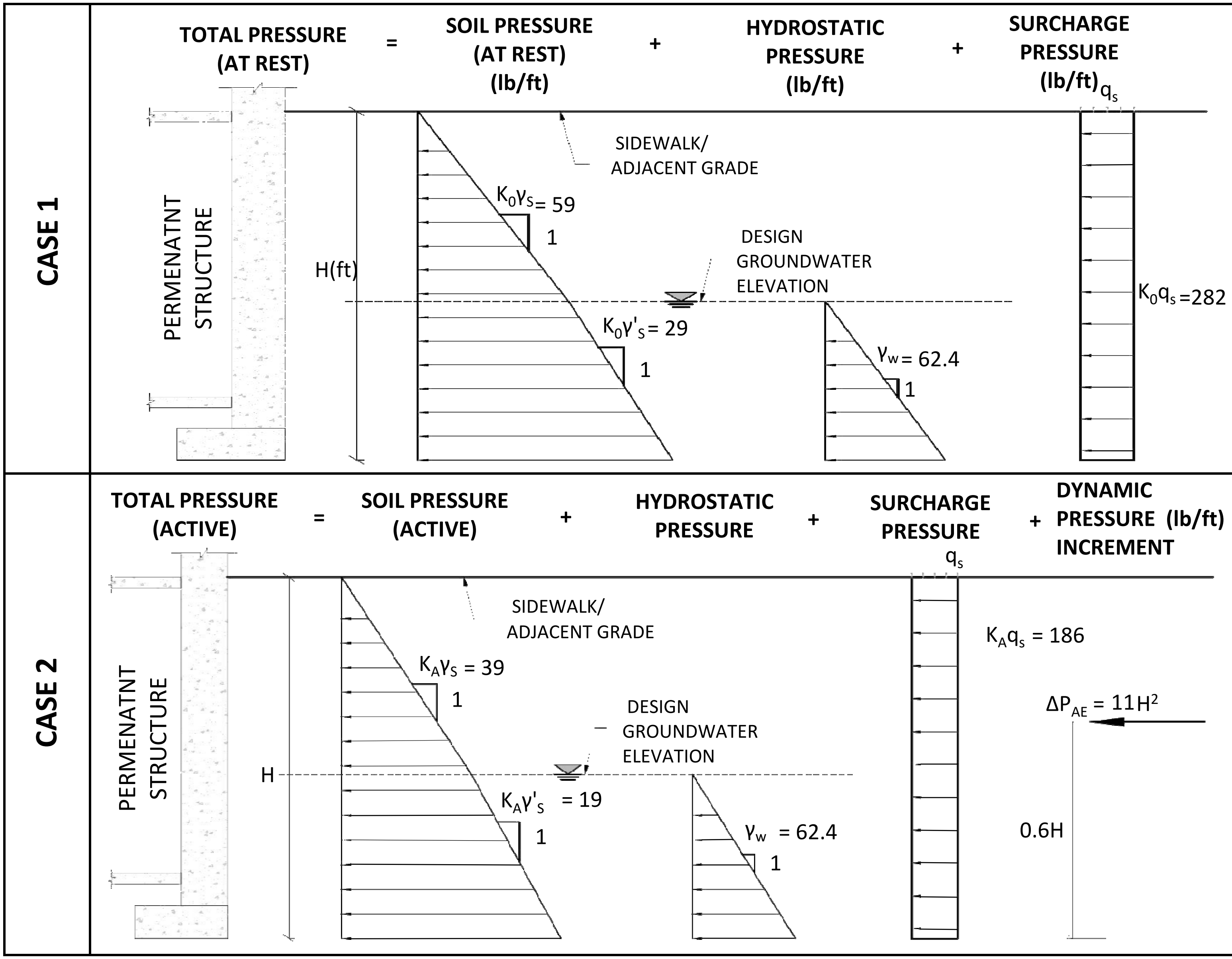
LATERAL EARTH PRESSURE



EARTH PRESSURE COEFFICIENTS:

AT-REST:

$K_O = 1 - \sin(\Phi)$

ACTIVE:

$K_A = \tan^2(45 - \Phi/2)$

DEFINITIONS:

Φ = SOIL FRICTION ANGLE*

γ_S = SOIL TOTAL UNIT WEIGHT* (pcf)

γ_{WATER} = 62.4 pcf

γ'_S = SOIL EFFECTIVE UNIT WEIGHT (pcf) $= \gamma_S - \gamma_{WATER}$

q_S = SURCHARGE LOAD = 600 psf FOR SIDEWALK TRAFFIC

A = ACCELERATION COEFFICIENT*

ΔP_{AE} = DYNAMIC PRESSURE INCREMENT PER SEED & WHITMAN 1970

#s USED FOR GENERATING THIS FIGURE REPRESENTING OUR INTERPRETATION OF THE BORING DATA:

$\Phi = 32°$, γ_S = 125 pcf (FILL)

A = 0.24 (SEISMIC CLASS D)

* REFER TO GEOTECHNICAL REPORT FOR VALUES

BY/CHECK: CQ/HY/NA

DATE: 12/8/2016

FIGURE 2

APPENDIX A – BORING LOGS

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Log of Boring: B-1

PROJECT	130 William Street	PROJECT NUMBER	15C1077
LOCATION	130 William Street	ELEVATION & DATUM	EL +22+/- NAVD88
DRILLING AGENCY	Warren George Inc.	DATE STARTED: 4/11/2017	DATE COMPLETED: 4/13/2017
DRILLING EQUIPMENT	Track Mounted Soilmax Drill Rig	COMPLETION DEPTH (FT): 120.0	ROCK DEPTH (FT): 110.0

SIZE AND TYPE OF BIT	3-7/8"	SIZE AND TYPE CORE BARREL		NO.SAMPLES	DIST. 19	UNDIST	N/A	CORE (FT)	20
CASING SIZE AND TYPE	5"	NX Double tube		WATER LEVEL	FIRST N/A	COMPL.	N/A	24HR	N/A
CASING HAMMER WEIGHT	140 lbs	DROP	30"	FOREMAN	Dave Osuch Sr				
SAMPLER	2"	DROP	30"	HELPER	Dave Osuch Jr.				
SAMPLER HAMMER WEIGHT	140 lbs	SAMPLING HAMMER TYPE: X Safety ☐ Donut ☐ ATH		INSPECTOR	Paras Khaitan				

DESCRIPTION	DEPTH (ft)	Samples: Type No.	Recov. FT / %	Resist. BL/6" / RQD%	Lab. Results: water cont. (%)	-200 (%)	STRATA	REMARKS
	0–5							**( ) NYCBC** **[ ] USCS** WOR: weight of rod
Fill: Sand, Silt, Gravel, Construction Debris **(7)**	5–7	S-1	4"	46 50/1" - -			FILL	Refusal
	7–10							Casing advanced
Top: Fill:Sand, Silt, Gravel, Construction Debris **(7)** Bottom: poorly graded coarse grained sand **(3a)[SP]**	10–12	S-2	7"	44 21 26 23			11.5' ±	6" of fill 1" of sand
	12–15							Casing advanced Casing stuck
Well Graded sand with gravel **(6) [SW]**	15–17	S-3	12"	4 4 5 8			SAND	3 layers in sample Sand with gravel, fine grained sand, coarse grained sand
	17–20							Mud lost Casing advanced to 20'

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Log of Boring: B-1

DESCRIPTION	DEPTH (ft)	Samples Type No.	Samples Recov. FT / %	Samples Resist. BL/6" / RQD%	Lab. Results water cont. (%)	Lab. Results -200 (%)	STRATA	REMARKS
Poorly graded fine grained sand with trace of gravel **(3b)[SP]**	20–22	S-4	9"	9 14 13 13				
	22–25							
Poorly Graded sand **(3a)[SP]**	25–27	S-5	17"	11 16 22 28				
	27–30							
Poorly graded fine grained sand **(3a)[SP]**	30–32	S-6	14"	15 18 28 29				
	32–35						SAND	
Poorly graded silty sand **(3b)[SP-SM]**	35–37	S-7	18"	10 11 13 14				
	37–40							
Poorly graded silty sand **(3b)[SP-SM]**	40–42	S-8	16"	9 12 14 14				
	42–45							

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Log of Boring: B-1

DESCRIPTION	DEPTH (ft)	Samples Type No.	Recov. FT / %	Resist. BL/6" / RQD%	Lab. Results water cont. (%)	-200 (%)	STRATA	REMARKS
Poorly graded silty sand **(3b)[SP-SM]**	46	S-9	18"	7 11 17 18				
	47							
	48							
	49						SAND	
	50							
Silt **(5b)[ML]**	51	S-10	24"	WOR 4 6 10				
	52							
	53						53.5' ±	
	54							
	55							
Silty Clay **(4a)[CL-ML]**	56	S-11	19"	19 25 37 39				There's a 8" lens of black and white sand. Remaining clay contains gravel
	57							
	58						TILL	
	59							
	60							
Silt **(5a)[ML]**	61	S-12	18"	19 32 57 62				
	62							
	63							
	64							
	65							
Silt **(5a)[ML]** Bottom: Poorly graded coarse grained sand **(3a) [SP]**	66	S-13	17"	23 32 22 23				Sample consisted of 10" of clay & 7" of sand
	67							
	68							
	69							
	70							

DESCRIPTION	DEPTH (ft)	Samples Type No.	Recov. FT / %	Resist. BL/6" / RQD%	Lab. Results water cont. (%)	-200 (%)	STRATA	REMARKS
Poorly graded sand with silts **(3a)[SP-SM]**	70–72	S-14	18"	12 20 20 24				
	72–75							
Poorly graded sand with gravel **(3a)[SP]**	75–77	S-15	14"	44 39 42 40				
	77–80							Hard drilling
Poorly graded sand with silts **(3a)[SP-SM]**	80–82	S-16	12"	54 68 50/3" -				4" of gravel Layer transitions to sand
	82–85						TILL	
No recovery	85–87	S-17	NR	- - - -				
	87–90							Didn't take another sample as the drilling was very hard Slow bouncy drilling.
Poorly graded gravel with sand **(2a)[GP]**	90–92	S-18	5"	90 50/2" - -				
	92–95							

Log of Boring: B-1

DESCRIPTION	DEPTH (ft)	Samples Type No.	Samples Recov. FT / %	Samples Resist. BL/6" / RQD%	Lab. Results water cont. (%)	Lab. Results -200 (%)	STRATA	REMARKS
Poorly graded gravel with sand **(2a)[GP]**	96	S-19	1"	100/2" - - -				
	97–100							
Boulder	100–105	C-1	40%	28%			TILL	Refusal at 100' prior to coring 3" casing advanced to 100' Coring started on 04/13/2017
Boulder	105–110	C-2	40%	8%			110'±	
Igneous rock **(1a)**	110–115	C-3	100%	97%			BEDROCK	
Igneous rock **(1a)**	115–120	C-4	100%	97%			120'±	Boring terminated at 120' on 04/13/2017 Moving to boring B5 End of Boring

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Log of Boring: B-2

PROJECT	130 William Street	PROJECT NUMBER	15C1077
LOCATION	130 William Street	ELEVATION & DATUM	EL +23 +/- NAVD88
DRILLING AGENCY	Warren George Inc.	DATE STARTED 4/7/2017	DATE COMPLETED 4/10/2017
DRILLING EQUIPMENT	Track Mounted Soilmax Drill Rig	COMPLETION DEPTH (FT) 105.0	ROCK DEPTH (FT) 97

SIZE AND TYPE OF BIT	4 7/8"	SIZE AND TYPE CORE BARREL		NO.SAMPLES	DIST. 20	UNDIST	N/A	CORE (FT)	5
CASING SIZE AND TYPE	5"	NX Double tube		WATER LEVEL	FIRST N/A	COMPL.	N/A	24HR	N/A
CASING HAMMER WEIGHT	140 lbs	DROP	30"	FOREMAN	Dave Osuch Sr.				
SAMPLER	2"	DROP	30"	HELPER	Dave Osuch Jr.				
SAMPLER HAMMER WEIGHT	140 lb	SAMPLING HAMMER TYPE: X Safety □ Donut □ ATH		INSPECTOR	Paras Khaitan				

DESCRIPTION	DEPTH (ft)	Samples: Type No.	Recov. FT / %	Resist. BL/6" / RQD%	Lab. Results: water cont. (%)	-200 (%)	STRATA	REMARKS
Fill: Sand, Silt, Gravel, Construction Debris **(7)**	0–2	S-1	12"	11, 17, 24, 35				**( ) NYCBC** **[ ] USCS** REF: refusal
Fill: Sand, Silt, Gravel, Construction Debris **(7)**	2–4	S-2	3"	26, 29, 31, 14				
	4–5							5" casing advanced
Fill: Sand, Silt, Gravel, Construction Debris **(7)**	5–7	S-3	8"	12, 10, 7, REF			FILL	
	7–10							Very Hard Drilling Probably Concrete Basement Slab
	10–12	S-4	NR	-, -, -, -				Hard drilling Casing advanced
	12–15						13.5' ±	Concrete slab ended at approx 13'
Poorly Graded sand **(3b)[SP]**	15–17	S-5	19"	9, 12, 13, 16			SAND	
	17–20							

Log of Boring: B-2

DESCRIPTION	DEPTH (ft)	Samples: Type No.	Samples: Recov. FT / %	Samples: Resist. BL/6" / RQD%	Lab. Results: water cont. (%)	Lab. Results: -200 (%)	STRATA	REMARKS
Poorly graded sand with silt **(3a)[SP-SM]**	20–22	S-6	12"	25 26 24 22				
	22–25							
Poorly graded sand with silt **(3a)[SP-SM]**	25–27	S-7	14"	11 13 19 13				
	27–30							
Poorly graded sand with silt **(3b)[SP-SM]**	30–32	S-8	19"	10 10 14 15			SAND	
	32–35							
Poorly graded sand with silt **(3b)[SP-SM]**	35–37	S-9	22"	10 10 13 16				
	37–40							
Poorly graded sand with silt **(3b)[SP-SM]**	40–42	S-10	18"	10 10 10 10				
	42–45							

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Log of Boring: B-2

Sheet 3 of 5

DESCRIPTION	DEPTH (ft)	Samples Type No.	Recov. FT / %	Resist. BL/6" / RQD%	Lab. Results water cont. (%)	-200 (%)	STRATA	REMARKS
Silty clayey fine grained sand **(3b)[SC-SM]**	45–47	S-11	24"	7 10 18 26			SAND	
	47–50						48.5' ±	
Poorly Graded sand **(3a)[SP]**	50–52	S-12	16"	20 26 38 40				
	52–55							
Silty Clay with Sand **(4a)[CL-ML]**	55–57	S-13	7"	27 44 53 50/4"			TILL	
	57–60							
Silty clayey sand **(3a)[SC-SM]**	60–62	S-14	12"	26 36 44 43				
	62–65							
Poorly Graded coarse grained sand **(3a)[SP]**	65–67	S-15	21"	18 27 27 19				
	67–70							

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Log of Boring: B-2

DESCRIPTION	DEPTH (ft)	Samples Type No.	Samples Recov. FT / %	Samples Resist. BL/6" / RQD%	Lab. Results water cont. (%)	Lab. Results -200 (%)	STRATA	REMARKS
Poorly Graded coarse grained sand with gravel **(3a)[SP]**	71	S-16	12"	16 20 20 19				
	72							
	73							
	74							
Poorly graded sand with gravel **(3a)[SP]**	75–76	S-17	13"	62 63 50/3" -				
	77							
	78							
	79							
Silty clayey sand with gravel **(3a)[SC-SM]**	80–81	S-18	18"	53 61 87 50/3"				
	82						TILL	Hard drilling
	83							
	84							
Poorly graded gravel with sand **(2a)[GP]**	85–86	S-19	4"	110/5" - - -				Boring started at 7:30 04/10/2017 Refusal after 5"
	87–88							Hard drilling. Very slow penetration. Probably boulder ended Steady drilling after 87.5'
	89							
Poorly graded sand with gravel **(3a)[SP]**	90–91	S-20	5"	110/5" - - -				
	92							
	93							
	94							
	95							

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Log of Boring: B-2

DESCRIPTION	DEPTH (ft)	Samples: Type No.	Samples: Recov. FT / %	Samples: Resist. BL/6" / RQD%	Lab. Results: water cont. (%)	Lab. Results: -200 (%)	STRATA	REMARKS
Poorly graded gravel with sand **(2a)[GP]**	96	S-21	3"	100/3" - - -			TILL	
	97						97' ±	Possibly drilling bedrock from 97'
	98							Casing slipped 3" inside the borehole
	99							Additional 5' casing pushed down the hole. Total 20'- 5" casing
	100							Drilling to 100' continued
Igneous rock **(1a)**	101						BEDROCK	3" casing installed to 100' depth
	102	C-1	100%	100%				
	103							
	104							Natural crack: change in properties from grey igneous rock to quartz
	105						105'±	Boring terminated at 13:45 04/10/2017
	106							
	107							
	108							
	109							
	110							
	111							
	112							
	113							
	114							
	115							
	116							
	117							
	118							
	119							
	120							

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Log of Boring: B-3

PROJECT	130 William Street	PROJECT NUMBER	15C1077
LOCATION	130 William Street	ELEVATION & DATUM	EL +21.50 +/- NAVD88
DRILLING AGENCY	Warren George Inc.	DATE STARTED: 4/7/2017	DATE COMPLETED: 4/10/2017
DRILLING EQUIPMENT	Track Mounted D50 Drill Rig	COMPLETION DEPTH (FT): 115.0	ROCK DEPTH (FT): 105.0

SIZE AND TYPE OF BIT	3 7/8	SIZE AND TYPE CORE BARREL		NO.SAMPLES	DIST. 21	UNDIST N/A	CORE (FT) 10
CASING SIZE AND TYPE	4"	NX Double tube		WATER LEVEL	FIRST N/A	COMPL. N/A	24HR N/A
CASING HAMMER WEIGHT	140 lbs	DROP	30"	SAMPLING	FOREMAN	Caesar Moreira / Eddie Fontanez	
SAMPLER	2"	DROP	30"	HAMMER TYPE	HELPER	Greg Williams / Brenton Rousey / Eddie Cardonia	
SAMPLER HAMMER WEIGHT	140 lbs	X Safety ☐ Donut ☐ ATH			INSPECTOR	Paras Khaitan	

DESCRIPTION	DEPTH (ft)	Samples Type No.	Recov. FT / %	Resist. BL/6" / RQD%	Lab. Results water cont. (%)	-200 (%)	STRATA	REMARKS
Fill: red-brown asphalt, brick, concrete, gravel, sand. **(7)**	0–2	S-1	4"	11, 11, 11, 12				**( ) NYCBC** **[ ] USCS** WOR: weight of rod
Same as above **(7)**	2–4	S-2	5"	15, 9, 10, 12				
Same as above **(7)**	4–6	S-3	6"	8, 13, 50/4", -				
	6						FILL	4" Casing installed
	7–8							Very Hard drilling. Probably Basement slab
No recovery	10–12	S-4	NR	50/3", -, -, -				Probably basement slab
	13.5						13.5' ±	
Poorly graded fine Sand with silt **(3a)[SP-SM]**	15–17	S-5	9"	14, 29, 21, 18			SAND	
	17							Day ended
	20							

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Log of Boring: B-3

DESCRIPTION	DEPTH (ft)	Samples Type No.	Samples Recov. FT / %	Samples Resist. BL/6" / RQD%	Lab. Results water cont. (%)	Lab. Results -200 (%)	STRATA	REMARKS
Poorly graded fine sand with silt **(6)[SP-SM]**	21	S-6	10"	4 4 5 6				Boring started at 9:00 - 04/08/2017
	22							
	23							
	24							
Same **(3b)[SP-SM]**	25–26	S-7	11"	4 5 5 6				
	27							
	28							
	29							
Same **(6)[SP-SM]**	30–31	S-8	14"	3 3 4 5				
	32						SAND	
	33							
	34							
Dark brown silty with fine sand. **(6)[ML]**	35–36	S-9	22"	WOR 2 2 4				
	37							
	38							
	39							
Brown silty fine sand **(3b)[SP-SM]**	40–41	S-10	13"	14 12 10 10				
	42							
	43							
	44							
	45						45' ±	

DESCRIPTION	DEPTH (ft)	Samples Type No.	Samples Recov. FT / %	Samples Resist. BL/6" / RQD%	Lab. Results water cont. (%)	Lab. Results -200 (%)	STRATA	REMARKS
Poorly Graded sand with silt **(3a)[SP-SM]**	46	S-11	15"	19 27 33 24				
	47							
	48							
	49							
Poorly graded sand **(3b)[SP]**	50							
	51	S-12	12"	10 14 14 12				
	52							
	53							
	54							
Poorly graded sand **(3a)[SP]**	55							
	56	S-13	16"	17 16 18 15				
	57							
	58						TILL	
	59							
Poorly graded sand **(3a)[SP]**	60							
	61	S-14	16"	19 22 17 17				
	62							
	63							
	64							
Poorly graded sand **(3a)[SP]**	65							
	66	S-15	19"	23 29 26 40				
	67							
	68							
	69							
	70							

DESCRIPTION	DEPTH (ft)	Samples Type No.	Samples Recov. FT / %	Samples Resist. BL/6" / RQD%	Lab. Results water cont. (%)	Lab. Results -200 (%)	STRATA	REMARKS
Poorly graded sand **(3a)[SP]**	71	S-16	17"	22 24 29 26				
	72							
	73							
	74							
Poorly graded sand **(3a)[SP]**	75–76	S-17	12"	19 16 23 20/0"				Gravel at sample bottom
	77							Hard drilling
	78							
	79						TILL	
Silty clayey sand **(3a)[SC-SM]**	80–81	S-18	18"	48 45 46 50/4"				
	82							
	83							
	84							
Poorly Graded fine grained sand **(3a)[SP]**	85–86	S-19	15"	28 30 47 50/3"				
	87							Hard drilling
	88							
	89							
Green, grey poorly graded gravel with sand **(2a)[GP]**	90–91	S-20	4"	55 50/1" - -				Refusal after 1"
	92							Hard drilling
	93							
	94							
	95							

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Log of Boring: B-3

DESCRIPTION	DEPTH (ft)	Samples Type No.	Samples Recov. FT / %	Samples Resist. BL/6" / RQD%	Lab. Results water cont. (%)	Lab. Results -200 (%)	STRATA	REMARKS
Brown, poorly graded sand with gravel **(3a)[SP]**	96	S-21	4"	100/4" - - -			TILL	
	97							
	98							
	99							
Black poorly graded sand with gravel **(3a)[SP]**	100							
	101	S-22	2"	100/2" - - -				Hard drilling
	102							
	103							
	104							
	105						105'±	
Igneous rock **(1b)**	106						BEDROCK	Coring started
	107	C-1	62%	61%				
	108							
	109							
	110							
Igneous rock **(1b)**	111							
	112	C-2	77%	76%				Core Recovery 85% Lots of mechanical breaks Declared rock sample as part of bedrock
	113							
	114							
	115						115'±	Boring terminated at 115' at 13:00 Moving rig towards B-7
	116							
	117							
	118							
	119							
	120							

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Log of Boring: B-4W

PROJECT	130 William Street	PROJECT NUMBER	15C1077
LOCATION	130 William Street	ELEVATION & DATUM	EL +29+/-NAVD88
DRILLING AGENCY	Warren George Inc.	DATE STARTED 4/12/2017	DATE COMPLETED 4/14/2017
DRILLING EQUIPMENT	Track Mounted D50 / Morooka XLS	COMPLETION DEPTH (FT) 145.0	ROCK DEPTH (FT) 140.0

SIZE AND TYPE OF BIT	3-7/8"	SIZE AND TYPE CORE BARREL		NO.SAMPLES	DIST. 20 / UNDIST N/A / CORE (FT) 30'
CASING SIZE AND TYPE	4"	NX Double tube		WATER LEVEL	FIRST N/A / COMPL. N/A / 24HR -25.8'
CASING HAMMER WEIGHT	300 lbs	DROP	24"	SAMPLING HAMMER TYPE	FOREMAN Caesar Moreira
SAMPLER	2"	DROP	30"		HELPER Eddie Cardona
SAMPLER HAMMER WEIGHT	140 lbs	x Safety ☐ Donut ☐ ATH			INSPECTOR Paras Khaitan

DESCRIPTION	DEPTH (ft)	Samples: Type No.	Samples: Recov. FT / %	Samples: Resist. BL/6" / RQD%	Lab. Results: water cont. (%)	Lab. Results: -200 (%)	STRATA	REMARKS
	0–5							**( ) NYCBC** **[ ] USCS** Casing advanced Water depth 04/17/2017 8:00 25' 10" Water depth 04/18/2017 7:50 25' 11"
Fill: Sand, Silt, Gravel, Construction Debris **(7)**	5–7	S-1	9"	5 11 7 5			FILL	Casing advanced
Fill: Sand, Silt, Gravel, Construction Debris **(7)**	10–12	S-2	7"	13 11 5 5			FILL	Casing advanced
Fill: Sand, Silt, Gravel, Construction Debris **(7)**	15–17	S-3	5"	8 5 2 2			FILL	Casing advanced
	18.5						18.5' ±	
	18.5–20						SAND	

DESCRIPTION	DEPTH (ft)	Samples Type No.	Recov. FT / %	Resist. BL/6" / RQD%	Lab. Results water cont. (%)	-200 (%)	STRATA	REMARKS
Poorly graded sand **(3a)[SP]**	21	S-4	11"	23 26 25 23				Casing added Total 25' casing Last casing hammered down
	22							
	23							
	24							
	25							
Poorly graded sand **(3b)[SP]**	26	S-5	12"	11 12 12 11				
	27							
	28							
	29							
	30							
Poorly graded sand **(3b)[SP]**	31	S-6	15"	15 13 12 13				
	32						SAND	
	33							
	34							
	35							
Poorly graded sand **(3b)[SP]**	36	S-7	16"	11 10 10 8				
	37							
	38							
	39							
	40							
Poorly graded sand **(3b)[SP]**	41	S-8	12"	10 12 14 16				
	42							
	43							
	44							
	45							

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Log of Boring: B-4W

DESCRIPTION	DEPTH (ft)	Samples Type No.	Samples Recov. FT / %	Samples Resist. BL/6" / RQD%	Lab. Results water cont. (%)	Lab. Results -200 (%)	STRATA	REMARKS
Clayey sand **(3a)[SP-SC]**	46	S-9	16"	11 18 18 21				
	47							Machine broke down while drilling.
	48							
	49							
Grayish brown, sandy silt with trace of gravel **(5b)[ML]**	50–51	S-10	23"	10 10 16 15				Rig changed to Morooka XLS Sampling started on 04/13/2017
	52							
	53						SAND	
	54							
Brown, sandy silt with trace of gravel **(5a)[ML]**	55–56	S-11	17"	14 18 20 24				
	57							
	58							
	59							
Brown, Poorly graded sand - Coarse grained **(3b)[SP]**	60–61	S-12	17"	11 13 14 19				
	62							
	63							
	64							
Brown, Poorly graded sand - Coarse grained **(3a)[SP]**	65–66	S-13	16"	17 17 22 22				
	67							
	68							
	69							
	70						70' ±	

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Log of Boring: B-4W

DESCRIPTION	DEPTH (ft)	Samples Type No.	Recov. FT / %	Resist. BL/6" / RQD%	Lab. Results water cont. (%)	-200 (%)	STRATA	REMARKS
Brown, Poorly graded sand - Fine grained **(3a)[SP]**	70-72	S-14	14"	19 21 24 20			TILL	
Brown, Poorly graded sand - Fine grained **(3a)[SP]**	75-77	S-15	15"	18 24 32 40				
Brown, Poorly graded sand - Fine grained **(3a)[SP]**	80-82	S-16	12"	18 18 19 24				
Black and white poorly graded sand **(3a)[SP]**	85-87	S-17	15"	14 20 33 42				7" of sand as above 8" of black and white sand sample
Brown, Poorly graded sand - Fine grained **(3a)[SP]**	90-92	S-18	22"	33 36 47 44				The sample had very dense clay at the bottom

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Log of Boring: B-4W

DESCRIPTION	DEPTH (ft)	Samples Type No.	Samples Recov. FT / %	Samples Resist. BL/6" / RQD%	Lab. Results water cont. (%)	Lab. Results -200 (%)	STRATA	REMARKS
Greenish grey, silty sand **(3a)[SP]**	96	S-19	16"	67 63 50/4" -				
	97							
	98							Encountered boulder
	99							
	100							
	101	S-20	NR	- - - -				Skipped
	102							
	103							
	104							
No recovery	105							
	106	S-21	NR	50/3" - - -				start coring
	107							
	108							
	109						TILL	
Occasional boulder Very dense poorly graded sand gray sand	110							
	111							
	112							
	113	C-1	20%	0%				
	114							
Occasional boulder Very dense poorly graded sand gray sand	115							
	116							
	117							
	118	C-2	20%	0%				
	119							
	120							

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Log of Boring: B-4W

DESCRIPTION	DEPTH (ft)	Samples Type No.	Samples Recov. FT / %	Samples Resist. BL/6" / RQD%	Lab. Results water cont. (%)	Lab. Results -200 (%)	STRATA	REMARKS
Occasional boulder Very dense poorly graded sand gray sand	120–125	C-3	20%	9%			TILL	
Occasional boulder Very dense poorly graded sand gray sand	125–130	C-4	13%	10%			TILL	
	130–135						TILL 135'±	Hole collapsed Foreman decided to drill to open up the hole Foreman received steady drill till 135'. He believes either big boulder or bedrock
Grey Igneous rock **(1d)**	135–140	C-5	90%	18%			DECOMPOSED ROCK 140'±	Lots of weathered cracks
Grey Igneous rock **(1b)**	140–145	C-6	95%	80%			BEDROCK 145'±	Some mechanical breaks Declared bedrock Boring terminated 4/14/2017 14:15 Boring back filled till 50' depth and converted to well on 04/15/17 Moving to boring B-6 End of boring

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Log of Boring: B-5

PROJECT	130 William Street			PROJECT NUMBER	15C1077		
LOCATION	130 William Street			ELEVATION & DATUM	EL + 28+/- NAVD88		
DRILLING AGENCY	Warren George Inc.			DATE STARTED	4/14/2017	DATE COMPLETED	4/18/2017
DRILLING EQUIPMENT	Track Mounted Soilmax Drill Rig			COMPLETION DEPTH (FT)	160.0	ROCK DEPTH (FT)	145.0
SIZE AND TYPE OF BIT	3-7/8"	SIZE AND TYPE CORE BARREL		NO.SAMPLES	DIST. 22	UNDIST N/A	CORE (FT) 20
CASING SIZE AND TYPE	5"	NX Double tube		WATER LEVEL	FIRST N/A	COMPL. N/A	24HR N/A
CASING HAMMER WEIGHT	140 lbs	DROP	30"	FOREMAN	Dave Osuch Sr./Eddie Cardona		
SAMPLER	2"	DROP	30"	HELPER	Dave Osuch Jr.		
SAMPLER HAMMER WEIGHT	140 lbs	SAMPLING HAMMER TYPE: x Safety □ Donut □ ATH		INSPECTOR	Paras Khaitan		

DESCRIPTION	DEPTH (ft)	Samples: Type No.	Recov. FT / %	Resist. BL/6" / RQD%	Lab. Results: water cont. (%)	-200 (%)	STRATA	REMARKS
	0–5						FILL	**( ) NYCBC** **[ ] USCS**
Fill: Red/black/white/gray Asphalt, concrete, sand, gravel **(7)**	5–7	S-1	11"	16 11 8 8				
	7–10							
Fill: Red/brown/white, concrete, sand, gravel **(7)**	10–12	S-2	8"	24 17 33/3" -				
	12–15							
No recovery	15–17	S-3	NR	25/5" - - -				Refusal Pieces of uniform size black gravels in tip of sampler
	17–18.5						18.5' ±	
	18.5–20						SAND	

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Log of Boring: B-5

DESCRIPTION	DEPTH (ft)	Samples Type No.	Samples Recov. FT / %	Samples Resist. BL/6" / RQD%	Lab. Results water cont. (%)	Lab. Results -200 (%)	STRATA	REMARKS
Brown poorly graded sand with silt **(3b)[SP-SM]**	20–22	S-4	14"	8 8 8 9			SAND	
	22–25							
Same as above **(3b)[SP-SM]**	25–27	S-5	8"	7 6 7 9				
	27–30							
Same as above **(3b)[SP-SM]**	30–32	S-6	15"	8 8 7 8				
	32–35						33.5' ±	
Brown Silt **(5b)[ML]**	35–37	S-7	13"	6 7 9 17			SILT	
	37–40							
Brown silt with trace of gravel **(5b)[ML]**	40–42	S-8	20"	3 8 11 13				
	42–45						43.5' ± SAND	

DESCRIPTION	DEPTH (ft)	Samples Type No.	Recov. FT / %	Resist. BL/6" / RQD%	Lab. Results water cont. (%)	-200 (%)	STRATA	REMARKS
Brown, poorly graded sand **(3b)[SP]**	46	S-9	8"	13, 11, 12, 16			SAND	
	47							
	48							
	49							
Same as above **(3b)[SP]**	50–51	S-10	15"	13, 14, 11, 12				
	52							
	53							
	54							
Same as above **(3b)[SP]**	55–56	S-11	13"	12, 12, 14, 13				
	57							
	58						58.5' ±	
	59							
Brown poorly graded sand with silt **(3a)[SP-SM]**	60–61	S-12	17"	22, 21, 24, 20			TILL	
	62							
	63							
	64							
Same as above **(3a)[SP-SM]**	65–66	S-13	17"	28, 25, 32, 32				
	67							
	68							
	69							
	70							

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Log of Boring: B-5

DESCRIPTION	DEPTH (ft)	Samples Type No.	Recov. FT / %	Resist. BL/6" / RQD%	Lab. Results water cont. (%)	-200 (%)	STRATA	REMARKS
Same as above **(3a)[SP-SM]**	70–72	S-14	15"	32 38 34 30			TILL	
	72–75							
Same as above **(3a)[SP-SM]**	75–77	S-15	16"	23 27 30 32				
	77–80							
Same as above **(3a)[SP-SM]**	80–82	S-16	19"	27 33 35 32				
	82–85							
Same as above **(3a)[SP-SM]**	85–87	S-17	12"	35 43 44 20/0"				
	87–90							
Grayish brown sand with silt **(3a)[SP-SM]**	90–92	S-18	10"	45 48 25/3" -				
	92–95							

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Log of Boring: B-5

DESCRIPTION	DEPTH (ft)	Samples Type No.	Recov. FT / %	Resist. BL/6" / RQD%	Lab. Results water cont. (%)	-200 (%)	STRATA	REMARKS
Grey well graded sand with silt, clay and gravel **(3a)[SW-SM]**	95-97	S-19	3"	25/3" - - -			TILL	Refusal
	97-100							
Same as above **(3a)[SW-SM]**	100-102	S-20	6"	60 - - -				
	102-105							
Same as above **(3a)[SW-SM]**	105-107	S-21	3"	50/3" - - -				
	107-110							
No recovery	110-112	S-22	NR	- - - -				Very hard drilling
	112-115							
Poorly graded gravel **(2a)[GP]**	115-117	S-23	1"	50/1" - - -				
	117-120							

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Log of Boring: B-5

DESCRIPTION	DEPTH (ft)	Samples: Type No.	Samples: Recov. FT / %	Samples: Resist. BL/6" / RQD%	Lab. Results: water cont. (%)	Lab. Results: -200 (%)	STRATA	REMARKS
Well graded sand with gravel **(3a)[SW]**	121	S-24	1"	50/1" - - -				
	122							
	123							
	124							
	125							Very hard drilling
	126							
	127							
	128							
	129							
	130						TILL	Very hard drilling
	131							
	132							
	133							
	134							
	135							Very hard drilling
	136							3" casing installation started
	137							
	138							
	139						140'±	
Decomposed rock **(1d)**	140							
	141							
	142	C-1	75%	57%			DECOMPOSED ROCK	Rock disintegrates when crushed by hand
	143							
	144							
	145						145'±	

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Log of Boring: B-5

DESCRIPTION	DEPTH (ft)	Samples Type No.	Samples Recov. FT / %	Samples Resist. BL/6" / RQD%	Lab. Results water cont. (%)	Lab. Results -200 (%)	STRATA	REMARKS
Mica schist with some decomposed rock **(1b)**	145–150	C-2	96%	76%			BEDROCK	Decomposed rock for 18" Mica schist for the remaining length
Mica schist **(1b)**	150–155	C-3	100%	83%				Mica schist Sharp sound when struck by hammer Decomposed slightly on the inside
Mica schist **(1a)**	155–160	C-4	96%	92%			160'±	Water level in tub reduced Probably a fracture in rock Declared rock sample as bedrock Boring terminated at 160' @ 13:15 End of boring
	160–170							

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Log of Boring: B-6

PROJECT	130 William Street	PROJECT NUMBER	15C1077
LOCATION	130 William Street	ELEVATION & DATUM	EL +28+/- NAVD88
DRILLING AGENCY	Warren George Inc.	DATE STARTED 4/15/2017	DATE COMPLETED 4/18/2017
DRILLING EQUIPMENT	Track Mounted Morooka XLS	COMPLETION DEPTH (FT) 170.0	ROCK DEPTH (FT) 165.0

SIZE AND TYPE OF BIT	3-7/8"	SIZE AND TYPE CORE BARREL		NO.SAMPLES	DIST. 19	UNDIST N/A	CORE (FT) 50
CASING SIZE AND TYPE	4"	NX Double tube		WATER LEVEL	FIRST N/A	COMPL. N/A	24HR N/A
CASING HAMMER WEIGHT	140 lbs	DROP	30"	SAMPLING	FOREMAN	Caesar Moreira	
SAMPLER	2"	DROP	30"	HAMMER TYPE	HELPER	Jazz Lawrence Miller /Eddy Cardona	
SAMPLER HAMMER WEIGHT	140 lbs	x Safety □ Donut □ ATH			INSPECTOR	Paras Khaitan	

DESCRIPTION	DEPTH (ft)	Samples Type No.	Recov. FT / %	Resist. BL/6" / RQD%	Lab. Results water cont. (%)	-200 (%)	STRATA	REMARKS
	1							( ) NYCBC [ ] USCS
	2							
	3							
	4							
	5							
Fill: Red, bricks and gravel **(7)**	6	S-1	1"	5 9 6 5				
	7							
	8							
	9							
	10						FILL	
Fill: Red/brown, bricks and sand **(7)**	11	S-2	4"	50/4" - - -				
	12							
	13							
	14							
	15							
Same as above **(7)**	16	S-3	13"	13 11 15 22				
	17							
	18							
	19							
	20							

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Log of Boring: B-6

DESCRIPTION	DEPTH (ft)	Samples Type No.	Recov. FT / %	Resist. BL/6" / RQD%	Lab. Results water cont. (%)	-200 (%)	STRATA	REMARKS
No recovery	21	S-4	NR	14 16 22 21				
	22							
	23							
	24						FILL	
Fill: Red/brown poorly graded sand with gravel **(7)**	25–26	S-5	3"	12 9 9 6				
	27							
	28						28.5' ±	
	29							
Brown poorly graded sand with trace of gravel **(3b)[SP]**	30–31	S-6	12"	9 8 9 12				
	32							
	33							
	34							
Brown poorly graded sand with silt **(3a)[SP-SM]**	35–36	S-7	12"	15 20 22 31			SAND	
	37							
	38							
	39							
Same as above **(3b)[SP-SM]**	40–41	S-8	18"	8 7 8 8				
	42							
	43							
	44							
	45							

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Log of Boring: B-6

DESCRIPTION	DEPTH (ft)	Samples Type No.	Recov. FT / %	Resist. BL/6" / RQD%	Lab. Results water cont. (%)	-200 (%)	STRATA	REMARKS
Same as above **(3b)[SP-SM]**	45–47	S-9	12"	9 10 13 11				
	48							
	49							
Same as above **(3b)[SP-SM]**	50–52	S-10	14"	8 10 9 10				
	53							
	54							
Silt with sand **(5b)[ML]**	55–57	S-11	13"	13 10 11 10			SAND	
	58							
	59							
Silt **(5b)[ML]**	60–62	S-12	23"	4 7 11 13				
	63							
	64							
Brown, Silt with trace of gravel **(5a)[ML]**	65–67	S-13	15"	13 17 20 22				Lower 7" had some amount of Clayey silt
	68							
	69							
	70						70'±	

DESCRIPTION	DEPTH (ft)	Samples Type No.	Recov. FT / %	Resist. BL/6" / RQD%	Lab. Results water cont. (%)	-200 (%)	STRATA	REMARKS
Brown, poorly graded sand with silt **(3a)[SP-SM]**	71	S-14	15"	30 31 32 34				Upper 4" were clayey silt with trace of gravel
	72							
	73							
	74							
Brown, poorly graded sand with trace of gravel **(3a)[SP]**	75–76	S-15	11"	23 30 28 29				
	77							
	78							
	79							
Brown poorly graded sand **(3a)[SP]**	80–81	S-16	22"	19 20 19 19				
	82						TILL	
	83							
	84							
Brown, poorly graded sand with silt **(3a)[SP-SM]**	85–86	S-17	14"	17 17 13 17				
	87							
	88							
	89							
Same as above **(3a)[SP-SM]**	90–91	S-18	18"	10 14 17 20				
	92							
	93							
	94							
	95							

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Log of Boring: B-6

DESCRIPTION	DEPTH (ft)	Samples: Type No.	Samples: Recov. FT / %	Samples: Resist. BL/6" / RQD%	Lab. Results: water cont. (%)	Lab. Results: -200 (%)	STRATA	REMARKS
Grayish brown, sand with silt & trace of gravel **(3a)[SP-SM]**	96	S-19	9"	26 52 - -			TILL	
	97							
	98							
	99						100'±	
Grey, Decomposed rock **(1d)**	100	S-20	9"	38 60 - -				Sample crumbles into gravel, sand and clay
	101							
	102							
	103							Hard drilling
	104							
No recovery	105	S-21	NR	50/2" - - -				
	106							
	107							
	108							
	109						DECOMPOSED ROCK	
	110							Very hard strata
	111							
	112							
	113							
	114							
	115							Very hard strata
	116							
	117							
	118							
	119							
	120							

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Log of Boring: B-6

DESCRIPTION	DEPTH (ft)	Samples: Type No.	Samples: Recov. FT / %	Samples: Resist. BL/6" / RQD%	Lab. Results: water cont. (%)	Lab. Results: -200 (%)	STRATA	REMARKS
Boulder	120–125	C-1	N/A	N/A				
Boulder	125–130	C-2	N/A	N/A				
Decomposed Rock **(1d)**	130–135	C-3	26%	21%			DECOMPOSED ROCK	
Same as above **(1d)**	135–140	C-4	40%	23%				
Same as above **(1d)**	140–145	C-5	28%	20%				

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Log of Boring: B-6

DESCRIPTION	DEPTH (ft)	Samples Type No.	Recov. FT / %	Resist. BL/6" / RQD%	Lab. Results water cont. (%)	-200 (%)	STRATA	REMARKS
Same as above **(1d)**	145–150	C-6	90%	28%				Multiple weathered cracks
Same as above **(1d)**	150–155	C-7	100%	97%				Mostly mechanical breaks Though high CR and RQD, rock quality is very poor. Crumbles under pressure
Same as above **(1d)**	155–160	C-8	100%	95%			DECOMPOSED ROCK	
Same as above **(1d)**	160–165	C-9	100%	83%			165'±	
Mica Schist **(1a)**	165–170	C-10	97%	90%			BEDROCK 170'±	Few signs of decomposition in first 16" Good sound and sharp edges Boring terminated at 170'

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Log of Boring: B-7

PROJECT	130 William Street	PROJECT NUMBER	15C1077
LOCATION	130 William Street	ELEVATION & DATUM	EL +30+/- NAVD88
DRILLING AGENCY	Warren George Inc.	DATE STARTED: 4/11/2017	DATE COMPLETED: 4/11/2017
DRILLING EQUIPMENT	Track Mounted D50 Drill Rig	COMPLETION DEPTH (FT): 62.0	ROCK DEPTH (FT): N/A

SIZE AND TYPE OF BIT	3- 7/8"	SIZE AND TYPE CORE BARREL		NO.SAMPLES	DIST. 11	UNDIST N/A	CORE (FT) N/A		
CASING SIZE AND TYPE	4"	NX Double tube		WATER LEVEL	FIRST N/A	COMPL. N/A	24HR N/A		
CASING HAMMER WEIGHT	140 lbs	DROP	30"	SAMPLING	FOREMAN	Caesar Moreira			
SAMPLER	2"	DROP	30"	HAMMER TYPE	HELPER	Eddie Cardonia			
SAMPLER HAMMER WEIGHT	140 lbs	X Safety ☐ Donut ☐ ATH			INSPECTOR	Paras Khaitan			

DESCRIPTION	DEPTH (ft)	Samples Type No.	Recov. FT / %	Resist. BL/6" / RQD%	Lab. Results water cont. (%)	-200 (%)	STRATA	REMARKS
	0							( ) NYCBC [ ] USCS
	4							4" casing advanced to 5'
Fill: Sand, Silt, Gravel, Construction Debris (7)	5–7	S-1	5"	11 11 26 34				
	9						FILL	4" casing advanced to 10'
Fill: Sand, Silt, Concrete, Construction Debris (7)	10–12	S-2	2"	17 10 14 10/0"				Probably basement slab
	12–14							Hard drilling for 1' and then steady drilling Hard drilling
	15–17	S-3	NR	- - - -				Skipped
	18.5						18.5' ±	
	19–20						SAND	

DESCRIPTION	DEPTH (ft)	Samples Type No.	Recov. FT / %	Resist. BL/6" / RQD%	Lab. Results water cont. (%)	-200 (%)	STRATA	REMARKS
Clayey sand **(3b)[SC]**	21	S-4	14"	5 4 8 10				
	22							
	23							
	24							
Poorly Graded fine grained sand **(3b)[SP]**	25–26	S-5	12"	13 13 15 17				
	27							
	28							
	29							
Poorly Graded sand **(3b)[SP]**	30–31	S-6	7"	7 9 10 11			SAND	
	32							
	33							
	34							
Poorly Graded sand **(3b)[SP]**	35–36	S-7	13"	11 12 13 15				
	37							
	38							
	39							
Fine grained clayey sand **(3b)[SP-SC]**	40–41	S-8	12"	7 9 13 15				
	42							
	43						43.5' ±	
	44						CLAY	
	45							

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Log of Boring: B-7

DESCRIPTION	DEPTH (ft)	Samples Type No.	Recov. FT / %	Resist. BL/6" / RQD%	Lab. Results water cont. (%)	-200 (%)	STRATA	REMARKS
Silty Clay (4b)[CL-ML]	46	S-9	19"	7 8 15 18				
	47							
	48							
	49							
Silty Clay (4a)[CL-ML]	50–51	S-10	24"	11 13 21 29			CLAY	
	52							
	53							
	54							
Silty Clay (4a)[CL-ML]	55–56	S-11	23"	7 15 15 30				
	57							
	58						58.5' ±	
	59							
Silty Clay (4a)[CL-ML]	60–61	S-12	16"	52 70 50/4" -			TILL 62'±	Sample was predominantly clay There was a small fraction of Sand at the bottom of the sampler
	62							Boring completed at 14:00 04/11/2017
	63							
	64							
	65							
	66							
	67							
	68							
	69							
	70							

APPENDIX B – LABORATORY RESULTS

APPENDIX C – CAISSON TEST PROGRAM

RA Consultants LLC
Geotechnical Engineering

Walter J. Papp, Jr., Ph.D, P.E.
Senior Partner

Nidal M. AbiSaab, P.E.
Partner

Robert Alperstein, P.E.
Consultant

December 12, 2016

15C1077

Mark Green
Senior Vice President |Construction
460 Park Avenue
New York, NY 10022

Re: Summary Report of:
Drilled Test Caissons
90 Fulton Street a.k.a. 130 William Street
New York, NY 10038

Dear Mr. Green:

We are pleased to submit this summary report covering our observations of drilled test caissons to date at above referenced address.

Work at the site was performed from grade approximately equal to sidewalk elevation.

Posillico drilled caisson C1 to a depth of 110-ft below drilling grade with a roller bit and did not reach bedrock.

Posillico drilled caisson C2 to a depth of 160-ft below drilling grade with an under reamer. Posillico seated caisson C2 in competent rock and drilled 20-ft rock socket.

Caisson C3 remains to be drilled.

Refer to Appendix A for Location Plan.

Caisson Design

Three types of test caissons were designed for allowable axial loads of 1,200-kip, 1,400-kip and 1,700-kip capacity. Table 1 below summarizes the details of caisson design.

Table 1 Caisson Design Summary

	1,200-kips	1,400-kips	1,700-kips
Caisson	16" x 0.5"	16" x 0.5"	16" x 0.5"
Rock Socket	11' length 14" diameter	13' length 14" diameter	16' length 14" diameter
Rebar	3- #28 GR 75	4- #28 GR 75	4- #32 GR 75
Grout	7000-psi	6000-psi	6500-psi

Caisson Installation

Posillico drilled two of three test caissons between November 10 and December 11, 2016. Our Messrs. Donatas Zvirblis, Nidal AbiSaab, Carter Qin and Bachir Brimo observed the caisson drilling.

Refer to Appendix A for Location Plan and Summary Table of Caisson Installation.

Posillico attempted different drilling methods: Method 1 included 2-ft soil plug; and Method 2 utilized an under-reamer hammer.

- Method 1: Caisson #1 was drilled between November 10 and 16, 2016. Drilling started with internal flush method utilizing a roller bit. The drilling bit trailed the casing tip by approximately 2-ft (soil plug) in accordance with New York City Transit (NYCT) requirement until the casing could not be advanced at about 35-ft depth. Posillico adjusted the internal rods to maintain only 7-inch plug and advanced the casing from 35- to 37-ft below drilling grade in about two hours. Posillico readjusted the drilling methods such that the roller bit was leading the casing by 2-inches and continued drilling from 37- to 100-ft below drilling grade. On average, the casing was advancing at a rate of 6-inches/min. It took over 30 minutes to advance the casing the last 2-ft due to encountered cobble layer. Posillico introduced Down-The-Hole-Hammer (DTHH) and advanced the casing from 100- to 108-ft below drilling grade. It took about 2 hours to advance the casing 8-ft in the cobble layer and over an hour for the last 2-ft stretch. The casing jammed at 108-ft depth and could not be advances further.

  Refer to caisson log in Appendix B for details.

- Method 2: Caisson #2 (1,200-kips) was drilled with an under reamer to attempt seating the casing into rock between November 26 and December 11, 2016. We understand that the contractor drilled the first 130-ft of caisson in one day without our observation. Posillico encountered an 8-ft boulder at a depth of 130-ft below drilling grade and mistook it for competent bedrock. Thus, Posillico changed the inner rods from an under-reamer to DTHH and back to under-reamer after bypassing the boulder. Posillico advanced the casing rom 130- to 160-ft and seated the casing in competent rock at about 160-ft below drilling grade. The rate of drilling with an under reamer was approximately 6-inches/min. The driving shoe got unscrewed at 160-ft depth limiting the size of DTHH that can be used to drill the rock socket. Posillico re-introduced the DTHH and drilled a 12-inch diameter rock socket consisting of 20-ft in about 30-minutes. with the RA Consultants LLC verified the quality of the rock using a video camera.

Refer to caisson log in Appendix B for details.

- Caisson #3 is not drilled yet.

Construction Variances

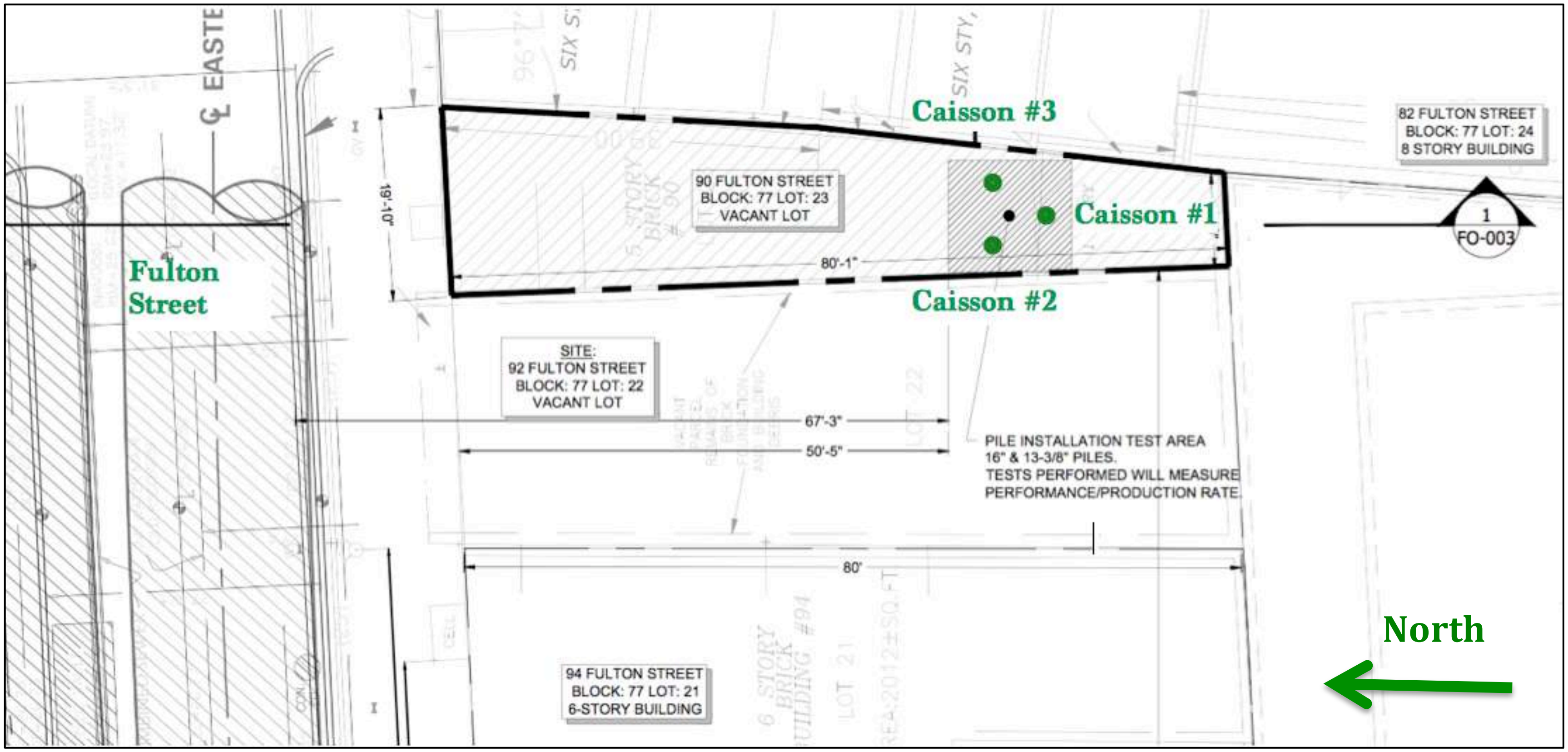
Posillico used a 12-inch diameter DTHH for Caisson #2 rock socket instead of 14-inch. As such, the maximum axial capacity of C2 is limited to 1200-kips. In addition, we requested that the rock socket length beincreased from 11-ft to 17-ft and the concrete strength increased from 7-ksi to 12-ksi to meet code requirements.

Posillico drilled a 20-ft rock socket. Caisson C2 should be sounded prior to tremie grouting.

Very truly yours,

Nidal M. AbiSaab

APPENDIX A



Pile Location Plan

Caissons

	Casing Length [ft]	Rock Socket Length [ft]	Top of Caisson El. (NAVD88)	Date Completed	Grout Results 7-Day [psi]
Caisson #1	110	Abandoned	+29	Abandoned	Abandoned
Caisson #2	162	20	+29	N/A	N/A
Caisson #3	NOT DRILLED YET				

RA CONSULTANTS LLC

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APPENDIX B

RA CONSULTANTS LLC
Geotechnical Engineering Est. 1991

CAISSON INSTALLATION RECORD

FILE NO. *15C1077*
DATE *November 10, 2016*

PROJECT: *130 William Street*
CONTRACTOR: *Posillico*
RES. ENGINEER: *D. Zvirblis / N. AbiSaab*
EQUIPMENT: *Chomacchio MC 24*

CAISSON NO. *Caisson #1*
CAISSON DESIGN LOADS:
TENSION *600- kips*
COMPRESSION *1,400- kips*
LATERAL *40- kips*

INSTALLATION DATE/TIME

	STARTED	FINISHED
CASING:	*2016/11/10 1300*	*N/A*
ROCK SOCKET:	*N/A*	*N/A*
VIDEO INSPECTION:	*N/A*	*N/A*
GROUT:	*N/A*	*N/A*

PILE DATA

CASING:	WALL THICKNESS	*0.5*	(IN)
	LENGTH	*110*	(FT)
	OUTSIDE DIA.	*16*	(IN)
	INSIDE DIA.	*15*	(IN)
ROCK SOCKET:	REQUIRED	*13*	(FT)
	CONSTRUCTED	*N/A*	(FT)
	DIAMETER	*15*	(IN)

QUALITY CONTROLS

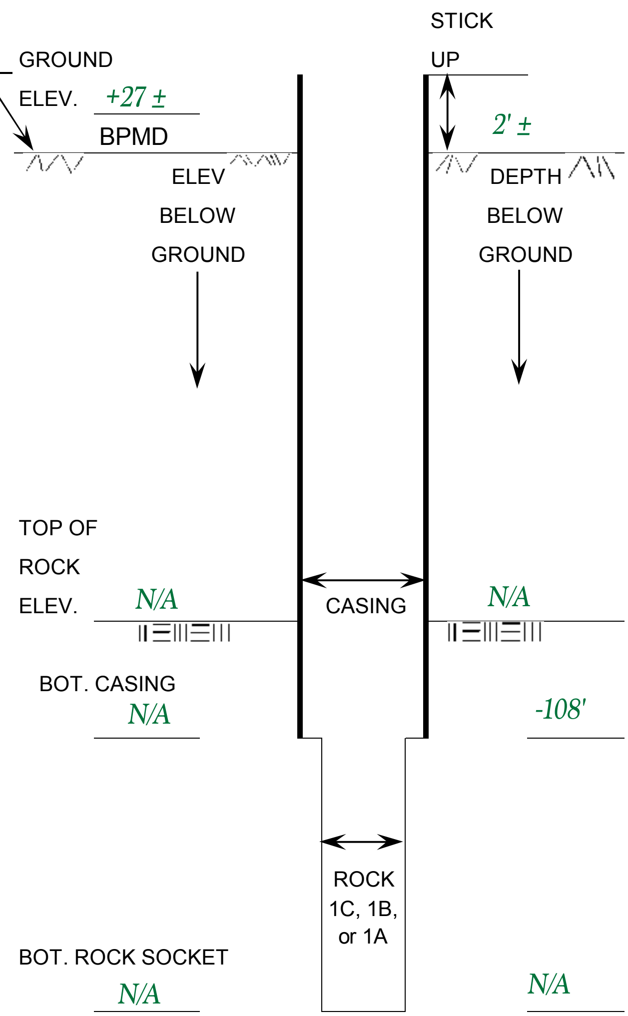
REINFORCING BAR	*4- #28*	
REINFORCING GRADE	*75*	(KSI)
REINFORCING BAR LENGTH	*N/A*	(FT)
DESIGN GROUT STRENGTH	*6,000*	(PSI)

VIDEO INSPECTION

ROCK DESCRIPTION *N/A*
COMMENTS: *N/A*

GROUT POUR DATA

TREMIE PIPE DEPTH *N/A* (FT)



SECTION (NOT TO SCALE)

REMARKS: *Caisson was abandoned.*

☐ Caisson complies with design documents
☒ Caisson Rejected

RA CONSULTANTS LLC
Geotechnical Engineering Est. 1991

CAISSON INSTALLATION RECORD

FILE NO. 15C1077
DATE November 26, 2016

PROJECT: 130 William Street
CONTRACTOR: Posillico
RES. ENGINEER: D. Zvirblis / N. AbiSaab
EQUIPMENT: Chomacchio MC 24

CAISSON NO. Caisson #2
CAISSON DESIGN LOADS:
TENSION: 600- kips
COMPRESSION: 1,200- kips
LATERAL: 40- kips

INSTALLATION DATE/TIME

	STARTED	FINISHED
CASING:	2016/11/26	2016/12/10 1225
ROCK SOCKET:	2016/12/11 0924	2016/12/11 0954
VIDEO INSPECTION:	2016/12/11 1200	2016/12/11 1215
GROUT:	N/A	N/A

PILE DATA

CASING:	WALL THICKNESS	0.5	(IN)
	LENGTH	162	(FT)
	OUTSIDE DIA.	16	(IN)
	INSIDE DIA.	15	(IN)
ROCK SOCKET:	REQUIRED	17	(FT)
	CONSTRUCTED	20	(FT)
	DIAMETER	12	(IN)

QUALITY CONTROLS

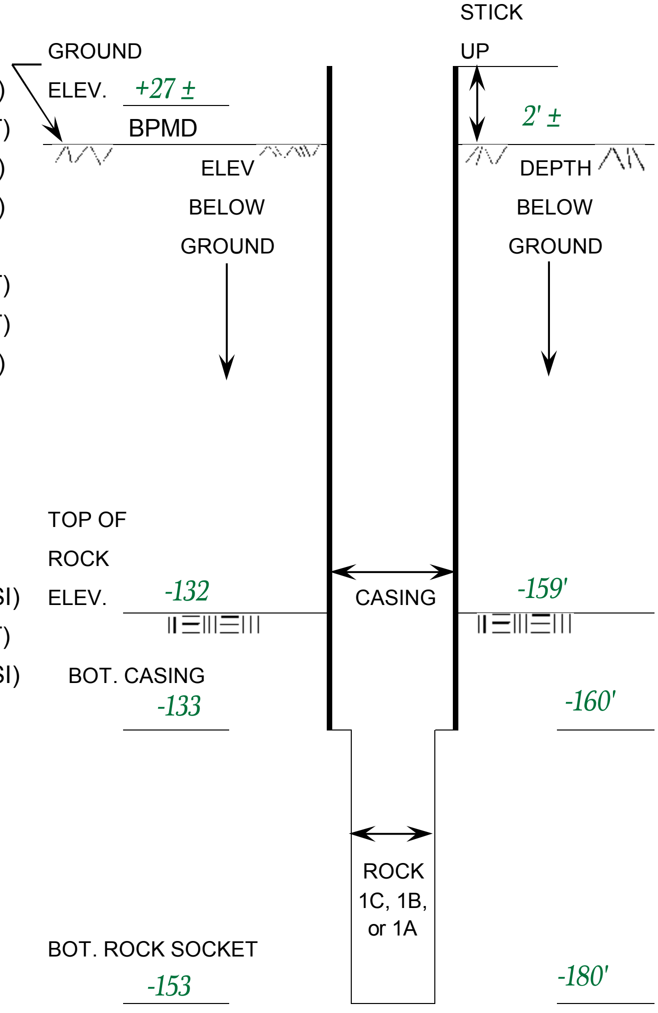
REINFORCING BAR	3- #28	
REINFORCING GRADE	75	(KSI)
REINFORCING BAR LENGTH	N/A	(FT)
DESIGN GROUT STRENGTH	13,000	(PSI)

VIDEO INSPECTION

ROCK DESCRIPTION: Mica Schist
COMMENTS: Class 1b or better

GROUT POUR DATA

TREMIE PIPE DEPTH: N/A (FT)



SECTION
(NOT TO SCALE)

REMARKS: Rock socket deviated from the design. Caisson was designed to have a 11-ft socket (14-in diameter) with 7,000-psi grout. For the design to work with a 12-in diameter socket, the socket length must be increased to 17-ft and grout to 13,000-psi. (Drilled with under reamer.)

☐ Caisson complies with design documents ☐ Caisson Rejected